CATF WHITE PAPER:
CORN ETHANOL GHG EMISSIONS UNDER VARIOUS RFS IMPLEMENTATION SCENARIOS

April 2013

In 2011, the Clean Air Task Force reviewed the US Environmental Protection Agency's lifecycle greenhouse gas emissions analysis of corn ethanol and found that the Agency severely underestimated the fuel's net GHG emissions. If EPA had analyzed corn ethanol produced during 2010-2015 (when production capacity was still ramping up) rather than corn ethanol produced in 2022 (seven years after EPA expects production to level off), the Agency would have found that corn ethanol's net emissions over 30 years are approximately *28% higher* than the emissions that would result from the use of gasoline over that same period.

CATF's 2011 analysis assumed that Renewable Fuel Standard-driven production of corn ethanol would plateau in 2015 at 15 billion gallons per year. That may not be case. Cellulosic biofuel production is projected to fall far short of the annual targets established in the Energy Independence and Security Act of 2007. For example, the Organization for Economic Cooperation and Development forecasts that a maximum of 4.7 billion tons of RFS-compliant cellulosic biofuel will be available in 2022; EISA targets 16 billions gallons. EPA can address this "cellulosic void" by reducing the overarching annual volume requirements for advanced biofuels and total renewable fuels, or it can allow non-cellulosic advanced biofuels like sugarcane ethanol and biomass-based diesel to make up for the shortfall.[1] If EPA chooses the latter approach, the OECD and others predict that the United States will have to significantly increase the amount of Brazilian sugarcane ethanol that it imports. OECD expects that Brazil, in turn, would likely import US corn ethanol in order to meet its own ethanol blending requirement. The result? A new spike in US corn ethanol production and another increase in damaging GHG emissions, much of it from direct and indirect land use changes.

This white paper revisits CATF's 2011 emissions analysis and then calculates the climate impact that would occur if EPA allows sugarcane ethanol to backfill the cellulosic void and, as a result, unmet ethanol demand in Brazil causes a significant increase in US corn ethanol production.

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[1] Theoretically, EPA might allow conventional biofuels like corn ethanol to fill the cellulosic void. EPA has so far rejected this approach. In its proposed 2013 RFS volume adjustment rule, the Agency properly stated that "we do not believe it would be appropriate to lower the advanced biofuel standard but not the total renewable standard, as doing so would allow conventional biofuels to effectively be used to meet the standards that Congress specifically set for advanced biofuels." 78 Fed. Reg. 9282, 9295/2 (Feburary 7, 2013). In any event, this white paper also analyzes the additional GHG emissions that would result if EPA allowed conventional biofuels to backfill the cellulosic void.

I. GHG Emissions from Corn Ethanol Assuming a 15-Billion Gallon Limit

A. Background: EPA's 2010 Lifecycle Analysis for Corn Ethanol

For the 2010 RFS implementation rule, EPA analyzed the lifecycle GHG emissions associated with corn ethanol based on the expected performance – including technological innovations and efficiency and yield improvements – of the corn ethanol industry in the year 2022; in other words, EPA used 2022 as the starting point for its assessment of corn ethanol's lifecycle GHG emissions. The Agency then analyzed the ethanol's lifecycle GHG emissions over the subsequent 30 years (from 2022 to 2051) and compared them to the GHG emissions that would result from the production and use of gasoline over that same period. Using this approach, EPA concluded that corn ethanol would have 21% less GHG emissions than the baseline gasoline on a lifecycle basis.

EPA achieved this result by running its lifecycle GHG analysis from 2022-2051, rather than when the fuels are actually produced and consumed. The Agency's decision created the following distortions:

- EPA assumed that lifecycle international indirect land use change (ILUC) emissions in 2022 are 60% lower than ILUC emissions in 2012.[2] The agency's analytic approach largely obscures the effect of ILUC.
- EPA assumed that ethanol production emissions in 2022 are 13% lower than present production emissions.[3]

EPA projects that, as a result of EISA, the annual production and consumption of corn ethanol in the United States will increase by 4.5 billion gallons during 2010 to 2015 (rising from 10.5 billion gallons in 2009 to 15 billion gallons in 2015, which is the full increment available to conventional corn ethanol under EISA).[4] EPA should have conducted the 30-year assessment of lifecycle GHG emissions for corn ethanol produced during the ramp-up period (2010-2015) by analyzing the net GHG emissions from incremental corn ethanol beginning in 2010 and ending in 2044 (2044 being the end of the 30-year lifecycle for new ethanol produced in 2015). Instead, as mentioned above, EPA began its analysis well after the point at which the industry is expected to stop adding new corn ethanol production capacity.

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[2] EPA Spreadsheet, Docket ID No. EPA-HQ-OAR-2005-0161-3173.5(1) (http://www.regulations.gov/search/Regs/home.html#docketDetail?R=EPA-HQ-OAR-2005-0161 ("Spreadsheet EPA-HQ-OAR-2005-0161.3173.5(1)")

[3] *Id*.

[4] See Table 1 in Section II below.

B. CATF Reanalysis of Corn Ethanol Emissions

Using 2022 as a starting point for its analysis, EPA concludes that corn ethanol will meet the 20 percent GHG reduction threshold in EISA. But if the lifecycle GHG emissions analysis starts in 2010 instead, corn ethanol's net emissions over 30 years are approximately *28% higher* than the emissions that would result from the use of gasoline over that same period. Therefore, if EPA had conducted the lifecycle GHG analyses in accordance with its own real-world projections regarding corn ethanol production, it would have concluded that corn ethanol produced by newly built facilities in 2010 to 2015 does not meet EISA's 20% reduction requirement.

CATF's analysis is based exclusively on the assumptions that EPA itself used in analyzing the GHG implications of corn ethanol in promulgating the RFS2 regulations.[5] The only parameter that was changed was the 30-year period being analyzed. Instead of analyzing the net emissions from corn ethanol over 30 years starting in 2022 (as EPA did), CATF relied upon EPA's assumption that no net increases in corn ethanol capacity will occur after 2015 – *i.e.*, the final 4.5 billion gallon increment of corn ethanol production allowed under EISA will come online between 2010 and 2015. Therefore, CATF analyzed the lifecycle GHG emissions from that additional corn ethanol capacity through 2044 (30 years after industry finishes adding new corn ethanol capacity pursuant to the requirements of EISA).

The analysis set forth below compares corn ethanol lifecycle GHG emissions over 30 years as compared to those arising from the equivalent amount of gasoline and demonstrates that the emissions from corn ethanol are approximately 28% higher. Again, all of the assumptions used to develop this analysis are EPA's; the only difference is the time period being analyzed.

According to EPA, new corn ethanol production will grow by a total of 4.5 billion gallons between 2010 and 2015.

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[5] These assumptions are found in the following materials: EPA, "Regulation of Fuel and Fuel Additives: Changes to Renewable Fuel Standard Program" at 75 Fed. Reg. 14,670 (Mar. 26, 2010); EPA, "The Renewable Fuel Standard 2 Regulatory Impact Analysis" (February 2010) (Document ID No. EPA-HQ-OAR-2009-0472-1132) (http://www.regulations.gov/search/Regs/home.html#home); and EPA, Docket ID No. EPA-HQ-OAR-2005-0161-3173.5(1) (http://www.regulations.gov/search/Regs/home.html#docketDetail?R=EPA-HQ-OAR-2005-0161 ("Spreadsheet EPA-HQ-OAR-2005-0161.3173.5(1)").

Table 1: Additions of new corn ethanol[6]

	Total Available Corn Ethanol Volume (billion gallons)	Incremental Increase (billion gallons)	Cumulative Increase (billion gallons)
2009	10.5		
2010	12	1.5	1.5
2011	12.6	.60	2.1
2012	13.2	.60	2.7
2013	13.8	.60	3.3
2014	14.4	.60	3.9
2015	15	.60	4.5

EPA corn ethanol emission rates assume that ethanol refineries are natural gas fired, and that 63 percent of the plants produce dry distillers grains and 37 percent produce wet distiller grains. Emission data below are derived from the EPA spreadsheet used to calculate corn ethanol lifecycle emissions.[7]

Table 2 below summarizes the emission assumptions used in this analysis (which mirror the assumptions used by EPA in its analysis). First year emissions are highest because of the initial indirect land use change driven by increased demand for ethanol in the US. In years 2 to 19 lower ILUC emissions are assumed, and in years 20 to 29 ILUC emissions are lower still.[8] The composite emission rates in the third column reflect the weighting between the processes produce dry distillers grains and those that produce wet distillers grains, as described above.

Table 2: Emission rates used in this analysis[9]

	Annual Emission rate (g CO_2e per mmBtu)		
	Dry Distillers Grains	Wet Distillers Grains	Composite
First year	1,721,152	1,709,111	1,716,697
Years 2-19	86,574	74,533	82,119
Years 20-29	56,276	44,236	51,821
Gasoline			98,204

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6 *See* Table I.A.1-1 in EPA's RFS2 Regulations,75 Fed. Reg. at 14,674.
7 Spreadsheet EPA-HQ-OAR-2005-0161-3173.5(1).
8 Spreadsheet EPA-HQ-OAR-2005-0161.3173.5(1).
9 Calculations derived from Spreadsheet EPA-HQ-OAR-2005-0161.3173.5(1))

Total emissions are heavily front-loaded because for each year new that ethanol production is added, there is an initial large pulse of ILUC emissions. Table 3 below presents corn ethanol emissions for 2010-2016. 2016 is the first year that new ethanol is not added, which accounts for the substantial drop in emissions. Figure 1 below presents these same data graphically, alongside comparable emissions from an energy equivalent amount of gasoline. The volumes on which this figure is based are presented in Table 1, above.

As Table 3 and Figure 1 demonstrate, by 2015, corn ethanol will have added 745 million tons of carbon dioxide equivalent ("CO_2e") to the atmosphere in contrast to 149 million tons arising from an energy equivalent amount of gasoline.

Table 3: Emissions from new corn ethanol and an energy equivalent amount of gasoline 2010-2016 (tons CO_2e)

	Gasoline	Corn Ethanol
2010	12,432,626	217,333,714
2011	17,405,677	97,329,751
2012	22,378,728	101,488,257
2013	27,351,778	105,646,763
2014	32,324,829	109,805,269
2015	37,297,879	113,963,775
2016	37,297,879	31,188,796
7-Year Cumulative	149 MT	745MT

Figure 1[10]

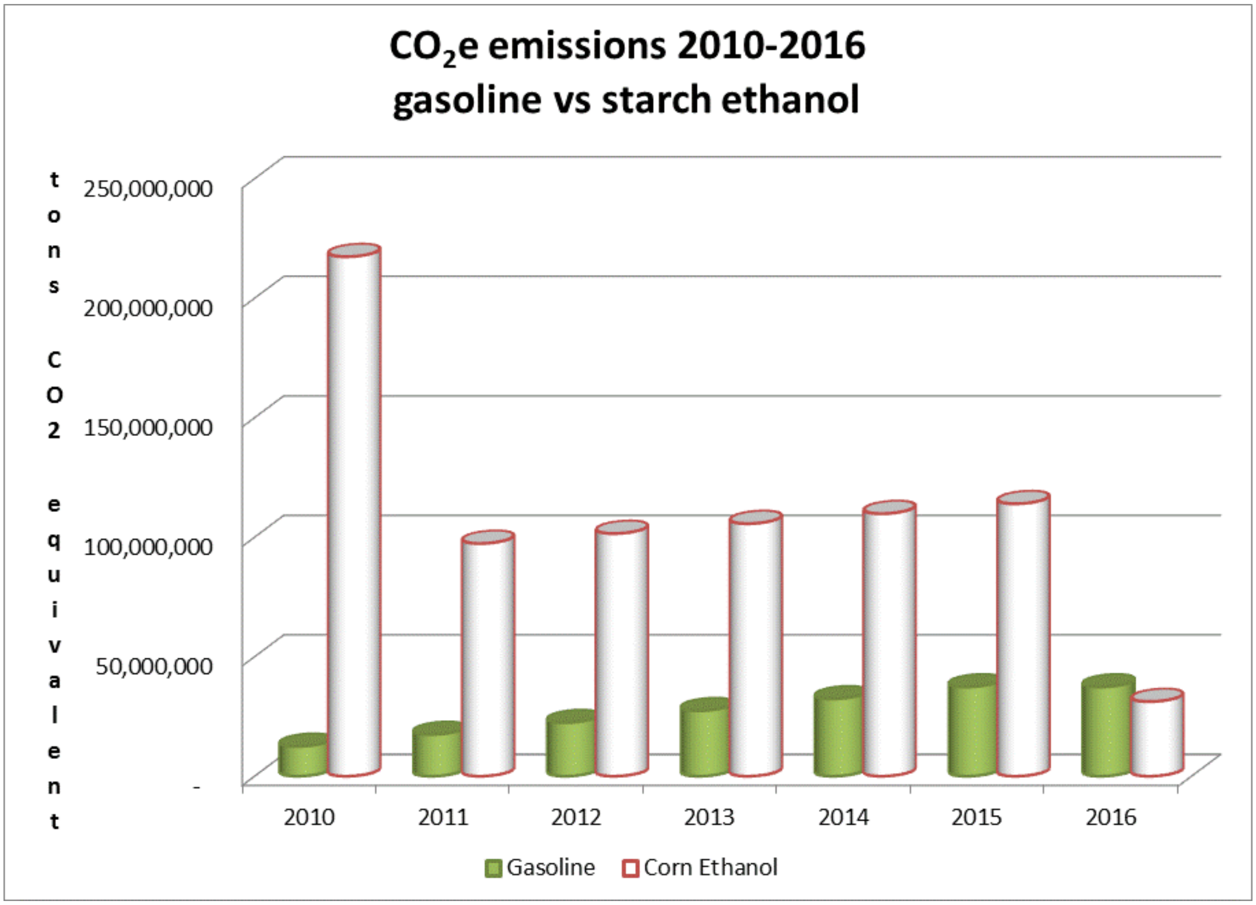
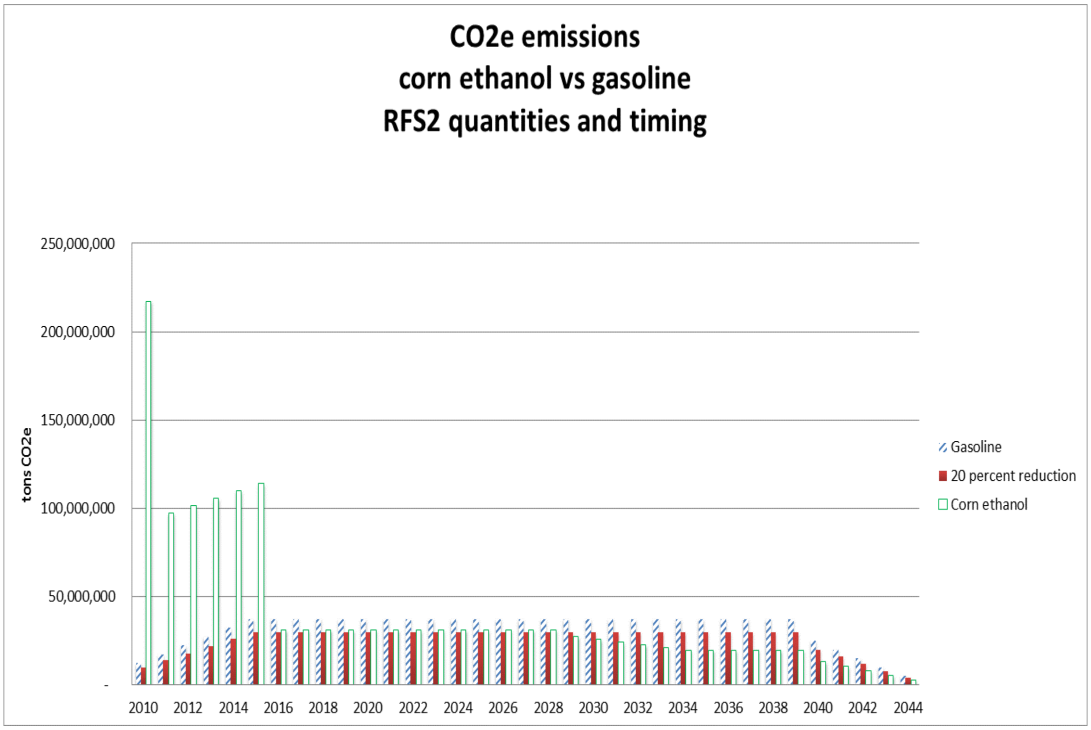


Figure 2 below presents year-by-year GHG emissions for corn ethanol and baseline gasoline, from 2010 through 2044. A 20 percent reduction below the baseline gasoline emissions level is also shown.

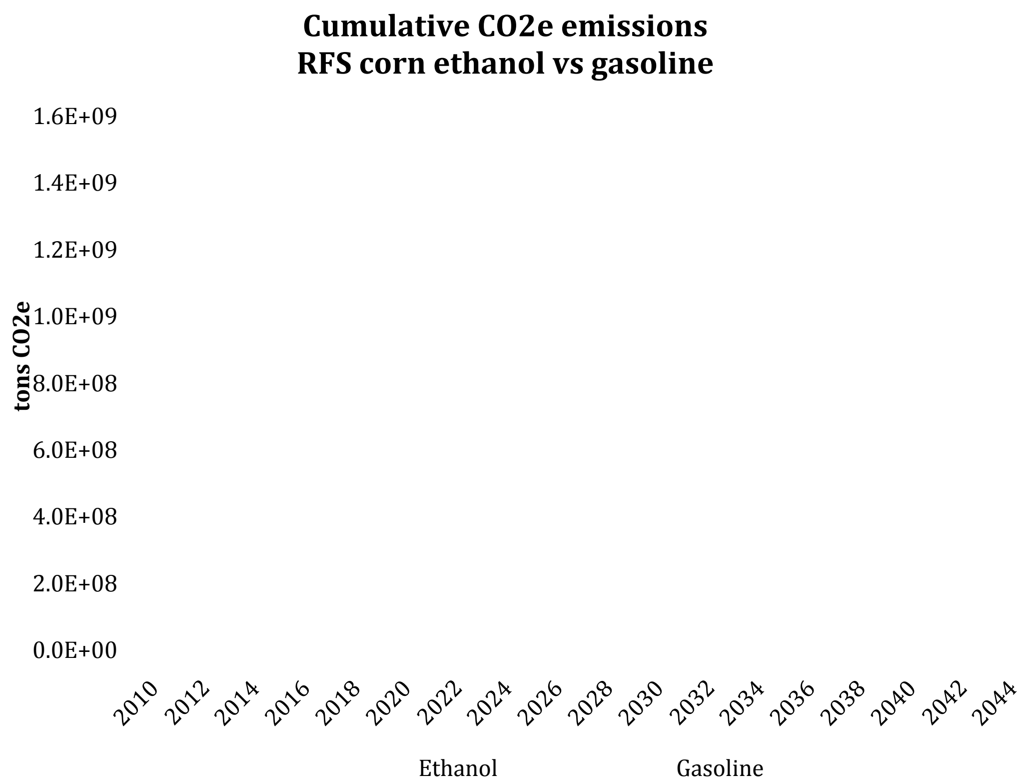
[10] Calculations derived from Spreadsheet EPA-HQ-OAR-2005-0161.3173.5(1)

Figure 2



And finally, Figure 3 (below) presents the cumulative emissions from the period 2010-2044 from corn ethanol and gasoline. This analysis is carried though 2044 to capture a full 30 years of emissions from each year-class of new ethanol (i.e., the 30-year lifecycle for ethanol added ends in 2044). In 2044, cumulative GHG emissions from corn ethanol equal about 1.4 billion tons; the emissions from an energy equivalent amount of gasoline equal 1.1 billion tons. The cumulative emissions from the production and use of gasoline do not exceed those from corn ethanol until 2054. In other words, when the lifecycle analysis encompasses the years when corn ethanol production and consumption actually increases pursuant to EISA, it shows that the 30-year lifecycle GHG emissions from corn ethanol are approximately 28% higher than those from gasoline.

Figure 3



II. New GHG Emissions from Corn Ethanol if Advanced and/or Conventional Biofuels Are Allowed to Backfill the Cellulosic Void

The Clean Air Act, as amended by EISA 2007, establishes annual cellulosic biofuel consumption targets for 2010-2022, but instructs EPA to adjust actual volume requirements for cellulosic fuels so that they match "the projected volume available during the calendar year."[11] So far, EPA has had to reduce the volume requirements each year, and industry analysts uniformly expect that cellulosic biofuel production will continue to fall short of EISA targets through 2022. EISA also authorizes EPA to make corresponding reductions to the overarching advanced biofuel and total renewable fuel volume requirements when it reduces the cellulosic requirement, but so far EPA has declined to use that authority and has instead allowed advanced biofuels like sugarcane ethanol and biomass-based diesel to make up for the shortfall in cellulosic production.

[11] CAA §211(o)(7)(D).

In *Agricultural Outlook 2012-2021*, a joint publication of the Organization for Economic Cooperation and Development and the UN Food and Agricultural Organization, the agencies write that "until now" EPA's adjustments to the annual cellulosic volume requirement "did not have important impacts on agricultural and biofuel markets because the level of the cellulosic shortfall was small." Going forward, that is no longer the case. "[B]y 2021," the agencies write, "the amounts will be much larger and EPA's decision will likely have impacts on agricultural markets."[12] Accordingly, Agricultural Outlook 2012-2021 "identifies the effect of three alternative implementation options" available to EPA.

- Option 1 assumes that EPA lowers the total and advanced biofuel mandates;
- Option 2 assumes that EPA maintains the mandates, and that the shortfall in US production is made up with imports of Brazilian sugarcane ethanol; US corn ethanol production rises to satisfy unmet demand in Brazil.
- Option3 assumes that EPA maintains the total mandate but lowers the advanced mandate, allowing the cellulosic void to be filled by additional US corn ethanol.

As far as the GHG emissions associated with corn ethanol are concerned, OECD's Option 1 is not materially different from situation CATF analyzed in 2011 (described above). US corn ethanol production is expected to level off at around 15 billion gallons per year.

Under both Options 2 and 3, however, US corn ethanol production would rise above the 15 billion "soft ceiling" created by EISA. In OECD's Option 2, additional corn ethanol is produced to replace the Brazilian sugarcane ethanol exported to the United States (i.e., the United States would increase the amount of Brazilian sugarcane ethanol it imports because sugarcane ethanol qualifies as an "advanced biofuel" under the RFS2; meanwhile, Brazilian consumers would import relatively cheaper corn ethanol from United States to meet Brazil's ethanol blending requirements). In OECD Option 3, conventional biofuels are allowed to directly fill the cellulosic void, so production of US corn ethanol increases.

The following table summarizes assumptions about US corn ethanol production for three OECD scenarios for 2021 relative to the assumptions we use in our RFS2 analysis:

Table 3: Assumptions about US corn ethanol production (RFS2 Baseline, OECD Scenarios)

Scenario	Total production (billion gallons)	Incremental production (relative to 10.5 billion gallon base) (billion gallons)	New annual increment 2016-2021 (additions over 6 years) (billion gallons)
RFS2	15	4.5	--
OECD-FAO Option 1	14.85	4.35	-.025
OECD-FAO Option 2	16.65	6.15	.275

[12] OECD-FAO, *Agricultural Outlook 2012-2021* 96 (2012) (http://www.oecd.org/site/oecd-faoagriculturaloutlook/)

OECD-FAO Option 3	21	10.5	1

The OECD-FAO report provides projections for only a single year, 2021. For this analysis, the addition of new corn ethanol is evenly spread out over six years, from 2016-2021.

The following graph (Figure 4) presents total annual CO_2 emissions from Options 2 and 3, along with CATF 2011 projections for the RFS2 and gasoline.

Figure 4: Annual Corn Ethanol CO_2 Emissions (RFS2 Baseline, OECD Options, Gasoline)

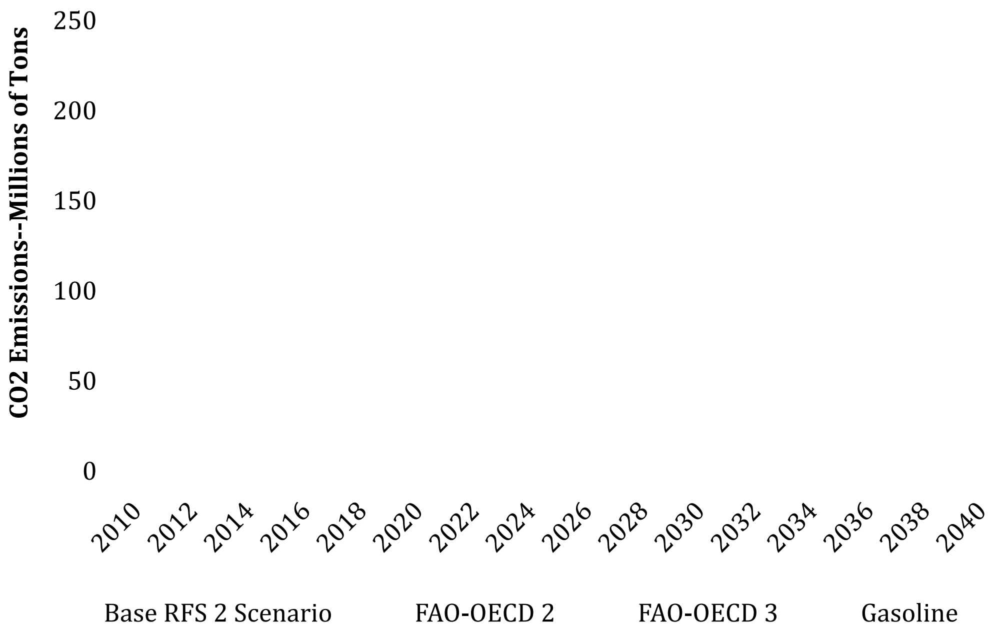


Table 4 below summarizes the CO_2 emissions consequence for each scenario and for projected gasoline consumption for the period 2010-2040:

Table 4

Scenario	Cumulative CO_2 emissions 2010-2040 (millions of tons)	Incremental Cumulative CO_2 emissions over the RFS2 baseline (millions of tons)
RFS2	1,400	
Option 2	1,880	477
Option 3	3,120	1,680
Gasoline	1,069	(-331)

Key points:

- Option 2 results in a 34% increase in CO_2 emissions relative to the RFS2 baseline;
- Option 3 more than doubles emissions, resulting in a 117% increase in CO_2 emissions relative to the RFS2 baseline.

As in CATF's 2011 analysis of RFS2 baseline (which examined emissions from the 4.5 billion gallon increase in corn ethanol production during 2010-2015), lifecycle emissions from the corn ethanol used to comply with the RFS would be higher than the emissions that would result from an energy equivalent volume of gasoline.

The following two figures are drawn from CATF's 2011 analysis. Figure 5 shows annual emissions for each of three trajectories: corn ethanol used to comply with RFS2 baseline volume requirement (referred to as "EtOH modeled"), an energy equivalent volume of gasoline, and a 20% reduction in GHG emissions from gasoline (which EISA required of non-grandfathered conventional biofuels).

Figure 5: Annual Corn Ethanol CO_2 Emissions

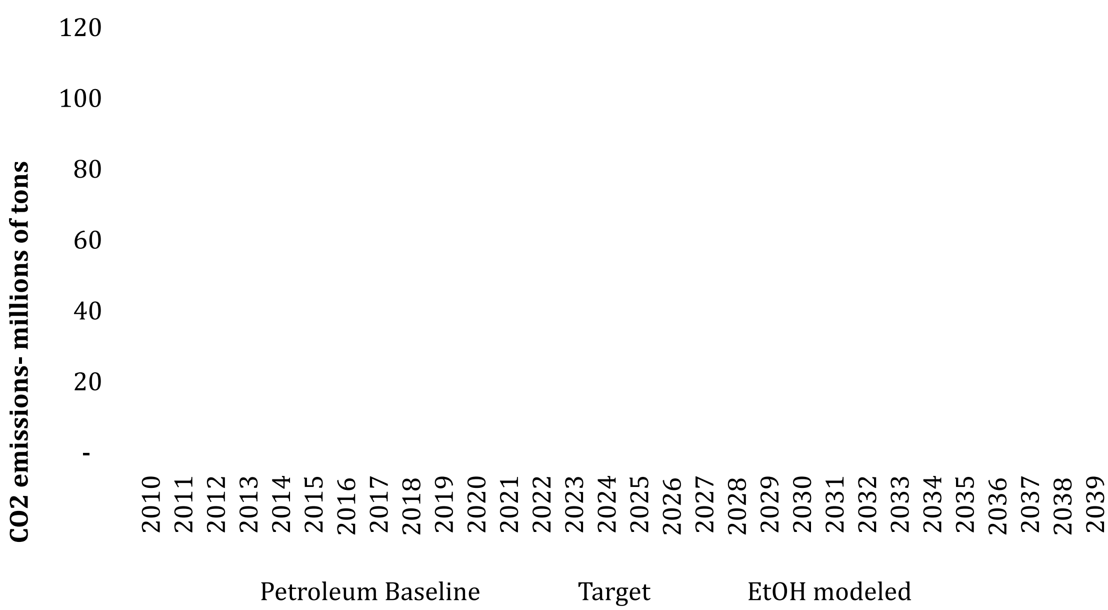
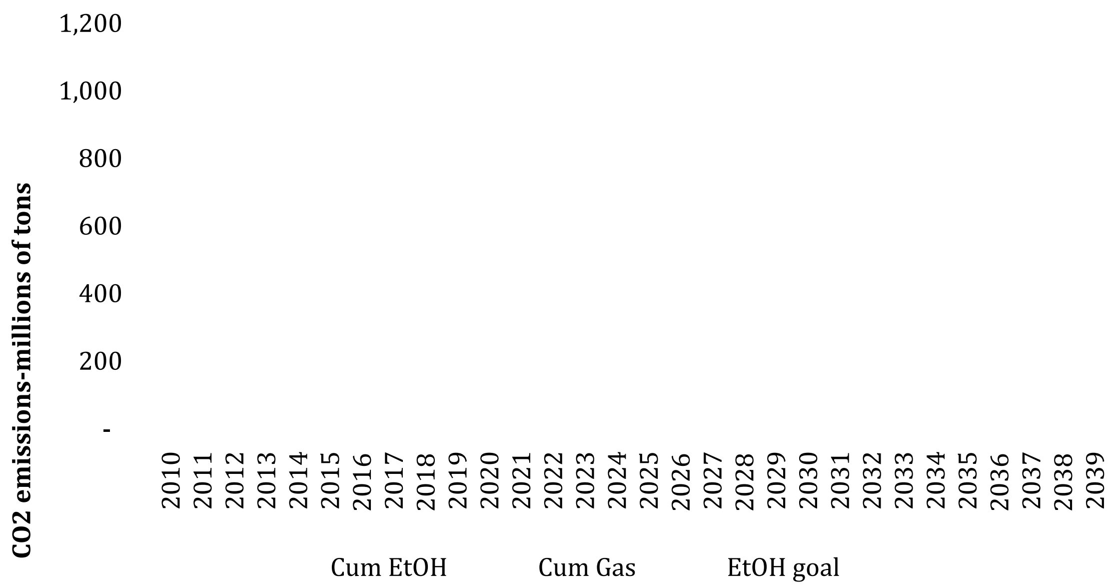


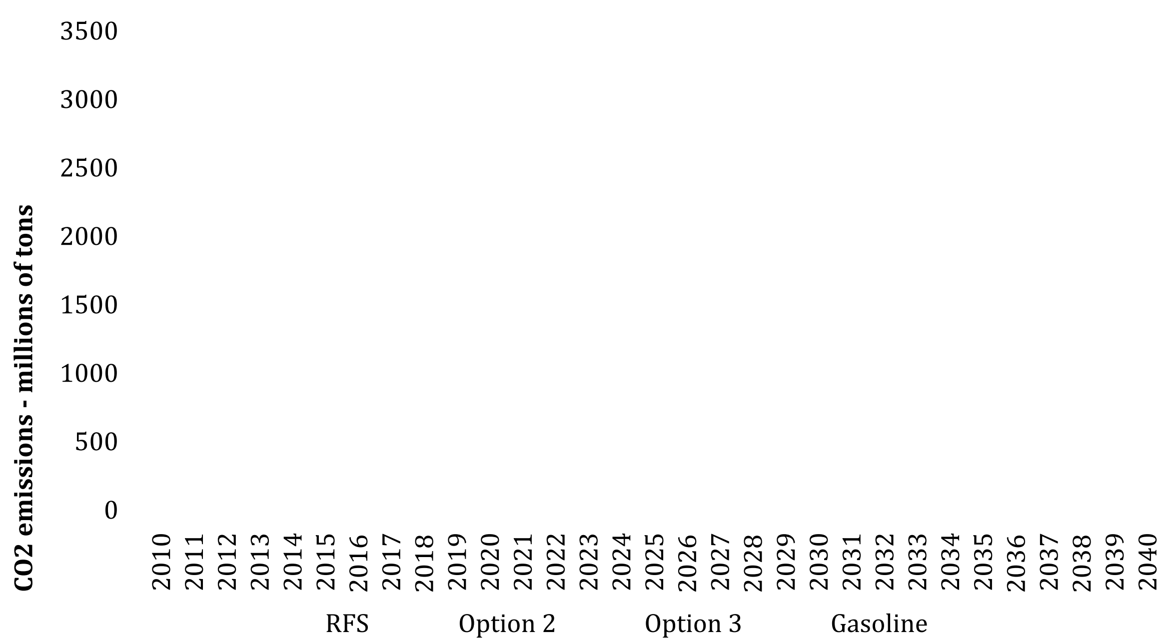
Figure 6 shows the cumulative emissions for the same three.

Figure 6



The following graph, Figure 7, presents cumulative emissions for RFS2 baseline, OECD Options 2 and 3, and gasoline:

Figure 7



It should be clear that both OECD Options 2 and 3 are significantly worse from a climate perspective than the RFS as originally modeled. Indeed, for the period considered, all three biofuel scenarios have significantly higher emissions than gasoline.

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Figure 115. EISA2007 RFS credits earned in selected years, 2010-2035 (billion credits)

	Other Ethanol	Imports	Corn-Based Ethanol	Biodiesel	Cellulosic Ethanol	Biomass-to-Liquids	Total
2010	0.14	0.01	12.63	0.34	0.00	0.08	**13.22**
2011	0.18	0.17	13.78	1.25	0.00	0.12	**15.50**
2012	0.22	0.60	12.30	1.42	0.00	0.12	**14.65**
2013	0.22	1.44	12.61	1.39	0.05	0.13	**15.85**
2014	0.22	1.36	12.63	1.61	0.13	0.49	**16.44**
2015	0.23	1.30	12.67	2.06	0.17	0.58	**17.02**
2016	0.24	1.21	12.85	2.02	0.18	0.76	**17.27**
2017	0.24	1.14	12.98	2.08	0.18	0.77	**17.39**
2018	0.25	1.38	13.41	2.60	0.18	1.01	**18.84**
2019	0.25	1.33	13.47	2.58	0.25	1.21	**19.10**
2020	0.27	1.33	13.99	2.67	0.34	1.29	**19.89**
2021	0.28	1.55	14.62	2.74	0.46	1.54	**21.18**
2022	0.28	1.66	14.99	2.72	0.62	1.84	**22.12**
2023	0.29	1.74	14.88	2.76	0.84	2.08	**22.58**
2024	0.29	1.64	14.94	2.80	1.12	2.52	**23.30**
2025	0.29	1.72	14.81	2.86	1.48	3.03	**24.19**
2026	0.29	1.74	14.79	2.86	1.94	3.50	**25.12**
2027	0.29	1.75	14.78	2.87	2.49	4.19	**26.37**
2028	0.31	1.79	14.73	2.88	3.14	4.96	**27.80**
2029	0.31	1.76	14.77	2.89	3.87	5.68	**29.28**
2030	0.31	1.77	14.69	2.98	4.66	6.60	**31.00**
2031	0.32	1.76	14.70	3.09	5.47	7.57	**32.90**
2032	0.34	1.93	15.00	3.06	6.25	8.47	**35.05**
2033	0.34	1.89	15.00	2.92	6.99	9.16	**36.29**
2034	0.34	2.01	15.00	3.12	6.82	9.76	**37.05**
2035	0.34	2.16	15.00	3.10	7.16	10.37	**38.12**

OECD-FAO Agricultural Outlook 2012-2021

Chapter 3

Biofuels

Biofuels were added to the *Outlook* in 2008 as an emerging sector that would increasingly affect agricultural markets. This has certainly turned out to be the case with currently some 65% of EU vegetable oil, 50% of Brazilian sugarcane, and about 40% of US corn production being used as feedstock for biofuel production. Today, it would be inconceivable to prepare an agricultural projection without taking biofuels into account. The biofuels chapter has been expanded this year to provide a more detailed description of the very complex US biofuel policy and an analysis of the policy options facing the US Environmental Protection Agency over the medium term.

Market situation

World ethanol prices (Figure 3.1) increased strongly in 2011 well above the levels of the 2007/08 highs in a context of strong energy prices, although the commodity prices of ethanol feedstock, mainly sugar and maize, decreased from their peaks in 2010. The two major factors behind this increase were the stagnating ethanol supply in the United States and a drop in Brazilian sugarcane production. Additionally, ethanol production was also significantly below expectations in developing countries having implemented mandates or ambitious targets for the use of biofuels.

World biodiesel prices (Figure 3.1) also increased in 2011. Contrary to the global ethanol market, production did not stagnate in 2011; the four major biodiesel producing regions (the European Union, the United States, Argentina, and Brazil) increased their supply compared to 2010. This increase was moderated by a decreasing biodiesel production in Malaysia (from about 1 Bnl in 2010 to almost nothing in 2011).

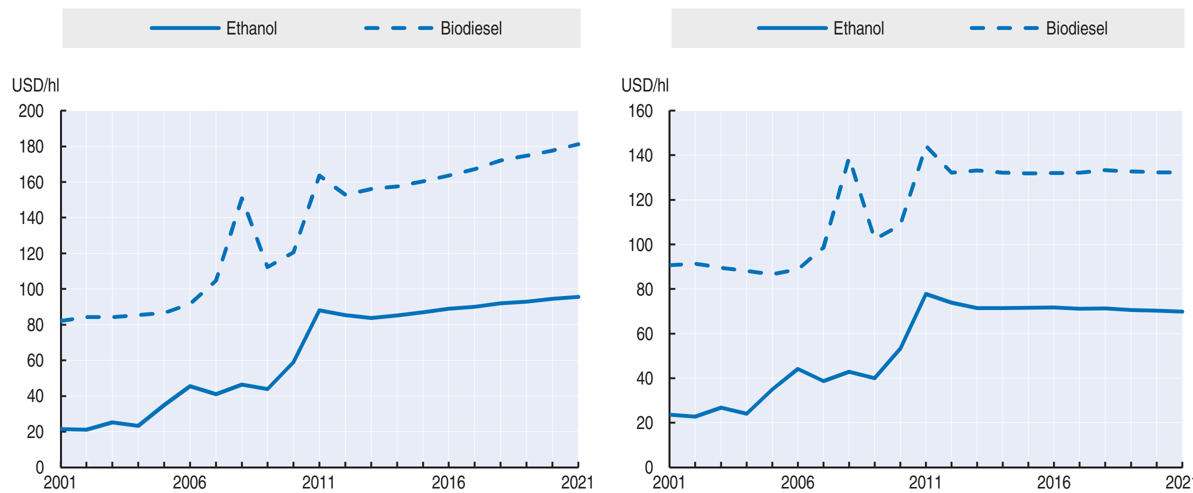
Projection highlights

- Over the projection period, ethanol and biodiesel prices are expected to remain supported by high crude oil prices and by the implementation and continuation of policies promoting biofuel use. Changes in the implementation of biofuel policies can strongly affect biofuel markets.
- Global ethanol and biodiesel production are projected to expand but at a slower pace than in the past. Ethanol markets are dominated by the United States, Brazil and to a smaller extent the European Union. Biodiesel markets will likely remain dominated by the European Union and followed by the United States, Argentina and Brazil.
- Biofuel production in many developing countries is projected to remain below expressed targets as the cultivation of non-edible crops to produce biofuels remains, in most cases, on a project or small-scale level and high prices of agricultural commodities do not encourage their use as biofuel feedstock.

- Biofuel trade is anticipated to grow significantly, driven by differential policies among major producing and consuming countries. The United States, Brazil and the European Union policies all "score" fuels differently for meeting their respective policies. This differentiation is likely to lead to additional renewable fuel trade as product is moved to its highest value market, resulting in potential cross trade of ethanol and biodiesel.

Figure 3.1. **Strong ethanol and biodiesel prices over the outlook period**

Evolution of prices expressed in nominal terms (left) and in real terms (right)



Notes: Ethanol: Brazil, Sao Paulo (ex-distillery), Biodiesel: Producer price Germany net of biodiesel tariff.

Source: OECD and FAO Secretariats.

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Market trends and prospects

Prices

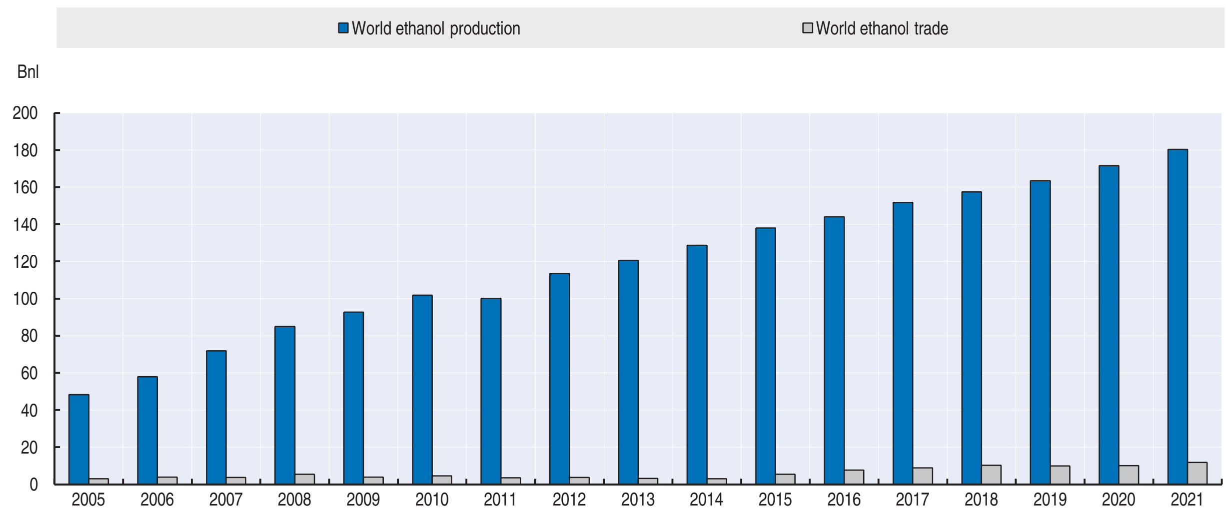
World ethanol prices[1] increased strongly in 2011, well above the levels of the previous 2007/08 highs. In 2012, a slight drop is projected but the price is expected to stay constant in real terms after 2013 following the price paths of the two major feedstocks maize and sugar (Figure 3.1). However, ethanol prices are not expected to increase as much as the crude oil price is assumed to over the projection period to reflect recent trends of the ethanol to crude oil price ratio.

World biodiesel prices[2] have increased in 2011 as well in a context of rising vegetable oil prices and high crude oil prices. This increase was smaller than for the world ethanol price because biodiesel production did not stagnate in 2011. Comparable to ethanol prices, biodiesel prices are projected to decrease slightly until 2013 and stay constant in real terms thereafter; this is in line with major biofuel feedstock prices.

Production and use of biofuels

Global ethanol production is projected to almost double over the projection period when compared to the 2009-11 base period and to reach some 180 Bnl by 2021 (Figure 3.2). The three major producers are expected to remain the United States, Brazil and the European Union. Production and use in the United States and the European Union are mainly driven by the policies in place, namely the US Renewable Fuel Standard (RFS2) final rule and the EU Renewable Energy Directive (RED). The growing use of ethanol in Brazil is linked to the development of the flex-fuel vehicle industry and the import demand of the United States to fill the advanced biofuel mandate. In the developing world, China should remain the main producer and user of ethanol with a production of 8 Bnl in 2011, projected to increase to 10 Bnl by 2021 (most of it is projected to be used for non-fuel applications), followed by India (4.2 Bnl in 2021).

Figure 3.2. **Development of the world ethanol market**



Source: OECD and FAO Secretariats.

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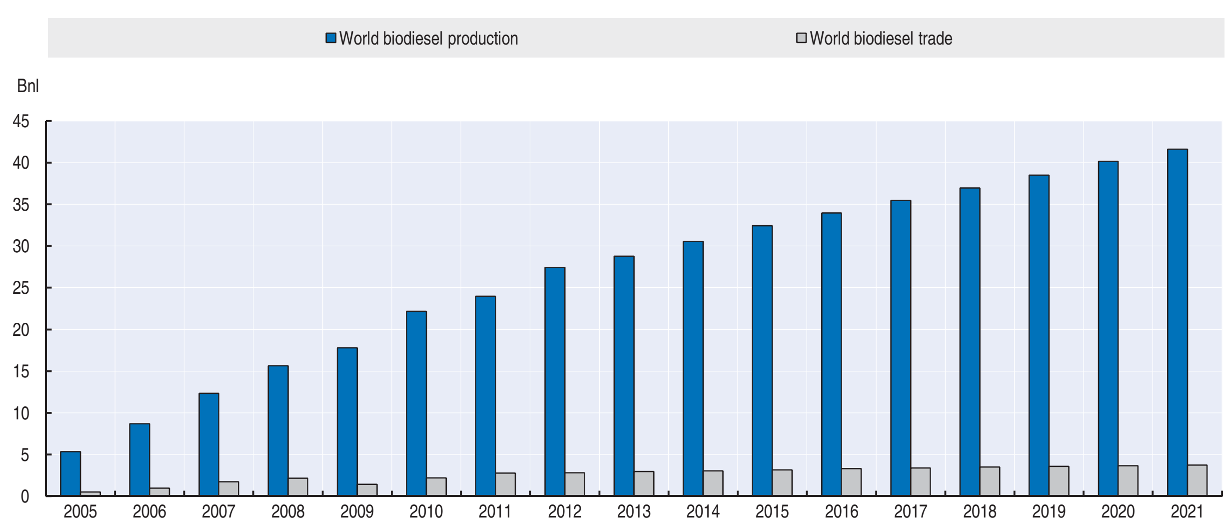
Global biodiesel production is expected to increase to above 42 Bnl by 2021 (Figure 3.3). The European Union is expected to be by far the largest producer and user of biodiesel. Other significant players are Argentina, the United States, Brazil, as well as Thailand and Indonesia.

Figure 3.3. **Development of the world biodiesel market**



Source: OECD and FAO Secretariats.

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To put in perspective the use of biofuel in total transport fuel use, Table 3.1 presents the projections for total transport and biofuel use both in energy and volume terms for a certain number of countries.

Table 3.1. **Transport fuel use in major biofuel producing countries**

		2009-2011			2021		
		Total	*Of which:* biofuel	Share of biofuel %	Total	*Of which:* biofuel	Share of biofuel %
Energy basis (1000toe)	Argentina						
	Gasoline type	3.5	0.1	2.7	4.1	0.1	3.4
	Diesel type	9	0.3	3.2	11	0.4	4.0
	Australia						
	Gasoline type	15	0.2	1.3	947	0.3	1.5
	Diesel type	16	0.5	3.1	18	0.5	3.1
	Brazil						
	Gasoline type	23	11.0	47.0	29	18.9	64.2
	Diesel type	40	1.6	4.0	54	2.4	4.6
	Canada						
	Gasoline type	30	0.8	2.6	32	1.1	3.4
	Diesel type	26	0.1	0.7	28	0.4	1.6
	China						
	Gasoline type	61	1.1	1.8	104	1.4	1.3
	EU						
	Gasoline type	103	2.8	2.7	103	8.6	8.3
	Diesel type	189	9.4	5.1	200	16.7	8.5
	USA						
	Gasoline type	409	21.9	5.4	412	45.0	10.9
	Diesel type	215	1.9	0.9	249	3.8	1.5
Volume basis (bnl)	Argentina						
	Gasoline type	4.7	0.2	4.0	5.4	0.3	5.0
	Diesel type	11	0.4	4.0	13	0.6	5.0
	Australia						
	Gasoline type	20	0.4	1.9	23	0.5	0.0
	Diesel type	19	0.6	3.9	22	0.7	3.8
	Brazil						
	Gasoline type	31	21.7	57.0	39	37.4	72.9
	Diesel type	48	2.1	5.0	64	3.2	5.7
	Canada						
	Gasoline type	40	1.6	3.8	42	2.1	5.0
	Diesel type	31	0.2	0.8	33	0.6	2.0
	China						
	Gasoline type	81	2.2	2.7	137	2.7	2.0
	EU						
	Gasoline type	137	5.5	4.0	136	16.9	12.0
	Diesel type	225	12.5	6.3	239	22.0	10.4
	USA						
	Gasoline type	541	43.4	7.8	545	89.1	15.5
	Diesel type	257	2.5	1.1	298	5.0	1.9

Source: OECD and FAO Secretariats.

StatLink http://dx.doi.org/10.1787/888932640540

Developed countries

With a global production share of about 50% in 2011, the United States is currently the biggest ethanol producer. The development of US biofuel markets has taken off since the enactment of the Energy Independence and Security Act of 2007 (EISA).[3] The implementation of this policy is made by the Environmental Protection Agency (EPA) through annual rules setting the levels for different fuel types. The Annex of the biofuel chapter provides a detailed description of US biofuel policies and, in particular, of the nested structure of quantitative minimums in place. An analysis of different implementation options is provided in the last section of the chapter. Current technological developments seem to suggest that the cellulosic biofuel mandate as it is currently regulated by the EPA is unlikely to be met by 2022.

It was assumed in the baseline that the production of cellulosic ethanol would rise steadily over the course of the outlook period to reach 16 Bnl by 2021, *i.e.* only about 30% of the cellulosic biofuel mandate.[4] EPA announcements for 2012 are incorporated in the baseline projections. For 2013 and remaining years of the projection period, the assumptions were made that the conventional ethanol gap would stay at the quantities in the legislation and that the other advanced gap could not shrink from year to year following the shortfall in cellulosic biofuels, *i.e.* that the total and advanced mandates would be reduced in parallel.[5]

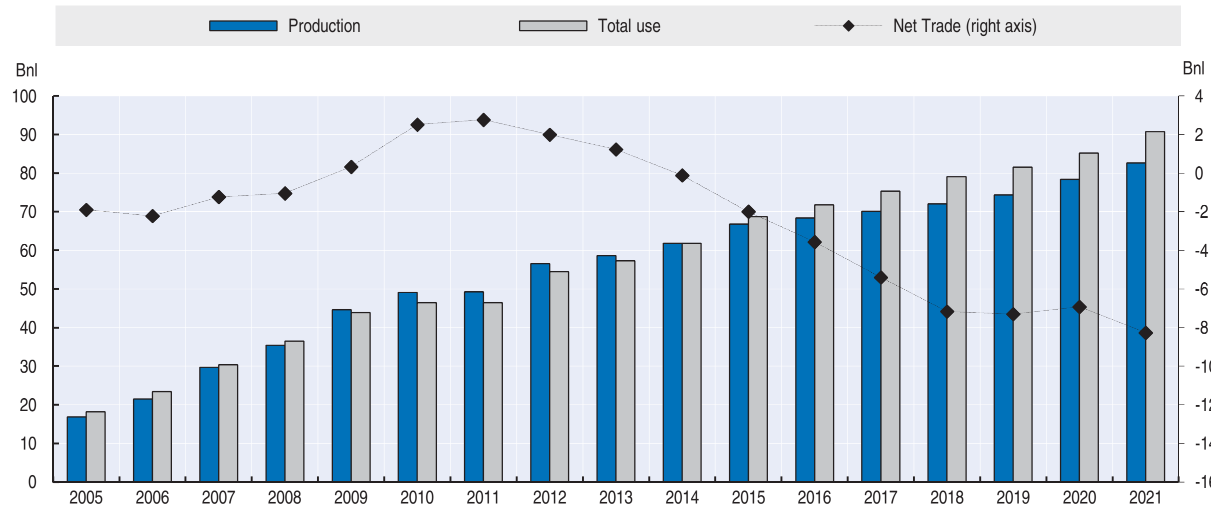
This adjusted total US biofuel mandate would amount to 96 Bnl in 2021. As the total biofuel mandate is projected to be binding throughout the projection period, ethanol use in the US is projected to follow the path of this mandate when subtracting the biodiesel mandate and reaches almost 90 Bnl (Figure 3.4). However, because of the high crude oil price, conventional ethanol production mostly based on coarse grains would be above the conventional gap.[6] Concerning the blend wall,[7] the EPA provided a decision in January 2011 to expand the ethanol blending percentage in regular gasoline from 10% to 15% expressed in a volume share for cars built in 2001 or later. At present, gasoline retailers are not ready to propose different types of gasoline to their customers because of logistics, warranties on motors as well as liability issues. It is assumed in the baseline projection that this issue will be resolved allowing cars built before 2001 to gradually disappear from the roads so that the full use of the 15% blend fuel would be reached at the end of the projection period. The assumed effective blend wall would be reached by 2017.[8] To meet the mandates, a slight expansion of the fleet of flex fuel vehicles is expected towards the end of the projection period.

The mandate for biodiesel defined in the RFS2 is extended from 3.8 Bnl to 4.8 Bnl to be used by 2012, driving the initial growth in US biodiesel use. Biodiesel production from tallow or other animal fat is expected to represent an important share of US biodiesel production. Because of relatively high ethanol Renewable Identification Numbers (RIN) prices, biodiesel production is expected to surpass the biodiesel mandate to reach 5 Bnl in 2021.

The RED[9] of the European Union requires that renewable fuels should increase to 10% of total transport fuel use by 2020. The RED allows for substitution with other renewable sources including electric cars. In that context, when adding together the energy content of ethanol and biodiesel, the *Outlook* assumes that only a 9.5%[10] share of renewable fuels can be reached by 2021.

In that context, fuel ethanol production mainly from wheat, coarse grains and sugar beet is projected to reach 16 Bnl in 2021 and ethanol fuel consumption amounts to an

Figure 3.4. **Projected development of the US ethanol market**

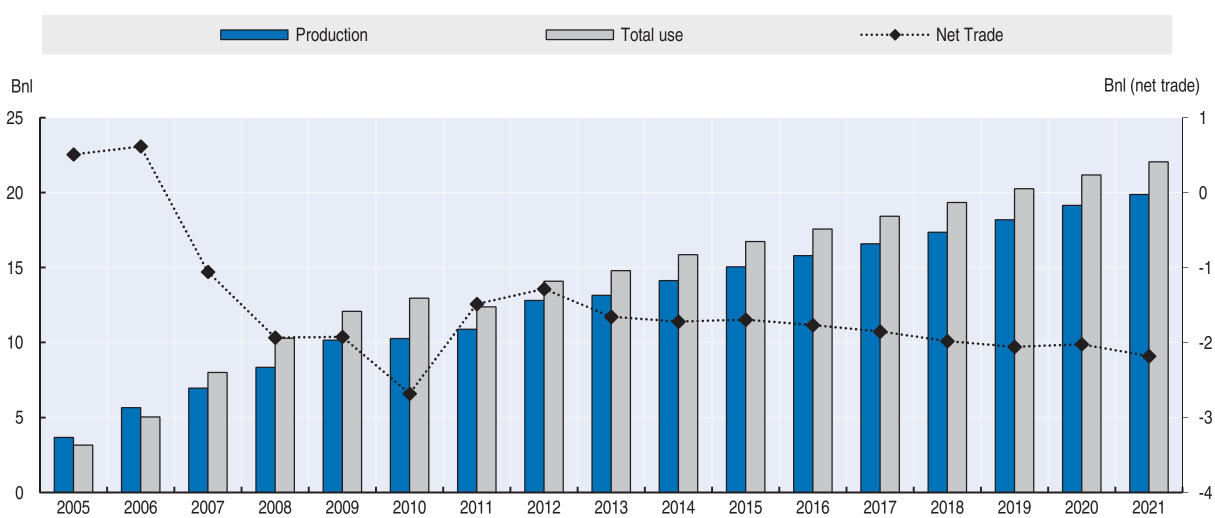


Source: OECD and FAO Secretariats.

StatLink http://dx.doi.org/10.1787/888932639419

average share of 8.3% in gasoline type transport fuels. Second generation ethanol is not assumed to play a major role throughout the projection period. Stimulated by mandates and tax reductions in European Member States, total biodiesel use is projected to reach 22 Bnl by 2021 (Figure 3.5) representing an average share of biodiesel in diesel type fuels of 8.5%. Domestic biodiesel production should increase to keep pace with demand. Second generation biodiesel production is assumed to reach about 4 Bnl in 2021.

Figure 3.5. **Projected development of the European biodiesel market**



Source: OECD and FAO Secretariats.

StatLink http://dx.doi.org/10.1787/888932639438

Canadian mandates require an ethanol share of 5% in gasoline type fuel use and a biodiesel share of 2% in diesel type fuel and heating oil use, both expressed in volume terms. Both mandates are projected to be filled; ethanol and biodiesel uses should grow in line with gasoline and diesel consumption. In Australia, the ethanol and biodiesel shares respectively in gasoline and diesel type fuel use are expected to remain almost unchanged over the projection period mostly driven by policies in place in two states (New South Wales and Queensland).

Developing countries

Within the last few years, several developing countries have implemented ambitious biofuel targets or even mandates. Their motivations are based mainly on two aspects: achieving a high level of energy supply security and/or independence and increasing domestic value added. However, the fuel production from promising feedstock such as jatropha or cassava are currently still on a project or small-scale level, far below the envisaged production levels. Rising biofuel feedstock prices provide strong incentives for exportation of agricultural raw products. This hampers the development of a domestic biofuel industry significantly; additionally, limited resources restrict the ability of governments to implement policies by supporting domestic production and use of biofuels through financial incentives. Subsequently the fill-rates of mandates and targets in several developing countries remain low.

Countries which already have a high potential for sugarcane and molasses production, such as India, Thailand, Colombia and the Philippines, or vegetable oil production such as Malaysia, Indonesia and Thailand, are expected to produce and use more ethanol and biodiesel over the projection period. However, it is very likely that, except for Brazil and Argentina, biofuel use in developing countries remains significantly below the targets/mandates and an export oriented biofuel industry does not develop anywhere.

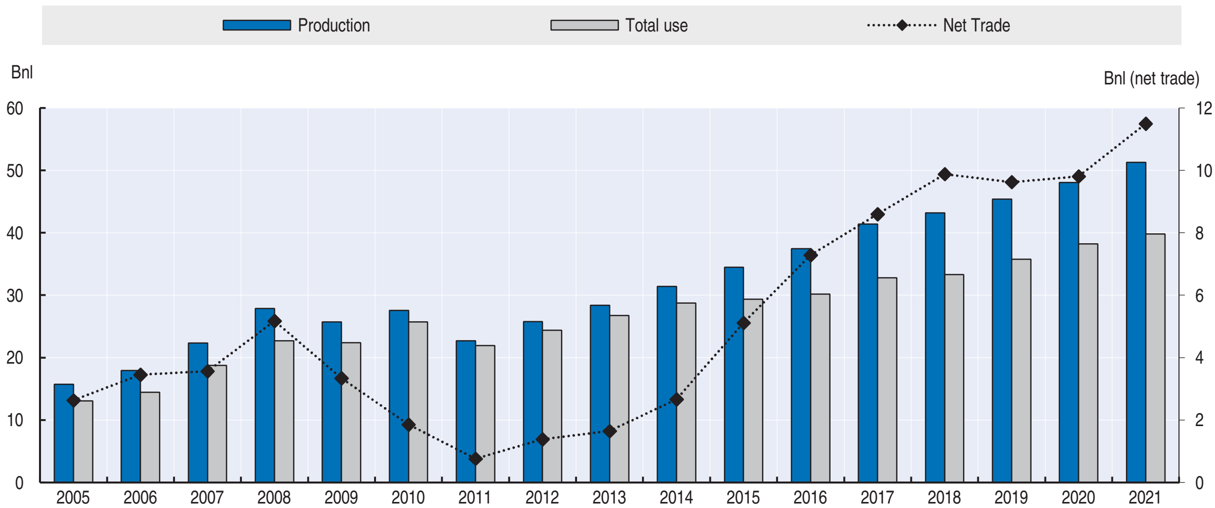
Brazil is projected to be the second largest ethanol producer. Brazilian ethanol derived from sugarcane should reach 51 Bnl and represent 28% of global ethanol production in 2021. One characteristic of the Brazilian ethanol industry is that it is very flexible. The sugarcane industry can quickly switch between sugar and ethanol production. Domestic ethanol demand is driven by the relative price ratios between ethanol and gasoline and between sugar and ethanol. It shifts with the growth of the flex-fuel vehicles fleet as well as the percentage of ethanol blended into gasoline. Brazilian ethanol domestic use is expected to increase over the projection period to reach 40 Bnl in 2021 (Figure 3.6). This growth is mainly driven by the growing fleet of flexi-fuel vehicles.[11]

Argentina has a biodiesel domestic use target (7% in volume share). However, most of its biodiesel production is planned to be exported due to the incentives offered by the differential export tax system. It will be the largest biodiesel producer in the developing world (4.2 Bnl in 2021). Driven by a domestic biodiesel consumption mandate, biodiesel production in Brazil should reach 3.2 Bnl.

Trade in ethanol and biodiesel

Global ethanol trade is set to increase strongly. While international trade represented on average about 4% of global production in the previous decade, the outlook projects it to increase to about 7% by 2021 (4.5 Bnl to 12 Bnl). Most of this increase is due to ethanol trade between Brazil and the United States. In 2021, the United States is expected to import about 16 Bnl of sugarcane based ethanol from Brazil which is assumed to be the cheapest alternative to fill the advanced biofuel mandate.[12] At the same time Brazil is projected to import 7.5 Bnl corn based ethanol from the United States to satisfy the flexfuel demand. Despite some tariffs, the European Union should increase imports by 2 Bnl of ethanol over

Figure 3.6. **Projected development of the Brazilian ethanol market**



Source: OECD and FAO Secretariats.

StatLink http://dx.doi.org/10.1787/888932639457

the projection period while some countries like Thailand, Pakistan or South Africa increase their export supply only marginally. Recently, the two major palm oil producers, Indonesia and Malaysia have developed flexible refining capacities that enable them to quickly switch to biodiesel production for export once the relative prices become favourable. Yet given the expected price ratio in the coming decade, biodiesel trade is projected to increase only slightly with Argentina remaining the major exporter due to its differential export tax system.

Feedstocks used to produce biofuels

Coarse grains are projected to remain the dominating ethanol feedstock but the share of coarse grains based ethanol production in global ethanol production is projected to 44% by 2021. By then, 14% of global coarse grain production should be used to produce ethanol by 2021. The sugarcane based ethanol share in global ethanol production should increase from 23% in 2009-11 to 28% in 2021. By 2021, 34% of global sugarcane production is expected to be used for ethanol production. While the share of ethanol produced from wheat and molasses should decrease, cellulosic ethanol is projected to take a global share of almost 9.5% – almost all stemming from production in the United States.

The share of biodiesel produced from vegetable oil in global biodiesel production is expected to decrease by 10% over the projection period down to 70%. Sixteen per cent of global vegetable oil production should be used to produce biodiesel by 2021. Second generation biodiesel production is projected to increase slightly over the projection period, mainly coming from the European Union.

Main issues and uncertainties

Global issues

The development of biofuel markets over the past few years has been strongly related to the level of crude oil prices, biofuel policy packages in place, and the macroeconomic environment. This *Outlook* is marked by the assumption of strong energy prices which favour the development of biofuels. A scenario on the effect of a lower crude oil price is presented in the Overview. It shows that if the crude oil price was lower by 25% on average over the projection period, the world ethanol price would be on average 12% lower and the world biodiesel price would be 5% lower on average.

The first generation of biofuels produced from agricultural feedstocks could be progressively replaced in the future by advanced biofuels produced from lignocellulosic biomass, waste material or other non-food feedstocks. The pace of this transition will depend on profitability expectations determining industry investment decisions and private R&D research and development efforts as well as on the biofuel policy framework which determines public spending and provides guidelines for the private sector. This *Outlook* remains very cautious on the medium-term potential of second generation biofuels. No specific assumptions have been made on the development of other advanced biofuels including drop-in fuels[13] such as bio-butanol. The conversion of some ethanol facilities in Brazil and the United States into bio-butanol facilities is currently in the pipeline, although potential associated environmental and safety problems still need to be resolved. Important investments are currently being made on these advanced biofuels, especially in the defence sector. Advancements should be monitored as they could displace many of the projected paths presented in this *Outlook*.

The sustainability criteria embedded in the US and European biofuel policies are expected to increasingly affect biofuel markets. In the coming years, biofuel producers will have to comply with GHG emission targets. This could limit the availability of imported biofuels or biofuel feedstock. Given the steadily increasing amount of agricultural commodities used as biofuel feedstocks it is expected that regulations set forth by biofuel policies will shape not only biofuel markets but all agricultural commodity markets.

The rest of this section presents a quantitative analysis of the uncertainties around the implementation of US biofuel policies. It is complemented by a description of US biofuel policies presented in the Annex of the chapter.

Implementation of US biofuel policies

Baseline assumptions concerning the implementation of US biofuel policies can be challenged as implementation possibilities open to the EPA are numerous. Until now, the yearly decisions taken by EPA did not have important impacts on agricultural and biofuel markets because the level of the cellulosic ethanol shortfall was small. But by 2021, the end of this *Outlook*, the amounts will be much larger and EPA's decision will likely have impacts on agricultural markets. This section identifies the effect of three alternative implementation options (as described in Annex 3.A1):

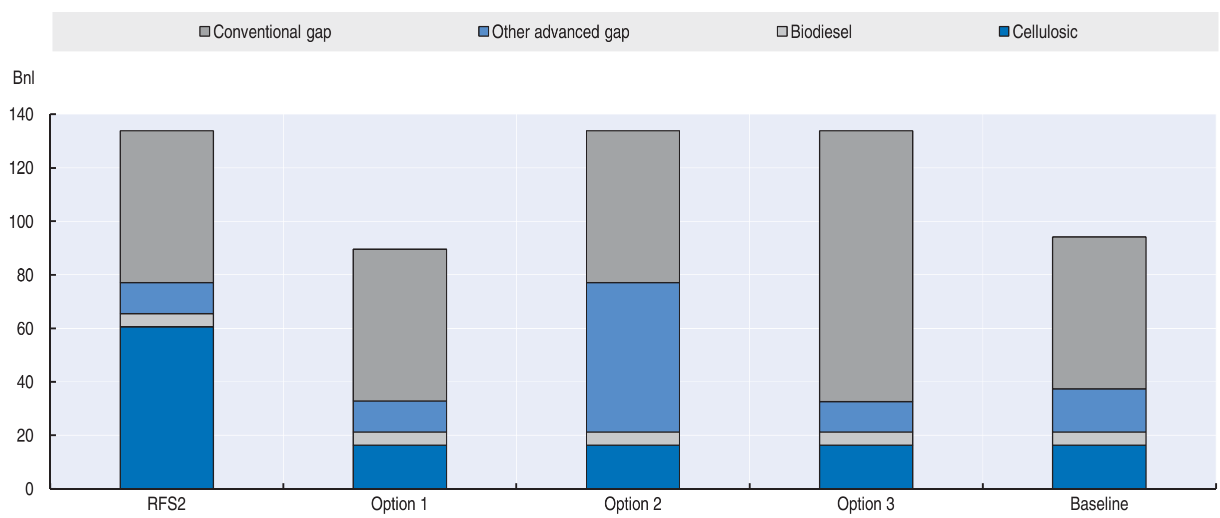
- *Option 1:* Lower the total and advanced mandates by the shortfall in the cellulosic mandate; EPA has not so far chosen this option which could seem to be the "simplistic" one.
- *Option 2:* Maintain both the advanced and total mandates, *i.e.* increase the other advanced gap. This is the option that has been chosen by the EPA. This scenario provides some insights regarding the sustainability of such an implementation option, especially when focusing on the interactions between US and Brazilian ethanol markets.
- *Option 3:* Maintain the total mandate and lower the advanced mandate by the shortfall in cellulosic production, *i.e.* increase the conventional gap. Maize based ethanol production is expected to exceed the conventional ethanol gap in baseline projections especially in

the latter years of the projection period when the conventional gap cannot exceed 56.8 Bnl. This scenario highlights the effects on international markets of the nested structure of US biofuel mandates.

The assumptions regarding the implementation of US biofuel policy in the baseline and in the three envisaged scenarios for 2021 are summarised in Figure 3.7. Scenarios were conducted after the completion of the revision of the US biofuel module of the AGLINK-COSIMO model, which captures the complex interplay of the different mandates, a simplified market of Renewable Identification Numbers (RINs) as well as the possibility to transfer these RINS between two years (*i.e.* roll-over). Scenario results are presented in Table 3.A2.1.

The decision taken by EPA will not be reflected fully by any of the scenario options. Those scenarios have been produced to illustrate the policy space, not to promote any particular policy option. This analysis focuses in different sub-sections on the impacts of the scenarios in comparison to baseline projections on ethanol markets (United States, Brazilian, European and global), on biodiesel markets and on agricultural markets. The last section provides key conclusions.

Figure 3.7. **Structure of US biofuel mandates in the law (RFS2), the baseline and the 3 options for 2021**



Source: OECD and FAO Secretariats.

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Impacts on US ethanol market

This section illustrates the key impacts in terms of supply, use, net trade and prices of the three implementation options on the US ethanol market. Results are summarised in Figure 3.A2.1. The three scenario options underline the fact that the US ethanol market – on the supply side as well as on the demand side – can adjust relatively easily to policy changes and to world price variations. On the demand side, the blend wall issue[14] is a major constraint for further expansion in ethanol use. An increase in the size of the flex-fuel vehicles is expected to be the most plausible outcome if the total mandate was to remain at the level defined in EISA towards the end of the projection period.

Option 1

With this implementation option, the total and advanced mandates are lowered by the shortfall in meeting the cellulosic ethanol mandate which keeps the conventional ethanol and other advanced fuel gaps unchanged from original levels. In 2021 the need for ethanol imports from Brazil to meet the other advanced gap is 30% lower than in the baseline, which leads to a 2% decrease of the world ethanol price. United States conventional ethanol production is projected to still exceed the conventional gap, but to be reduced by 1% in 2021 when compared to the baseline, in line with the reduction of the ethanol producer price. Option 1 leads to lower percentages of ethanol blended into regular gasoline: the blend wall is not achieved in any year of the projection period and consequently there is no need to expand the fleet of flex-fuel vehicles.

Option 2

In this case, EPA would maintain both the advanced and total mandate. This would result in the widening of the other advanced gap and in an important increase of advanced ethanol imports, *i.e.* imports of sugarcane based ethanol from Brazil. Those would reach 51 Bnl in 2021, compared to 16 Bnl in the baseline. This additional demand for advanced biofuels on world markets triggers a 17% higher world ethanol price in 2021 when compared to the baseline which is transmitted in part to the US ethanol producer price. In 2021, conventional ethanol production is expected to exceed baseline levels by 10%; this additional production would be largely exported to Brazil (see next section). On the demand side, Option 2 leads to ethanol use being 40% higher in 2021 than in the baseline. Ethanol blended into regular gasoline is expected to reach the assumed blend wall limit from 2014 onwards. Additional ethanol use should come from the development of the fleet of flex fuel vehicles which leads to a lower ratio between ethanol consumer price and gasoline consumer price induced by higher RIN prices.

Option 3

This option would mean that the other advanced gap would be kept fixed by reducing the advanced mandate by the same amount as the shortfall in cellulosic fuels while maintaining the total mandate. The conventional ethanol gap would exceed the baseline level by more than 70% in 2021, reaching 97 Bnl. Conventional ethanol production would not be able to reach the mandate despite being 40% above the baseline in 2021[15] – the ethanol producer price exceeds baseline levels by 40% – and US ethanol exports outside North America would be close to zero. To meet the global mandate, the United States would have to import ethanol. The world ethanol price in 2021 is projected to be 6% above the baseline level. This disparity in the movement of the Brazilian and US ethanol price is caused by the passage of the US price from the export floor (world price minus transport cost) to the import ceiling (world price plus transport cost plus a small *ad valorem* tariff) basis.[16] On the demand side, Option 3 leads to a situation very similar to Option 2 because the total mandate that has to be consumed is the same: ethanol blended into regular gasoline is expected to reach the assumed blend wall limit from 2014 onwards and additional ethanol use should come from the development of the flex fuel vehicle fleet. However, a stronger increase in biodiesel production leads to an ethanol consumption increase of only 38% compared to 40% in Option 2.

Interactions between the US and Brazilian ethanol markets

The different EPA implementation options analysed in this section have major implications for US import demand of ethanol able to qualify for the advanced biofuel mandate. Currently, the only ethanol type qualifying and being produced on a large scale is from sugarcane. In the outlook period, Brazil is the sole country that has the capacity and the flexibility to respond to strong additional demand from non domestic markets.[17] This means that the three implementation options have direct effects on Brazilian ethanol and sugar sectors.

Figure 3.A2.2 illustrates the most important interactions between the US and Brazilian ethanol markets. US ethanol imports directly impact Brazilian ethanol exports. In Brazil, the expansion/contraction of ethanol exports are due to several inter-related factors on the domestic market: expansion/contraction of domestic ethanol production and thus of sugarcane and sugar production, but also shifts in domestic ethanol demand through the adjustment of the car fleet as well as possibilities of ethanol re-imports from the United States.

Option 1

In the case of Option 1, US ethanol import demand is reduced. It is interesting to note that Option 1 has hardly any effects on the Brazilian and the world sugar markets when compared to baseline levels. Although ethanol exports to the United States are 30% lower in 2021, ethanol production in Brazil is only reduced by 3%, reducing sugarcane area by 2% while domestic consumption with a rising flex-fuel fleet increases by 3%. However, the lower sugarcane production does not have a visible impact on sugar production given the flexibility of the Brazilian sugar industry.

Option 2

Option 2 is associated with the strongest increase in US ethanol import demand when compared to baseline levels in 2021. This additional demand of about 35 Bnl induces larger Brazilian ethanol production by only about 10 Bnl. The rest will become available because of lower Brazilian consumption and higher imports from the United States.

Impact on Brazilian sugar markets: To produce more ethanol, the Brazilian sugarcane area is extended by 9% when compared to the baseline and the share of sugarcane used for biofuel production is increasing at the expense of sugar production. On the domestic Brazilian sugar market, lower sugar production implies higher domestic sugar prices, a lower sugar demand and a significant decrease of sugar exports. As a consequence, world sugar prices in Option 2 are 6% above baseline levels in 2021.

Impact on Brazilian ethanol use: Brazilian ethanol demand in a context of higher prices is expected to decrease considerably when compared to baseline levels in 2021. This decrease can be decomposed into two components:

- Low blend demand is reduced to the minimum blending requirement (18% of total fuel consumption on an energy equivalent basis).
- Ethanol used by flex-fuel vehicles is reduced to 21% of total fuel consumption – the 2011 level – compared to 41% in the baseline.

Ethanol imports from the United States: To meet domestic demand – even if it is much lower than in the baseline – in a context of tremendous increase[18] of Brazilian ethanol exports, Brazil needs to import some ethanol. Imports are projected to reach 18 Bnl, to a large extent originating from the United States where, in turn, the maize based ethanol production is stimulated by high ethanol prices. So Option 2 would create a large policy driven two-way trade in ethanol.

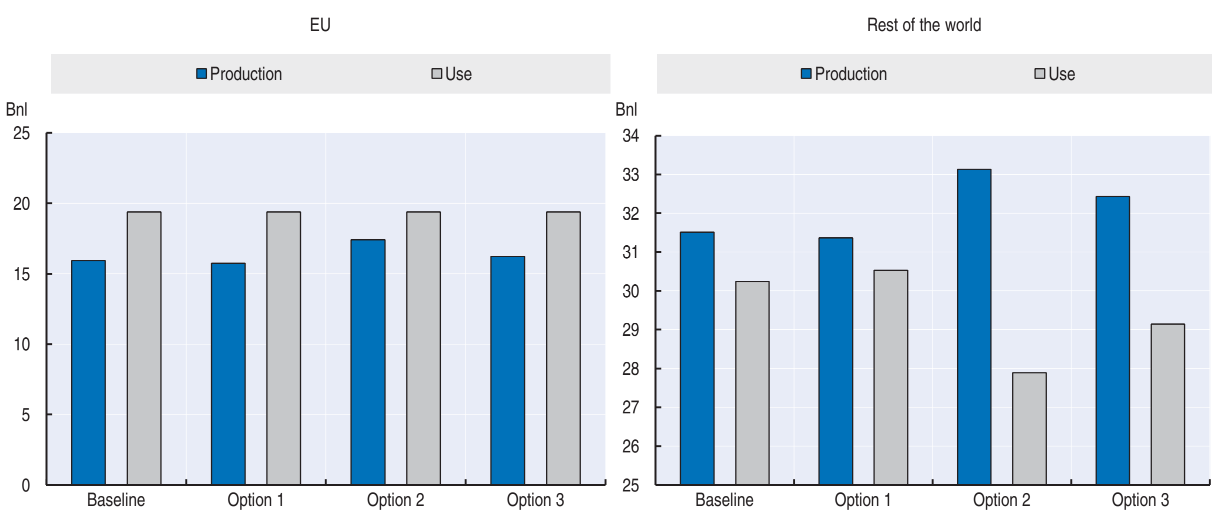
Option 3

The same argumentation can be built for Option 3. However, impacts on Brazilian ethanol and sugar markets are lower as US import demand is only 11% higher than in the baseline case in 2021. With much higher requirement for other conventional ethanol, the price of ethanol in the United States increases to levels eliminating the possibilities of exporting any ethanol outside North America. Brazil replaces this amount (close to 7 Bnl in the baseline) by domestic production and increases exports to the United States.

Implications on global ethanol production

The impacts of the scenarios on the European Union are only visible on the supply side, because consumption is bound by the EU mandate. In Option 2, with high world ethanol prices and a lot of competition on the world market, EU ethanol production is increasing by 9% (Figure 3.8). In the rest of the world, the supply and demand responses follow the world price incentives. In Option 2, China, India, Thailand and Canada make more than 50% of the production increase and even more in Option 3, where Canada shows the strongest supply increase given the tight connection to the US ethanol market. Consumption changes mainly take place in China, Thailand and Ukraine.

Figure 3.8. **Global ethanol market effects**



Source: OECD and FAO Secretariats.

StatLink http://dx.doi.org/10.1787/888932639495

Implications on biodiesel markets

Given the implicitly strong increases in RIN prices for ethanol in Options 2 and 3, biodiesel is likely to become more competitive against ethanol to meet the advanced mandate. In Option 2, US biodiesel production and use are increasing by about 50% to

7.5 Bnl when compared to the baseline. They increase even more in Option 3 where they reach 8 Bnl. Effects on global biodiesel markets are quite low, as the US biodiesel net trade position does not change considerably in the scenarios when compared to the baseline. In that context, the world biodiesel price does only increase slightly.

Implications on other agricultural sectors

The increasing production of ethanol from sugarcane and from coarse grains in Options 2[19] and 3 is sufficient to generate significant impacts on the other sectors, which is not the case for Option 1. Therefore, only Options 2 and 3 are reflected in this section. The impacts are summarised in Figure 3.A2.3.

Impacts on biofuel feedstock sectors

The starting point is obviously an increase in the demand for coarse grains and for sugarcane by the ethanol producers by 11% and 20% respectively in Option 2 and by 35% and 3%, respectively, under Option 3. This leads to an increase in the world price of coarse grains and sugar of 5% and 6%, respectively, in Option 2 and of 16% and 4% in Option 3. Many factors are mitigating the price impact and in particular the strong reduction in consumption of ethanol by flex fuel cars in Brazil and an increase in coarse grains and sugarcane production by 1% and 6% in Option 2 and by 2.5% and 0.5% in Option 3.

Overall, the larger amount of coarse grains consumed by ethanol producers (20 Mt and 64 Mt respectively in Option 2 and 3) is accounted for in the model by a larger production, increase in distiller's dry grain (DDG) production (5 Mt and 20 Mt) and by a reduction in the amount consumed by human either directly or indirectly through non-ruminant meats. Basically, the reduction in human consumption represents less than 50% of the additional demand by ethanol producers in Option 2 and Option 3. In the case of sugarcane, 80% of the additional amount used by ethanol producers is accounted for by larger production and 20% by lower sugar consumption in Option 2. In Option 3, these percentages are 41 and 59, respectively.

Impact on other sectors

The increase in the world coarse grains price affects many other sectors. First, through demand and supply substitution, it leads to a higher price of wheat and oilseeds by 2% in Option 2 and by 5% and 4% in the case of Option 3. The higher oilseed price reduces crush demand leading to lower supply of protein meal and vegetable oil. This combined with substitution on the feed demand side lead to a significant increase in the price of protein meal by 2% and 5% in Options 2 and 3 respectively.

The increasing price of feed generates a reduction in supply and production of non-ruminant meats. World pigmeat and poultry production falls respectively by 0.1% and 0.2 % in Option 2 and by 0.2% and 0.7% in Option 3. This leads to higher price and lower consumption of these meats. Taking the Pacific market as an example, the price of pork is 2% higher in Option 2 and 7% higher in Option 3. The US price of poultry increases by about the same percentage.

Considering the smaller share of feed in the variable cost of producing beef and the longer production cycle, the impact on the beef sector is different. In fact, the increasing demand for beef generated by the higher price of pork and poultry crosses the lower supply generated by the higher feed prices at a point leading to higher price and to a small increase in world production by 0.1% and 0.3% in Options 2 and 3.

The impact on the fish sector is also different since capture and raised molluscs, the largest share of supply, are not directly influenced by feed prices. On the other hand, demand for fish as food is entirely influenced by the movement in meat prices. Another important point is that China, which counts for 61% of world aquaculture production, is not strongly tied to the movement in the world price of coarse grains. Chinese coarse grain price is only 3% higher in Option 3 compared to a 16% increase for the world price. The combination of all these elements and world capture being mostly controlled by production quotas, leads to a small impact on production. For aquaculture production, the increasing price caused by the larger demand generated by higher meat prices compensates for the increasing feed cost.

Key conclusions of the scenarios

Option 1 (the total and advanced mandates are lowered by the shortfall in the cellulosic mandate), does not differ much from the baseline except from the fact that low blend ethanol use in the United States would not reach the blend wall in any years and that the United States would be less dependent on advanced ethanol imports.

Option 2 analysed in this section corresponds to maintenance of the actual policy of the EPA: both the advanced and total mandates are kept at the EISA level. The main conclusions of Option 2 compared to baseline projections are the following:

- Important policy driven two-way ethanol trade emerges between Brazil and the United States.
- Spill-over effects are expected in the coarse grains market as ethanol trade is completely free between the United States and Brazil, but the impact on the world price of coarse grains is not expected to be large.
- The largest adjustment will come from a severe reduction in consumption of ethanol by flex fuel cars in Brazil, *i.e.* the improvement in the US energy independence would be partly achieved through a reduction in Brazil's energy independence.
- The potential increase in sugarcane production is sufficient to prevent a large increase in the sugar price.

If, on the contrary, the EPA decides to reduce as well the advanced mandate without changing the total mandate as is the case in Option 3, then the impact on the coarse grains markets will be much larger. This is due to the fact that the US ethanol price will be much higher because it will go from an export floor price basis to an import ceiling. Not surprisingly, this will put even more upward pressure on the price of coarse grains. The main conclusions of this scenario are the following:

- US ethanol exports outside North America disappear and imports from Brazil driven by price advantage increase significantly.
- World coarse grains price is almost 16% higher in 2021, compared to the baseline.
- About half of the coarse grains or sugarcane used to produce the additional ethanol is derived from lower human consumption, taking into account additional production and the greater availability and use of DDGs.

- Quantities of food consumed around the world are somehow similar but at higher prices. Option 3 would put even more pressure on countries where food expenditure already accounts for a large share of income.
- The reduction in feed demand comes entirely from the non-ruminant meat sectors.

Finally, the impacts of the decisions to be taken by the EPA concerning the implementation of the US biofuel policy in the coming years are not fully reflected by the scenario options presented. However, it is clear from this analysis that the impacts will vary according to the decisions taken, that they are likely to be important, and that they will affect not only the biofuel sector in the United States but more broadly the global biofuel and agricultural markets. The implementation decision will have an impact on world ethanol and agricultural commodity prices. It will require some adjustment in terms of ethanol production and consumption patterns, as well as in terms of ethanol feedstocks use around the world.

Notes

1. Brazil, Sao Paolo (ex-distillery).
2. Producer price Germany net of biodiesel tariff.
3. Energy Independence and Security Act of 2007, Public Law 110–140 (2007) *www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf.*
4. Cellulosic ethanol production is an exogenous model component.
5. The total and advanced mandates are reduced by about 90% of the difference between the assumed applied and the legislated cellulosic biofuel mandate at the end of the projection period.
6. The conventional gap is the difference between the total mandate and the advanced mandate, see Annex 3.A1 for more explanations.
7. For more information on the blend wall, see Annex 3.A1.
8. In baseline assumptions, the blend wall is gradually extended from 10% to 15% over the projection period (accounting for the disappearance of older vehicles and for the resolution of logistic problems by blenders). These assumptions result in an assumed effective blend wall slightly lower than E15 in all years of the projection period except 2021. For example, it is assumed that the maximum ethanol blending percentage in regular gasoline would be of 13% in 2017.
9. *eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF.*
10. This percentage takes into account the fact that the contribution of second generation biofuels will be counted twice toward the EU RED mitigation targets.
11. Currently, gasoline prices in Brazil are not allowed to exceed a certain cap value. The *Outlook* assumes that this cap will be adjusted upwards given rising energy prices so that the driving ethanol/gasoline price ratio remains slightly in favour of ethanol.
12. According to the RFS2, sugarcane based ethanol is classified to be an advanced biofuel, while maize based ethanol is not.
13. Drop-in fuels are defined as renewable fuels that can be blended with petroleum products, such a gasoline, and utilised in the current infrastructure of petroleum refining, storage, pipeline and distribution.
14. Vehicles produced in 2001 or later are allowed since 2011 to use blends up to 15% ethanol. Annex 3.A1 contains a specific section on the blend wall and associated constraints on US biofuel demand.
15. In Option 3, in 2021, 53% of US coarse grains production would be consumed by ethanol producers.
16. US imports in Option 2 occur even if Brazilian ethanol prices are high because of the classification of sugarcane based ethanol as advanced biofuel. The US ethanol price, which can be interpreted as the conventional ethanol price, is therefore tight to the marginal quantity of US ethanol exported.

In Option 3, exports completely disappear and Brazilian sugar-cane ethanol exports now compete inside the conventional gap.

17. Other producers in the world are also reacting to a smaller extent to the higher ethanol price and mitigate some of the shortfall on the world market created by the US policy.
18. In 2021, Brazilian exports that qualify for the US advanced mandate are projected to be more than 260% higher than in the baseline.
19. All impacts reported are with respect to the baseline for the last year of the *Outlook* period, *i.e.* 2021.

ANNEX 3.A1

US biofuel policy

Biofuel policies in the United States are entering a new phase as the long standing blenders credits on ethanol and biodiesel and the tariff on imported ethanol expired at the end of 2011 and mandated quantities of biofuels continue to expand.

The expiration of the ethanol blenders credit of USD 0.45 per gallon (USD 0.12 per litre) with an offsetting USD 0.54 per gallon (USD 0.14 per litre) import tariff and the USD 1.00 per gallon (USD 0.26 per litre) blenders credit on biodiesel ends a decade's long policy of subsidisation to mix the renewable fuels into general motor fuel use.[1] The unique producers' credit for cellulosic biofuels of USD 1.01 per gallon (USD 0.27 per litre) is set to expire at the end of 2012. While there are calls for renewal of the credits, and it has happened in the past (even retroactively), as of the writing of this text the credit paid for by US taxpayers has expired. What remains is a system of mandates on blenders for inclusion of four classes of renewable fuels, total, advanced, bio-based diesel and cellulosic biofuels, into broader petrol and distillate use.

US biofuel mandates

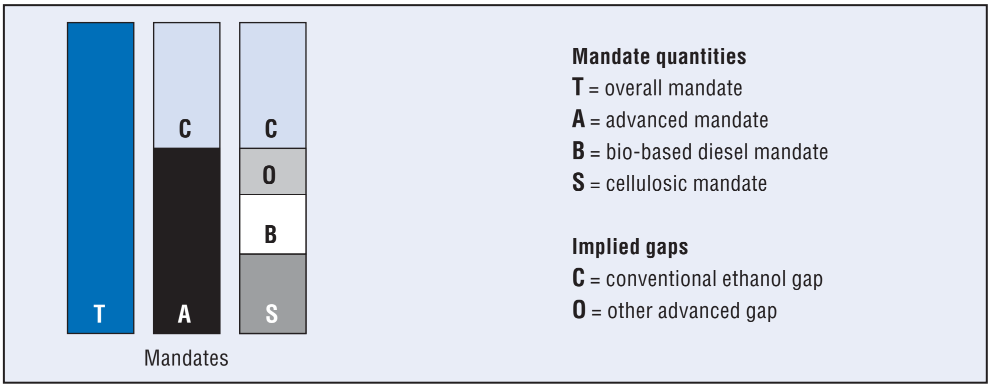
The mandates on blenders represent their share of the calendar year quantitative national mandates laid out in the Energy Independence and Security Act of 2007 (EISA).[2] The mandates are segmented into four classes presented in Figure 3.A1.1 based on the fuel's feedstock and its estimated greenhouse gas (GHG) reduction score relative to the 2005 base level as specified in EISA but are not independent of each other; they are a nested structure of quantitative minimums.

The overarching total mandate (T) requires fuels to achieve at least a 20% GHG reduction. Advanced fuels (A), as specifically defined in the legislation, are fuels which achieve a 50% greenhouse gas reduction score, ethanol derived from sugar is explicitly defined as an advanced fuel. Of that advanced mandate, a minimum quantity must come from bio-based diesel fuels (B), a distillate replacement with a 50% GHG reduction score, and cellulosic renewable fuels (S), either petrol or distillate replacement fuels, with a 60% green house gas reduction score.

The biodiesel and cellulosic minimums leave another advanced gap (O), the difference between the advanced mandate and the minimum that must come from cellulosic fuels and biodiesel, which can be met with fuels such as sugar based ethanol or excess biodiesel (B) and cellulosic fuel (S) consumption.

The conventional gap (C), the difference between the total mandate and the minimum that must come from advanced fuels, is then the portion of the total mandate that could

Figure 3.A1.1. **Mandated quantities and implied gaps**



Source: OECD and FAO Secretariats.

potentially come from conventional biofuels such as maize starch based ethanol and therefore only needs to meet the 20% GHG reduction criteria. It is worth noting here that there is no explicit mandate for maize based (specifically maize starch) ethanol in the system, only that it may compete with both other conventional biofuels[3] and advanced biofuels which may be consumed in excess of its mandate, in filling the conventional gap (C).

The mandates only restrict minimum quantities and are nested within each other, creating a hierarchy of biofuel types. Any overproduction in a sub-category can be used to fulfill the next broader mandate. Under varying conditions all, some or none of the four mandates may be binding at any given time.

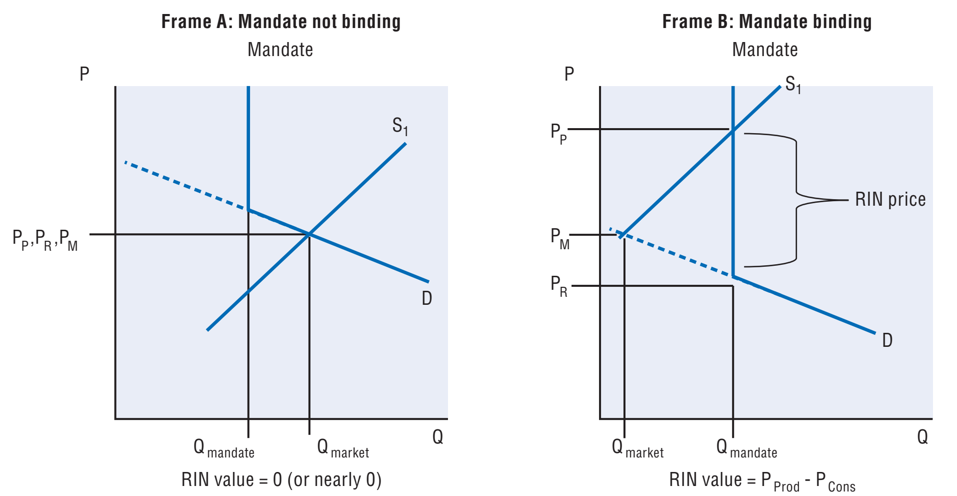
RIN markets and prices

Blenders are the obligated party in the system of mandates and show compliance in all four mandate categories, total, advanced, bio-based diesel and cellulosic biofuels, through the submission of Renewable Identification Numbers (RINs). A RIN is a 38-digit number which indicates the year, volume and highest mandate classification the renewable fuel is capable of meeting and is obtained from the US Environmental Protection Agency (EPA) by the biofuel producer upon production and registration of the fuel. Conveyed along with the fuel, for example maize starch based ethanol, is the associated RIN (in this case a conventional RIN) where the blender can detach and use the RIN for compliance or sell the RIN to another blender to help satisfy their obligation. The RIN price may be very low if the market demands quantities in excess of the mandate, such as when oil prices are high relative to biofuel prices, or the RIN may be very costly if the mandate quantity is well in excess of true market demand.

When the market (P_M) demands more than the mandated quantity (frame A in Figure 3.A1.2) the price paid for the renewable fuel from producer (P_P), blended and sold into the retail supply chain (P_R) will be equivalent when adjusted for taxes and margins. However, when the mandate is in excess of that the market would otherwise demand the wholesale price of the renewable fuel will rise relative to its value to consumers (frame B). In this context, blenders must pay a price to producers high enough to obtain the quantities they need to meet the mandate (P_P). The blenders cannot impose the cost directly on the ethanol share of the retail fuel or risk reducing demand for renewable, making the mandate even harder to achieve. They therefore must sell it at a lower price (P_R)

based on consumers preferences. Blenders must spread the cost of RINs out over the entire motor fuel sales, both petrol and distillates, maintaining relative renewable and conventional fuel prices; which in turn raises costs to motor fuel consumers. This difference between what the blenders pay (P_P) and what they impose on the retail market (P_R) is reflected in the RIN price. With four separate mandates there are potentially four separate RIN prices each of which reflects the per gallon cost born by motor fuel consumers of imposition of that mandate.

Figure 3.A1.2. **Determination of a binding mandate and RIN price evaluation**



Source: OECD and FAO Secretariats.

The hierarchical nature of the mandates will be reflected in the RIN prices. A biodiesel RIN can be priced no lower than an advanced RIN as any lower priced biodiesel RINs would be diverted to satisfy the advanced mandate equalising prices. If the biodiesel mandate is highly binding, biodiesel RIN prices would rise, but advanced RINs which, conversely, cannot be used for biodiesel compliance may lag behind.

Examples illustrating the nested nature of the biofuels mandates

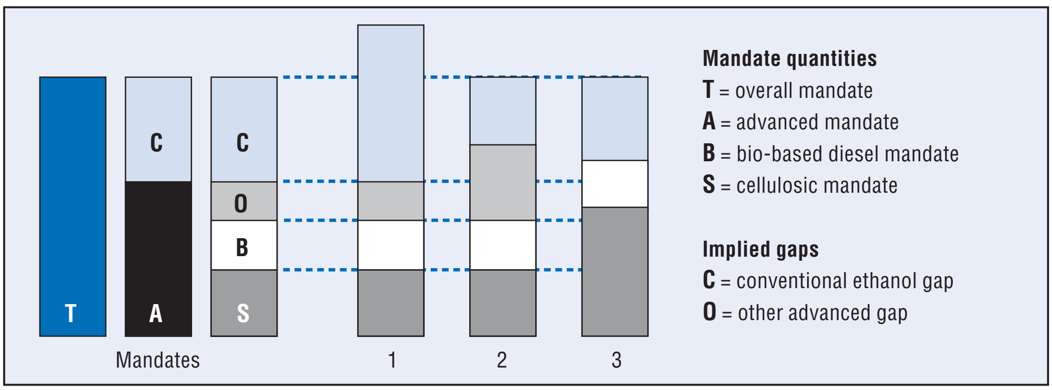
A number of examples not intended to be exhaustive, can highlight some of the possible outcomes and clarify the hierarchical nature of the mandates (Figure 3.A1.3).

Market outcome 1 shows the situation where, perhaps due to high petroleum prices and low agricultural commodity prices, maize ethanol consumption exceeds the conventional mandate gap (C) and therefore total ethanol RIN supplies exceed the total mandate. The total mandate would then be non-binding, conventional RIN prices would approach zero.

Market outcome 2 highlights the point that no specific mandate for conventional ethanol exists within EISA, but only a conventional biofuel gap. This case may be reflected in a situation where the total biofuel mandate may be binding, but imports of sugarcane ethanol, perhaps from high maize prices as a result of a short-crop, could enter and displace maize starch based ethanol in meeting the total mandate. In this instance the total mandate may be binding while the advance mandate is not and conventional and advanced RIN prices will be close in value.

Finally, market outcome 3 further highlights the hypothetical situation where there is a technological breakthrough in cellulosic ethanol production which reduces the cost of production, while the overall mandate remains binding, perhaps in the context of a low petroleum price. In this instance, cellulosic production may far exceed its mandate, but it cannot displace bio-based diesel production which has its own category specific mandate. Together, biodiesel and cellulosic ethanol may provide sufficient quantities to meet and exceed the advanced biofuel mandate and even displace some of the corn starch based ethanol being used to meet the total mandate. The biodiesel mandate and the total mandate may be binding but the cellulosic and advanced mandates would not be. In this situation, the prices for cellulosic and conventional RINs would be very close.

Figure 3.A1.3. **Nesting of mandates, examples of different market outcomes**



Source: OECD and FAO Secretariats.

Mandate flexibilities

Additional flexibility and complexity is added to the mandate system with provisions allowing blenders to "rollover" or run a "deficit" of RINs into the following year. Up to 20% of a given mandate may be met with RINs produced in the previous year. This allows for limited "stock holding" of obligations which can be drawn down in years where RIN prices rise. The blender can hold an additional stock of RINs as a hedge against rising biofuel and RIN costs or other compliance issues. This allows for some moderation of feedstock prices when a transient shock, such as below average crop yields, push RIN prices higher.

On an individual basis, blenders may fall short of the mandate in a particular year if in the following year they make up the "deficit" from the previous year and fully comply with the mandate in the current year. Running a deficit in the current year introduces considerable rigidity in the following year for blenders, as failure to comply with mandates can result in a fine of USD 37 500 per day plus any economic benefit derived from non-compliance.[4] Such flexibility in the mandate should mitigate swings in feedstock and biofuel prices from transient shocks in energy prices and crop production.

Mandate waivers and the implication of EPA implementation

The OECD-FAO baseline maintains current US biofuel policy with respect to mandates;[5] however, implementation of the policy by the Environmental Protection Agency (EPA) remains a significant source of uncertainty and could have significant effects on commodity markets.

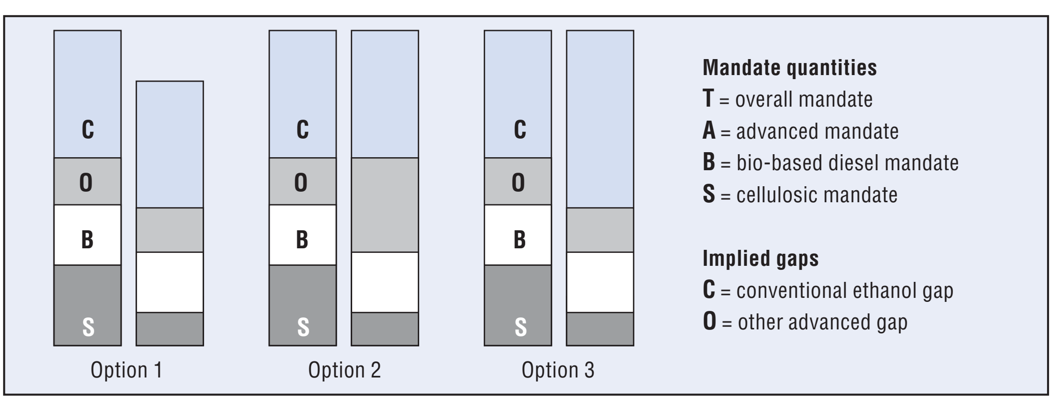
Each year, the EPA puts forth the minimum quantities for each of the four classes of biofuels required (total, advanced, bio-based diesel and cellulosic biofuels), taking into account what can be viably produced or imported. Thus far, the production capacity for cellulosic ethanol has lagged well behind the quantities mandated in 2010, 2011 and 2012. For 2012 the EISA legislation calls for 500 Mn gallons (1.893 Bnl), but has been reduced by the EPA to just 8.65 Mn gallons (32.7 Mnl) or just 1.7% of the targeted quantity. The cellulosic mandate also grows at an increasing rate for the remainder of the projection period. While this shortfall has its own implications for biofuel markets in terms of potential feedstock use and production, there is concern that meeting the cellulosic mandate faces considerable hurdles.[6, 7]

This leaves the EPA with an important decision each year regarding the other mandates. It is within their power to adjust each of the other mandate levels or leave them as legislated in EISA. The EPA may choose Option 1 in Figure 3.A1.4, in this case they lower the total and advanced mandate by the shortfall in cellulosic ethanol which keeps the conventional ethanol gap and other advanced fuel gap consistent with EISA. This policy maintains the maximum quantity of maize based ethanol that can be used to meet the mandate as well as the need for advanced fuels to meet the "other advanced gap". This choice is likely to lead to the lowest commodity and food prices while also resulting in the lowest GHG savings.

Alternatively the EPA could choose Option 2 in Figure 3.A1.4 and maintain both the advanced and total mandate which results in the widening of the other advanced gap and potentially drawing in additional imports such as sugarcane ethanol from Brazil. This option is likely to have a larger impact on commodity and food prices and mandate compliance costs than Option 1.

The EPA could alternatively choose to keep the other advanced gap fixed by reducing the advanced mandate by the same amount as the shortfall in cellulosic fuels while maintaining the total mandate. This would result in a growth in the conventional ethanol gap and a larger potential market for maize ethanol (Option 3 in Figure 3.A1.4). The EPA could also choose to do a partial adjustment on either the advanced mandate or total mandate or any combination of the two.

Figure 3.A1.4. **EPA mandate implementation options**



Source: OECD and FAO Secretariats.

Thus far, with the cellulosic mandate at relatively low levels, the EPA has chosen to keep the total and advanced mandate at their original levels (*i.e.* Option 2 in Figure 3.A1.4). This has led to the opening up of the "other advanced gap" of undefined advanced fuels needed to meet the mandate, such as imports of sugarcane ethanol from Brazil, a gap which will grow rapidly in the future if EPA maintains this option (Table 3.1).

Under legislated quantities, in 2020 the advanced gap would require 2.58 Bn gallons (9.76 Bnl) of other advanced fuel. Under our projected cellulosic biofuel production path, the continuation of current EPA implementation would result in the need for 10.731 Bn gallons (40.624 Bnl) of other advanced fuels in 2020. In developing the baseline for the *OECD-FAO Agricultural Outlook 2012-2021*, this was deemed an unlikely outcome; the most viable fuels to fill this gap, under current projections, would appear to be significant additional imports of sugarcane ethanol with possible additional production of biodiesel beyond its mandated minimum. This volume of imports would represent more than the total ethanol production for Brazil in 2011.

In the *OECD-FAO Outlook 2012-2021*, it was therefore decided to reduce both the total and advanced mandate by a proportion of the shortfall in cellulosic biofuels such that the other advanced gap did not shrink from year to year and the conventional ethanol gap was held to the quantities in the legislation. Changes in this assumption would have significant impact on commodity prices and consumer fuel costs as well as biofuel prices and trade. The production of cellulosic biofuels is an exogenous component in the model; all other categories of biofuels as defined in the nested structure of mandates are modeled endogenously.

The blend wall and constraints on biofuel demand

While the system of mandates in US policy specify quantities of biofuels which must be domestically consumed it provides no direction on *how* such fuels should be consumed. Petrol dominates US fuel consumption, representing 62% of consumption, with diesel fuels representing another 28%.[8] Short run technical constraints, referred to as "the blend wall" in the petrol market, act as an impediment to increased ethanol consumption. Biodiesel use could face similar constraints in the future.

Prior to 2011, conventional petrol vehicles in the United States were limited, by EPA rules, to a maximum blend of 10% ethanol by volume with a small number of flex fuel vehicles (FFV) able to take up to 85% blends.[9] The 10% constraint posed little problem when motor fuel use was near 568 Bnl annually and ethanol production well below the constraint of 57 Bnl. With rising quantitative mandates and stagnating aggregate motor fuel use as a result of the financial crisis and of higher mileage vehicles, the United States quickly was approaching saturation of the conventional vehicle market.[10] In 2011 the EPA announced that vehicles produced in 2001 or later would be allowed to use blends up to 15% ethanol[11] and preliminary rules and consumer guidelines were released in early 2012.[12] Data from a similar 11 year period from 1998 to 2009 showed the newer vehicles represented 70% of household automobile ownership but these vehicles represented over 77% of the miles driven.[13]

While this increases substantially the size of the ethanol market in conventional vehicles, many obstacles remain along the distribution chain. These constraints can have significant impact on the costs to consumers of the mandate system and the competition between renewable fuels, primarily ethanol and biodiesel, to fill the undefined advanced fuel quantities (O) within the EISA mandate. While EPA rules allow the dispensing of E15, retailers may be hesitant to offer it to consumers until the issue of liability is resolved. Earlier car warrantees may limit ethanol content to the previous 10% limit and would expose retailers to other consumer complaints. In addition, with a bifurcated market of newer and older vehicles, retailers must take action to minimise the mis-fuelling of vehicles by consumers who may be unaware of the restrictions. There may also simply be no "room" at the pump to add yet another handle dispensing an additional fuel type (different octane and ethanol inclusion rate combinations). Furthermore, the installation of additional underground tanks is very costly.

While even modest growth in E15 dispensing would allow for full absorption of maize ethanol that could be used to fulfill the conventional ethanol mandate gap (C), any significant growth in cellulosic ethanol production[14] or imports of sugarcane ethanol to meet the advanced mandate gap (O) could put pressure on the distribution system. This pressure will be reflected in increased RIN prices, ultimately born by consumers, and increase the incentives for blenders to expand the availability of E15 and E85 fuels and to price them competitively. This pressure also increases the motor fuel costs to consumers who may consume less in aggregate and thus make the ethanol blend-wall even more constraining. As an alternative, the constraint of the blend-wall also increases the potential for biodiesel consumption to exceed its own mandate to fulfill the larger advanced mandate if consumption of renewable diesel is less constrained.

It is assumed in baseline projections that the blend wall is gradually extended from 10% to 15% over the projection period and that the assumed effective blend wall would be reached by 2016.

Further reading

The discussion of US biofuel policy and its implementation are drawn from the following works where additional detail may be found.

Meyer, Seth and Wyatt Thompson. "EPA Mandate Waivers Create New Uncertainties in Biodiesel Markets", *Choices*, Vol. 26 (2), 2011.

Thompson, Wyatt, Seth Meyer and Patrick Westhoff. "Renewable Identification Numbers are the tracking Instrument and Bellwether of US Biofuel Mandates", *EuroChoices,* Vol. 8 (3), pp 43-50, 2009.

Notes

1. The vast majority of cars in the US have gasoline engines while the trucking fleet is dominated by diesel engine trucks.
2. Energy Independence and Security Act of 2007, Public Law 110–140 (2007) *www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf*.
3. Ethanol derived from corn starch is explicitly named as a conventional biofuel but it is not the only conventional biofuel. Other grains could be used to produce ethanol and if a 50% GHG reduction is not achieved the derived ethanol would be considered as a conventional biofuel.
4. EPA clams this authority under sections 205 and 211 of the Clean Air Act *www.epa.gov/air/caa/title2.html*.
5. Including the assumption that the cellulosic mandate will continue to be set by EPA at a reduced volume relative to that legislated in EISA.
6. *www.fas.org/sgp/crs/misc/R41106.pdf*.

7. The *Outlook* baseline for cellulosic biofuel production in the United States is exogenous and dependent on a fixed technology path.
8. Jet fuel consumption represents the remaining 10%, *www.eia.gov/forecasts/steo/report/us_oil.cfm*.
9. In October of 2010, the EPA granted a partial waiver for the use of E15 in model year 2007 and newer vehicles.
10. The mandates are quantitative and do not respond to aggregate motor fuel use. Factors which increase or decrease aggregate motor fuel use, change the effective share of biofuels required in consumption.
11. *http://edocket.access.gpo.gov/2011/2011-1646.htm*.
12. *www.gpo.gov/fdsys/pkg/FR-2011-07-25/pdf/2011-16459.pdf*.
13. National Travel Household Survey (*http://nhts.ornl.gov/download.shtml*) Author's query from data set using NTHS estimates of miles driven by age, self reported miles driven would increase the share of newer vehicle miles to over 81%. The results do not correct for potential differences in miles per gallon based on age of vehicle.
14. Cellulosic biodiesel also qualifies as a cellulosic fuel.

ANNEX 3.A2

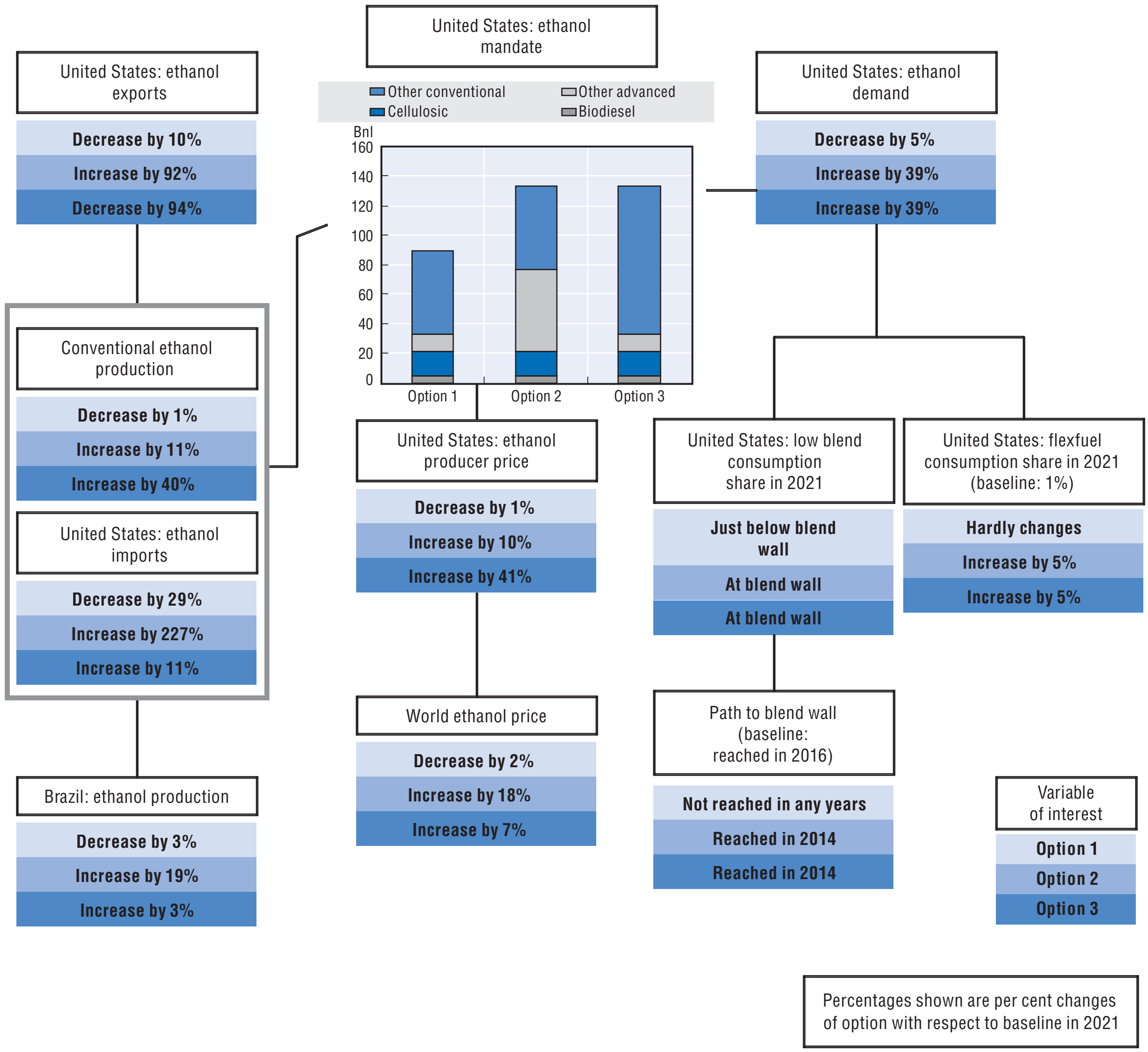
Uncertainties around the implementation options of US biofuel policies: Results of the scenarios

Table 3.A2.1. **Results of the three options scenarios**

		Baseline		Option 1	Option 2	Option 3
		Average 2009-2011	2021	2021	2021	2021
Ethanol production						
USA	MN L	47 617	82 610	81 860	89 553	108 960
Brazil	MN L	25 331	51 300	49 625	61 048	52 627
European Union	MN L	6 424	15 748	15 572	17 145	15 986
Canada	MN L	1 565	1 992	1 978	2 135	2 550
China	MN L	8 094	10 058	10 016	10 507	10 146
India	MN L	1 976	4 194	4 174	4 376	4 237
Rest of World	MN L	7 213	14 673	14 598	15 337	14 776
Ethanol use						
USA	MN L	45 582	90 757	86 217	126 462	125 778
Brazil	MN L	23 347	39 805	41 287	25 902	34 467
European Union	MN L	7 877	19 388	19 388	19 388	19 388
Canada	MN L	1 759	2 356	2 356	2 356	2 356
China	MN L	7 994	10 242	10 433	8 905	9 646
India	MN L	2 254	4 384	4 385	4 381	4 383
Rest of World	MN L	8 406	13 460	13 573	12 524	13 076
Energy share in Gasoline type fuels						
USA	%	5.4	10.9	10.4	15.3	15.2
Brazil	%	47.1	64.3	66.8	40.4	55.1
European Union	%	2.7	8.3	8.3	8.3	8.3
Canada	%	2.6	3.4	3.4	3.4	3.4
China	%	1.8	1.3	1.4	0.7	1.0
Ethanol trade						
USA	MN L	1 864	–8 268	–4 479	–37 030	–16 943
Brazil	MN L	1 984	11 495	8 338	35 146	18 160
European Union	MN L	–1 453	–3 640	–3 816	–2 243	–3 402
Canada	MN L	–195	–364	–378	–221	194
China	MN L	100	–183	–416	1 602	500
India	MN L	–278	–190	–211	–5	–146
Rest of World	MN L	–1 205	1 214	1 025	2 813	1 700
Biodiesel						
USA production	MN L	2 834	5 083	5 083	7 571	8 006
USA consumption	MN L	2 546	4 979	4 979	7 515	7 956
USA net trade	MN L	288	104	104	56	50
Prices						
World						
Ethanol	USD/hl	64	96	94	113	102
Biodiesel	USD/hl	132	181	181	184	185
Coarse grains	USD/t	228	246	245	259	286
Raw sugar	USD/t	533	483	482	516	503
Wheat	USD/t	267	279	279	286	294
Oilseeds	USD/t	503	550	549	562	572
Vegetable oils	USD/t	1 067	1 232	1 232	1 256	1 265
Beef and veal (USA)	USD/t	3 477	4 718	4 711	4 780	4 900
Pigmeat (USA)	USD/t	1 658	2 380	2 375	2 434	2 542
Poultry (USA)	USD/t	1 074	1 121	1 119	1 148	1 204
Fish	USD/t	2 500	3 445	3 441	3 484	3 532
USA						
Ethanol	USD/hl	61	77	76	85	108

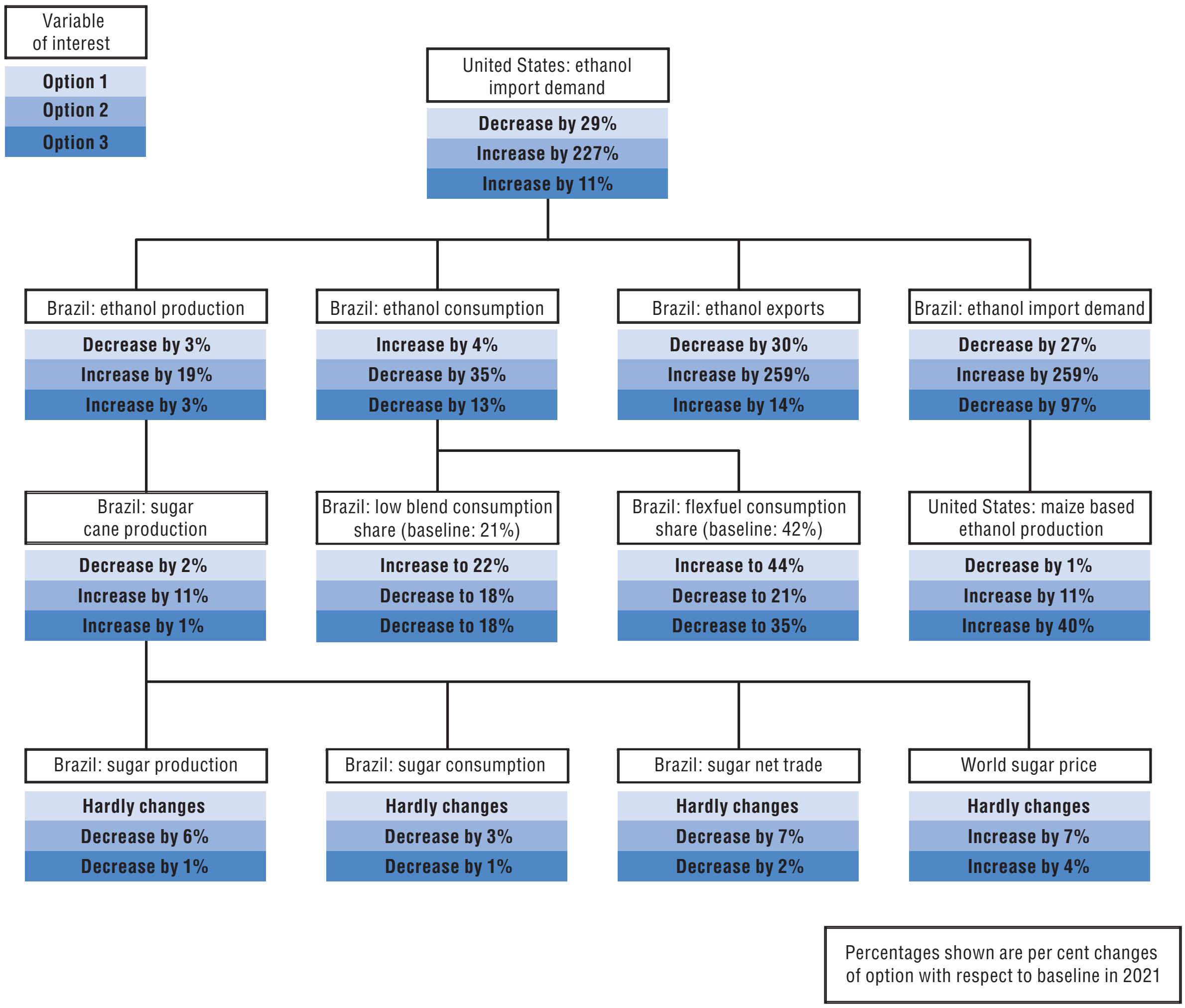
Note: For the definition of world prices, please refer to footnotes of Table 1.A.2. 30 and 31.
Source: OECD and FAO Secretariats.

Figure 3.A2.1. **Implications of the three options on the US ethanol market**



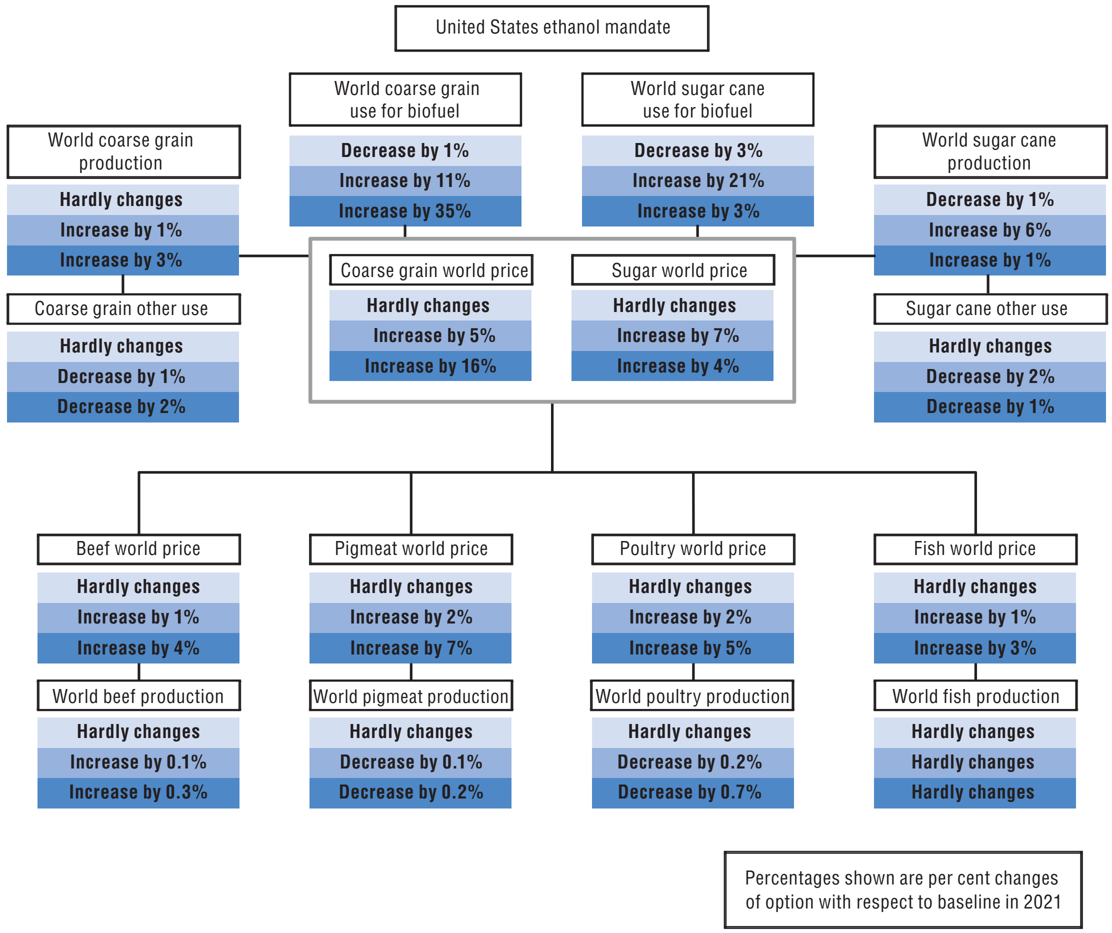
Source: OECD and FAO Secretariats.

Figure 3.A2.2. **Interactions between US and Brazilian ethanol markets**



Source: OECD-FAO Secretariats.

Figure 3.A2.3. **Impacts on the other agricultural sectors**



Source: OECD and FAO Secretariats.

Questions for Stakeholder Comment:

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

   The answer to all of these questions is an unqualified "yes." The RFS is the single most important public policy initiative stimulating the development of low-carbon, domestic and non-petroleum based fuels in the United States. Our company, Clean Energy Renewable Fuels, is dedicated to the production, marketing and distribution of biomethane vehicle fuel through the natural gas vehicle fuel infrastructure of our parent company, Clean Energy Fuels (NASDAQ: CLNE). The existence of the RFS, which enables us to realize the economic benefit of the low-carbon and renewable attributes of our fuel, is fundamental to our continued growth and development.

   We own and operate two biomethane production facilities that derive biomethane the decomposition of organic waste. This fuel can be used to supplement or completely substitute for conventional natural gas in any natural gas vehicle without any compromise in vehicle performance. Depending on the source of the biogas (e.g., landfill, waste water treatment plant, agricultural digester), this fuel can reduce carbon emissions from vehicle fueling by anywhere from 70 percent to 100% or more (i.e. acting as a "carbon sink") when compared to petroleum fuel. Moreover, biomethane can be used to fuel any natural gas vehicle type – from passenger cars to long-haul 18-wheelers - and meet 100% of their fueling requirements. Our two operational facilities are capable of producing almost 30 million gasoline gallon equivalents of biomethane every year and can profitably and sustainably sell this fuel at a substantial discount to current prices of petroleum fuel.

   However, in the absence of the RFS and the incentives it creates for the production of low-carbon, non-petroleum-based fuel, our ability to continue to sustainably grow our business would be severely compromised. Fundamental to our growth plans has been the assumed stability of the RFS program throughout the life of the program. Alternative fuel production facilities are capital intensive, long-term investments and require regulatory stability to survive. Full implementation of the RFS will continue to drive our transportation fuel use across the United States to lower-carbon, non-petroleum fuels and break the hammer lock that petroleum-based fuel currently has on our transportation infrastructure. The RFS does not provide subsidies or require tax-payer funding. It depends on the market pricing of the alternative fuel credits (RINS) and therefore naturally incentivizes cost reduction and rewards the low cost producer of alternative fuels. It is working and will continue to work as it is implemented over the coming decade and is a crucial component of reducing U.S. greenhouse gas emissions.

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

   This issue does not impact our fuel (biomethane) and therefore we have no comment.

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

We believe the definition is adequate.

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

   We can only comment on the impacts of our fuel, biomethane. Biomethane, like natural gas, burns cleaner than petroleum fuels with respect to a number of airborne pollutants. One only need imagine replacing their natural gas stovetop with a gasoline or diesel based stovetop in their home to understand the difference. There are substantial air quality regulations already on the books, and we do not think RFS implementation requires any new air regulations to mitigate any adverse impact, and we are not aware of any adverse impact in any event.

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

   We do not believe that the RFS anticipated the growth of natural gas vehicle fuel use in the United States. With the growth in the natural gas fuel distribution infrastructure, a tremendous opportunity has developed for biomethane vehicle fuel. The increased availability and environmental benefits of commercial scale biomethane vehicle fuel production and use are a direct result of the RFS and are an unanticipated benefit.

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

   No comment.

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

   As is outlined above, the RFS s the single most important public policy initiative and regulation for reducing greenhouse gas emissions from the transportation sector. The RFS puts hundreds of thousands of Americans to work producing sustainable, low-carbon, non-petroleum fuels. It must be maintained in order to continue to ensure a viable market for the emerging alternative fuel companies, like Clean Energy Renewable Fuels, that have invested so much in meeting the program's goals.

   In the absence of the RFS, investment in low-carbon, renewable fuel production will unquestionably decline. The transportation fuel market will not diversify, and will continue to rely almost entirely on petroleum. At Clean Energy Renewable Fuels, we are today producing commercial scale, economic, low-carbon and renewable fuels entirely from organic waste streams. The investments we have made and the growth of our business depend on the stability and maintenance of the RFS. There are many, many companies like us. Without the RFS, greenhouse gas emissions from the transportation sector will undoubtedly RISE on a per mile travelled basis. At a time when atmospheric carbon has passed 400 ppm, we cannot afford to go in reverse in terms of transitioning to a low carbon transportation sector.

Sincerely,

Harrison Clay
President

Clean Energy Renewable Fuels

3020 Old Ranch Parkway, Suite 400
Seal Beach, CA 90740
P: 562.493.7231
E: hclay@cleanenergyfuels.com

May 24, 2013 (copy edited May 29)

Honorable Fred Upton
Chairman
Honorable Henry Waxman
Ranking Member
House Committee on Energy and Commerce
RFS@Mail.House.Gov

Dear Sirs,

This comment letter addresses Question 1(a) of your Renewable Fuel Standard (RFS) White Paper on Greenhouse Gas Emissions and Other Environmental Impacts, which asks: "Is the RFS reducing greenhouse gas emissions below that of baseline petroleum-derived fuels?"

Although not posed in the White Paper, a related question is whether the original energy security and climate change rationales for the RFS program are as sound or compelling as they appeared to be in 2007. I offer some thoughts on this topic in an addendum.

My main conclusions are as follows:

1. The RFS may be a net contributor to greenhouse gas emissions.
2. Even if ethanol does emit less carbon dioxide on a life-cycle basis than the gasoline it displaces, the RFS may still be an inefficient mitigation strategy.
3. The energy-security assumptions underpinning the RFS are dated and, arguably, false.
4. The scientific assumptions underpinning the RFS are dated and, arguably, false.

Thank you for the opportunity to provide comment on your timely and thoughtful reassessment of the RFS.

Sincerely,

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Question 1(a): Is the RFS reducing greenhouse gas emissions below that of baseline petroleum-derived fuels?

The RFS may actually be a net contributor to greenhouse gas emissions. What's more, even if ethanol does emit less carbon dioxide (CO_2) on a life-cycle basis than the gasoline it displaces, the RFS may still be an inefficient mitigation strategy.

Fargione et al. (2008) found that, "Converting rainforests, peatlands, savannas, or grasslands to produce food-based biofuels in Brazil, Southeast Asia, and the United States creates a 'biofuel carbon debt' by releasing 17 to 420 times more CO_2 than the annual greenhouse gas (GHG) reductions these biofuels provide by displacing fossil fuels."[1]

Similarly, Searchinger et al. (2008) found that when farmers worldwide "convert forest and grassland to new cropland to replace the grain (or cropland) diverted to biofuels," corn ethanol, "instead of producing a 20% savings, nearly doubles greenhouse emissions over 30 years and increases greenhouse gasses for 167 years." The researchers also found that cellulosic biofuel is not necessarily a 'climate-friendly' alternative to corn ethanol: "Biofuels from switchgrass, if grown on U.S. corn lands, increase emissions by 50%. This result raises concerns about large biofuel mandates and highlights the value of using waste products."[2]

The Fargione and Searchinger papers stirred up a controversy that simmers to this day. In a letter published in *Science* magazine,[3] Michael Wang of Argonne Laboratory's Transportation Technology Center and Zia Haq of the Department of Energy's Office of Biomass criticized Searchinger et al.'s assumptions and methods. In various rebuttals, Searchinger argued that his critics, who also included the California Air Resources Board (CARB) and the New Fuel Alliance (NFA), misrepresented the study, used inaccurate economics, and employed faulty logic.[4]

Hertel et al. (2010) found that the Fargione and Searchinger studies overestimated life-cycle CO_2 emissions associated with corn-ethanol production. Nonetheless, they concluded that corn ethanol offers no climate benefit compared to conventional gasoline:

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[1] Joseph Fargione, Jason Hill, David Tilman, Stephen Polasky, and Peter Hawthorne, "Land clearing and the biofuel carbon debt," *Sciencexpress*, Feb. 7, 2008, http://www.sjsu.edu/people/dustin.mulvaney/courses/envs133/s1/Fargione%20et%20al%202008%20Land%20Clearing.pdf

[2] Timothy Searchinger, Ralph Heimlich, R. A. Houghton, Fengxia Dong, Amani Elobeid, Jacinto Fabiosa, Simla Tokgoz, Dermot Hayes, and Tun-Hsiang Yu, "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land Use Change," *Sciencexpress*, Feb. 7, 2008, http://www.whrc.org/resources/publications/pdf/SearchingeretalScience08.pdf

[3] Available at http://www.bioenergywiki.net/images/2/2c/Wang_response_to_land_use.pdf

[4] Searchinger's response to Wang and Haq and the NFA is available at http://www.bioenergywiki.net/images/3/31/Searchinger_Response.pdf; his response to CARB is available at http://www.bioenergywiki.net/images/4/43/Searchinger_letter_re_letter_to_CARB.pdf.

> Factoring market-mediated responses and by-product use into our analysis reduces cropland conversion by 72% from the land used for the ethanol feedstock. Consequently, the associated GHG release estimated in our framework is 800 grams of carbon dioxide per megajoule (MJ); 27 grams per MJ per year, over 30 years of ethanol production, or roughly a quarter of the only other published estimate of releases attributable to changes in indirect land use. Nonetheless, 800 grams are enough to cancel out the benefits that corn ethanol has on global warming, thereby limiting its potential contribution in the context of California's Low Carbon Fuel Standard.[5]

Even if we assume, per Wang et al. (2007),[6] that corn ethanol achieves a 20% life-cycle reduction in greenhouse gas emissions compared to gasoline, the RFS may still be an inefficient mitigation strategy.

Consider a related biofuel policy, the volumetric ethanol excise tax credit (VEETC), which expired in December 2011. In July 2010, the Congressional Budget Office (CBO) analyzed the budgetary cost in foregone tax revenue of each ton of CO_2 avoided through the VEETC.[7] Citing Wang et al., CBO assumed that on a Btu-equivalent basis, corn ethanol emits 20% less CO_2 than does gasoline or diesel fuel.

CBO estimated that "taxpayers' costs for reducing greenhouse gas emissions through the ethanol tax credit are $754 per metric ton of CO2e (that is, per metric ton of greenhouse gases measured in terms of an equivalent amount of carbon dioxide), and about $300 per metric tons of CO2e for biodiesel." CBO noted that if the VEETC is responsible for only 15% of ethanol consumption, as Iowa State University researchers had estimated,[8] then "the costs to taxpayers of reducing emissions through the credits would be about $1,700 per metric ton of CO2e rather than roughly $750."

For perspective, the Energy Information Administration (EIA) estimated that under the American Clean Energy and Security Act, emission allowances in the "basic case" would sell for

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[5] Thomas W. Hertel, Alla A. Golub, Andrew D. Jones, Michael O'Hare, Richard J. Plevin, and Daniel M. Kammen, "Global Land Use and Greenhouse Gas Emissions: Estimating Market-mediated Responses," *BioScience* Vol. 60, No. 3, March 2010, http://www.aibs.org/bioscience-press-releases/resources/Hertel.pdf

[6] Michael Wang, May Wu, and Hong Huo, "Life-Cycle Energy and Greenhouse Gas Emission Impacts of Different Corn Ethanol Plant Types," Environmental Research Letters, vol. 2, no. 2 (2007), http://iopscience.iop.org/1748-9326/2/2/024001/pdf/erl7_2_024001.pdf

[7] Congressional Budget Office, Using Biofuel Tax Credits to Achieve Energy and Environmental Policy Goals, July 2010, http://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/114xx/doc11477/07-14-biofuels.pdf

[8] Bruce A. Babcock, Kanlaya Barr, and Miguel Carriquiry, *Costs and Benefits to Taxpayers, Consumers, and Producers from U.S. Ethanol Policies*, Staff Report 10SR-106, Center for Agricultural and Rural Development, Iowa State University, July 2010, http://www.card.iastate.edu/publications/DBS/PDFFiles/10sr106.pdf

\$32 per metric ton in 2020 and \$65 per metric ton in 2030.[9] Per ton of CO_2 avoided, the VEETC was about 11 to 24 times more costly than ACESA.

How does the RFS compare to ACESA on a bang-for-buck basis? To answer this question, we first need to estimate two quantities: (1) the total annual tons of CO_2 avoided through the RFS and (2) the total annual cost of such mitigation.

Here's my back-of-the-envelope, beginning with annual tons avoided. A Purdue University analysis found that even without the RFS, refiners would continue to blend ethanol as an octane booster and oxygenate at levels close to E10.[10] Similarly, the Iowa State University study referenced above estimated that in 2011, the RFS would increase ethanol production by 1.72 billion gallons.[11]

TABLE 1. Average results for ethanol policy scenarios in 2011

Ethanol Policies in Place	Corn Price (\$/bu)	U.S. Ethanol Price[a] (\$/gal)	Brazil Ethanol Price[b] (\$/gal)	RIN Price (\$/gal)	U.S. Ethanol Production (BG[c])	Imported Ethanol (MG[d])
Mandate, Tax Credit, Tariff	3.79	1.83	1.76	0.07	13.51	13
Mandate, Tax Credit	3.78	1.82	1.80	0.07	13.48	83
Mandate, Tariff	3.56	1.71	1.76	0.32	12.83	0
Mandate Only	3.55	1.71	1.78	0.32	12.80	37
Mandate, Tax Credit = Tariff	3.79	1.83	1.77	0.07	13.51	13
No Programs	2.98	1.55	1.76	0.0	11.08	11

[a]Average U.S. wholesale price. Includes any RIN price.
[b]Wholesale domestic Brazilian ethanol price for anhydrous ethanol. The exchange rate is set at 1.75 reals per dollar.
[c]Billion gallons.
[d]Million gallons.

Figure Source: *Babcock et al. (2010)*

On the other hand, U.S. ethanol production increased from 3.9 billion gallons in 2005, when Congress created the RFS, to 13.9 billion in 2011 (declining to 13.3 billion gallons in 2012 due to

[9] Energy Information Administration, E*nergy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009*, p. 12, http://www.eia.gov/oiaf/servicerpt/hr2454/pdf/sroiaf(2009)05.pdf
[10] Wallace E. Tyner, Farzad Taheripour, and Chris Hurt, *Potential Impacts of a Partial Waiver of the Ethanol Blending Rules*, Farm Foundation and Purdue University, August 16, 2012, pp. 3-4, http://www.farmfoundation.org/news/articlefiles/1841-Purdue%20paper%20FINAL%20%2010-17-12.pdf
[11] Babcock, Barr, and Carriquiry, *Ibid.*, Table 1, p. 16

the drought).[12] Was it just a coincidence that ethanol production more than tripled after Congress created the RFS in 2005 and expanded it in 2007? If so, the RFS – at least to date – has much less impact on the U.S. motor fuel market than either proponents or critics contend.

As a plausible starting point, let's assume that in recent years, the RFS is responsible for increasing ethanol consumption by at least 2 billion gallons annually above a no-RFS baseline and potentially by as much as 6 billion gallons. Since ethanol has two-thirds the energy content of gasoline,[13] it follows that the RFS displaces 1.3-4.0 billion gallons of gasoline per year. Since each gallon of gasoline emits 2.791 kilograms of CO_2,[14] the gasoline currently displaced by ethanol would if combusted emit between 3.6 million and 11.2 million metric tons of CO_2 annually. Finally, if we assume that ethanol emits 20% less CO_2 than the gasoline it displaces, the RFS avoids between 744,000 and 2,223,800 metric tons of CO_2 annually.

At what cost? The RFS imposes costs on refiners,[15] livestock producers,[16] restaurants,[17] domestic food consumers,[18] motorists,[19] and grain-import dependent developing countries.[20] Estimates of these costs are controversial, but they range in the billions of dollars. Tufts University researcher Timothy Wise estimates that U.S. ethanol production cost developing countries $6.6 billion in higher corn prices from 2005-6 to 2010-11. That averages out to more than $1 billion annually.[21] The recent surge in renewable identification number (RIN) credit prices could increase gasoline prices by 7 cents per gallon this year, imposing a hidden fuel tax of $11.5 billion on motorists.[22] The Congressional Research Service (CRS) projects that the RFS

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[12] Renewable Fuels Association, Statistics, http://www.ethanolrfa.org/pages/statistics#A
[13] Energy Information Administration, Frequently Asked Questions: How much ethanol is in gasoline and how does it affect fuel economy? http://www.eia.gov/tools/faqs/faq.cfm?id=27&t=4
[14] International Carbon Bank & Exchange, http://www.icbe.com/carbondatabase/CO2volumecalculation.asp.
[15] NERA Economic Consulting, *Economic Impacts Resulting from Implementation of RFS2 Program*, October 2012, http://www.api.org/~/media/Files/Policy/Alternatives/13-March-RFS/NERA_EconomicImpactsResultingfromRFS2Implementation.pdf
[16] Thomas Elam, *Ethanol Production: Impact on Meat and Poultry Consumption, Value, and Jobs*, FarmEcon LLC, October 30, 2012, http://www.farmecon.com/Documents/RFS%20Meat%20production%20impacts%20ELAM%2010-30-12.pdf
[17] PWC, *Federal Ethanol Policies and Chain Restaurant Food Costs*, November 2012, http://www.nccr.net/flipbook/index.html#/0
[18] Thomas Elam, *Food Costs Are Eating American Family Budgets*, FarmEcon LLC, January 8, 2013, http://www.farmecon.com/Documents/Food%20Spending%20Eating%20American%20Budgets%20ELAM%201-8-13.pdf
[19] Bill Lapp and Dave Juday, "Biofuels Policy Itself Is Warning That It's Near Breaking Point," GlobalWarming.Org, May 1, 2013, http://www.globalwarming.org/2013/05/01/biofuels-policy-itself-is-warning-that-its-near-breaking-point/#more-16668
[20] Timothy A. Wise, *The Cost to Developing Countries of U.S. Corn Ethanol Expansion*, Global Development and Environment Institute Working Paper No. 12-02, October 2012, http://www.ase.tufts.edu/gdae/Pubs/wp/12-02WiseGlobalBiofuels.pdf
[21] Wise, Ibid., p. 3
[22] Lapp and Juday, Ibid.

will lead "to an annual increase in the cost of food per capita of about $10 by 2022, or over $3 billion."[23] This may be a gross underestimate.

According to economist Thomas Elam, in current 2012 dollars, the average U.S. consumer paid a 2012 food bill that was $514 higher than the pre-2005 food-price trend. For the nation as a whole, the above-trend food bill in 2012 was $162 billion. Of that, about $71.3 billion, or 44%, is "due to 2005-2012 price increases for grains, soybean products, DDGS [distiller's dried grains with solubles, an ethanol byproduct] and hay." Although other factors also contribute to food-price inflation, the RFS was an important factor, Elam contends.[24]

The fact that the RFS bestows windfalls on corn farmers, increasing demand for their product and increasing the value of farm land, does not negate or cancel out the costs imposed on others. Cap-and-trade is the appropriate analogy here. Those who receive free emission allowances reap windfalls, as do producers of low- and-zero carbon energy. Nonetheless, to assess the efficiency of the program, the per-ton cost of emission reductions must be estimated.

Let's begin with the implausible assumption that the costs of the RFS are as low as $100 million annually. If, as crudely estimated above, the RFS avoids 744,000 to 2,223,800 metric tons of CO_2 annually, the RFS reduces CO_2 emissions at a cost of $44.78 to $134.40 per ton. The higher of those costs is more than double the EIA-estimated price of ACESA emission permits in 2030.

If, as seems more realistic, the combined burden on adversely affected interests ranges in the billions of dollars, then the RFS is grossly inefficient compared to ACESA. For example, if refiners, livestock producers, and consumers combined pay only an additional $500 million annually, then the RFS costs between $223.90 and $672.00 per ton of CO_2 avoided. If ACESA's projected emission allowances prices had been that high, it likely would not have passed in the House.

Recommendation: Ask CBO to assess the cost-effectiveness of the RFS as a mitigation program. The analysis should reflect the range of estimates in reputable studies regarding: (a) How much the RFS increases ethanol consumption above a no-RFS baseline; (b) the life-cycle carbon intensity of ethanol compared to gasoline; and (c) the economic impacts on refiners, livestock producers, restaurants, food consumers, motorists, developing-country grain importers, and others who bear the costs of the RFS program.

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[23] Congressional Research Service, *Renewable Fuel Standard (RFS): Overview and Issues*, March 14, 2013, p. 17, http://www.fas.org/sgp/crs/misc/R40155.pdf

[24] Elam, Ibid, p. 6

Addendum: What do recent developments in domestic energy production and climate science indicate about the original rationales for the RFS program?

Congress enacted the RFS in 2005 and expanded it in 2007. That period was a high watermark of U.S. oil import dependence. The expert consensus at the time held that America was fated to become ever more dependent on imported oil and natural gas.

During those same years, Vice President Al Gore's *An Inconvenient Truth*, the Bali Road Map[25] (anticipating the Copenhagen climate conference), the devastation of New Orleans by Hurricane Katrina, the *Stern Review* on climate change economics,[26] and the IPCC's *Fourth Assessment Report*[27] set the terms of national debate on climate change.

The tenor of the times was, in a word, one of alarm. Fear of peak oil merged with fear of climatic disruption to produce a policy – the RFS – that aimed both to reduce U.S. oil dependence and mitigate global climate change. A lot has happened since then.

<u>Energy</u>

In recent years, the national security rationale for regulating America 'beyond petroleum' has become less persuasive, as advances in unconventional oil and gas production rapidly transform North America into a major hydrocarbon producing region. Imports as a share of U.S. petroleum consumption declined from 60% in 2005 to 40% in 2012.[28]

By 2011, more than half the imports came from the Western hemisphere, with Canada's share more than twice that of Saudi Arabia. Petroleum products became America's leading export for the first time in 2011,[29] and again topped the list in 2012.[30]

Some experts now view the "shale revolution" as a source of U.S. global leadership and geopolitical influence. U.S. hydrocarbon exports, they contend, have the potential to undermine Russia's leverage over Europe, weaken OPEC, improve relationships with friendly

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25 http://unfccc.int/key_documents/bali_road_map/items/6447.php

26 *Stern Review on the Economics of Climate Change*, 2006, http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/sternreview_index.htm

27 http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html

28 Energy Information Administration, "How dependent are we on foreign oil?" http://www.eia.gov/energy_in_brief/article/foreign_oil_dependence.cfm

29 AP, "In a first, gas and other fuels are top U.S. export," *USA Today*, December 31, 2011, http://usatoday30.usatoday.com/money/industries/energy/story/2011-12-31/united-states-export/52298812/1

30 U.S. Census Bureau, *U.S. International Trade in Goods and Services December 2012*, February 8, 2013, http://www.bea.gov/newsreleases/international/trade/2013/pdf/trad1212.pdf

nations such as Japan and South Korea, and strengthen the U.S. bargaining position vis-à-vis our top creditor – China.[31]

Analyses by Citibank,[32] Wood McKenzie,[33] and IHS Global Insight[34] support the assessment of energy analyst Mark Mills that "unleashing the North American energy colossus" could create millions of new jobs by 2020 and provide hundreds of billions in cumulative new federal, state, and local tax revenues.[35]

In a study released this week, Mills makes the case that more than two-thirds of America's annual $750 billion trade deficit could be eliminated if Congress and the Obama administration remove political impediments to hydrocarbon energy development, approve all qualified entities seeking to export natural gas, and direct the Department of Commerce to approve exports of crude oil.[36]

In short, a bright future for hydrocarbon energy now competes in the public mind with yester-year's gloomy prognostications of depletion, dependency, and decline. In 2007, legislators did not know how rapidly advances in directional drilling and hydraulic fracturing would change the U.S. energy outlook. The energy security assumptions underpinning the RFS are dated and, arguably, false. For this reason, too, the Committee's reassessment is timely and commendable.

Climate

For many years, a constant refrain of carbon mitigation advocates has been that climate change is "even worse" than scientists previously believed – as if all news about the state of the climate must inevitably be bad news. This once-fashionable narrative is losing credibility and influence.

One reason is simply that "it's worse than we predicted" is hard to square with a 15-year period of no-net global warming. The long pause in global warming is a development IPCC-affiliated scientists did not predict and struggle to explain.[37] Whatever the underlying causes, what

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[31] Testimony of Amy Meyers Jaffe, Subcommittee on Energy and Power, "U.S. Energy Abundance: Exports and the Changing Global Energy Landscape," May 7, 2013, http://docs.house.gov/meetings/IF/IF03/20130507/100793/HHRG-113-IF03-Wstate-JaffeA-20130507.pdf

[32] Citibank, *Energy 2020: North America, the New Middle East?* March 20, 2012, http://fa.smithbarney.com/public/projectfiles/ce1d2d99-c133-4343-8ad0-43aa1da63cc2.pdf

[33] Wood McKenzie, U*.S. Supply Forecast and Potential Jobs and Economic Impacts (2012-2020)*, September 7, 2011, http://www.api.org/newsroom/upload/api-us_supply_economic_forecast.pdf

[34] IHS, *The Economic and Employment Contributions of Shale Gas in the U.S.*, http://www.ihs.com/info/ecc/a/shale-gas-jobs-report.aspx

[35] Mark P. Mills, *Unleashing the North American Energy Colossus: Hydrocarbons Can Fuel Growth and Prosperity*, Manhattan Institute Power & Growth Initiative Report, No. 1, July 2012, http://www.manhattan-institute.org/html/pgi_01.htm#notes

[36] Mark P. Mills, *The Case for Exports: America's Hydrocarbon Industry Can Revive the Economy and Eliminate the Trade Deficit*, Power & Growth Initiative Report No. 3 May 2013, http://www.manhattan-institute.org/html/pgi_03.htm

[37] Judith Curry, "Has Trenberth Found the Missing Heat?" March 29, 2013, http://judithcurry.com/2013/03/29/has-trenberth-found-the-missing-heat/

cannot be denied, NASA scientist Roy Spencer argues, is that the observed rate of warming over the past 15 years is lower than the IPCC's best estimate.[38]

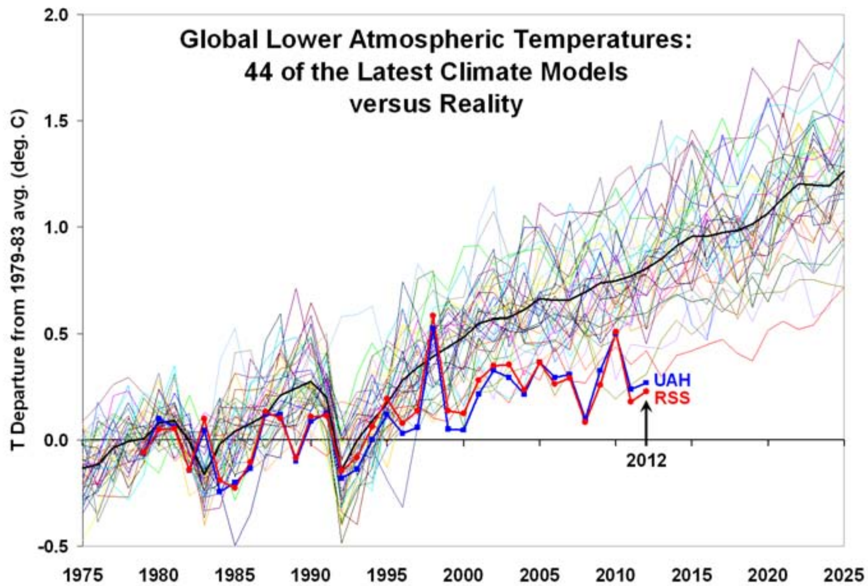

Figure Source: *John Christy and Roy Spencer. The thin colored lines are climate model projections of global temperature change. The black line is the IPCC best estimate. The thicker red and blue lines are satellite-based temperature observations.*

There are competing hypotheses but a plausible explanation, based on several 2012 studies summarized by Cato Institute climatologist Chip Knappenberger, is that the climate system is less sensitive to greenhouse forcing than "consensus" science had assumed.[39]

[38] Roy Spencer, "Global Warming Slowdown: The View from Space," April 13, 2013, http://www.drroyspencer.com/2013/04/global-warming-slowdown-the-view-from-space/

[39] Chip Knappenberger, "Global Lukewarming: Another Good Intellectual Year (2012 Edition)," MasterResource.Org, February 4, 2013, http://www.masterresource.org/2013/02/lukewarmers-2012-edition/

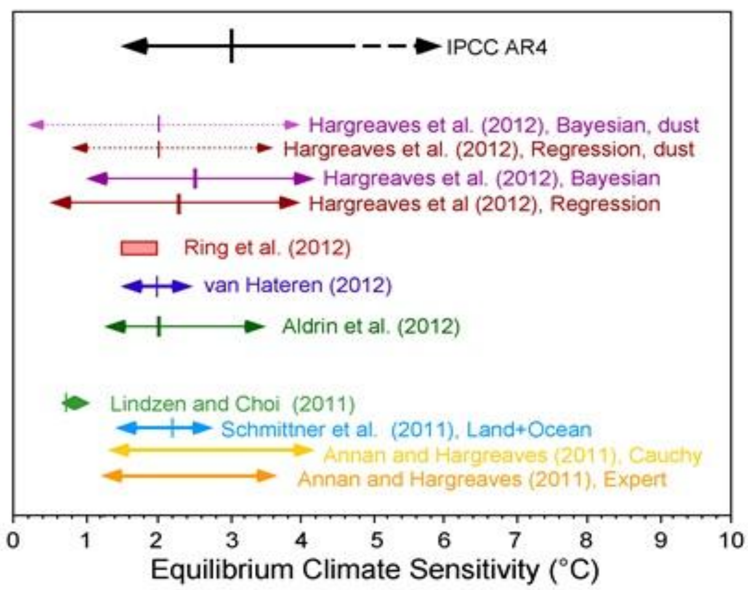

Figure explanation*: Climate sensitivity estimates from new research published since 2010 (colored), compared with the range given in the IPCC Fourth Assessment Report (black). The arrows indicate the 5 to 95% confidence bounds for each estimate along with the mean (vertical line) where available. Ring et al. (2012) present four estimates of the climate sensitivity and the red box encompasses those estimates. The right-hand side of the IPCC range is dotted to indicate that the IPCC does not actually state the value for the upper 95% confidence bound of their estimate. The thick black line represents the IPCC's "likely" range.*

Otto et al. (2013), a study published this week in *Nature*, also indicates that climate sensitivity is at the low-end of the IPCC range.[40] "Using up-to-date data on radiative forcing, global mean surface temperature and total heat uptake in the Earth system," the researchers conclude that the "most likely value" for equilibrium climate sensitivity (ECS) is 2.0°C. In addition, based on observations of the most recent decade, they conclude that the "best estimate" for "the more policy-relevant" transient climate response (TCR)[41] is 1.3°C.

As noted by one of the co-authors, Nicholas Lewis, 14 of the researchers are lead or coordinating authors of IPCC AR5 WGI chapters, and two – Myles Allen and Gabi Hegerl – are

[40] Alexander Otto, Friederike E. L. Otto, Olivier Boucher, John Church, Gabi Heger, Piers M. Forster, Nathan P. Gillett, Jonathan Gregory, Gregory C. Johnson, Reto Knutti, Nicholas Lewis, Ulrike Lohmann, Jochem Marotzke, Gunnar Myhre, Drew Shindell, Bjorn Stevens and Myles R. Allen. Energy Budget Constraints on Climate Response, *Nature Geoscience*, May 19, 2013, http://www.nature.com/ngeo/journal/vaop/ncurrent/pdf/ngeo1836.pdf

[41] TRC is "The global average surface air temperature averaged over a 20-year period centered at the time of CO_2 doubling in a 1% yr–1 increase experiment." IPCC, Climate Change 2007, Working Group I: The Physical Science Basis, T.S.4.5 Climate Response to Radiative Forcing, http://www.ipcc.ch/publications_and_data/ar4/wg1/en/tssts-4-5.html

lead authors of the chapter discussing ECS and TCR estimates as constrained by observational evidence.[42] Lewis describes the significance of the study as follows:

> The take-home message from this study, like several other recent ones, is that the 'very likely' 5–95% ranges for ECS and TCR in Chapter 12 of the leaked IPCC AR5 second draft scientific report, of 1.5–6/7°C for ECS and 1–3°C for TCR, and the most likely values of near 3°C for ECS and near 1.8°C for TCR, are out of line with instrumental-period observational evidence.

Lower climate sensitivity means less warming, hence less damaging climate change impacts. That's good news.

But wait, there's more! In 2006-2007, Al Gore's *An Inconvenient Truth*,[43] Joseph Romm's *Hell and High Water*,[44] and Fred Pearce's *With Speed and Violence*[45] popularized scary climate change impact scenarios, such as ice sheet disintegration and catastrophic sea-level rise, dramatic increases in extreme-weather frequency and/or severity, and climate-destabilizing releases of CO_2 and methane from melting permafrost. Recent scientific studies undercut the credibility of those scenarios. A partial list follows:

- **King et al. (2012)**: The rate of Antarctic ice loss is not accelerating and translates to less than one inch of sea-level rise per century.[46]
- **Faezeh et al. (2013)**: Greenland's four main outlet glaciers are projected to contribute 19 to 30 millimeters (0.7 to 1.1 inches) to sea level rise by 2200 under a mid-range warming scenario (2.8°C by 2100) and 29 to 49 millimeters (1.1 to 1.9 inches) under a high-end warming scenario (4.5°C by 2100).[47]
- **Weinkle et al. (2012)**: There is no trend in the strength or frequency of land-falling hurricanes in the world's five main hurricane basins during the past 50-70 years.[48]
- **Chenoweth and Divine (2012)**: There is no trend in the strength or frequency of tropical cyclones in the main Atlantic hurricane development corridor over the past 370 years.[49]

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[42] Nic Lewis, "New energy-budget derived estimates of climate sensitivity and transient response in *Nature Geoscience*," Bishop Hill Blog, May 19, 2013, http://bishophill.squarespace.com/blog/2013/5/19/new-energy-budget-derived-estimates-of-climate-sensitivity-a.html

[43] Al Gore, *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (New York: Rodale, 2006)

[44] Joseph Romm, *Hell and High Water: Global Warming – the Solution and the Politics – and What We Should Do* (New York: William Morrow, 2007)

[45] Fred Pearce, *With Speed and Violence: Why Scientists Fear Tipping Points in Climate Change* (Boston: Beacon Press, 2007)

[46] Matt A. King, Rory J. Bingham, Phil Moore, Pippa L. Whitehouse, Michael J. Bentley & Glenn A. Milne, 2012. Lower satellite-gravimetry estimates of Antarctic sea-level contribution. *Nature*, Vol. 491, 586–589, http://www.nature.com/nature/journal/v491/n7425/full/nature11621.html

[47] Faezeh M. Nick, Andreas Vieli, Morten Langer Andersen, Ian Joughin, Antony Payne, Tamsin L. Edwards, Frank Pattyn & Roderik S. W. van de Wal, 2013. Future sea-level rise from Greenland's main outlet glaciers in a warming climate. *Nature*, Vol. 497, 235-238, http://www.nature.com/nature/journal/v497/n7448/full/nature12068.html

[48] Jessica Weinkle, Ryan Maue, Roger Pielke, Jr., 2012. Historical Tropical Cyclone Landfalls. *Journal of Climate*, Vol. 25, 4729-4735, http://sciencepolicy.colorado.edu/admin/publication_files/2012.04.pdf

- **Bouwer (2011)**: There is no trend in hurricane-related damages since 1900 once economic loss data are adjusted for changes in population, wealth, and the consumer price index.[50]
- **NOAA**: There is no trend since 1950 in the frequency of strong (F3-F5) U.S. tornadoes.[51]
- **National Climate Data Center**: There is no trend since 1900 in U.S. soil moisture as measured by the Palmer Drought Severity Index.[52]
- **Hirsch and Ryberg (2011)**: There is no trend in U.S. flood magnitudes over the past 85 years.[53]
- **Dmitrenko et al. (2011)**:[54] Even under the most extreme climatic scenario tested, permafrost thaw in the Siberian shelf will not exceed 10 meters in depth by 2100 or 50 meters by the turn of the next millennium, whereas the bulk of methane stores are trapped roughly 200 meters below the sea floor.[55]
- **Kessler et al. (2011):** Microbes digested the methane released during the 2010 BP Deepwater Horizon oil spill. Any future warming-induced "large-scale releases of methane from hydrate in the deep ocean are likely to be met by a similarly rapid methanotrophic response."[56]
- **Sistla et al. (2013)**: Over the past two decades, warming increased net eco-system carbon storage in the Arctic tundra as the growth of woody biomass outpaced the increase in CO_2 emissions from subsoil microbial activity.[57]
- **Goklany (2009)**: Global deaths and death rates related to extreme weather have declined by 93% and 98%, respectively, since the 1920s.[58]

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- **Range et al. (2012)**: There is no evidence of CO_2-related mortalities of juvenile or adult mussels "even under conditions that far exceed the worst-case scenarios for future ocean acidification."[59]

Notwithstanding such studies, the paradigm of climate disruption still has plenty of fight in it – more so than the paradigm of peak oil. In part, that is because *climate* risk is easily confused with climate *change* risk. Due to their sheer magnitude and terror, natural catastrophes have an almost super-natural aspect. People by nature are prone to imagine that natural disasters have non-natural causes. Thus, each time natural disaster strikes, pundits – especially those with scientific credentials – can plausibly blame fossil fuels and declare "it's worse than we predicted."

Many commentators and even some scientists, for example, implied or asserted that Hurricane Sandy, or its immense devastation, would not have occurred but for global warming. There was, however, no real science to support that narrative.

Roughly 95 tropical storms have hit New York since the 18th century. The strongest on record was the New England Hurricane of 1938, a category 3 storm that killed upwards of 600 people.[60]At the time, global CO_2 concentrations were 310 parts per million[61] – well below the 350 ppm concentration deemed the maximum safe level by former NASA scientist James Hansen.[62]

Sandy was a category 1 storm before making landfall in the Northeast.[63] What made Sandy a "super storm" was its merging with a winter, frontal storm. Some commentators insinuated that any such "frankenstorm" must, like the monster in Mary Shelley's novel, be man-made (anthropogenic). MIT's Kerry Emanuel cautioned that scientists "don't have very good theoretical or modeling guidance on how hybrid storms might be expected to change with climate." He added: "I feel strongly about that. I think that anyone who says we do know that is not giving you a straight answer."[64]

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[58] Indur Goklany, Death and Death Rates from Extreme Weather Events: 1900-2008, *Journal of American Physicians and Surgeons*, Vol. 14, No. 4, Winter 2009, http://www.jpands.org/vol14no4/goklany.pdf

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[63] Willie Drye, "A Timeline of Hurricane Sandy's Path of Destruction," *National Geographic*, November 2, 2012, http://newswatch.nationalgeographic.com/2012/11/02/a-timeline-of-hurricane-sandys-path-of-destruction/

[64] Lisa Palmer, "Hybrid Hell Entry 1: Hurricane Sandy is a kind of storm scientists don't understand well," *Slate*, October 29, 2012,

New York Times columnist Andrew Revkin commendably points out that societal factors determine the magnitude of devastation from extreme weather events to a far greater degree than any possible modification of the climate system. In a column on the recent Oklahoma tornado, he writes:

> I'll add a final thought about the persistent discussion of the role of greenhouse-driven climate change in violent weather in Tornado Alley. . . .It's an important research question but, to me, has no bearing at all on the situation in the Midwest and South — whether there's a tornado outbreak or drought. The forces putting people in harm's way are demographic, economic, behavioral and architectural. Any influence of climate change on dangerous tornadoes (so far the data point to a moderating influence) is, at best, marginally relevant and, at worst, a distraction.[65]

James Hansen is probably the most influential purveyor of the alarm narrative. During the height of last year's drought, he published an op-ed in the *Washington Post* titled "Climate change is here – and worse than we thought." [66] Hansen's evidence was a study that he and two colleagues published in *Proceedings of the National Academy of Sciences*.[67] He contended that the worst hot spells of recent years – the European heat wave of 2003, the Russian heat wave of 2010, the Texas-Oklahoma drought of 2011, and the Midwest drought of 2012 – were "a consequence of climate change" and have "virtually no explanation other than climate change."

There was just one problem. The Hansen team did not examine any of those events to assess the relative contributions of natural variability and global warming. They provided no event-specific evidence that the particular heat wave or drought would not have occurred, or would have been less than record-breaking, in the absence of climate change.

Other scientists did undertake meteorological analyses of those events, and in each case they attributed the event principally to natural variability.

Chase et al. (2006)[68] found "nothing unusual" in the 2003 European heat wave that would indicate a change in global climate. The global temperature map included in the study is telling.

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http://www.slate.com/articles/health_and_science/science/features/2012/hurricane_sandy_and_climate_change/hurricane_sandy_hybrid_storm_kerry_emanuel_on_climate_change_and_storms.html

[65] Andrew Revkin, "A Survival Plan for America's Tornado Disaster Zone," *New York Times*, May 21, 2013, http://dotearth.blogs.nytimes.com/2013/05/21/a-survival-plan-for-americas-tornado-danger-zone/

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[68] Thomas N. Chase, Klaus Wolter, Roger A. Pielke Sr., Ichtiaque Rasool, 2006. Was the 2003 European Heat Wave Unusual in a Global Context? Geophysical Research Letters, Vol. 33, Issue 23, http://onlinelibrary.wiley.com/doi/10.1029/2006GL027470/abstract

During June, July, and August 2003, more than half the planet was cooler than the mean temperature from 1979 through 2003. Europe – a tiny fraction of the Earth's surface – was the only place experiencing high heat. Europe's anomalous heat was due to local meteorology – atmospheric blocking. There was no discernible link to global climatic factors.

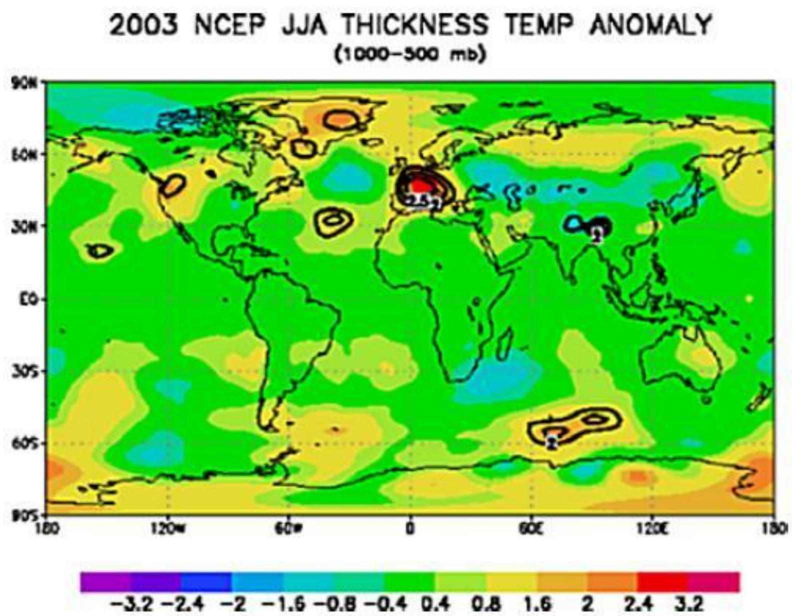

Figure explanation *(courtesy of World Climate Report[69]): 1000–500 mb thickness temperature anomaly for June, July, and August 2003. Green and blue tones indicate below-normal temperature anomalies.*

Similarly, NOAA scientists[70] found that the 2010 Russian heat wave "was mainly due to natural internal atmospheric variability." The study specifically addressed the question of a possible linkage to anthropogenic climate change:

> Despite this strong evidence for a warming planet, greenhouse gas forcing fails to explain the 2010 heat wave over western Russia. The natural process of atmospheric blocking, and the climate impacts induced by such blocking, are the principal cause for this heat wave. It is not known whether, or to what extent, greenhouse gas emissions may affect the frequency or intensity of blocking during summer. It is important to note that observations reveal no trend in a daily frequency of July blocking over the period since 1948, nor is there an appreciable trend in the absolute values of upper tropospheric summertime heights over western Russia for the period since 1900.

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[69] European Heat Wave of 2003: A Global Perspective, *World Climate Report*, January 31, 2007, http://www.worldclimatereport.com/index.php/2007/01/31/european-heat-wave-2003-a-global-perspective/

[70] Dole, R. M. Hoerling, J. Perlwitz, J. Eischeid, P. Pegion, T. Zhang, X. Quan, T. Xu, and D. Murray, 2010. Was There a Basis for Anticipating the Russian 2010 Heat Wave? *Geophysical Research Letters*, 38, L06702, doi:10.1029/2010GL046582, http://www.esrl.noaa.gov/psd/csi/events/2010/russianheatwave/papers.html

The Texas-Oklahoma drought of 2011 broke heat and drought records in several climate divisions in Texas, Oklahoma, and New Mexico. The world is experiencing a period of climatic warmth, and greenhouse gas concentrations keep rising. However, correlation does not prove causation. A complicated analysis is required before one could detect and, if possible, quantify the contribution of climate change to this regional anomaly.

Texas State Climatologist John Nielsen-Gammon conducted a "preliminary analysis" of the role of global warming in the Texas drought.[71] Although not definitive, the study is probably the most thorough analysis to date. Nielsen-Gammon estimates that climate change contributed 0.9°F of the 5.4°F above-average warmth, which was chiefly caused by drought (lack of evaporative cooling). The drought, in turn, has no discernible link to climate change. From 1895 to 2010, precipitation in Texas increased overall by more than 10%, and Texas precipitation variability has not changed since 1920.

Nielsen-Gammon concluded that "even without global warming," the hot spell in Texas "would have broken the all-time record for summer temperatures," and the drought would have been "an outlier and record-setter."

As for the Midwest drought of 2012, NOAA scientists attribute it chiefly to natural variability.[72] From the agency's Web site:

> The central Great Plains drought during May-August of 2012 resulted mostly from natural variations in weather.
>
> - Moist Gulf of Mexico air failed to stream northward in late spring as cyclone and frontal activity were shunted unusually northward.
> - Summertime thunderstorms were infrequent and when they did occur produced little rainfall.
> - Neither ocean states nor human-induced climate change, factors that can provide long-lead predictability, appeared to play significant roles in causing severe rainfall deficits over the major corn producing regions of central Great Plains.

Based on the foregoing discussion of extreme heat events and the studies cited above, I conclude that "worse than we thought" assessments of climate change are not consistent with the best available science. To the contrary, the climate change outlook is better than we have long been told.

In 2007, most legislators did not know that the world was warming more slowly than feared, that long-term hurricane behavior was not changing, that runaway warming from permafrost

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[71] John Nielsen-Gammon, Texas Drought and Global Warming, *Climate Abyss*, September 9, 2011, http://blog.chron.com/climateabyss/2011/09/texas-drought-and-global-warming/

[72] NOAA, An Interpretation of the Origins of the 2012 Central Plains Drought, http://drought.gov/media/pgfiles/DTF%20Interpretation%20of%202012%20Drought%20FINAL%202%20pager.pdf

melting and methane releases was wildly implausible, and that the great ice sheets were more likely to contribute inches rather than feet to sea-level rise.

The scientific assumptions underpinning the RFS are dated and, arguably, false. For this reason, too, the Committee's reassessment of the RFS program is timely and commendable.

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Renewable Fuels Standard Assessment White Paper
The Committee on Energy and Commerce

CountryMark is Indiana's only American-owned oil refining and marketing company and is recognized as a leader in the distribution of biodiesel and ethanol. The CountryMark refinery uses 100% American crude oil sourced from the Illinois Basin located in Illinois, southwest Indiana, and western Kentucky. Our refinery processes 28,000 barrels of crude per day which represents only 0.15% of the entire domestic refining industry. Even though CountryMark is small from a refining industry perspective, we have a large impact on the State of Indiana. CountryMark supplies over 75% of the agricultural market fuels and 50% of school district fuels in the state.

CountryMark is owned and controlled by its member cooperatives that are in turn owned and controlled by individual farmers within our trade territory. Over 100,000 farmers in Indiana, Michigan, and Ohio participate in these local cooperatives who own CountryMark. CountryMark's Board of Directors is comprised of farmers. Each year, profits are distributed back to these farmers via the cooperative system. These distributions remain in rural communities where the dollars support local economies.

CountryMark appreciates the opportunity to comment on the Renewable Fuels Standard (RFS) Assessment White Paper #3: *The Environmental Impacts of Renewable Fuel Standard* and provide valuable information as the Committee on Energy and Commerce deliberates changes to the RFS.

On the following pages you will find input on many of the questions that were posed in the RFS Assessment White Paper. For continuity, the question numbers are consistent with those in the solicitation. CountryMark has decided to only address questions that are related to our business.

1. *Is the RFS reducing greenhouse gas emissions below that of baseline petroleum-derived fuels?*

   Figure 1 illustrates the life cycle of oil and ethanol processing. On an equivalent energy life cycle basis, the RFS is not reducing greenhouse gas emissions below that of the baseline of petroleum-derived fuels. One barrel of diesel can support the exploration, drilling, extraction, and refining to make nine new barrels of petroleum products; one of which is feed stock for the chemical industry. To produce the same net energy of eight barrels of motor fuels, 32 barrels of ethanol are required.

   Important items that should be noted from Figure 1:

   a.) This illustration includes the entire life cycle, on an energy equivalence basis, of both fuel products. Often times only a combustion comparison is provided for analysis, which is misleading to the reader. On a combustion basis, ethanol results in lower emissions because the fuel is a lower energy density. Oil production and refining into transportation fuels results is less GHG emissions than planting and harvesting corn, followed by fermentation and separation that is required for ethanol production.

   b.) Figure 1 is a complete mass and energy balance for equivalent energy production, including emissions and water consumption from both energy processes.

c.) A comparison of water requirements is provided for both processes. 2,500 gallons of water is required to convert 9 barrels of oil into products. 2,700,000 gallons of water is required for the same energy production of ethanol.

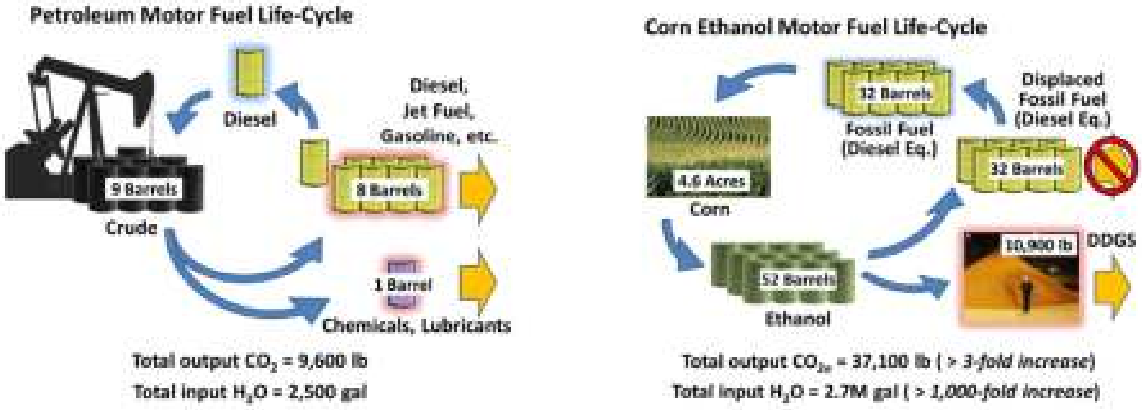

Figure 1. Life Cycle Comparison of Crude Oil and Biofuels [1]

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

The RFS will not produce further greenhouse gas emission reductions. Considering the lifecycle of the process, biofuels cannot compete with fossil fuel on an energy equivalent basis and therefore on an emissions basis. Renewable fuels require fossil fuels as inputs to the process to a greater extent than exploration, production, refining, and transportation of those same fossil fuels.

In addition to the higher demand of fossil fuel, supplementary land is required for production of biomass than is required for oil production. 40% of the domestic corn crop is used for ethanol production, resulting in land being converted from forestry or wildlife habitat to farming to support food production. Land conversion is not confined to property within the United States, but is occurring in several countries without strong citizen land rights, such as Sudan and Liberia[2]. Millions of acres around the world are being confiscated for food and biofuels production to meet the needs of industrialized nations.

While this practice may reduce food resources for local populations, it results in increased greenhouse gas emissions through converting environmentally sensitive areas to corn production for the biofuels industry. After several production cycles, land is no longer suitable for biomass production; requiring new land to be developed. This land conversion removes large CO_2 sinks resulting in a net increase in greenhouse gas emissions. In the end, biofuels do not reduce greenhouse gas emissions; however, small business refiners like CountryMark are still mandated to use such fuels. The result of which reduces our market share, increases our operating costs, and decreases the profit sharing opportunity for our farmer owners.

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

   EPA needs to consider the overall result of implementing the RFS program; which includes life cycle impacts and indirect land usage. EPA should measure changes in all GHG emissions specifically related to policy changes, such as RFS. Most of the domestic corn used for ethanol production today was previously being produced for human and livestock consumption. After accounting for the annual increase in corn yield, 11% more corn was produced to meet ethanol demand. 89% of the corn growth was already part of the CO_2 balance prior to RFS implementation.

This policy change has resulted in an increase in CO_2 emissions, not a decrease in emissions. While the emissions as a result of planting and harvesting corn moderately increased, the additional fossil fuels required to produce ethanol, purify, and deliver it to market have increased CO_2 emissions. NO_x emissions have also increased as a result of the fertilizer required to increase corn yield per acre.

Evaluating the ethanol fermentation process, one third of the carbon in the process can be used for transportation fuels, one third is released back into the atmosphere as CO_2, and the final third is used for livestock feed. Resultant energy available as transportation fuel from ethanol production is only about 25% greater than the energy required to produce the product. As a comparison, fossil fuels result in 800%-1000% greater energy available than the energy required for production of the product[1].

In addition, indirect land use is another unintended consequence releasing more GHG emissions due to land use changes. Land use is converted by expanding crop growth for biofuels production from forestry land. Land switching is a driven by higher corn prices on a world wide scale.

4. *What are the non-greenhouse gas impacts of the RFS on the environment relative to a comparable volume of petroleum-derived fuels?*

Non-greenhouse gas impacts of the RFS are higher food costs. Those who promote renewable fuels state that livestock feed corn are used for ethanol production[3]. While the specific corn product is different, land and water used for corn growth is the same. This is an opportunity cost that biofuel corn is planted in place of food grade corn. Figure 2 illustrates the switch that has occurred since the implementation of RFS. Data is from USDA.

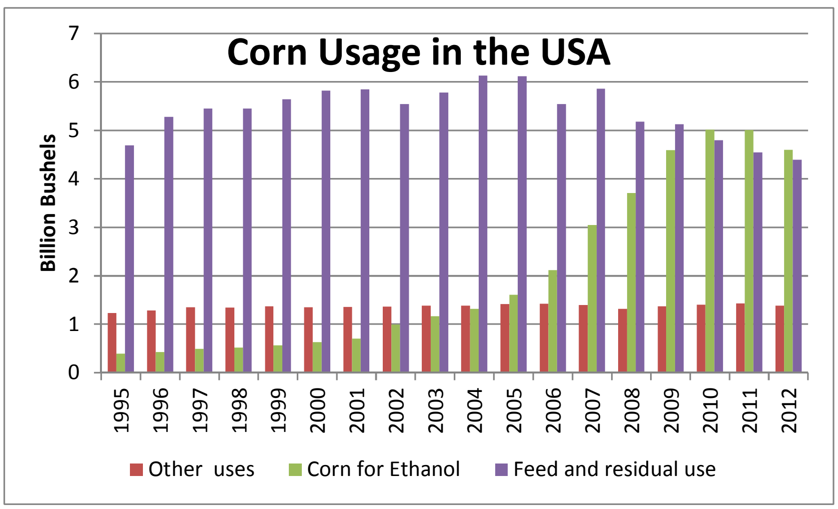

Figure 2. Corn Usage in the United States

Petroleum products are used to transport goods and services throughout the US and world economy. Those who promote biofuels argue that higher food prices are only a result of higher oil prices[4]. While oil prices have an impact on all goods and services, oil prices are not the largest contributor to food prices. As oil prices change over time, prices for all goods and services will generally follow the same trend. Food prices are not only impacted by the cost of planting, harvesting, and transporting goods to market, they also compete with RFS obligations for the same resources (primarily land and water).

A second non-greenhouse gas impact of the RFS on the environment is the incompatibility of ethanol with fuel systems. Ethanol is more corrosive than gasoline or other oxygenates blend stocks. Ethanol blended gasoline has been proven to dissolve plastic fuel tanks in marine vessels and other small combustion devices. All of the waste fuel systems and damaged parts find their way to the local land fill.

The third unintended consequence of RFS is the mixing of gasoline, ethanol, and water. When a containment breach occurs, ethanol and gasoline are released into the environment. Ethanol is well mixed in both gasoline and water, resulting in gasoline being mixed into the water phase instead of floating on top of the water as a separate phase. A mixture of water, ethanol, and gasoline is more damaging to ecosystems and more difficult to clean up than a mixture of just water and gasoline because it will migrate further into soil when released.

CountryMark, like other small business refiners that operate terminal operations or retail marketing have an increased exposure for potential environmental liability due to the corrosive nature of ethanol and its behavior when blended with gasoline. This exposure increases the insurance requirements which in turn increases operating costs and decreases profitability. Since small business refiners have less volume to distribute costs, the higher cost per barrel puts this segment of the industry at a competitive disadvantage.

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

   A challenge that has been created by the RFS is nitrogen oxide (N_2O) being released into the atmosphere through the crop fertilization process. N_2O has almost 300 times the GHG effect as CO_2 and is not regulated or controlled. Several studies have published results stating that conventional fuel consumption will result in less GHG emissions than developing new land for Biomass fuel production[5]. In comparison, CountryMark has had to spend significant capital and expense to control nitrogen oxide emissions from our refining operation.

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

   A minimum percentage of biofuels in fossil fuel blends should not be regulated. The optimal percentage of ethanol in gasoline or biodiesel in diesel should be decided by the market, not by Federal regulations. Both biomass products have value in the transportation fuels market, but the government should not take the position to regulate the fuels markets. In an open market, consumers and producers will set the blending percentage based on buying preferences and commodity pricing. As refiners are able to profit from biofuels blending and consumer demand is sustainable, higher volumes will be blended.

   The maximum percentage of ethanol blended should be determined by industries involved in the production, transportation, and consumption of fuel products. Companies participating in this market should be permitted to set fuels standards for blending instead of the government regulating fuel specifications under the umbrella of RFS compliance. This model has worked well for other sectors to develop industry standards and comply with them. Some specific examples of systems that are impacted through this regulation are listed below:

   a) Fuels transportation system. Ethanol cannot be transported by pipeline, the most cost effective, efficient, and lowest GHG emissions method of shipping transportation fuels. Ethanol must be transported by rail or truck to distribution points where it is mixed into final fuel blends for sale.

   b) Fuel station systems must be designed to store and dispense ethanol blended gasoline because of the corrosive nature of ethanol.

c) Auto manufacturers design the automobile fuel storage, delivery, and combustion systems to be compatible with specific fuel types. Currently auto manufacturers are not recommending use of E15, stating that consumption will void their warranty.

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

   Best options for reducing greenhouse gas emissions is not to regulate the market, but enable companies to perform and drive innovative solutions; principles that made America great in previous decades. Many companies developing solutions in a competitive environment will lead to long term success as opposed to government agencies selecting winners and losers in the transportation fuels industries. Under the current model, the government is mandating the oil industry to sell biofuels products instead of enabling competition among producers.

   CountryMark started blending ethanol at ten percent long before being obligated under the RFS because it made economic sense. CountryMark also started blending biodiesel in 2005 because our customers wanted to purchase the product. This supported the renewable fuels industry which provides our owners with an alternative use for their products. Renewable fuels were growing without government mandates. With the government mandates, commodity prices have increased due to the increased amounts of corn and soybeans being used to produce fuels.

   The RFS is picking winners and losers in the fuel industry and by doing so is also choosing those communities and citizens that will benefit because in a world of declining fuel demand the RFS favors the biomass fuel production at the expense of the known economic benefits provided by CountryMark. The RFS should be revised to eliminate the mandates and enable the market to determine the appropriate blending ratio of biofuels with fossil fuels.

Thank you for your consideration of these comments. As Congress moves to address the Renewable Fuels Standard and the significant challenges that it presents in the current transportation fuels market, CountryMark will be an enthusiastic and valuable participant in your deliberations.

For further information or any questions, please contact Matt Smorch, Vice President – Strategy, Countrymark Cooperative Holding Corporation, 225. S. East Street Suite 144, Indianapolis, IN 46022 (office: 317-238-8228; email: matt.smorch@CountryMark.com).

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May 24, 2013

VIA ELECTRONIC MAIL
rfs@mail.house.gov

The Honorable Fred Upton
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The Honorable Henry A. Waxman
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Dear Chairman Upton and Ranking Member Waxman:

On behalf of the DuPont Company, I am pleased to offer the following responses to stakeholder questions that accompanied the House Energy and Commerce Committee's white paper on Greenhouse Gas Emissions and Other Environmental Impacts released on May 9, 2013. The white paper and stakeholder questions raise key issues and DuPont is well positioned to provide constructive feedback. I look forward to working with you and the entire Committee in providing additional responses to the RFS-related white papers planned for later this year.

DuPont is an industry leader in providing advantaged products for agricultural energy crops, feedstock processing, animal nutrition, and biofuels. Our three-part approach to biofuels includes: (1) improving existing ethanol production through differentiated agriculture seed products, crop protection chemicals, as well as enzymes and other processing aids; (2) developing and supplying new technologies to allow conversion of cellulose to ethanol; and (3) developing and supplying next generation biofuels with improved performance, such as biobutanol.

DuPont has been a global leader in greenhouse gas emission reduction for many years, having begun systematic reduction of emissions from our operations almost two decades ago. Between 1990 and 2004 DuPont reduced our global greenhouse gas emissions by more than 70%. By 2015 we will further reduce our greenhouse gas emissions at least 15% from a revised base year of 2004 that reflects portfolio changes. We believe biofuels have a critical role to play in the development of alternatives for the transportation fuels sector, in ways that are renewable, cost-effective, and commercially viable in multiple geographies with minimal environmental footprints.

The RFS has been critical in incenting substantial private sector investments in conventional and advanced renewable fuels. Those fuels have produced meaningful environmental benefits, and the future fuels under the RFS will have even greater environmental benefits. DuPont has developed technologies, demonstrated them at representative scales and developed robustly engineered process technologies. One third of the way into the lifespan of the RFS we are constructing our first cellulosic ethanol production facility and are in active discussions with multiple parties to begin commercialization of bio-butanol. Any changes to the RFS at this critical juncture would risk both devaluing the substantial investments we have made and limiting the future environmental benefits anticipated under the RFS.

Questions for Stakeholder Comment

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

Response: The RFS is by its construction affirmatively reducing GHG emissions and spurring the commercialization of lower GHG fuels and has the potential, as it continues to expand, to play a significant role in reducing the GHG intensity of US transportation.

To comply with the RFS renewable fuels must meet minimum standards of GHG performance over petroleum fuels, and that performance grows as the RFS reaches maturity in grain ethanol production and future growth is in advanced renewable fuels such as cellulosic ethanol, which has a GHG lifecycle performance some 90% better than gasoline. Under the RFS grain ethanol is at minimum 20% better than gasoline on a GHG basis, and as grain ethanol production technology is refined and the quality of petroleum crudes decline that relative improvement only grows. With advanced biofuels the minimum standard is 50% to 60% better than gasoline, and for many of these new generation fuels which are now being commercialized that improvement is significantly better than these minimums. There is near unanimous agreement that biofuels derived from cellulosic sources give significant reductions in GHG emissions versus gasoline.[1]

As domestic grain ethanol capacity is already near the 15 billion gallons that are the upper limit under the RFS, the future growth of domestic renewable fuel production under the RFS will be in these increasingly cleaner fuels.

There are also additional GHG benefits arising from the RFS. For example, several of the cellulosic ethanol technologies being commercialized use agricultural residues such as corn stover as a feedstock. As crop residues are partially removed from the field to become feedstock for cellulosic biofuels, there is evidence that lower tillage practices can be adopted,

[1] Althoff k. et al., DuPont, Sustainable Solutions from Feedstock to Fuel for Advance Biofuel Production, Chapter 18 in Sustainable Alternative Fuel Feedstock Opportunities, Challenges and Roadmaps for Six U.S. Regions, Proceedings of the Sustainable Feedstocks for Advance Biofuels Workshop, Editor(s): Ross Braun, Doug Karlen, and Dewayne Johnson, Published Online: September 27, 2011 at: www.swcs.org/roadmap.

which has the potential to result in further GHG savings.[2] In addition, these cellulosic ethanol facilities are often integrated with existing grain ethanol facilities, and they produce co-product solid fuels that can be used to produce power for both the grain and cellulosic operations, offsetting fossil fuels otherwise used for that purpose, and thereby further reduce the GHG intensity of the resulting fuels.

The RFS2 renewable fuels volumes offer the promise of further and significant reductions to the U.S. transportation greenhouse gas footprint.

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

Response: Like any modeling-based analytical tool EPA's life cycle method for calculating life cycle GHG emissions can be improved, and EPA has all the authority it needs to make improvements over time. No statutory changes need to be nor should be made.

For example, when EPA included theoretical land use change effects in the life cycle modeling approach the science was in its very early stages, and there were many data gaps. Data quality and quantity for determining potential land use change effects has improved dramatically over the past several years. The volume of corn grain ethanol under the RFS is nearly at its maximum. There should be enough data available currently to validate the accuracy of many of the assumptions and calculations that were initially included in the RFS.

As the Renewable Fuels Association detailed in a November 2012 letter to Lisa Jackson, analytical improvements and the availability of more robust data provide a good basis for EPA to improve its methodology for calculating lifecycle greenhouse gas emissions associated with renewable fuels. The improved analysis and data is related to: the types of land most likely to be converted, the most likely location of predicted conversions, crop yields on newly converted lands, crop yield responses to changes in prices, carbon stocks and emissions from land conversion, the effects of animal feed co-products on land use, and crop switching/cross-commodity effects. EPA's current methodology evaluates land use impacts as if one biofuel was increasing in production rather than simulating concurrent increases in the various biofuels required by the RFS.

Another area in which improvements could be made by EPA is in transparency of the modeling. The methodology used by EPA makes it very difficult to quantify how changes other than process energy use would affect the lifecycle GHG emissions. Utilizing an approach similar to California's Low Carbon Fuel Standard LCA calculations, with an attributional methodology to determine the GHG impact of the fuel and an additional consequential approach used for determining the indirect land use change impact, would offer much greater transparency into the calculations.

Lastly, EPA's calculations could be updated to reflect the increasingly heavy and carbon intensive crudes that are entering the US and other markets, which are degrading the GHG intensity of petroleum fuels against which steadily improving renewable fuels are compared.

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[2] Kim, S et al., Life Cycle Assessment of Corn Grain and Corn Stover in the United States The International Journal of Life Cycle Assessment 14: 160-174, Published on-line January 20, 2009 at: http://www.springerlink.com/content/c2205l5747622673/fulltext.pdf

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

Response: The statute's definition of renewable biomass is quite restrictive and more than adequate.

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

Response: In 2010, EPA conducted extensive air quality modeling[3] based on final revisions of the RFS2. EPA examined particulate matter, ozone, and a number of air toxics. While the findings are highly technical and detailed, some basic conclusions can be drawn. The RFS2 will result in overall lower fine particulate matter levels, an incrementally small increase in ozone levels (0.15 part per billion), and relatively little impact on national concentrations of the modeled air toxics.

Ethanol has served as a gasoline oxygenate to reduce smog formation and low-level ozone pollution in urban areas across the country. Ethanol also reduces tailpipe carbon monoxide emissions.

As a source of octane ethanol displaces petroleum aromatics in gasoline, compounds with well documented environmental and health effects.

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

Response: There are several benefits that have arisen form the RFS that were not anticipated at the time of its passage. The transition to less intensive tillage practices associated with the partial removal of crop residues for cellulosic biofuel production is a benefit that has not been included in the calculations for the RFS. DuPont and USDA's National Resource Conservation Service have a joint agreement which aims to set voluntary standards for sustainable harvesting of agricultural residues. This could provide additional environmental benefits associated with cellulosic feedstocks.[4]

Beyond the environmental benefits of the RFS, a November 2012 Oak Ridge National Laboratory study[5] concluded that the RFS is producing significant positive economic effects in the United States while reducing crude oil prices, decreasing crude oil imports, increasing gross domestic product (GDP), and having only minimal impacts on global food markets and

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[3] http://www.epa.gov/otaq/renewablefuels/454r10001.pdf

[4] http://www.usda.gov/wps/portal/usda/usdahome?contentid=2013/03/0058.xml&contentidonly=true

[5] Oladosu, G. Global economic effects of US biofuel policy and the potential contribution from advanced biofuels. November 2012. http://www.future-science.com/doi/abs/10.4155/bfs.12.60?journalCode=bfs&

land use. In the future, full implementation of the RFS' advanced biofuel requirements will substantially amplify these economic benefits.

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

Response: Renewable fuels provide multiple benefits; environmental improvements, particularly regarding GHG emissions, energy security through reduced reliance on imported petroleum, economic security through reduced exposure to the global price of oil, and rural economic development opportunities.

Each of these benefits rises as more renewable fuel is produced and consumed. As such, maximizing the amount of renewable fuels, including ethanol, in the US fuels pool would maximize those benefits.

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

Response: As already noted the RFS has been and will increasingly be an important contributor the reducing transportation sector GHG emissions. The upgraded CAFÉ standards and GHG tailpipe standards are also making significant contributions. Continuing to implement the RFS in its current form will provide significant additional GHG benefits.

In the near term facilitating the infrastructure build out for higher level ethanol blends (E-15 and E-85) will help speed the pace at which low GHG cellulosic ethanol can enter the market.

A large number of cars on the road today are compatible with E-15 given the extensive fuel testing done by EPA and DOE and the proportion of E-15 compatible vehicles increases every year. Ford and General Motors have both announced that E-15 is acceptable for use in later model cars and light trucks. For General Motors, 2012 and 2013 model-year vehicles can use gasoline blends with up to 15% ethanol and Ford's 2013 vehicles can accept E-15 fuel. Ford has also indicated that its vehicles as old as model year 2010 can accept E-15. Additionally, there are a significant number of E-85 compatible vehicles on the road today.

Cellulosic biofuels offer a way to significantly further reduce GHG emissions. Private sector companies such as our own have been investing significant quantities of private capital to bring this technology to meet the RFS. Additional information regarding our ongoing commercialization of cellulosic ethanol can be found at http://biofuels.dupont.com/cellulosic-ethanol/nevada-site-ce-facility/ Continuing the RFS in its current form is critical to the realization of the environmental benefits of cellulosic biofuels.

Thank you for the opportunity to comment on the Greenhouse Gas Emissions and Other Environmental Impacts white paper. We look forward to providing additional responses for the white papers that are planned for later this year and assisting the Committee with its deliberations. Please contact me at Jan.Koninckx@dupont.com if you have any questions about the responses provided.

Sincerely,

Jan Koninckx
DuPont Industrial Biosciences

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May 13, 2013

The Committee on Energy and Commerce
Mr. Ben Lieberman
Majority Staff
RFS@mail.house.gov

Subject: Renewable Fuel Standard Assessment White Paper – Questions for Stakeholder Comment

Dear Mr. Lieberman,

The Committee on Energy and Commerce has issued a series of White Papers as the first step in reviewing the Renewable Fuel Standard (RFS). The latest white paper poses several questions regarding the environmental impacts of the RFS for stakeholder comments. My research team at the University of Illinois at Chicago Energy Resources Center has been extensively modeling, publishing and informing the scientific discourse pertaining to the life cycle greenhouse gas (GHG) and energy impacts of various biofuels pathways for the last decade. I have also served on the Expert Working Group for the California Low Carbon Fuel Standard.

Our research has demonstrated that today's average corn-based ethanol does indeed provide significant GHG emission reductions compared to petroleum—even when potential indirect land use change (ILUC) emissions are considered for ethanol. Further, our work has shown that the corn ethanol industry has demonstrated a uniquely high rate of innovation and technology adoption, which has resulted in steady reductions in GHG impacts. It is our belief that the RFS has played an important role in creating a stable market environment that encourages development of, and investment in, new environmentally beneficial technologies that will also provide benefits to other renewables.

I offer the following responses to specific questions listed in the White Paper.

Is the RFS reducing greenhouse gas emissions below that of baseline petroleum-derived fuels?

Yes, the renewable fuels used for RFS compliance today are reducing GHG emissions relative to baseline petroleum. Every day an ethanol gallon displaces a petroleum gallon, GHG reductions are realized. Our research shows energy use and related GHG emissions by ethanol plants have been trending downward over the past decade. Additionally, recent analyses demonstrate potential ILUC emissions are substantially lower than initially estimated by U.S. EPA and others.

Our group surveyed the ethanol industry's 2008-era energy use in 2009 and the results showed significant reductions over previous survey results.[1] This ethanol energy use data was combined with

[1] Mueller, S. (2010). 2008 National dry mill corn ethanol survey. *Biotechnology Letters*, *32*, 1261-1264.

more contemporary feedstock production data from USDA to update the Argonne National Laboratory "GREET" model in 2012.[2] Based on the updated version of the GREET model, average corn ethanol with ILUC emissions included was recently shown by Wang et al. to reduce GHG emissions by 19-48% (mean=34%) compared to gasoline.[3] Excluding ILUC emissions, average corn ethanol was shown to reduce GHG emissions by 29-57% (mean=44%) relative to gasoline. Based on the latest availability of even more recent ethanol plant energy consumption and land use change data (discussed in the next section), the 2012 GREET results (pending the regular release of an updated GREET version) likely understate the GHG reductions associated with using corn ethanol.

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

Yes, our research indicates that the RFS very likely has a positive impact on the adoption of new technologies, for example, at corn ethanol plants. As a follow up to our published 2008 Corn Ethanol Survey we conducted an assessment of energy consumption at corn ethanol plants during 2012.[4] Our work includes an assessment of over 50% of operating dry grind corn ethanol plants.

On average, 2012 dry grind plants produce ethanol at higher yields with lower energy inputs than 2008 corn ethanol. Furthermore, significantly more corn oil is separated at the plants now, which combined with the higher ethanol yields results in a slight reduction in DDG production and a negligible increase in electricity consumption. The table below summarizes the results.

Despite a general lack of investment in energy technologies in other industrial sectors during the recent economic downturn, ethanol plants kept investing in new technologies. Our extensive interaction with the plants during the survey process revealed that the continued adoption of new technologies is at least partially attributable to incentives and market certainty provided by the RFS.

	2012 Corn Ethanol	2008 Corn Ethanol
Yield (anhydrous/undenatured, gallon/bushel)	2.82	2.78
Thermal Energy (Btu/gallon, LHV)	23,862	26,206
Electricity Use (kWh/gallon)	0.75	0.73
DDG Yield (dry basis) including corn oil (lbs/bu)	15.73	15.81
Corn Oil Separated (lbs/bushel)	0.53	0.11
Water Use (gallon/gallon)	2.70	2.72

2 GREET is the acronym for the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation model. Argonne National Laboratory is part of the Department of Energy laboratory system.

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

4 2012 Corn Ethanol: Emerging Plant Energy and Environmental Technologies; Issued April 29, 2013; available at http://www.erc.uic.edu/PDF/mueller/2012_corn_ethanol_draft4_10_2013.pdf

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

Yes, as indicated above, research at Argonne National Laboratory's Transportation R&D Center has yielded continuous updates to the GREET model (GREET in modified form was also used in earlier versions for the RFS modeling). These updates include a Carbon Calculator for Land Use Change from Biofuels Production (CCLUB). The CCLUB model includes calculations that take feedstock-specific soil carbon emissions and sequestration effects from land use change (LUC) into account. The results are published, and the published results in turn were validated by other institutions in separate peer reviewed publications.[5] Most notably, a recent publication by Purdue University that reviews several LUC emissions factor models concludes that those LUC emissions factor models (such as CCLUB) that properly account for soil carbon changes in land cover and tillage practices result in much lower emissions than other models.[6] In fact, for selected modeling runs (that take realistic, projected crop yield increases into account) the LUC emissions in CCLUB for corn ethanol total 7.6 gCO_2e/MJ (as opposed to 28 gCO_2e/MJ used by EPA for corn ethanol).[7]

Unfortunately, EPA's lifecycle analysis (conducted in 2008/09) relies on by now significantly outdated information and data related to energy use and technology application at ethanol plants, energy use (and related emissions) and technology adoption in the feedstock production process, and land use requirements for ethanol expansion. These factors result in EPA overestimating the GHG emissions associated with corn ethanol production and use. EPA could greatly improve upon its existing lifecycle GHG analysis by using updated and re-structured models that incorporate more current and more robust input data.

Another important variable that needs to be considered in land use modeling is a relationship called yield-price elasticity which refers to the response of farmers due to price signals. The economic land use change models used in LUC analyses indicate that higher demand for corn due to biofuels production will stabilize or at times increase corn prices. However, recent research confirms that higher commodity prices actually mitigate land use impacts because growers (in response to higher corn prices) invest in more productive technologies.[8]

[5]Modeling state-level soil carbon emission factors under various scenarios for direct land use change associated with United States biofuel feedstock production; Ho-Young Kwon, Steffen Mueller, Jennifer B. Dunn, Michelle M. Wander; Biomass and Bioenergy (2013), http://dx.doi.org/10.1016/j.biombioe.2013.02.021

[6] Induced Land Use Emissions due to First and Second Generation Biofuels and Uncertainty in Land Use Emission Factors; Farzad Taheripour and Wallace E. Tyner; Economics Research International, Volume 2013, Article ID 315787, 12 pages; published March, 2013.

[7] Land-use change and greenhouse gas emissions from corn and cellulosic ethanol; Jennifer B Dunn, Steffen Mueller, Ho-young Kwon and Michael Q Wang; Biotechnology for Biofuels 2013, 6:51 doi:10.1186/1754-6834-6-51; Published: 10 April 2013

[8] Is Yield Endogenous to Price? An Empirical Evaluation of Inter and IntraSeasonal Corn Yield Response; Barry K. Goodwin, Michele Marra, Nicholas Piggott and Steffen Mueller; June 3, 2012. Available at: http://www.erc.uic.edu/PDF/mueller/2012_corn_ethanol_draft4_10_2013.pdf

Another recent debate that has the potential to significantly influence the impact from LUC centers around the accounting method for emissions over time: researchers and regulatory agencies, including EPA, have been assuming that biofuels production plants will only exist for 30 years and therefore the LUC models have been "amortizing" emissions over this time period. However, much longer biofuels production periods are likely. Separately, recent peer reviewed research by the University of Illinois at Chicago has shown that a different emissions accounting method altogether that takes future land use needs for food into account substantially reduces emissions (by up to 50%) associated with biofuels production.[9]

Finally, emerging practices and technologies have been shown to further reduce land demands from biofuels production. Most noteworthy is the emerging practice of corn stover removal for animal feed. If acres that deliver corn to ethanol plants also remove stover for feed, then this animal feed product does not need to be grown on separate acres. A simplified way to gain an insight on the co-product impact of stover provides the following example: A corn field with a yield of 160 bu/acre produces 4.5 tons of corn and approximately an equivalent amount of corn stover. If 50%, or 2.25 tons, of that stover can be sustainably removed for feed (a very reasonable removal rate for many corn growing areas) this is equivalent to producing an extra 80 bushel of corn on that acre (assuming an equal substitution for stover of corn in animal diets).

Stover removal has been documented and filed as a pending pathway under the California Low Carbon Fuel Standard. Besides stover removal other agricultural practices including the application of nitrification inhibitors (a market that has seen 20% year over year growth for the last 5 years), new enzymes including enzymes contained in the corn kernel (e.g., Syngenta's Enogen), advanced hybrid seeds, and precision agriculture have continued to improve biofuels feedstock production.

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

Yes, in my research the soil carbon sequestration effects associated with biofuels production in many geographic regions as documented in the CCLUB supporting publications would indicate that biofuels production (including corn ethanol production) can play an important role in *improving* soil health. This recent research is, to some extent, diverging from results detailed in EPA's draft First Triennial Report to Congress published in January 2011.

[9] Baseline time accounting: Considering global land use dynamics when estimating the climate impact of indirect land use change caused by biofuels; Jesper Hedal Kløverpris & Steffen Mueller; Int J Life Cycle Assess DOI 10.1007/s11367-012-0488-6; published September 2012.

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

The RFS is working; improving the environment, incenting the development and implementation of new technologies that further drive environmental improvements, and improve sustainable agricultural productivity. Yes, as detailed above, we believe that the RFS has provided an environment that stimulates technology adoption both at the biorefinery as well as the feedstock production level.

Sincerely,

Dr. Steffen Mueller
Principal Research Economist
Energy Resources Center
University of Illinois at Chicago

June 18, 2013

Global Automakers Response to House Energy and Commerce Committee's Stakeholder Questions Regarding the Renewable Fuel Standard

The Association of Global Automakers[1] appreciates the opportunity to offer the following response to one of the questions in the Committee's May 9, 2013 White Paper Series on the Renewable Fuel Standard (RFS). This White Paper examines questions involving Greenhouse Gas Emissions and Other Environmental Impacts of the RFS.

The following response is intended to supplement responses previously provided by Global Automakers to the House Energy and Commerce Committee in connection with the release of its first White Paper, issued March 20, 2013. This initial White Paper raised questions about the "blend wall" and fuel compatibility issues associated with the RFS.

Stakeholder Question and Comments

Question 6:

What is the optimal percentage of ethanol in gasoline?

Response:

Global Automakers supports sensible, effective measures to address global climate change and enhance energy security. Global Automakers also supports the goal of greater U.S. energy independence, a key aim of the Renewable Fuel Standard (RFS). In pursuit of this goal and a cleaner environment, Global Automakers' members have pioneered new, advanced powertrain technologies that help reduce our dependence on petroleum, including gasoline-hybrid and hybrid-electric vehicles, natural gas vehicles, battery electric vehicles and fuel cell vehicles. Global Automakers' members have also been at the forefront of efforts to improve the fuel economy performance of the internal combustion engine.

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[1] The Association of Global Automakers represents international motor vehicle manufacturers, original equipment suppliers and other automotive-related trade associations. These companies have invested $46 billion in U.S. based production facilities, directly employ 90,000 Americans, and sell 43 percent of all new vehicles purchased annually in the United States. Our members operate more than 260 production, design, R&D, sales, finance and other facilities across the United States. For more information, visit www.globalautomakers.org.

Given these efforts, a program like the RFS that seeks to increase the level of ethanol in America's fuel supply creates challenges for automakers, retail fuel providers, and consumers. More specifically, RFS requirements measured in gallons can create uncertainty with respect to the amount of ethanol to be blended in the fuel supply, particularly if the aggregate demand for gasoline drops – as it is projected to do. In its 2013 analysis, EIA forecasts a drop in aggregate demand for gasoline in the transportation sector from 8.67 barrels per day in 2012 to 7.62 billion barrels per day in 2025, a decline of more than 12 percent.[2] Much of this drop is attributed to improved fuel economy performance, consistent with the CAFE and Greenhouse Gas regulations effective through 2025, along with increased market penetration of alternate powertrain technologies.

Indeed, if gasoline demand drops consistent with EIA's projections and the advanced biofuels industry develops (allowing the statutory RFS target levels to be met), the percentage of ethanol in the fuel supply will likely increase beyond the E15 level currently authorized by EPA. The percentage of ethanol in the fuel supply could also continue to increase even if the RFS targets currently in place were held constant, should the demand for gasoline in the transportation sector drops beyond EIA's current projections.

Among the challenges posed by ever increasing ethanol content levels are:

- The need to develop vehicles capable of running on ever higher ethanol content levels which also comply with applicable emissions standards and emissions warranty requirements. For example, available data[3] suggests that some MY2001-and-newer vehicles will, over time, fail to meet applicable emissions standards and experience other performance problems when fueled with E15, subjecting consumers to expensive auto repairs. Should future RFS standards require that a higher level of ethanol be blended into the fuel supply, the ethanol content of gasoline available to consumers could rise beyond E15. Vehicles designed and warranted to run on E15 would then encounter the same issues as vehicles designed and warranted for E10 face today.

- The need to ensure the widespread availability of legacy fuels for vehicles (and other products) not designed and warranted to run on higher ethanol content fuel. This "bifurcation" of the country's fuel supply will impose costs on automakers and

[2] AEO2013 Early Release Overview, see: http://www.eia.gov/forecasts/aeo/er/executive_summary.cfm
[3]The Coordinating Research Council (CRC) has conducted a number of such studies. The CRC, a non-profit organization supported by automakers and the American Petroleum Institute, directs engineering and environmental studies on the interaction between automotive and other mobility equipment and petroleum products. See http://www.crcao.com/reports/recentstudies2012/CM-136-09-1B%20Engine%20Durability/CRC%20CM-136-09-1B%20Final%20Report.pdf. See also: http://www.crcao.com/reports/recentstudies2013/CRC%20664%20%5BAVFL-15a%5D/AVFL%2015a%20%5BCRC%20664%5D%20Final%20Report%20only.pdf.

retailers, and create the significant chance that consumers will intentionally or unintentionally use a non-approved fuel, particularly if there is a price difference between the old and new fuels.

Apart from E85, which is used only in specially designed flex-fuel vehicles (FFVs), Global Automakers believes the optimal percentage of ethanol in gasoline for today's vehicles is E10 and that any increase in the allowable ethanol content be effective on a prospective basis only, with adequate lead-time for both automakers and fuel suppliers to develop and incorporate the necessary changes in vehicles and fueling infrastructure. Keeping the maximum ethanol content at a fixed level over time avoids the need and expense of constantly redesigning vehicles. Retaining the E10 level also avoids the bifurcation of our nation's fuel supply, along with consumer confusion and misfueling that will inevitably result. Overall, we believe the best way to ensure the viability of the RFS is to continue to encourage the development of "drop-in" fuels that can be seamlessly incorporated into the existing legacy fleet, distributed in existing pipelines, and marketed *via* existing filling station infrastructure.

Additionally, Global Automakers suggests the following principles as guides for policymakers contemplating the future of the RFS:[4]

- Any increase in ethanol content above E10 should not apply to vehicles designed and certified for E10. Changes must be prospective and provide automakers with adequate lead time to re-design engines and other vehicle components.

- Adequate supplies of legacy fuels for vehicles and engines not designed or warranted for higher level ethanol blends should be assured until such time as these products are no longer in general and widespread use.

- If ethanol levels above E10 are permitted, appropriate infrastructure must be in place to support the simultaneous introduction of both vehicles and fuels in the marketplace.

- Standards for ethanol blends above E10 should include effective mechanisms to avoid misfueling by consumers.

- If ethanol levels above E10 are permitted, refiners should not be allowed to alter gasoline formulations in ways that offset the benefits of octane increases due to higher ethanol content requirements.

[4] Each of the following bullet points equally apply to EPA's decision to allow E15 to be used in certain vehicles designed and certified for E10.

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May 24, 2013

Representative Fred Upton
Chairman
House Committee on Energy and Commerce
2125 Rayburn House Office Building
Washington, DC 20515

Representative Henry Waxman
Ranking Member
House Committee on Energy and Commerce
2322 Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton and Ranking Member Waxman:

Growth Energy is the leading trade association for America's ethanol producers and supporters. Growth Energy promotes expanding the use of ethanol in gasoline, decreasing our dependence on foreign oil and creating American jobs. As such, we are pleased to submit these comments in response to your questions for stakeholder comment released on May 9, 2013 regarding the Greenhouse Gas Emissions and Other Environmental Impacts of the RFS.

Sincerely,

Tom Buis
CEO, Growth Energy

Questions for Stakeholder Comment

1. Is the RFS reducing greenhouse gas emissions below that of baseline petroleum-derived fuels? Is the RFS incentivizing the development of a new generation of lower greenhouse gas emitting fuels?

   The RFS has been one of the most successful energy policies of the last 40 years. It is reducing greenhouse gas emissions, reducing our dangerous dependence on foreign oil and creating American jobs. EPA estimates that by 2022, the RFS will reduce greenhouse gas emissions by 138 million metric tons, the equivalent of taking 27 million passenger vehicles off the road. In particular, studies show that traditional corn ethanol reduces greenhouse gas emissions by as much as 59 percent compared to gasoline (*Improvements in Lifecycle Energy Efficiency and Greenhouse Gas Emissions of Corn-Ethanol*, Liska et al., which can be found here: http://onlinelibrary.wiley.com/doi/10.1111/j.1530-9290.2008.00105.x/abstract).

   As we move to the next generation of biofuels, greenhouse gas emissions will be even further reduced. Recent studies have shown that using switchgrass and corn stover to produce cellulosic ethanol will reduce greenhouse gases by as much as 94 percent and more than 100 percent, respectively (*Energy and Greenhouse Gas Emission Effects of Corn and Cellulosic Ethanol with Technology Improvements and Land Use Changes*, Wang et al., which can be found here: http://www.sciencedirect.com/science/article/pii/S0961953411000298).

   The long-term certainty of the RFS has driven significant investment for both the next generation of biofuels and new technologies utilized in ethanol production and in agriculture. Some of these new technologies will be "bolted-on" to existing biofuel production to take advantage of current power and resource streams – maximizing efficiency and driving greenhouse gas emissions even further down. Only by keeping this policy in place will we continue to see this type of drive towards more efficient systems to better our environment.

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

   While EPA has calculated that traditional corn-based ethanol reduces greenhouse gas emissions 20 percent more than gasoline, its analysis continues to include calculations using the controversial theory of indirect land use change (ILUC). A great deal of research has been dedicated to the study of indirect land use change. Most recently, Dr. Bruce Dale and Dr. Seungdo Kim of Michigan State University concluded that indirect land use from the production of biofuels is negligible or non-existent both domestically and internationally, as discussed in their study released in 2011 (*Indirect Land Use Change for Biofuels: Testing Predictions and Analytical Methodologies* appears in Biomass and Bioenergy 2011 http://www.sciencedirect.com/science/article/pii/S0961953411002418). However, even though ILUC has not been proven, biofuels continue to be penalized based on simulations and predictive models used to espouse ILUC rather than proven scientific data. Any true lifecycle analysis should not penalize, but instead should recognize the science that proves how biofuels are much cleaner and better for the environment compared to fossil fuels.

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

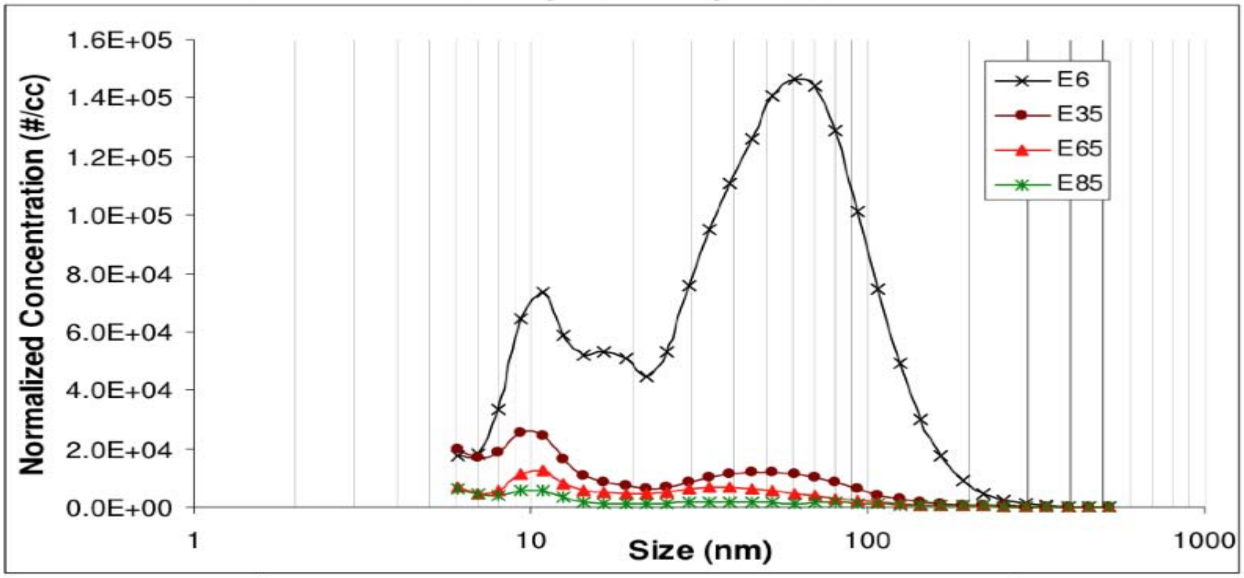
   The Renewable Fuel Standard means just that, fuels should be derived from renewable resources, like grains such as corn and sorghum, crop residues and food waste that can be reproduced year after year. The definition of biomass should not be expanded to include transportation fuels derived from natural gas, coal and petroleum as these are finite resources.

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

   The RFS has, and is, continuing to reduce our dangerous dependence on foreign oil and improve our nation's environment. Ethanol's primary use as an oxygenate in nearly 90 percent of our nation's gasoline has directly replaced harmful additives like MTBE – which has since been banned in a number of states because it was found to pollute groundwater. Additionally, ethanol replaces other octane boosters in gasoline that include harmful carcinogens such as benzene, toluene and xylene and reduces carbon monoxide. There has also been considerable work done in the area of ethanol's impact to substantially reduce particulate emissions. The results reported by Mang Zhang are also particularly informative (Zhang et al, *A Comparison of Total Mass, Particle size Distribution and Particle Number Emissions of Light Duty Vehicles* tested at Haagen-Smit Laboratory from 2009 to 2010," found here: http://www.calevc.org/carbzhang.pdf). The key results are shown below. In this test, a 2008 Flex Fuel vehicle (FFV) was tested on a hot Unified Cycle on E6, E35, E65, and E85. Ethanol appears to have caused a large reduction in PM emissions (and particularly PN) from E6 to E35, with further PM reductions as ethanol concentration increased.

2008 MY - Flex Fuel

Hot UC – composite phase 1 and 2



Ethanol Fuel	PM mg/mile	PN 10^{12} #/mile
E6	1.60	4.70
E35	N/A	0.70
E65	0.60	0.30
E85	0.27	0.14

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

   The RFS has provided significant environmental and economic benefits. The RFS has improved our nation's air quality, continues to drive yields, efficiency and deployment of new technologies in our nation's agriculture production, and today, the ethanol industry accounts for nearly 400,000 jobs – many of which are in rural America. By increasing yields, increasing efficiency, and deploying new technologies, ethanol and agriculture production continues to soften its footprint on the environment – while fossil fuels like crude oil and natural gas become harder and harder to extract. Just in the past four years, we have seen significant results - we are getting more ethanol for each bushel of corn: 2.82 gallons/bushel in 2012 vs. 2.78 gallons/bushel in 2008, using less water: 2.70 gallons of water per gallon of ethanol in 2012 vs. 2.72 gallons of water per gallon of ethanol in 2008, and are using less energy to produce a gallon of ethanol: 23,862 BTU/gallon in 2012 vs. 26,208 BTU/gallon in 2008 (Mueller and Kwik, *2012 Corn Ethanol: Emerging Plant Energy and Emerging Technologies*, http://www.erc.uic.edu/PDF/mueller/2012_corn_ethanol_draft4_10_2013.pdf).

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

   With the new CAFE and greenhouse gas regulations for light-duty vehicles, many automakers are moving to smaller, higher compression direct-injection engines. These engines require higher octane fuels to drive their higher performance. Ethanol is currently used as the most-effective, low-cost octane booster on the market. By adding ethanol to gasoline, you can produce high-octane midlevel ethanol blends such as E30 (30 percent ethanol) that would perform in these next-generation engines. An E30 blend has many benefits – with ethanol consistently trading below the cost of gasoline, adding more ethanol saves consumers considerably at the pump- all the while boosting engine performance with a high-octane premium fuel. Attached is a letter from the Auto Alliance to the EPA Administrator discussing the need for a high octane fuel commensurate with the additional volumes of ethanol found in the RFS (Letter from Mitch Bainwol, Auto Alliance, to Administrator Lisa Jackson, RE: Changes to U.S. Retail Gasoline, October 6, 2011). Additionally, researchers at Ford Motor Company and AVL recently completed a study that found "…a mid-level ethanol blend (greater than E20 and less than E40) appears to be attractive as a long-term future fuel for the US, especially if used in vehicles optimized for such as fuel" (Stein, R., Anderson, J., and Wallington, T., "An Overview of the Effects of Ethanol-Gasoline Blends on SI Engine Performance, Fuel Efficiency, and Emissions," *SAE Int. J. Engines*6(1):470-487, 2013, doi:10.4271/2013-01-1635.http://papers.sae.org/2013-01-1635/).

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

   Yes, the RFS is a critical component of all efforts to further reduce greenhouse gas emissions. While there have been additional technologies such as electric vehicles and hydrogen fuel cells, the U.S. transportation sector will continue to be largely dependent on liquid fuels for the foreseeable future. Only by continuing the certainty of the RFS and opening the market for additional biofuel blends can we continue to reduce our greenhouse gas emissions from our transportation sector.

HONDA

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May 24, 2013

Honorable Fred Upton, Chairman
Honorable Henry A. Waxman, Ranking Minority Member
Committee on Energy and Commerce
2125 Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton and Ranking Member Waxman:

Thank you for the opportunity to comment on your committee's Renewable Fuel Standard Assessment White Paper on Greenhouse Gas Emissions and Other Environmental Impacts. Honda recognizes the policy's goal of producing environmental benefits through the use of greater quantities of renewable fuel, while also limiting unintended environmental harm that may occur as a result of a shift toward greater biofuel use. As the Committee has noted in its Renewable Fuel Standard (RFS) white papers, the RFS is a complex issue, requiring accurate accounting of environmental benefits and damages associated with renewable fuels to serve as an effective policy. This is a challenging and somewhat uncertain activity, dependent upon the quality of available data and a host of methodological assumptions.

Honda previously responded to questions posed in the Committee's first white paper, and our opinion on those issues has not changed. Of the questions posed in the Committee's third white paper, Honda appreciates the opportunity to respond to the following question:

What is the optimal percentage of ethanol in gasoline?

Honda believes that the optimal percentage of ethanol in gasoline is 10 percent, the prevailing fuel in today's marketplace. While many of our latest vehicles are capable of running on mid-level ethanol blends up to E15, we have long voiced concerns about the consequences of misfueling legacy fleet vehicles and small engine products with mid-level blends. Our legacy fleet and small engine products were not designed – and are not recommended – to operate on mid-level ethanol blends. Yet as no effective misfueling countermeasures have been proposed to date, this creates a genuine risk that our customers may experience product failures. Regardless of fault, those consumers will assume a deficiency in their product and look to the manufacturer for redress. As such, Honda supports maintaining a market fuel of E10.

Should E15 gain commercial appeal and become an accepted "market fuel," it will still be critically important that fuel providers continue to make E10 available as well, for the need to fuel legacy fleet vehicles and non-automotive products will remain. Today's products requiring E10 have long lifetimes – 15 years or more for passenger vehicles; frequently much longer for non-automotive products – and consumers will need assurance that their purchases are not stranded by a shifting fuel market. It is worth noting that even this simple scenario elucidates challenges with misfueling mitigation, particularly at small retail outlets that are less-equipped to serve a broad customer base.

To allow the RFS to remain viable without increasing the amount of ethanol in our fuel supply, Honda supports the pursuit of advanced "drop-in" biofuels that can utilize advanced bio-based feedstocks while, at the same time, maintaining current fuel characteristics. Such drop-in fuels would obviate many of the problems that manufacturers, distributors, providers and consumers currently face with mid-level ethanol blends.

Drop-in fuel development has been slow to date, though properly incentivizing them could help spur their growth. Honda supports the use of economic incentives to advance development of drop-in fuels until they are price competitive. For example, the Renewable Identification Number (RIN) system could be modified to incorporate a higher multiplier credit that promotes the use of drop-in fuels such as biobutanol.

Thank you again for the opportunity to respond.

Sincerely,

Edward B. Cohen
Vice President
Government & Industry Relations

May 23, 2013

The Honorable Fred Upton
Chairman
Committee on Energy and Commerce
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Washington, DC 20515

The Honorable Henry Waxman
Ranking Member
Committee on Energy and Commerce
2322A Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton and Ranking Member Waxman:

Thank you for the opportunity to submit comments and address some questions regarding “Greenhouse Gas Emissions and their Environmental Impacts” as they relate to the Renewable Fuels Standard (RFS). While the Renewable Fuel Standard was initiated to reduce our dependence on petroleum fuels and increase our national energy security, in 2007 with the passage of the Energy Independence and Security Act (EISA) it became much broader in scope when it differentiated the value of renewable fuels based on their greenhouse gas (GHG) impacts. The Renewable Fuel Standard has been a tremendous success in reducing our dependence on foreign oil. Our gasoline throughout the U.S. now contains 10 percent ethanol with the opportunity to move quickly to higher blends if we stay the course and remove certain barriers. This will allow us to reduce prices at the pump, improve our economy and clean our air.

While we have serious concerns on how U.S. Environmental Protection Agency (USEPA) has calculated greenhouse gas emissions reductions assigned to corn starch ethanol, we have no doubt that the Renewable Fuel Standard has been successful in reducing these emissions. One of the reasons that the signators on this letter, as well as other agriculture groups and the ethanol industry, have invested so much money in research and modeling to determine the greenhouse gas emissions from corn starch ethanol is that we want USEPA to get the numbers right. The Illinois Corn Growers Association alone has invested more than $1 million into this work with some very impressive results. We are concerned that USEPA has underestimated the benefits for corn starch ethanol which may negatively impact its role in both environmental and energy policy in the future. We are fully aware that greenhouse gas emissions will be part of any future transportation fuels regulations and it is important for these numbers to be correct. In an earlier paper we talked about CAFÉ standards and the need for continued adequate credits for the automobile manufacturers to continue building flex fuel vehicles (FFVs) which will help achieve the goals of the RFS and reduce greenhouse gas emissions as required in the rules. Assuring that the greenhouse gas emissions reductions of ethanol are accounted for properly will help ensure that the automobile manufacturers receive as much credit as possible in reducing greenhouse gas emissions through higher blends of ethanol.

According to a recent report issued by the Global Renewable Fuels Association, ethanol production and use is estimated to have reduced greenhouse gas emissions by 100 million metric tons in 2012, which is equivalent to removing 20.2 million light duty vehicles from the highways.

While these numbers are very impressive, we strongly encourage USEPA to do the correct accounting for greenhouse gas emissions reductions already achieved through the RFS. We are five years into the program and it is time to begin accurately documenting our success.

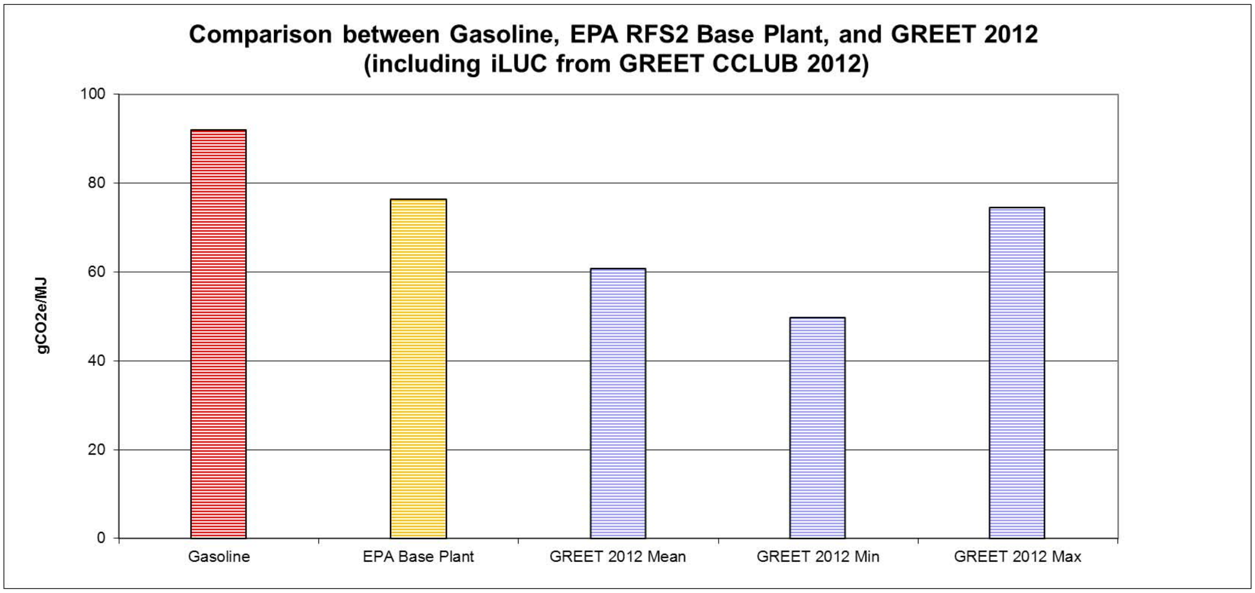
1. **Is the RFS reducing greenhouse gas emissions below that of baseline petroleum-derived fuels? Is the RFS incentivizing the development of a new generation of lower greenhouse gas emitting fuels? Will the RFS produce further greenhouse gas emissions reductions when it is fully implemented?**

These are excellent questions that are easy to answer very definitively. In the 1990's Argonne National Laboratory began comparing the greenhouse gas emissions of different fuels to gasoline through a Life Cycle Analysis which they called "Well to Wheels." This original work was supported by several automobile companies, oil companies and agriculture. Using the "GREET Model" which is the Greenhouse Gases, Regulated Emissions and Energy use in Transportation model developed by Argonne, the original modeling estimated that corn ethanol reduced greenhouse gas emissions by over 30 percent compared to gasoline. This was based on the agriculture production inputs/outputs and ethanol production technologies available at the time (early 1990s). When USEPA published their rules in 2009, they had corn starch ethanol as only 20 percent better than gasoline by 2022 based on outdated data and the indirect land use penalty.

Unfortunately this gave the California Air Resources Board further encouragement to penalize corn based ethanol as they developed their Low Carbon Fuel Standards for California. The California Low Carbon Fuel Standards incentivized sugar cane ethanol over ethanol produced in the U.S. which created an economic and environmental aberration based on bad science and poor public policy, again hamstringing American agriculture and U.S. industry. This was so bizarre that the Renewable Fuels Association (RFA) began calling this phenomenon "the ethanol shuffle."

The most recent work developed by the University of Illinois-Chicago and reviewed by Argonne National Laboratory shows that according to Dr. Steffen Mueller, "the renewable fuels used for RFS compliance today are reducing GHG emissions relative to baseline petroleum. Every day an ethanol gallon displaces a petroleum gallon, GHG reductions are realized. Our research shows energy use and related GHG emissions by ethanol plants have been trending downward over the past decade."

The University of Illinois-Chicago conducted two surveys of the ethanol industry in the last three years. The first looked at dry mill ethanol plants through 2008 and the second survey published April 29, 2013, entitled “2012 Corn Ethanol: Emerging Plant Energy and Environmental Technologies” analyzed the state of the industry as of 2012. The survey showed that some plants were achieving yields of ethanol at 2.89 gallons per bushel of corn when several years ago the average was 2.7 gallons per bushel. The most impressive finding is the overall energy efficiency achievements at the corn dry mill plants between 2008 and 2012, which is the period of time when the RFS was encouraging more gallons of corn starch ethanol to be produced. Below is a table from the above referenced publications which summarizes the comparisons between 2008 and 2012.



Based on the above survey results and other land use studies conducted by the University of Illinois-Chicago experts believe that the current corn starch ethanol industry is close to proving that the greenhouse gas emissions are 50 percent better than the greenhouse gas emissions of baseline gasoline produced in 2005. While the carbon footprint for corn starch ethanol has been proven to improve with each incremental gallon, each new barrel of oil is marginally worse in CO_2 emissions due to more energy intensive extraction processes, transportation costs, and quality of the crude requiring more energy at the refineries. Also, unlike corn starch ethanol, USEPA has assigned no indirect land use penalty to gasoline. To really understand the true greenhouse gas emissions benefits derived through the RFS, the correct emissions numbers need to be calculated. The actual cost per gram of CO_2 reduction would prove to be very favorable under the current RFS II program.

Below is a chart prepared by the University of Illinois-Chicago illustrating the current state of the corn ethanol industry as it moves toward being 50 percent better than gasoline in CO_2 emissions.

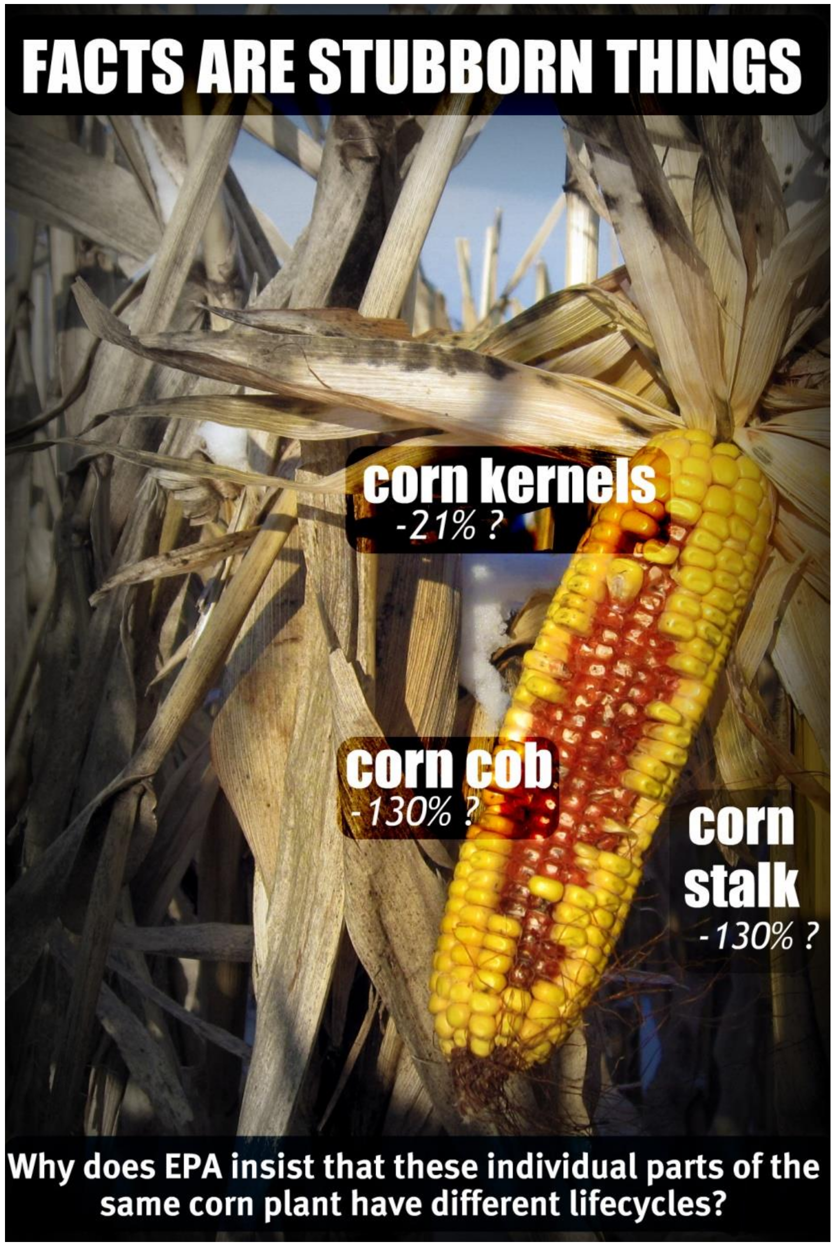
	2012 Corn Ethanol	2008 Corn Ethanol
Yield (anhydrous/undenatured, gallon/bushel)	2.82	2.78
Thermal Energy (Btu/gallon, LHV)	23,862	26,206
Electricity Use (kWh/gallon)	0.75	0.73
DDG Yield (dry basis) including corn oil (lbs/bu)	15.73	15.81
Corn Oil Separated (lbs/bushel)	0.53	0.11
Water Use (gallon/gallon)	2.70	2.72

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

We feel strongly that USEPA's methodology for calculating lifecycle greenhouse gas emissions be improved, including its treatment of indirect land use change. We worked with Argonne National Laboratory early on using the GREET model to determine that corn based ethanol could reduce greenhouse gas emissions approximately 30 percent when compared to gasoline. The first numbers that USEPA issued indicated that current ethanol production in 2008 was not much better than gasoline in its greenhouse gas emissions and by 2022 it would only be 20 percent better if certain new technologies were adopted. In originally evaluating the numbers, Illinois Corn Growers Association tried to make sense of their analysis but could not.

EISA also required that for the first time Indirect Land Use Change (ILUC) be part of the Life Cycle Analyses for all of the renewable fuels under the RFS. This was unprecedented in its attempt to hold American agriculture responsible for actions happening in other countries beyond our control. This had the same impact as signing a unilateral treaty penalizing us for economic growth and environmental improvement. Although Argonne National Laboratory included indirect land use change in its life cycle analyses modeling, Argonne was not comfortable with the degree of correlation between the growth in biofuels and land changes outside the U.S. Other modelers and researchers were not so constrained by commonsense.

The models that USEPA used to determine the carbon footprint for corn ethanol were economic input/output models not designed to predict land use change. These included very reputable models such as FAPRI, FASOM, and GTAP. Therefore the results suffered due to three major deficiencies: a. the input data used in these models were in many cases outdated, b. funding and time should have been made available to optimize these models to accurately predict indirect land use change before they were used for final rules and regulations, c. for the most part the models were not transparent and therefore the results were difficult to duplicate and evaluate.



As an example of how inaccurate and unscientific these results were when USEPA published the proposed rules, the greenhouse gas emissions numbers for corn stover and corn residue for cellulose ethanol was 130 percent better than gasoline, while ethanol produced from the kernel was only 19 to 21 percent better than gasoline. The EPA determined that two parts of the same plant produced from the same seed had different life cycle analyses. The image (right) demonstrates this huge miscalculation.

Several state corn grower associations and others were so concerned about the data and models used by USEPA to determine the indirect land use penalties against corn starch ethanol, a petition was filed to "Bifurcate the Rulemaking Docket" The requested relief was the following:

Petitioners respectfully move the United States Environmental Protection Agency ("USEPA") to bifurcate the rulemaking docket in this matter into two separate dockets (Dockets A and B) as follows:

> Docket A – Use the existing docket to establish greenhouse gas ("GHG") footprints for each category of renewable fuel and petroleum, as specified under the 2007 Energy and Security Act of 2007 (EISA), without consideration of potential international land use change ("ILUC"). Proceed to consider comments and revise the proposed rule in Docket A as expeditiously as possible, including additional notice and comment.

Docket B – Open a new docket to develop verifiable and consistent international data and a reliable model for ILUC. Establish a timetable for any necessary studies (e.g. by the National Academy of Sciences or National Laboratories, such as Argonne or Oak Ridge) and subsequent rulemaking action in Docket B.

EPA has interpreted this statutory language as requiring it to include emissions associated with ILUC. ("EPA believes that compliance with the EISA mandate … makes it necessary to assess those direct and indirect impacts that occur not just within the United States and also those that occur in other countries." *NPRM, p.25020*)

However, based on the record created in this proceeding, it has become clear that there is no *currently available* means for *accurately* determining the nature and quantity of ILUC or its GHG emissions. Nor is there a means of *relating ILUC and its emissions to U.S. biofuel production*. Absent this information, the theory and assumptions applied in the Notice of Proposed Rulemaking ("…we have identified several of the key drivers with these lifecycle GHG emission estimates, including *assumptions* about international land use change …" NPRM p. 25022 [emphasis added]) much be revisited. *The threshold determinations that indirect ILUC emissions are "significant" and are "related to" the lifecycle of any of the four categories of biofuels specified in EISA must be based on a sound scientific record, not a theory supported by assumptions.*

While USEPA did not approve the request to set-aside the penalties for indirect land use change until better data and models were developed to make the determination of accurate indirect land use metrics, much research has been completed which USEPA needs to incorporate in their analyses to update their rules. This will then provide Congress accurate estimates of the true greenhouse gas emissions reductions achieved through the RFS II.

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

We are not aware of any unintended environmental consequences due to the definition of renewable biomass.

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

As we increase the use of renewable fuels in our transportation sector we have less opportunity for oil spills during ocean transportation or ocean drilling. We have less contamination at our ports from oil leaks with less impact on marine life as we increase our use of domestic renewable fuels. There are many other environmental benefits as optimized ethanol replaces petroleum in our gasoline supplies including reduced air toxins, reduced particulates and reduced aromatics.

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

Based on the investments that production agriculture and the ethanol industry have made in new technologies, processes and equipment, both have become much more efficient which results in unexpected benefits such as reduced regulated emissions and reduced water usage at ethanol plants (3.5 gallons of water reduced to 2.7 gallons of water per gallon of ethanol). Additionally, production agriculture has reduced their use of fertilizer, pesticides and herbicides per bushel as they invest in better technologies. Farmers today are adopting reduced tillage practices, planting more cover crops and increasing their soil health.

6. **What is the optimal percentage of ethanol in gasoline?**

This is a critical question that needs to be fully addressed through research, testing, and forward looking policy that is consistent and compatible with the goals for energy security, environmental improvements, economic development, greenhouse gas emissions reductions and sustainability. Once a roadmap is developed, the goal can be realized through commonsense rules and guidelines. It is important that regulations regarding the RFS, TIER III standards and the new CAFÉ rules are not at cross purposes which would reduce the likelihood of achieving the goals or increase the costs of meeting the regulations which will be passed on to the consumers. Brazil has been quite successful in bringing higher blends of ethanol into their transportation sector. Almost 100 percent of the cars sold in Brazil are FFVs.

It is tremendously important for the agriculture industry and the ethanol industry to immediately work together with the automobile industry and eventually the petroleum industry to develop a pathway for determining this optimum percentage of ethanol in gasoline and the strategy to achieve the goal. This optimum blend of ethanol can be realized with the full faith cooperation of USEPA. It would then serve to meet the requirements for the new CAFÉ standards and the goals of the RFS II.

A positive response to this excellent question is already underway with some of the agricultural groups, automobile industry representatives and the ethanol industry to address the issue of the need for more FFVs to utilize higher blends of ethanol and future optimized vehicles for higher octane gasoline through higher blends of ethanol. Several of the automobile manufacturers, agriculture equipment manufacturers, national laboratories and the ethanol industry have done some excellent work already in testing and researching the use of higher blends of ethanol in optimized engines to reduce emissions, increase efficiency and increase performance. With the future price of ethanol expected to be below the price of gasoline this seems like a future transportation policy that most consumers would endorse. Whatever Congress can do to facilitate this collaboration would be very beneficial.

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

The RFS is doing its job by significantly and economically reducing greenhouse gas emissions from the transportation sector. USEPA needs to accurately measure and publish these greenhouse gas emissions reductions to give policy makers, Congress and industry a benchmark regarding the overall success of the RFS II. According to different sources the RFS has been responsible for reducing 205 million metric tons of CO_2 emissions.

The United States needs to maintain the course - increasing the production and use of renewable fuels, reducing our dependence on imported oil, improving our environment, reducing our greenhouse gas emissions and stimulating rural development and industry investment for jobs and sustainability. All of these above goals have been successfully driven through the RFS.

What is critical is that Congress and USEPA adhere to a consistent energy policy with regulations that complement each other and are not at odds.

For example the recently published CAFÉ rules and guidance document for FFVs issued by USEPA, does away with the incentives for the automobile industry, both domestic and foreign, to produce FFVs after 2016 or 2017. This is a real blow to the future success of the RFS. USEPA in its original rules for the RFS II estimated that the growth in FFVs would be critical to meet the future renewable fuel requirements in the RFS II. Now the USEPA's final CAFÉ rules will make it more difficult to meet the RFS requirements and much more expensive to meet the CAFÉ standards by 2022.

The RFS II has stimulated investment in increased efficiency and productivity in corn production and in ethanol production. The RFS II will also increase investments in other technologies, industries and feedstocks in the future.

We appreciate the time you are taking to evaluate our concerns and look forward to working with Congress to continue growing the U.S. ethanol industry.

Sincerely,

Paul Taylor, President
Illinois Corn Growers Association

Ray Defenbaugh
Illinois Renewable Fuels Association

INEOS Bio

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May 21, 2013

The Honorable Fred Upton
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The Honorable Henry A. Waxman
Ranking Member
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U.S. House of Representatives
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RE: Comments on Greenhouse Gas Emissions and Other Environmental Impacts

Dear Chairman Upton and Ranking Member Waxman:

On behalf of INEOS Bio, I appreciate the opportunity to submit the following comments in response to the Energy and Commerce Committee's third white paper on the renewable fuel standard (RFS).

INEOS Bio is part of INEOS, one of the leading petrochemical companies in the world. INEOS is a leading producer of commodity chemicals and one of the leading independent refiners in Europe. In the U.S. INEOS employs over 3,000 people, and we have manufacturing facilities in Alabama, Ohio, Texas, Illinois, Massachusetts, California, and Florida.

The Indian River BioEnergy Center coming online in Florida is one of the first cellulosic biofuels facilities in Florida and is the first plant in the world showcasing our new technology that converts waste materials into cellulosic biofuels and renewable power. We are in the final start-up phase and when the facility is in full operation, it will produce 8 million gallons of cellulosic ethanol and 6 megawatts (gross) of renewable power annually. We use the vegetative, yard and agricultural waste from the Indian River/Treasure Coast region to run this plant and make cellulosic ethanol and renewable power.

As we will discuss in the responses to the questions below, the INEOS Bio process technology offers significant greenhouse gas emissions reductions compared to traditional gasoline. Repealing the RFS will undermine investments in innovation and jeopardize our ability to displace fossil fuels with cleaner, cellulosic domestic fuels.

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

A1: The answer to all three questions is an emphatic "yes."
By statute, new renewable fuels that qualify for the RFS must achieve a minimum greenhouse gas emission (GHG) reduction of 20% compared to traditional gasoline. (Granted, some first-generation plants were grandfathered in under the statute and may not have to meet the 20% GHG threshold. But newer, more efficient ethanol plants are in the process of displacing them.)

More importantly, the 15 billion gallon cap on first-generation corn-starch renewable fuel and the increasing volumes of advanced and cellulosic biofuels facilitates the development of new technologies that achieve significant GHG emissions reductions of over 50% when compared with gasoline. When the RFS is fully implemented and advanced and cellulosic fuels contribute a larger share of total volumes, even more significant GHG emission reductions will result. The Environmental Protection Agency (EPA), which conducts a rigorous GHG lifecycle analysis for each feedstock and technology pathway before approval, estimates the RFS when fully implemented in 2022 will reduce greenhouse gas emissions by 138 million metric tons—equivalent to taking about 27 million vehicles off the road.[1]

As new cellulosic biofuels being commercialized exceed the minimum 60% GHG reduction requirement, the potential greenhouse gas savings under the RFS will be even greater. INEOS Bio's own technology, which is coming online in Florida this year, will provide GHG emissions reductions of over 100%, without any indirect land use issues. INEOS Bio hired the consulting firm Eunomia to conduct a lifecycle assessment of the INEOS Bio process. The key objective of the study was to compare the performance of the INEOS Bio process, with the performance of alternative technologies, when processing a range of waste feedstocks. Eunomia found that the INEOS Bio process, when utilizing residual municipal solid waste (MSW) as a feedstock, resulted in GHG emissions reductions of 84-91% when compared to fossil-based fuel. Food and yard waste resulted in even higher GHG emissions reductions of 109%. The numbers can exceed 100% not only because the INEOS Bio process exports electricity, which displaces electricity from fossil generation, but also because the waste feedstocks would otherwise end up in landfills, where they would emit methane, a greenhouse gas twenty-three times more potent than carbon dioxide.

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

A2: EPA's methodology, as described in its initial rulemaking, is extensive and incorporated the best science and data available at the time. No changes are needed at this time. However, it is worth noting that as the GHG emissions reductions for cellulosic fuels drop lower, the comparative baseline for fossil fuels GHG emissions creeps higher. While new extraction technologies have expanded known global reserves of unconventional oil, accessing those resources requires increasing amounts of energy. Accessing Canadian tar sands, for instance, requires enormous inputs of fossil-energy and generates significantly more carbon dioxide than conventional oil production. According to a recent Congressional Research Service report, "Well-to-Wheel GHG emissions" of Canadian oil sands crudes contain, on average, 14% to 20% more GHGs than the weighted average of transportation fuels sold or distributed domestically.[2] The report concludes that the "Well-to-Tank" or production GHG

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[1] U.S. Environmental Protection Agency, "Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis." Washington, DC: EPA-420-R-10-006, February 2010.
[2] Richard K. Lattanzio, "Canadian Oil Sands: Life-Cycle Assessments of Greenhouse Gas Emissions." Congressional Research Service, March 2013.

emissions of oil sands crudes are on average 70%-110% higher than for the average domestic transportation fuel.[3] Thus, while neither tar sands or cellulosic currently supply a large portion of our fuel supply, the future trajectory is clear: increasing emissions for unconventional fuels and declining GHG emissions for cellulosic fuels.

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

A3: The definition of renewable biomass adequately protects against unintended environmental consequences. If anything, the definition—and this is statutory, not a regulatory problem—is overprotective and impedes the use of new feedstocks. The definition of renewable biomass for the RFS2—one of several definitions of renewable biomass in federal statutes—severely limits the use of woody biomass and waste materials. The definition of renewable biomass excludes woody biomass from lands cleared or cultivated after 2007 and excludes tree crops, tree residues, and other biomass materials obtained from federal lands. INEOS Bio is interested in developing a plant utilizing woody biomass, but until EPA conducts a lifecycle assessment on round woods and completes the pending pathway requests in this area, the regulatory uncertainty does not warrant moving forward.

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

A4: Ethanol blending provides public health benefits apart from GHG emissions reductions. Unlike gasoline, ethanol combusts without producing air toxics, the principal source of unhealthy particulate matter (PM). Another benefit of ethanol versus gasoline is that it creates a cleaner fuel that allows for the use of less detergent additives that are required by the EPA to reduce the formation of engine deposits that occur from gasoline. These deposits increase exhaust emissions and result in the loss of fuel economy and performance. The benefits of cleaner fuel would only increase with higher ethanol blends, reducing the need for these expensive detergents, since only the gasoline portion needs to be treated with the deposit control additives. In addition, ethanol enjoys significantly higher octane ratings than neat gasoline fuel, which enables higher compression and more efficient combustion engines.[4] (This is in part why NASCAR uses a 15 percent ethanol blend (E15), and the Indy Racing League uses 100 percent ethanol.[5])

In fact, as part of the EPA's Tier III rulemaking, the EPA is proposing moving to higher octane fuels as a way to boost the efficiency of their engines. EPA notes in the proposed rule that the shift to higher octane

> "could help manufacturers that wish to raise compression ratios to improve vehicle efficiency, as a step toward complying with the 2017 and later light-duty greenhouse gas and CAFE standards. This in turn could help provide a market incentive to increase ethanol use beyond E10 by overcoming the disincentive of lower fuel economy associated with increasing ethanol concentrations in fuel,

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[3] *Id.*

[4] See Matthew Wald, "Squeezing More from Ethanol." The New York Times, May 3, 2013.

[5] Liz Clarke, "IndyCar Makes Switch to Ethanol," Washington Post, March 21, 2007; Chris Woodyard, "NASCAR Takes Steps to Drive Green," USA Today, April 7, 2013.

and enhance the environmental performance of ethanol as a transportation fuel by using it to enable more fuel efficient engines."[6]

Refiners commonly use the components that contain benzene, toluene, and xylene (BTX)—so-called aromatics—to raise octane levels in gasoline. These additives are known carcinogens.[7] EPA acknowledged in a 2007 rulemaking that aromatics, in addition to their toxic emissions, also account for 30 to 70% of Secondary Organic Aerosols, the largest source of urban particulate matter (PM).[8] After MTBE was phased out due to water contamination issues, refiners now blend ethanol with gasoline to boost octane. Using higher blends of ethanol to displace BTX would result in significant public health benefits.

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

A5: The increased use of waste as a feedstock for biofuel production will have ancillary benefits for how the U.S. deals with its waste. By diverting post-recycled waste materials to biorefineries like ours instead of landfills, communities can avoid the environmental impacts of ever-expanding landfills, such as water contamination, odor, and methane leakage. By "right-sizing" technology like ours to handle a community's particular waste needs, biorefineries can be a community-based solution to waste management. This is what INEOS Bio is doing on the Treasure Coast of Florida, and what we hope to do across the United States if the RFS remains in place.

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

A6: There may not be a precise optimal percentage of ethanol in gasoline, but significantly higher ethanol blends than E10 can improve automobile performance, reduce greenhouse gases, replace harmful aromatics, and provide overall improved air quality and health benefits.

High octane biofuels like ethanol offer a means to meet the higher mileage CAFE standards. As part of the Tier III rulemaking, the EPA is proposing to make E15 the default test fuel instead of E0 and to give automakers the option of having their vehicles certified for E30. Automakers support higher octane blends, although they do not want to be responsible for making the fuels available. At the April 29, 2013 EPA public hearing in Chicago on the Tier III rulemaking, Mercedes Benz North America embraced higher octane fuels. Mercedes Benz not only supporting the E15 test fuel proposed in the rule but also calling for blends exceeding E20, particularly E25.[9] The technology for higher blends is readily available and would reduce greenhouse gas emissions significantly.

In addition, the Alliance of Automobile Manufacturers filed comments to EPA's fuel efficiency rulemaking in 2012 stressing "the need to transition to higher octane grades

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[6] Environmental Protection Agency, "Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards," EPA–HQ–OAR–2011–0135 (prepublication version) March 29, 2013, page 24.

[7] See U.S. Department of Health and Human Services, "Interaction Profile for Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX)," May 2004 at 2, available at www.atsdr.cdc.gov/interactionprofiles/ip-btex/ip05.pdf.; Cliona M.McHale, Luoping Zhang and Martyn T. Smith, "Current understanding of the mechanism of benzene-induced leukemia in humans: implications for risk assessment." *Carcinogenesis* 33: 2 pp.240–252 (2012); see also Clean Fuels Development Coalition, "Improving Air Quality through Transportation Fuels" at 2 (2011), available at www.cleanfuelsdc.org/pubs/documents/CFDCIssueBrief0311_8.pdf.

[8] See 72 Fed. Reg. 20586, 20593 (Apr. 25, 2007).

[9] Testimony of Bill Woebkinberg, Mercedes Benz of North America, April 29, 2013.

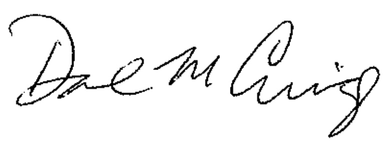
(most likely commensurate with higher ethanol or other bio-based fuel blend content), and related issues about renewable fuel and base gasoline contributions.... Higher octane grades in market fuels would enable optimization of combustion/thermal efficiency, for example in certain high compression or turbocharged engines."[10]

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

A7: The RFS remains an important tool to reduce greenhouse gas emissions from the transportation sector. The benefits of the RFS will increase significantly when advanced and cellulosic fuels are produced in larger quantities. The cellulosic volume requirements of the RFS give companies like ours certainty to make needed investments in commercializing cellulosic technologies. RFS volume obligations for first-generation fuels encourage ethanol infrastructure investments that also benefit next-generation biofuels. As mentioned in the response to questions 4 and 6 above, using ethanol to replace harmful aromatics and increase octane levels can help improve vehicle fuel efficiency. This has several benefits: reducing total gallons of fuel used (and thus total emissions), removing harmful aromatics, improving air quality, and significantly reducing the GHG emission profiles of those fuels consumed.

We appreciate the opportunity to provide these comments on green house gas emissions and other environmental impacts involved with the RFS.

Sincerely,



Daniel M. Cummings

[10] Alliance of Automobile Manufacturers, Comments on the Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for MY 2017-2025 (*Submitted February 13, 2012*), available at http://www.autoalliance.org/index.cfm?objectid=6CADFDC0-B980-11E1-9E4C000C296BA163 (last accessed May 21, 2013).

May 23, 2013

The Honorable Fred Upton
Chairman
Committee on Energy and Commerce
2125 Rayburn House Office Building
Washington, DC 20515

The Honorable Henry Waxman
Ranking Member
Committee on Energy and Commerce
2322A Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton and Ranking Member Waxman:

On behalf of more than 7,000 grower members of the Iowa Corn Growers Association (ICGA), we appreciate the opportunity to comment on this third White Paper, “Greenhouse Gas Emissions and Other Environmental Impacts,” from the House Committee on Energy and Commerce.

Growing corn and producing ethanol are continually being done in ways that make significant strides in sustainability. Farmers are producing more bushels on fewer acres with fewer inputs. Ethanol facilities are making more gallons with fewer bushels and fewer inputs. Both lead to better environmental performance than when the Renewable Fuel Standard (RFS) was first enacted in 2005. On the other hand, petroleum is getting harder to extract at higher environmental costs and has a dirtier environmental footprint than when the RFS was first passed. The RFS is an important tool in the Nation’s effort to achieve cleaner fuels and we believe the EPA has sufficient authority to properly encourage clean renewable fuels moving forward. It is also important to note that unnecessary Congressional tinkering with the RFS will jeopardize investment in advanced and cellulosic biofuels, undermine incentives for further innovation in the existing renewable fuels sector, and make us more dependent on dirtier petroleum sources than when the RFS was first enacted in 2005.

Corn farmers work hard to be good stewards of the land and environment while producing crops that will be used for animal feed, fuel, food and hundreds of other applications. Farmers know first-hand that they must embrace and seek practices that will sustain the soil and climate to produce the crops of the future.

Fortunately, U.S. Agriculture has made incredible technological advances. In 1960, the average U.S. farmer fed 26 people; today, due to these advances, the number has increased to 155 people. In fact, in the last 30 years, corn production has improved on all measures of resource efficiency, by decreasing per bushel: land use by 30 percent, soil erosion by 67 percent, irrigation by 53 percent, energy use by 43 percent and greenhouse gas (GHG) emissions by 36 percent.[1] All of these improvements have continued while the ethanol industry has increased corn demand.

[1] “Environmental and Socioeconomic Indicators for Measuring Outcomes of On-Farm Agricultural Production in the United States” Field to Market: The Keystone Alliance for Sustainable Agriculture, July 2012.

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With increasing yields in agricultural production, farmers have avoided clearing additional acres of land that would have been required to produce the same amount of food. The impact of the higher yields has curbed greenhouse gases equal to a third of the total emissions since the dawn of the Industrial Revolution in 1850. No other industry can claim to have done more. A 2010 study[2] from Stanford University found that advances in high-yield agriculture have prevented massive amounts of GHG from entering the atmosphere, the equivalent of 590 billion metric tons of carbon dioxide (CO_2). In fact, the study concludes that "improvements of crop yields should therefore be prominent among a portfolio of strategies to reduce global greenhouse gas emissions."

Today's transportation sector contributes 28 percent to the nation's greenhouse gas production and is predicted to maintain this share for the next several decades.[3] Since the U.S., China, and Japan consume approximately 35 percent of the world's gasoline supply, we have a tremendous opportunity to impact the environment as we plan for the future of our planet. As you know, the RFS was implemented, in part, to reduce the production of GHG by increasingly substituting ethanol into the transportation fuel sector. Ethanol produced from corn has multiple environmental attributes when compared to gasoline from petroleum. A few comparative facts are worth review:

1. Ethanol is made from a renewable resource, corn, with additional feedstock planned for the future. Petroleum (and natural gas) took millions of years to form and thus are considered non-renewable. Many of the new supplies require more energy intensive extraction and processing methods. In fact, exploration for oil is growing rapidly in some of the most fragile ecosystems on the planet including the boreal forests of Russia and Canada, the tropical forests and savannas of central Africa, the wetlands and seas of Myanmar and Southeast Asia, and the Peruvian Amazon.[4]

2. In the U.S., corn processed into ethanol represents less than 6 percent of harvested cropland. When corn grows, it takes CO_2 from the air and converts it into part of the plant, namely starch and cellulose (fiber). In fact, numerous studies show that the growth of corn increases soil health, through the return of carbon via the roots and decomposing corn stalks.[5,6] In contrast, petroleum extraction does not return carbon back to the Earth.

3. Ethanol, because of its non-toxic and inherent octane properties was chosen to replace petroleum-derived MTBE (methyl tertiary-butyl ether), a ground-water contaminant. In order to extract petroleum, landscape fragmentation and generation of toxic, hazardous, and potentially radioactive waste streams often occur.[7]

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[2] http://news.stanford.edu/news/2010/june/agriculture-global-warming-061410.html
[3] Fairly, P. (2011). Introduction: next generation biofuels. Nature 474:S2-S5.
[4] Orta-Martinez, M. and Finer, M. (2010). Oil frontiers and indigenous resistance in the Peruvian Amazon. Ecol Econ 70(2): 207-218.
[5] Clay, D., et al. (2012). Corn yields and no-till affects carbon sequestration and carbon footprints. Agronomy Journal 104(3): 763-770.
[6] Kwon, H, et al. (2013). Modeling state-level soil carbon emission factors under various scenarios for direct land use change associated with United States biofuel feedstock production. Biomass and Bioenergy, http://dx.doi.org/10.1016/j.biombioe.2013.02.021.
[7] Parish, E. et al. (2013). Comparing scales of environmental effects from gasoline and ethanol production. Environmental Management 51:307-338.

4. When the RFS was enacted and then modified in 2007, the EPA calculated that by 2022, corn starch ethanol would produce approximately 20 percent less GHG than the isolation and conversion of petroleum into gasoline. Corn conversion to ethanol has already reached this level today. As this document will summarize, corn starch derived ethanol has not only reached the 2022 goal of reduced GHG emissions today, but due to significant advances in agriculture and ethanol production practices, it produces nearly 50 percent fewer GHG emissions compared to gasoline. Conversely, the U.S. oil and gas industry generates more solid and liquid waste than municipal, agricultural, mining and other sources combined.[8]

The premise of this White Paper is to address GHG emissions. Transportation fuels emit GHG at different stages of their production and use. Lifecycle analysis (LCA) is a method to estimate, track and compare GHG emissions within and between systems. Within the LCA for fuel production, GHG emissions are measured, calculated and/or estimated within three main categories: feedstock production, fuel production, and tailpipe emissions. These processes contribute either 'direct' or 'indirect' impacts with respect to GHG emissions. The processes can be compared side-by-side (e.g., petroleum to gasoline conversion vs. corn to ethanol production) or summed together for an overall LCA comparison. For petroleum, the analysis may be referred to as 'well-to-wheel' and for ethanol as 'seed-to-wheel.' A tool for comparative analysis is necessary; however the underpinning measurements are very complex and often inaccurate. There are numerous reasons behind imprecise analyses, several examples include: outdated and/or inaccurate data, range of scale, and calculations based on old technologies to name a few. Our responses to the Committee-posed questions will address the challenges and opportunities in some of these areas.

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

In short, yes; the RFS has stimulated the production of renewable fuel, mainly in the form of ethanol from corn starch and thus reduced GHG emissions below that of gasoline production from petroleum. According to a recent report issued by the Global Renewable Fuels Association, ethanol production and use was estimated at reducing GHG emissions by 100 million metric tons in 2012 alone, equivalent to removing 20.2 million light duty vehicles from the highways.

While a definite reduction in GHG emissions is clear, the reduction is underestimated for multiple reasons. First, corn yield improvements have increased at a rate of 2.1 percent per year for the last 35 years (including the drought from 2012) - a huge gain reflected in several contributing categories. This increase in yield decreases the amount of land needed to grow corn. In addition, fertilizer use, especially nitrogen, has decreased per unit of grain produced. Fertilizer production and usage are the most intensive GHG emission contributors to farming; the amount of fertilizer needed to produce the same amount of grain has decreased in the last 30 years and, thus, so has the GHG intensity of U.S. farming. Furthermore as yields increase, farmers are able

[8] Ibid.

to harvest a portion of the corn stalks/cobs, known as stover, normally left in the field. Stover can be used as animal feed or can now be collected as a cellulose feedstock for ethanol production.

Second, the EPA underestimated the rate of improvement in corn ethanol process technologies. As shown in Table 1, the values EPA estimated in 2008 for ethanol production in 2012 were significantly lower than recently measured.

Table 1: Comparison of fuel production for ethanol, EPA estimated vs. actual

Energy or GHG emissions	**EPA value (estimated in 2008 for 2012)**	**Actual value (determined in 2012)[9]**
Natural Gas, BTU/gal	33,032	23,862
Electricity, kWh/gal	0.780	0.750

Additionally, when the renewable fuel standard was developed, corn ethanol plants made two products, ethanol and distillers dried grains (DDGs). DDGs are a valuable high protein product which is used to feed livestock. Today, most ethanol plants also produce corn oil, which is used to produce biodiesel or fed to the livestock industry. Although the EPA anticipated the development of a corn oil industry, it dramatically underestimated the speed of technology adoption. This underestimation results in higher calculated energy requirements for processing the DDGs. American agriculture and corn ethanol processing are lowering the GHG intensity of ethanol, and are producing more products using fewer resources. We fully expect this trend to continue as both farmers and ethanol producers continue to become more efficient.

Third, baseline emissions determined for petroleum-derived fuels did not take into consideration real-world scenarios thereby underestimating their emissions. Increasing amounts of U.S. petroleum feedstock deriving from tar sands, and sour, heavy crudes have significantly higher GHG emissions than conventional hydrocarbons. The old baseline is no longer appropriate since petroleum feedstock are becoming more energy and GHG emission intensive.

Fourth, current indirect GHGs are overestimated for biofuels while the indirect GHG for petroleum fuels are simply omitted. Thus, the actual improvements being made far exceed the estimated numbers. Today, EPA considers the total GHG emission value of gasoline from petroleum as 91.54 g CO_2/MJ of fuel (baseline 2005 value) vs. 77.56 g CO_2/MJ of ethanol from corn (calculated for 2022). When all of these optimizations are taken into consideration further improvements in GHG savings would be more evident. In fact, a case can be made to demonstrate that corn starch ethanol today produces nearly 50 percent less GHG emissions than petroleum, as shown in Table 2. This represents tremendous advancements in agriculture and corn starch to ethanol production technologies.

Table 2. Comparison of GHG emissions for petroleum and corn ethanol

	Petroleum	**Corn Ethanol**	**Corn Ethanol (including optimizations)[9,10]**

[9] Mueller, S. et al. (2013). 2012 Corn ethanol: emerging plant energy and environmental technologies, available: http://www.erc.uic.edu/PDF/mueller/2012_corn_ethanol_draft4_10_2013.pdf

Direct GHG g CO_2/MJ	91.54	41.39	46.4
Indirect GHG g CO_2/MJ	0*	30.17	2.14
Total g CO_2/MJ	**91.54**	**77.56**	**48.58**

*Note that petroleum has no indirect GHG accounting. This ignores LCA for petroleum to gasoline and is addressed below.

In response to the second part of Question #1, yes, the RFS is incentivizing the development of a new generation of lower greenhouse gas emitting fuels. As stated earlier, corn stover is becoming one of the first cellulose feedstocks. However, an inconsistency in terms of GHG accounting occurs. We are perplexed that the corn stover is given more GHG credit than corn grain. These are two parts of the same plant. Both products should be given an overall GHG score that reflects the entire process. In other words, the corn grain GHG score should be reflective of the entire plant and not separated from the corn plant.

Finally, yes, the RFS will continue to produce further greenhouse gas emission reductions when fully implemented. The magnitude of these additional future emission reductions is strongly dependent on significant integration of cellulosic biofuels into the market (e.g., corn stover and corn kernel fiber). However, uncertainty about the RFS's future is being fostered by the petroleum industry and slow approval of advanced and cellulosic biofuel pathways by EPA is hindering rollout of cellulosic biofuel projects.

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

There are several ways the calculations used by the EPA could and should be improved, both for direct and indirect GHG emissions. EPA currently has the regulatory authority to implement these fixes without any legislative changes. First, indirect calculated GHG emissions should include 'credits' to the overall score from agricultural management techniques that are not part of the current EPA baseline calculations for biofuels, for example:

- corn residues converted to animal feed (i.e., less grain is thereby needed)
- growing and/or harvesting double crops
- reduced- or no-tillage practices
- precision fertilizer application
- cover crops

[10] Lifecycle greenhouse gas emissions were estimated for a corn ethanol pathway that includes collecting corn stover and substituting it for corn grain in cattle feed plus the isolation of corn oil during ethanol production. Using stover as feed results in a GHG credit for the displaced corn. The credit includes the energy inputs and emissions associated with corn farming and transport of corn as well as reduced indirect land use change (ILUC) emissions associated with corn farming. ILUC is defined as the conversion of forests and other natural lands around the globe to agriculture to replace grain or cropland diverted to biofuels.

In other words, EPA should both recognize as well as incentivize good agricultural management practices that help meet GHG emission reductions. Studies suggest that high prices motivate farmers to increase yields.

Second, EPA and/or other federal funding agencies should examine the additional direct and indirect GHG emissions of petroleum fuels that are not included in their current calculations. Additional studies are required to provide a better understanding of the total GHG emissions of petroleum fuels including, but not limited to, the following items.

The U.S. spends billions of U.S. tax dollars to defend oil in foreign lands. Liska and Perrin have written the only quantitative analysis of resultant GHG emissions from these actions.[11] These authors estimate that military-related emissions add about 15-27 grams of CO_2 per megajoule of gasoline/diesel fuel in the U.S. This is very close in magnitude to the latest estimate of indirect GHG emissions assigned to corn ethanol by EPA (see Table 2). The Liska and Perrin study needs to be verified by further studies and then applied when estimating the total GHG emissions of petroleum fuels.

While the EPA uses LCA to estimate GHG emissions from biofuels, the manner used violates several key principles of LCA including:

i. Different boundaries (bases for comparison) are being used to compare petroleum (non-renewable) to renewable fuel. This is most evident in the use of indirect GHG emissions for biofuels but <u>not</u> for petroleum fuels. Clearly, petroleum fuels have some indirect GHG emissions, but these are totally ignored in EPA modeling efforts and should be included. Note the value of '0' for indirect effects of petroleum in Table 2.

ii. LCA principles require the use of the most up-to-date data. One clear example where this is not being followed is with regard to the baseline GHG emissions for petroleum fuels. The 2005 baseline is clearly out of date and needs to be revised. Note the value 91.54 g CO_2/MJ for petroleum in Table 2.

iii. Perhaps most importantly, the major purpose of LCA is as a tool to generate environmental improvements. In the case of indirect land use change (ILUC)[12], however, LCA is not used this way. Some of the improvements that could be made to corn ethanol production with corresponding improvements in GHG emissions and other environmental performance metrics are described within this document. Other such management tools exist. We ought to incentivize and reward the best biofuel producers.

All of the estimates of ILUC have been based on modeling studies using different approaches that yield significantly different predictions. Models may or may not represent reality and their validity must be checked. At least two peer-reviewed papers from two different research groups (Michigan State University and Oak Ridge National Lab) cast serious doubts on the validity of

[11] Liska, A. and Perrin, R. (2010). Environment, "Securing Foreign Oil: A Case for Including Military Operations in the Climate Change Impact of Fuels." Available: http://www.environmentmagazine.org/Archives/Back%20Issues/July-August%202010/securing-foreign-oil-full.html

[12] See footnote 10 for a definition of ILUC.

the model predictions for ILUC.[13,14] Those reports found no empirical, reality-based, evidence for ILUC from corn ethanol.

Further, the modeling used by EPA for GHG emission calculations is complex, inconsistent, lacks transparency, and is unresponsive to market needs. Moreover, the results are inconsistent with models developed by the Department of Energy, and have not been updated as the science and quality of information has improved. The EPA developed a unique modeling framework by combining the results of multiple models including, but not limited to[15]: GREET, FASOM, FAPRI, MOVES and others to estimate fuel LCA. The benefit of this complexity should be that the best model is used to calculate an input for each component of the overall system. However, errors or limitations occurring from combining these components include, but are not limited to: the individual component models may handle the same issue different ways; different emissions for the same activity can be calculated differently in the various models; emissions can be counted twice because of model overlap; and emissions or credits can be missed because of gaps in the modeling framework. As an example of just one of the inconsistencies between the models, the emission factors for fertilizer production using FASOM and FAPRI are compared in Table 3. In general, FASOM overestimates the emissions for fertilizer inputs, an important aspect of the biomass production systems. There are similar inconsistencies in other aspects of the models.

Table 3. Comparison of FASOM and FAPRI values

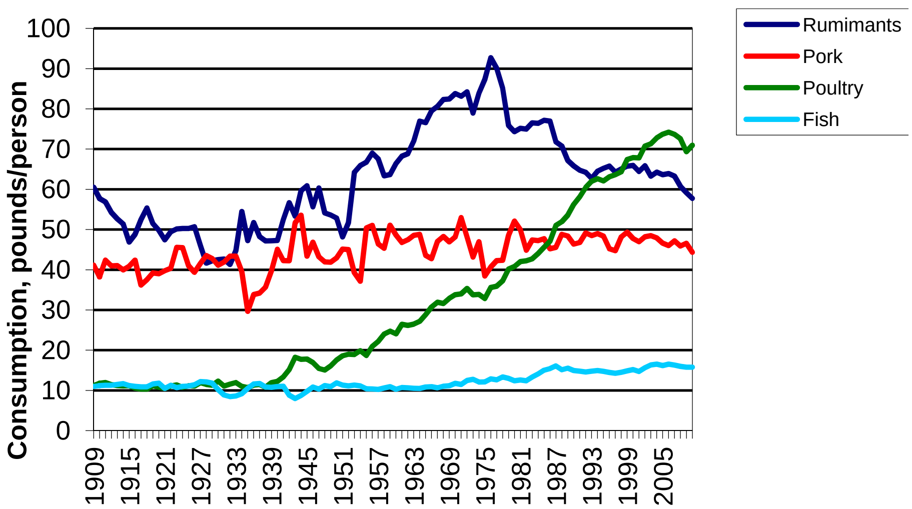
Fertilizer	FASOM kg CO_2eq/kg material	FAPRI kg CO_2eq/kg material
Nitrogen,	3.5-6.2	3.3
Phosphorus	3.0-11.5	1.1
Potassium	1.1-3.5	0.7
Pesticides	24.6-40.7	27.2

Additionally, during the process of ILUC calculations, it has also been pointed out to the EPA that the sum of the land use change attributed to each of three primary feedstock investigated (corn, soybeans, and sugarcane) is much higher than the land use change determined and utilized when all three feedstocks are modeled together. [16] This inconsistency results in a dramatic overestimation of the value for the ILUC emission factor. There is still considerable uncertainty in the models and this must be addressed to accurately reflect the dramatic savings in GHG emissions that biofuels have provided and will continue to provide to the environment.

[13] Oladosu, G. et al. (2011). Sources of corn for ethanol production in the United States: a decomposition analysis of the empirical data. Biofpr 5, 640-655.
[14] Kim, S. and Dale, B. (2011). Indirect land use change for biofuels: testing predictions and improving analytical methodologies. Biomass and Bioenergy 35, 3235-3240.
[15] GREET-Greenhouse gases, regulated emissions and energy use in transportation model; FASOM-Forest and agricultural sector optimization model; FAPRI-Food and agricultural policy research institute; MOVES-motor vehicle emission simulator
[16] RFA Letter to EPA. August 4, 2010. http://renewablefuelsassociation.createsend1.com/t/y/l/qhyitk/kuluiiuhh/y

Almost all of the models used by EPA are static models that aim to isolate the impact of a single variable, such as increased biofuel production. In reality there are many changes that are occurring and it is not possible to isolate just one. One of the important agricultural changes that has been happening and is not included in any of models is in the livestock sector. The American diet has been constantly changing over the past 100 years, both in terms of meat consumed and the type of meat eaten as shown in the following figure.

As the per capita beef consumption has decreased and the chicken consumption has increased,



the quantity of livestock feed required has decreased significantly as poultry requires 5 to 6 times less feed per pound of meat. The trend to lower beef consumption started in 1975, before the development of the fuel ethanol industry. These changing diets have had a large impact on the amount of land required for food production in the United States-- as feed yields of corn and soybeans have increased, and demand for livestock feed has dropped, new markets for these products were required and biofuels have filled the void. These trends need to be reflected in the FASOM model.

Further, while ILUC modeling has evolved significantly since the EPA started their work in 2008, a recent review by Wicke et al.[17] documents some of the differences and challenges impacting modeling in general. The study summarizes some of the uncertainties and shortcomings of the existing ILUC modeling work and these include, but are not limited to:

- uncertainties in the underlying datasets
- the amount, location and type of projected LUC
- by-and co-product allocation
- future production and trade patterns of bioenergy
- technological changes over time
- lack of comprehensive uncertainty analysis
- a focus on first-generation biofuels

[17] Wicke, B. et al. (2012). Indirect land use change: review of existing models and strategies for mitigation. Biofuels 3(1), 87-100.

- not accounting for the indirect effects of fossil fuels (addressed above)
- not accounting for the effects of sustainability criteria and land use policies
- not assessing all impacts of LUC

Despite recent improvements and refinements of the models, large uncertainties and shortcomings still exist. Thus, serious inaccuracies have resulted in final number calculations and are reflected in a less than optimal value for biofuels. In addition, these complexities mean that the evaluation of new feedstock and new production pathways to the appropriate regulatory agency can take a very long time to evaluate and approve. It is not unusual for pathways to take 2-3 years to move through the approval process.

In conclusion, in the five years since EISA was enacted and EPA modeled ILUC, significant advances to the art of calculating ILUC have been developed. This, combined with improved models as well as empirical evidence illustrate that the initial calculations by the EPA grossly over predicted the ILUC impacts to renewable fuels and negatively impacted the true value of reductions in GHG emission savings for corn starch ethanol.

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

ICGA feels that the definition is complex enough to meet this objective. ICGA does not support the expansion of the RFS to natural gas.

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

Regarding air quality, there is no need for additional regulations. In a recent report by Oak Ridge National Laboratory et al.,[18] test results indicate that when compared to fuel containing zero percent ethanol, very little to no changes were noted in common emission substances, e.g., carbon monoxide and nonmethane organic gases. Additionally, as described within section 209 of the Energy Independence and Security Act of 2007, Congress directed the Administrator to "determine whether the renewable fuel volumes required by this section will adversely impact air quality as a result of changes in vehicle and engine emissions of air pollutants regulated under this Act." If adverse effects are determined, then due to anti-backsliding, within three years of the rulemaking (i.e., 2010) "the Administrator shall (A) promulgate fuel regulations to implement appropriate measures to mitigate, to the greatest extent achievable, considering the results of the study under paragraph (1), any adverse impacts on air quality, as the result of the renewable volumes required by this section; or (B) make a determination that no such measures are necessary.''

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

[18] West, B., et al. (2012). Intermediate Ethanol Blends Catalyst Durability Program: ORNL/TM-2011/234.

The long-term sustainability of crop production is a high priority for farmers. Because of the RFS and the quantitation of LCA for the biofuel process, increased attention has been given to soil health. Recent studies have shown that depending upon farming practices, e.g., tillage, corn can increase carbon content within soil. While the impacts are expected to vary depending upon location, environment, and soil content, several studies have shown that corn farming can lead to soil carbon sequestration.[19,20, 21] These findings have provided evidence that environmental groups, private industry, governmental agencies and farmers can work together to develop and measure good practices for positive environmental outcomes.

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

As auto companies work to increase fuel efficiency to meet the Administration's CAFE-GHG rules, it is becoming increasingly clear that higher octane fuels will be critical to the auto companies' ability to be successful. Increasing ethanol levels will play a critical role in this effort and we are working with our auto partners in this regard.

Enhanced octane-rated components are blended into fuel to control engine knock. There are two choices to increase the octane rating of fuel offered here. The first is to increase amounts of the already present carcinogenic and toxic aromatic hydrocarbons such as benzene, toluene and xylene (BTX) in our gasoline supply. This is the approach favored by the oil industry, since they control the supply of these aromatics. Another approach is to splash blend more ethanol into gasoline. This would provide assistance toward achieving the renewable fuel volume mandates found in the RFS and thereby continue to decrease the amount of GHG emissions provided by the transportation sector.

The optimal concentration of ethanol varies depending on engine design and compression ratio. Not surprisingly, one engine compression ratio may be optimal for a given concentration, yet a different ethanol concentration would be optimal for another engine design. From one perspective, the optimal blend becomes the percentage that can be reliably provided consistently to the marketplace nationwide. From another standpoint, the optimal octane rating should be the resultant octane rating from the splash blend of ethanol onto an existing base gasoline available today. We need to maintain octane of the base fuel to achieve the higher octane level. The recommended optimal concentration of ethanol should be determined through science-based studies designed and coordinated between the experts who design engines, regulatory agencies that set emission policy, feedstock and fuel producers and the retailer infrastructure sectors. There have been published studies by automobile manufacturers who have investigated the performance of varying levels of ethanol in engines.[22, 23]

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[19] Follet, R., et al. (2012). Soil Carbon Sequestration by Switchgrass and No-Till Maize Grown for Bioenergy. Bioenergy Research 5:866-875.
[20] Kwon, H., et al. (2013). Modeling state-level carbon emission factors. Biomass and Bioenergy, http://dx.doi.org/10.1016/j.biombioe.2013.02.021.
[21] Clay, D., et al. (2012). Great Plains Soils May be C Sinks. Better Crops, 96:22-24.
[22] Stein, R., Anderson, J. and Wallington, T. (2013). An Overview of the Effects of Ethanol-Gasoline Blends on SI Engine Performance, Fuel Efficiency, and Emissions. SAE Int. J. Engines 6(1) doi:10.4271/2013-01-1635.
[23]Jung, H., et al., (2013). Fuel Economy and CO_2 Emissions of Ethanol-Gasoline Blends in a Turbocharged DI Engine, SAE Int. J. Engines 6(1):2013, doi:10.4271/2013-01-1321.

These studies provided the following observations:

> The increased octane rating of ethanol-gasoline blends plus other fuel characteristics, e.g., high heat of evaporation, help engines avoid knock under high operating conditions. By reducing the knock potential, engine sizes can continue to be downsized and/or engine operating speeds reduced while still meeting the same level of consumer power and performance expectations.
>
> Splash blended ethanol blends with an octane rating of 96 RON enabled a compression ratio increase from 10:1 to 11.9:1 in 3.5L engine.
>
> Ethanol has demonstrated improvements in emissions and depending upon the ethanol blends, CO_2 emissions decreased.

Both studies clearly suggest that any increase in the ethanol blend levels needs to retain the additional octane rating associated with the addition of ethanol. Specifically, the base (E10) gasoline should not be allowed to be downgraded by stripping out high octane components in anticipation of the ethanol addition as has occurred when the U.S. moved from E0 to E10.

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

During the past seven years the RFS has been responsible for reducing 205 million metric tons of CO_2, which is the equivalent of taking 39 million cars off the road.[24] Continued and expanded replacement of fossil fuels with lower GHG emitting renewable transportation fuel will lead to even greater advances in CO_2 reductions. In the process of achieving the RFS goal of utilizing over 13 billion gallons of ethanol from corn starch, private and public research labs will continue to invest in the development of new technologies that further enhance the efficiency of conventional biofuels and the realization of second generation advanced and cellulosic biofuels. Such investment in conventional biofuels has resulted in the development of combined heat and power, corn oil separation, cold-cook processing, and corn expressed enzymes that continue to reduce the CO_2 emissions of conventional biofuels in comparison to gasoline since 2008.[25]

Stability of the RFS provides incentive for continued investment in the development of advanced and cellulosic biofuels, which have the ability to reduce the carbon footprint of transportation fuels to even greater levels. Without the requirements of the RFS, low carbon fuels would no longer have a market and investment in process technologies to convert for example corn stover cellulose into biofuels would essentially be lost and with it the energy security upon which the RFS was established and the corresponding reduction in carbon emissions.

It is important to note that the RFS is also a key contributor to the success of other policies that will contribute to lowered emissions of CO_2 and other transportation related pollutants such as

[24] Renewable Fuels Association.
[25] Mueller, S. et al. (2013). 2012 Corn ethanol: emerging plant energy and environmental technologies, available: http://www.erc.uic.edu/PDF/mueller/2012_corn_ethanol_draft4_10_2013.pdf

SOx, NOx and particulate matter. These policies include the corporate average fuel economy, or CAFE standards, recently finalized by the National Highway and Transportation Safety Administration (NHTSA) and the EPA and the proposed Tier III standards to reduce sulfur in transportation fuel in development by EPA. These regulations will further reduce CO_2 emissions but will require renewable fuels to achieve their goals.

The CAFE standards require corporate average fuel economy to reach 54.5 mpg by 2025, which will reduce CO_2 emissions by 163 grams per driven mile. High octane fuels such as ethanol are a critical factor contributing to the development of lighter but higher compression engines by the auto industry. Ethanol blends greater than 10 percent are considered optimal for this use and will contribute to meeting the RFS requirements in the same time frame.

In 2012, the 2017 GHG/CAFE Standards effectively eliminated CO_2 reduction incentives for FFVs (flex-fuel vehicles) beginning in 2016. Instead, these standards emphasize GHG reduction through the use of non-liquid fuel sources, specifically electricity or natural gas. These fuels have limited infrastructure in place and the required infrastructure is significantly more expensive than E85. The anticipated additional cost for these automobiles is tens or even a hundred times higher than FFVs. The credits to build these were based on the claim that they would produce lower GHG emissions. This is misleading. In the accounting for the GHG emissions, EPA only considers emissions from the tailpipe. Electric cars are powered by electricity and 42 percent of the nation's electricity is generated by coal, a major contributor to GHG emissions and thus this should be included in the calculation as well. Cars that run on natural gas provide a number of challenges not the least of which is an extremely limited existing fueling infrastructure, a very high cost of additional infrastructure, and the use of natural gas that is not renewable (extracted from the Earth along with petroleum). Thus in 2012, a complete switch in the focus of automobiles and infrastructure occurred from a system designed to decrease GHG emissions using a renewable feedstock to one that increases GHG emissions using non-renewable feedstock. The National Corn Growers Association requested sufficient incentives be restored through the entire term of the RFS2 and 2017 GHG/CAFE Standards to insure at least 50 percent production of FFVs from all automobile manufacturers.

In summary, the Renewable Fuel Standard is not only one of our best options to substantially reduce greenhouse gas emissions from the transportation sector but is also a critically important component to the development of new technologies and of other efforts that will contribute to doing the same. Therefore, we strongly urge that this important policy be maintained.

Sincerely,

Bruce S. Rohwer
President
Iowa Corn Growers Association

Montauk energy®

May 23, 2013

VIA E-Mail: RFS@mail.house.gov
House Energy & Commerce Committee
United States House of Representatives
2125 Rayburn House Office Building
Washington, DC 20515

Ladies and Gentlemen:

Montauk Energy specializes in the management, recovery and utilization of landfill methane for energy recovery. Based in Pittsburgh, PA, we are pioneers in successfully utilizing a waste—biogas from landfills—into a valuable product that also avoids greenhouse gas emissions. Montauk Energy is a charter member of the Coalition for Renewable Natural Gas and we appreciate the opportunity to share with your Committee our thoughts on the Renewable Fuel Standard, specifically the questions posed by your staff in the White Paper entitled "Greenhouse Gas Emissions and Other Environmental Benefits."

Before addressing the specific questions posed in the White Paper, we offer some background on biogas, its potential for use as transportation fuel, and why we believe the Renewable Fuel Standard, properly implemented, represents the single most important policy that Congress has enacted to speed the transformation to a low carbon economy.

First, some basic facts about biogas. Biogas is a mixture of methane and other gases produced from the decomposition of organic materials. It is produced naturally in landfills, and from the processing of animal waste, sewage, crop waste, and cellulosic and non-cellulosic crops. When properly collected, biogas can be used to create electricity. Currently, there are approximately 500 landfill gas electrification projects in the U.S. Montauk Energy owns and operates nine (9) such projects in four states (Texas, Oklahoma, California, and New Jersey), with a nameplate capacity of 43 MW.

Although electric generation remains the predominant use of biogas, there is growing interest in converting biogas into pipeline-quality natural gas or "renewable natural gas" ("RNG"), and either pressurizing it for introduction into a common pipeline system for use as compressed natural gas in fleets ("CNG"), or using the gas on-site for fleets, in some cases by converting the gas to a liquid and creating liquefied natural ("LNG"). In either case, in order to create RNG, the biogas must undergo a conversion process that involves water removal, pretreatment to remove trace organics, CO2 separation, and compression. To date, there are approximately 30 projects nationwide that produce RNG. Montauk Energy is the largest producer of RNG in the US, with four (4) projects in three states (Texas, Pennsylvania, and Ohio) producing approximately 10,000 mmbtu/day.

There is enormous untapped potential for additional biogas use in the United States. Both DOE and EPA have analyzed the size of the resource. As of 2007, there were over 1,750 "active" landfills accepting 137 million tons of waste annually, or 54% of the total waste generated in the US. An additional 6,000 landfills are inactive. EPA estimates that while 75% of these landfills collect methane—a GHG gas estimates to be 21 times more potent than CO2—the remaining 25% is uncontrolled, resulting in significant GHG emissions that could be captured and used for transportation fuels. While many of these opportunities will never be developed because they lack commercial scale, there remains significant development opportunities with the right set of predictable, long-term energy policies.

There is growing interest in converting diesel fleets to natural gas, given the dramatic cost spread between petroleum and natural gas. With such conversion comes significant environmental benefits, since natural gas results in a 4%percent reduction in CO2 emissions. The potential benefits from applying the RFS to the conversion of diesel to RNG are enormous. The EIA recently forecasted that over 50 billion gallons of diesel will be used annually by 2017. DOE estimates that renewable natural gas has the potential of providing all 10 billion gallons, all from existing landfills and agricultural waste sources, using fully commercialized technology. **This amount is almost one-third of the total volume requirements of the RFS.**

In response to two of the seven specific questions in the White Paper—

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

The use of RNG for transportation – currently a D5 RIN—provides the lowest carbon intensity of all transportation fuels modeled by the California Air Resources Board (*See attached*). Regarding incentives, Montauk Energy is only beginning to explore the RFS as a potential driver for dedicating our RNG for transportation use. That said, the price differential between fossil gas and the cost of RNG is making new projects challenging. So long as the US does not "price" the environmental benefits of biogas recovery (and likewise fails to capture the environmental externalities of fossil fuels) we do not anticipate significant new project development. Further greenhouse gas emission reductions from biogas are dramatic. If all 10 billion gasoline gallon equivalent of biogas were produced and used as vehicle fuel, the reduction would be 500 million metric tons of CO2 reduction per year. That is equivalent to taking 90 million light-duty gasoline vehicles off the road.

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

In our view, the single best option is to promote the use of RNG in transportation fleets that currently use fossil CNG. The RFS is critical to that transformation.

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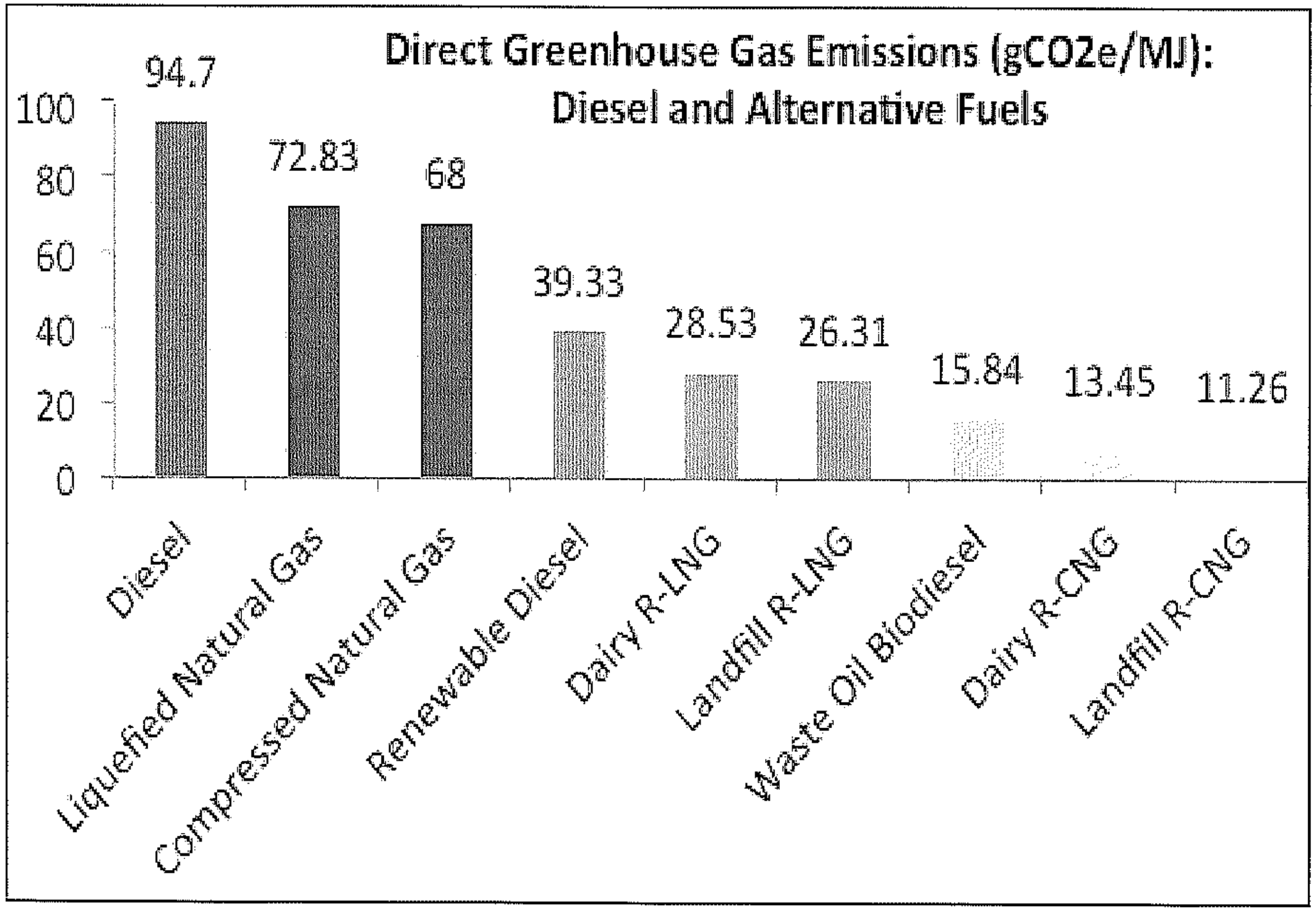
In his State of the Union address in 2007, President Bush called for the use of 35 billion gallons of renewable and alternative fuel by 2017. Renewable natural gas represents the greatest hope to meet that goal with technology that is fully commercialized and using a domestic, largely untapped resource. The RFS can promote a sustainable, clean form of transportation, but only if Congress shows patience and allows the program to work. We urge the Committee to work with EPA and industry to fully explore all of the potential opportunities of the RFS before attempting to reform it, and offer to help in that effort. Thank you for the opportunity to share our views.

Sincerely,

David Herman, President and CEO



Derived from CA Air Resources Board LCFS, 2009.

Comments of the National Alliance of Forest Owners
Committee on Energy and Commerce
Renewable Fuel Standard Assessment White Paper
Greenhouse Gas Emissions and Other Environmental Impacts
May 24, 2013

Introduction

The National Alliance of Forest Owners ("NAFO") is pleased to submit these comments in response to the Committee on Energy and Commerce's *Renewable Fuel Standard Assessment White Paper: Greenhouse Gas Emissions and Other Environmental Impacts* ("*RFS White Paper*"). 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 80 million acres of private forestland in 47 states. NAFO members are well positioned to help our nation meet 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 fuel goals, if placed on a level playing field with other renewable fuel feedstocks.

NAFO believes that the RFS program can play a significant role in meeting our nation's energy independence and GHG emission reduction goals. However, to do so, the RFS program must create a level playing field that promotes strong markets for all renewable fuel feedstocks. With respect to forest-based biomass, this requires the adoption of a broader and more inclusive definition of renewable biomass and the approval of a full range of pathways and feedstocks for the production of forest-based renewable fuels. By creating the necessary conditions to support a strong market for forest biomass, Congress and the Environmental Protection Agency ("EPA") can ensure the continued vitality of working forests and the many environmental and economic benefits that they provide to this nation.

In further response to the *RFS White Paper*, NAFO provides the following answer to the Committee's questions:

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

While NAFO supports Congress' objectives in the Energy Independence and Security Act of 2007 ("EISA"), the potential for forest-based biomass to help achieve these objectives far exceeds that envisioned in the EISA and its implementing regulations. To fully realize its potential for reducing GHG emissions, the RFS program must fully embrace forest-based biomass as a clean, renewable energy source and promote strong markets for forest biomass feedstocks. When viewed over an appropriate time scale, well-managed forests produce a stable supply of forest products with no net carbon dioxide ("CO_2") emissions. Forest products—including biomass used for fuel—are part of the natural forest carbon cycle. The scientific principles of the forest carbon cycle are well understood and uncontroversial. CO_2 is sequestered in forests through photosynthesis and emitted through respiration, decomposition, and combustion. The dynamic processes of carbon sequestration and emission occur simultaneously on the landscape and form an ongoing cycle by which emitted carbon is sequestered and vice versa. As a result, the CO_2 released through combustion of forest biomass for energy or as fuel was only recently sequestered from the atmosphere and is replaced by an equivalent amount of CO_2 through ongoing forest growth and regeneration as part of the natural forest carbon cycle.[1] Thus, both domestic and international bodies have consistently recognized the GHG emissions reduction benefits that forest biomass offers when compared to fossil fuels.[2]

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[1] Because of the long rotation cycles for many forest products, the GHG emission reductions associated with forest biomass must be assessed at a landscape level. While forest carbon stocks on each individual stand vary during the growth and harvest cycle, overall forest carbon stocks remain stable across the landscape of working forests. Thus, the alleged "carbon debt" that has been reported in some stand-based analyses disappears entirely when one considers the broad landscape over which working forests are managed.

[2] The United Nations' Intergovernmental Panel on Climate Change ("IPCC") highlighted the carbon benefits of forest biomass, stating "[i]n the long term, a sustainable forest management strategy aimed at maintaining or increasing forest stocks, while producing an annual sustained

Unfortunately, due to limitations in the RFS program, forest biomass is not currently realizing its full potential as a significant feedstock for commercial scale renewable fuel production. In order to fully realize the GHG reduction benefits of forest biomass, both statutory and regulatory changes are required. First, as described in response to Question 3 below, the RFS definition of renewable biomass is too narrow and needlessly excludes certain types of forest biomass by adding requirements that limit eligible forest-based feedstocks to *planted* trees from actively managed plantations. These requirements eliminate millions of acres of otherwise eligible forest-based biomass feedstocks and should be removed. Second, to date, EPA has only approved renewable fuel pathways for limited categories of forest-based biomass such as slash, pre-commercial thinning, and tree residues. *See* 40 C.F.R. § 80.1426. Until EPA approves the limited but critical planted tree pathway for additional forest biomass feedstocks and fuels, the uncertain availability of approved forest biomass feedstocks will preclude investment in necessary commercial-scale renewable fuel production from forest biomass. Therefore, to fully realize the RFS program's GHG emissions reduction potential, Congress and EPA should revise the RFS program and its implementing regulations to make full use of the absolute potential for forest-based biomass eligible renewable fuel feedstocks. Unless such broader approval occurs, the RFS program will impede the development of a strong renewable fuels market for forest biomass.

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yield of timber, fiber, or energy from the forest, will generate the greatest [GHG] mitigation benefit." 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. Likewise, EPA has concluded that there is "'scientific consensus' . . . that the carbon dioxide emitted from burning biomass will not increase CO2 in the air if it is done on a sustainable basis." Environmental Protection Agency Combined Heat and Power Partnership, *Biomass Combined Heat and Power Catalog of Technologies*, 96 (Sept. 2007) available at www.epa.gov/chp/documents/biomass_chp_catalog.pdf. Similar positions have been adopted bhy teh United States Energy Information Administration ("EIA"), the World Resources Institute ("WRI"), and other credible scientific bodies.

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

While NAFO supports EPA's life cycle analysis ("LCA") concluding that renewable fuel made from slash, pre-commercial thinnings, and tree residues qualifies for the advanced biofuel categories under the RFS program, the failure to complete the LCA for the planted tree pathway has impeded the development of commercial-scale renewable fuel production using forest-based biomass. To fully integrate forest-based biomass, EPA must complete the LCA so that planted trees will be eligible for inclusion in the RFS program.

As NAFO explained in its comments on EPA's proposed RFS2 rulemaking, LCAs for forest-based biomass consistently show that it is among the best possible feedstocks in terms of overall environmental performance.[3] In fact, LCAs for forest-based biomass consistently report GHG emissions reductions that exceed 60% when compared to fossil fuel alternatives.[4] If EPA continues to rely on the best available science regarding forest-based biomass, NAFO is confident that the GHG emission reduction benefits of forest-based biomass will be fully recognized by EPA.

However, two specific issues related to forest-based biomass deserve particular attention. First, any LCA conducted by EPA must include harvested wood products ("HWP") as a carbon pool. Forest-based biomass used for renewable energy production will often be produced in combination with durable HWP that will continue to store carbon for decades after harvest. This continued sequestration should be accounted for in any LCA. Second, NAFO believes that EPA must proceed with caution with respect to the incorporation of indirect land use changes. The desire to delve deeper into questions of

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[3] *See, e.g.*, Rainer Zah, *et al.*, *Life Cycle Assessment of Energy Products: Environmental Assessment of Biofuels*, May 2007.

[4] Pehnt, M., *Dynamic life cycle assessment (LCA) of renewable energy technologies*, Renewable Energy 31:55-71; doi:10.1016/j.renene.2005.03.002 (2006) (85-95% reduction); Cherubini, F., *et al., Energy- and greenhouse gas-based LCA of biofuel and bioenergy systems: Key issues, ranges and recommendations*, Resources, Conservation and Recycling 53:434-447; doi:10.1016/j.resconrec.2009.03.013 (2009) (90-95% reduction); Zhang, Y., *et al.*, *Life cycle emissions and cost of producing electricity from coal, natural gas, and wood pellets in Ontario, Canada,* Environmental Science and Technology 44(1):538-544; doi:10.1021/es902555a (2010) (78-91% reduction); Raymer, A.K.P., *A comparison of avoided greenhouse gas emissions when using different kinds of wood energy*, Biomass and Bioenergy 30:605-617; doi:10.1016/j.biombioe.2006.01.009 (2006) (81-98% reduction).

indirect land use impacts is a worthy scientific effort that may, over time, yield improved methodologies and useful data, but at present, the methodologies and data remain too crude and speculative to be relied upon for approving new pathways under the RFS program. Thus NAFO believes that EPA should refrain from including indirect land use change in any LCAs it conducts for forest-based biomass.

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

Private forests are among our nation's most important environmental resources. In addition to serving as the nation's largest carbon sink, they provide a suite of other important environmental benefits at no cost to the society as a whole. However, these positive externalities will not be produced in the absence of a strong market for forest products. Unless forest owners can be assured of viable markets for forest products that provide a reasonable return on their investment, forest owners will face increasing pressure to convert their land to other uses that will not provide the same environmental benefits as working forests. To support a strong market for forest-based renewable fuels, Congress and EPA must adopt a broad definition of renewable biomass that includes all forest-based biomass feedstocks without restriction and allows forest biomass to compete with other renewable fuel feedstocks on a level playing field.

In order to fully realize the environmental benefits that forest biomass can offer, Congress and EPA must adopt laws and regulations that provide a level playing field for market access across all feedstocks and encompasses the full range of forest biomass, including trees and other plants, forest residuals (e.g., tops branches, bark, etc.), and byproducts of manufacturing (e.g., sawdust, bark, chips, dissolved wood retrieved from the paper-making process, etc.). Unfortunately, the current definition in the RFS includes a number of significant qualifications that limit the types of eligible forest-based biomass feedstocks. Specifically, the statutory definition limits applicability to planted trees and requires active management on tree plantations. *See* 42 U.S.C. § 7545(o)(1)(I). NAFO believes that this statutory definition provides significant limitations on the types of biomass that are eligible under the RFS program and severely limits EPA's discretion to recognize forest biomass as a qualifying pathway. These restrictions needlessly disqualify millions of acres of private forests that could otherwise serve as a source for renewable fuels. By effectively foreclosing many forest owners from this new market, the RFS program places further economic pressure on an industry that is already reeling from steep declines in traditional markets such as solid wood and pulp and paper manufacturing. It also places forest biomass at a significant disadvantage in comparison to other biomass feedstocks, such as short rotation agricultural crops that require more energy, nutrients, and water to grow, as well as other renewable energy sources.

To remedy this condition, NAFO urges Congress to consider the broad and inclusive definition of renewable biomass that was subsequently adopted by Congress in the 2008 Farm Bill. The Farm Bill's definition of renewable biomass includes "any organic matter that is available on a renewable or recurring basis from non-Federal land . . . ." 7 U.S.C. § 8101(12)(B). While this definition is broad enough to include all forest-based biomass feedstocks without restriction, including dedicated energy crops, it should be improved in two essential areas. The definition should explicitly exclude recyclable paper and explicitly include mill residues and byproducts. Thus, NAFO urges Congress to amend the statutory definition of renewable biomass by adopting the definition in the 2008 Farm Bill (with revisions to include mill residues and byproducts and exclude recyclable paper).

By adopting an appropriately broad and inclusive definition of renewable biomass, Congress will ensure that working forests will continue to provide a full suite of environmental benefits. In addition to producing valuable products such as renewable fuels, working forests produce significant environmental benefits at little or no cost to society, including watershed protection, wildlife habitat, carbon dioxide absorption, and other "environmental services." While these benefits are produced "free of charge" by forest owners, their continued provision is dependent upon the primary forest products which are produced on working forests.

Whenever policymakers consider new environmental requirements for private forestry, such as eligibility requirements for forest biomass intended for renewable energy or fuel use, the implications for the economic viability of working forests must be considered. When existing markets for forest products are strong, or when new markets such as renewable fuels emerge, forest owners are able to invest in tree planting and forest health treatments which help maintain the private forest land base, keep private forests economically competitive with other land uses, and maintain family-waged jobs in the forestry sector. In contrast, if regulatory requirements reduce private forest owners' ability to realize value from working forests, or if new market limitations constrain market opportunities for working forests, private forest owners might be compelled to consider other uses for their forests. Thus, the definition of renewable biomass used in the RFS program will not only impact the economic viability of working forests, but also the important—and uncompensated—environmental benefits that they provide. By adopting a broad definition of renewable biomass as described above, Congress can ensure that it maximizes the environmental benefits associated with renewable fuel production.

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

As described in our response to Question 3, above, in addition to carbon sequestration, working forests provide a wide range of environmental benefits such as watershed protection and wildlife habitat. If the RFS program more fully embraces forest biomass, it will produce significant environmental benefits when compared to petroleum-derived fuels.

Like other renewable fuels, combustion of forest-based biomass does produce tailpipe emissions comparable to those produced by petroleum-derived fuels. However, because tailpipe emissions are subject to the same Clean Air Act requirements regardless of the nature of the feedstock, there is no need for additional air quality regulations to address emissions from forest-based biomass fuels. Instead, EPA has—and will continue to—subject vehicles associated with forest-based renewable fuel production to the same existing environmental safeguards as any other fuel. Simply put, there is nothing unique about forest-based biomass emissions that will require new or different treatment under the Clean Air Act.

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

At this time, the limited scope of the RFS approval for forest biomass-based pathways under the RFS program has in turn limited the full opportunities for the production of commercial-scale renewable fuels from forest biomass. While the limited production of renewable fuels from forest-based biomass has been promising, the full environmental benefits available under the RFS will not be realized until forest-based biomass is fully incorporated into the RFS program.

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

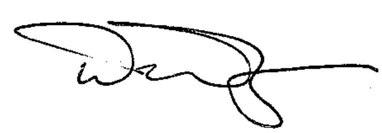
NAFO does not have a position on this issue.

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

As described above, forest-based biomass is among the most environmentally beneficial renewable fuel feedstocks available to the transportation sector. As long as strong markets are available, working forests, such as those owned by NAFO's members, have the capacity to produce a wide variety of valuable forest products—including renewable fuel—while maintaining, or even increasing, forest carbon stocks. As a result, the production of renewable fuels from forest-based biomass produces few, if any, GHG emissions on a lifecycle basis. And at the same time that that GHG emission reduction benefits are produced, working forests provide critical environmental co-benefits such as watershed protection and wildlife habitat as well as economic stability and jobs in many rural areas across the country.

In order to establish its position as a central component of our nation's efforts to reduce GHG emissions from the transportation sector, the RFS program must fully embrace forest-based biomass as a renewable fuel feedstock. Therefore, NAFO urges Congress and EPA to adopt laws and regulations that define renewable forest biomass broadly and ensure that all types of forest-based biomass are eligible for inclusion in the RFS program. By doing so, Congress and EPA will create a regulatory framework that encourages the development of a strong renewable fuels market for forest biomass. At the same time, by allowing forest-based biomass to compete on a level playing field with other renewable fuel feedstocks, Congress and EPA can ensure that the renewable fuel mandates included in the RFS program are being fulfilled in an economically efficient manner.

Respectfully Submitted,



David P. Tenny
President and CEO
National Alliance of Forest Owners

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May 24, 2013

U.S. House Committee on Energy and Commerce
Chairman Fred Upton
Ranking Member Henry Waxman
2125 Rayburn House Office Building
Washington, DC 20515

Submitted via Email: RFS@mail.house.gov

RE: Committee White Paper on Renewable Fuel Standard and Greenhouse Gas Emissions and Other Environmental Impacts

Dear Chairman Upton and Ranking Member Waxman:

Once again we appreciate the opportunity to weigh in on this series of white papers issued by the Committee on Energy and Commerce as you review the Renewable Fuel Standard (RFS). Already we have commented on two issues: the ethanol blend wall and agricultural sector impacts; and we look forward to commenting on the final two white papers. Today we submit our discussion of "Greenhouse Gas Emissions and Other Environmental Impacts." As always, we appreciate your efforts to better understand the issues related to the RFS, especially as it relates to biodiesel. We believe the RFS is already one of the most effective U.S. energy policies in recent history and look forward to working with both Congress and the Administration as this country continues its shift toward a true "all of the above" energy policy that will stimulate domestic production while strengthening our economic, energy and environmental security.

The National Biodiesel Board (NBB) is the national trade association representing the biodiesel industry and the coordinating body for research and development in the United States. Since 1992 when it was founded, NBB has developed into a comprehensive industry association that works closely with a broad range of stakeholders including industry, government and academia. Before we discuss the relevant questions highlighted by the Committee, it is important to note that the Biomass-based Diesel section of the RFS is working as intended. Biodiesel is the first EPA-designated Advanced Biofuel to be produced on a commercial scale across the country, and it has exceeded its RFS targets over the past two years. It is made from a diverse mix of feedstocks – including recycled cooking oil, agricultural oils such as soybean and canola oil, and animal fats, with new feedstocks like algae and camelina developing each year. Most biodiesel producers can seamlessly move from one feedstock to another, giving the industry tremendous flexibility.

As with all of these white papers, it is important to understand the scale and perspective of the biodiesel marketplace. In 2011 and 2012, the U.S. biodiesel industry produced about 1 billion gallons each year. In 2013 the RFS requires 1.28 billion gallons, and already the industry is ahead of last year's production. By comparison, the diesel pool is nearly 60 billion gallons, the gasoline pool is nearly 133 billion gallons, and the ethanol pool is approximately 13.5 billion gallons (biodiesel made up 1.6 percent of the diesel pool in 2012).

Since the Biomass-based Diesel (BBD) program began in 2010 under the RFS, our industry has produced more biodiesel than is required by the program and has lowered the price of diesel to consumers. *Furthermore, we believe biodiesel is the single best and most viable transportation fuel produced on a commercial scale in the U.S when measuring its tailpipe emissions, lifecycle carbon emissions and energy balance.*

First, tailpipe emissions from traditional diesel – primarily from older trucking fleets, school buses and other vehicles – are a significant health and air quality concern. In a recent update to its National-Scale Air Toxics Assessment, EPA cited diesel exhaust as one of the nation's most dangerous pollutants, saying it is "among the substances that may pose the greatest risk to the U.S. population." Thousands of trucks and buses hit the road every day burning traditional diesel fuel. Substituting higher amounts of biodiesel for traditional diesel fuel and heating oil is the simplest, most effective way to immediately reduce those emissions, including particulate matter, carbon monoxide, and other well-documented dangerous air pollutants.

Additionally, biodiesel is among the most cost-effective, practical means of reducing carbon emissions available today. The EPA has determined, based on the performance requirements established by the Energy Independence and Security Act (EISA) (P.L. 110-140), that domestically produced biodiesel is an Advanced Biofuel under the RFS. This means that the EPA has determined, based on years of peer-reviewed scientific study, that biodiesel reduces carbon emissions by at least 50 percent compared with petroleum diesel. Biodiesel is the only commercial-scale fuel sold and produced across the United States to achieve this designation.

Beginning in 2005 through December 2012, the biodiesel industry has produced 4.587 billion gallons of domestic renewable fuel and biodiesel has reduced lifecycle greenhouse gas emissions by 61.5969 billion pounds, the equivalent of removing 5.4 million passenger vehicles from America's roadways. In fact, the EPA estimates that biodiesel reduces lifecycle greenhouse gas emissions by as much as 86 percent compared to petroleum diesel fuel and creates 5.5 units of energy for every unit of energy that is used to produce the fuel.

Biodiesel is produced under strict technical standards and refined to meet a specific commercial fuel definition and specification. The fuel meets the D6751 fuel specification set forth by ASTM International, the official U.S. fuel-certification organization. Biodiesel is one of the most- and 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 can play a major role in expanding domestic refining capacity and reducing our reliance on foreign oil. Biodiesel is primarily marketed as a five percent (B5) blending component with conventional diesel fuel, but can be used in concentrations up to twenty percent (B20). It is distributed utilizing the existing fuel distribution infrastructure with blending occurring both at fuel terminals and "below the rack" by fuel jobbers.

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

Answer: Yes. According to the EPA, biodiesel reduces lifecycle greenhouse gas emissions by 57 percent to 86 percent compared with petroleum diesel. This lifecycle analysis accounts for modeling regarding indirect land use and other factors. Beginning in 2005 through December 2012, the biodiesel industry has produced 4.587 billion gallons of domestic renewable fuel, reducing lifecycle greenhouse gas emissions by 61.5969 billion pounds, the equivalent of removing 5.4 million passenger vehicles from America's roadways. These numbers illustrate that biodiesel is among the most practical, cost-effective ways available today to significantly reduce carbon emissions.

Regarding production advancements, biodiesel already is one of the most diverse fuels in the world, produced using everything from plant oils to animal tallow to used cooking oil. This diversity of feedstocks, which has grown significantly in recent years, has helped shape a nimble industry that is constantly searching for new technologies and feedstocks. In fact, industry demand for less expensive, reliable sources of fats and oils is stimulating – and often financing – promising research on next-generation feedstocks such as algae and camelina.

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

Answer: Lifecycle analysis involves difficult and inexact modeling that continues to be improved. To date, EPA's methodology is the most complete and thorough analysis of peer-reviewed science on the issue and is viewed as the most comprehensive analysis available. Additionally, more recent studies from prestigious academic institutions and government laboratories confirm EPA's analysis that biodiesel from a diversity of feedstocks delivers significant GHG reduction relative to petroleum even when including the international emissions from increased food production as an indirect impact of the Renewable Fuel Standard's global economic benefit. For example, the latest study from the University of Idaho and USDA[1] shows that biodiesel produced from vegetable oil, such as soybean oil, reduces GHGs by 76.4 percent including indirect emissions from international land use change.

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

Answer: The NBB does not recommend any changes to the definition, which is pasted below. We believe it is a comprehensive definition that adequately covers the salient environmental issues and protects against unintended consequences.

> Renewable biomass means each of the following (including any incidental, de minimus contaminants that are impractical to remove and are related to customary feedstock production and transport):
>
> (1) Planted crops and crop residue harvested from existing agricultural land cleared or cultivated prior to December 19, 2007 and that was nonforested and either actively managed or fallow on December 19, 2007.
>
> (2) Planted trees and tree residue from a tree plantation located on non-federal land (including land belonging to an Indian tribe or an Indian individual that is held in trust by the U.S. or subject to a restriction against alienation imposed by the U.S.) that was cleared at any time prior to December 19, 2007 and actively managed on December 19, 2007.
>
> (3) Animal waste material and animal byproducts.
>
> (4) Slash and pre-commercial thinnings from non-federal forestland (including forestland belonging to an Indian tribe or an Indian individual, that are held in trust by the United States or subject to a restriction against alienation imposed by the United States) that is not ecologically sensitive forestland.
>
> (5) Biomass (organic matter that is available on a renewable or recurring basis) obtained from the immediate vicinity of buildings and other areas regularly occupied by people, or of public infrastructure, in an area at risk of wildfire.
>
> (6) Algae.
>
> (7) Separated yard waste or food waste, including recycled cooking and trap grease, and materials described in §80.1426(f)(5)(i).

[1] Pradham et. al., University of Idaho and USDA, Reassessment of Lifecycle Greenhouse Gas Emissions for Soybean Biodiesel, 2012 American Society of Agricultural and Biological Engineers

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

Answer: Biodiesel significantly reduces or eliminates non-carbon tailpipe emissions such as sulfur, carbon monoxide and particulate matter. Additionally, it is non-toxic and biodegradable, significantly reducing any impacts from spills or leaks. This compares very favorably to the negative environmental impacts of using petroleum, including but not limited to:

1. The explosion and sinking of the *Deepwater Horizon* oil rig, which claimed 11 lives, a sea-floor oil gusher flowed unabated for 87 days, until it was capped on 15 July 2010. The total discharge is estimated at 4.9 million barrels (210 million US gal; 780,000 m^3); and

2. The 1989, Exxon Valdez, which spill 10.8 million gallons in Prince William Sound and where 4 people lost their lives during clean up;

3. The negative implications including water pollution created by fracking; and

4. Tailpipe emissions from traditional diesel – primarily from older trucking fleets, school buses and other vehicles – which are a significant health and air quality concern. In a recent update to its National-Scale Air Toxics Assessment, EPA cited diesel exhaust as one of the nation's most dangerous pollutants, saying it is "among the substances that may pose the greatest risk to the U.S. population."

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

Answer: We think most definitely. It is clear the statute, among other things, did not anticipate the following:

1. that biodiesel would reduce greenhouse gas emissions by some 86 percent;

2. that beginning in 2005 through December 2012, the biodiesel industry would produce and replace some 4.587 billion gallons of domestic renewable fuel;

3. that biodiesel has reduced lifecycle greenhouse gas emissions by 61.5969 billion pounds, the equivalent of removing 5.4 million passenger vehicles from America's roadways; and

4. that biodiesel would create 5.5 units of energy for every unit of energy that is used to produce the fuel;

5. that biodiesel would encourage restaurants to recycle their waste cooking oil into fuel;

6. that biodiesel would assist municipal water systems by decreasing the amount of trap grease sent to local sewer systems;

7. that biodiesel would decrease the cost of diesel fuel to consumers;

8. that biodiesel would support some 50,000 jobs to the U.S. economy in 2012 and more as the volume grows beyond 1.0 billion gallons;

9. that discretionary blenders of biodiesel (non-obligated parties) would blend some 500 million gallons of biodiesel (without being required to do so) into their diesel fuel supplies each year.

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

Answer: Biodiesel is primarily marketed as a five percent (B5) blending component with conventional diesel fuel, but it can be used in concentrations up to twenty percent (B20) or higher under warranty, per the vehicle manufacturers' recommendations. All major Original Equipment Manufacturers (OEMs) selling diesel vehicles and equipment in the U.S. support at least B5 and lower blends, provided they are made with biodiesel meeting ASTM D6751 specifications. Most OEMs also recommend sourcing the fuel from a BQ-9000 quality certified supplier. In addition, currently more than 75 percent of the total diesel vehicle and equipment manufacturers in the U.S. market also support the use of B20 or higher blends in at least some of their equipment and nearly 90 percent of the medium- and heavy-duty truck markets support B20 under warranty. For a complete listing of OEM position statements on biodiesel, as well as the current U.S. Diesel Vehicles List, visit: www.biodiesel.org/using-biodiesel/oem-information.

Biodiesel blends are distributed from nearly 2,000 retail and distribution outlets nationwide utilizing the existing fuel distribution infrastructure, with blending occurring both at fuel terminals and “below the rack” by fuel jobbers.

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

Answer: Unfortunately there are no easy answers for reducing greenhouse gas emissions, and no silver bullet for addressing them. However, to date, we believe the RFS has been the single most effective policy in recent history at displacing high-carbon fossil fuels in the transportation sector and reducing greenhouse gas emissions. We believe biodiesel has been an incredible success story under this policy as the first and only EPA-designated advanced biofuel in commercial scale production nationwide. The industry has grown from a niche fuel just five or six years ago to a 1 billion gallon industry. While other incentives such as tax credits and grant programs for building infrastructure and capacity are also effective, we believe policy certainty regarding the RFS is critical to building on and expanding the success of the program in diversifying our transportation fuels and reducing harmful emissions. Policy certainty will stimulate investment and infrastructure in advanced biofuels such as biodiesel, creating even greater emissions benefits as the program matures.

Thank you again for the opportunity to submit comments on this important subject. Should you have any questions or need further information, please don't hesitate to call me at 202-737-8801. I can also be reached via email at asteckel@biodiesel.org.

Best Regards,

Anne Steckel
Vice President, Federal Affairs
National Biodiesel Board

May 23, 2013

The Honorable Fred Upton
Chairman
Committee on Energy and Commerce
2125 Rayburn House Office Building
Washington, DC 20515

The Honorable Henry Waxman
Ranking Member
Committee on Energy and Commerce
2322A Rayburn House Office Building
Washington, DC 20515

Dear Chairman Upton and Ranking Member Waxman:

On behalf of more than 38,000 grower members of the National Corn Growers Association, we appreciate the opportunity to comment on this third White Paper, "Greenhouse Gas Emissions and Other Environmental Impacts," from the House Committee on Energy and Commerce.

Growing corn and producing ethanol are continually being done in ways that make significant strides in sustainability. Farmers are producing more bushels on fewer acres with fewer inputs. Ethanol facilities are making more gallons with fewer bushels and fewer inputs. Both lead to better environmental performance than when the Renewable Fuel Standard (RFS) was first enacted in 2005. On the other hand, petroleum is getting harder to extract at higher environmental costs and has a dirtier environmental footprint than when the RFS was first passed. The RFS is an important tool in the Nation's effort to achieve cleaner fuels and we believe the EPA has sufficient authority to properly encourage clean renewable fuels moving forward. It is also important to note that unnecessary Congressional tinkering with the RFS will jeopardize investment in advanced and cellulosic biofuels, undermine incentives for further innovation in the existing renewable fuels sector, and make us more dependent on dirtier petroleum sources than when the RFS was first enacted in 2005.

Between 1900 and 2012, the world's population grew from 1.6 billion to more than 7 billion. The Food and Agriculture Organization of the United Nations estimates that the world's population will increase to 9 billion by 2050. With the increased demand for conventional agriculture, it is more important than ever to produce crops today while looking towards the future health of the planet. Corn farmers work hard to be good stewards of the land and environment while producing crops that will be used for animal feed, fuel, food and hundreds of other applications. Farmers know first-hand that they must embrace and seek practices that will sustain the soil and climate to produce the crops of the future.

Fortunately, U.S. Agriculture has made incredible technological advances. In 1960, the average U.S. farmer fed 26 people; today, due to these advances, the number has increased to 155 people. In fact, in the last 30 years, corn production has improved on all measures of resource efficiency, by decreasing per bushel: land use by 30 percent, soil erosion by 67 percent, irrigation by 53 percent, energy use by 43 percent and greenhouse gas (GHG) emissions by 36 percent.[1] All of these improvements have continued while the ethanol industry has increased corn demand.

With increasing yields in agricultural production, farmers have avoided clearing additional acres of land that would have been required to produce the same amount of food. The impact of the higher yields has curbed greenhouse gases equal to a third of the total emissions since the dawn of the Industrial Revolution in 1850. No other industry can claim to have done more. A 2010 study[2] from Stanford University found that advances in high-yield agriculture have prevented massive amounts of GHG from entering the atmosphere, the equivalent of 590 billion metric tons of carbon dioxide (CO_2). In fact, the study concludes that "improvements of crop yields should therefore be prominent among a portfolio of strategies to reduce global greenhouse gas emissions."

Today's transportation sector contributes 28 percent to the nation's greenhouse gas production and is predicted to maintain this share for the next several decades.[3] Since the U.S., China, and Japan consume approximately 35 percent of the world's gasoline supply, we have a tremendous opportunity to impact the environment as we plan for the future of our planet. As you know, the RFS was implemented, in part, to reduce the production of GHG by increasingly substituting ethanol into the transportation fuel sector. Ethanol produced from corn has multiple environmental attributes when compared to gasoline from petroleum. A few comparative facts are worth review:

1. Ethanol is made from a renewable resource, corn, with additional feedstock planned for the future. Petroleum (and natural gas) took millions of years to form and thus are considered non-renewable. Many of the new supplies require more energy intensive extraction and processing methods. In fact, exploration for oil is growing rapidly in some of the most fragile ecosystems on the planet including the boreal forests of Russia and Canada, the tropical forests and savannas of central Africa, the wetlands and seas of Myanmar and Southeast Asia, and the Peruvian Amazon.[4]

2. In the U.S., corn processed into ethanol represents less than 6 percent of harvested cropland. When corn grows, it takes CO_2 from the air and converts it into part of the plant, namely starch and cellulose (fiber). In fact, numerous studies show that the growth of corn increases soil health, through the return of carbon via the roots and decomposing corn stalks.[5,6] In contrast, petroleum extraction does not return carbon back to the Earth.

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1 "Environmental and Socioeconomic Indicators for Measuring Outcomes of On-Farm Agricultural Production in the United States" Field to Market: The Keystone Alliance for Sustainable Agriculture, July 2012.
2 http://news.stanford.edu/news/2010/june/agriculture-global-warming-061410.html
3 Fairly, P. (2011). Introduction: next generation biofuels. Nature 474:S2-S5.
4 Orta-Martinez, M. and Finer, M. (2010). Oil frontiers and indigenous resistance in the Peruvian Amazon. Ecol Econ 70(2): 207-218.
5 Clay, D., et al. (2012). Corn yields and no-till affects carbon sequestration and carbon footprints. Agronomy Journal 104(3): 763-770.
6 Kwon, H, et al. (2013). Modeling state-level soil carbon emission factors under various scenarios for direct land use change associated with United States biofuel feedstock production. Biomass and Bioenergy, http://dx.doi.org/10.1016/j.biombioe.2013.02.021.

3. Ethanol, because of its non-toxic and inherent octane properties was chosen to replace petroleum-derived MTBE (methyl tertiary-butyl ether), a ground-water contaminant. In order to extract petroleum, landscape fragmentation and generation of toxic, hazardous, and potentially radioactive waste streams often occur.[7]

4. When the RFS was enacted and then modified in 2007, the EPA calculated that by 2022, corn starch ethanol would produce approximately 20 percent less GHG than the isolation and conversion of petroleum into gasoline. Corn conversion to ethanol has already reached this level today. As this document will summarize, corn starch derived ethanol has not only reached the 2022 goal of reduced GHG emissions today, but due to significant advances in agriculture and ethanol production practices, it produces nearly 50 percent fewer GHG emissions compared to gasoline. Conversely, the U.S. oil and gas industry generates more solid and liquid waste than municipal, agricultural, mining and other sources combined.[8]

The premise of this White Paper is to address GHG emissions. Transportation fuels emit GHG at different stages of their production and use. Lifecycle analysis (LCA) is a method to estimate, track and compare GHG emissions within and between systems. Within the LCA for fuel production, GHG emissions are measured, calculated and/or estimated within three main categories: feedstock production, fuel production, and tailpipe emissions. These processes contribute either 'direct' or 'indirect' impacts with respect to GHG emissions. The processes can be compared side-by-side (e.g., petroleum to gasoline conversion vs. corn to ethanol production) or summed together for an overall LCA comparison. For petroleum, the analysis may be referred to as 'well-to-wheel' and for ethanol as 'seed-to-wheel.' A tool for comparative analysis is necessary; however the underpinning measurements are very complex and often inaccurate. There are numerous reasons behind imprecise analyses, several examples include: outdated and/or inaccurate data, range of scale, and calculations based on old technologies to name a few. Our responses to the Committee-posed questions will address the challenges and opportunities in some of these areas.

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

In short, yes; the RFS has stimulated the production of renewable fuel, mainly in the form of ethanol from corn starch and thus reduced GHG emissions below that of gasoline production from petroleum. According to a recent report issued by the Global Renewable Fuels Association, ethanol production and use was estimated at reducing GHG emissions by 100 million metric tons in 2012 alone, equivalent to removing 20.2 million light duty vehicles from the highways.

While a definite reduction in GHG emissions is clear, the reduction is underestimated for multiple reasons. First, corn yield improvements have increased at a rate of 2.1 percent per year

[7] Parish, E. et al. (2013). Comparing scales of environmental effects from gasoline and ethanol production. Environmental Management 51:307-338.
[8] Ibid.

for the last 35 years (including the drought from 2012) - a huge gain reflected in several contributing categories. This increase in yield decreases the amount of land needed to grow corn. In addition, fertilizer use, especially nitrogen, has decreased per unit of grain produced. Fertilizer production and usage are the most intensive GHG emission contributors to farming; the amount of fertilizer needed to produce the same amount of grain has decreased in the last 30 years and, thus, so has the GHG intensity of U.S. farming. Furthermore as yields increase, farmers are able to harvest a portion of the corn stalks/cobs, known as stover, normally left in the field. Stover can be used as animal feed or can now be collected as a cellulose feedstock for ethanol production.

Second, the EPA underestimated the rate of improvement in corn ethanol process technologies. As shown in Table 1, the values EPA estimated in 2008 for ethanol production in 2012 were significantly lower than recently measured.

Table 1: Comparison of fuel production for ethanol, EPA estimated vs. actual

Energy or GHG emissions	**EPA value (estimated in 2008 for 2012)**	**Actual value (determined in 2012)**[9]
Natural Gas, BTU/gal	33,032	23,862
Electricity, kWh/gal	0.780	0.750

Additionally, when the renewable fuel standard was developed, corn ethanol plants made two products, ethanol and distillers dried grains (DDGs). DDGs are a valuable high protein product which is used to feed livestock. Today, most ethanol plants also produce corn oil, which is used to produce biodiesel or fed to the livestock industry. Although the EPA anticipated the development of a corn oil industry, it dramatically underestimated the speed of technology adoption. This underestimation results in higher calculated energy requirements for processing the DDGs. American agriculture and corn ethanol processing are lowering the GHG intensity of ethanol, and are producing more products using fewer resources. We fully expect this trend to continue as both farmers and ethanol producers continue to become more efficient.

Third, baseline emissions determined for petroleum-derived fuels did not take into consideration real-world scenarios thereby underestimating their emissions. Increasing amounts of U.S. petroleum feedstock deriving from tar sands, and sour, heavy crudes have significantly higher GHG emissions than conventional hydrocarbons. The old baseline is no longer appropriate since petroleum feedstock are becoming more energy and GHG emission intensive.

Fourth, current indirect GHGs are overestimated for biofuels while the indirect GHG for petroleum fuels are simply omitted. Thus, the actual improvements being made far exceed the estimated numbers. Today, EPA considers the total GHG emission value of gasoline from petroleum as 91.54 g CO_2/MJ of fuel (baseline 2005 value) vs. 77.56 g CO_2/MJ of ethanol from corn (calculated for 2022). When all of these optimizations are taken into consideration further improvements in GHG savings would be more evident. In fact, a case can be made to demonstrate that corn starch ethanol today produces nearly 50 percent less GHG emissions than

[9] Mueller, S. et al. (2013). 2012 Corn ethanol: emerging plant energy and environmental technologies, available: http://www.erc.uic.edu/PDF/mueller/2012_corn_ethanol_draft4_10_2013.pdf

petroleum, as shown in Table 2. This represents tremendous advancements in agriculture and corn starch to ethanol production technologies.

Table 2. Comparison of GHG emissions for petroleum and corn ethanol

	Petroleum	**Corn Ethanol**	**Corn Ethanol (including optimizations)**[9,10]
Direct GHG g CO_2/MJ	91.54	41.39	46.4
Indirect GHG g CO_2/MJ	0*	30.17	2.14
Total g CO_2/MJ	**91.54**	**77.56**	**48.58**

*Note that petroleum has no indirect GHG accounting. This ignores LCA for petroleum to gasoline and is addressed below.

In response to the second part of Question #1, yes, the RFS is incentivizing the development of a new generation of lower greenhouse gas emitting fuels. As stated earlier, corn stover is becoming one of the first cellulose feedstocks. However, an inconsistency in terms of GHG accounting occurs. We are perplexed that the corn stover is given more GHG credit than corn grain. These are two parts of the same plant. Both products should be given an overall GHG score that reflects the entire process. In other words, the corn grain GHG score should be reflective of the entire plant and not separated from the corn plant.

Finally, yes, the RFS will continue to produce further greenhouse gas emission reductions when fully implemented. The magnitude of these additional future emission reductions is strongly dependent on significant integration of cellulosic biofuels into the market (e.g., corn stover and corn kernel fiber). However, uncertainty about the RFS's future is being fostered by the petroleum industry and slow approval of advanced and cellulosic biofuel pathways by EPA is hindering rollout of cellulosic biofuel projects.

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

There are several ways the calculations used by the EPA could and should be improved, both for direct and indirect GHG emissions. EPA currently has the regulatory authority to implement these fixes without any legislative changes. First, indirect calculated GHG emissions should include 'credits' to the overall score from agricultural management techniques that are not part of the current EPA baseline calculations for biofuels, for example:

- corn residues converted to animal feed (i.e., less grain is thereby needed)

[10] Lifecycle greenhouse gas emissions were estimated for a corn ethanol pathway that includes collecting corn stover and substituting it for corn grain in cattle feed plus the isolation of corn oil during ethanol production. Using stover as feed results in a GHG credit for the displaced corn. The credit includes the energy inputs and emissions associated with corn farming and transport of corn as well as reduced indirect land use change (ILUC) emissions associated with corn farming. ILUC is defined as the conversion of forests and other natural lands around the globe to agriculture to replace grain or cropland diverted to biofuels.

- growing and/or harvesting double crops
- reduced- or no-tillage practices
- precision fertilizer application
- cover crops

In other words, EPA should both recognize as well as incentivize good agricultural management practices that help meet GHG emission reductions.

Second, EPA and/or other federal funding agencies should examine the additional direct and indirect GHG emissions of petroleum fuels that are not included in their current calculations. Additional studies are required to provide a better understanding of the total GHG emissions of petroleum fuels including, but not limited to, the following items.

The U.S. spends billions of U.S. tax dollars to defend oil in foreign lands. Liska and Perrin have written the only quantitative analysis of resultant GHG emissions from these actions.[11] These authors estimate that military-related emissions add about 15-27 grams of CO_2 per megajoule of gasoline/diesel fuel in the U.S. This is very close in magnitude to the latest estimate of indirect GHG emissions assigned to corn ethanol by EPA (see Table 2). The Liska and Perrin study needs to be verified by further studies and then applied when estimating the total GHG emissions of petroleum fuels.

While the EPA uses LCA to estimate GHG emissions from biofuels, the manner used violates several key principles of LCA including:

i. Different boundaries (bases for comparison) are being used to compare petroleum (non-renewable) to renewable fuel. This is most evident in the use of indirect GHG emissions for biofuels but <u>not</u> for petroleum fuels. Clearly, petroleum fuels have some indirect GHG emissions, but these are totally ignored in EPA modeling efforts and should be included. Note the value of '0' for indirect effects of petroleum in Table 2.

ii. LCA principles require the use of the most up-to-date data. One clear example where this is not being followed is with regard to the baseline GHG emissions for petroleum fuels. The 2005 baseline is clearly out of date and needs to be revised. Note the value 91.54 g CO_2/MJ for petroleum in Table 2.

iii. Perhaps most importantly, the major purpose of LCA is as a tool to generate environmental improvements. In the case of indirect land use change (ILUC)[12], however, LCA is not used this way. Some of the improvements that could be made to corn ethanol production with corresponding improvements in GHG emissions and other environmental performance metrics are described within this document. Other such management tools exist. We ought to incentivize and reward the best biofuel producers.

[11] Liska, A. and Perrin, R. (2010). Environment, "Securing Foreign Oil: A Case for Including Military Operations in the Climate Change Impact of Fuels." Available: http://www.environmentmagazine.org/Archives/Back%20Issues/July-August%202010/securing-foreign-oil-full.html

[12] See footnote 10 for a definition of ILUC.

All of the estimates of ILUC have been based on modeling studies using different approaches that yield significantly different predictions. Models may or may not represent reality and their validity must be checked. At least two peer-reviewed papers from two different research groups (Michigan State University and Oak Ridge National Lab) cast serious doubts on the validity of the model predictions for ILUC.[13,14] Those reports found no empirical, reality-based, evidence for ILUC from corn ethanol.

Further, the modeling used by EPA for GHG emission calculations is complex, inconsistent, lacks transparency, and is unresponsive to market needs. Moreover, the results are inconsistent with models developed by the Department of Energy, and have not been updated as the science and quality of information has improved. The EPA developed a unique modeling framework by combining the results of multiple models including, but not limited to[15]: GREET, FASOM, FAPRI, MOVES and others to estimate fuel LCA. The benefit of this complexity should be that the best model is used to calculate an input for each component of the overall system. However, errors or limitations occurring from combining these components include, but are not limited to: the individual component models may handle the same issue different ways; different emissions for the same activity can be calculated differently in the various models; emissions can be counted twice because of model overlap; and emissions or credits can be missed because of gaps in the modeling framework. As an example of just one of the inconsistencies between the models, the emission factors for fertilizer production using FASOM and FAPRI are compared in Table 3. In general, FASOM overestimates the emissions for fertilizer inputs, an important aspect of the biomass production systems. There are similar inconsistencies in other aspects of the models.

Table 3. Comparison of FASOM and FAPRI values

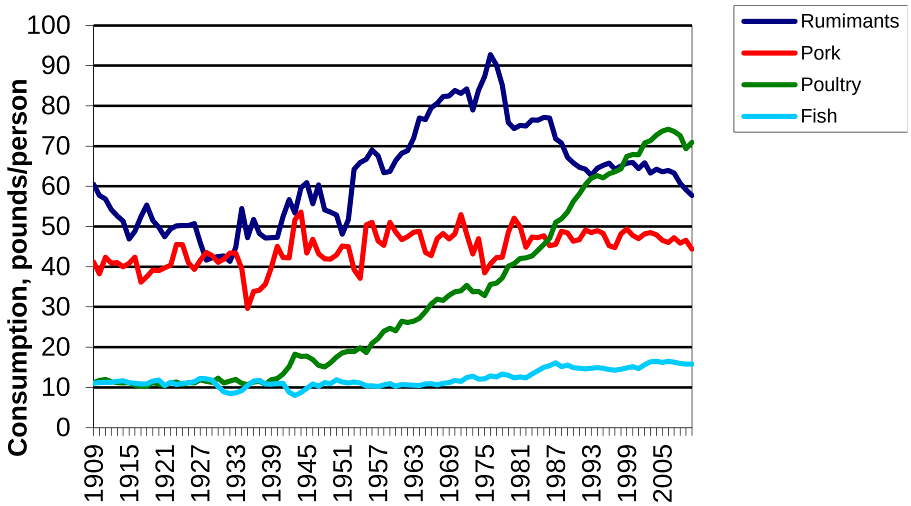
Fertilizer	FASOM kg CO_2eq/kg material	FAPRI kg CO_2eq/kg material
Nitrogen,	3.5-6.2	3.3
Phosphorus	3.0-11.5	1.1
Potassium	1.1-3.5	0.7
Pesticides	24.6-40.7	27.2

Additionally, during the process of ILUC calculations, it has also been pointed out to the EPA that the sum of the land use change attributed to each of three primary feedstock investigated (corn, soybeans, and sugarcane) is much higher than the land use change determined and utilized when all three feedstocks are modeled together. [16] This inconsistency results in a dramatic overestimation of the value for the ILUC emission factor. There is still considerable uncertainty

[13] Oladosu, G. et al. (2011). Sources of corn for ethanol production in the United States: a decomposition analysis of the empirical data. Biofpr 5, 640-655.
[14] Kim, S. and Dale, B. (2011). Indirect land use change for biofuels: testing predictions and improving analytical methodologies. Biomass and Bioenergy 35, 3235-3240.
[15] GREET-Greenhouse gases, regulated emissions and energy use in transportation model; FASOM-Forest and agricultural sector optimization model; FAPRI-Food and agricultural policy research institute; MOVES-motor vehicle emission simulator
[16] RFA Letter to EPA. August 4, 2010. http://renewablefuelsassociation.createsend1.com/t/y/l/qhyitk/kuluiiuhh/y

in the models and this must be addressed to accurately reflect the dramatic savings in GHG emissions that biofuels have provided and will continue to provide to the environment.

Almost all of the models used by EPA are static models that aim to isolate the impact of a single variable, such as increased biofuel production. In reality there are many changes that are occurring and it is not possible to isolate just one. One of the important agricultural changes that has been happening and is not included in any of models is in the livestock sector. The American diet has been constantly changing over the past 100 years, both in terms of meat consumed and the type of meat eaten as shown in the following figure.



As the per capita beef consumption has decreased and the chicken consumption has increased, the quantity of livestock feed required has decreased significantly as poultry requires 5 to 6 times less feed per pound of meat. The trend to lower beef consumption started in 1975, before the development of the fuel ethanol industry. These changing diets have had a large impact on the amount of land required for food production in the United States-- as feed yields of corn and soybeans have increased, and demand for livestock feed has dropped, new markets for these products were required and biofuels have filled the void. These trends need to be reflected in the FASOM model.

Further, while ILUC modeling has evolved significantly since the EPA started their work in 2008, a recent review by Wicke et al.[17] documents some of the differences and challenges impacting modeling in general. The study summarizes some of the uncertainties and shortcomings of the existing ILUC modeling work and these include, but are not limited to:

- uncertainties in the underlying datasets
- the amount, location and type of projected LUC
- by-and co-product allocation
- future production and trade patterns of bioenergy
- technological changes over time

[17] Wicke, B. et al. (2012). Indirect land use change: review of existing models and strategies for mitigation. Biofuels 3(1), 87-100.

- lack of comprehensive uncertainty analysis
- a focus on first-generation biofuels
- not accounting for the indirect effects of fossil fuels (addressed above)
- not accounting for the effects of sustainability criteria and land use policies
- not assessing all impacts of LUC

Despite recent improvements and refinements of the models, large uncertainties and shortcomings still exist. Thus, serious inaccuracies have resulted in final number calculations and are reflected in a less than optimal value for biofuels. In addition, these complexities mean that the evaluation of new feedstock and new production pathways to the appropriate regulatory agency can take a very long time to evaluate and approve. It is not unusual for pathways to take 2-3 years to move through the approval process.

In conclusion, in the five years since EISA was enacted and EPA modeled ILUC, significant advances to the art of calculating ILUC have been developed. This, combined with improved models as well as empirical evidence illustrate that the initial calculations by the EPA grossly over predicted the ILUC impacts to renewable fuels and negatively impacted the true value of reductions in GHG emission savings for corn starch ethanol.

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

NCGA feels that the definition is complex enough to meet this objective.

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

Regarding air quality, there is no need for additional regulations. In a recent report by Oak Ridge National Laboratory et al.,[18] test results indicate that when compared to fuel containing zero percent ethanol, very little to no changes were noted in common emission substances, e.g., carbon monoxide and nonmethane organic gases. Additionally, as described within section 209 of the Energy Independence and Security Act of 2007, Congress directed the Administrator to "determine whether the renewable fuel volumes required by this section will adversely impact air quality as a result of changes in vehicle and engine emissions of air pollutants regulated under this Act." If adverse effects are determined, then due to anti-backsliding, within three years of the rulemaking (i.e., 2010) "the Administrator shall (A) promulgate fuel regulations to implement appropriate measures to mitigate, to the greatest extent achievable, considering the results of the study under paragraph (1), any adverse impacts on air quality, as the result of the renewable volumes required by this section; or (B) make a determination that no such measures are necessary.''

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

[18] West, B., et al. (2012). Intermediate Ethanol Blends Catalyst Durability Program: ORNL/TM-2011/234.

The long-term sustainability of crop production is a high priority for farmers. Because of the RFS and the quantitation of LCA for the biofuel process, increased attention has been given to soil health. Recent studies have shown that depending upon farming practices, e.g., tillage, corn can increase carbon content within soil. While the impacts are expected to vary depending upon location, environment, and soil content, several studies have shown that corn farming can lead to soil carbon sequestration.[19,20, 21] These findings have provided evidence that environmental groups, private industry, governmental agencies and farmers can work together to develop and measure good practices for positive environmental outcomes.

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

As auto companies work to increase fuel efficiency to meet the Administration's CAFE-GHG rules, it is becoming increasingly clear that higher octane fuels will be critical to the auto companies' ability to be successful. Increasing ethanol levels will play a critical role in this effort and we are working with our auto partners in this regard.

Enhanced octane-rated components are blended into fuel to control engine knock. There are two choices to increase the octane rating of fuel offered here. The first is to increase amounts of the already present carcinogenic and toxic aromatic hydrocarbons such as benzene, toluene and xylene (BTX) in our gasoline supply. This is the approach favored by the oil industry, since they control the supply of these aromatics. Another approach is to splash blend more ethanol into gasoline. This would provide assistance toward achieving the renewable fuel volume mandates found in the RFS and thereby continue to decrease the amount of GHG emissions provided by the transportation sector.

The optimal concentration of ethanol varies depending on engine design and compression ratio. Not surprisingly, one engine compression ratio may be optimal for a given concentration, yet a different ethanol concentration would be optimal for another engine design. From one perspective, the optimal blend becomes the percentage that can be reliably provided consistently to the marketplace nationwide. From another standpoint, the optimal octane rating should be the resultant octane rating from the splash blend of ethanol onto an existing base gasoline available today. The recommended optimal concentration of ethanol should be determined through science-based studies designed and coordinated between the experts who design engines, regulatory agencies that set emission policy, feedstock and fuel producers and the retailer infrastructure sectors. There have been published studies by automobile manufacturers who have investigated the performance of varying levels of ethanol in engines.[22, 23]

[19] Follet, R., et al. (2012). Soil Carbon Sequestration by Switchgrass and No-Till Maize Grown for Bioenergy. Bioenergy Research 5:866-875.
[20] Kwon, H., et al. (2013). Modeling state-level carbon emission factors. Biomass and Bioenergy, http://dx.doi.org/10.1016/j.biombioe.2013.02.021.
[21] Clay, D., et al. (2012). Great Plains Soils May be C Sinks. Better Crops, 96:22-24.
[22] Stein, R., Anderson, J. and Wallington, T. (2013). An Overview of the Effects of Ethanol-Gasoline Blends on SI Engine Performance, Fuel Efficiency, and Emissions. SAE Int. J. Engines 6(1) doi:10.4271/2013-01-1635.
[23] Jung, H., et al., (2013). Fuel Economy and CO_2 Emissions of Ethanol-Gasoline Blends in a Turbocharged DI Engine, SAE Int. J. Engines 6(1):2013, doi:10.4271/2013-01-1321.

These studies provided the following observations:

> The increased octane rating of ethanol-gasoline blends plus other fuel characteristics, e.g., high heat of evaporation, help engines avoid knock under high operating conditions. By reducing the knock potential, engine sizes can continue to be downsized and/or engine operating speeds reduced while still meeting the same level of consumer power and performance expectations.
>
> Splash blended ethanol blends with an octane rating of 96 RON enabled a compression ratio increase from 10:1 to 11.9:1 in 3.5L engine.
>
> Ethanol has demonstrated improvements in emissions and depending upon the ethanol blends, CO_2 emissions decreased.

Both studies clearly suggest that any increase in the ethanol blend levels needs to retain the additional octane rating associated with the addition of ethanol. Specifically, the base (E10) gasoline should not be allowed to be downgraded by stripping out high octane components in anticipation of the ethanol addition as has occurred when the U.S. moved from E0 to E10.

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

During the past seven years the RFS has been responsible for reducing 205 million metric tons of CO_2, which is the equivalent of taking 39 million cars off the road.[24] Continued and expanded replacement of fossil fuels with lower GHG emitting renewable transportation fuel will lead to even greater advances in CO_2 reductions. In the process of achieving the RFS goal of utilizing over 13 billion gallons of ethanol from corn starch, private and public research labs will continue to invest in the development of new technologies that further enhance the efficiency of conventional biofuels and the realization of second generation advanced and cellulosic biofuels. Such investment in conventional biofuels has resulted in the development of combined heat and power, corn oil separation, cold-cook processing, and corn expressed enzymes that continue to reduce the CO_2 emissions of conventional biofuels in comparison to gasoline since 2008.[25]

Stability of the RFS provides incentive for continued investment in the development of advanced and cellulosic biofuels, which have the ability to reduce the carbon footprint of transportation fuels to even greater levels. Without the requirements of the RFS, low carbon fuels would no longer have a market and investment in process technologies to convert for example corn stover cellulose into biofuels would essentially be lost and with it the energy security upon which the RFS was established and the corresponding reduction in carbon emissions.

It is important to note that the RFS is also a key contributor to the success of other policies that will contribute to lowered emissions of CO_2 and other transportation related pollutants such as SOx, NOx and particulate matter. These policies include the corporate average fuel economy, or

[24] Renewable Fuels Association.
[25] Mueller, S. et al. (2013). 2012 Corn ethanol: emerging plant energy and environmental technologies, available: http://www.erc.uic.edu/PDF/mueller/2012_corn_ethanol_draft4_10_2013.pdf

CAFE standards, recently finalized by the National Highway and Transportation Safety Administration (NHTSA) and the EPA and the proposed Tier III standards to reduce sulfur in transportation fuel in development by EPA. These regulations will further reduce CO_2 emissions but will require renewable fuels to achieve their goals.

The CAFE standards require corporate average fuel economy to reach 54.5 mpg by 2025, which will reduce CO_2 emissions by 163 grams per driven mile. High octane fuels such as ethanol are a critical factor contributing to the development of lighter but higher compression engines by the auto industry. Ethanol blends greater than 10 percent are considered optimal for this use and will contribute to meeting the RFS requirements in the same time frame.

In 2012, the 2017 GHG/CAFE Standards effectively eliminated CO_2 reduction incentives for FFVs (flex-fuel vehicles) beginning in 2016. Instead, these standards emphasize GHG reduction through the use of non-liquid fuel sources, specifically electricity or natural gas. These fuels have limited infrastructure in place and the required infrastructure is significantly more expensive than E85. The anticipated additional cost for these automobiles is tens or even a hundred times higher than FFVs. The credits to build these were based on the claim that they would produce lower GHG emissions. This is misleading. In the accounting for the GHG emissions, EPA only considers emissions from the tailpipe. Electric cars are powered by electricity and 42 percent of the nation's electricity is generated by coal, a major contributor to GHG emissions and thus this should be included in the calculation as well. Cars that run on natural gas provide a number of challenges not the least of which is an extremely limited existing fueling infrastructure, a very high cost of additional infrastructure, and the use of natural gas that is not renewable (extracted from the Earth along with petroleum). Thus in 2012, a complete switch in the focus of automobiles and infrastructure occurred from a system designed to decrease GHG emissions using a renewable feedstock to one that increases GHG emissions using non-renewable feedstock. NCGA requested sufficient incentives be restored through the entire term of the RFS2 and 2017 GHG/CAFE Standards to insure at least 50 percent production of FFVs from all automobile manufacturers.

In summary, the Renewable Fuel Standard is not only one of our best options to substantially reduce greenhouse gas emissions from the transportation sector but is also a critically important component to the development of new technologies and of other efforts that will contribute to doing the same. Therefore, we strongly urge that this important policy be maintained.

Sincerely,

Pamela G. Johnson

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House Committee on Energy and Commerce
Chairman Fred Upton
Ranking Member Henry Waxman

RE: Greenhouse Gas Emissions and Environmental Impacts of the RFS

23 May 2013

We submit these comments in response to the Energy and Commerce Committee's solicitation for comments from interested stakeholders on the greenhouse gas and other environmental impacts of the Renewable Fuel Standard (RFS), as described in the Committee's third White Paper, "Greenhouse Gas Emissions and Other Environmental Impacts." The National Wildlife Federation (NWF) appreciates the opportunity to offer our input to the Committee as part of its review of the RFS.

NWF is dedicated to protecting wildlife and habitat—and to inspiring the next generation of conservationists. Begun in the early 1900s, NWF is America's largest conservation organization, with 48 affiliates across the country. As part of our work to solve the climate crisis and conserve wildlife habitat, NWF is working to develop sustainable, low-carbon biofuels as well as to increase the carbon storage and ecosystem services provided by America's working farms and forests. Properly implementing and/or revising the RFS, particularly its protections from converting native grasslands, wetlands and forestlands for feedstock production, is part of our work to develop biofuels in ways that don't destroy habitat and release stored carbon.

Our comments focus on questions #3: "Is the definition of renewable biomass adequate to protect against unintended environmental consequences? If not, how should it be modified?" and #5: Has implementation of the RFS revealed any environmental challenges or benefits not fully anticipated in the statute?

NWF thinks that the RFS' statutory definition of renewable biomass included critical protections against converting natural or undeveloped lands for feedstock production. The definition's protections for native grasslands, wetlands and forestlands were and continue to be necessary to curb the conversion of these lands and protect the habitat, clean air and water they provide. For lands to produce feedstocks eligible for RINs, the definition requires that lands were "cleared or converted" prior to date of enactment, and "non-forested." NWF thinks these conditions on the eligibility of land provide crucial limits to the spread of feedstock production, particularly annual crops like corn and soy but eventually even perennial herbaceous crops. These limits are especially important as corn and other commodity prices have increased and, with them, the incentive to convert natural lands.

However, the implementation of the statue has fallen short of Congress' laudable goals. In its implementation of the definition of renewable biomass, the Environmental Protection Agency (EPA) developed what it called an "aggregate compliance approach" which, by design, avoided requiring that biofuel facilities demonstrate or document that the lands producing feedstocks were actually cleared or converted, and non-forested at the date of enactment. Under its aggregate compliance approach, EPA determined the amount of land in cultivation in 2007, and established a threshold for investigation if subsequent cropland got within 5 million acres of that amount. EPA said it would only require biofuel facilities to demonstrate and document the eligibility of feedstock production through individual recordkeeping if subsequent cropland exceeded the amount of cropland in 2007.

As we discuss in the Appendix, we believe that substantial evidence exists that lands that were converted or cleared after enactment are being used for feedstock production.

If the RFS' renewable biomass definition is to be changed, NWF believes that the original intent of the statute to protect natural, undeveloped lands from conversion for feedstock production can be accomplished more effectively by placing a positive requirement on biofuel facilities to show that the lands where their agricultural feedstocks were produced were actually cleared or converted, and non-forested at the date of enactment. To document that agricultural land was in crop production on date of enactment, biofuel facilities can have feedstock producers submit their 2007 farm records, which are widely-used to establish eligibility for a range of farm programs. Far from imposing new or burdensome requirements on producers, this change would be similar to the "Sodsaver" provision included in the Senate Farm Bill, which requires producers to establish that cropland has been in production, or receive smaller subsidies for crop insurance, and be eligible for reduced indemnity payments.

With feedstocks producers' 2007 farm records, demonstrating that feedstocks were grown on eligible land would be straightforward. Producers' total eligible acres could be multiplied by average county crop yields, as established by the Farm Service Agency (FSA), to determine the total volume of eligible feedstocks that each producer could sell. Biofuel facilities would keep farm records and purchase records to demonstrate that they only purchased eligible volumes or less from every producer.

Including such a requirement to document the eligible status of the lands in the definition of renewable biomass will avoid uncertainty and reduce risk that lands that weren't cleared or converted, and non-forested were being used for feedstock production.

Concerns about invasive potential of new RFS feedstock pathways

The National Wildlife Federation is extremely concerned about the unintended consequences of the approval of potentially invasive feedstocks under the RFS. Executive Order 13112, signed by President Clinton on February 3, 1999, requires federal agencies to: "not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions."[i]

Widespread cultivation of potentially invasive species, including novel cultivars, could pose significant risks to native ecosystems and possibly even to commercial agriculture. Magnifying this risk is the fact that some of the very characteristics that make a plant ideal as a source of biomass – and the characteristics that will likely be enhanced through modification and breeding (high above-ground biomass production, tolerance, and competitiveness, to name a few) are the very same characteristics that make a plant potentially highly invasive. Should an invasive bioenergy feedstock escape and become established in nearby natural areas, the results could be devastating for native ecosystems. It is therefore critical that the invasive potential of all novel feedstock species, cultivars, and hybrids by thoroughly evaluated before EPA considers whether the feedstocks qualify under the RFS. Likewise, feedstocks that are found to be high risk should not qualify for the RFS.

NWF is particularly concerned about the pending approval of a new feedstock pathway for two known invasive species- *Arundo donax*, (also known as giant reed or giant cane) and *Pennisetum Purpureum* (also known as napier grass). *Arundo donax* is a non-native species that is a well-known and well-documented invader of natural areas. At least five published weed risk assessments have determined that *Arundo donax* is a likely invasive species.[ii] USDA, in their June 2012 weed risk assessment, concluded with very low uncertainty that *Arundo donax* is a high risk species, noting that it is a "highly invasive grass" and a "serious environmental weed" that can alter the hydrology, nutrient cycling, and fire regimes in areas where it becomes established.[iii] *Arundo donax* displaces native vegetation and negatively impacts certain threatened and endangered species such as the Least Bell's Vireo. In the United States, *Arundo donax* is listed as a noxious weed in Texas[iv] California,[v] Colorado[vi], and Nevada.[vii] Additionally, it has been noted as either invasive or a serious risk in New Mexico, Alabama, and South Carolina.[viii] Once *Arundo donax* has invaded an area, control is difficult and costly. In California, costs range between $5,000 and $17,000 per acre to eradicate the weed. Other estimates put that cost as high as $25,000 per acre.[ix] Given the high risk of invasion, incentivizing the cultivation of *Arundo donax* by allowing it to qualify as an advanced biofuel feedstock under the RFS has the potential for serious unintended ecological and economic impacts.

As EPA moves forward with the RFS, NWF recommends that the agency integrates rigorous screening protocols and the use of the precautionary principle as key components when creating pathways for non-native, potentially invasive species. In particular, we urge EPA to comply with Executive Order 13112 by assessing the invasion risk of alien species (including hybrids, varieties and cultivars) before they are given pathway approval and by declining to approve or requiring measures to reduce invasion risk for approved pathways that may cause or contribute to the introduction or spread of invasive species in the United States.

Appendix:

Evidence of land conversion and ineligible feedstock production

In its original RFS rule, EPA said it would monitor various kinds of data to assess its aggregate compliance approach, including cropping patterns, aerial imagery and the economics of farming practices. Since 2011, new data from precisely these sources has been released, and the new data casts doubt on the effectiveness of the aggregate compliance approach in the US to provide reasonable assurance that feedstocks grown on ineligible grasslands converted after December 17, 2007 are not being used to for biofuel production in compliance with RFS2.

Three sources of data attest to the conversion of ineligible grasslands, particularly uncultivated hay fields and native prairies.

USDA surveys of farmers

In 2011, USDA Economic Research Service (ERS) released an assessment of changes in cropping patterns and landuse in response to bioenergy markets called "The Ethanol Decade."[1] Based on Agricultural Resource Management Surveys (ARMS) of farmers, the focus of the report was how farmers changed their cropping practices between 2006 and 2008 in response to increasing price of corn.[2] Importantly, this data isn't presented here to suggest that all or most of the conversions referenced in the survey data are themselves ineligible for feedstock production under the RFS2's definition of renewable biomass, though of course land converted in 2008 would be ineligible. Instead, the data is presented because it contradicts EPA's presumption that conversions of uncultivated lands would only occur at de minimis rates.

In the report, the USDA researchers stress the importance of regional differences in how farmers changed their cropping changes, such as the fact that while soybean acreage didn't decline nationally, it decreased substantially in certain regions, but increased in others.[3] More to the point, the USDA researchers specifically identified the inherent limitations of aggregate data, particularly at the national level, and the need to use farm-level data. "Aggregate national data do not show a net movement out of soybeans," they wrote, and added that aggregate national data cannot explain "why county-level data show an increase in total harvested acreage in some regions." The USDA researchers specifically observed that not all increases in cropland acreage at the state and county level could be accounted for acreage coming out of CRP or shifts from other crops.

To identify the sources of the new cropland, the USDA researchers said they needed to turn to farm-level data, which they found in the ARMS results:

> Regional differences are also apparent in how farms expand total harvested acreage (fig. 4). Expanding harvested acreage was an important trend in the Northern and Southern Plains, as well as in the lower Mississippi River Valley. Aggregate data sources do not provide detail on how harvested

[1] http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib79.aspx

[2] The National Agricultural Statistics Service (NASS) and Economic Research Service (ERS) conduct the annual Agricultural Resources Management Survey (ARMS). Each year, a portion of ARMS targets specific commodities. In 2008, the ARMS included questions related to bioenergy feedstock growth that targeted corn and soybean farmers, and also included questions related to crop acreage between 2006 and 2008.

[3] http://www.ers.usda.gov/media/121204/eib79.pdf. Downloaded Friday, March 8th.

> acreage might have expanded, including conversion of previously uncultivated or fallowed land to cultivated cropland or the expansion of double cropping. For that, we turn to farm-level data.[4]

The ARMS' results indicated three main ways that farms expanded crop production acreage—expanding farm size through consolidation (acquiring additional land), double cropping, and cultivating land that was previously idled or uncultivated. Cultivating previously uncultivated land, the surveys revealed, represented a significant source of increased corn and soy cropland.

> In the 2008 ARMS, farm operators were asked directly about expanding cropland into previously uncultivated acreage. About 16 percent of 2008 corn and soybean farms brought new acreage into production between 2006 and 2008. The uncultivated land brought into production by these farms accounted for approximately 30 percent of the average farm's expansion in total harvested acreage. Most acreage conversion came from uncultivated hay.

Though the previously uncultivated land brought into cultivation prior to December 19th, 2007 would not be excluded from the RFS' renewable biomass definition, the conversions of land in 2008 would be excluded. The USDA's survey data clearly established that 1) a significant percentage of farmers (16% of corn and soybean farmers) were converting previously uncultivated land to increase corn production, and 2) that these conversions amounted to a very significant amount of cropland (about 30% of the average corn and soybean farm's expanded cropland). These data documents that a significant acreage of previously uncultivated land was converted to crop production in 2008—land that would be ineligible for RFS2 biofuels feedstock production.

Beyond the acreage converted in 2008 that should be ineligible for feedstock production, USDA's data has a much broader significance. It directly challenges EPA's assertion that land conversions were likely to only happen at a *de minimis* rate after enactment of the RFS2. This assertion was a key part not only of EPA's rationale for its dismissal of a challenge to its aggregate compliance approach, but also was a key part of EPA's presumptions underlying its overall aggregate compliance approach.[5] USDA's data casts grave doubt on EPA's use of data aggregated at the national level to monitor conversions of ineligible land. Given continuing high prices for corn in 2010 and 2011, there is no reason to expect that the high rates of conversion of previously uncultivated land would have declined. Indeed, the new aerial imagery and agricultural economics data we present next strongly corroborate USDA survey data showing a precedent for significant rates of conversion of native grasslands for biofuel production, particularly in certain counties.

GIS analysis of LANDSAT, USDA cropping history and CRP enrollments, and other data
Most aerial imagery can't distinguish between cultivated vs. uncultivated types of grassland—that is, between CRP and pasture vs. uncultivated hay land and native prairie. As a result, satellite imagery can't establish that post-2007 grassland conversions represent conversions of native prairie or other types of lands ineligible for RFS2 biofuel feedstock production. Rather,

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[4] http://www.ers.usda.gov/media/121204/eib79.pdf. Page 7.

[5] http://www.epa.gov/otaq/fuels/renewablefuels/rfs-response-to-petitions-02-17-11.pdf

when used in conjunction with other types of data, aerial imagery can be used to identify patterns in the geographic distribution of grassland conversions where ineligible land may be producing biofuel feedstocks, and where biofuel feedstock production is directly and indirectly impacting the kinds of lands that the RFS2 renewable definition was intended to protect.

In 2013, Wright and Wimberly used the National Agricultural Statistics Service (NASS) Cropland Data Layer (CDL), FSA cropping data, soil and wetland maps and found that within the western Corn Belt, grassland conversions are concentrated in the eastern counties of North and South Dakota, and areas of Iowa outside of its core corn belt.[6] By focusing only on conversion from a variety of types of grasslands (CRP, pastures, hay and native prairies) to corn and soy but not other crops, they found:

> "an arc of intermediate grass cover along the western edge of the Corn Belt where grassland is being converted to corn or soybeans at comparatively fast rates; 5% to 30% from 2006 to 2011 (annualized rates, 1.0–5.4%). This range of annualized rates is very similar to grassland conversion rates predicted by an econometric model that takes into account recent increases in corn prices."

Wright and Wimberly further isolated counties where rates of conversion from grasslands to corn and soy exceeded reductions in CRP acreage. In NE, they found that counties where grassland conversions exceeding CRP reductions were spread across the state, probably due to use of irrigation in the drier western counties. But in most states in the western corn belt, Wright and Wimberly found that areas where grassland conversions to corn and soy exceeded CRP reductions were concentrated in certain counties, particularly in eastern South Dakota and outside the core corn belt in Iowa. Importantly, at the state level, the distribution patterns where grassland conversions to corn and soy exceeded reductions in CRP were not always equivalent to patterns at the county level. Overall in ND, for instance, reductions in CRP acreage exceeded grassland conversions to corn and soy. But in certain eastern ND counties, reductions in CRP acreage did not exceed grassland conversions to corn and soy, raising the possibility that in these counties post-2007 conversions of uncultivated grasslands were occurring, which would be ineligible for biofuels feedstock production.

Wright and Wimberly overlaid aerial imagery with cropping, soil and wetland data to also reveal that high rates of grassland conversions are occurring on and near the very kinds of marginal and sensitive lands that the EPA, in its original RFS2 rules, rightly interpreted the RFS2's renewable biomass definition as intended to protect. Though Wright and Wimberly found important state-level differences, they conclude that "in aggregate, conversion has been concentrated on more marginal lands characterized by high erosion potential, shallow soils, poor drainage, and less suitable climates for corn/soy production." Importantly, the western corn belt largely overlaps the Prairie Pothole Region, which has a high frequency of wetlands interspersed in grasslands. This proximity of wetland and grassland in the Prairie Pothole Region provides the nesting habitat to a majority of the country's ducks. Wright and Wimberly found that in North and South Dakota, 80% of the grassland conversion are occurring within 500m of wetlands, which removes nesting habitat as well as degrades water quality by increasing sedimentation and nutrient runoff.

[6] http://www.pnas.org/content/110/10/4134.full.pdf+html

Though the practice of converting uncultivated lands for corn production was clearly significant at the outset of the RFS2, and in fact amounted to about 30% of the new corn acreage, EPA's aggregate compliance approach, and particularly its use of data aggregated at the national level, did not and could not detect it. Similarly, though concentration of high rates of grassland conversions are clear in aerial imagery, they are missed by EPA's aggregate compliance approach, dependent as it is on national-level data.

Changing economics of native grassland conversions
One of EPA's presumptions underlying the aggregate compliance approach was that the farm-level economics of converting uncultivated grassland for feedstock production were generally unfavorable. In its explanation of the presumptions underlying its aggregate compliance approach, EPA said breaking native sod and other uncultivated grasslands would be uncommon because:

> … it can be assumed that most undeveloped land that was not used as agricultural land in 2007 is generally not suitable for agricultural purposes and would serve only marginally well for production of renewable fuel feedstocks. Due to the high costs and significant inputs that would be required to make the non-agricultural land suitable for agricultural purposes, it is highly unlikely that farmers will undertake the effort to "shift" land that is currently non-agricultural into agricultural use.[7]

New research by Ruiqing, Hennessy and Feng casts doubt on this presumption.[8] In their 2013 paper, Ruiqing, et. al. use current crop prices to develop a dynamic model, calibrated with data from south-central ND, of the economics of converting native prairies to row crop production. By comparing the net present value of converting native prairie to the costs of converting it, their model allows predictions to be made as to when farmers will find that rising crop prices will justify their costs in breaking it. Land conversion costs include the costs of cultivating, stone picking, removing brush, and applying herbicide; land conversion costs range from $15/acre for pasture to about $100/acre for native prairie.

Ruiqing, et. al. found that the economics of converting native prairie changed dramatically with higher crop prices. With the lower crop prices in the 1989-2006 period, the threshold for breaking sod was $107/acre, meaning that if farmers estimated that their conversion costs were below that amount, they would have converted native prairie. As a result, with lower crop prices, most farmers found it marginally profitable to break native sod, since average costs of breaking native sod were about $100/acre. As their model predicts, actual breaking rates were lower.

However, with the higher crop prices after 2007, Ruiqing, et. al. found that the conversion threshold value shot up to $429/acre, meaning that farmers would convert if their conversion costs were less than $429/acre. With costs of converting native prairie about $100/acre, or even lower due to herbicide-tolerant crop varieties that in some cases allows the use of herbicide instead of plowing, their model predicts that many more farmers would break native sod.

Ruiqing et. al. also found that crop insurance makes it more likely that farmers will convert native prairie. Their model found that crop insurance that offsets 20% of a crop return shortfall

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[7] http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2005-0161-2642
[8] http://www.card.iastate.edu/publications/dbs/pdffiles/13wp536.pdf

will increase the sod-busting cost threshold by 41%, making it more profitable for farmers to convert their native prairie to crop production.

This new data suggests that in the era after enactment of the RFS, the combination of high crop prices and crop insurance has created conditions in which farmers are much more likely to convert native prairie. These market and policy conditions differ markedly from the presumptions EPA used in developing its aggregate compliance approach.

Based on USDA's surveys of farmers, USDA CDL and other data that can locate counties where grassland conversions exceed CRP losses, and economic modeling that predicts and confirms native prairie conversion rates, we believe compelling justification exists for the renewable biomass definition to be revised and include a positive requirement on biofuel producers to demonstrate and document the eligibility of lands where their feedstocks were grown.

NWF appreciates the opportunity to provide this input to the Energy and Commerce Committee as it reviews the RFS.

Sincerely,

Ben Larson
Agricultural Program Manager

And Aviva Glaser, Legislative Representative, Agricultural Policy
NWF

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[i] EO 13112 § 2(a)(3) (1999).

[ii] Gordon, D.R., K.J. Tancig, D.A. Onderdonk, and C.A. Gantz. 2011. Assessing the invasive potential of biofuel species proposed for Florida and the United States using the Australian Weed Risk Assessment. *Biomass and Bioenergy* 35: 74-79; Buddenhagen, C.E., C. Chimera, and P. Clifford. 2009. Assessing biofuel crop invasiveness: A case study. *PLoS ONE* 4 : e5261; Gassó N, Basnou C & Vilà M (2010). Predicting plant invaders in the Mediterranean through a weed risk assessment system. Biol. Invasions 12:463-476; Barney JN & Ditomaso JM (2008). Nonnative species and bioenergy: are we cultivating the next invader? BioScience 58: 64-70; USDA APHIS. 2012. Weed risk assessment for *Arundo donax* L. (Poaceae) – Giant reed. Version 1.

[iii] USDA APHIS. 2012

[iv] USDA NRCS. "Invasive and Noxious Weeds." http://plants.usda.gov/java/noxious?rptType=State&statefips=48 (accessed March 8, 2012).

[v] California Department of Food and Agriculture. "Encyloweedia: Data Sheets." http://www.cdfa.ca.gov/plant/ipc/weedinfo/winfo_list-pestrating.htm (accessed March 8, 2012).

[vi] Colorado Department of Agriculture. "Noxious Weed Management Program." http://www.colorado.gov/cs/Satellite/Agriculture-Main/CDAG/1174084048733 (accessed March 8, 2012).

[vii] Nevada Department of Agriculture. "Noxious Weed List." http://agri.nv.gov/nwac/PLANT_NoxWeedList.htm (Last modified February 2, 2012).

[viii] Florida Native Plant Society. "Florida Native Plant Society Policy Statement on *Arundo donax*." http://www.fnps.org/committees/policy/pdfs/policyarundo_policy_statement1.pdf (Last updated November 6,2006).

[ix] Giessow, J., J. Casanova, R. Leclerc, G. Fleming, and J. Giessow. 2011. *Arundo donax* (Giant Reed): Distribution and Impact Report. *California Invasive Plant Council*.