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ENERGY AND COMMERCE COMMITTEE
SUBCOMMITTEE ON ENERGY AND POWER

HEARING ON THE RENEWABLE FUEL STANDARD
JULY 23-24, 2013

REDUCING THE NEGATIVE CLIMATE IMPACTS OF THE RENEWABLE FUEL STANDARD

COMMENTS SUBMITTED BY
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CLEAN AIR TASK FORCE

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A. Overview

The Clean Air Task Force (CATF) is a non-profit environmental organization that works to protect the earth's atmosphere by improving air quality and reducing global climate change through scientific research, public advocacy, technological innovation, and private sector collaboration. In advance of the hearings on the federal Renewable Fuel Standard (RFS) that the United States House of Representatives Energy & Commerce Committee will hold on July 23-24, 2013, CATF is pleased to provide these comments on the climate impacts associated with the RFS.

These comments address, first, how the RFS-mandated scale-up of corn ethanol consumption has caused a significant net increase in greenhouse gas emissions; second, how implementation strategies under consideration by the United States Environmental Protection Agency (EPA) could exacerbate the negative impact that the RFS has had on climate change; and, third, how the RFS's negative climate impact can be reduced going forward. The comments provided here emphasize several points that were made in CATF's response to the Committee's RFS Assessment White Papers on "Greenhouse Gas Emissions and Other Environmental Impacts"[1] and "Blend Wall/Fuel Compatibility Issues."[2] The comments also highlight a concern that CATF and other organizations have raised with EPA concerning the Agency's proposed plan to allow "advanced biofuels" like sugarcane ethanol and soy biodiesel to "make up" for the shortage in cellulosic biofuels.[3]

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[1] CATF's response to the Committee's white paper on environmental impacts of the RFS can be found at: http://www.catf.us/resources/filings/biofuels/20130524-CATF%20Response%20to%20House%20EC%20GHG%20and%20Environment%20Questions.pdf

[2] CATF's response to the Committee's white paper on RFS and the blend wall can be found at: http://www.catf.us/resources/filings/biofuels/20130405-CATF_Response_to_House_EC_Blend_Wall_Question.pdf

[3] CATF's detailed comments on EPA's proposed volume requirements for 2013, as well as general comments from CATF, ActionAid, Union of Concerned Scientists, Natural Resources Defense Council, and National Wildlife Federation, can be found, respectively, at: http://www.catf.us/resources/filings/biofuels/20130405-CATF_Comments_on_EPA_RFS_2013_Volume_Adjustment_78FedReg9282.pdf and http://www.catf.us/resources/filings/biofuels/20130405-UCS-ActionAid-CATF-NWF-NRDC-RFS-Letter.pdf

B. The RFS-mandated scale-up of corn ethanol consumption has caused a significant net increase in greenhouse gas emissions

The Energy Independence and Security Act of 2007 (EISA) and its implementing regulations (the RFS) require that gasoline "sold or introduced into commerce in the United States" contains 36 billion gallons of biofuel by 2022. The bulk of that requirement—21 billion gallons by 2022—is to be met by various "advanced biofuels," a category which includes cellulosic biofuels that are shown to reduce lifecycle greenhouse gas (GHG) emissions by at least 60% when compared to gasoline as well as biodiesel and other biofuels that achieve 50% reductions.

To date, however, the RFS has largely amounted to a mandate for corn ethanol. Corn ethanol has accounted for more than 90% of the fuel by volume that has been mandated under the RFS since 2006, and will account for 83% of the mandated volume this year. Corn ethanol is likely to dominate the RFS going forward as well, as cellulosic biofuels struggle to reach commercial scale and further expansion of "advanced biofuels" like sugarcane ethanol and soy biodiesel is complicated by market- and environment-related constraints.

Under EISA, the *de facto* corn mandate grows from 10.5 billion gallons per year in 2010 to 15 billion gallons in 2015, at which point it levels off. From 2015 to 2022, no more than 15 billion gallons of corn ethanol can be used to satisfy the RFS's annual volume requirements, absent a special showing by the Agency. Consequently, corn ethanol produced during 2010-2015 (while production capacity is still ramping up) has much higher lifecycle emissions than corn ethanol produced in 2022 (seven years after production of corn ethanol is supposed to level off).

EPA, for reasons it never adequately justified, chose to regulate all corn ethanol production according to the lifecycle GHG emissions analysis it did for corn ethanol produced in 2022 – even though it had also calculated the lifecycle greenhouse gas emissions for corn ethanol produced in 2012 and 2017. The chart below, which EPA placed in the RFS implementation rule docket but never referenced,[4] lists 33 different ways to produce corn ethanol (each of which was modeled by EPA), and shows how the lifecycle GHG emissions in 2012, 2017, and 2022 for each production method compare to the lifecycle emissions from the baseline petroleum fuel. The corn ethanol production pathways that result in the same or higher lifecycle GHG emissions than gasoline are shaded in dark gray. The pathways that achive lower lifecycle GHG emissions than gasoline but still fall short of EISA's 20% reduction requirement are shaded in light gray.

[4] All text and data taken directly from an EPA chart in Docket No. EPA-HQ-OAR-2005-0161-3173.5

	2012	2017	2022
Dry Mill NG (dry DDGS)	33%	10%	-17%
w/ CHP (dry DDGS)	30%	7%	-20%
w/ CHP and Fractionation (dry DDGS)	28%	5%	-22%
w/ CHP, Fractionation and Membrane Separation (dry DDGS)	24%	1%	-25%
w/ CHP, Fractionation, Membrane Separation, and Raw Starch Hydr	19%	-4%	-30%
Dry Mill NG (wet DGS)	21%	-2%	-27%
w/ CHP (wet DGS)	17%	-5%	-30%
w/ CHP and Fractionation (wet DGS)	19%	-4%	-29%
w/ CHP, Fractionation and Membrane Separation (wet DGS)	15%	-8%	-33%
w/ CHP, Fractionation, Membrane Separation, and Raw Starch Hydr	12%	-10%	-36%
Dry Mill Coal (dry DDGS)	66%	41%	12%
w/ CHP (dry DDGS)	64%	39%	10%
w/ CHP and Fractionation (dry DDGS)	56%	31%	3%
w/ CHP, Fractionation and Membrane Separation (dry DDGS)	47%	22%	-5%
w/ CHP, Fractionation, Membrane Separation, and Raw Starch Hydr	36%	13%	-14%
Dry Mill Coal (wet DGS)	41%	17%	-10%
w/ CHP (wet DGS)	39%	15%	-12%
w/ CHP and Fractionation (wet DGS)	37%	14%	-13%
w/ CHP, Fractionation and Membrane Separation (wet DGS)	28%	5%	-21%
w/ CHP, Fractionation, Membrane Separation, and Raw Starch Hydr	22%	-1%	-26%
Dry Mill Biomass (dry DDGS)	6%	-15%	-40%
w/ CHP (dry DDGS)	-2%	-23%	-47%
w/ CHP and Fractionation (dry DDGS)	0%	-21%	-45%
w/ CHP, Fractionation and Membrane Separation (dry DDGS)	1%	-20%	-45%
w/ CHP, Fractionation, Membrane Separation, and Raw Starch Hydr	0%	-21%	-45%
Dry Mill Biomass (wet DGS)	6%	-16%	-41%
w/ CHP (wet DGS)	-3%	-24%	-48%
w/ CHP and Fractionation (wet DGS)	0%	-21%	-46%
w/ CHP, Fractionation and Membrane Separation (wet DGS)	0%	-21%	-45%
w/ CHP, Fractionation, Membrane Separation, and Raw Starch Hydr	0%	-21%	-46%
Wet Mill with NG	37%	17%	-7%
Wet Mill with coal	64%	43%	19%
Wet Mill with biomass	-3%	-24%	-48%

As EPA's chart shows, only three of the 33 modeled pathways result in lower emissions than gasoline in 2012. The story improves in 2017, but not dramatically: 15 of the 33 pathways produce emissions that are higher than those from gasoline and only nine of the pathways achieve the 20% reduction required by EISA.[5]

Given that EPA had conducted lifecycle GHG emission analyses for 2012 and 2017 that more closely addressed the issue of corn ethanol's actual (rather than hypothetical) environmental performance, CATF and other environmental organizations questioned the Agency's decision to rely on the 2022 analysis, as did the National Research Council (NRC) in a 2011 report. According to the NRC,

> EPA found corn-grain ethanol, regardless of whether the coproduct is sold wet or dry, to have life-cycle GHG emissions higher than gasoline in 2012 or 2017 unless it is produced in a biorefinery that uses biomass as a heat source. EPA calculated its 21-percent GHG reduction as a weighted average of projected biorefinery and corn production efficiencies that could be realized in 2022. Thus, according to EPA's own estimates, corn-grain ethanol produced in 2011, which is almost exclusively made in biorefineries using natural gas as a heat source, is a higher emitter of GHG than gasoline. Nevertheless, corn-grain ethanol produced at the time this report was written still qualified for RFS2 based upon EPA's industry-weighted average of projected 2022 industry. The discrepancy between how RFS2 is implemented (under the assumption of 21-percent reduction of GHG emissions by corn-grain ethanol compared to gasoline) and EPA's own analysis *suggests that RFS2 might not achieve the intended GHG reductions*.[6]

In fact, the RFS does *not* achieve the intended GHG reductions. Using the 30-year lifecycle analysis that EPA conducted for corn ethanol produced in 2012 (instead of the analysis for 2022), CATF calculated the cumulative lifecycle GHG emissions from corn ethanol produced during the ramp-up period (2010-2015). CATF carried its analysis 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 in 2015 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. In other words, the cumulative lifecycle GHG emissions from corn ethanol are 28% higher than those from gasoline.

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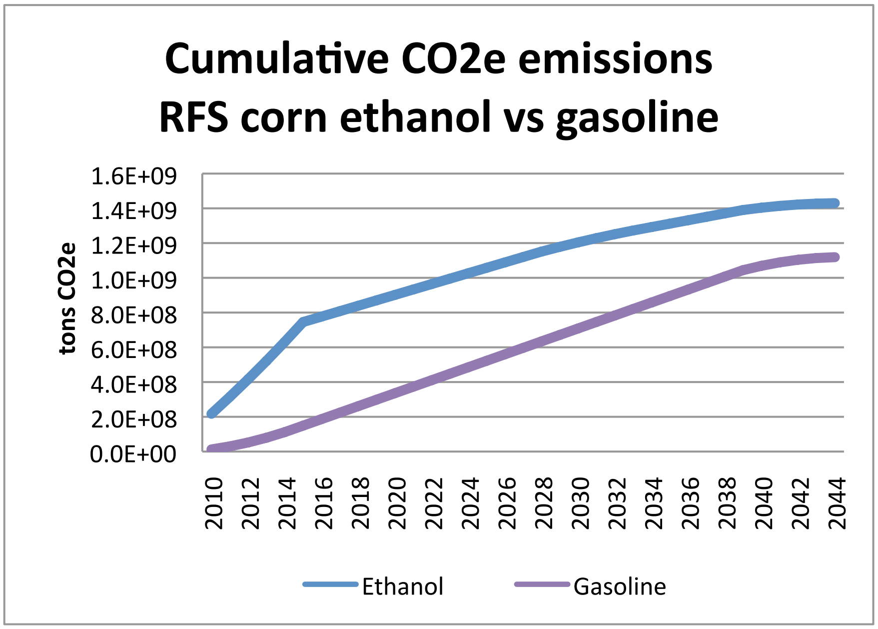
[5] The version of this chart that was included in CATF's May 24, 2013 response to the Committee (cited in footnote 1, above) contained several typographical errors that have been corrected here.

[6] *See* Lester Lave, *et al*. 2011. *Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy* 221 (Report by the National Research Council Committee on Economic and Environmental Impacts of Increasing Biofuels Production) (emphais supplied; internal citations omitted) (http://www.nap.edu/openbook.php?record_id=13105).



CATF's full analysis of EPA's lifecycle GHG emissions data can be found in a 2013 white paper titled "Corn Ethanol GHG Emissions Under Various RFS Implementation Scenarios," which is appended to these comments.

If the production of corn ethanol plateaus in 2015 at 15 billion gallons per year as envisioned by Congress, the global agricultural market will no longer have to bring new land into production in order to accommodate the RFS-driven increase in demand for farm goods, and—as a result—the lifecycle GHG emissions associated with each gallon of ethanol will decrease over time. It is critically important, therefore, to prevent any subsequent expansions of corn ethanol production that would set off a new round of land use-related emission increases. As explained in the following section, however, EPA is considering an implementation strategy that could exacerbate the negative impact that the RFS has had on climate change by causing corn ethanol production in the United States to increase.

C. Implementation strategies under consideration by EPA could exacerbate the negative impact that the RFS has had on climate change

As long as cellulosic biofuel production falls short of the annual targets set by Congress, EPA must make annual adjustments to the RFS cellulosic volume mandate.[7] Congress gave EPA the authority to make corresponding reductions to

[7] CAA §211(o)(7)(D)(i) ("For any calendar year for which the projected volume of cellulosic biofuel production is less than the minimum applicable volume established under paragraph (2)(B), as determined by the Administrator based on the estimate provided under paragraph

the overarching annual volume requirements for "advanced biofuels" and conventional "renewable fuel."[8] So far, though, the Agency has declined to make corresponding reductions, opting instead to allow extra production of "advanced biofuels" like sugarcane ethanol and biodiesel to make up for the shortfall in cellulosic fuels.

1. The Shortfall in Cellulosic Biofuel Production

The "cellulosic void"—*i.e.*, the difference between the annual cellulosic volume targets specified at Section 211(o)(2)(B)(III) of the Clean Air Act and the volumes of cellulosic biofuel that are projected to become available over time—will be large and persistent. EPA expects that only 10-20 million gallons of cellulosic biofuel will be produced in 2013 (as compared to the EISA target of 1 billion gallons). The US Energy Information Administration projects that less than three billion gallons of cellulosic biofuel will be produced on an annual basis by 2022, and that production levels will not reach the 16 billion gallon target set by Congress until at least 2033. Accordingly, the cellulosic void will be too large and last too long to be sustainably backfilled with non-cellulosic advanced biofuels. Nevertheless, EPA allowed "advanced biofuels" like sugarcane ethanol and soy biodiesel to make-up for the missing cellulosic biofuel in 2011 and 2012, and it has proposed to do so again in 2013.[9]

If EPA continues to pursue this strategy of backfilling the cellulosic void with advanced biofuels, a likely indirect—but predictable—consequence will be increases in the production of corn ethanol and/or palm oil. The reasons that the increased use of sugarcane ethanol and soy biodiesel would result in increased production of corn ethanol and palm biodiesel are discussed in this section, as is the rise in lifecycle GHG emissions that would occur as a result.

The decision to dramatically expand the RFS in 2007 was based in part on the assumption that mass production of cellulosic biofuels was imminent. The assumption proved too optimistic, however, as a combination of challenges stalled the commercial development of cellulosic biofuels. Few if any companies have identified enzyme- or microorganism-based processes that can profitably convert lignocellulosic material into useable sugars at commercial scale. The unresolved technology risks have steered potential investment away from cellulosic

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(3)(A), not later than November 30 of the preceding calendar year, the Administrator shall reduce the applicable volume of cellulosic biofuel required under paragraph (2)(B) to the projected volume available during that calendar year. For any calendar year in which the Administrator makes such a reduction, the Administrator may also reduce the applicable volume of renewable fuel and advanced biofuels requirement established under paragraph (2)(B) by the same or a lesser volume.")

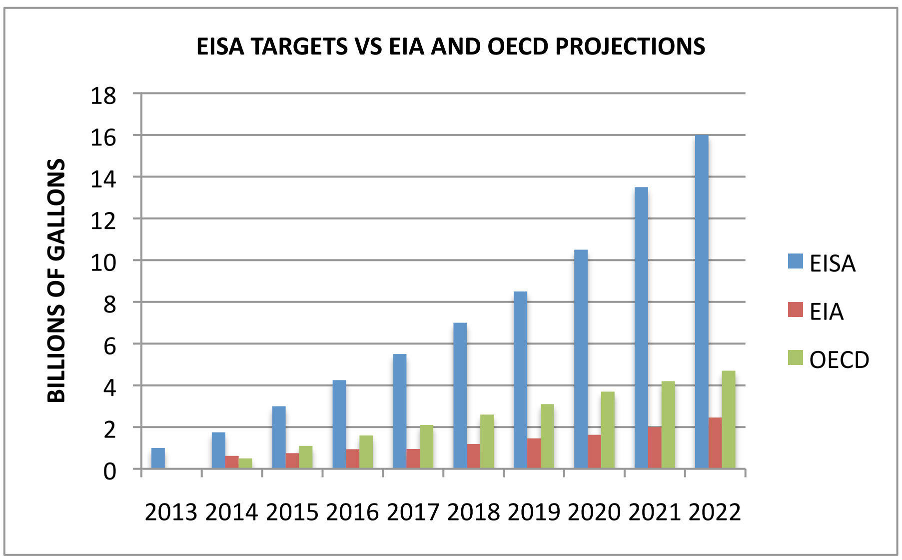
[8] *Id*.

[9] *See* EPA, "Regulation of Fuels and Fuel Additives: 2013 Renewable Fuel Standards–Proposed Rule," 78 Fed. Reg. 9282 (February 7, 2013).

development, as have concerns around production costs, the economic recession that began in late 2007, and uncertainty about future demand and the stability of the RFS and other policies that incentivize cellulosic fuel. And, ironically, the volume-driven structure of the RFS itself may be impeding cellulosic development by promoting fuels that appear to be rapidly scalable at the expense of fuels that better serve other goals (*e.g.*, low land-use impacts).

The struggle to produce cellulosic biofuels at commercial scale has tempered much of the earlier optimism about the industry's likely rate of growth. Recent forecasts tend to predict a ramp-up in cellulosic fuel production that lags far behind the volume targets established in EISA.

EIA's Annual Energy Outlook for 2012 ("*AEO2012*") projects that cellulosic biofuel production (including all "biomass-to-liquids") by 2022 will amount to around 2.5 billion gallons per year (or 15% of EISA's 16 billion gallon target).[10] The projection in a joint report by the Organization for Economic Cooperation and Development and the United Nations Food and Agriculture Organization ("OECD-FAO") is closer to 30% when extrapolated out to 2022%.[11] As the figure below demonstrates, the cellulosic shortfall implied by these projections is dramatic.



[10] US EIA, *Annual Energy Outlook 2012* (June 2012) ("AEO2012") – *Fig. 115: EISA2007 RFS credits earned in selected years, 2010-2035 (billion credits).* Available at: http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf. The forecast in Annual Energy Outlook 2013 ("AEO2013") is even less optimistic—*see AEO2013* at 83. Available at: http://www.eia.gov/forecasts/aeo/pdf/0383(2013).pdf

[11] OECD-FAO, *Agricultural Outlook 2012-2021 – Fig. 3.7: Structure of US biofuel mandates in the law (RFS), the baseline and the three options for 2021* (http://dx.doi.org/10.1787/888932639476).

Under both projections (EIA and OECD-FAO), the cellulosic void grows from just under a billion gallons in 2013 (assuming EPA finalizes its proposed reduction of the cellulosic volume requirement) to more than 11 billion gallons by 2022. Furthermore, the void will persist well after 2022. *AEO2012* projects that the combined production of cellulosic ethanol and biomass-to-liquids will reach the EISA target of 16 billion gallons in 2033;[12] the long-term projection in *AEO2013* is even more bearish, with cellulosic biofuels production at less than 10 billion gallons in 2040.[13]

2. Filling the Cellulosic Void with Sugarcane Ethanol—GHG Emissions Consequences

CATF's 2011 reanalysis of the GHG lifecycle emissions from corn ethanol (detailed above and in the appended white paper) assumed that RFS-driven production of corn ethanol would plateau in 2015 at 15 billion gallons per year. That would not be the case, however, if EPA allows non-cellulosic advanced biofuels to fill the cellulosic void. If EPA continues address the cellulosic shortfall by allowing fuels like sugarcane ethanol and soy biodiesel make up for missing volumes of cellulosic biofuel, the United States will have to significantly increase its imports of Brazilian sugarcane ethanol—which in turn would cause Brazil to significantly increase its imports of US corn ethanol in order to satisfy its own biofuel consumption mandate. According to OECD-FAO, the projected increase in US demand for Brazilian sugarcane ethanol would "create a large policy driven two-way trade in ethanol" causing sugarcane ethanol exports from Brazil to the United States to triple and triggering a 17% increase in world ethanol price by 2021.[14]

The result? A new spike in US corn ethanol production[15] and another increase in damaging GHG emissions, much of it from direct and indirect land use changes.

In the appended white paper titled "Corn Ethanol GHG Emissions Under Various RFS Implementation Scenarios," CATF revisits its 2011 emissions analysis and then calculates the climate impact that would occur if (a) EPA allows sugarcane ethanol to backfill the cellulosic void and (b) the resulting unmet ethanol demand in Brazil leads to a significant increase in US corn ethanol production. (The paper also

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[12] US EIA, *AEO2012 – Fig. 115*.

[13] US EIA, *AEO2013* at 83.

[14] OECD-FAO, *Agricultural Outlook 2012-2021* at 98-99.

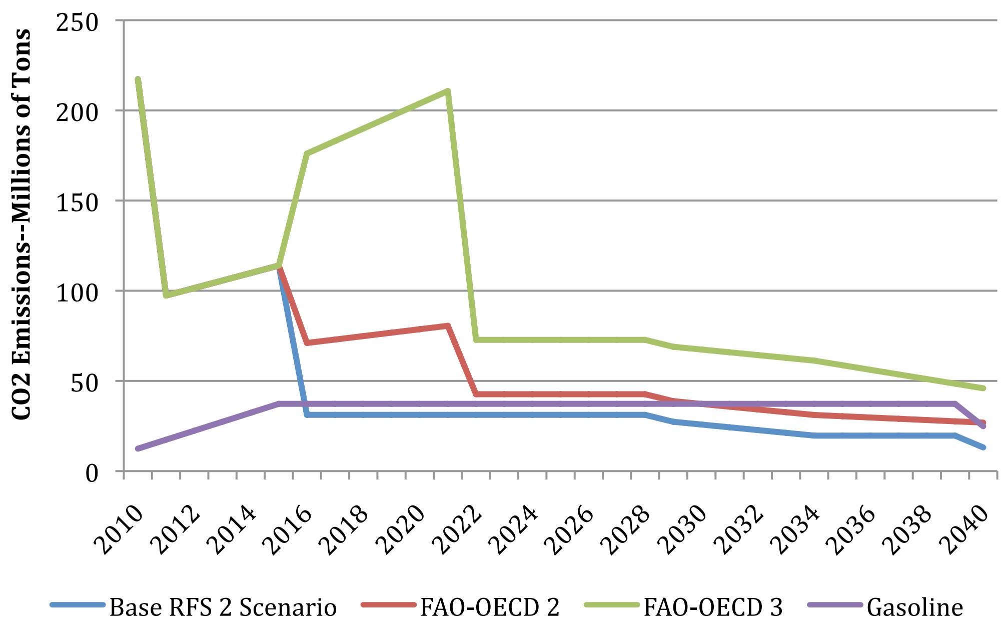
[15] *Id*. ("Imports (of ethanol by Brazil) are projected to reach 18 Bnl [4.7 billion gallons], to a large extent originating from the United States where, in turn, the maize based ethanol production is stimulated by high ethanol prices. So Option 2 would create a large policy driven two-way trade in ethanol.")

calculates the enormous emissions impact of allowing conventional biofuels (specifically, corn ethanol) to fill the cellulosic void directly.[16])

While CATF's findings are described in full in the appended white paper, three key points from the analysis are worthy summarizing here. First, under the baseline RFS, annual production of US corn ethanol is projected by EPA to rise from 10.5 billion gallons in 2009 to 15 billion gallons in 2015, and then remain at 15 billion gallons per year through 2022. If advanced biofuels like sugarcane ethanol are allowed to backfill the cellulosic void (referred to here as "OECD Option 2"), US corn ethanol production would rise to 16.65 billion gallons per year. If corn ethanol is used to backfill the void directly ("OECD Option 3"), production would rise to 21 billion gallons per year.

Second, OECD Options 2 and 3 would both increase the annual lifecycle emissions from corn ethanol produced to comply with the RFS. As illustrated in the graph below, the annual emission levels under Option 2 between 2016 and 2022 would be more than twice as high as the emission levels in the baseline RFS scenario, while the emission levels from Option 3 during that period would be 7-8 times higher.

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

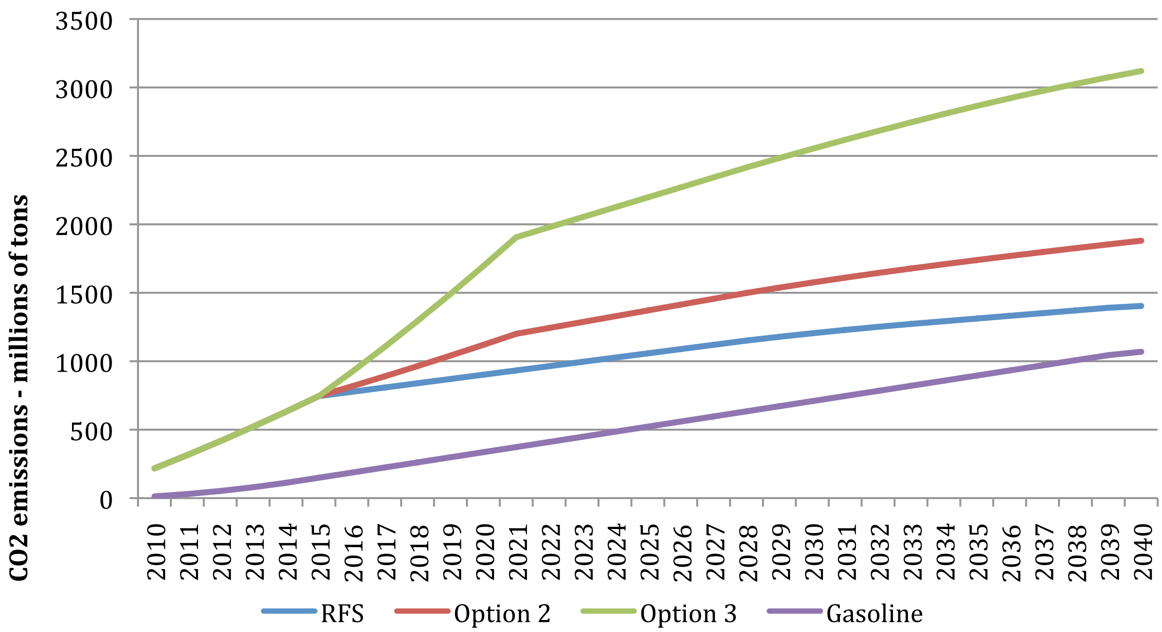


Third, cumulative lifecycle GHG emissions would increase by 34% under Option 2 (in which sugarcane ethanol backfills the cellulosic void) and by 117% under Option 3 (in which corn ethanol backfills the void directly). The following graph shows the

[16] EPA correctly rejected this approach in its proposed 2013 volume rule, *see* 78 Fed. Reg. at 9295/2.

cumulative lifecycle emissions for the RFS2 baseline, for OECD Options 2 and 3, and for an energy-equivalent volume of gasoline:

Cumulative Corn Ethanol CO_2 Emissions (RFS2 Baseline, OECD Options, Gasoline)



3. Filling the Cellulosic Void with Soy Biodiesel—GHG Emissions Consequences

CATF's recent emissions analysis (summarized above and appended to these comments) assumes that the cellulosic void will be filled with imported sugarcane. But if soy biodiesel makes up most of the shortfall instead (an option that is made more feasible by extensions of the biodiesel tax credit), the possibility of increased lifecycle GHG emissions remains high. The reason is that increased demand for soy biodiesel would indirectly increase the overall demand for vegetable oil, which in turn would enlarge the market for palm oil. As the Union of Concerned Scientists (UCS) explained in April 2013 comments to EPA,

> Palm oil is the cheapest, fastest growing source of vegetable oil in the world, and occupies an even larger share of the global vegetable oil trade. This makes it highly likely that whether or not palm oil is directly imported into the U.S., palm oil will ultimately replace the oils and fats used to make biodiesel … Since palm oil will ultimately be the source of oil that indirectly replaces the oils and fats required to fill an expanded biodiesel mandate, it is likely that expanding the advanced mandate will not only fail to achieve the

> 50% GHG emissions reduction requirement of advanced biofuels, but may also fail to reduce emissions at all. Palm oil is associated with a host of disquieting problems, mostly about draining peat swamps and cutting down forests to expand plantations, at great cost to orangutans, local people, and the global climate.[17]

In 2012, EPA made a preliminary finding that palm oil-based biodiesel did not achieve the 20% in lifecycle GHG emissions that EISA requires of conventional biofuels. Furthermore, CATF, UCS, and a number of other organizations demonstrated in comments on EPA's proposed determination that several important flaws in the Agency's assessment of the lifecycle GHG emissions associated with palm oil biofuels led the Agency to substantially underestimate the emissions from palm biodiesel.[18] Because the lifecycle GHG emissions from palm biodiesel are almost certainly higher than those from corn ethanol or gasoline, palm biodiesel "should not be allowed to indirectly fill an expanded advanced biofuel mandate,"[19]—but that would be the result of allowing soy biodiesel to backfill the RFS's growing cellulosic void.

D. Options for reducing the RFS's negative climate impact going forward

There are two options for minimizing the negative climate impacts described above.

First, instead of allowing advanced biofuels to backfill the cellulosic void—as EPA did in 2011 and 2012, and proposes to do in 2013—the Agency can use the authority granted to it at Section 211(o)(7)(D) of the Clean Air Act to make corresponding reductions to the annual RFS volume requirements for advanced biofuels and total renewable fuel whenever it reduces the annual volume requirement for cellulosic biofuel. By reducing the advanced biofuel requirement

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[17] UCS, Comments on U.S. Environmental Protection Agency's "Regulation of Fuels and Fuel Additives: 2013 Renewable Fuel Standards" 78 Fed. Reg. 9282 (February 21, 2013) [EPA-HQ-OAR-2012-0546] (filed April 5, 2013) at 18-19 ("UCS 2013 RFS Volume Comments"). Available at: http://www.ucsusa.org/assets/documents/clean_vehicles/UCS-Comments-on-RFS-2013-Volumes.pdf. *See also id*. ("The International Food Policy Research Institute (IFPRI) recently did an analysis of oil substitution in biodiesel markets and found that because demand for soybeans is largely driven by meal, 60% of soybean oil used to make biodiesel was replaced by other oils, especially palm oil. This led to lifecycle emissions for soy biodiesel similar to fossil diesel. As volumes of vegetable oil based biodiesel grow larger, they are increasingly likely to outstrip the demand for meal, leading to a global imbalance that will be rectified indirectly by substitution of palm oil for the missing food grade vegetable oil.")

[18] UCS, *et al.*, Joint Science and Environmental Stakeholder Comments on: Docket No. EPA–HQ–OAR–2011–0542 – EPA's analyses of palm oil used as a feedstock under the Renewable Fuel Standard (RFS) program (filed April 27, 2012). Available at: http://www.ucsusa.org/assets/documents/global_warming/EPA-palm-oil-comments-final.pdf

[19] UCS 2013 RFS Volume Comments at 19.

and the total renewable fuel requirements by the same amount it reduces the cellulosic biofuel requirement, EPA would eliminate the need to backfill the cellulosic void with additional volumes of non-cellulosic advanced biofuels or conventional biofuels and avoid the GHG emissions increases analyzed above. The environmental and legal bases for pursuing this approach are detailed in CATF's April 2013 comments on EPA's proposed 2013 RFS volume rule.[20]

Moreover, if EPA addresses the cellulosic void by reducing the advanced biofuel and total renewable fuel volume requirements by the same amount that it reduces the cellulosic volume requirement each year, it can substantially alleviate the pressure created by the "blend wall." According to OECD-FAO, an RFS implementation strategy that makes corresponding reductions to the advanced and total renewable volume requirements would "lead[] to lower percentages of ethanol blended into the 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."[21] In contrast, allowing advanced biofuel to backfill the cellulosic void would increase ethanol use 40% by 2021; ethanol blending would "reach the assumed blend wall limit from 2014 onward."[22]

The second option for minimizing the negative climate impacts associated with the RFS and the shortfall in cellulosic production is to require EPA to make corresponding reductions to the annual volume requirements for advanced biofuel and total renewable fuel whenever it reduces the volume requirement for cellulosic biofuels. Congress could change Section 211(o)(7)(D)(i) of the Clean Air Act by replacing the term "may" with the term "shall" and deleting the phrase "or a lesser". The revisions are shown below:

(i) For any calendar year for which the projected volume of cellulosic biofuel production is less than the minimum applicable volume established under paragraph (2)(B), as determined by the Administrator based on the estimate provided under paragraph (3)(A), not later than November 30 of the preceding calendar year, the Administrator shall reduce the applicable volume of cellulosic biofuel required under paragraph (2)(B) to the projected volume available during that calendar year. For any calendar year in which the Administrator makes such a reduction, the Administrator ~~may~~ **shall** also reduce the applicable volume of renewable fuel and advanced biofuels requirement established under paragraph (2)(B) by the same ~~or a lesser~~ volume.

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[20] Comments available at: http://www.catf.us/resources/filings/biofuels/20130405-CATF_Comments_on_EPA_RFS_2013_Volume_Adjustment_78FedReg9282.pdf
[21] *Agricultural Outlook 2012-2021* at 98.
[22] *Id*.

E. Conclusion

The Clean Air Task Force is grateful for the opportunity to describe the significant increase in lifecycle greenhouse gas emissions that have resulted from the RFS-mandated corn ethanol production, as well as the steps that EPA and Congress can take to reduce future emissions increases.

Respectfully submitted,

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Senior Counsel
Clean Air Task Force

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

[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]

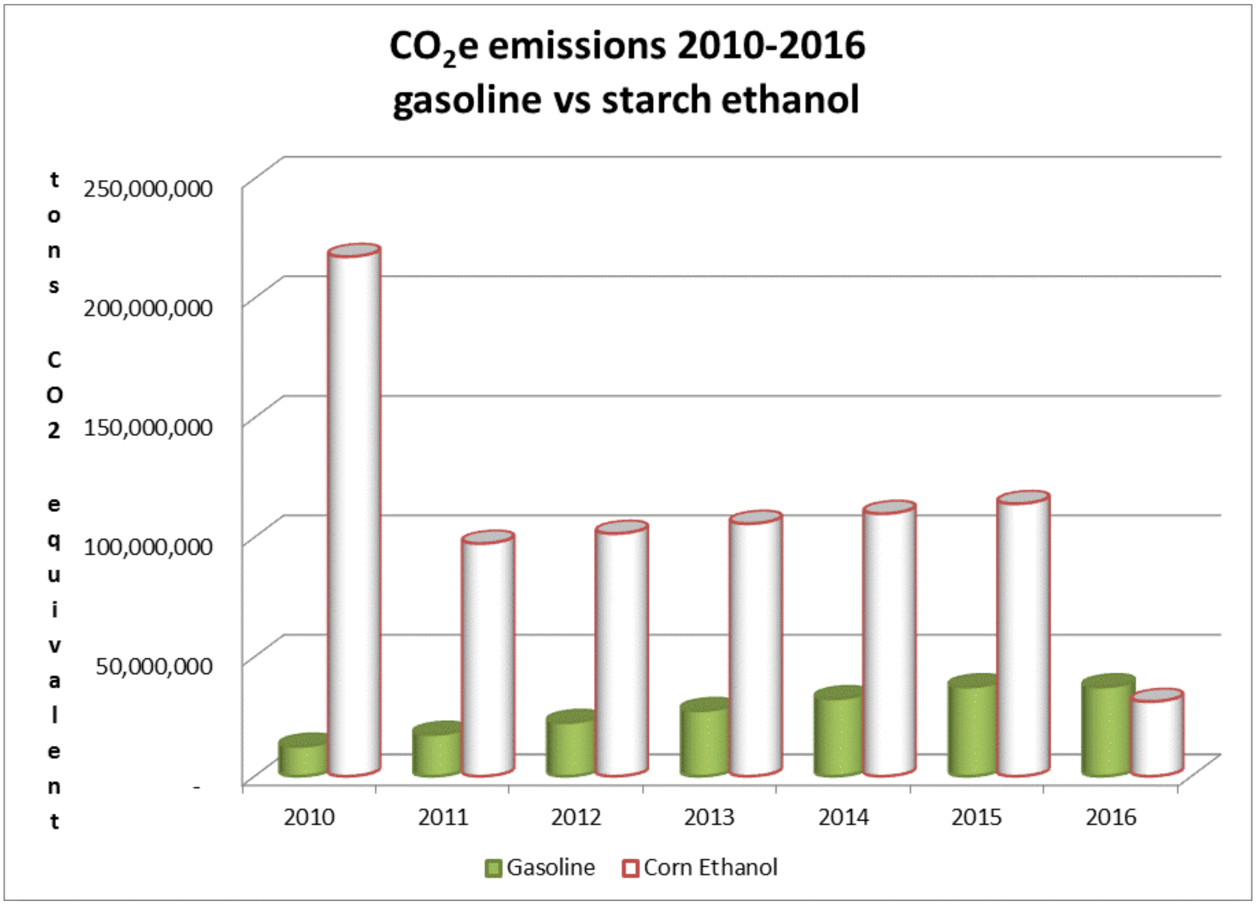
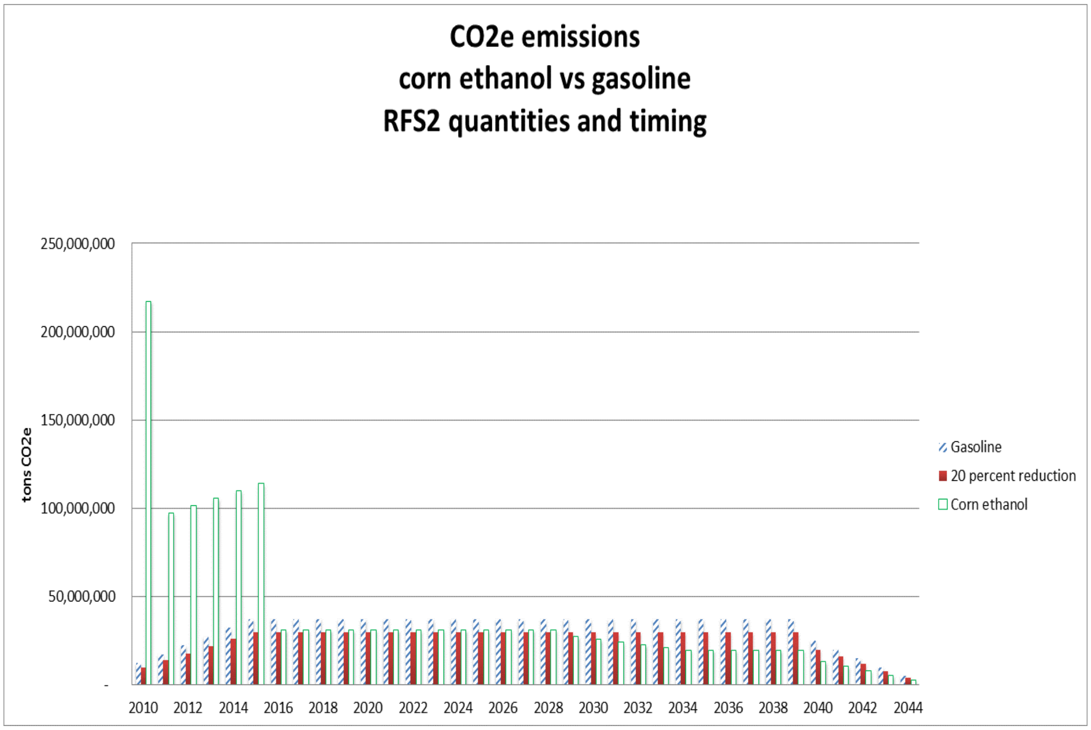


Figure 2 below presents year-by-year GHG emissions for corn ethanol and baseline gasoline, from 2010 through 2044. A 20 percent reduction below the baseline gasoline emissions level is also shown.

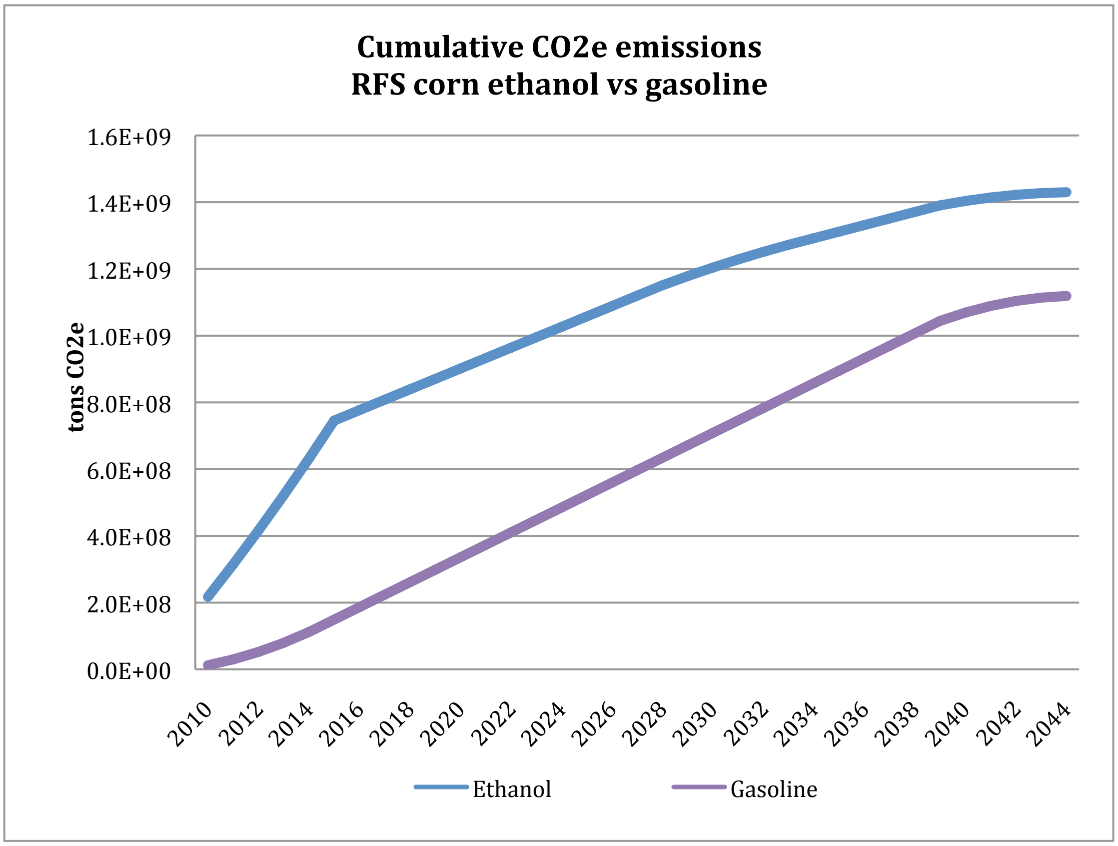
[10] Calculations derived from Spreadsheet EPA-HQ-OAR-2005-0161.3173.5(1)

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)

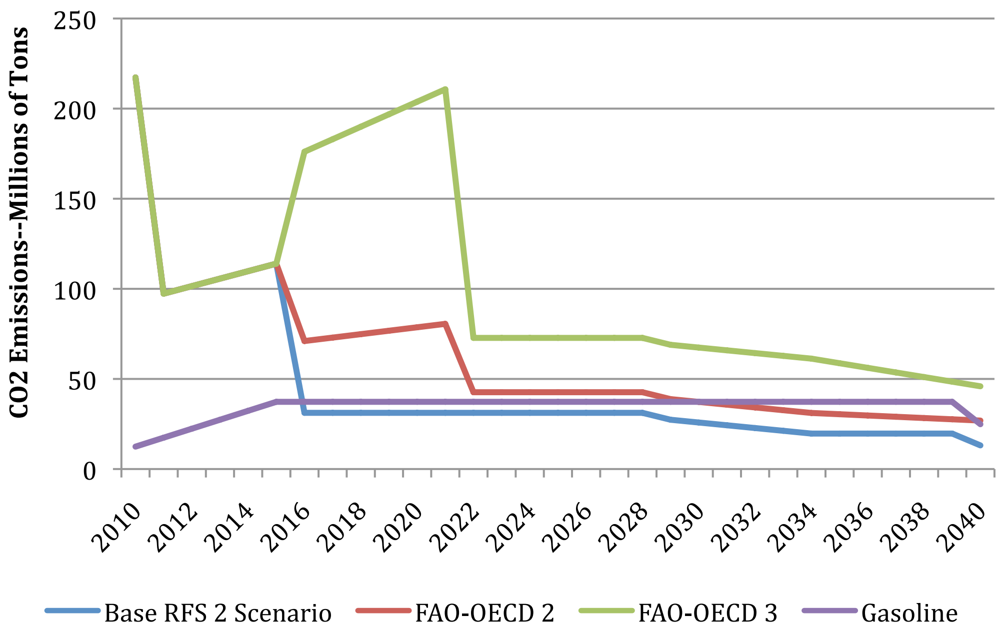


Table 4 below summarizes the CO_2 emissions consequence for each scenario and for projected gasoline consumption for the period 2010-2040:

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

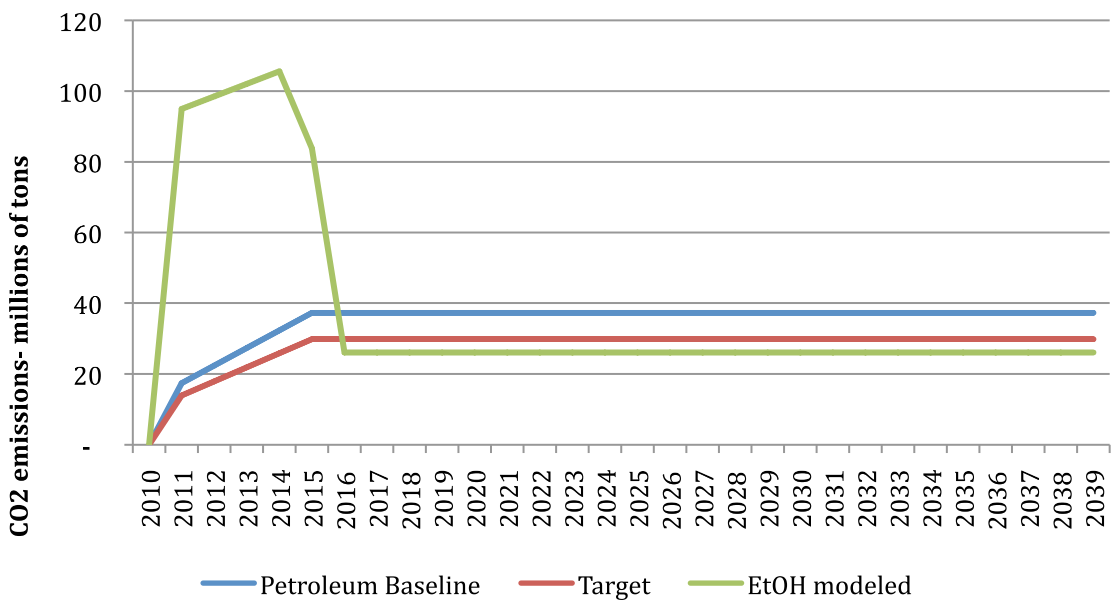
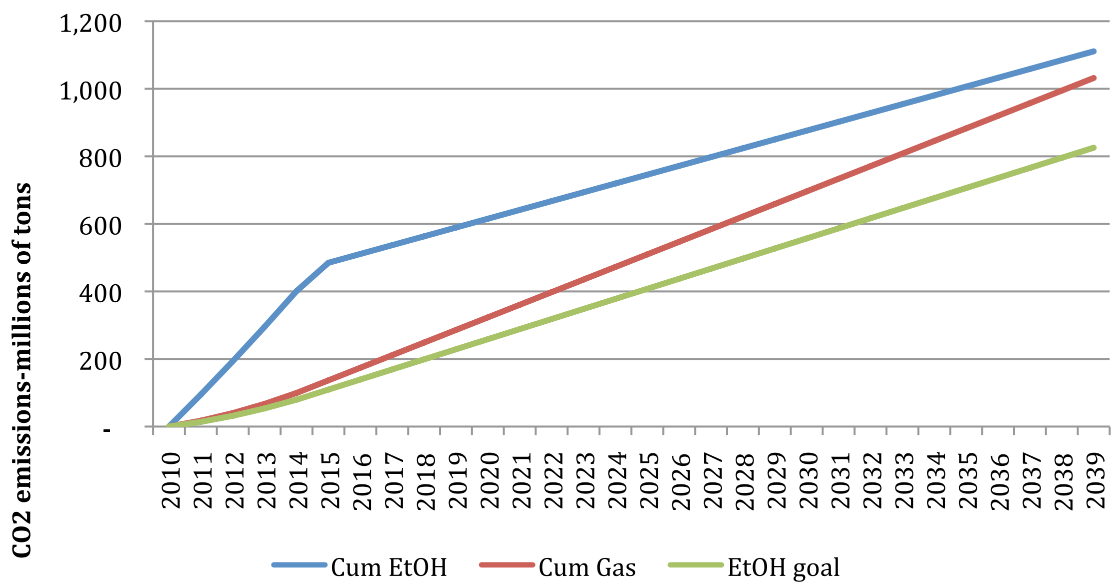


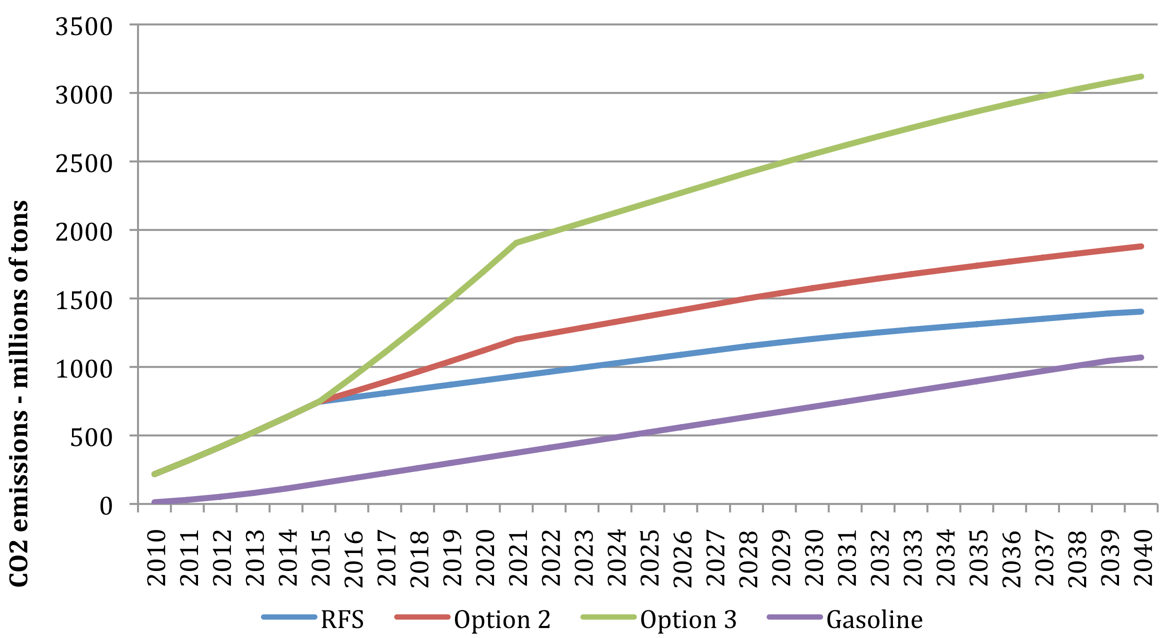
Figure 6 shows the cumulative emissions for the same three.

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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