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Prepared Statement for the Record

Sofie E. Miller

Senior Policy Analyst
The George Washington University Regulatory Studies Center

Hearing on

Oversight of the Renewable Fuel Standard

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The George Washington University Regulatory Studies Center
805 21st St. NW, Suite 612
Washington, DC 20052
202-994-7543
RegulatoryStudies@gwu.edu
www.RegulatoryStudies.gwu.edu

Introduction

Thank you Chairman Inhofe, Ranking Member Boxer, and Members of the Committee for inviting me to submit for the record my research on the effects of the Renewable Fuel Standard (RFS) and prospects for reform. I am Senior Policy Analyst at the George Washington University Regulatory Studies Center, where I analyze the effects of regulation on public welfare. My research focuses especially on the effects of regulations governing the energy and environment sphere, including the Environmental Protection Agency's RFS rules.

I appreciate the Committee's interest in evaluating the RFS program and determining whether there are opportunities for Congress to improve it. My prepared statement includes the following points:

- The statute that created the RFS program was enacted over a decade ago, and since that time new information has become available about the effects of mandated biofuel production.
- Due to falling domestic demand for gasoline and delays in the development of cellulosic ethanol, the statutory biofuel production levels outlined in the Energy Independence and Security Act of 2007 put the RFS program on an unsustainable trajectory.
- New information and research on the environmental effects of the RFS program indicate that mandated biofuel production may not reduce greenhouse gas emissions relative to gasoline. In addition, biofuel production produces criteria pollutants and damages water systems from crop fertilizer runoff. These environmental effects are significant and negative.

The Renewable Fuel Standard Program

In 2005, Congress passed the Energy Policy Act (EPAct), which, as amended in 2007, requires the Environmental Protection Agency (EPA) to issue regulations mandating the production and use of biofuels such as corn ethanol, cellulosic ethanol, and biomass-based diesel. As a part of the RFS program, the EPA sets biofuel blending targets that require refiners to blend specific amounts of renewable fuels into transportation fuel, such as gasoline and diesel. The RFS program was created to reduce U.S. dependence on both foreign oil and domestic gasoline consumption. To that end, EPA regulations currently mandate the production of 18.11 billion gallons of total renewable fuel in 2016.

In its recent final rule, EPA set minimum standards for the production of biodiesel and cellulosic biofuel, which also count toward the agency's total renewable fuel standards. Although it is the largest type of domestic biofuel, corn ethanol is only one component of the overall total renewable fuel standards promulgated by EPA. The agency also sets advanced biofuel standards, which can be met by the production of three main fuel sources: biodiesel, imported sugarcane ethanol, and cellulosic biofuel.

The total renewable fuel standards prescribed for 2015 and 2016 must be met through a combination of corn ethanol and advanced biofuels (cellulosic and biodiesel). Historical levels of mandated biofuel production can be seen in the table below.

EPA-Regulated Renewable Fuel Standards

	2010	2011	2012	2013	2014	2015	2016
Ethanol *(billion gallons)*	12.0	12.6	13.2	13.8	13.61	14.05	14.5
Biodiesel *(billion gallons)*	0.65[a]	0.8	1.0	1.28	1.63	1.73	1.9
Cellulosic biofuel *(million gallons)*	6.5	6	10.45	6	33	123	230
Advanced biofuel *(billion gallons)*	0.95	1.35	2.0	2.75	2.67	2.88	3.61
Total[b]	**12.95**	**13.95**	**15.2**	**16.55**	**16.28**	**16.93**	**18.11**

All gallon values are ethanol-equivalent on an energy content basis, except for biodiesel which is actual

[a] The rule implementing the 2010 RFS combined the 2009 and 2010 biomass-based diesel requirements and applied them to 2010.

[b] The totals listed at the bottom are the sum of the ethanol and advanced biofuel totals. The standards set by EPA are a minimum, and the advanced biofuel minimum can be reached by either increases in biodiesel, cellulosic biofuel, or other advanced biofuel production above the minimum standards ascribed by EPA.

While the stated goals of the RFS are to reduce crude oil imports and increase the use of renewable fuels, an implicit purpose of the RFS program is to benefit the environment by moving away from fuels that result in substantial net carbon emissions (e.g. gasoline and diesel). According to EPA, the RFS program "was created to promote substantial, sustained growth in biofuel production and consumption" resulting in "reductions in greenhouse gas emissions, enhanced energy security, economic development, and technological innovation."[1] However, while crude oil imports and gasoline demand have decreased, it is less clear whether the increased production of biofuels has actually reduced emissions or benefitted the environment.

The literature is mixed on the environmental effects of biofuel production, with many estimates indicating that the production of ethanol and biodiesel may significantly increase emissions, specifically of the greenhouse gases carbon dioxide (CO_2) and nitrous oxide (N_2O) and criteria

[1] Environmental Protection Agency. 2013. "2014 Standards for the Renewable Fuel Standard Program." *78 Federal Register*: 71731.

pollutants such as particulate matter. The following sections examine the statutory authority underpinning the RFS program, explain the unsustainable trajectory of increased biofuel production, and review the recent research on the environmental impacts of the RFS program.

Statutory Authority

Under the Clean Air Act (CAA), as amended by the EPAct of 2005 and the Energy Independence and Security Act of 2007 (EISA), EPA sets the annual volume of biofuel required to meet its renewable fuel standard. Section 211(o)(2)(B) of the CAA specifies annual biofuel targets for EPA's RFS; the volume requirements for 2016, both from the statute and EPA's rule, finalized in December 2015, are outlined in the table below.

	Previous volume requirements (*2013*)	**Statutory applicable volume requirements (*2016*)**	**Current volume requirements (*2016*)**
Biomass-based diesel	1.28 billion gallons	≥1.0 billion gallons	1.9 billion gallons
Cellulosic biofuel	6 million gallons	4.25 billion gallons	230 million gallons
Advanced biofuel	2.75 billion gallons	7.25 billion gallons	3.61 billion gallons
Total renewable fuel	**16.55 billion gallons**	**22.25 billion gallons**	**18.11 billion gallons**

Note: Cellulosic biofuel and biomass-based biodiesel are nested within the "advanced biofuel" category, which is itself nested within the "renewable fuel" category.

EPA's recent final rule increases the overall volume requirements for renewable fuels from 16.55 billion gallons in 2013 to 18.11 billion gallons in 2016, an increase of 1.56 billion gallons. Cellulosic biofuel and biomass-based diesel (biodiesel) are both advanced biofuels which are nested within the "renewable fuel" category. EPA's final rule set volume requirements for these advanced biofuels at 3.61 billion gallons in 2016, an 860 million gallon increase over the last standards promulgated by the agency for 2013.

However, these increases fall short of the statutory applicable volumes for 2016 outlined in the table above. For all but one fuel type, EPA set the volume requirement below the statutory level. Although mandated cellulosic biofuel production is proposed to increase by a factor of 38, the 230 million gallons proposed for 2016 are still only about 5% of the levels set in the CAA. The targets for all advanced biofuels (a category which includes both cellulosic biofuel and biodiesel) are half of the statutory volume levels, and the final standards for total renewable fuels are 4.14 billion gallons shy of the volume levels specified in the CAA.

RFS Program's Unsustainable Trajectory

EPA does have some discretion to set applicable volume requirements below those specified in the statute, under certain conditions. EPA has exercised its cellulosic waiver authority under CAA section 211(o)(7)(D)(i) and the general waiver authority under CAA section 211(o)(7)(A) to mandate less cellulosic biofuel and total renewable fuel than Congress specified in the EISA.

Obstacles to an Increased Biofuel Mandate

Most recently, EPA opted to exercise its waiver authority because there was in 2014 (and will continue to be in 2015 and 2016) an insufficient supply of total renewable fuels and advanced biofuels to meet the statutory mandate. There are a few reasons for this supply shortage. As EPA explained in its 2015 proposed rule:

> For non-ethanol renewable fuels, the primary supply constraint at present is the projected shortfall in domestic production or importation of qualifying volumes. For ethanol blends, there are both legal and practical constraints on the amount of ethanol that can be supplied to the vehicles that can use it, notwithstanding the considerable volumes that can be produced and/or imported.[2]

For the advanced biofuels, the primary constraint is growth in the cellulosic biofuel market. While Congress set ambitious targets for cellulosic production in 2014, actual production was 33 million gallons, less than 2% of the statutory volume requirements for 2014. Due to the high costs of producing cellulosic and the technological barriers facing the industry, it is likely that cellulosic production will continue to fall short of statutory levels for the foreseeable future. Increased production of biodiesel, although it currently surpasses the minimum volumes prescribed in the statute, is not sufficient to make up for the shortfall of cellulosic ethanol. Because both of these fuels are nested within the "advanced biofuels" category, EPA must reduce both the cellulosic volume requirements and the advanced biofuel volume requirements as a result of these supply shortages.

Ethanol faces a different set of obstacles. While the U.S. has the capacity and ability to either import or produce more ethanol, more ethanol cannot feasibly be blended into gasoline. Legally, only flex fuel vehicles (FFVs) can use fuel with ethanol concentrations greater than 15%, and these vehicles only constitute about 6% of all light-duty cars and trucks.[3] Practically, non-flex-fuel vehicles cannot use fuel with ethanol concentrations greater than 10%, which is termed the "blendwall." While the authorizing statute requires more ethanol to be blended into

[2] Environmental Protection Agency. 2015. "Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017." *80 Federal Register*: 33121.

[3] Environmental Protection Agency. 2015. "Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017." *80 Federal Register*: 33120.

transportation fuel each year until 2022, the only way this is possible is if demand for gasoline increases significantly in the near term. This creates a ceiling on the practical growth of ethanol as a transportation fuel. In its most recent RFS proposal, EPA was very cognizant of the fact the blendwall makes it infeasible to significantly increase the volume requirements for ethanol.[4]

Gasoline Demand

One purpose of the RFS program is to reduce gasoline consumption. However, domestic demand for gasoline has not kept pace with Congress's and EPA's expectations. While Congress and EPA expected gasoline consumption to continue increasing, actual demand dropped from a high of 142 billion gallons of gasoline in 2007, when the EISA was passed, to 136 billion in 2014.[5] As EPA explained:

> The decrease in total gasoline consumption in recent years which resulted in a corresponding and proportional decrease in the maximum amount of ethanol that can be consumed if all gasoline was E10, the limited number and geographic distribution of retail stations that offer higher ethanol blends such as E15 and E85, the number of FFVs that have access to E85, as well as other market factors, combine to place significant restrictions on the volume of ethanol that can be supplied to vehicles at the present time.[6]

This is particularly important because two of the primary goals of the RFS are 1) to increase use of renewable fuels and 2) to reduce crude oil imports. However, these goals are at least partially at odds: most of the biofuels produced to comply with the RFS are not drop-in fuels, which could act as perfect substitutes for gasoline or diesel. Instead, biofuels such as corn ethanol and biodiesel must be blended into existing fuel stock, and in some cases cannot legally exceed certain concentrations in fuel (for instance, 10% for ethanol,[7] and 5% for biodiesel). Paradoxically, without more gasoline/crude oil, it will be difficult—both legally and practically—to increase the use of renewable fuels. In its proposed rule, EPA explained that:

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[4] However, EPA's position seems to have shifted between its June 2015 proposed rule and its December 2015 final rule, in which EPA stated "Our final rule includes volumes of renewable fuel that will require either ethanol use at levels significantly beyond the level of the E10 blendwall, or significantly greater use of non-ethanol renewable fuels, such as biodiesel and renewable diesel, than has occurred to date, depending on how the market responds to the standards we set." 80 FR 77423

[5] U.S. Energy Information Administration. "Petroleum & Other Liquids: U.S. Product Supplied of Finished Motor Gasoline." Accessed January 10, 2016. *Data converted from barrel units to gallons.* http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MGFUPUS1&f=A

[6] Environmental Protection Agency. 2015. "Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017." *80 Federal Register*: 33109-10.

[7] 10% ethanol is the legal maximum for most vehicles, but some 2001 and newer light-duty vehicles are permitted to use fuels with concentrations of up to 15% ethanol. Flex-fuel vehicles are the only vehicles that can legally use fuel with ethanol concentrations greater than 15%.

> since the majority of renewable fuel today is currently consumed as 10 percent ethanol blends, changes in demand for gasoline can have a significant impact on the ability of the marketplace to blend fixed volumes of renewable fuels.[8]

It is becoming increasingly difficult to increase the production of renewable fuels while demand for gasoline is decreasing. At the same time, the price of gasoline has decreased due to supply curve shifts, which changes the economic calculus for renewable fuels. These constraints certainly justify EPA's use of its waiver authorities to prescribe lower volume requirements than those listed in the statute. Because the RFS program is on an unsustainable trajectory, Congress should consider reevaluating the statutory volume requirements established in the 2007 EISA and consider other approaches that would be more feasible and better for the environment.

Environmental Effects of Biofuel Production

In the decade since Congress created the Renewable Fuels Program, information has emerged that affects our understanding of the true effects of mandating the production of large quantities of biofuels. Availability of recent data and the proliferation of new third-party analyses provide Congress with a key opportunity to revisit the assumptions about environmental effects and demand for gasoline that underpinned its initiation of the RFS program.

Greenhouse Gases

There has been significant development in the relevant literature on the environmental impacts of renewable fuel production since Congress passed the EISA and EPA first analyzed the impacts of the RFS program. Recent research indicates that the environmental benefit of the RFS is extremely modest[9] at best and, at worst, could result in a significant increase in CO_2 emissions over gasoline.[10] Overall, the post-2007 literature largely reinforces this worst-case scenario, although estimates differ as to the extent of the environmental damage posed by biofuel mandates. A number of factors influence the extent of any potential environmental damage as a result of the RFS.

First, increased biofuel production causes land use changes (LUC) that result in the release of soil organic carbon. Increased demand for corn and soy provides farmers with an incentive to produce more crop and convert unused lands into cropland, which releases a significant amount of soil organic carbon and foregoes future carbon sequestration and storage. This increase in

[8] Environmental Protection Agency. 2015. "Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017." *80 Federal Register*: 33109.

[9] Chen et al. 2014. "Alternative transportation fuel standards: Welfare effects and climate benefits" *Journal of Environmental Economics and Management* 67: 241–257

[10] Searchinger et al. 2008. "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change." *Science*. Vol. 319 no. 5867 pp. 1238-1240

release of CO_2 may, depending on tillage practices and land type, outweigh any potential CO_2 savings from combusting ethanol.

For example, in 2008, Searchinger et al. found that that biofuels increase carbon emissions by 93% compared to gasoline when the effects of LUC are considered.[11] Fargione et al. find that diverting domestic grassland and abandoned cropland in the Midwest to ethanol production incurs between 69 and 134 megagrams (Mg) of CO_2 per hectare, requiring a payback period of between 48 and 93 years to repay the initial carbon debt.[12] While LUC in the literature is primarily described as it relates to corn ethanol, researchers have also found that the carbon emissions from LUC are 34% greater per megajoule for soybean-based biodiesel.[13] This is particularly troubling as shortfalls in cellulosic capacity mean that EPA will continue to rely on increases in biodiesel production to meet Congress' ambitious advanced biofuel targets.

In addition, these effects are not limited to the United States: changes in worldwide agricultural markets as a result of biofuel mandates may also lead to international land use change (or *indirect* land use change, "ILUC"), which occurs when other countries alter growing habits to replace crops that were previously imported from the U.S. When taking ILUC into account, Chakravorty and Hubert find that international emissions may increase by 33%, in comparison to a modest 1% reduction in domestic emissions.[14] Bento et al. find that the RFS "unambiguously" increases carbon emissions, offsetting more than 70% of the intended emissions savings.[15] Other research finds that, when considering ILUC, the environmental benefit of the RFS is very modest at best.[16,17]

EPA considered both potential LUC and ILUC in its 2010 analysis of RFS by weighing factors such as tilling practices, irrigation, crop yields over time, and supply and demand for agricultural

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[11] Searchinger et al. 2008. "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change." *Science*. Vol. 319 no. 5867 pp. 1238-1240

[12] Fargione et al. 2008. "Land Clearing and the Biofuel Carbon Debt." *Science* 29: 1235-1238

[13] Chen, Huang, and Khanna. "Land Use and Greenhouse Gas Implications of Biofuels: Role of Technology and Policy." Paper prepared for presentation at the Agricultural & Applied Economics Association's 2011 AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24- 26, 2011. http://ageconsearch.umn.edu/bitstream/103216/2/CCE_for_AAEA2011.pdf

[14] Ujjayant Chakravorty and Marie-Hélène Hubert. 2012. "Global Impacts of the Biofuel Mandate under a Carbon Tax." American Journal of Agricultural Economics

[15] Bento, Klotz, and Landry. "Are there Carbon Savings from US Biofuel Policies? The Critical Importance of Accounting for Leakage in Land and Fuel Markets" (2012; forthcoming 2015 in Energy Journal)

[16] Oliver and Khanna. 2015. "Implementing the Renewable Fuel Standard with the Renewable Portfolio Standard in the US: Implications for Policy Costs and Greenhouse Gas Emissions."

[17] Chen, Huang, and Khanna. "Land Use and Greenhouse Gas Implications of Biofuels: Role of Technology and Policy." Paper prepared for presentation at the Agricultural & Applied Economics Association's 2011 AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24- 26, 2011.

products.[18] However, EPA estimated that production of ethanol results in 34 grams of CO_2 per megajoule, which recent evidence suggests is on the very low-end of plausible values for carbon emissions.[19] Even if EPA's lower estimate is accurate, recent research finds that emissions as little as 27g/MJ are "enough to cancel out the benefits that corn ethanol has on global warming,"[20] meaning that EPA may have seriously underestimated the potential climate costs of implementing the RFS program.

Second, fertilizer input for the production of crops used to produce biofuels results in emissions of N_2O, a greenhouse gas that contributes to climate change. A 2012 analysis found that the necessary fertilizer input for the increased production of corn and rapeseed leads to N_2O emissions that matched or exceeded the corresponding cooling achieved by the reduction in CO_2 emissions resulting from fossil fuel replacement.[21]

One additional result of increased fertilizer usage—especially for corn ethanol—is water pollution. Increased fertilizer runoff damages ecosystems, harms biodiversity, and is contributing to the Gulf of Mexico's "Dead Zone."[22] This damage is most pronounced when acreage is diverted from another crop to corn production, which relies heavily on nitrogen fertilization and requires more irrigation than displaced crops, such as cotton.

Third, increased demand for and consumption of oil from across the globe could displace any domestic reductions resulting from the RFS, which could offset any domestic environmental benefit. EPA estimates that the largest benefit of the RFS program is a "monopsony" benefit. That is, because the U.S. is such a major consumer of international crude oil, reduced crude oil imports as a result of RFS can reduce the price of crude oil, and any remaining barrels of crude oil imported will be imported into the U.S. at a lower price. However, this lower price has a rebound effect on international gasoline demand, offsetting any reductions effected at the

[18] Environmental Protection Agency. 2010. "Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis." §2.4.4 - §2.4.5.

[19] Plevin, O'Hare, Jones, Torn and Gibbs. 2010. "Greenhouse Gas Emissions from Biofuels' Indirect Land Use Change are Uncertain but May Be Much Greater than Previously Estimated." *Environmental Science & Technology* 44: 8015–8021

[20] Hertel, Golub, Jones, O'Hare, Plevin and Kammen. 2010. "Effects of US Maize Ethanol on Global Land Use and Greenhouse Gas Emissions: Estimating Market-mediated Responses." *BioScience* 60 (3): 223.

[21] Smith, Mosier, Crutzen and Winiwarter. 2012. "The role of N2O derived from crop-based biofuels, and from agriculture in general, in Earth's climate." *Philosophical Transactions of the Royal Society* 367: 1169–1174

[22] Welch, H.L., Green, C.T., Rebich, R.A., Barlow, J.R.B., and Hicks, M.B., 2010, Unintended consequences of biofuels production—The effects of large-scale crop conversion on water quality and quantity: U.S. Geological Survey Open-File Report 2010–1229, 6 p.

domestic level. This rebound effect could offset more than 60% of the intended emissions savings of the RFS program.[23]

Criteria Pollutants

Particulate matter (PM) is a criteria pollutant regulated under the Clean Air Act. PM is "principally characterized as discrete particles that exist in the condensed (liquid or solid) phase spanning several orders of magnitude in size," primarily PM_{10} (less than or equal to 10 micrometers, μm) and $PM_{2.5}$ (less than or equal to 2.5 μm),[24] and is associated with certain undesirable health effects such as premature mortality. In its 2009 RFS2 proposal EPA estimated that in 2022, PM_{10} and $PM_{2.5}$ emissions would have increased by a combined 64,626 annual tons as a result of the RFS program.[25] EPA's initial regulatory impact analysis also indicates that biofuel production causes increased emissions of particulate matter.[26]

In January 2013, EPA released estimates of PM costs per ton by emissions sector, and valued the reduction of one ton of area source $PM_{2.5}$ at between $320,000 and $710,000.[27,28] Based on EPA's per-ton damage estimates, the quantified air quality disbenefits of ethanol production through 2015 for $PM_{2.5}$ alone could be as large as $93 billion.[29]

Biodiesel production also incurs PM costs. In its 2012 rulemaking mandating the production of 1.28 billion gallons of biomass-based diesel, EPA valued the PM disbenefits of its rule at between $0.17 – $0.19/gallon.[30] Using EPA's estimate, the total PM costs of the rule were $841 million in 2015, and will reach $1.2 billion in 2016.

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[23] Bento, Antonio M., Richard Klotz, and Joel R. Landry. "Are there carbon savings from US biofuel policies? Accounting for leakage in land and fuel markets." *Presentation at the agricultural & applied economics association AAEA & NAREA joint annual meeting*. 2011. Forthcoming in Energy Journal 2015.

[24] Environmental Protection Agency. 2009. "Proposed Rule: Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program." *74 Federal Register:* 25064.

[25] Environmental Protection Agency. 2009. "Proposed Rule: Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program." *74 Federal Register:* 25060, Table VII.A–1.

[26] Environmental Protection Agency. 2012."Regulation of Fuels and Fuel Additives: 2013 Biomass-Based Diesel Renewable Fuel Volume." *77 Federal Register*: 59480-82.

[27] Environmental Protection Agency. 2013. "Technical Support Document Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors." 13, Table 5. http://www.epa.gov/air/benmap/models/Source_Apportionment_BPT_TSD_1_31_13.pdf

[28] There is no corresponding per-ton damage valuation for PM_{10}. However, since all particulate matter that is less than 2.5 μm is also less than 10 μm, valuing increases of both $PM_{2.5}$ and PM_{10} may result in double-counting. This estimate measures only changes in PM2.5 and values those according to EPA's estimate. To see the methodology used, view the attached Appendix.

[29] See the attached Appendix for more information on how these quantities and values were calculated.

[30] Environmental Protection Agency. 2012b. "Regulation of Fuels and Fuel Additives: 2013 Biomass-Based Diesel Renewable Fuel Volume." *77 Federal Register*: Table VI.B.2.b-3.

Cost of Particulate Matter Increases from Ethanol Production ($PM_{2.5}$ Only)					
Year	**Ethanol consumption**	**PM2.5 emissions (tons)**	**Lower-bound**	**Base Case**	**Upper-bound**
2006	5,481,210,000	6,541.37	($2,093,237,558)	($3,368,804,194)	($4,644,370,831)
2007	6,885,690,000	8,217.50	($2,629,599,106)	($4,232,011,062)	($5,834,423,017)
2008	9,683,352,000	11,556.27	($3,698,007,573)	($5,951,480,938)	($8,204,954,303)
2009	11,036,592,000	13,171.25	($4,214,800,908)	($6,783,195,211)	($9,351,589,514)
2010	12,858,497,000	15,345.54	($4,910,574,281)	($7,902,955,483)	($10,895,336,686)
2011	12,893,315,000	15,387.10	($4,923,871,043)	($7,924,354,960)	($10,924,838,877)
2012	12,881,879,000	15,373.45	($4,919,503,711)	($7,917,326,285)	($10,915,148,859)
2013	13,215,621,000	15,771.74	($5,046,957,556)	($8,122,447,316)	($11,197,937,077)
2014	13,443,976,000	16,044.27	($5,134,164,808)	($8,262,796,488)	($11,391,428,168)
*2015**	*11,610,910,000*	*13,856.65*	*($4,434,129,123)*	*($7,136,176,557)*	*($9,838,223,992)*
Total	**109,991,042,000**	**131,265.14**	**($42,004,845,666)**	**($67,601,548,494)**	**($93,198,251,322)**
*Data for 2015 are incomplete, and as of 2/11/2016 include consumption only through October, 2015. Actual yearly total will be higher than listed.					

Particulate Matter Costs of Biodiesel Production			
Year	**PM damages/gallon***	**Gallons biodiesel produced**	**Damages**
2012	$(0.18)	991,000,000	$(178,380,000)
2013	$(0.18)	1,359,000,000	$(244,620,000)
2014	$(0.18)	1,270,000,000	$(228,600,000)
2015	$(0.18)	1,054,000,000	$(189,720,000)
2016	$(0.18)	*1,900,000,000**	*$(342,000,000)**
Total		6,574,000,000	**$(1,183,320,000)**
*Projected production/damages based on EPA's 2015 final rule mandating the production of 1.9 billion gallons of biomass-based diesel in 2016			

Conclusion

The past decade has provided evidence that the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007 set unrealistic volume requirements that bind EPA to an unsustainable regulatory approach. As EPA stated in its June 2015 proposed rule:

> Over the past few years, we have seen analysis concluding that the ambitious statutory targets in the Clean Air Act exceed real world conditions. Despite significant efforts by the U.S. Departments of Agriculture (USDA) and Energy (DOE) to promote the use of renewable fuels, real-world limitations, such as the slower than expected development of the cellulosic biofuel industry, less growth in gasoline use than was expected when Congress enacted these provisions in

> 2007, and constraints in supplying certain biofuels to consumers, have made the timeline laid out by Congress extremely difficult to achieve.[31]

In addition, a wealth of new information has become available on the environmental effect of renewable fuel production since Congress authorized the EISA in 2007. This literature broadly finds that meeting the volume requirements in the statute or in EPA's regulations may increase greenhouse gas emissions, in addition to polluting waterways. This information is particularly pertinent because Congress in 2007 surely did not intend its RFS program to cause significant environmental damage. While EPA is constrained in its ability to respond to these unintended consequences, Congress is not.

Over the past ten years, the RFS program has created new costs for families and businesses by artificially inflating the market for agricultural commodities like corn and soy. Given the evidence gained from implementation of the RFS program, Congress should consider reevaluating the goals of the program and attempt to determine whether the RFS is meeting its stated goals.

[31] Environmental Protection Agency. 2015. "Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017." *80 Federal Register*: 33101.

Appendix

Valuing the Costs of Particulate Matter Emissions from Corn Ethanol

We can calculate the PM effects per gallon of ethanol by dividing the number tons of PM emissions that EPA anticipated in its initial analysis by the expected increase in ethanol production by 2022 over the RFS1 baseline (12 billion gallons). This yields a value of 4.19E-06 tons of PM_{10} and 1.19E-06 tons of $PM_{2.5}$ per gallon of ethanol. These values can then be multiplied by the historical number of gallons of ethanol produced, and multiplied again by the EPA's per-ton cost values for $PM_{2.5}$.

There is no corresponding per-ton damage valuation for PM_{10}. However, since all particulate matter that is less than 2.5 μm is also less than 10 μm, valuing increases of both $PM_{2.5}$ and PM_{10} may result in double-counting. Two options present themselves: count only changes in PM_{10} and monetize the effects using $PM_{2.5}$ values, or count only changes in $PM_{2.5}$ and monetize them accordingly. The first option risks either over- or under-counting if PM_{10} values in fact differ significantly from $PM_{2.5}$ values. The second option poses a definite risk of under-counting, as PM_{10} particles larger than 2.5 μm are ignored completely. While neither approach is perfect, this submitted statement used the second approach to conservatively quantify the effects of increased $PM_{2.5}$ as a result of the RFS program.

An estimate that counts only changes in PM_{10} monetized using $PM_{2.5}$ values is presented here.

Cost of Particulate Matter Increases Resulting from Ethanol Production (PM_{10} Only)

Year	Ethanol consumption	PM_{10} emissions (tons)	$PM_{2.5}$ emissions (tons)	Lower-bound	Base Case	Upper-bound
2006	5,481,210,000	22,977.69	6,541.37	($7,352,860,508)	($11,833,509,880)	($16,314,159,252)
2007	6,885,690,000	28,865.39	8,217.50	($9,236,923,612)	($14,865,673,938)	($20,494,424,264)
2008	9,683,352,000	40,593.42	11,556.27	($12,989,893,930)	($20,905,610,543)	($28,821,327,156)
2009	11,036,592,000	46,266.31	13,171.25	($14,805,220,282)	($23,827,151,391)	($32,849,082,500)
2010	12,858,497,000	53,903.89	15,345.54	($17,249,245,109)	($27,760,503,847)	($38,271,762,585)
2011	12,893,315,000	54,049.85	15,387.10	($17,295,952,295)	($27,835,673,225)	($38,375,394,155)
2012	12,881,879,000	54,001.91	15,373.45	($17,280,611,283)	($27,810,983,783)	($38,341,356,283)
2013	13,215,621,000	55,400.98	15,771.74	($17,728,315,051)	($28,531,507,035)	($39,334,699,019)
2014	13,443,976,000	56,358.27	16,044.27	($18,034,645,671)	($29,024,507,878)	($40,014,370,084)
*2015**	*11,610,910,000*	*48,673.90*	*13,856.65*	*($15,575,648,735)*	*($25,067,059,682)*	*($34,558,470,630)*
Total	**109,991,042,000**	**461,091.61**	**131,265.14**	**($147,549,316,475)**	**($237,462,181,202)**	**($327,375,045,929)**

This estimate risks either over- or under-counting if PM_{10} values differ significantly from $PM_{2.5}$ values. In this case, ethanol consumption since passage of the EPAct accounts for at least $147.5 billion in environmental disbenefits from increased criteria pollution, and as much as $327 billion.