

**THE RENEWABLE FUEL STANDARD:
A TEN-YEAR REVIEW OF COSTS AND BENEFITS**

JOINT HEARING
BEFORE THE
SUBCOMMITTEE ON ENVIRONMENT &
SUBCOMMITTEE ON OVERSIGHT
COMMITTEE ON SCIENCE, SPACE, AND
TECHNOLOGY
HOUSE OF REPRESENTATIVES
ONE HUNDRED FOURTEENTH CONGRESS

FIRST SESSION

November 3, 2015

Serial No. 114-47

Printed for the use of the Committee on Science, Space, and Technology



Available via the World Wide Web: <http://science.house.gov>

U.S. GOVERNMENT PUBLISHING OFFICE

97-766PDF

WASHINGTON : 2017

For sale by the Superintendent of Documents, U.S. Government Publishing Office
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**THE RENEWABLE FUEL STANDARD:
A TEN-YEAR REVIEW OF
COSTS AND BENEFITS**

TUESDAY, NOVEMBER 3, 2015

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENVIRONMENT AND
SUBCOMMITTEE ON OVERSIGHT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittees met, pursuant to call, at 10:05 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Jim Bridenstine [Chairman of the Subcommittee on Environment] presiding.

LAMAR S. SMITH, Texas
CHAIRMAN

EDDIE BERNICE JOHNSON, Texas
RANKING MEMBER

Congress of the United States
House of Representatives

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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Subcommittees on Environment and Oversight

***The Renewable Fuel Standard:
A Ten Year Review of Costs and Benefits***

Tuesday, November 3, 2015
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

Witnesses

Dr. Terry Dinan, Senior Advisor, Congressional Budget Office

Mr. Ed Anderson, CEO and President, WEN-GAP, LLC

Dr. John DeCicco, Research Professor, University of Michigan Energy Institute

Mr. Brooke Coleman, Executive Director, Advanced Biofuels Business Council

Mr. Charles Drevna, Distinguished Senior Fellow, Institute for Energy Research

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY**

HEARING CHARTER

The Renewable Fuel Standard: A Ten Year Review of Costs and Benefits

Tuesday, November 3, 2015
10:00 a.m. – 11:30 a.m.
2318 Rayburn House Office Building

PURPOSE

The Subcommittees on Environment and Oversight will hold a joint hearing titled *The Renewable Fuel Standard: A Ten Year Review of Costs and Benefits* on Tuesday, November 3, 2015, starting at 10:00 a.m. in Room 2318 Rayburn House Office Building. The purpose of this hearing is to examine the environmental impact and cost of the Renewable Fuel Standard (RFS) over the ten year history of the program, as well as the economic impact and specific technical challenges involved in meeting future RFS requirements. This hearing will also specifically examine the impact of the RFS on the price of food and fuel.

WITNESSES

- **Dr. Terry Dinan**, Senior Advisor, Congressional Budget Office
- **Mr. Ed Anderson**, CEO and President of WEN-GAP, LLC
- **Dr. John DeCicco**, Research Professor, University of Michigan Energy Institute
- **Mr. Brooke Coleman**, Executive Director, Advanced Biofuels Business Council
- **Mr. Charles Drevna**, Distinguished Senior Fellow, Institute for Energy Research

BACKGROUND

The Renewable Fuel Standard (RFS) was established in the Energy Policy Act of 2005 (EPACT 05), which required transportation fuels in the continental U.S. contain, or be blended with, renewable biofuels at increasing volumes.¹ When the RFS was initially designed, the primary goals were to reduce greenhouse gas emissions and reduce U.S. reliance on crude oil imports by accelerating the use of biofuels in the U.S. transportation fuel supply.²

In 2007, the Energy Independence and Security Act of 2007 (EISA) expanded the scope of the RFS (commonly known as RFS2) by mandating the blending of 20.5 billion gallons of biofuels into U.S. transportation fuels by 2015, and 36 billion gallons by 2022.³ EISA established four

¹ P.L. 109-58, Energy Policy Act of 2005. Aug. 8, 2005. Available at <http://www.gpo.gov/fdsys/pkg/PLAW-109publ58/pdf/PLAW-109publ58.pdf>

² Environmental Protection Agency, Renewable and Alternative Fuels. Available at <http://www.epa.gov/otaq/fuels/alternative-renewablefuels/index.htm>

³ P.L. 110-140, Energy Independence and Security Act of 2007. Dec. 19, 2007. Available at <http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf>

specific categories of renewable fuel—conventional biofuels, advanced biofuels, cellulosic biofuels, and biomass-based diesels, with specific target requirements for each category of fuel outlined in the law. The conventional biofuels category is primarily made up of fuels from corn ethanol.⁴

Advanced biofuels are biofuels produced from feedstocks other than cornstarch that achieve lifecycle greenhouse gas emissions that are 50% lower than petroleum fuels, while cellulosic biofuels are required to reduce lifecycle greenhouse gas emissions by 60%.⁵

Under EISA, the EPA has waiver authority to reduce volumes of renewable fuels below the volumes specified in statute under certain circumstances, including annual production rate of renewable fuels, impact on energy security and the environment, as well as other factors such as job creation, price and supply of agricultural commodities, rural development and food prices.⁶ The EPA has consistently used this waiver authority, lowering the cellulosic biofuel mandate from 2010 to 2013, and proposing to do so again for all renewable fuel volumes in 2014-2016.⁷ Under the terms of a consent decree from litigation brought by the American Petroleum Institute (API) and the American Fuel and Petrochemical Manufacturers (AFPM), the EPA is required to finalize volume requirements for 2014 and 2015 by November 30, 2015.⁸

After ten years, the RFS program continues to create compliance challenges for industry, and promised environmental and economic benefits have yet to materialize. In 2014, the Congressional Budget Office outlined ongoing challenges with the law, including the lack of domestic production capacity of advanced biofuels fuels, the blend wall, and outlining the significant difference in outcome between the volumes mandated in the EISA and the current EPA waiver volume requirements.⁹ If the volumes mandated by EISA are strictly enforced, CBO estimated that the price of petroleum-based diesel would increase by up to 14%, and the cost of E10 (the most commonly used form of gasoline in the U.S.) increases by up to 9%.¹⁰

While the RFS program has contributed to a 267% increase in corn ethanol production (from 3.9 billion gallons in 2005 to 14.3 billion gallons in 2014), advanced biofuels and cellulosic ethanol production has stagnated.¹¹ This increase in corn ethanol production due to the RFS is

⁴ Environmental Protection Agency, *Renewable Fuel Standard (RFS)*. Available at <http://www.epa.gov/OMSWWW/fuels/renewablefuels/index.htm>

⁵ Congressional Research Service, *Calculation of Lifecycle Greenhouse Gas Emissions for the Renewable Fuel Standard (RFS)*. March 12, 2010. Available at <http://nationalaglawcenter.org/wp-content/uploads/assets/crs/R43325.pdf>

⁶ P.L. 110-140, Energy Independence and Security Act of 2007. Dec. 19, 2007. Available at <http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf>

⁷ Congressional Research Service, *The Renewable Fuel Standard (RFS): In Brief*, June 29, 2015. Available at <http://nationalaglawcenter.org/wp-content/uploads/assets/crs/R43325.pdf>

⁸ Environmental Protection Agency, *2015 Announcements for Renewable Fuel Standard Program*. Available at <http://www2.epa.gov/renewable-fuel-standard-program/2015-announcements-renewable-fuel-standard-program>

⁹ Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond*. June 2014. Available at <https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/45477-Biofuels2.pdf>

¹⁰ Ibid.

¹¹ English, Burton and De La Torre Ugarte, Daniel, *A 10-Year Review of the Renewable Fuels Standard: Impacts to the Environment, the Economy, and Advanced Biofuels Development*. Department of Agricultural and Resource

significant due to the emissions profile of corn ethanol. In testimony during a Science Committee hearing last July, Dr. Jason Hill from the University of Minnesota confirmed that when considering lifecycle emissions, “corn ethanol has higher life cycle emissions than gasoline of five major pollutants that contribute to PM2.5 and O3 levels” while cellulosic ethanol emits greater amounts of some pollutants than gasoline but lower amounts of others.¹² This research contradicts predictions that if enacted, the biofuels mandate would significantly reduce emissions. With corn ethanol composing 87% of national biofuels production, the promised environmental benefits of the RFS appear to be impossible without significant adjustments to current law.¹³

RFS Compliance

The EPA manages compliance with the RFS through a fuel credit system incorporating Renewable Identification Credits (RINs).¹⁴ RINs are generated with each qualifying gallon of renewable fuels produced by biofuel producers and importers, and can be traded and sold like other commodities. In order to comply with biofuel volumes mandated under the RFS, petroleum refiners and importers within the continental U.S. and Hawaii must acquire RINs to meet their renewable volume obligation (RVO), and submit these RINs to the EPA to show compliance with annual RFS requirements.¹⁵ The chart below provides an overview of the complex RIN credit system.

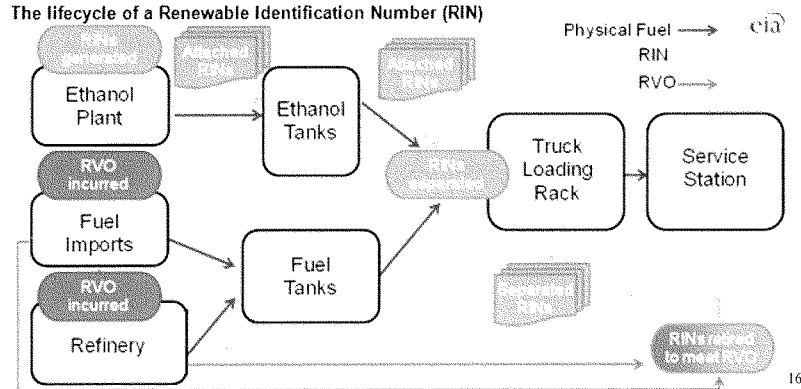
Economics, The University of Tennessee. October 14, 2015. Available at http://beag.ag.utk.edu/pub/TenYrReviewRenewableFuelStandard_1015.pdf

¹² Hill, Jason. *Statement before the Subcommittee on Energy and Subcommittee on Oversight on the EPA Renewable Fuel Standard Mandate*. July 23, 2015. Available at <https://science.house.gov/sites/republicans.science.house.gov/files/documents/HHRG-114-SY20-WState-JHill-20150723.pdf>

¹³ English, Burton and De La Torre Ugarte, Daniel, *A 10-Year Review of the Renewable Fuels Standard: Impacts to the Environment, the Economy, and Advanced Biofuels Development*. Department of Agricultural and Resource Economics, The University of Tennessee. October 14, 2015. Available at http://beag.ag.utk.edu/pub/TenYrReviewRenewableFuelStandard_1015.pdf

¹⁴ Congressional Research Service, *The Renewable Fuel Standard (RFS): In Brief*, June 29, 2015. Available at <http://nationalaglawcenter.org/wp-content/uploads/assets/crs/R43325.pdf>

¹⁵ Ibid.



The EPA sets the annual RVO by translating the biofuels volumes required under EISA into a percentage of the total transportation fuel (gasoline and diesel) sold within the U.S. The EPA estimates the total volume of the annual transportation fuel supply to determine this percentage, issues a proposed rule, and is required to promulgate an annual standard by November 30th each year to provide percentages to industry. Accordingly, each individual refiner's RVO is determined by the total gasoline and diesel fuel they produce for sale multiplied by the annual renewable fuel percentage standards mandated by EPA.¹⁷ This formula allows refiners to determine the number of RINs the refiner is responsible for submitting to EPA to prove compliance with the RFS.¹⁸

To date, the majority of annual volumes required under the RFS have been met with corn ethanol biofuels, largely through the sale of E10, or ten percent blended gasoline. However, as the RFS volumes continue to increase over time, the share of mandated volumes for advanced and cellulosic biofuels grows, with cellulosic biofuels requirements increasing from less than 1% of required volumes in 2010 to 44% of the required volumes in 2022.¹⁹

Challenges

The RFS creates a number of compliance challenges for refiners, biofuel producers, engine manufacturers, and distributors of the U.S. transportation fuel supply—eventually impacting American consumers through the price and availability of fuels. These issues include ongoing uncertainty in EPA management of the RFS, difficulty in achieving adequate levels of renewable fuel production, and the impact of “blend wall” in meeting RFS volume requirements in the

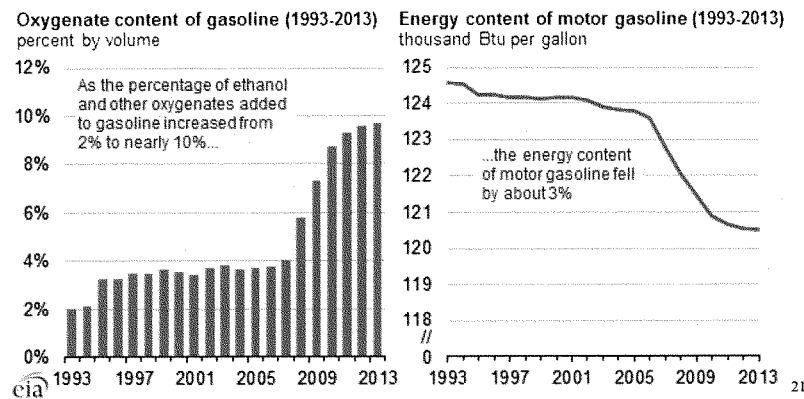
¹⁶ Energy Information Administration, *RINs and RVOs are used to implement the Renewable Fuel Standard*. June 3, 2013. Available at <http://www.eia.gov/todayinenergy/detail.cfm?id=11511>

¹⁷ Ibid.

¹⁸ Energy Information Administration, *RINs and RVOs are used to implement the Renewable Fuel Standard*. June 3, 2013. Available at <http://www.eia.gov/todayinenergy/detail.cfm?id=11511>

¹⁹ P.L. 110-140, Energy Independence and Security Act of 2007. Dec. 19, 2007. Available at <http://www.gpo.gov/fdsys/pkg/PLAW-110publ140/pdf/PLAW-110publ140.pdf>

future. Reductions in the energy content and efficiency of transportation fuels due to increased blending of biofuels (as outlined in the graphic below) also lower customer demand for mid-level ethanol blend fuels.²⁰



Uncertainty and Demand

The EPA finally released a proposed standard to implement the RFS for 2014-16 on May 29, 2015, after almost an 18 month delay for the 2014 standard. This delay created uncertainty for both conventional and renewable fuel producers. In November 2014, EPA announced it would not finalize a rule at all during the calendar year, and would instead postpone the updated standard from 2014 until 2015.²² The EPA's decision to ignore statutory requirements created long-term uncertainty in the energy market place that threatened adequate supply for meeting volume requirements for renewable fuels in the future.

Demand and consumption rates also present challenges to the RFS. EISA projected significantly higher demand for gasoline than has occurred, and assumed technological advances in cellulosic and advanced biofuels production to meet increasing volume requirements.²³ As statutory mandates increase and demand declines based on projections, higher percentages of biofuels are required to be blended into the fuel supply to meet the RFS requirements. In the proposed RFS rule for 2014-2016, the EPA recognized that "limitations in the ability of the industry to produce sufficient volumes of qualifying renewable fuel, particularly non-ethanol fuels" was a significant

²⁰ Energy Information Administration, *Increasing ethanol use has reduced the average energy content of retail motor gasoline*, October 27, 2014. Available at <http://www.eia.gov/todayinenergy/detail.cfm?id=18551>

²¹ Ibid.

²² Bloomberg, *EPA Won't Finalize Renewable Fuel Standard in 2014, Cites Lengthy Delays*, November 24, 2014. Available at <http://www.bna.com/epa-wont-finalize-n17179912489/>

²³ Environmental Protection Agency, *EPA Proposes Renewable Fuel Standards for 2014, 2015, and 2016, and the Biomass-Based Diesel Volume for 2017*, May 2015. Available at <http://www.epa.gov/OMSWWW/fuels/renewablefuels/documents/420f15028.pdf>

limiting factor in meeting the volume requirements outlined in statute.²⁴ In addition, limits on the amount of ethanol that can be blended, also known as the “blend wall” offer a significant challenge to meeting future requirements.

The Blend Wall

The “blend wall”, or ten percent ethanol, is considered the upper limit to the total amount of ethanol that can be blended into U.S. transportation fuel supply while still maintaining engine performance and compliance with the Clean Air Act.²⁵ The blend wall is considered a significant challenge to meeting future biofuel volumes mandated in the RFS, and is in conflict with the biofuel volumes mandated in the RFS. The EPA specifically acknowledged the blend wall in the proposed rule issued last May and recognized “limitations in the volume of ethanol that can be consumed given practical constraints on the supply of higher ethanol blends to the vehicles that can use them” as a primary factor in EPA’s decision to exercise its waiver authority.²⁶

Due to the blend wall, which places a physical limit on blending that is less than what is mandated in statute, RFS volumes that exceed approximately 13.3 billion-gallons/year cannot be met by incorporating more E10 into the transportation fuel supply.²⁷ In an effort to avoid the blend wall, Growth Energy and 54 ethanol manufacturers petitioned the EPA in 2009 to allow E15, a mid-level or intermediate ethanol blend, into the commercial marketplace.²⁸

E15

Under the Clean Air Act, the EPA is prohibited from introducing a new fuel unless it is “substantially similar” to gasoline, but is authorized to grant a waiver of this prohibition. In response to the Growth Energy petition, the EPA issued a partial waiver for E15 in October 2010, to allow the introduction of E15 into the commercial marketplace for use in model year 2007 and newer cars, light-duty trucks, and SUVs.²⁹ In January 2011, EPA granted another partial waiver for use of E15 in model year 2001 and newer vehicles.

The EPA did not grant a waiver for the use of E15 fuel in model years prior to 2001. Nor is E15 approved for use in motorcycles, vehicles with heavy-duty engines, off-road vehicles (such as boats and snowmobiles), engines in off-road equipment (such as lawnmowers and chain saws),

²⁴ Ibid.

²⁵ Congressional Research Service, *The Renewable Fuel Standard (RFS): In Brief*, June 29, 2015. Available at <http://www.crs.gov/pdfl/loader/R43325>.

²⁶ Environmental Protection Agency, *EPA Proposes Renewable Fuel Standards for 2014, 2015, and 2016, and the Biomass-Based Diesel Volume for 2017*, May 2015. Available at <http://www.epa.gov/OMSWWW/fuels/renewablefuels/documents/420f15028.pdf>

²⁷ Tyner, Wallace. *Biofuel Economics and Policy: The Renewable Fuel Standard, the Blend Wall, and Future Uncertainties* Purdue University, West Lafayette, IN, USA. Available at <https://www.safaribooksonline.com/library/view/bioenergy/9780124079090/XHTML/B9780124079090000304/B9780124079090000304.xhtml>

²⁸ Environmental Protection Agency, *E15 (a blend of gasoline and ethanol)*. Available at <http://www.epa.gov/otaq/regs/fuels/additive/e15/index.htm>

²⁹ Ibid.

cars manufactured in the year 2000 or earlier, light-duty trucks, and medium-duty passenger vehicles.³⁰ These limitations on the practical use of E15 reduce its demand and broader use.

E85

E85 is a blend of 85 percent ethanol and 15 percent gasoline.³¹ E85 is heavily restricted and is only available for use in Flex Fuel Vehicles (FFVs) that are specifically designed to run on E85, gasoline, or a blend of both fuels.³² E85 cannot be used in gasoline-only, conventional engines of any kind. E85 also has limited availability nationwide, due to low demand and minimal distribution infrastructure.

However, much like E15, due to limitations in use that lower demand, E85 does not currently offer a reasonable pathway to overcome the limitations of the blend wall.

Important questions and key issues to be discussed at the hearing include:

- After ten years, has the overall economic and environmental impact of the RFS been positive or negative?
- What is the impact of the RFS on the price of fuel and food for American consumers?
- Would these costs increase if the RFS was enforced as outlined in the EISA? Would these costs decrease if the RFS was repealed?
- Is the U.S. transportation fuel market capable of absorbing higher volumes of E85 and E15 that will be necessary to meet future RFS requirements? What impact could those higher volumes have on consumer pricing?
- What is the environmental impact of increased use of biofuels, including the lifecycle emissions and impact on air quality? How do the lifecycle emissions of corn ethanol and cellulosic ethanol compare to gasoline?
- How do the current emissions from biofuels compare with emissions predicted by models before the RFS was enacted? What steps should the EPA take to correct existing emissions models?

³⁰ Ibid.

³¹ Environmental Protection Agency, *E85 and Flex Fuel Vehicles*, May 2010. Available at <http://www.epa.gov/otaq/fuels/renewablefuels/documents/420f10010a.pdf>

³² Ibid.

Chairman BRIDENSTINE. The Subcommittee on Environment and Oversight will come to order.

Without objection, the Chair is authorized to declare recesses of the Subcommittee at any time.

Welcome to today's hearing entitled the "Renewable Fuel Standard: A Ten-Year Review of Costs and Benefits." I recognize myself for five minutes for an opening statement.

Good morning, and welcome to today's joint hearing of the Environment and Oversight Subcommittees examining the Renewable Fuel Standard. Today, we will hear from witnesses on the cost and environmental impact of this complex and misguided mandate, as well as the future consequences if Congress does not take action.

The RFS is an example of the federal government picking winners and losers by forcing the use of renewables in transportation fuels. The mandate was supported by a bipartisan coalition, the ethanol industry, and environmental organizations; and justified by claims of environmental benefits and enhanced U.S. energy security.

Unfortunately, but not surprisingly, eight years after the current RFS was expanded by Congress as part of the Energy Independence and Security Act of 2007, these promises have yet to materialize. Congress designed the RFS using flawed projections about gasoline consumption, availability of renewable fuel infrastructure, bio-refinery technology, and the market demand for renewable fuels. In almost every category, these projections do not reflect today's energy market.

Today, demand for gasoline is significantly lower than was forecast when the RFS became law. A sluggish economy and improvements in vehicle energy efficiency continue to hold down gasoline consumption. And technology advancements have unlocked our domestic resources of oil and gas to an extent that was not anticipated when the RFS was designed.

Incorporating renewable fuels was supposed to deliver environmental benefits. But time and again, researchers, including one of our witnesses today, have found that corn ethanol produced to meet the RFS makes air quality worse, and has higher lifecycle emissions than gasoline. And while corn-based fuel ethanol production, supported by the requirements of this standard, has grown substantially since EISA became law, the advanced biofuels and cellulosic ethanol industries expected under the RFS still aren't ready for primetime.

The RFS is an egregious perversion of the free market. Instead of a transportation fuel market driven by consumer demand, we are stuck with a complex mandate based on outdated assumptions about gasoline demand, environmental impact, and technological readiness. Each year, the RFS requires still higher volumes of renewable fuel, which now exceed the volumes that can be accommodated given current gasoline demand.

The RFS mandate is unworkable even with EPA's dubious assertion that E15 can safely be used in select vehicles, even though most vehicles were designed to use E10, gasoline containing not more than ten percent ethanol. This is on top of the simple fact that consumers do not want these fuels. Just .5 percent of what

HollyFrontier—a merchant refiner with facilities in my district—sells are products greater than E10, one-half of one percent.

And because the ethanol blending volumes required under law are impossible to meet with the current production levels of E10, E15, and other higher level ethanol blends, including E85, refiners are left at the mercy of uncertain annual waivers from the EPA. I'm going to repeat that. Refiners are left at the mercy of uncertain annual waivers from the EPA to keep the mandatory blending volumes at achievable levels. When EPA even bothers to follow the law and announce annual requirements—and that is when EPA bothers to follow the law and announce annual requirements on time.

Refiners have had to file lawsuits to get the EPA to do their job and announce the annual blend levels, which is absurd. Congress cannot continue to sit back and leave the EPA to manage the consequences of an unrealistic and poorly crafted law.

So what is the end result of this confusing mandate? American consumers are stuck with higher prices across the economy. The mandate has already increased prices at the pump, and if the RFS is enforced as enacted, the Congressional Budget Office estimates that E10 fuel prices could increase by 15 percent or more by 2017.

By increasing demand for corn, the RFS also distorts commodity prices, raising the cost of food for American families. We will hear testimony that the RFS costs the chain restaurant industry \$3.2 billion a year in higher food prices, which must be passed on to consumers, our constituents.

The federal government's RFS mandate has led to multiple negative consequences, propelled by willful disregard for consumer preferences and flawed economic and environmental assumptions. Demand for fuels with blends of ethanol greater than E10 is very limited, even with the most favorable market conditions. And more corn ethanol hasn't helped the environment. It hasn't reduced costs or encouraged the development of commercial-scale advanced biofuels.

Federal mandates are the wrong approach to fuel innovation, and the RFS is a prime example of the elites in Washington, D.C., believing they know best, imposing a misguided standard, then standing back while it damages our economy.

I want to thank our witnesses today for testifying on the challenges of the RFS—testifying on the challenges the RFS has created in today's energy market, and I look forward to a discussion about the consequences caused by the federal government's intervention in the American energy market.

It's time for Congress to fix the problems caused by this outdated and ill-conceived law and pass legislation to repeal the RFS.

[The prepared statement of Chairman Bridenstine follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON ENVIRONMENT
CHAIRMAN JIM BRIDENSTINE

Good morning and welcome to today's joint hearing of the Environment and Oversight subcommittees, examining the Renewable Fuel Standard. Today, we will hear from witnesses on the cost and environmental impact of this complex and misguided mandate, as well as the future consequences if Congress does not take action.

The RFS is an example of the federal government picking winners and losers by forcing the use of renewables in transportation fuels. The mandate was supported by a bipartisan coalition, the ethanol industry, and environmental organizations, and justified by claims of environmental benefits and enhanced U.S. energy security.

Unfortunately, but not surprisingly, eight years after the current RFS was expanded by Congress as part of the Energy Independence and Security Act of 2007, these promises have yet to materialize. Congress designed the RFS using flawed projections about gasoline consumption, availability of renewable fuel infrastructure, bio-refinery technology, and the market demand for renewable fuels. In almost every category, these projections do not reflect today's energy market.

Today, demand for gasoline is significantly lower than was forecast when the RFS became law. A sluggish economy and improvements in vehicle energy efficiency continue to hold down gasoline consumption. And technology advancements have unlocked our domestic resources of oil and gas to an extent that was not anticipated when the RFS was designed.

Incorporating renewable fuels was supposed to deliver environmental benefits. But time and again, researchers—including one of our witnesses today - have found that corn ethanol produced to meet the RFS makes air quality worse, and has higher life cycle emissions than gasoline.

And while corn-based fuel ethanol production, supported by the requirements of this standard, has grown substantially since EISA became law, the advanced biofuels and cellulosic ethanol industries expected under the RFS still aren't ready for primetime.

The RFS is an egregious perversion of the free market. Instead of a transportation fuel market driven by consumer demand, we are stuck with a complex mandate based on outdated assumptions about gasoline demand, environmental impact, and technological readiness. Each year, the RFS requires still higher volumes of renewable fuel which now exceed the volumes that can be accommodated given current gasoline demand.

The RFS mandate is unworkable even with EPA's dubious assertion that E15 can safely be used in select vehicles, even though most vehicles were designed to use E10, gasoline containing not more than 10 percent fuel ethanol. This is on top of the simple fact that consumers do not want these fuels. Just 0.5 percent of what HollyFrontier, a merchant refiner with facilities in my district, sells are products greater than E10. One half of one percent!

And because the ethanol blending volumes required under law are impossible to meet with the current production levels of E10, E15, and other higher level ethanol blends, including E85, refiners are left at the mercy of uncertain annual waivers from the EPA to keep the mandatory blending volumes at achievable levels—when EPA even bothers to follow the law and announce annual requirements on time. Refiners have had to file lawsuits to get the EPA to do their job and announce the annual blend levels, which is patently absurd. Congress cannot continue to sit back and leave the EPA to manage the consequences of an unrealistic and poorly crafted law.

So what is the end result of this confusing mandate? American consumers are stuck with higher prices across the economy. The mandate has already increased prices at the pump, and if the RFS is enforced as enacted, the Congressional Budget Office estimates that E10 fuel prices could increase by 15 percent or more by 2017.

By increasing demand for corn, the RFS also distorts commodity prices, raising the cost of food for American families. We will hear testimony that the RFS costs the chain restaurant industry \$3.2 billion a year in higher food prices, which must be passed on to consumers, our constituents.

The federal government's RFS mandate has led to multiple negative consequences, propelled by willful disregard for consumer preferences and flawed economic and environmental assumptions. Demand for fuels with blends of ethanol greater than E10 is very limited, even in the most favorable market conditions. And more corn ethanol hasn't helped the environment, reduced costs, or encouraged the development of commercial scale advanced biofuels.

Federal mandates are the wrong approach to fueling innovation, and the RFS is a prime example of the elites Washington, DC believing they know best, imposing a misguided standard, then standing back while it damages our economy.

I want to thank our witnesses today for testifying on the challenges the RFS has created in today's energy market, and I look forward to a discussion about the consequences caused by the federal government's intervention in the American energy market.

It's time for Congress to fix the problems caused by this outdated and ill-conceived law, and pass legislation to repeal the RFS.

Chairman BRIDENSTINE. I now recognize the Ranking Member, the gentlewoman from Oregon, for an opening statement.

Ms. BONAMICI. Thank you very much, Mr. Chairman, and thank you to our witnesses for being here today to discuss the history and future of the Renewable Fuel Standard.

In 2005, Congress established the Renewable Fuel Standard as a way to both reduce our dependence on foreign oil and reduce greenhouse gas emissions. The RFS policy also had the added benefit of advancing rural economic development. In 2007, Congress expanded the RFS to drive additional innovation and investment in the biofuels industry. And now, ten years later, the original goals and motivation for the Renewable Fuel Standard still remain valid.

Despite this fact, we will hear today from some who will assert that the RFS is a failed policy and that it should be repealed. I respectfully disagree. Our nation's long-term economic and energy security is tied to our ability to diversify our energy portfolio and to transition to lower carbon energy sources.

Biofuels have an important part to play in this energy future. It would be better if we were further along, but the Renewable Fuel Standard has been, and should continue to be, a critical mechanism for fostering the development of this emerging industry.

In my home State of Oregon, we've recognized the significant opportunities in biofuels, especially with our State's strong agriculture and forestry industries. For example, Red Rock Biofuels is investing about \$200 million to build a biorefinery facility in southern Oregon where they will transform waste biomass from forests and sawmills into jet fuel. Now, that's a place that really needs the jobs, down there in southern Oregon. Red Rock plans to sell 6 million gallons of its renewable jet fuel each year to Southwest Airlines and FedEx Express. This type of innovation will greatly reduce the carbon footprint of our airlines and create jobs in an area that needs them.

Additionally, in my Congressional district, Summit Natural Energy converts food processing and agricultural wastes into bioethanol for racecars. And I've spoken with the racecar drivers. They rave about this product.

The potential of biofuels, especially advanced biofuels, in addressing climate change is real and it is something that we should be encouraging, not trying to undermine. Reducing carbon pollution from the transportation sector is critical in our fight against climate change, and the economic costs of not acting are catastrophic.

In fact, a recent report by Citigroup GPS shows that the costs of climate inaction could be up to \$44 trillion by 2060. We need to use a variety of mechanisms to curb greenhouse gases, and the RFS is one of these tools. Most recent estimates of the Argonne National Laboratory's Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation model have shown that corn ethanol can produce up to 48 percent less greenhouse gases than gasoline across the entire lifecycle.

Investments in first-generation biofuels are serving as an important bridge to the development of advanced biofuels, including cellulosic biofuels. Just last week, DuPont opened the world's largest cellulosic ethanol plant in Iowa. If done correctly in a sustainable

and thoughtful manner, we can produce biofuels that will lower carbon emissions of our transportation sector.

A viable competitive advanced biofuels industry relies on the infrastructure developed for the first-generation conventional biofuels. The RFS was designed to provide market certainty to drive the production of domestically produced biofuels. We have seen what an industry can do when given a strong market signal, a signal that the RFS can provide.

Overreliance on a limited range of technologies and finite resources is unreasonable. Our nation cannot drill our way to energy security and a thriving economy. We must continue to take steps to mitigate climate change. We need to unleash the creativity of our scientists, engineers, and entrepreneurs, and the Renewable Fuel Standard is an important tool in spurring innovation and unlocking our energy potential.

Thank you very much, Mr. Chairman. I look forward to hearing from the witnesses, and I yield back the balance of my time.

[The prepared statement of Ms. Bonamici follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON ENVIRONMENT
MINORITY RANKING MEMBER SUZANNE BONAMICI

Thank you, Mr. Chairman, and thank you to our witnesses for being here today to discuss the history and future of the renewable fuel standard.

In 2005, Congress established the renewable fuel standard as a way to both reduce our dependence on foreign oil and reduce greenhouse gas emissions. The RFS policy also had the added benefit of advancing rural economic development. In 2007, Congress expanded the RFS to drive additional innovation and investment in the biofuels industry. And now ten years later, the original goals and motivation for the renewable fuel standard still remain valid.

Despite this fact, we will likely hear from some today who will assert that the RFS is a failed policy and that it should be repealed. I respectfully disagree.

Our nation's long-term economic and energy security is tied to our ability to diversify our energy portfolio and to transition to lower carbon energy sources. Biofuels have an important part to play in this energy future. It would be better if we were further along, but the renewable fuel standard has been and should continue to be a critical mechanism for fostering the development of this emerging industry.

In my home state of Oregon, we have recognized the significant opportunities in biofuels, especially with our state's strong agriculture and forestry industries. For example, Red Rock Biofuels is investing about \$200 million to build a biorefinery facility in Southern Oregon, where they will transform waste biomass from forests and sawmills into jet fuel. Red Rock plans to sell 6 million gallons of its renewable jet fuel each year to Southwest Airlines and FedEx Express. This type of innovation will greatly reduce the carbon footprint of our airlines, and create jobs in areas that need them. Additionally, in my Congressional district, Summit Natural Energy converts food processing and agricultural wastes into bioethanol for race cars—and the drivers rave about it!

The potential of biofuels, especially, advanced biofuels, in addressing climate change is real and it is something that we should be encouraging, not trying to undermine. Reducing carbon pollution from the transportation sector is critical in our fight against climate change and the economic costs of not acting are catastrophic. In fact, a recent report by Citigroup GPS shows that the costs of climate inaction could be up to \$44 trillion by 2060. We need to use a variety of mechanisms to curb greenhouse gases—and the RFS is one of those tools. Most recent estimates of the Argonne National Laboratory's GREET (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) model have shown that corn ethanol can produce up to 48 percent less greenhouse gases than gasoline across the entire lifecycle.

Investments in first generation biofuels are serving as an important bridge to the development of advanced biofuels, including cellulosic biofuels. Just last week DuPont opened the world's largest cellulosic ethanol plant in Iowa. If done correctly—in a sustainable and thoughtful manner—we can produce biofuels that will lower the carbon emissions of our transportation sector.

A viable, competitive advanced biofuels industry relies on the infrastructure developed for the first generation conventional biofuels. The RFS was designed to provide market certainty to drive the production of domestically produced biofuels. We have seen what industry can do when given a strong market signal—a signal that the RFS can provide.

Overreliance on a limited range of technologies and finite resources is unreasonable. Our nation cannot drill our way to energy security and a thriving economy. We must continue to take steps to mitigate climate change. We need to unleash the creativity of our scientists, engineers, and entrepreneurs and the renewable fuel standard is an important tool in spurring innovation and unlocking our energy potential.

Thank you, Mr. Chairman, and again thank you to our witnesses for being here this morning. I yield back the balance of my time.

Chairman BRIDENSTINE. I'd like to thank the Ranking Member. I now recognize the Chairman of the Subcommittee on Oversight, Mr. Loudermilk, for his opening statement.

Mr. LOUDERMILK. Well, thank you, Mr. Chairman, and witnesses for being here with us today.

I'd like to thank you for taking your time to come here and discuss this extremely important matter that we're facing.

Today, we're here to examine the big-picture challenge of the Renewable Fuel Standard and its impact on our country and the American people. Ten years ago, supporters of the RFS promised to put our country on a path to being cleaner, greener, and more energy independent in a time of heavy dependence on foreign oil and high gas prices. Back then, gasoline consumption was on the rise, America relied on foreign oil, and renewable fuels were just starting to become an option for consumers.

Fast-forward to today where the demand for gasoline is decreasing, our country is now considering exporting crude oil, and we know that ethanol and biofuels are not as clean as we once thought.

In the Committee's hearing on the RFS this summer, we heard testimony from Dr. Jason Hill from the University of Minnesota, who debunked the misnomer that corn ethanol is cleaner than regular gasoline. Dr. Hill acknowledged that while ethanol fuels generally burn cleaner than gasoline at the tailpipe, if you look at the lifecycle emissions of ethanol, you can see that the process of growing and fermenting grain, and distilling, distributing, and combusting ethanol releases far more of the five particulate pollutants that contribute to increased particulate matter 2.5 and ozone levels than gasoline. In short, corn-based ethanol is simply not cleaner than gasoline.

Dr. DeCicco, who joins us today, has conducted careful analysis of more than 100 related studies concluding that serious flaws exist in the government-sponsored modeling used to justify the RFS. It comes as no surprise that the Office of Inspector General for the EPA announced this month that they are planning to investigate whether the EPA complied with the reporting requirements associated with the RFS. The IG will also be examining whether the EPA appropriately updated the lifecycle analysis supporting the RFS with findings from studies mandated in the statute on the environmental impacts of biofuels. We look forward to their findings.

It is also clear that the demand today for biofuels is far less than the EPA anticipated it would be. In our last hearing we heard from CountryMark, a farmer-owned integrated oil company that sells

E10, E15, and E85 fuel at its stations. This farmer-owned small business refiner cannot sell E85 to the very farmers who grow the corn used for the ethanol it's blended because there is no demand for this fuel.

It is also becoming clear that Americans are ill-equipped to make smart decisions about gasoline choices entering the marketplace. According to a recent study conducted by the Outdoor Power Equipment Institute, Americans choose to purchase gasoline based on price and simply don't pay attention to the warning labels placed at the pump. This results in consumers using fuels with higher blends of ethanol in lawnmowers, chainsaws, generators, and other small engine equipment that are not certified to use those fuels. This can cause damage or permanently destroy those products.

And with that, Mr. Chairman, I would like to enter into the record a letter from Todd Teske, President of Briggs & Stratton, which outlines these points in further detail.

Chairman BRIDENSTINE. Without objection, so ordered.

[The information appears in Appendix II]

Mr. LOUDERMILK. Finally, I want to thank our witnesses today for testifying on the impact that the RFS has on the American people. It's time for Congress to make a change. When existing law is unworkable, Congress must listen to experts and adjust the law as it is needed. I hope that this hearing will bring to light some of the unintended consequences of the RFS, and provide guidance to lawmakers as we decide the future of this law.

And with that, Mr. Chairman, I yield back balance of my time.
[The prepared statement of Mr. Loudermilk follows:]

PREPARED STATEMENT OF OVERSIGHT SUBCOMMITTEE
CHAIRMAN BARRY LOUDERMILK

Good morning everyone. I would like to welcome and thank all of our witnesses for being here today.

Today, we are here to examine the big picture challenge of the Renewable Fuel Standard and its impact on our country and the American people. Ten years ago, the RFS promised to put our country on a path to being cleaner, greener and more energy independent in a time of heavy dependence on foreign oil and high gas prices. Back then gasoline consumption was on the rise, America relied on foreign oil, and renewable fuels were just starting to become an option for consumers.

Fast forward to today where the demand for gasoline is decreasing, our country is now considering exporting crude oil, and we now know ethanol and biofuels are not as clean as we once thought.

In the Committee's hearing on the RFS this summer, we heard testimony from Dr. Jason Hill from the University of Minnesota, who debunked the misnomer that corn ethanol is cleaner than regular gasoline. Dr. Hill's work showed us that while ethanol fuels generally burn cleaner than gasoline at the tailpipe, if you look at the lifecycle emissions of ethanol you can see that growing and fermenting grain, and distilling, distributing, and combusting ethanol releases far more of the five major pollutants that contribute to increased PM 2.5 and ozone levels than gasoline. Corn-based ethanol is simply not cleaner than gasoline.

Dr. DeCicco who joins us today, has conducted careful analysis of more than 100 related studies concluding that serious flaws exist in the government-sponsored modeling used to justify the RFS. It comes as no surprise that the Office of Inspector General for the EPA announced this month they are planning to investigate whether the EPA complied with the reporting requirements associated with the RFS and whether the EPA appropriately updated the lifecycle analysis supporting the RFS with findings from statutorily mandated studies on the environmental impacts of biofuels. We look forward to their findings.

It is also clear that the demand today for biofuels is far less than the EPA anticipated they would be. In our last hearing we heard from CountryMark, a farmer-owned integrated oil company that sells E10, E15, and E85 fuel at its stations. This farmer-owned small business refiner cannot sell E85 to the very farmers who grow the corn used for the ethanol it's blended with because there is just no demand for this fuel.

It is also becoming clear that Americans are ill-equipped to make smart decisions about new gasoline choices entering the market place. According to a recent study conducted by the Outdoor Power Equipment Institute, Americans choose to purchase gasoline based on price, and simply don't pay attention to the warning labels placed at the pump. This results in consumers using fuels with higher blends of ethanol in lawnmowers, chainsaws, generators and other small engine equipment that are not certified to use those fuels. This can cause damage or permanently destroy those products. And with that, I would like to enter into the record a letter from Todd Teske, President of Briggs & Stratton, which outlines these points in further detail.

Finally, I want to thank our witnesses today for testifying on the impact that the RFS has on the American people. It's time for Congress to make a change. When existing law is unworkable, Congress must listen to experts, and adjust the law as it is needed. I hope that this hearing will bring to light some of the unintended consequences of the RFS, and provide guidance to lawmakers as we decide the future of this law.

Chairman BRIDENSTINE. Thank you, Chairman Loudermilk.

I now recognize the Ranking Member of the Subcommittee on Oversight, Mr. Beyer, for his opening statement.

Mr. BEYER. Thank you, Mr. Chairman.

And thank you, Chairmen Bridenstine and Loudermilk, for holding today's hearing, and thank you to the witnesses for testifying.

The greatest challenge of this generation—climate change—requires innovative solutions if we ever hope to make a meaningful difference. It requires us to look at every aspect of our energy production and consumption. We must find ways to end our dependence on fossil fuels and reduce our greenhouse gas emissions.

The Renewable Fuel Standard has helped us push the technological limits and the capacity of industry to innovate our transportation fuels. In the past ten years, we've seen increasing production of biofuels from both corn ethanol and advanced biofuels. And this increase has come with considerable advancements in how corn ethanol is produced, improving production efficiencies, while decreasing both the costs and the greenhouse gas emissions.

The Renewable Fuel Standard was designed to integrate all biofuels into our fuel supply and lay the groundwork for growth and development of advanced biofuels with a 50 percent reduction in greenhouse gas emissions compared to that of conventional gasoline. And I'm interested in learning more about the advancements in this area and where we can expect biofuels to be in the next ten years.

We realize there have been challenges. The EPA is prepared to finalize the volumetric requirements for 2014, 2015, 2016 next month while missing—or later this month—after missing the statutory deadline two years in a row. And while they're inundated with public comments during the proposal process, that doesn't excuse the lengthy delay.

The Agency has issued waivers for the required cellulosic biofuels and plans to do so again, but I hope that the proposed biometric obligations can be finalized by November 30 deadline, provide market certainty, and signals to investors that the United States in-

tends to be a world leader in the development and production of these advanced fuels.

With a wide-ranging body of research looking at every aspect of production and a range of stakeholders that have advocated for almost every different scenario available, we as lawmakers are left with difficult decisions to make. And I want to thank the witnesses again for providing expert testimony on this pressing topic.

Mr. Chairman, I yield back.

[The prepared statement of Mr. Beyer follows:]

PREPARED STATEMENT OF SUBCOMMITTEE ON OVERSIGHT
MINORITY RANKING MEMBER DON BEYER

Thank you Chairmen Bridenstine and Loudermilk for holding today's hearing and thank you to the witnesses for testifying.

The greatest challenge of this generation—climate change—requires innovative solutions if we ever hope to make a meaningful difference. It requires us to look at every aspect of our energy production and consumption. We must find ways to end our dependence on fossil fuels and reduce our greenhouse gas emissions.

The Renewable Fuel Standard has helped to push the technological limits and the capacity of industry to innovate our transportation fuels. In the past ten years we have seen increasing production of biofuels from both corn ethanol and advanced biofuels. This increase has come with considerable advancements in how corn ethanol is produced, improving production efficiencies while decreasing both costs and greenhouse gas emissions.

The Renewable Fuel Standard was designed to integrate all biofuels into our fuel supply and lay the groundwork for the growth and development of advanced biofuels with at least a 50% reduction in greenhouse gas emissions compared to that of conventional gasoline. I am interested in hearing more about the advancements in this area and where we can expect biofuels to be in the next ten years.

All of this does not go without saying that there have been challenges. The Environmental Protection Agency is prepared to finalize the volumetric requirements for 2014, 2015, and 2016 next month, after missing the statutory deadline two years in a row. While inundated with public comments during the proposal process, it does not excuse this lengthy delay. The agency has issued waivers for the required cellulosic biofuels and plans to do so again. I hope the proposed volumetric obligations can be finalized by the November 30th deadline to provide market certainty and signal to investors that the U.S. intends to be a world leader in the development and production of these advanced fuels.

With a wide ranging body of research looking at every aspect of production and a range of stakeholders that have advocated for almost every different scenario available, we as lawmakers are left with difficult decisions to make. Thank you again to the witnesses for providing expert testimony on this pressing topic.

Thank you Mr. Chairman.

Chairman BRIDENSTINE. Thank you, Mr. Beyer.

Let me introduce our witnesses. Our first witness today is Dr. Terry Dinan, Senior Adviser at the Congressional Budget Office. Dr. Dinan received her bachelor's degree from John Carroll University and her Ph.D. in economics from Iowa State University.

Our next witness is Mr. Ed Anderson, President and CEO of WEN-GAP, LLC. Mr. Anderson received his bachelor's degree from Guilford College and currently owns 11 Wendy's franchises.

Our third witness today is Dr. John DeCicco, Research Professor at the University of Michigan Energy Institute. Dr. DeCicco received his bachelor's degree in mathematics from Catholic University, his master's degree in mechanical engineering from North Carolina State University, and his Ph.D. in mechanical engineering from Princeton University.

Our fourth witness today is Mr. Brooke Coleman, Executive Director of the Advanced Biofuels Business Council. Mr. Coleman re-

ceived his bachelor's degree from Wesleyan University and his law degree from Northeastern.

Our final witness today is Mr. Charles Drevna, Distinguished Senior Fellow at the Institute for Energy Research. Mr. Drevna has over 40 years of extensive experience in legislative, regulatory, public policy, and marketplace issues involving energy and the environment. Prior to joining IER, he served as President of the American Fuel and Petrochemical Manufacturers. Mr. Drevna received his bachelor's degree in chemistry from Washington and Jefferson College.

I now recognize Dr. Dinan for five minutes to present her testimony.

**TESTIMONY OF DR. TERRY DINAN,
SENIOR ADVISOR, CONGRESSIONAL BUDGET OFFICE**

Dr. DINAN. Good morning, Chairmen Bridenstine, Chairman Loudermilk, Ranking Member Bonamici, Ranking Member Beyer, and members of the committee. Thank you for the opportunity to testify about the Renewable Fuel Standard. This testimony updates a Congressional Budget Office's report on the RFS, which was published in June 2014.

The RFS establishes minimum volumes of various types of renewable fuels that suppliers must blend into the U.S. transportation fuel supply. Those volumes, as defined by the Energy Independence and Security Act of 2007, or EISA, are intended to grow each year through 2022. To date, the requirements of the RFS have been met largely by blending gasoline with ethanol made from cornstarch. In the future, EISA requires use of increasingly large amounts of advanced biofuels, which include diesel made from biomass, ethanol made from sugarcane, and cellulosic biofuels.

CBO concludes that the rising requirements of EISA would be very hard to meet in the future because of two main obstacles. First, making cellulosic biofuels is complex and costly. Second, the increasing requirement for the total gallons of renewable fuels would push the average concentration of ethanol and gasoline to well above ten percent, the maximum concentration that is feasible in order to avoid corrosion damage in older vehicles.

Because of those challenges, EPA has been scaling back the requirements of EISA. That strategy decreases compliance costs in the short run, but it also reduces incentives for companies to invest in the production capacity for advanced biofuels and to expand the availability of high ethanol blends.

CBO also examined how prices for food and fuel would vary in an illustrative year, 2017, based on three scenarios. The first, the 2016 volume scenario, is one in which the EPA would keep the RFS requirements for 2017 at the same amounts it has proposed for 2016. The second, the EISA volume scenario, is one in which fuel suppliers would have to meet the total requirements for renewable fuels and for advanced biofuels that are stated in EISA for 2017 but not the requirement for cellulosic biofuels. The final scenario was one in which lawmakers would immediately abolish the RFS.

CBO found that food prices would be similar under the three scenarios. To the extent that the RFS increased the demand for corn

ethanol, it would raise corn prices and put upward pressure on prices of foods made with corn.

Under the EISA volume scenario, CBO estimated—sorry. Under the EISA volume scenario, CBO estimated that the resulting increase in the demand for corn would raise the average price of corn by about three percent relative to the 2016 volume scenario. However, because corn and food made with corn account for only a small fraction of total U.S. spending on food, that total spending would only increase by about 1/10 of 1 percent.

The effect that repealing the RFS would have on the price of corn is limited because suppliers would probably find it cost-effective to use a roughly ten percent blend of corn ethanol in gasoline in 2017 even in the absence of the RFS. As a result, CBO estimates that, in comparison with the 2016 volume scenario, repealing the RFS would cause food prices to fall by less than 1/10 of 1 percent.

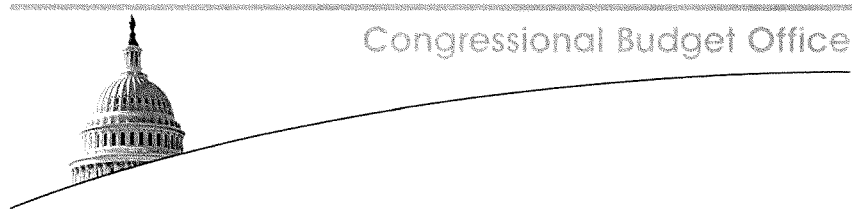
In contrast, CBO found that the prices of transportation fuels would vary significantly under the three scenarios. Compared with the 2016 volume scenario, we found that complying with the EISA volume scenario would increase the price of petroleum-based diesel by 25 cents to 45 cents per gallon. We also estimated that the price of E10, a blend of fuel that contains up to ten percent ethanol and which is currently the most commonly used transportation fuel in the United States, would rise by 15 cents to 30 cents.

CBO found that complying with the EISA volume scenario would reduce the price of E85, a blend containing up to 85 percent ethanol, by roughly 80 cents to \$1.20.

Finally, compared with the 2016 volume scenario, CBO estimates that repealing the RFS would have only small effects on fuel prices. Specifically, we estimate that repealing the RFS would have essentially no effect on the 2017 price of E10, would lower the price of petroleum-based diesel by roughly 5 cents, and would increase the price of E85 by about 15 cents.

Thank you again for this opportunity to testify, and I will be happy to answer any questions that you might have on CBO's analysis.

[The prepared statement of Dr. Dinan follows:]



Testimony

The Renewable Fuel Standard: Issues for 2015 and Beyond

**Terry Dinan
Senior Advisor**

**Before the
Subcommittee on Environment and the
Subcommittee on Oversight
Committee on Science, Space, and Technology
U.S. House of Representatives**

November 3, 2015

*This document is embargoed until it is delivered at
10:00 a.m. (EST) on Tuesday, November 3, 2015. The
contents may not be published, transmitted, or otherwise
communicated by any print, broadcast, or electronic
media before that time.*

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Chairman Bridenstine, Chairman Loudermilk, Ranking Member Bonamici, Ranking Member Beyer, and Members of the Committees, thank you for the opportunity to testify about the Renewable Fuel Standard. This testimony updates the Congressional Budget Office's report from 2014 on that topic.¹

Summary

The Renewable Fuel Standard (RFS) establishes minimum volumes of various types of renewable fuels that suppliers must blend into the United States' supply of fuel for transportation. Those volumes—as defined by the Energy Independence and Security Act of 2007 (EISA)—are intended to grow each year through 2022. In recent years, the requirements of the RFS have been met largely by blending gasoline with ethanol made from cornstarch. In the future, EISA requires the use of increasingly large amounts of “advanced biofuels,” which include diesel made from biomass (such as soybean oil or animal fat), ethanol made from sugarcane, and cellulosic biofuels (made from converting the cellulose in plant materials into fuel).

Policymakers and analysts have raised concerns about the RFS, including whether complying with the standard will be feasible, whether it will increase prices for food and transportation fuels, and whether it will lead to the intended reductions in greenhouse gas emissions. Because of those concerns, some policymakers have proposed repealing or revising the Renewable Fuel Standard.

In this testimony, CBO assesses how much the supply of various types of renewable fuels would have to increase over the next several years to comply with the RFS. CBO also examines how prices for food and fuel would vary in an illustrative year, 2017, under three scenarios for the Renewable Fuel Standard:

- *The 2016 volumes scenario*, in which the Environmental Protection Agency (EPA)—which implements the RFS and has some discretion to modify the mandates of EISA—would keep the RFS requirements for 2017 at the same amounts it has proposed for 2016;

- *The EISA volumes scenario*, in which fuel suppliers would have to meet the total requirement for renewable fuels, the requirement for advanced biofuels, and the cap on corn ethanol that are stated in EISA for 2017—but not the requirement for cellulosic biofuels, because the capacity to produce enough of those fuels is unlikely to exist by 2017; and

- *The repeal scenario*, in which lawmakers would immediately abolish the RFS.

The repeal scenario would require Congressional action. In the absence of such action (or of legal restrictions), CBO considers the 2016 volumes scenario much more likely than the EISA volumes scenario, which would require a large and rapid increase in the use of advanced biofuels and would cause the total percentage of ethanol in the nation's gasoline supply to rise to levels that would require significant changes in the infrastructure of fueling stations. As a result, CBO uses the 2016 volumes scenario as a reference case against which to measure the effects of the other two scenarios. If EPA used its discretion to set standards for volume in 2017 lower (or higher) than the proposed 2016 volumes, then the effects of repealing the RFS on food and fuel prices would be correspondingly smaller (or larger).

Full Compliance With the Mandates in EISA Poses Significant Challenges

The rising requirements in EISA would be very hard to meet in future years because of two main obstacles, which relate to the supply of cellulosic biofuels and the amount of ethanol that older vehicles are said to be able to tolerate. Fuel suppliers have had trouble meeting the annual requirements for cellulosic biofuels because making such fuels is complex, capital-intensive, and costly. Although production capacity is expanding, only a few production facilities are currently operating. The industry's capacity in coming years is projected to fall far short of what would be necessary to achieve the very rapid growth in the use of cellulosic biofuels required by EISA.

Ethanol is the most common form of renewable fuel; however, adding increasing volumes of it to the U.S. fuel supply could be difficult. Currently, most gasoline sold in the United States is actually a blend (referred to as E10) that contains up to 10 percent ethanol—the maximum concentration that is feasible to avoid corrosion damage to the fuel systems of older vehicles. EISA's increasing requirements for the total gallons of renewable fuels to be used each year, combined with a projected decline in

1. Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), www.cbo.gov/publication/45477.

gasoline use, suggest that the average concentration of ethanol in gasoline would have to rise to well above that 10 percent “blend wall,” potentially increasing to about 25 percent by 2022. More ethanol could be accommodated in the fuel supply if motorists who drive “flex-fuel” vehicles, which can run on blends that contain as much as 85 percent ethanol (referred to as E85), bought larger amounts of such fuel. But at present, only a little more than 2 percent of filling stations in the United States sell high-ethanol blends.

Because of the challenges described above, EPA has been eliminating or greatly reducing the annual requirements for cellulosic biofuels, advanced biofuels, and total renewable fuels in its final and proposed rules in recent years. Although scaling back those standards addresses existing compliance problems and decreases compliance costs in the short run, it also reduces incentives for companies to invest in production capacity for cellulosic and other advanced biofuels and to expand the availability of high-ethanol blends.

Using the Total Volumes of Advanced Biofuels Specified in EISA Would Require Extremely Large Increases in the Production of Those Fuels

For the scenario in which fuel suppliers would have to comply with the total volumes of advanced biofuels and of renewable fuels as a whole stated in EISA, CBO assumed that EPA would allow suppliers to substitute other forms of advanced biofuels for cellulosic biofuels, as it has done in the past. Fuel suppliers would probably do so by using two types of advanced biofuels: biomass-based diesel (mostly produced in the United States) and sugarcane ethanol (nearly all imported from Brazil). However, relying on that strategy for 2017 would necessitate extremely large increases in the production of those fuels. For example, even a 60 percent increase in the projected U.S. production of biomass-based diesel in 2017 and a 50 percent increase in Brazil’s projected production of sugarcane ethanol would not provide enough additional gallons of advanced biofuels to meet the higher volumes required in the EISA volumes scenario than in the 2016 volumes scenario.

Food Prices Would Be Similar Whether the RFS Was Continued or Repealed

Roughly 40 percent of the U.S. corn supply is used to make ethanol. To the extent that the Renewable Fuel Standard increases the demand for corn ethanol, it will raise corn prices and put upward pressure on the prices of

foods made with corn—ranging from corn-syrup sweeteners to meat, poultry, and dairy products. Corn ethanol use in 2017 would be about 7 percent (or 1 billion gallons) higher under the EISA volumes scenario than under the 2016 volumes scenario. CBO estimates that the resulting increase in the demand for corn would raise the average price of corn by about 3 percent. However, because corn and food made with corn account for only a small fraction of total U.S. spending on food, that total spending would increase by about 0.1 percent.

CBO expects that, if lawmakers repealed the RFS, the amount of corn ethanol used in 2017 would be smaller by less than 1 billion gallons than if the 2017 requirements were equal to EPA’s proposed 2016 volumes. Suppliers would probably find it cost-effective to use a roughly 10 percent blend of corn ethanol in gasoline in 2017 even in the absence of the RFS. Therefore, food prices would be only slightly lower in 2017 (by less than 0.1 percent) if the RFS was repealed than under the 2016 volumes scenario.

Compared With the 2016 Volumes Scenario, Meeting the Requirements in the EISA Volumes Scenario Would Have Significant Effects on Prices of Transportation Fuels

Under the EISA volumes scenario, fuel suppliers would have to use more than twice as many gallons of advanced biofuels than under the 2016 volumes scenario, and they would have to add much more ethanol to the gasoline supply than could be accommodated by selling only a 10 percent blend. The cost of boosting consumption of high-ethanol blends (such as E85) would fall on the producers and consumers of gasoline and diesel. Specifically, the policy would increase the price of petroleum-based fuels and lower-ethanol blends (such as E10) while lowering the price of E85. (Under both scenarios, CBO anticipates that EPA would sharply reduce the requirement for cellulosic biofuels, given the limited production capacity for those fuels expected to exist in 2017.)

In this analysis, CBO used a range of estimates of the price premium necessary to encourage sufficient additional supplies of advanced biofuels and the price subsidy necessary to motivate sufficient sales of E85. The agency estimates that, compared with the 2016 volumes scenario, complying with the EISA volumes scenario would have the following effects on the prices—rounded to the nearest 5 cents—of three key types of transportation fuels in 2017:

CBO.

- The price of petroleum-based diesel would rise by 25 cents to 45 cents per gallon;
- The price of E10—which is currently the most commonly used transportation fuel in the United States—would increase by 15 cents to 30 cents per gallon; and
- The price of E85 would decline by 80 cents to \$1.20 per gallon.

Because the changes in the production and use of renewable fuels required under the EISA volumes scenario are so large—and because little information is available about how the supply of and demand for renewable fuels respond to changes in their price—those estimates are highly uncertain. Actual price changes could fall outside the ranges described above.

Compared With the 2016 Volumes Scenario, Repealing the RFS Would Have Very Modest Effects on Prices of Transportation Fuels

CBO estimates that repealing the RFS would have only small effects on prices in comparison with the 2016 volumes scenario. Specifically, CBO estimates that repealing the RFS would have essentially no effect on the 2017 price of E10, would lower the 2017 price of petroleum-based diesel by roughly 5 cents, and would increase the 2017 price of E85 by about 15 cents. The effect on fuel prices of repealing the RFS is limited because a significant quantity of renewable fuels would continue to be used even in the absence of the mandate.

Overview of the Renewable Fuel Standard and Its Implementation

Lawmakers enacted the Renewable Fuel Standard in 2005 and expanded its requirements in 2007 in the Energy Independence and Security Act. The standard is imposed on suppliers (generally refiners or importers) of gasoline and diesel fuels used for transportation. It aims to foster greater use of fuels made from plants, plant products, and other renewable sources, thereby reducing the United States' dependence on petroleum and the greenhouse gas emissions that are released when petroleum-based fuels are burned and contribute to climate change. EISA requires that the emissions associated with a gallon of renewable fuel be at least a certain percentage lower than the emissions associated with the gasoline or diesel fuel that the renewable fuel replaces. Advanced

biofuels and the subcategory of cellulosic biofuels are required to meet more stringent emission standards than those that apply to corn ethanol. The Environmental Protection Agency is charged with implementing the standard and ensuring compliance.

What the RFS Requires

The Energy Independence and Security Act sets minimum volumes of renewable fuels that suppliers must blend into the nation's supply of transportation fuel each year. Except for corn ethanol made in certain facilities, the renewable fuels used to comply with the RFS must be certified by EPA as having greenhouse gas emissions that are at least 20 percent lower than the emissions associated with the fuels that they replace. The total minimum volume of renewable fuels specified in EISA rises each year through 2022 (see Figure 1) and EISA requires that an increasing share of that volume be met with advanced biofuels, which must have greenhouse gas emissions that are at least 50 percent lower than those of conventional fuels.

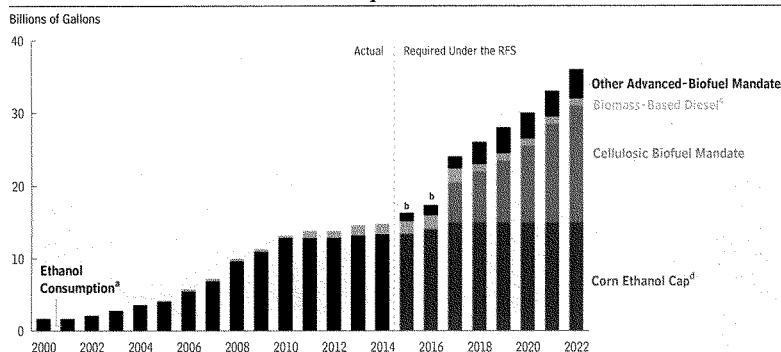
So far, fuel suppliers have been able to comply with the RFS largely by blending gasoline with corn ethanol, which is made from the starch in corn kernels. By 2022, EISA requires the use of 36 billion gallons of renewable fuels. Of those, at least 21 billion gallons must be advanced biofuels, including the following:

- At least 16 billion gallons of cellulosic biofuels, which are made from the cellulose in various plant materials, including grasses and corn stover (the residue left after corn is harvested). Cellulosic biofuels must have greenhouse gas emissions that are at least 60 percent lower than their petroleum-based counterparts.
- At least 1 billion gallons of biomass-based diesel (typically made from soybean or other vegetable oils). EPA has the discretion to set the mandate for biomass-based diesel at a higher level.²

The other 4 billion gallons (or less) can consist of any type of advanced biofuel that meets the 50-percent-lower

2. Unless otherwise indicated, the amounts of biomass-based diesel discussed in this report are measured in "compliance-equivalent gallons." Under EISA, 1 gallon of biomass-based diesel is considered equivalent to 1.5 gallons of ethanol for purposes of complying with the RFS.

Figure 1.
Past Use of Renewable Fuels and Future Requirements of the Renewable Fuel Standard



Source: Congressional Budget Office based on data for 2000 to 2014 from Energy Information Administration, *Monthly Energy Review*, DOE/EIA-0035(2015/10) (October 2015), www.eia.gov/totalenergy/data/monthly, and requirements for 2015 to 2022 from the Energy Independence and Security Act of 2007; and EPA, "Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017: Proposed Rule," Federal Register vol. 80, no. 111 (June 10, 2015).

Note: EPA = Environmental Protection Agency; RFS = Renewable Fuel Standard.

- Most of the ethanol used in the United States in the past consisted of corn ethanol, although relatively small amounts of sugarcane ethanol and other types of advanced biofuels, either produced domestically or imported, were also used.
- The requirements shown for 2015 and 2016 are those recently proposed by EPA, which are lower than those called for under EISA. EPA has proposed reducing the requirement for cellulosic biofuels from 3 billion gallons to 1.06 billion gallons in 2015 and from 4.25 billion gallons to 2.06 billion gallons in 2016; reducing the requirement for advanced biofuels from 5.5 billion gallons to 2.9 billion gallons in 2015 and 7.25 billion gallons to 3.4 billion gallons in 2016; and, by reducing the mandate for total renewable fuels from 20.5 billion gallons to 16.3 billion gallons in 2015 and 22.25 billion gallons to 17.4 billion gallons in 2016, EPA proposes to reduce the cap on the amount of corn ethanol that can be used to meet the total requirement for renewable fuels from 15 billion gallons in 2015 and 2016 to 13.4 billion gallons in 2015 and 14 billion gallons in 2016. EPA has also proposed increasing the requirement for biomass-based diesel from 1 billion gallons to 1.7 billion gallons in 2015, to 1.8 billion gallons in 2016, and to 1.9 billion gallons in 2017.
- The amounts of biomass-based diesel shown here for 2018 and later years reflect the minimum requirement of 1 billion gallons specified in EISA. EPA will set the actual requirement for each year through future rulemaking.
- The cap on corn ethanol represents the maximum amount of such ethanol that can be used to meet the total requirement for renewable fuels under EISA.

emission standard, such as noncellulosic ethanol made from sugarcane.

The portion of the RFS that does not have to be met with advanced biofuels—in 2022, up to 15 billion gallons—can be met with other qualifying renewable fuels, such as corn ethanol. Thus, the requirements for cellulosic biofuels and for biomass-based diesel are nested within the requirement for advanced biofuels, which in turn is nested within the overall requirement for renewable fuels.³

The total volume of renewable fuels mandated by EISA increases much faster than the projected growth in the use of gasoline and diesel. As a result, under the RFS, renewable fuels would make up a greater share of the U.S. supply

3. Cellulosic feedstocks can be used to make diesel or gasoline as well as to make biofuels. A gallon of cellulosic diesel would count toward satisfying either the cellulosic biofuel mandate or the biomass-based diesel mandate.

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of transportation fuel over time, rising from about 7 percent in 2013 to about 18 percent in 2022 (see Figure 2).

How EPA Implements the RFS

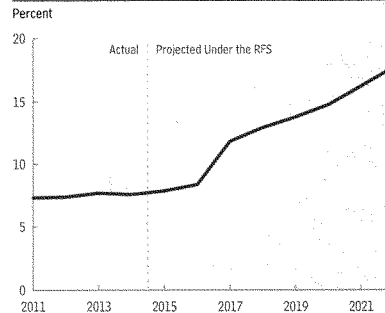
To ensure that fuel suppliers use the mandated volumes of renewable fuels, the Environmental Protection Agency translates the yearly volume requirements in EISA into percentage standards (sometimes called blend requirements) that are based on projections of the total amount of gasoline and diesel that will be used in that year. For example, if the projected amount was 100 billion gallons and the total renewable fuel requirement was 14 billion gallons, EPA would set a 14 percent blend requirement. Further, if the nested mandates for advanced biofuels and for biomass-based diesel were 4 billion gallons and 2 billion gallons, respectively, EPA would establish a 4 percent blend requirement for advanced biofuels and a 2 percent requirement for biomass-based diesel.

To monitor suppliers' compliance with the requirements, EPA assigns a unique "renewable identification number" (RIN) to each qualifying gallon of renewable fuel. Every RIN includes a code that identifies which of the four RFS requirements—for total renewable fuels, advanced biofuels, cellulosic biofuels, or biomass-based diesel—the gallon satisfies. Each fuel supplier, regardless of what kind of fuel it produces or imports, must meet all of the blend requirements for a given compliance year. The supplier can do that by using the required amounts of renewable fuels itself and submitting the corresponding RINs to EPA to demonstrate compliance, by purchasing RINs from other suppliers that have excess RINs to sell, by submitting RINs that it acquired in the previous year and saved for future use, or by borrowing RINs that it expects to acquire in the following year.⁴ With the hypothetical requirements above, each fuel supplier would have to submit 14 RINs (including 4 for advanced biofuels and 2 for biomass-based diesel) for each 100 gallons of gasoline or diesel that it sold. Suppliers with excess biomass-based diesel RINs could either sell them or apply them toward their advanced-biofuel requirement.

4. If a fuel supplier that is obligated to meet the RFS is out of compliance at the end of a year (after accounting for its RINs and its use of renewable fuels), EPA may fine the supplier as much as \$32,500 per day, plus the savings to the supplier that result from its noncompliance. Those penalties are specified in sections 205 and 211(d) of the Clean Air Act, 42 U.S.C. §§7524, 7545(d) (2013).

Figure 2.

Renewable Fuels as a Share of the Total U.S. Supply of Transportation Fuels

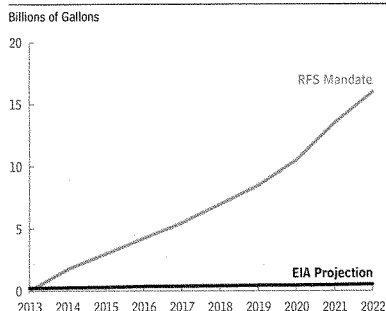


Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015) (April 2015), www.eia.gov/forecasts/aeo, and *Monthly Energy Review*, DOE/EIA-0035(2015/10) (October 2015), www.eia.gov/totalenergy/data/monthly.

Notes: CBO's calculations are based on the Energy Information Administration's (EIA's) most recent projections of the use of blended gasoline and diesel fuel and EPA's recent proposal to modify 2015 through 2017 mandates specified in the Energy Independence and Security Act of 2007 (EISA). EIA projects that in 2022, less renewable fuel will be used than required under the mandates specified in EISA. For the analysis in this figure, CBO assumed that total use of renewable fuels would rise to the level mandated by that law, although total energy consumption of transportation fuels would remain the same. In addition, because part of the overall mandate for renewable fuels will be met with biomass-based diesel and the specific requirement for such diesel is set annually, CBO assumed that consumption of biomass-based diesel is equal to the mandated volume proposed by EPA for years 2015 to 2017. CBO also assumed that consumption of biomass-based diesel in later years would be equal to either 1.28 billion gallons (the current requirement, which is equal to 1.92 billion compliance-equivalent gallons for the purposes of meeting the total mandate for renewable fuels) or 25 percent of the requirement for advanced biofuels, whichever is greater.

EPA = Environmental Protection Agency; RFS = Renewable Fuel Standard.

Figure 3.
Projected Use of Cellulosic Biofuels,
Compared With the Use Mandated by the
Renewable Fuel Standard



Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2013, With Projections to 2040*, DOE/EIA-0383(2013) (April 2013, EIA's most recent publicly available long-term projection of cellulosic biofuel use), Figure 100, www.eia.gov/forecasts/archive/aeo13, and Regulation of Fuels and Fuel Additives: 2013 Renewable Fuel Standards, 78 Fed. Reg. 49794 (August 15, 2013), <https://federalregister.gov/a/2013-19557>.

Notes: The Energy Independence and Security Act of 2007 set annual requirements for cellulosic biofuels starting in 2010; however, the Environmental Protection Agency virtually eliminated the requirements before 2013 because of a lack of commercial production capacity for cellulosic biofuels.

EIA = Energy Information Administration; RFS = Renewable Fuel Standard.

Challenges in Meeting the Renewable Fuel Requirements of EISA

Complying with the Renewable Fuel Standard has raised several challenges, and EPA has modified the requirements of the RFS in past years in response to them. In particular, meeting the requirements for advanced biofuels specified in the Energy Independence and Security Act has posed two difficulties:

- The supply of cellulosic biofuels is limited because such fuels are complex and expensive to produce.

- The use of renewable fuels is constrained by a practical limit on the total amount of ethanol that can be blended into the fuel supply, given the technologies used by older vehicles and the existing fueling-station infrastructure. That limit was not a significant constraint in the past, but it is becoming one as the requirements of EISA increase and the use of transportation fuel grows more slowly than anticipated.

The way in which EPA has responded to those challenges has made it less costly for fuel suppliers to comply with the RFS. But at the same time, that response has lessened the incentives that the RFS provides for investment in renewable fuel infrastructure and for the development of improved technologies for producing advanced biofuels.

Limited Supply of Cellulosic Biofuels

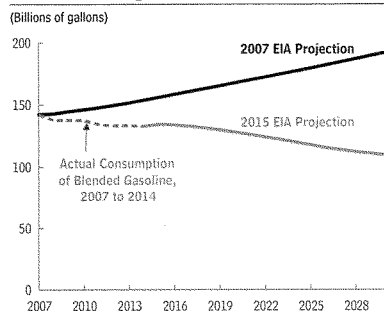
To date, the greatest challenge in meeting the requirements specified in EISA has been the small supply of cellulosic biofuels. The industry that produces those fuels is in its infancy, and the volumes required by EISA far outstrip the projected growth in the industry's production capacity. EISA first set requirements for cellulosic biofuels in 2010, mandating the use of 100 million gallons in that year and larger amounts in each subsequent year. Before 2013, however, no commercial plants to produce cellulosic biofuels were in operation, and EPA virtually eliminated the requirements until that year.

By the middle of 2015, four commercial plants had begun making cellulosic biofuels, and half a dozen more plants are expected to begin operating by 2017. Even so, the gap between production capacity and the volumes of cellulosic biofuels mandated in EISA is expected to widen quickly. The Energy Information Administration forecasts that production of cellulosic biofuels will increase only to 327 million gallons by 2022, a small fraction of the 16 billion gallons required by EISA in that year (see Figure 3).⁵

Production capacity has been slow to expand for several reasons. Producing ethanol from cellulose is more complex than producing it from cornstarch, entails higher

5. See Energy Information Administration, *Annual Energy Outlook 2013, With Projections to 2040*, DOE/EIA-0383(2013) (April 2013), Figure 100, www.eia.gov/forecasts/archive/aeo13. (This is EIA's most recent publicly available long-term projection of cellulosic biofuel use.)

Figure 4.
Changing Expectations About the
Future Consumption of Blended Gasoline



Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2007, With Projections to 2030*, DOE/EIA-0383(2007) (February 2007), www.eia.gov/oiaf/archive/aeo07, and *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015) (April 2015), www.eia.gov/forecasts/aeo.

Note: EIA = Energy Information Administration.

capital costs, and poses logistical problems. For example, commercial-scale use of cellulosic feedstocks requires that systems and equipment be developed to harvest the often-bulky materials and transport them to production facilities; for year-round production, seasonal feedstocks would also require ample storage space.

Difficulties in Using the Required Volume of Renewable Fuels

Ten percent is effectively the maximum ethanol content that blended fuel can contain and still be used by virtually all vehicles now on the road. That limit protects vehicles built before 2001, whose engines and fuel systems are thought to be vulnerable to corrosion from ethanol concentrations greater than 10 percent. For that reason, 10 percent constitutes a practical constraint, or blend wall, on how much ethanol most blended gasoline can accommodate. Many states limit ethanol concentrations to 10 percent, except in fuels intended for flex-fuel vehicles, which can run on blends of as much as 85 percent ethanol.⁶

The challenges posed by the blend wall are expected to increase. When EISA was enacted, in 2007, use of blended gasoline in the United States totaled about 140 billion gallons a year and was projected to grow (see Figure 4). Thus, rising requirements for renewable fuels were not expected to raise concerns about the blend wall. Instead of growing, however, use of blended gasoline has declined slightly, to about 137 billion gallons a year, and the Energy Information Administration now projects that it will fall to about 127 billion gallons in 2022 and then continue to drop, to around 108 billion gallons per year by 2040.⁷ (The agency's 2007 projection did not anticipate the decline in total annual vehicle-miles traveled and the increase in average fuel economy that have since occurred.)

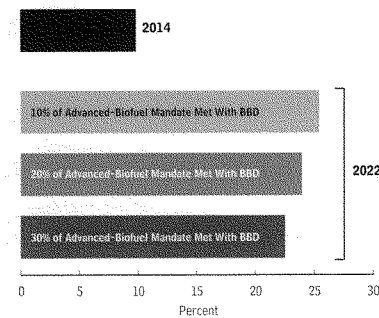
If the latest projections prove accurate, the renewable fuel requirements of EISA will gradually increase the average ethanol content of the U.S. gasoline supply (including high-ethanol blends for flex-fuel vehicles) to well above 10 percent. Using illustrative assumptions about the extent to which fuel suppliers would comply with the requirement for advanced biofuels by using biomass-based diesel, CBO estimates that full compliance with the EISA mandates could require the average ethanol content of blended gasoline to reach about 25 percent by 2022 (see Figure 5). For retail gasoline markets to accommodate that much ethanol—while limiting the ethanol content of the blended gasoline that most drivers use to 10 percent—a very large increase in the use of high-ethanol blends would be necessary.

One possibility for raising the total amount of ethanol that the market can accommodate is to boost both the number of flex-fuel vehicles on the road and the extent to which drivers of those vehicles refuel with E85 rather than with conventional blends, such as E10. Flex-fuel technology is relatively inexpensive—adding a few hundred dollars to

6. Flex-fuel vehicles are identical to ordinary passenger vehicles except for slight differences in their fuel systems and, in many cases, an identifying badge on a fender or rear panel. According to the Department of Energy, many owners of flex-fuel vehicles are not aware that their vehicles can run on blends of more than 10 percent ethanol. See Department of Energy, "Alternative Fuels Data Center—Flexible Fuel Vehicles" (October 3, 2013), www.afdc.energy.gov/vehicles/flexible_fuel.html.

7. See Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015), www.eia.gov/forecasts/aeo/.

Figure 5.
Ethanol as a Percentage of Blended Gasoline
Under Different Assumptions About the
Future Use of Biomass-Based Diesel



Source: Congressional Budget Office based on Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015) (April 2015), www.eia.gov/forecasts/aeo.

Notes: CBO's calculations are based on the Energy Information Administration's most recent projection of the use of blended gasoline. CBO's estimate of the percentage of ethanol in blended gasoline depends on how much biomass-based diesel is used to comply with the mandate for advanced biofuels. In evaluating the effects of different amounts of use, CBO assumed that the total energy consumption of blended gasoline would remain the same.

BBD = biomass-based diesel.

the manufacturing cost of a new vehicle—and many such vehicles are currently on the road because automobile manufacturers received compliance credits under the Corporate Average Fuel Economy (CAFE) standards for selling flex-fuel vehicles (even if drivers of those vehicles never actually fill up their tanks with E85). However, substantially increasing the use of E85 would also require increasing the number of filling stations that offer such fuel. Only a little more than 2 percent of stations in the United States currently sell E85, although the number has been rising steadily in recent years (it grew fivefold between 2005 and 2014, to more than 2,650 stations).⁸ The Biofuel Infrastructure Partnership, a new initiative funded by the Department of Agriculture, with matching funds provided by 21 states and private entities—aims to nearly double the number of renewable-fuel pumps in the United States.⁹ Another factor limiting sales of E85 is its

price: Although E85 costs less than regular E10 gasoline, it also has a lower energy content, meaning that it offers fewer miles per gallon. Drivers who could use E85 would be willing to buy it only if its price was low enough relative to the price of E10 to compensate for its lower energy content and potentially for the need to drive farther to find an E85 fueling station.

Although consumption of E85 has been expanding rapidly in recent years, it still accounts for only a tiny fraction of the fuel that passenger vehicles use. Recent projections indicate that annual consumption of E85 will reach just 0.6 billion gallons by 2022 (and 1.1 billion gallons by 2024), out of a total of 127 billion gallons of blended gasoline projected to be used in that year.¹⁰

Another possibility for raising the average concentration of ethanol in the fuel supply above 10 percent is to make blended gasoline with up to 15 percent ethanol content (E15) widely available. EPA has certified that vehicles built since 2001—roughly 80 percent of vehicles now on the road—can run on E15 without risking corrosion damage to their fuel lines and engine parts.¹¹ Many automakers disagree and have discouraged their customers from using E15.¹² However, some major manufacturers—including

8. See U.S. Department of Energy, Alternative Fuels Data Center, "Ethanol Fueling Station Locations" (accessed October 30, 2015), www.afdc.energy.gov/fuels/ethanol_locations.html. See also Kristi Moriarty, "E85 Deployment" (presentation prepared for the Energy Information Administration's biofuels workshop by the National Renewable Energy Laboratory, March 20, 2013), www.eia.gov/biofuels/workshop/presentations/2013.

9. See Department of Agriculture, "Biofuel Infrastructure Partnership—State Table" (accessed November 1, 2015), <http://igo.usa.gov/caqrz>.

10. See Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015), www.eia.gov/forecasts/aeo/.

11. See Oak Ridge National Laboratory, *Transportation Energy Data Book* (September 2015), Chapter 3, Tables 3.8 and 3.9, <http://cta.ornl.gov/data/chapter3.shtml>.

12. Industry groups challenged EPA's certification of E15 in court. In 2013, the Supreme Court dismissed those challenges, which prompted the Alliance of Automobile Manufacturers to assert that "vehicles [built since 2001] were never designed to run on this more corrosive fuel. Automakers continue to urge consumers to check their owner's manuals for the recommended fuel to use safely in their vehicles." See Alliance of Automobile Manufacturers, "Alliance Response to Supreme Court Decision Today to Dismiss Challenges to EPA's E15 Decision" (June 24, 2013), <http://tinyurl.com/q8am8eg>.

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Ford and General Motors—have stated that their models from 2012 or 2013 and later can use E15 without risk.

Experience with vehicles running on E15 has been limited because, until mid-2012, no filling stations offered that fuel. In recent years, the Department of Agriculture provided funding (through the Rural Energy for America Program) for installing pumps that can dispense either E10 or E15; currently, a small number of stations have E15 pumps.¹³ But because filling stations that would like to offer both blends would incur costs to acquire new pumps and underground storage tanks, the growth of E15 sales is expected to be slow. In addition, some station owners may be concerned about potential liability claims arising from drivers who inadvertently refuel a pre-2001 vehicle with E15.

A final possibility for addressing the blend wall is to rely more on “drop-in” fuels made from cellulose. The same sorts of cellulosic feedstocks that are used to make biofuels can also be used to produce gasoline or diesel. Those drop-in fuels are identical to conventionally made gasoline and diesel and can substitute for them in full, rather than having to be blended into conventional fuel. The technologies for making any kind of cellulosic fuel are new, however, and production remains costly. (In addition, only a fraction of the cellulosic production plants projected to open in the next few years are expected to make drop-in fuels.) Nevertheless, to the extent that production of cellulosic gasoline and diesel grows, using more of those drop-in fuels can increase the renewable content of the nation’s supply of transportation fuel without exacerbating concerns about the blend wall.

EPA’s Response to Compliance Challenges

The Energy Independence and Security Act requires that EPA evaluate the Renewable Fuel Standard’s requirements each year and adjust them, if necessary, on the basis of market conditions. EPA’s response to the gap between the RFS mandate governing use of cellulosic biofuels and actual production of those fuels has been to use its waiver authority to significantly alter that mandate.

For 2010, the first year the cellulosic biofuel mandate was in effect, EPA reduced the requirement of 100 million gallons stated in EISA to 6.5 million gallons—the target that fuel suppliers could meet using RINs they had obtained in previous years by exceeding those years’

requirements. (The earlier requirements were based on a broader definition of cellulosic biofuels, as described in the Energy Policy Act of 2005.) For 2011 and 2012, EPA initially reduced the cellulosic biofuel mandates significantly. However, after negligible production of cellulosic biofuels in those years and court challenges by the petroleum industry, EPA eliminated the mandate for 2012 and has retroactively proposed doing so for 2011, but the proposal has not yet been officially accepted.¹⁴ In addition, the agency lowered the 2013 requirement from 1 billion gallons to less than 1 million gallons (reflecting the industry’s production capacity in that year).¹⁵ EPA did not also reduce the requirements for total renewable fuels or for advanced biofuels when it lowered those cellulosic mandates; fuel suppliers were able to make up for the lack of cellulosic biofuels mainly by using biomass-based diesel and noncellulosic ethanol made from sugarcane.¹⁶

EPA has proposed reducing the cellulosic biofuel requirement from 1.75 billion gallons to 33 million gallons for 2014, from 3 billion gallons to 106 million gallons for 2015, and from 4.25 billion gallons to 206 million gallons for 2016.¹⁷ (Although EPA announced its proposal for the 2014 requirement in November 2013 and revised the proposal in June 2015, it has not yet issued a final rule. Under the proposed rule, the compliance deadline for the 2014 mandate would be June 1, 2016.) The proposed rule for 2014 marks the first time that EPA has also proposed decreasing the RFS mandates on total advanced

14. For the legal decision about the 2012 mandate, see *API v. EPA*, 706 F.3d 474 (D.C. Cir. 2013). For a discussion of the proposed repeal for 2011, see Environmental Protection Agency, *EPA Proposes Renewable Fuel Standards for 2014, 2015, and 2016, and the Biomass-Based Diesel Volume for 2017*, EPA-420-F-15-024 (May 2015), Table 1, p. 3, <http://go.usa.gov/cxheto> (PDF, 233 KB).

15. See Environmental Protection Agency, *EPA Issues Direct Final Rule for 2013 Cellulosic Standard*, EPA-420-F-14-018 (April 2014), <http://go.usa.gov/9rd3> (PDF, 151 KB).

16. EPA has not relieved suppliers of their compliance obligations for those years but instead has allowed them to satisfy the obligations in a different way. Specifically, whenever EPA has reduced the RFS mandate on cellulosic biofuels, it has offered credits for sale to fuel suppliers in an amount equal to the new, revised mandate. If suppliers plan to substitute some other advanced biofuel for cellulosic biofuel, they must buy a waiver credit from EPA as well as the gallon of that other fuel. EPA determines the price of waiver credits on the basis of the previous year’s wholesale price of gasoline.

17. See Environmental Protection Agency, *EPA Proposes Renewable Fuel Standards for 2014, 2015, and 2016, and the Biomass-Based Diesel Volume for 2017*, EPA-420-F-15-024 (May 2015), Table 1, p. 3, <http://go.usa.gov/cxheto> (PDF, 233 KB).

13. See Department of Energy, Alternative Fuels Data Center, “E15” (June 16, 2015), www.afdc.energy.gov/fuels/ethanol_e15.html.

biofuels and total renewable fuels: Those requirements would shrink by more than 1 billion gallons and by over 2 billion gallons, respectively (from 3.75 billion to 2.68 billion gallons of advanced biofuels and from 18.15 billion to 15.93 billion gallons of renewable fuels). EPA has made similar reductions in its proposals for 2015 and 2016. EPA's proposals reflect concern that the total renewable fuel requirements in EISA would cause the average ethanol content of the nation's gasoline supply to exceed the 10 percent concentration that many non-flex-fuel vehicles can use. To maintain a proportional cap on the use of corn ethanol, EPA has also proposed reducing the portion of the RFS that does not have to be met with advanced biofuels (for example, reducing it from 14.4 billion to 13.25 billion gallons in 2014).

The annual mandates for cellulosic biofuels specified in EISA through 2022 are so much greater than the industry's projected capacity that EPA will probably continue to reduce the mandate every year, rather than impose large fines on fuel suppliers that cannot meet the requirement because the fuels are not available. However, granting fuel suppliers a waiver for cellulosic biofuels is likely to have the unintended effect of slowing the growth of production capacity for such fuels by weakening incentives for the private sector to invest in building that capacity. Similar effects would occur for other advanced biofuels if the mandates for those fuels were reduced. In addition, if EPA continues to lower the annual requirements for total renewable fuels to avoid exceeding the blend wall, it will lessen incentives to expand the number of filling stations that offer E85, even though such expansion would help retail gasoline markets accommodate more ethanol in the fuel supply.

The Use of Renewable Fuels Under Three Scenarios

To illustrate how the Renewable Fuel Standard—and potential changes to it—might affect the use of renewable fuels over the next several years, CBO estimated the amount of renewable fuels that would be consumed in 2017 under three alternative scenarios: if the requirements for 2017 were set at the amounts currently proposed for 2016, if fuel suppliers had to comply with the requirements stated in EISA (other than the cellulosic biofuel mandate), and if lawmakers immediately repealed the RFS.

2016 Volumes Scenario

For the 2016 volumes scenario, CBO assumed that the requirements for various types of renewable fuels in 2017 would be set at the same volumes that EPA has proposed for 2016. Total U.S. consumption of transportation fuels is projected to be similar in 2017 and 2016, so this scenario would make the Renewable Fuel Standard about as stringent in 2017 as it would be in 2016.

In the absence of Congressional action or legal restrictions, CBO considers this scenario much more likely than the EISA volumes scenario, which would require a large and rapid increase in the use of advanced biofuels and would cause the total percentage of ethanol in the gasoline supply to rise to levels that would require significant changes in the infrastructure of fueling stations.

Under the 2016 volumes scenario, fuel suppliers would be required to use the following in 2017 (see Table 1):

- 17.4 billion gallons of renewable fuels in all, including
- 3.4 billion gallons of advanced biofuels, of which 2.7 billion compliance-equivalent gallons would have to be biomass-based diesel, and
- No more than about 14 billion gallons of corn ethanol.

Under this scenario, fuel suppliers would have to use about 700 million gallons of advanced biofuels in addition to 2.7 billion gallons of biomass-based diesel (reported here in compliance equivalent gallons and corresponding to 1.8 physical gallons). Suppliers would probably meet that requirement by using slightly more biomass-based diesel (which is a subcategory of advanced biofuels) than required and by importing some sugarcane ethanol.

EISA Volumes Scenario

The EISA volumes scenario represents what would be likely to occur if, for 2017, EPA did not alter the total requirement for renewable fuels, the advanced-biofuel mandate, the biomass-based diesel mandate, and the corn ethanol cap specified in EISA—for example, if the courts or lawmakers prevented EPA from making such modifications.

Table 1.
Use of Renewable Fuels in 2017 Under Three Alternative Scenarios for the Renewable Fuel Standard

	2016 Volumes Scenario ^a		EISA Volumes Scenario ^b		Repeal Scenario ^c Estimated Volume (Billions of gallons)
	Volume Requirement (Billions of gallons)	Blend Requirement (Percent) ^d	Volume Requirement (Billions of gallons)	Blend Requirement (Percent) ^d	
Advanced Biofuels					
Biomass-based diesel ^e	2.7	1.5	3.0	1.6	About 1
Other advanced biofuels	0.7	0.4	6.0	3.4	f
Subtotal	3.4	1.9	9.0	5.0	About 1
Corn Ethanol	14.0	g	15.0	g	13.4 ^h
Total Renewable Fuels	17.4	9.6	24.0	13.3	14 to 15

Source: Congressional Budget Office based on section 202 of the Energy Independence and Security Act of 2007; Renewable Fuel Standard Program, 80 Fed. Reg. 33100 (proposed June 10, 2015); and Energy Information Administration, *Annual Energy Outlook 2015: With Projections to 2040* (April 2015), www.eia.gov/forecasts/aeo.

- For this scenario, CBO assumed that the 2017 requirements for renewable fuels would be set at the same volumes that EPA has proposed for 2016. Thus, the 0.7 billion gallons of other advanced biofuels would have to include at least 206 million gallons of cellulosic biofuels. Total use of transportation fuels in the United States is projected to be similar in 2017 and 2016, so this scenario would make the Renewable Fuel Standard about as stringent in 2017 as it would be in 2016.
- For this scenario, CBO assumed that fuel suppliers would have to comply with the total requirement for renewable fuels and the cap on corn ethanol that are specified for 2017 in the Energy Independence and Security Act of 2007 (EISA). Those requirements mean that fuel suppliers would also be required to use 9 billion gallons of advanced biofuels, with specific quantities consisting of biomass-based diesel and cellulosic biofuels. The Environmental Protection Agency (EPA) has not yet specified the requirement for biomass-based diesel for 2017 (EISA mandates that it be at least 1.5 billion gallons, measured in compliance-equivalent gallons). For illustrative purposes, CBO assumed that fuel suppliers would be required to use 2.0 billion gallons of biomass-based diesel (which count as 3.0 billion compliance-equivalent gallons)—slightly more than EPA has required under the proposed rule for 2016. The 6.0 billion gallons of advanced biofuels not composed of biomass-based diesel would include a minimum quantity of cellulosic biofuels, which has not yet been specified by EPA.
- For this scenario, CBO assumed that lawmakers would repeal the Renewable Fuel Standard in 2015, so fuel suppliers would not be subject to any requirements for the use of renewable fuels in 2017.
- EPA translates the annual volume requirements in EISA into percentage blend requirements using projections of the total amount of gasoline and diesel that will be used in a given year. Those requirements specify the percentages of various renewable fuels that suppliers must blend into gasoline or diesel to comply with the EISA mandates. CBO estimated the percentage requirements for 2017 using the relationship between the volume requirements and blend requirements that EPA calculated for 2016 (because total U.S. consumption of gasoline and diesel is projected to be similar in those two years).
- Figures for biomass-based diesel are measured in compliance-equivalent gallons. Under EISA, 1 gallon of biomass-based diesel is considered equivalent to 1.5 gallons of other types of advanced biofuels or of corn ethanol for the purposes of complying with the Renewable Fuel Standard. EPA's proposed standard for 2016 is 1.8 billion gallons of biomass-based diesel, which would equal 2.7 billion compliance-equivalent gallons.
- If lawmakers repealed the Renewable Fuel Standard, fuel suppliers would probably continue to use small quantities of other advanced biofuels in addition to biomass-based diesel. Those quantities would include sugarcane ethanol used to meet state requirements for renewable fuel use as well as the small amounts of cellulosic biofuels that would continue to be produced at existing plants.
- The volume specified for corn ethanol is an upper limit on its use rather than a minimum requirement, so EPA does not calculate a percentage blend requirement for corn ethanol.
- This figure is based on the expectation that corn ethanol will make up roughly 10 percent of the 134 billion gallons of blended gasoline projected to be used in the United States in 2017.

Under the EISA volumes scenario, fuel suppliers would be required to use the following in 2017:

- 24 billion gallons of renewable fuels in all, including
- 9 billion gallons of advanced biofuels, of which roughly 3 billion compliance-equivalent gallons would have to be biomass-based diesel,¹⁸ and
- No more than 15 billion gallons of corn ethanol.

In addition to those requirements, EISA mandates that 5.5 billion gallons of the advanced-biofuel requirement be met by using cellulosic biofuels. For this scenario, CBO assumed that EPA would continue to reduce the requirement for cellulosic biofuels to the amount that could be made from available production capacity—projected by the Energy Information Administration to be about 170 million gallons in 2017—and that fuel suppliers would be allowed to use other types of advanced biofuels to make up the remaining volume for the advanced-biofuel mandate.

The requirements of EISA outlined above imply that fuel suppliers would have to use 5.6 billion more gallons of advanced biofuels of some sort in 2017 than would be required under the 2016 volumes scenario. What types of fuel they would use to meet that goal is highly uncertain. To date, no more than 500 million additional gallons of advanced biofuels have been required under finalized rules (beyond the mandate for biomass-based diesel).¹⁹ Suppliers have met that requirement by using slightly more biomass-based diesel than required and by importing sugarcane ethanol. Increasing the use of those types of advanced biofuels enough to use the additional 5.6 billion gallons of advanced biofuels required under the EISA

volumes scenario (relative to the 2016 volumes scenario)—especially over just a few years—would probably be challenging and costly. For example, consider the following illustrative increases in advanced biofuels:

- The Energy Information Administration currently projects that the United States will use roughly 2.5 billion gallons of biomass-based diesel (measured in compliance-equivalent gallons) in 2017 and expects annual consumption to remain constant through 2040.²⁰ To use an additional 1.5 billion compliance-equivalent gallons of biomass-based diesel would mean a 60 percent increase in the projected supply of that fuel, which would most likely require a significant increase in its price.
- To import an additional 3 billion gallons of sugarcane ethanol from Brazil (the primary source of the sugarcane ethanol used in the United States) would require a 50 percent increase in Brazil's production from the amount projected for 2017.²¹ Fostering such a large increase in production in a short time would be difficult—and would probably require a significant increase in the price of sugarcane ethanol—given the time lags involved in planting and harvesting a perennial crop such as sugarcane and the need for additional production capacity and transportation infrastructure.²²

Even such large boosts in supply would leave more than 1 billion gallons to be filled by other types of advanced biofuels. Rising prices for advanced biofuels could

18. EISA allows EPA to set the requirement for biomass-based diesel at a volume not lower than 1 billion gallons. Each gallon of biomass-based diesel provides 1.5 RINs for the purposes of complying with the advanced-biofuel requirement, so the requirement for 1 billion gallons accounts for 1.5 billion gallons of compliance. EPA has not yet set that volume for 2017. For illustrative purposes, CBO assumed that it would be 3 billion compliance-equivalent gallons, only slightly more than the 2016 requirement.

19. In calculating that gap, CBO accounted for the fact that each gallon of biomass-based diesel provides 1.5 RINs for the purposes of complying with the advanced-biofuel requirement. So far, the largest gap occurred in 2012, when the requirement for advanced biofuels was set at 2 billion gallons and the requirement for biomass-based diesel was set at 1 billion gallons (1.5 billion on a compliance-equivalent basis).

20. See Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015), www.eia.gov/forecasts/aeo/.

21. That figure is CBO's estimate based on Energy Information Administration, *International Energy Outlook 2014, With Projections to 2040*, DOE/EIA-0484(2014) (September 2014), www.eia.gov/forecasts/ieo/.

22. Some industry observers have speculated that larger U.S. imports of sugarcane ethanol from Brazil could be achieved not by encouraging increased production in Brazil but by exchanging sugarcane ethanol made in that country for corn ethanol made in the United States. (That type of swap has already taken place to a limited degree, as discussed in Energy Information Administration, *Biofuels Issues and Trends*, October 2012, www.eia.gov/biofuels/issuestrends/.) CBO did not estimate the cost of that approach because it would impose large logistical challenges, and such an exchange would not increase the global use of advanced biofuels but would consume scarce resources and produce additional greenhouse gas emissions to transport the swapped ethanol supplies.

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encourage the production of new supplies based on additional feedstocks, such as sorghum. However, at present, little information exists to project how large such supplies would be and how they could become available by 2017.

Repeal Scenario

The repeal scenario represents CBO's assessment of what would happen if lawmakers immediately eliminated the RFS. Under that scenario, fuel suppliers would have no requirements to use specific types or amounts of renewable fuels, and they would use such fuels only to the extent that doing so was cost-effective for them.

CBO estimates that in the absence of the Renewable Fuel Standard, in 2017 fuel suppliers would use roughly 1 billion gallons of biomass-based diesel (measured in compliance-equivalent gallons) or about 1.7 billion gallons less than the amount required in the 2016 volumes scenario. Although data are limited, the agency estimates that 1 billion gallons is about the amount of biomass-based diesel that could be cost-effectively produced in 2017 in the absence of the RFS mandates—primarily that which can be made from food waste. About half of the less than 2 billion gallons of biomass-based diesel fuel produced in 2013 was made from soybean oil, but available evidence suggests that the cost of producing diesel from soybean oil is higher than the wholesale price of petroleum-based diesel.²³ In contrast, biomass-based diesel produced from food waste would probably remain cost-effective even without the incentives created by the RFS because the materials are generally available at a relatively low cost.²⁴ If the other half of the 2013 production came from food waste and the amount of waste available for such production increased somewhat between 2013 and 2017, the amount of biomass-based diesel that could be cost-effectively produced would increase to roughly 1 billion gallons.

Consumption of corn ethanol would be 13.4 billion gallons under the repeal scenario, CBO estimates. Because

ethanol is expected to cost less per gallon than gasoline in 2017, fuel suppliers would probably find it profitable to use 13.4 billion gallons of ethanol in that year—the volume that corresponds to the maximum blend of ethanol in gasoline (10 percent) that virtually all vehicles now on the road can use.²⁵ Even if ethanol did not have a price advantage, it would probably continue to be in demand to some extent because of its other benefits. In particular, adding ethanol helps suppliers ensure that their fuel meets emission limits for carbon monoxide (an air pollutant regulated by EPA) and octane requirements (for improved vehicle performance).

Over the longer term, the effect of a repeal on the use of ethanol could be greater. For example, the per-gallon price of corn ethanol might rise above that of gasoline, causing fuel suppliers to reduce the concentration of ethanol in gasoline below current levels. Another possibility is that future advances in technology could allow the development of cost-effective octane-enhancing substitutes for ethanol, which could cause fuel blenders to favor the use of those substitutes. If so, ethanol consumption under the repeal scenario could fall short of that under the other scenarios by growing amounts.

Prices and Spending for Food Under Three Scenarios

To the extent that the Renewable Fuel Standard raises the demand for ethanol made from cornstarch, it will increase corn prices and thus prices for the wide variety of foods that are produced with corn—ranging from corn syrup sweeteners to meat, dairy, and poultry products.²⁶ Some policymakers have expressed concern about the size of those potential price increases and their effects on households' food spending. Although food prices depend on many uncertain factors, CBO's analysis suggests that

23. See Scott Irwin and Darrel Good, "Recent Trends in Biodiesel Prices and Production Profits" (Department of Agricultural and Consumer Economics, University of Illinois Urbana-Champaign, September 18, 2013), <http://farmlanddaily.illinois.edu/2013/09/>; and Don Hofstrand, "Tracking Biodiesel Profitability" (Iowa State University Extension and Outreach, July 2012), <http://tinyurl.com/pwvx3ac>.

24. See Ralph Groschen, *Overview of the Feasibility of Biodiesel From Waste/Recycled Greases and Animal Fat* (Minnesota Department of Agriculture, October 2002), <http://tinyurl.com/l6222gh> (PDF, 319 KB).

25. For expectations that ethanol will cost less per gallon than gasoline in 2017, see CME Group, "RBOB Gasoline Futures" and "CBOT Denatured Fuel Ethanol Futures" (accessed October 30, 2015), www.cmegroup.com. Although the current futures price of ethanol are somewhat higher than those of gasoline per British thermal unit (Btu) of energy content, analysts generally believe that for blends of 10 percent ethanol or less, fuel suppliers make choices based on the per-gallon cost of the two fuels rather than the per-Btu cost. See Scott Irwin and Darrel Good, "Ethanol Blending Margins, RFS2 Compliance, and the Price of Gasoline" (AgFax, April 3, 2012), <http://tinyurl.com/qjdtg7>.

26. For an earlier study on that topic, see Congressional Budget Office, *The Impact of Ethanol Use on Food Prices and Greenhouse Gas Emissions* (April 2009), www.cbo.gov/publication/41173.

differences in food prices and spending under the agency's three scenarios for the RFS would probably be small. Specifically, expenditures on food would be slightly higher under the EISA volumes scenario than under the 2016 volumes scenario. CBO estimates that, compared with the 2016 volumes scenario, the increase in the demand for corn stemming from the increased production of corn ethanol under the EISA volumes scenario would boost spending on food by about \$1.6 billion in 2017, or by roughly 0.1 percent of the approximately \$1.8 trillion in spending on food expected in 2017.²⁷ Alternatively, CBO estimated that total U.S. food expenditures in 2017 would be slightly lower if the RFS was repealed than under the 2016 volumes scenario—by roughly \$1.0 billion, or less than 0.1 percent of spending on food.²⁸

How the RFS Affects the Use of Corn Ethanol

A key consideration when evaluating the effect of the renewable fuel mandates on food prices is the extent to which the use of corn ethanol differs among the scenarios. As described above, CBO expects that the use of corn ethanol would be about 7 percent (1 billion gallons) higher if fuel suppliers had to meet the 2017 requirements specified in EISA (15 billion gallons of corn ethanol) than in the 2016 volumes scenario. If, by contrast, the RFS was repealed, CBO estimates that ethanol consumption in the repeal scenario would be about 4 percent (about 600 million gallons) lower. Changes in the quantity of ethanol used—either higher or lower—in turn affects the demand for corn.

How the Demand for Corn Ethanol Affects the Price of Corn

Of the U.S. corn supply, roughly 10 percent is used for food products, 40 percent for animal feed, and 40 percent for ethanol production (the rest is exported). Thus,

27. An increase in the prices of certain types of food would cause consumers to reduce the amount of those foods that they purchased. But because the effects on food prices in this analysis are small, any reduction in the amounts of certain types of food consumed would also be small, and it would be offset at least in part by increased consumption of other types of food. Thus, CBO's calculations reflect the assumption that the increase in food prices would not affect the total quantity of food purchased.

28. The calculations used in this analysis are described in Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), Appendix, www.cbo.gov/publication/45477.

any significant change in the demand for corn ethanol that resulted from the RFS could have a noticeable effect on corn prices. The extent to which corn prices would be affected would depend on how sensitive the supply of and demand for corn are to changes in its price. Analysts have produced a range of estimates for that sensitivity (known as an elasticity). Using estimates that are in the middle of that range, CBO projects that consuming 15 billion gallons of corn ethanol as called for in the EISA volumes scenario would raise corn prices in 2017 by 12 cents per bushel relative to prices in the 2016 volumes scenario (an increase of roughly 3 percent). Alternatively, consuming 600 million fewer gallons of corn ethanol under the repeal scenario in comparison with the 2016 volumes scenario would lower corn prices in 2017 by about 7 cents per bushel (roughly 2 percent). Those estimates take into account the extent to which higher prices in the EISA volumes scenario (or lower prices in the repeal scenario) would boost (or lower) corn production and reduce (or raise) nonethanol uses of corn (such as for food or animal feed), both of which would limit some of the changes in price that would otherwise result.

The difference in corn prices between the repeal scenario and the 2016 volumes scenario could be larger over the longer term. If, after the repeal of the RFS, the ethanol content of the gasoline supply fell below 10 percent, the gap between ethanol use under the 2016 volumes scenario and the repeal scenario would widen. As a result, differences in the consumption of corn ethanol, and thus in the price of corn, between those scenarios would grow over time.

How the Price of Corn Affects the Cost of Food and Federal Spending Programs

Changes in corn prices affect food prices directly because of the large variety of food products that contain corn. Changes in corn prices would also operate indirectly through two different mechanisms. First, higher prices for corn used as animal feed would lead to price increases for meat, poultry, and dairy products. Second, higher corn prices would cause farmers to produce corn in place of other crops, such as soybeans, and decreased production of those crops would in turn raise their prices. Lower prices for corn would have the opposite effect: Lower prices for corn lead to decreases in prices for meat, poultry, and dairy products and for crops planted in place of corn.

Changes in food prices could affect federal programs that are linked to those prices, such as the Supplemental Nutrition Assistance Program, or SNAP (formerly known as Food Stamps), and various programs that provide meals to children at school and in other settings. Once a year, the government adjusts the benefits paid under SNAP and the child nutrition programs on the basis of shifts in food prices. As a result, changes in food prices would lead to roughly proportionate changes in spending on such benefits. Spending for farm price and income support programs also would be affected by changes in the price of corn. A higher corn price would probably lead to lower spending for those programs, whereas a lower corn price would increase such spending for a given program year.

Prices of Transportation Fuels Under Three Scenarios

The Renewable Fuel Standard boosts the use of renewable fuels by requiring fuel suppliers to obtain a specific number of RINs (with each RIN corresponding to a gallon of renewable fuel that has been blended into the fuel supply) for every gallon of petroleum-based gasoline or diesel that they use. How that requirement affects the prices of various fuels depends on a fuel's composition of petroleum-based and renewable elements. To better understand the potential size of those effects over the next several years, CBO estimated how the price of diesel fuel and E10—the two most commonly consumed transportation fuels—and the price of E85 would differ in 2017 among its three scenarios for the RFS.

The 2016 Volumes Scenario

Earlier this year EPA proposed RFS mandates for 2014, 2015, and 2016, with volume requirements gradually increasing each year. To implement the Renewable Fuel Standard, EPA translates the volume requirements into percentage blend requirements, which equal the mandated volume of each category of renewable fuel divided by the projected volume of gasoline and diesel that is subject to EISA, as discussed above. Those percentage obligations are applied to each fuel supplier's actual sales of gasoline and diesel to determine the number of RINs that the supplier must submit. Fuel suppliers obtain RINs by purchasing qualifying gallons of renewable fuels and blending them into the fuel they sell or by purchasing RINs from suppliers that have accumulated excess RINs by using more renewable fuel than the RFS requires.

Compliance Requirements. Given the percentage blend requirements of the 2016 volumes scenario, for each 100 gallons of diesel or gasoline that a fuel supplier used in 2017, it would need to submit 9.6 RINs to EPA, of which 1.9 would have to qualify as advanced biofuels (shown in Table 1 on page 11). Of those 1.9 advanced-biofuel RINs, at least 1.5 would have to be biomass-based diesel RINs. Thus, taking into account the nested nature of the standard, for each 100 gallons of diesel or gasoline it used, a fuel supplier would have to submit the following to EPA:

- 1.5 biomass-based diesel RINs,
- 0.4 advanced-biofuel RINs (the total of 1.9 advanced-biofuel RINs minus the 1.5 met by biomass-based diesel), and
- 7.7 renewable fuel RINs (the total of 9.6 renewable fuel RINs minus the 1.9 advanced-biofuel RINs).

RIN Prices. Given the increase in volume requirements, for the purposes of this analysis, CBO estimated that complying with the 2016 volumes scenario in 2017 would result in RIN prices that are slightly more than 10 percent higher than those observed most recently.²⁹ Specifically, CBO estimated that RIN prices would be roughly as follows:

- 40 cents for a renewable RIN (those generated by corn ethanol),
- 55 cents for an advanced biomass-based diesel RIN, and
- 55 cents for an advanced biofuel RIN (generated by biomass-based diesel or other form of advanced biofuel, such as sugarcane ethanol).

CBO used those RIN prices to calculate the effects of the EISA volumes scenario and the repeal scenario on 2017 fuel prices relative to the 2016 volumes scenario.

The EISA Volumes Scenario

If EPA set the total requirement for renewable fuels and the cap on corn ethanol at the 2017 volumes stated in EISA, fuel suppliers would have to use about 6.6 billion

29. This is consistent with current RIN prices rising at a real (inflation-adjusted) annual rate of roughly 5 percent.

gallons more than they would use under the 2016 volumes scenario (including about 5.6 billion additional gallons of advanced biofuels).

Compliance Requirements. Given the percentage blend requirements of the EISA volumes scenario, for each 100 gallons of diesel or gasoline that a fuel supplier used in 2017, it would need to submit 13.3 RINs to EPA, of which 5 would have to qualify as advanced biofuels. Of those 5 advanced-biofuel RINs, at least 1.6 would have to be biomass-based diesel RINs. Thus, taking into account the nested nature of the standard, for each 100 gallons of diesel or gasoline it used, a fuel supplier would have to submit the following to EPA:

- 1.6 biomass-based diesel RINs,
- 3.4 advanced-biofuel RINs (the total of 5 advanced-biofuel RINs minus the 1.6 biomass-based diesel RINs), and
- 8.3 renewable fuel RINs (the total of 13.3 renewable fuel RINs minus the 5 total of advanced-biofuel RINs).

RIN Prices. Estimating the effects of the EISA volumes scenario on the prices of diesel, E10, and E85 requires estimating how the Renewable Fuel Standard would affect the price of each type of RIN. It also involves calculating RIN requirements on the basis of the percentages of petroleum-based and renewable fuels in the fuel that a supplier sells.

In a previous analysis, CBO estimated the RIN prices that would result if suppliers had to comply with the volumes stated in EISA for 2017 (but could meet the cellulosic requirement by using other advanced biofuels).³⁰ Updating that analysis, CBO finds that the RIN prices necessary to yield the total volume of renewable fuels mandated under the EISA volumes scenario would be roughly as follows:

- \$1.55 to \$2.10 for a renewable RIN (\$1.15 to \$1.70 more than under the 2016 volumes scenario), and

- \$3.00 to \$6.00 for both advanced biomass-based diesel RINs and other advanced-biofuel RINs (about \$2.45 to \$5.45 more than under the 2016 EISA volumes scenario).

The much higher RIN prices found under the EISA volumes scenario than under the 2016 volumes scenario reflect the substantially higher volumes of both advanced biofuels and total renewable fuels required under the EISA volumes scenario.

Meeting the EISA volumes requirements would necessitate a substantial and rapid increase in the use of E85. Such an increase would require a significant expansion in the number of stations providing E85 (with associated capital investment). Moreover, CBO estimates that the price of driving a mile with E85 would need to be roughly 40 percent to 60 percent lower than the cost of driving a mile with E10 to compensate for the lower energy content of E85 and the inconvenience that drivers would face because of needing to fill up their tanks more often and to go out of their way to find fueling stations that offer E85.

Meeting the larger advanced-biofuel requirement under the EISA volumes scenario (in comparison with the 2016 volumes scenario) would require a large and rapid increase in the supply of both biomass-based diesel and sugarcane ethanol, potentially entailing more than a 60 percent increase in U.S. production of biomass-based diesel and a 50 percent increase in Brazil's production of such ethanol (if Brazil's own consumption did not change), representing a more than eightfold increase in the country's exports of sugarcane ethanol from the 2014 level.³¹

Effect on the Prices of Transportation Fuels in the United States. Applying both the RIN prices and the blend requirements listed above, CBO estimated that complying with the EISA volumes scenario would alter fuel prices relative to the 2016 volumes scenario (CBO's reference case) in the following manner:

30. For a discussion of how those RINs prices were estimated, see Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), www.cbo.gov/publication/45477.

31. Brazil exported about 1.4 million cubic meters (370 million gallons) of ethanol in 2014. The United States, South Korea, and China received the largest shares of those exports. See Brazilian Sugarcane Industry Association, "Monthly Report of Brazilian Ethanol Exports, Calendar Year 2015," <http://tinurl.com/krawepw> (accessed October 30, 2015).

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- The price for petroleum-based diesel would rise by roughly 25 to 45 cents;
- The price for E10 would rise by about 15 to 30 cents; and
- The price of E85 would fall by roughly \$0.80 per gallon to \$1.20.

The methods that CBO used to derive these estimates are very similar to those used to examine the EISA scenario in CBO's report last year.³²

The Repeal Scenario

If lawmakers were to repeal the RFS, fuel suppliers would probably continue to use 13.4 billion gallons of corn ethanol and about 1 billion gallons of biomass-based diesel. The decisions to use those amounts, however, would be driven by economics rather than by a mandate.

CBO finds that repealing the RFS would only have a very small effect on prices of E10 and petroleum-based diesel relative to the 2016 volumes scenario. In contrast, the price of E85 would increase by around 26 cents because the RFS-induced subsidies encouraging its use would be removed. (Although the 2016 volume scenario results in a somewhat significant subsidy to E85, the quantity of E85 consumed is so small in relation to the quantities of E10 and diesel consumed that the effect on the prices of E10 and petroleum-based diesel would be very small.)

Price of Petroleum-Based Diesel. CBO estimated the effect of the repeal scenario on the price of diesel fuel relative to the 2016 volumes scenario by applying the RIN prices described above for the 2016 volumes scenario to the additional cost components identified for suppliers of diesel. Thus, for each 100 gallons of diesel that a fuel supplier sold, the additional cost avoided by repeal would be the sum of the following:

- $1.5 \times$ the \$0.55 price of a biomass-based diesel RIN,
- $0.4 \times$ the \$0.55 price of an advanced-biofuel RIN, and
- $7.7 \times$ the \$0.40 price of a renewable fuel RIN.

32. Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), www.cbo.gov/publication/45477.

Those costs would add about \$4 for each 100 gallons of petroleum-based diesel, so eliminating them would lower the average cost of producing petroleum-based diesel in 2017 by about 5 cents per gallon.

Price of E10. For each 100 gallons of E10 that a fuel supplier sells, it uses 90 gallons of petroleum-based gasoline and 10 gallons of corn ethanol. Its RIN requirements are based only on its consumption of gasoline, so those requirements are 10 percent less than if it sold 100 gallons of purely petroleum-based gasoline. In addition to the RIN requirements associated with the 90 gallons of petroleum-based gasoline used, an E10 supplier would pay 3 cents more for each of the 10 gallons of corn ethanol that it used in 2017 under the 2016 volumes scenario (the price increase necessary to induce the extra 1 billion gallons of corn ethanol consumed in that scenario). In total, for each 100 gallons of E10 that the supplier sold, the lower cost resulting from repealing the RFS would be the sum of the following:

- $0.9 \times (1.5 \times \text{the } \$0.55 \text{ price of a biomass-based diesel RIN}),$
- $0.9 \times (0.4 \times \text{the } \$0.55 \text{ price of an advanced-biofuel RIN}),$
- $0.9 \times (7.7 \times \text{the } \$0.40 \text{ price of a renewable fuel RIN}),$ and
- $10 \times \text{the } \$0.03\text{-per-gallon increase in the price of corn ethanol}.$

Removing those costs would subtract roughly \$4 for each 100 gallons of E10. However, those lower costs would be partly offset by the lost value of RINs that the E10 supplier would have obtained along with each gallon of corn ethanol that it bought. Because the supplier would blend 10 gallons of corn ethanol into every 90 gallons of its fuel supply, it would have received 10 renewable fuel RINs. When that ethanol was blended into the fuel supply, each of those RINs would have been worth \$0.40.³³ (The E10 supplier would use 6.9, or 0.9×7.7 , of those renewable fuel RINs to meet its own compliance obligations—

33. That value includes the additional 10 cents per gallon that the fuel supplier would pay for each gallon of corn ethanol. Thus, the supplier would receive \$1.45 to \$2.00 of net revenue for any RIN that it sold. Likewise, the opportunity cost if the supplier used a RIN for its own compliance purposes would be \$1.45 to \$2.00.

offsetting the cost that it would otherwise incur to obtain RINs—and would sell the remaining 3.1.) The value of those 10 RINs would have roughly offset the blenders' compliance costs. As a result, relative to the 2016 volumes scenario, repealing the RFS would have only a very small effect on the price of E10.

Price of E85. The category of fuel referred to as E85 generally contains between 51 percent and 83 percent ethanol, depending on the season (winter blends have less ethanol to help vehicles start in cold weather). For this analysis, CBO anticipates that E85 will contain an average of 75 percent ethanol and 25 percent gasoline, consistent with recent projections by the Energy Information Administration.³⁴ Thus, for each 100 gallons of E85 that a fuel supplier sold, it would use 25 gallons of petroleum-based gasoline and 75 gallons of corn ethanol. Its RIN requirements under the RFS would be based only on its consumption of gasoline, so those requirements would be 75 percent less than if it sold 100 gallons of petroleum-based gasoline. The lower cost that suppliers

would incur if the RFS was repealed would be the sum of the following:

- $0.25 \times (1.5 \times \text{the } \$0.55 \text{ price of a biomass-based diesel RIN}),$
- $0.25 \times (0.4 \times \text{the } \$0.55 \text{ price of an advanced-biofuel RIN}),$
- $0.25 \times (7.7 \times \text{the } \$0.40 \text{ price of a renewable fuel RIN}),$ and
- $75 \times \text{the } \$0.03\text{-per-gallon increase in the price of corn ethanol.}$

Those effects would have subtracted about \$13 for each 100 gallons of E85, but they would have been more than offset by the value of an E85 supplier's renewable fuel RINs. Because the supplier would mix 75 gallons of corn ethanol into every 100 gallons of its fuel supply, it would have received 75 renewable fuel RINs. Once that ethanol was blended into the fuel supply, each RIN would have had a value of 40 cents, providing the supplier with \$30 of RIN value ($75 \times \0.40) for each 100 gallons of E85. Thus, on net, the repeal scenario would *increase* the average cost of a gallon of E85 by about 15 cents.

34. See Energy Information Administration, *Annual Energy Outlook 2015, With Projections to 2040*, DOE/EIA-0383(2015) (April 2015), Table A11, "Petroleum and Other Liquids Supply and Disposition," www.eia.gov/forecasts/aeo/.

About This Document

This testimony was prepared by Terry Dinan and Ron Gecan, with contributions from David Austin and Tristan Hanon, and with guidance from Joseph Kile and Chad Shirley. It updates CBO's report, *The Renewable Fuel Standard: Issues for 2014 and Beyond*, published in June 2014. In keeping with the Congressional Budget Office's mandate to provide objective, impartial analysis, this testimony contains no recommendations.

Keith Hall, Jeffrey Kling, and Robert Sunshine reviewed the testimony; Gabe Waggoner edited it; and Maureen Costantino and Jeanine Rees prepared it for publication. An electronic version is available on CBO's website (www.cbo.gov/publication/50944).

Terry Dinan is a Senior Advisor at the Congressional Budget Office. She has written about the economic costs, emission effects, and distributional consequences of a variety of environmental and energy policies, including policies that would cap, or tax, greenhouse gas emissions; renewable fuel standards; corporate average fuel economy (CAFE) standards; renewable portfolio standards; and subsidies for fuels and energy technologies. She has testified before the Congress on these topics, published in a variety of professional journals, and served as an associate editor for the *Journal of Environmental Economics and Management* as well as a member of the board of the Association of Environmental and Resource Economists. She has a Ph.D. in economics from Iowa State University. Before joining CBO, she worked at the Environmental Protection Agency and at Oak Ridge National Laboratory.

Chairman BRIDENSTINE. Thank you, Dr. Dinan.
I now recognize Mr. Anderson for five minutes to present his testimony.

**TESTIMONY OF MR. ED ANDERSON,
CEO AND PRESIDENT OF WEN-GAP, LLC**

Mr. ANDERSON. Good morning, Chairman Bridenstine, Chairman Loudermilk, Ranking Members Bonamici and Beyer, and members of the subcommittees.

My name is Ed Anderson. My wife Judy and I, with our sons Eddie and Jeff, own a small Wendy's franchise with 11 restaurants in Virginia. We have 385 employees. I am also on the board of Wendy's Quality Supply Chain Co-op, QSCC, a not-for-profit purchasing co-op owned by Wendy's restaurant operators like me. QSCC purchases the food for Wendy's and is staffed by experts who understand and help us interpret commodity markets.

The National Council of Chain Restaurants asked me to testify on behalf of the local small business chain restaurant community.

In July 2013, I testified at a similar hearing on the RFS before the House Energy and Commerce Committee. Until then, I had never done anything like this and never imagined that I would. I run restaurants, but I have a responsibility to my family, employees, fellow franchisees, customers, and our industry to explain to policymakers that the well-intended RFS has turned out to be a very serious problem.

Judy and I are the face of American small business men and women. We've worked for decades to build our business, but when Congress passed the Renewable Fuel Standard, it created a new burden for businesses like ours. Now restaurant owners and employers like us are being hurt at a time when our country can't afford it.

The last time I was here I doubted many restaurant operators, let alone our customers, knew that a federal government mandate called the RFS is at the root of food cost increases. But more and more of us in the food business understand the RFS is a big mistake, and the average consumer is starting to catch on, too.

There have been several studies of the RFS impact on food commodity volatility and costs. A study from PricewaterhouseCoopers in late 2012 found that the RFS is costing the chain restaurant segment of the restaurant industry, which is the segment I and thousands of small business franchisees are in, up to \$3.2 billion in higher food commodity costs every year.

My own analysis is that the RFS is costing my small company up to \$34,000 more in higher food costs per restaurant each and every year. For our family, that's up to \$374,000 a year in additional costs. That might not be a lot of money in Washington, D.C., but for me and many others in the restaurant business that's a lot of money.

If Congress repealed the RFS, it would level the playing field and over time return normalcy to the commodities market so everyone competes fairly and food becomes more affordable. It's the RFS that distorts the market so much that restaurants, our suppliers, and consumers are forced to pay more than we would under normal market conditions.

Please understand we're not anti-ethanol. We know if it wasn't for American farmers and ranchers, we wouldn't be here. We get all our beef and chicken from the United States and Canada. But this mandate is making food so expensive that it's harder to continue investing in new or remodeled restaurants, which would create badly needed construction and restaurant jobs.

I believe with all my heart that we live in the greatest country in the world. It was built on the hard work and the ingenuity of those willing to risk it all to build something, creating jobs and opportunity for others along the way. Removing the mandate for ethanol allows that industry to stand on its own, like Judy and I do, like our sons who work for us do.

Capitalism allows us all to adjust and be successful. Let the market, not a mandate, dictate the cost of corn. We can't pass these costs on to our customers. They're already struggling in this economy, and their own food costs at grocery stores have also gone up because of the RFS.

We're appealing to Congress to provide relief from this policy which distorts food commodity markets and harms consumers and everyone in the food chain. Congress created the RFS, so it's up to Congress to repeal it.

Thoughtful lawmakers in both the House and Senate introduced legislation to repeal or significantly reform the RFS. H.R. 703 and 704 would repeal the entire RFS or repeal the worst part of it, the corn ethanol mandate. Both bills enjoy growing bipartisan support.

The RFS was a big mistake and it's broken beyond repair. We came here today to respectfully ask Congress to repeal it. Judy and I are here as small business owners, as employers, and as a family to bring attention to the real-life impact the RFS has had and to ask Congress to take action for all of us, because without your action, this situation will only get worse.

Thank you.

[The prepared statement of Mr. Anderson follows:]

TESTIMONY OF ED ANDERSON

CHIEF EXECUTIVE OFFICER AND PRESIDENT OF WEN-GAP LLC,

RENEWABLE FUEL STANDARD: A TEN YEAR REVIEW OF COSTS AND BENEFITS

BEFORE THE SUBCOMMITTEE ON OVERSIGHT AND SUBCOMMITTEE ON ENVIRONMENT
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
November 3, 2015

INTRODUCTION:

Good afternoon Chairman Bridenstine, Chairman Loudermilk, Ranking Members Bonamici and Beyer and Members of the subcommittees.

My name is Ed Anderson. My wife Judy and I, with our sons Eddie and Jeff, own a small Wendy's franchise with eleven restaurants in Virginia. We have 385 employees.

I am also on the board of Wendy's Quality Supply Chain Co-op, QSCC, a not-for-profit purchasing co-op owned by Wendy's restaurant operators like me. QSCC purchases the food for Wendy's and is staffed by experts who understand and help us interpret commodity markets.

The National Council of Chain Restaurants asked me to testify on behalf of the local, small business chain restaurant franchise community. In July 2013, I testified at a similar hearing on the RFS before the House Energy & Commerce Committee. Until then I had never done anything like this and never imagined I would. I run restaurants, but I have a responsibility to my family, employees, fellow franchisees, customers and our industry, to explain to policymakers that the well-intended RFS has turned out to be a very serious problem. I'm back two years later to tell you that things are getting worse.

Judy and I are the face of American small business men and women. We've worked for decades to build our business but when Congress passed the Renewable Fuel Standard it created a new burden for businesses like ours. Now restaurant owners and employers like us are being hurt at a time when our country can't afford it.

The last time I was here I doubted many restaurant operators, let alone our customers, knew that a federal government mandate called the RFS is at the root of food cost increases. But more and more of us in the food business understand the RFS is a big mistake, and the average consumer is starting to catch on too.

There have been several analyses of the RFS' impact on food commodity volatility and costs. A study from PwC in late 2012 found that the RFS is costing the chain restaurant segment of the restaurant industry, which is the segment I and thousands of small business franchisees are in, up to \$3.2 billion in higher food commodity costs every year.

My own analysis is that the RFS is costing my small company up to \$34,000 more in higher food costs, per restaurant, each and every year. For our family business, that's up to \$374,000 a year in additional cost. That might not be a lot of money in Washington D.C. – but for me and many others in the restaurant business – that's a LOT of money.

If Congress repealed the RFS, it would level the playing field and over time return normalcy to the commodities market so everyone competes fairly and food becomes more affordable. It's the RFS that distorts the market so much that restaurants, our suppliers and consumers are forced to pay more than we would under normal market conditions.

Please understand we're not anti-ethanol. We know if it wasn't for American farmers and ranchers we wouldn't be here. We get all our beef and chicken from the U.S. and Canada. But this mandate is making food so expensive that it's harder to continue investing in new or remodeled restaurants which would create badly needed construction and restaurant jobs.

I believe with all my heart that we live in the greatest country in the world. It was built on the hard work and the ingenuity of those willing to risk it all to build something creating jobs and opportunity for others along the way. Removing the mandate for ethanol allows that industry to stand on its own – like Judy and I do – like are boys who work with us do. Capitalism allows us all to adjust and be successful. Let the market, not a mandate, dictate the cost of corn.

We can't pass these costs on to our customers they are already struggling in this economy and their own food costs at grocery stores have also gone up because of the RFS. We're appealing to Congress to provide relief from this policy which distorts food commodity markets and harms consumers and everyone in the food chain. Congress created the RFS, so it is up to Congress to repeal it.

Thoughtful lawmakers in both the House and the Senate introduced legislation to repeal or significantly reform the RFS. H.R. 703 and 704 would repeal the entire RFS or repeal the worst part of it, the corn ethanol mandate. Both bills enjoy growing bipartisan support.

The RFS was a big mistake and it's broken beyond repair. We came here today to respectfully ask Congress to repeal it.

Judy and I are here as small business owners, as employers, and as a family, to bring attention to the real-life impact the RFS has had and to ask Congress to take action for all of us because without your action, this situation will only get worse.

Thank you.

Ed Anderson Biography

Ed Anderson is Chief Executive Officer and President of WEN-GAP LLC, a franchise operator of Eleven Wendy's restaurants in Virginia. Previously, he was Chief Operating Officer of Wen-Rich, a Wendy's franchise that operated 21 restaurants in Virginia and Georgia.

Ed played a critical role in the formation of Quality Supply Chain Co-Op (QSCC), the independent, not-for-profit purchasing cooperative for Wendy's restaurants in the U.S. and Canada. He was the Co-op's first Board Chairman from 2009-2013 and currently serves on QSCC's Board of Directors.

Ed was inducted into the Wendy's Hall of Fame in 2010. He also won a Wendy Award for excellence in all areas of business from operations to training and development. In addition, Ed won a Jim Near Employer of Choice Award for his people development programs.

Ed has contributed much to the Wendy's system. He currently serves on the Franchise Advisory Council (FAC) for six years. During that time, Ed also chaired the Supply Chain Sub-Committee and was involved in the negotiations that led to the formation of QSCC. He currently chairs the Next Generation Sub-Committee which serves to develop the younger franchisees of the Wendy's system. In addition, he serves as President of his DMA.

Ed is a strong supporter of the Dave Thomas Foundation for Adoption and the cause of adoption.

More than 35 years ago, Ed began his Wendy's career as a manager trainee. He held positions as a General Manager, District Manager, Area Director and Franchise Area Director before becoming a franchisee in 1989.

Ed grew up in Manalapan, New Jersey and graduated in 1980 from Guilford College in Greensboro, North Carolina which is also where he met his wife Judy. They have three sons: Eddie, Jeff and Joey. Currently two of his sons are involved with Wen-GAP.

Chairman BRIDENSTINE. Thank you, Mr. Anderson.
Dr. DeCicco, you are recognized for five minutes.

**TESTIMONY OF DR. JOHN DECICCO,
RESEARCH PROFESSOR,
UNIVERSITY OF MICHIGAN ENERGY INSTITUTE**

Dr. DECICCO. Thank you. And I wish to thank the Chairman—
Chairman BRIDENSTINE. Could you turn on your microphone?

Dr. DECICCO. Yes. I wish to thank the Chairmen and Ranking
Members, as well as other members of the subcommittee and full
committee for inviting me to today's hearing.

My name is John DeCicco, and I hold a doctorate in engineering
from Princeton. Before joining the University of Michigan faculty
in 2009, I worked professionally on energy issues since 1977, in-
cluding 21 years at major environmental organizations. However,
the findings I'm presenting today are my own professional views as
an independent academic and do not reflect those of the University
of Michigan, my past affiliations, or funders.

My research shows that the Renewable Fuel Standard, or RFS,
has been harmful to the environment from its inception. Now, ten
years after the 2005 Energy Policy Act, the program has resulted
in higher CO₂ emissions than would have otherwise incurred. It
also harms the environment in other ways. Sadly, the adverse im-
pacts of the RFS have grown worse since it was expanded by the
Energy Independence and Security Act of 2007.

The notion that renewable fuels readily reduce CO₂ is based on
a scientifically incorrect understanding of carbon neutrality. Only
under certain conditions does substituting a biofuel for a fossil fuel
neutralize the CO₂ leaving a tailpipe. For that to occur, harvesting
the feedstock must significantly increase how rapidly cropland ab-
sorbs CO₂ from the atmosphere on a net basis. That condition is
not met for corn ethanol mandated by the RFS. It might be satis-
fied for cellulosic feedstocks, but once properly evaluated, the gains
may not be as great as advocates assume.

The lifecycle models used to calculate fuel carbon footprints, in-
cluding EPA's RFS model and the DOE-sponsored GREET model,
automatically credit all biofuels with complete carbon neutrality
without checking whether that assumption is valid. My studies,
which rely on crop data instead of computer modeling, find that the
carbon neutrality condition is not being met.

We evaluated corn ethanol for which lifecycle analysis claim to
a 40 percent reduction in greenhouse gas emissions compared to
gasoline. But examining data for the croplands actually supplying
the facility finds no significant reduction in emissions. Under some
circumstances, the emissions could be as much as 70 percent high-
er than those of gasoline. And these results do not even include the
indirect land-use change, which would increase biofuel-related
emissions even more.

The key problem is that diverting harvest from existing produc-
tive land does not remove more carbon from the air than was al-
ready being removed during prior crop growth. All it does is it
shuffle carbon around. In effect, it robs Peter to pay Paul.

Our ongoing research involves a detailed carbon balance analysis
of U.S. renewable fuel production since 2005. Preliminary results

show that no significant direct CO₂ reduction can be claimed for the RFS. Once indirect land-use change is considered, the result is substantially higher CO₂ emissions overall.

Excess CO₂ is not the only environmental harm caused by this policy. Fellow University of Michigan researchers have documented how ethanol production has destroyed habitat for waterfowl and other wildlife. Expanding corn ethanol production is worsening water pollution, contributing to algae blooms in the Gulf of Mexico and Lake Erie. And as for other air pollution, recent research found that the country's third-largest corn ethanol refinery emits 30 times more air pollution than was assumed for the RFS regulatory analysis.

Ethanol's corrosive properties are also incompatible with cars already on the road and degrade the operation of lawnmowers, motorboats, and other gasoline-powered equipment used by homeowners and businesses alike.

In summary, a careful look at the data shows that the studies used to justify the RFS were flawed. Scientifically speaking, lifecycle analysis is an inappropriate method for specifying public policy. Inserting lifecycle requirements into the law has proven to be a mistake. Only a direct year-at-a-time accounting provides a scientifically sound way to evaluate the CO₂ impact of fuels. Once that is done, it is clear that the production and use of biofuels, as mandated by the RFS, has increased CO₂ emissions to date.

Thank you again for allowing me to share my findings, and I'll look forward to any questions you may have.

[The prepared statement of Dr. DeCicco follows:]

Testimony on the
Environmental Impact of the Renewable Fuel Standard

John M. DeCicco, Ph.D.
Research Professor
University of Michigan Energy Institute

before the
Subcommittee on Environment and Subcommittee on Oversight
Committee on Science, Space, and Technology
U.S. House of Representatives

November 3, 2015

SUMMARY STATEMENT

I wish to thank Chairman Bridenstine and Chairman Loudermilk as well as other members of your Subcommittees and the full Committee for inviting me to this morning's hearing.

My name is John DeCicco and I hold a doctorate in mechanical engineering from Princeton University. Before joining the University of Michigan faculty in 2009 I worked professionally on energy issues since 1977, including 21 years at major environmental organizations. However, the findings I'm presenting today are my own professional views as an independent academic and do not reflect those of the University of Michigan, my past affiliations or funders.

My research shows that the RFS has been harmful to the environment from its inception. Now, ten years after the 2005 Energy Policy Act, the program has resulted in higher CO₂ emissions than would have occurred otherwise. It also harms the environment in other ways. Sadly, the adverse impacts of the RFS have grown worse since it was expanded by Energy Independence and Security Act (EISA) of 2007.

The notion that renewable fuels readily reduce CO₂ emissions is based on a scientifically incorrect understanding of carbon neutrality. Only under certain conditions does substituting a biofuel for a fossil fuel neutralize the CO₂ leaving the tailpipe. For that to be true, harvesting the feedstock must significantly increase how rapidly croplands absorb CO₂ from the atmosphere on a net basis. That condition is not met for the corn ethanol and soy biodiesel mandated by the RFS. It might be satisfied for cellulosic feedstocks, but once properly evaluated, the gains may not be as great as biofuel advocates assume.

The lifecycle models used to calculate fuel carbon footprints, including EPA's RFS model and the DOE-sponsored GREET model, automatically credit all biofuels with complete carbon neutrality without checking whether the conditions are valid. My studies, which rely on crop data instead of modeling assumptions, find that the carbon neutrality condition is not being met. We evaluated corn ethanol from a facility for which lifecycle modeling claimed a 40% reduction in greenhouse gas emissions compared to gasoline. Our analysis of the cropland supplying the facility found no significant reduction in emissions. Under some circumstances, the emissions could be as much as 70% higher than those of gasoline. These results do not even include indirect land-use change, which would increase biofuel-related emissions even more.

The key problem is that diverting harvest from existing productive land does not remove more carbon from the air than was already being removed during prior crop growth; all it does is shuffle carbon around. In effect, it robs Peter to pay Paul.

Our ongoing research involves a detailed carbon balance analysis of U.S. renewable fuel production since 2005. Preliminary results show that no significant direct CO₂ reduction can be claimed for the RFS. Once indirect land-use change is considered, the result is substantially higher CO₂ emissions overall.

Excess CO₂ is not the only environmental harm caused by the RFS. Fellow University of Michigan researchers have documented how corn ethanol production has destroyed habitat for waterfowl and other wildlife. Expanded corn production to meet the ethanol mandate is worsening water pollution, contributing to algae blooms and oxygen-starved zones in the Gulf of Mexico and Lake Erie. Biofuel processing also releases other forms of air pollution; for example, recent research has found that the country's third largest corn ethanol refinery emits 30 times more air pollution than was assumed for the RFS regulatory analysis. Ethanol's corrosive properties are also incompatible with many cars already on the road and degrade the operation of lawn mowers, motor boats and other gasoline-powered equipment used by homeowners and businesses alike.

In summary, a careful look at real-world data reveals that the lifecycle studies used to justify the RFS were flawed. Scientifically speaking, lifecycle analysis is an inappropriate method for specifying public policy. Congress got bad advice from the advocates who proposed inserting lifecycle requirements into the law. Only direct, year-at-a-time accounting provides a scientifically sound way to evaluate the CO₂ impact of fuels. Once that is done, it is clear that the production and use of biofuels as mandated by the RFS has increased CO₂ emissions to date.

Thank you, again, for allowing me to share my findings with you, and I look forward to any questions you may have. ■

Testimony on
**The Environmental Impact of the
Renewable Fuel Standard**

John M. DeCicco, Ph.D.
Research Professor
University of Michigan Energy Institute

Before the
Subcommittee on Environment and Subcommittee on Oversight
Committee on Science, Space, and Technology
U.S. House of Representatives
114th Congress of the United States of America

Hearing on the
**Renewable Fuel Standard:
A Ten Year Review of Costs and Benefits**
2318 Rayburn House Office Building
Washington, D.C.

Tuesday, November 3, 2015

DISCLAIMER

The findings and perspectives presented in this testimony represent the author's own professional assessment as an independent academic researcher. They should not be taken to reflect the views of the University of Michigan, the University of Michigan Energy Institute and other units of the university, the author's past affiliations, or funders present or past.

The Environmental Impact of the Renewable Fuel Standard

INTRODUCTION

The Renewable Fuel Standard (RFS) was first established by the Energy Policy Act of 2005, which amended the Clean Air Act to require that 7.5 billion gallons of renewable ethanol be blended into the nation's gasoline supply by 2012. The RFS was expanded by the Energy Independence and Security Act of 2007 (EISA) to target a total of 36 billion gallons of renewable fuel by 2022 along with specific requirements for certain categories of advanced, cellulosic and biomass-based diesel fuels to meet specified levels of greenhouse gas (GHG) reduction, relative to the petroleum-based fuels they replace, as determined by the Administrator of the Environmental Protection Agency (EPA) through lifecycle analysis (LCA). Starch-based ethanol from facilities placed into operation after the enactment of EISA must also meet a lifecycle GHG intensity ("carbon intensity" or "CI") threshold, specified as being 20% lower than that of baseline 2005 petroleum gasoline.

Three public policy rationales underpin the RFS and other policies to promote biofuels. One is to support the domestic agricultural sector by creating an additional market for corn and soybeans, thereby bolstering prices for these commodities and enhancing farmer and processor incomes. The second is energy security, which could be strengthened by developing domestic sources of liquid fuels that can replace the petroleum fuels that involve dependence on imported oil. The third rationale, which was elevated in the expanded RFS called for by EISA, is environmental. It rests on the potential for biofuels, which utilize carbon recycled from the atmosphere through crop growth, to reduce carbon dioxide (CO₂) emissions from the transportation sector. Such so-called "low-carbon" renewable fuels can include biomass-based ethanol and biodiesel as well as potential "drop-in," i.e., fully fungible, fuels derived from biomass that might without limit be incorporated into existing transportation fuel distribution and use systems. This testimony focuses on the environmental rationale for the RFS and examines whether the program has reduced CO₂ emissions when evaluated using real-world data on fuel production and use over the ten years since the policy was established.

From an energy policy perspective, a longstanding assumption has been that renewable fuels are inherently "carbon neutral," meaning that the CO₂ emitted when they are burned is fully offset by CO₂ uptake during feedstock growth. That assumption leads many scientists to presume that environmental impact assessments need only consider production-related GHG emissions throughout a biofuel's lifecycle. The carbon neutrality assumption is an accounting convention that is built into the LCA models used to compare the carbon intensity (CI, meaning lifecycle GHG emissions impacts) of different fuels. Such is the case for the GREET model¹ that is developed and maintained by Argonne National Laboratory (ANL) with support from the U.S. Department of Energy (DOE). It is also the case for the LCA models developed to administer the RFS, as seen in EPA's statement that "CO₂ emissions from biomass-based fuel combustion are not included in their lifecycle emissions results."²

Nevertheless, biofuel carbon neutrality is just an accounting convention and when it is used uncritically in lifecycle comparisons of biofuels with fossil fuels, it results in greatly misleading estimates of the actual impact of fuel substitution. Such erroneous comparisons underpin not only EPA's analyses for the RFS, but also California's LCA-based fuels regulation known as the Low-Carbon Fuel Standard (LCFS)³ as well as numerous GREET analyses,⁴ including those used to claim GHG reductions for the RFS.⁵ The notion that using a renewable fuels automatically reduces CO₂ emissions (short of processing impacts) is based on a scientifically incomplete, and therefore incorrect, understanding of how carbon is recycled through plant growth. Only under limited conditions does substituting a biofuel for a fossil fuel neutralize tailpipe CO₂ emissions. However, the lifecycle models used for public policy to date assume carbon neutrality for biofuels without checking whether the conditions under which that assumption might be true are verified for actual biofuel production.

A careful examination of actual renewable fuel production since the RFS was established shows that the carbon neutrality conditions are not met in practice. As a first step in explaining this finding, the next section of the paper describes the principles that underpin scientifically verifiable carbon accounting for interactions among the terrestrial biosphere (which is the source of biofuel feedstocks), the geosphere (the source of fossil fuel feedstocks) and the atmosphere (in which excess CO₂ concentrations can disrupt the climate).

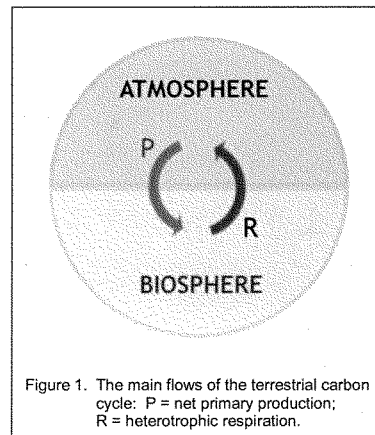
PRINCIPLES FOR VERIFIABLE CARBON ACCOUNTING

A crucial foundation for any analysis of biofuels is the fact that CO_2 is always cycling between the biosphere and the atmosphere, whether or not biomass-based products are being used for fuel. Figure A-1 at the end of this document depicts the major flows of the global carbon cycle. The small diagram in Figure 1 highlights the key flows need for a proper analysis of the substitution of biofuels for fossil fuels, based on the "Biofuels Carbon Balance" paper published in the journal *Climatic Change*.⁶

In this diagram, P stands for Net Primary Production (NPP), which is the amount of carbon absorbed into plants as they grow after subtracting plants' own metabolic release of CO_2 . R stands for heterotrophic respiration (often designated R_h), which is the CO_2 respired by organisms that consume plants. That includes humans and livestock, but the vast majority of such respiration is from soil bacteria, fungi and other organisms collectively known as decomposers. These creatures form a critical part of the food chain that sustains all living things. Carbon is the fuel of life. In nature, no carbon is wasted; it is all put to use whether or not it is used commercially.

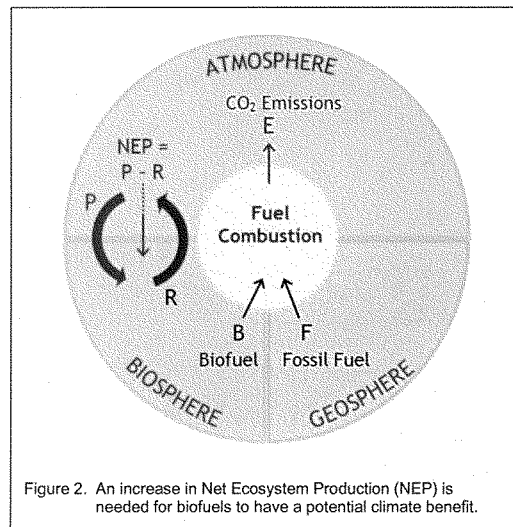
On average, P exceeds R, which enables carbon to accumulate in the biosphere.

Another key tenet is the fact that the total amount of carbon in the world is fixed. Otherwise put, whether as food for biological processes, CO_2 in the atmosphere, fuel for motor vehicles or in living biomass such as forests, wetlands and other carbon-rich ecosystems, carbon utilization occurs in a closed system. This reflects the law of conservation of mass as applied to the use of carbon. Unfortunately, however, this basic principle is neglected in the LCA models used to analyze biofuels. This serious error is related to the fact that these models were designed without properly accounting for CO_2 uptake (that is, P in the diagram above) even though they track CO_2 emissions throughout a fuel's lifecycle. The failure to respect the law of conservation of mass is one of the reasons why most prior evaluations of the RFS (and biofuel use generally) give results that inconsistent with the realities of carbon uptake in the biosphere.



Using these key principles for carbon accounting, a scientifically rigorous analysis of what happens when a biofuel substitutes for a fossil fuel is quite straightforward. The situation is depicted in Figure 2, which shows the carbon flows associated with fuel use in addition to the basic carbon cycle flows illustrated in Figure 1. Also shown is the P-minus-R difference, which is termed Net Ecosystem Production (NEP).⁷ It is given as a downward arrow and reflects the net flow of carbon from the atmosphere to the biosphere.

At the center of the figure is fuel combustion. Whether the source of carbon in the fuel is biomass (B) or fossil (F), the amount of CO₂ emitted (E) when burning the fuel is essentially the same per unit of useful energy. In other words, using a biofuel (such as ethanol or biodiesel) instead of a fossil fuel (such as gasoline or diesel from petroleum) does not appreciably change the rate at which CO₂ flows into the atmosphere, e.g., from vehicle tailpipes or jet engines. As a matter of basic chemistry as far



as climate is concerned, it is clear that if biofuels have a benefit, it's not when they are burned.

To measurably reduce CO₂ buildup in the atmosphere, the emissions from fuel combustion must be balanced by *increasing* NEP, that is, speeding up how quickly CO₂ is removed from the atmosphere on cropland. Mathematically, this condition is written as

$$d(\text{NEP})/dt > 0$$

and it means that there must be an acceleration of rate at which CO₂ flows from the atmosphere into biosphere. If this condition is not met, biofuels cannot provide a climate mitigation benefit and biofuel use is not carbon neutral. Moreover, this failure to reduce net GHG emissions comes even before considering the emissions involved in growing the feedstock and processing it into

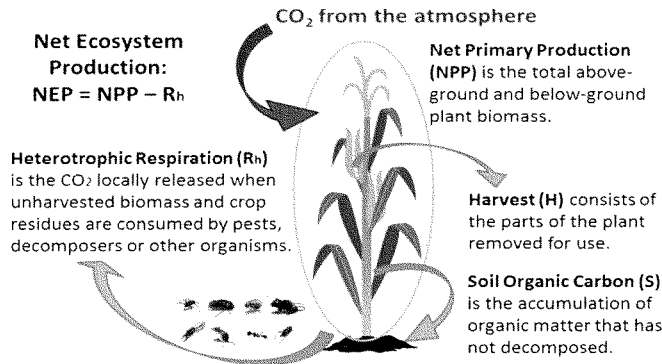


Figure 3. Carbon exchanges associated with an annual crop
 Image Credit: Jane Thomas, Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/imagegallery/)

fuel. It is also before considering the land-use change impacts that have become so prominent in the biofuels debate.

NEP can be evaluated over any area of land from a farm field up to the entire globe. To determine the potential climate protection benefits of a biofuel, it is necessary to evaluate how NEP changes on the cropland from which the feedstock is harvested. Figure 3 shows how NEP can be evaluated for an annual crop such as corn. In annual crops, very little carbon accumulates in the soil from year to year; as NRC (2011) points out, the uncertainties in soil carbon changes are large relative to the magnitudes involved, and so it is fair to assume no change in soil carbon on average. Therefore, NEP is essentially proportional to the harvest (H as shown in Figure 3).

For example, on a 40 acre farm field that grows corn with an annual yield of 160 bushels per acre, the amount of carbon removed in the harvest is roughly 59 metric tons.⁸ That means that the downward rate of carbon flow from the atmosphere into the biosphere over the field (that is, its NEP) is 59 tons of carbon per year. Corn is among the most productive of crops in terms of yield, and so the NEP on a cornfield is significantly higher than that of other crops. An average soybean yield is 44 bushels per acre, and so a similar calculation for a 40 acre soybean field implies a NEP of roughly 18 tons of carbon per year.⁹ As noted in the analysis discussed below, a gain in NEP occurs when rotating from soy to corn; conversely, a loss in NEP occurs when rotating back to soy.

DIRECT CARBON BALANCE EFFECTS FOR ETHANOL PRODUCTION

The extent to which biofuel feedstock production results in an increase in NEP is the empirical test that can be used to evaluate whether the GHG reductions predicted by LCA models actually occur in practice. To answer this question, we examined a case study for a state-of-the-art natural gas dry mill corn ethanol biorefinery and the farmland that serves it. The method we used relies on the directly measurable carbon flows associated with crop growth, refining and other production processes associated with both ethanol and gasoline, and the tailpipe ("end-use") CO₂ emitted when vehicles are driven.

Figure 4 is a schematic illustration of the items to be analyzed in a careful carbon balance. Notable, this analysis always includes carbon uptake on cropland, because it occurs whether or not the crops are used for fuel. As shown it also include process emissions, including any process-related CO₂ that comes from biomass itself (known as biogenic emissions), which for ethanol production includes the CO₂ released during fermentation. As also shown in the diagram, flows of fixed carbon (as opposed to CO₂) are exported across the fuel system boundary in the form of biomass products (corn, soybeans and other agricultural products or coproducts)

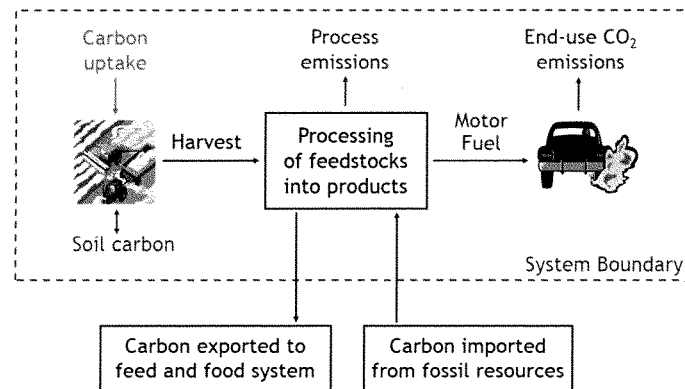


Figure 4. Schematic diagram for direct carbon balance analysis of motor fuel GHG impacts

and are imported across the system boundary from fossil resources such as crude oil. Changes in these external flows result in displacement effects, such as reduced corn and soybean

consumption in the food and feed system, which is partly offset by coproducts such as distillers' grains, and petroleum that remains unused by motor vehicles but which can induce a rebound effect in fuel markets. However, these flows of fixed carbon do not result in CO₂ emissions to the atmosphere from the vehicle-fuel system itself, which is the subject of an analysis of the extent to which tailpipe CO₂ emissions are offset by CO₂ uptake on cropland.

Table 1 summarizes what we found, based on the detailed analysis documented in our recent report.¹⁰ The first line gives the carbon uptake on land, shown as a negative emission and reflecting the downward flow of CO₂ from the atmosphere into growing biomass, including carbon removed in the harvest plus any gain in soil carbon [units are thousand metric tons (10⁶ kg) of carbon mass per year, kt_c/yr]. The difference column shows the change in carbon uptake; it is negative because the rate of carbon removal from the atmosphere by the cropland went up from the baseline year to the ethanol production year. The main reason for this large gain in uptake is a shift from growing soybeans on nearly half the cropland serving the facility to growing all corn when ethanol was produced; corn yields are higher than soybean yields, which means that a corn field removes more CO₂ from the atmosphere than a soybean field. The second line gives process emissions, which are higher for ethanol production than for petroleum refining. These values are consistent with typical LCA estimates of the GHG emissions from feedstock and fuel processing, but for ethanol the ABC method also includes biogenic process emissions, notably the CO₂ released during fermentation. Vehicle tailpipe CO₂ emissions differ only slightly, with ethanol 2.2% lower than gasoline.

Table 1. Summary of direct annual basis carbon (ABC) flows for a unified vehicle-fuel system using gasoline in a baseline year and corn ethanol the following year

Carbon-equivalent mass flows, thousand metric tons per year (kt _c /yr)			
	Year ₀ using gasoline	Year ₁ using ethanol	Year ₁ - Year ₀ Difference
Carbon exchange on cropland	(119)	(189)	(70)
Process emissions	39	115	76
Vehicle emissions	89	87	(2)
Net emissions impact of the system	10	14	4
Biomass carbon exported from system	119	65	(53)
Source: combined pathway results from DeCicco & Krishnan (2015); note that 1 kt _c /yr = (12/44)kt _{CO2} /yr			

Summing these values indicates that the net GHG emissions impact of the unified system (cropland, upstream and downstream processing and motor vehicles) is higher when ethanol is used than when gasoline is used. The difference is about 4 thousand metric tons of carbon per year (kt/yr), which in relative terms is 4.3% of the baseline 89 kt/yr end-use CO₂ emissions from gasoline use. This estimate is not a lifecycle ("well-to-wheels") CI metric, but simply the difference in direct GHG emissions from the circumscribed system of Figure 4 when using corn ethanol instead of gasoline. This increase in direct GHG emissions contradicts the previously published GREET analysis of the facility's first year of operation, which found a lifecycle CI for the corn ethanol that was 40% lower than that of gasoline.

The bottom row of Table 1 shows the changes in the rate at which carbon leaves the system in exported biomass. In the baseline year when gasoline is used, corn and soybeans are supplied to the external food system. When fuel ethanol is produced, only the coproducts are supplied to the food system. This large change in the supply of food-related biomass drives the displacement effects analyzed using the consequential modeling that has become part of LCA for fuels policy. For the case study examined here, the 53 kt/yr loss of biomass exports represents 45% of the baseline 119 kt/yr of exported biomass. Although not shown in the table, there is a reduction of 111 kt/yr of fossil carbon imported into the system as petroleum. Nevertheless, this reduction of fossil fuel use does not result in a direct reduction of CO₂ emissions because vehicle emissions do not significantly change.

This analysis highlights the critical importance of pre-existing CO₂ uptake on the land from which a biofuel feedstock is sourced. In the LCA methods used for the RFS, such baseline carbon uptake is automatically and fully credited against tailpipe CO₂ emissions, a modeling convention equivalent to assuming that uptake was zero before the feedstock was harvested for producing biofuel rather than for feed and food. But CO₂ uptake is never zero on productive land and is in fact substantial for existing cropland, the main source of biofuels produced at commercial scale. For the facility analyzed here, a gain in CO₂ uptake occurred because of the shift from growing soybeans to growing corn on nearly half the cropland serving the facility.

Corn-soy is the dominant crop rotation on U.S. farmland, but farms cannot permanently shift from soy to all corn, and so the case illustrated in Table 1 represents a best-case scenario for carbon uptake. We conducted a sensitivity analysis different baseline conditions for crop rotation

and yield; those results are detailed in the aforementioned report. We found that a situation that just involves diverting corn from food and feed markets to the fuel market, and which does not credit a yield gain that would mostly likely have occurred anyway, resulted in an emissions increase of 61 kt/yr, implying that using corn ethanol would increase GHG emissions by nearly 70% compared to baseline tailpipe CO₂ emissions using gasoline. This can be considered an upper bound scenario, in contrast to the relatively insignificant 4 kt/yr emissions increase shown in Table 1, which can be considered a best-case scenario. The conclusion is that the change in direct CO₂ emissions when using corn ethanol instead of gasoline is insignificant at best, and it could make matters worse.

In other words, the biofuel carbon neutrality assumption built into LCA models does not hold up for real-world biofuel production. Direct accounting of actual carbon flows shows that, at best, corn ethanol production fails to reduce CO₂ emissions relative to petroleum gasoline, and even that result depends on the gain in cropland carbon uptake that occurs with a large shift from growing soybeans to growing corn. If the baseline land use was corn production, then the increase in GHG emissions due to ethanol production would be significantly higher. Finally, if consequential effects including ILUC were to be included, the result would be a yet even higher estimate of the adverse net GHG emissions impact of biofuel use.

Our next and still ongoing phase of research is doing a data-driven carbon balance analysis of the effect of the RFS nationwide since 2005. To perform this analysis, we are examining how carbon uptake changed on all U.S. cropland from 2005 through 2013, which was the year of most recently available complete data when we started the analysis.

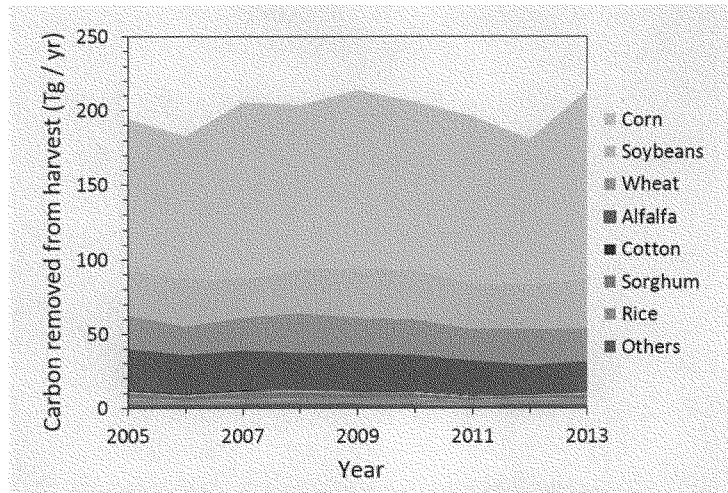


Figure 5. Rate of carbon uptake on U.S. cropland, 2005-2013.

Source: Derived from USDA Crop Production Summary data.

The preliminary results are shown in Figure 5, which shows the rate of CO₂ uptake on cropland in teragrams (10¹⁵g) of carbon per year (TgC/yr), which is the same as millions of metric tons of carbon per year.¹¹ and we find that there The gain from 2005 to 2013 amounted to roughly 20 TgC/yr, indicating an increase of 10% in the net rate at which CO₂ flows downward from the atmosphere into vegetation growing on cropland. It reflects changes in harvested area, crop mix and yield. The estimated 20 TgC/yr gain in CO₂ uptake is essentially an upper bound on the potential offset of end-use CO₂ emissions that might be achieved when substituting biofuels derived from the cropland for fossil fuel products. The amount of this gain in uptake that can be reasonably attributed to the demand for grains created by the RFS is less than the total amount of carbon contained in the harvest supplied to biorefineries. That means that once processing and direct land-use change emissions are factored in, there is no significant reduction in net GHG emissions due to the use of the corn ethanol and soy biodiesel. Using EPA's estimates for indirect land-use change then pushes the total CO₂ impact to a much higher level, imply substantially higher cumulative CO₂ emissions overall.

Net CO₂ uptake on cropland (i.e., NEP) can be increased by using crop residues to make fuel, as now being pursued at a small scale through cellulosic ethanol production. NEP then increases because R decreases, e.g., by collecting corn stover that would otherwise decompose and thereby reducing the CO₂ emissions from cornfields after grain is harvested. In any case, it is necessary to do a careful, location-specific assessment of how NEP actually changes when biofuel feedstocks are produced; one cannot just assume (as lifecycle models now do) that the carbon in a harvest fully offsets CO₂ emissions during fuel combustion. Ecologically speaking, the extent to which one can safely "starve the decomposers" by harvesting residues is likely to be limited.

The implication is that, while it may be possible for biofuels to contribute to climate mitigation, the conditions under which they actually do so are much more restricted than is commonly assumed. Moreover, because any climate benefit hinges not on biofuel use per se, but rather on raising the net rate of CO₂ removal from the atmosphere, there are likely to be other ways to accomplish that task which are less costly and more ecologically sound.

OTHER ENVIRONMENTAL IMPACTS

Although my own studies have focused on the GHG emissions impacts of renewable fuel use, excess CO₂ emissions are not the only environmental harm caused by the RFS.

Other researchers at University of Michigan conducted a detailed, geographically explicitly assessment of how the cropland expansion related to the rising mandated demand for corn ethanol has destroyed habitat for waterfowl and other wildlife.¹² Expanded corn production to meet the ethanol mandate is worsening water pollution, contributing to algae blooms and oxygen-starved zones in the Gulf of Mexico and Lake Erie.¹³ Biofuel processing also releases other forms of air pollution; for example, recent research has found that the country's third largest corn ethanol refinery emits 30 times more air pollution than was assumed for the RFS regulatory analysis.¹⁴ Ethanol's corrosive properties are also incompatible with many cars already on the road and degrade the operation of lawn mowers, motor boats and other gasoline-powered equipment used by homeowners and businesses alike.

CONCLUSION

My studies identify the flaws in the lifecycle modeling done for the RFS, and I have shared these findings with EPA and other agencies. The recently announced EPA Inspector General investigation of the RFS lifecycle analysis is a promising step that will hopefully shed further light on these issues. Nevertheless, my research indicates that the RFS has been harmful to the environment to date. The program has resulted in higher cumulative CO₂ emissions than otherwise would have occurred and has also damaged the environment in many other ways. In summary, careful scientific analysis indicates that the lifecycle studies used to justify the RFS were flawed. A correct carbon accounting reveals that the production and use of corn ethanol mandated by the policy has increased CO₂ emissions to date.

¹ Wang (1999).

² EPA (2009), RFS2 NPRM, Federal Register 74(99), p. 25040.

³ CARB (2010).

⁴ For example, Wang et al. (2007, 2011, 2012).

⁵ BIO (2015).

⁶ DeCicco (2013).

⁷ Lovett et al (2006).

⁸ The assumptions for this calculation are that a bushel of corn weighs 56 pounds; that its moisture content is 14% and that its carbon content is 42.1% of the dry mass.

⁹ For soybeans, the parameters are a weight of 60 lbs/bu, 12.5% moisture and 42.6% carbon.

¹⁰ DeCicco & Krishnan (2015).

¹¹ Unless otherwise noted, values are reported on a carbon rather than CO₂ mass basis, where C:CO₂ = 12:44; this includes CO₂ equivalences of other GHGs as weighted by 100-year global warming potential.

¹² Brooke et al (2010).

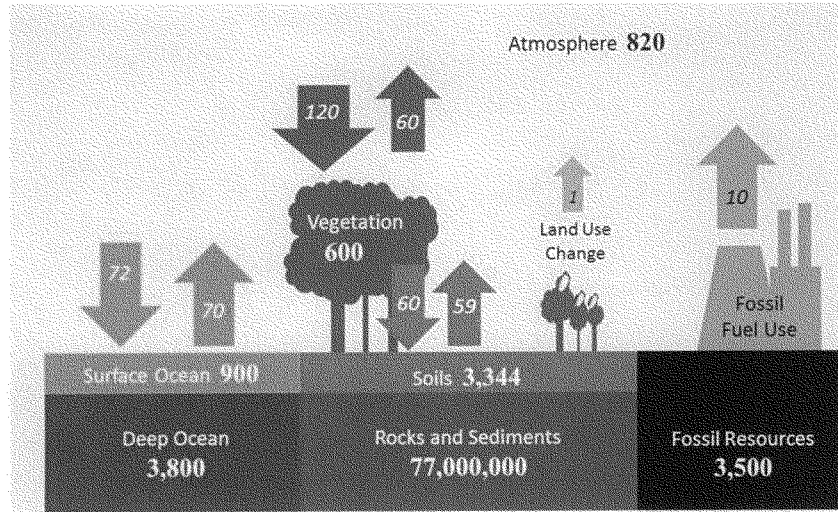
¹³ Cho (2011).

¹⁴ de Gouw et al (2015).

REFERENCES

- BIO. 2015. The Renewable Fuel Standard: A Decade's Worth of Carbon Reductions. Washington, DC: Biotechnology Industry Organization. August. www.bio.org/sites/default/files/RFS%2010%20Year%20GHG%20Reductions.pdf
- Brooke, R., G. Fogel, A. Glaser, E. Griffin and K. Johnson. 2010. Corn Ethanol and Wildlife: How increases in corn plantings are affecting habitat and wildlife in the Prairie Pothole Region. Report prepared for the National Wildlife Federation. Ann Arbor: University of Michigan, School of Natural Resources and Environment, January. <http://www.nwf.org/News-and-Magazines/Media-Center/Reports/Archive/2010/Corn-Ethanol-And-Wildlife.aspx>
- CARB. 2010. Final Regulation Order: Low Carbon Fuel Standard. Sacramento, CA: California Air Resources Board; January 12. www.arb.ca.gov/regact/2009/lcfs09/finalfro.pdf
- Cho, R. 2011. Ethanol's Impacts on Our Water Resources. New York: Columbia University Earth Institute. <http://blogs.ei.columbia.edu/2011/03/21/ethanol%E2%80%99s-impacts-on-our-water-resources/>
- Churkina, G. 2013. An introduction to carbon cycle science. Chapter 2 in D.G. Brown et al. (eds), *Land Use and the Carbon Cycle: Advances in Integrated Science, Management, and Policy*. Cambridge: Cambridge University Press.
- DeCicco, J.M. 2013. Biofuel's carbon balance: doubts, certainties and implications. *Climatic Change* 121(4): 801-814. <http://dx.doi.org/10.1007/s10584-013-0927-9>
- DeCicco, J.M. 2015. The liquid carbon challenge: evolving views on transportation fuels and climate. *WIREs Energy Environ.* 4(1): 98-114. <http://dx.doi.org/10.1002/wene.133>
- DeCicco, J., and R. Krishnan. 2015. Annual Basis Carbon (ABC) Analysis of Biofuel Production at the Facility Level. Report. Ann Arbor, MI: University of Michigan Energy Institute, August. <http://hdl.handle.net/2027.42/113068>
- de Gouw, J.A., et al. 2015. Airborne measurements of the atmospheric emissions from a fuel ethanol refinery, *J. Geophys. Res. Atmos.*, 120, 4385–4397. doi:10.1002/2015JD023138.
- EPA. 2009. Regulation of Fuels and Fuel Additives: Changes to the Renewable Fuel Standard Program; Proposed Rule. Washington, DC: U.S. Environmental Protection Agency. Federal Register 74(99): 24904ff, May 26.
- GCP. 2015. Global Carbon Project. <http://www.globalcarbonproject.org/>
- Kirschbaum, M.U.F., et al. 2001. Definitions of some ecological terms commonly used in carbon accounting, pp. 2-5 in Kirschbaum, M.U.F., and Mueller, R. (eds.) 2001. *Net Ecosystem Exchange*. Canberra, Australia: Cooperative Research Centre for Greenhouse Accounting. http://www.steverox.info/Downloads/Software/C_Accounting_Definitions.pdf
- Lovett, G.M. J.J. Cole and M.L. Pace. 2006. Is net ecosystem production equal to ecosystem carbon accumulation? *Ecosystems* 9: 1-4. <http://dx.doi.org/10.1007/s10021-005-0036-3>

- NRC. 2011. Renewable Fuel Standard: Potential Economic and Environmental Effects of U.S. Biofuel Policy. Report of the National Research Council. Washington, D.C.: The National Academies Press.
- Wang, M.Q. 1999. The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model. Argonne, IL: Argonne National Laboratory, Center for Transportation Research. See greet.es.anl.gov for latest version of the model.
- Wang, M.Q., et al. 2007. Life-cycle energy and greenhouse gas emission impacts of different corn ethanol plant types. *Environ. Res. Lett.* 2 024001 <http://dx.doi.org/10.1088/1748-9326/2/2/024001>
- Wang, M.Q., et al. 2011. Energy and greenhouse gas emission effects of corn and cellulosic ethanol with technology improvements and land use changes. *Biomass & Bioenergy* 35(5): 1885-96. <http://dx.doi.org/10.1016/j.biombioe.2011.01.028>
- Wang, M.Q., 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. <http://stacks.iop.org/ERL/7/045905>



Stocks in petagrams (10^{15} g) of carbon (PgC) in **bold serif**, flows in PgC/year in *italic sans serif*
 Sources: Churkina (2013) as updated by GCP (2015); illustration by Angelika Kurthen

Figure A-1. Major stocks and flows of the global carbon cycle.

John M. DeCicco, Ph.D.

John M. DeCicco is a Research Professor at the University of Michigan Energy Institute (UMEI) where his work examines transportation energy use and its associated climate mitigation challenges. His research addresses vehicle-fuel systems, greenhouse gas (GHG) emissions, petroleum demand and transportation energy policy as well as broader issues related to national energy and climate strategies.

Professor DeCicco's past studies of vehicle efficiency were instrumental in establishing the technical basis for recent updates to automobile fuel economy and GHG emissions standards. He pioneered consumer-oriented green car ratings in the United States, developing original evaluation methodologies and creating *ACEEE's Green Book* (launched in 1998). Current areas of focus include mitigation of CO₂ emissions from transportation fuels, notably the challenging policy questions that surround biofuels and other petroleum alternatives, and the energy implications of automated vehicles. He serves on the management committee of the university's Mobility Transformation Center (MTC) and also directs the *University of Michigan Energy Survey*.

Previously, Professor DeCicco was senior fellow for automotive strategies at the Environmental Defense Fund (EDF, 2001-2009) and transportation director for the American Council for an Energy-Efficient Economy (ACEEE, 1990-2000). He has three books and over 100 published papers, reports, and formal public comments to his credit. DeCicco holds a Ph.D. in mechanical engineering from Princeton University.

Surname pronunciation: Dë-Chëë'koe

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Research blog: CarsClimate.com

Chairman BRIDENSTINE. Thank you, Dr. DeCicco.
Mr. Coleman, you're recognized for five minutes.

**TESTIMONY OF MR. BROOKE COLEMAN,
EXECUTIVE DIRECTOR,
ADVANCED BIOFUELS BUSINESS COUNCIL**

Mr. COLEMAN. Thank you. Good morning, Chairman Bridenstine, Chairman Loudermilk, Ranking Members Bonamici and Beyer, and Members of the Subcommittee. My name is Brooke Coleman. I run something called the Advanced Biofuels Business Council.

The council represents worldwide leaders in the efforts to develop and commercialize next-generation advanced and cellulosic biofuels ranging from cellulosic ethanol made from switchgrass, which is an agricultural waste, to advanced biofuels made from sustainable energy crops, municipal solid waste, and algae. We are honored to be here today to help accurately assess the impacts of the federal Renewable Fuel Standard.

When I was thinking about my testimony today, it was quite clear that I would be giving a counter-perspective, and I want to give it. The RFS in my opinion is one of the most effective energy policies ever passed by Congress. Its notoriety stems not from its failures and unforeseen costs, as alleged, but instead its effectiveness in breaking the oil monopoly that leaves our economy and our environment at risk.

So if we're going to assess the RFS from a ten-year perspective, let's look a little bit back at what we—where we were ten years ago. We were in the middle of an MTBE crisis where the oil industry used a gasoline additive to avoid ethanol that polluted drinking water. The political deal in essence that happened on RFS1 was a way to facilitate getting MTBE out of gasoline and out of our families' drinking water, and it happened in less than a year because Congress sent a clear market signal that ethanol, a homegrown American renewable product, would replace MTBE in the marketplace.

A couple years later, Congress decided to pass a stronger RFS, and RFS2 passed in December 2007, built upon those successes and now supports more than 800,000 American jobs in 29 States, producing homegrown renewable fuels as an alternative to foreign oil.

This industry now displaces the foreign oil equivalent almost of Saudi Arabia and approximately Ecuador, and now we are innovating. I just returned from Nevada, Iowa, where DuPont just opened the largest cellulosic ethanol plant in the world. The plant will produce biofuel from corn silver, the unused part of the corn plant collected from local farms within 100 miles of the facility.

Quad County Syngenta was one of the first if not the first to produce commercial volumes of cellulosic biofuels. Their Cellerate technology produces cellulosic ethanol that is 129 percent better than gasoline on carbon emissions, reduces energy inputs, and increases the quality and quantity of production co-products like corn oil and cattle feed.

Abengoa and POET/DSM are deploying similar technologies using agricultural waste to make the lowest carbon, most innovative fuel in the world.

One more example, a member of mine, Fulcrum BioEnergy, just signed a \$60 million deal with United Airlines to make intermediate biocrude and bioJet.

Unfortunately, the program's clear record of success is often lost in the cloud of misinformation kicked up by the oil industry and the so-called researchers, fellows, and experts funded by them. Just as the oil industry has been able to finance doubt about climate change, they are doing a heck of a job financing doubt about their primary competitor in biofuels.

I want to touch on a couple of these examples, and I hope that we can touch on some of the reports and positions that we have mentioned during Q&A. The first is this notion that we are in a free market. It has been mentioned—it was mentioned by the Chairman; it was mentioned by multiple experts up here today. This is not a free market. The oil markets are controlled at the top by OPEC. They are controlled here in the United States by vertically integrated, highly consolidated oil companies.

We need the RFS because we can't get shelf space. We have to sell to our primary competitors who want to see us fail in order to gain market access. The problem is we are experiencing what it is like to be in a market-controlled environment as we speak. We don't have low gasoline prices because we have efficiency, we don't have low gasoline prices because suddenly our economy is doing something different. We have low gasoline prices because OPEC made a decision one year ago to drive down the price of fuel to put the U.S. oil boom on its heels and to kill oil rig counts in this country.

So OPEC is killing the very thing that the oil industry says we don't—is the reason we don't need the RFS anymore. In essence, the RFS is a hedge against this market power and allows our industry to grow and innovate over time with an expectation of market. If you give us a true free market, we will give you the RFS.

Finally, with my last 25 seconds, I'd like to say one of the most incredible arguments made against us is the food price argument. I have compassion, of course, for franchise owners, but the problem is that corn prices today are lower than they were when President Bush signed this law in 2007. It is hard for me to believe that the RFS is increasing food costs when the primary reason that the restaurants claim while they pull in record profits over the last ten years, this year, is that corn prices are increasing when they're actually decreasing.

So one of the things I would like to do and have the opportunity to do as we move forward in Q&A is discuss some of these issues, and I look forward to that very much. But I'm confident that the facts will prevail on the RFS discussion, and I appreciate the opportunity to speak today.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Coleman follows:]

Written Testimony of:

Mr. Brooke Coleman
Executive Director, Advanced Biofuels Business Council

Subcommittee on Environment and Subcommittee on Oversight
 Committee on Science, Space, and Technology
 U.S. House of Representatives

Renewable Fuel Standard: A Ten Year Review of Costs and Benefits

November 3, 2015

Good morning Chairman Bridenstine, Chairman Loudermilk, Ranking Members Bonamici and Beyer and members of the subcommittees. My name is Brooke Coleman and I am the Executive Director of the Advanced Biofuels Business Council (ABBC).

The Advanced Biofuels Business Council represents worldwide leaders in the effort to develop and commercialize next generation, advanced and cellulosic biofuels, ranging from cellulosic ethanol made from switchgrass, wood chips and agricultural waste to advanced biofuels made from sustainable energy crops, municipal solid waste and algae. Our members include those operating production facilities, those augmenting conventional biofuel plants with “bolt on” or efficiency technologies, and those developing and deploying the technologies necessary to make advanced biofuel production a commercial reality.

We are honored to be here today to help accurately assess the impacts of the federal Renewable Fuel Standard (RFS) now ten years into the program. My primary role today is to talk about the continued development of the advanced biofuels industry. However, we would also like to provide context for the ongoing discourse about the rationale for, and efficacy of, ongoing federal policy support for biofuels.

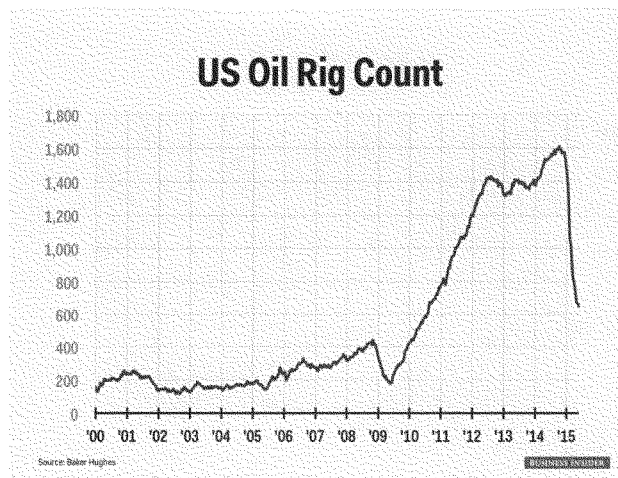
1. Oil dependence is still a problem, and recent trends are not changing the big picture

If there was a central underpinning of Congressional support for the RFS ten years ago – and again when it was amended in 2007 – it was bipartisan support for reducing U.S. dependence on foreign oil. Between 2000 and 2012, the cumulative total of U.S. spending on imports of goods and services exceeded U.S. export earnings by \$7.1 trillion dollars – U.S. trade deficits in crude oil and refined petroleum products were \$2.87 trillion during this period, or 40.5 percent of the cumulative deficit in all goods and services (petroleum accounted for 55 percent of the trade deficit in 2012).¹

¹ U.S. Department of Commerce, Bureau of Economic Analysis, International Data, pulled October 2015. See <http://www.bea.gov/international/index.htm>.

One argument made against the RFS is the United States no longer has a serious issue with foreign oil dependence due to recent trends in U.S. and global oil markets. However, it would be a mistake to confuse the short-term economic benefits of recent increases in U.S. oil production and decreases in gasoline prices with long-term energy security for the following reasons:

- **Low gasoline prices are occurring primarily because controlling interests in the Organization of the Petroleum Exporting Countries (OPEC) are using their market power to snuff out the U.S. oil boom.** Certain members of OPEC decided in late 2014 to allow global crude oil prices to slip in part to snuff out competition and reclaim market control. In simple terms, colluding to lower the price of oil changes the economics on U.S. oil production, which cannot compete with today's oil prices. A recent Bloomberg report entitled "OPEC Is About to Crush the U.S. Oil Boom" notes that the strategy is working.² In just 12 months, OPEC has knocked U.S. oil production back significantly. OPEC's September report openly acknowledges the effort and its effects: "In North America there are signs that US production has started to respond to reduced investment and activity. Indeed, all eyes are on how quickly US production falls."³ In essence, policymakers would be unwise to be lulled into a false sense of security by low gasoline prices and a U.S. oil boom now paralyzed by OPEC.

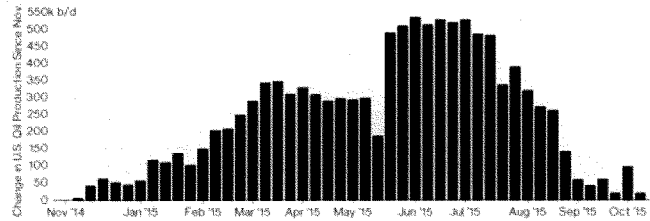


² See: <http://www.bloomberg.com/news/articles/2015-10-20/after-year-of-pain-opec-close-to-halting-u-s-oil-in-its-tracks>.

³ See: http://www.opec.org/opec_web/static_files_project/media/downloads/publications/MOMR_September_2015.pdf

The Fruit of OPEC's Labor

U.S. oil output has risen and fallen and is now close to the level seen at OPEC's Nov. 27 meeting.

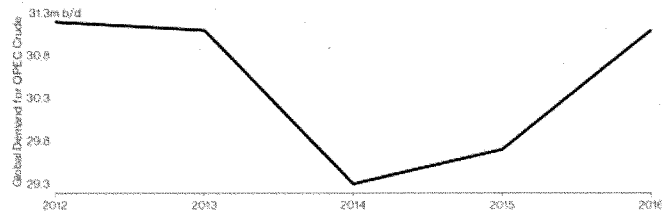


Source: U.S. Energy Information Administration

Bloomberg

OPEC Loses (and Reclaims) Market Share

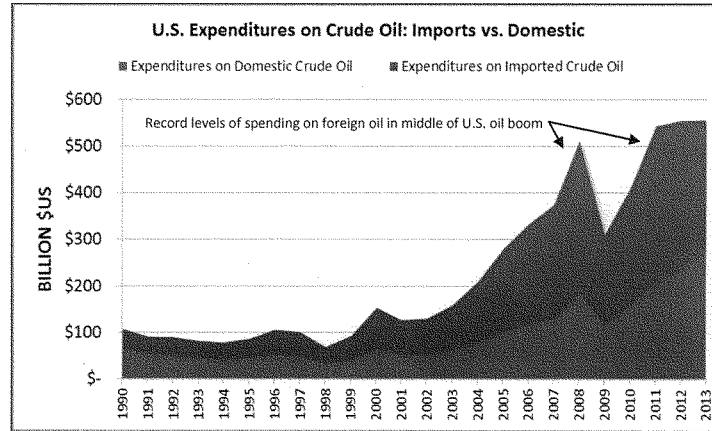
U.S. supply ate into demand for OPEC's crude. Now the group is on the rise again.



Source: The International Energy Agency

Bloomberg

- Even if a significant percentage of “new” U.S. oil production survives OPEC’s predatory strategy, the vulnerability of the U.S. economy to foreign oil dependence is all about price. Even if U.S. oil production stabilizes, OPEC will reduce output at some point and crude oil prices will increase sharply. If the U.S. continues to consume far more oil than it produces (inevitable) and oil prices increase (inevitable), consumers will continue to spend enormous sums of money on foreign oil and the U.S. economy will continue to suffer at the hands of its dependence on foreign oil. The problem was evident from 2007-2013. U.S. consumers were spending more and more money buying oil from U.S. producers as U.S. production increased, but consumers were also spending more and more money on foreign oil because oil prices were so high and increasing at the same time. The magnitude of the economic drain can be staggering. Americans transferred nearly \$1 trillion to OPEC members during the oil price spike of 2008, in just 6-8 months. The figure below demonstrates how increasing U.S. oil production does not necessarily protect the U.S. economy and consumers from unsustainable and dangerous levels spending on foreign oil.



- **Recent headlines notwithstanding, the federal government cannot assess accurately the energy security and economic risks of oil depletion.** When assessing energy security risk as associated with oil, Congress should be aware that: (1) there is virtually no transparency when it comes to “source data” for the myriad of claims about future oil markets made on an everyday basis by analysts in the sector; and, (2) the oil industry and its analysts have a long history of seriously overestimating the vastness of its claimed reserves.
 - With regard to transparency, Russia (one of the world’s largest conventional oil producers) declared all oil data a state secret in 2004. Neither Saudi Arabia nor Venezuela share data publicly when they make claims about future capacity. This is a concern in part because “there are political and financial pressures to misreport figures.”⁴ OPEC member quotas are based on reported reserves; the higher the reserve, the higher the quota relative to other members. OPEC members also face the challenge of attracting investment, from both government and outside sources. As reported in a recent peer-reviewed article in *Science*, “there are fears that Saudi oil reserves (and others) may have been over-estimated by at least 40%,” and, “[a]t best Saudi reserves are seen as near maturity,” given that 7 million barrels of sea water are being injected in the main field on a daily basis to increase flow.⁵ The oil industry and OPEC also has the incentive of exaggerating reserves to weaken political and market interest in developing alternatives. OPEC first admitted its focus on

⁴ Chapman, I., *The end of Peak Oil? Why this topic is still relevant despite recent denials*, Energy Policy (2013). <http://dx.doi.org/10.1016/j.enpol.2013.05.010> at p. 3.

⁵ See Chapman, I., *The end of Peak Oil? Why this topic is still relevant despite recent denials*, Energy Policy (2013). <http://dx.doi.org/10.1016/j.enpol.2013.05.010> at p. 4.

alternative fuels in 2006, when it openly admitted that its price setting is designed partially to deter their use.⁶

- With regard to overestimation, recent statements about game changing oil reserves should be regarded carefully because we have heard similar claims in the past about Alaska and the Gulf of Mexico. In 2002, the U.S. Geological Survey estimated that the National Petroleum Reserve-Alaska contained 10.6 billion barrels (mean estimate) of oil. In late 2010, USGS revised their estimate to 896 million barrels – a downward adjustment of roughly 90 percent.⁷ When BP discovered the Thunder Horse field in the Gulf of Mexico in 1999, they estimated that the reserve contained more than a billion barrels of oil. The discovery fundamentally changed projections about U.S. oil capacity and was credited with changing the global price of oil. BP and partners built the largest oil platform in the Gulf. However, oil extraction was delayed by more than 3 years due to technical difficulties, and according to a consultant for oil exploration, “Thunder Horse hasn’t reached anywhere near its expected potential.”⁸ Tight oil plays (e.g. the Bakken) face similar challenges. As noted in an April 2013 article in *Science*, “data on reserves of many unconventional sources are now regarded as optimistic, compounded by thermodynamic inefficiencies in the processes, often relying on high energy inputs, will ultimately limit the net gain to provide fuel quantities well below predicted figures.”⁹ As a point of reference, the 4.3 billion barrels of technically recoverable tight oil from the Bakken (as estimated by the U.S. Geological Survey) is less than one year’s worth of crude oil consumption by U.S. refineries. And investors are running away from tight oil in the current marketplace, due to the aforementioned market conditions imposed by OPEC.

2. The United States is not going to “free market” its way out of its foreign oil dependence problem or emerge as the global leader in advanced biofuel development without aggressive policies to attract investment

In a competitive marketplace, the increasing cost and scarcity of crude oil would play to the benefit of alternatives such as advanced biofuels. That is, the declining production cost of biofuels would attract investment over the increasing cost and scarcity of petroleum, and new alternative fuel products would emerge to replace petroleum. In essence, free markets reward innovation. However, U.S. and global liquid fuel markets are not free markets. As discussed, they are distorted by the price-controlling behavior of OPEC, driven by policy as opposed to price, and are dominated by highly-

⁶ See <http://www.foxnews.com/story/0,2933,222840,00.html>

⁷ See http://www.newsminer.com/news/alaska_news/oil-estimates-slashed-for-national-petroleum-reserve-alaska/article_999d982e-5823-59c2-82f7-8b6bb65d8fd6.html.

⁸ See <http://www.theoilbarrel.com/node/6415>.

⁹ Chapman, I., *The end of Peak Oil? Why this topic is still relevant despite recent denials*, Energy Policy (2013). <http://dx.doi.org/10.1016/j.enpol.2013.05.010>.

consolidated and vertically integrated incumbent oil companies that continue to receive the large majority of federal subsidies to the U.S. fuel energy sector. While many of these policies lie outside of the jurisdiction of these committees, the RFS must be assessed in its proper context – as a fuel energy policy designed to address problems in motor fuel markets – to be properly understood.

For example, the largest leaseholder in the Bakken told the Senate Finance Committee in 2012 that “[w]ithout the current capital [federal tax] provisions in place ... that let us keep our own money ... we would not have been able to fail over and over again, which is what it took to advance the technology needed to produce the Bakken and numerous other [tight oil/fracking] resource plays across America.”¹⁰ It is critical to point out that cellulosic biofuel producers and “tight oil” producers have something in common; they are both endeavoring to supply the country and world markets with what the Energy Information Administration (EIA) terms “unconventional fuel.” While facing similar technology risk, the cellulosic biofuels industry does not receive the same tax treatment as companies like Continental Resources (from the perspective of value or duration).

More broadly, the fossil fuels industry enjoys the benefit of a number of unique federal tax allowances – unavailable to renewable fuels – that de-risk and lower the cost of the ongoing development of oil and gas resources relative to other sources of liquid fuel. For example, a recent study estimates that fossil fuels received 70 percent of U.S. federal energy subsidies between 2002 and 2008, to the tune of more than \$70 billion during this time period.¹¹ This number does not include the loopholes in oil and gas laws that, according to the Government Accountability Office (GAO), allowed petroleum companies to forego paying \$53 billion in royalty payments, over just four years, for extracting natural resources from lands owned by the American taxpayer. The federal government also helps incumbent industries develop new technologies. According to a recent Congressional Research Service report, [f]or the period from 1948 through 2012, 11.6% of Department of Energy R&D spending went to renewables, 9.7 % to efficiency, 25% to fossil energy, and 49.3% to nuclear.¹² According to a recent report, “energy innovation has driven America’s growth since before the 13 colonies came together to form the United States, and government support has driven that innovation for nearly as long.”¹³ Governmental support drove investment in coal, timber, engine innovations, land settlement for resource extraction and other forms of innovation in the 19th and 20th centuries, and domestic energy consumption and GDP have tracked closely for at least 200 years.¹⁴ Given the importance of energy security, we believe that the federal government’s engagement in domestic energy development is appropriate, and there is a clear case for making advanced biofuels a focal point of that effort going forward.

¹⁰ <http://www.finance.senate.gov/imo/media/doc/Hamm%20Testimony1.pdf>, p. 2.

¹¹ See http://www.elistore.org/Data/products/d19_07.pdf.

¹² See <http://www.fas.org/spp/crs/misc/R522858.pdf>

¹³ See note 2, at p. 11.

¹⁴ *Id.*

3. The RFS has a clear record of success when it comes to achieving its economic and environmental objectives in the face of a perpetually uncertain and non-competitive global oil marketplace.

Any objective analysis of the RFS shows that the program has met or exceeded expectations when it comes to the primary objectives set forth by Congress in passing the law:

- ***Petroleum Dependence and Gas Prices***

While motor fuel prices are temporarily low as a result of OPEC's decision to weaken competition in the global oil marketplace, most of the last ten years have been marked by historically high oil prices. The primary reason for higher prices is the reduced availability of cheap crude oil supply relative to increased demand, and the market response (both direct and via speculation) to this dynamic. The RFS has driven the development of a new alternative fuel industry during a period of very high economic vulnerability and fuel prices in the United States. Speaking to this dynamic, energy economist Philip K. Verleger (who served as an advisor on energy issues to both the Ford and Carter administrations) recently said, "the U.S. renewable fuels program has cut annual consumer expenditures in 2013 between \$700 billion and \$2.6 trillion ... [t]his translates to consumers paying between \$0.50 and \$1.50 per gallon less for gasoline."¹⁵ Mr. Verleger notes that the RFS put the equivalent of Ecuador's world oil output on the market during a period of extreme tightness:

Had Congress not raised the renewable fuels requirement, commercial crude oil inventories at the end of August [2013] would have dropped to 5.2 million barrels, a level two hundred million barrels lower than at any time since 1990 ... [t]he lower stocks would almost certainly have pushed prices higher. Crude oil today might easily sell at prices as high as or higher than in 2008. Preliminary econometric tests suggest the price at the end of August would have been \$150 per barrel."

Renewable fuels reduce gas prices in two ways: (1) the predominant fuel used to date to meet the RFS is ethanol, which has been \$.60 to \$1.00 cheaper per gallon than wholesale gasoline for the bulk of the time that the RFS has been in place; and, (2) by adding supply to very tight oil markets, which reduces the impact of both perceived and real disruptions to supply and curtails speculative engagement by the markets. One would have to stand basic economics on its head to argue that reducing the use of renewable fuels will not exacerbate petroleum dependence and increase gas prices.

- ***Economic Development and Job Creation***

Given the inherent uncertainties with analyzing the economic impact of any industry, the most effective way to assess the job and economic development impacts of the RFS is to consider

¹⁵ See http://www.pkverlegerllc.com/assets/documents/130923_Commentary.pdf.

multiple reports conducted by different entities. It is clear, however, that the RFS triggered the development of a robust, homegrown renewable energy industry. For example, a recent RFS footprint analysis conducted by Fuels America concluded that the RFS now creates \$184.5 billion of economic output, 852,056 jobs, and \$46.2 billion in wages and \$14.5 billion in taxes each year in the United States.¹⁶ A recent assessment published by the Oak Ridge National Laboratory found that the RFS is producing significant positive economic effects (“the net global economic effects of the RFS2 policy are positive with an increase of 0.8% in U.S. gross domestic product (GDP) in 2022...[well in excess of \$100 billion]” stemming from the fact that the RFS reduces crude oil prices, decreases crude oil imports, increases gross domestic product (GDP), and is having only minimal impact on global food markets and land use.¹⁷ Roughly half of the projected economic benefits will stem from advanced biofuel production. The economic picture is even more robust in certain states. The RFS supports more than 70,000 jobs and \$5 billion in wages in Iowa, 60,000 jobs and \$3.7 billion in wages in California, 39,000 jobs and \$3.9 billion in wages in Ohio, and more than 28,000 jobs in Kentucky (e.g.) and other states not commonly associated with the biofuels industry.¹⁸

While much of the economic footprint of the RFS stems from the production and use of first generation biofuels, the advanced biofuels industry is deploying commercially today. And the scale of opportunity is enormous. According to the Sandia National Laboratory, the U.S. could produce 75 billion gallons per year of cellulosic biofuels (one subset of the advanced biofuel industry, and 4.5 times the amount of cellulosic biofuel required by the RFS) without displacing food and feed crops.¹⁹ This would be enough cellulosic biofuel alone to displace more than half of gasoline demand. A Bloomberg analysis released in 2012 looked at eight select regions to assess the potential for next generation ethanol production.²⁰ The study found that eight regions -- Argentina, Australia, Brazil, China, EU-27, India, Mexico and the United States -- could displace up to 50 percent of their demand for gasoline by 2030 making ethanol from a very small percentage of its each region’s agricultural residue supply. The economic opportunity, with specific regard to advanced biofuel production, is robust. First, roughly half of the economic benefits discussed in the Oak Ridge paper above are from advanced biofuels. An RFS study by Bio-Economic Research Associates (commissioned by BIO) concluded that compliance with the advanced biofuels requirement of the RFS will create roughly 800,000 direct and indirect jobs.²¹

The cellulosic biofuels industry is acutely aware of public criticism about our rate of deployment. But we would encourage the committees to focus closely on the clear visual and data-statistical evidence of real progress in our industry. From an RFS perspective, the production capacity

¹⁶ See http://www.fuelsamerica.org/pages/fuels_america_releases_new_footprint_analysis

¹⁷ See <http://www.future-science.com/doi/abs/10.4155/bfs.12.60?journalCode=bfs>.

¹⁸ <http://fuelsamerica.guerrillaeconomics.net/>; http://www.fuelsamerica.org/pages/fuels_america_releases_new_footprint_analysis

¹⁹ See https://share.sandia.gov/news/resources/news_releases/biofuels-can-provide-viable-sustainable-solution-to-reducing-petroleum-dependence-say-sandia-researchers/.

²⁰ See http://www.novozymes.com/en/sustainability/benefits-for-the-world/biobased-economy/white-papers-on-biofuels/Documents/Next-Generation%20Ethanol%20Economy_Executive%20Summary.pdf

²¹ See U.S. Economic Impact of Advanced Biofuels Production: Perspectives to 2030, Bio-Economic Research Associates.

of the broader advanced biofuels industry (i.e. all types of fuel qualifying as advanced biofuel under the RFS) exceeded the 2013 statutory target of 2.75 billion gallons established by Congress via RFS2.²² U.S. EPA relied on the administrative flexibility provided to the agency by Congress to allow more bio-/renewable diesel and less cellulosic biofuel to be used to meet the 2013 standard. But delay should not be interpreted to mean failure when it comes to the commercial deployment of the most carbon-reductive, innovative fuels in the world. The ABBC's website (AdvancedBiofuels.org) details roughly two dozen advanced/cellulosic biofuel projects in the United States and abroad. And there are numerous U.S. commercial facilities now in commissioning or production phases, including:

- Quad County/Syngenta Cellerate (Galva, IA): Quad County Corn Processors and Syngenta formed a joint venture to produce 2 million gallons of cellulosic ethanol (from corn fiber) at their first generation ethanol plant in Iowa and license the technology elsewhere. The facility is producing and selling cellulosic ethanol today that reduces carbon emissions by more than 100 percent in comparison to gasoline, and uses a technology that also decreases energy use while increasing the production of valuable co-products like corn oil.
- DuPont (Nevada, IA): DuPont just held a grand opening for its ~ \$225 million cellulosic ethanol facility in Nevada, Iowa. The 30 million gallon per year capacity plant is the largest cellulosic ethanol plant in the world, and will use corn stover biomass (an agricultural "waste" stream) secured from up to 500 farmers within a 30-mile radius around the facility. The project created 1000 construction jobs and will maintain 85 permanent jobs.
- Abengoa (Hugoton, KS): The global renewable energy company has completed construction of a 25 million gallon per year plant in southwest Kansas that will produce ethanol and renewable electricity from agricultural waste. The company has contracted with local farmers to secure the roughly 1,100 dry tons per day of waste feedstock needed to run the plant, and is in position to replicate its successes quickly via its other ethanol plants.
- POET/DSM (Emmetsburg, IA): Project Liberty – a joint venture between POET and Royal DSM – will make ethanol from corn cobs, leaves, husk and stalk that pass through the combine during corn harvest. The 25 million gallon per year plant will produce enough renewable electricity, as a co-product, to power itself and the POET grain ethanol plant next door. POET owns and operates 27 first generation ethanol facilities; most of which are candidates to deploy the cellulosic biofuel production technologies developed in Emmetsburg very quickly.
- Novozymes (Blair, NE): Novozymes, an advanced bio-products and sustainable agriculture company, operates the largest industrial bio-enzymes production facility in the United States in Blair, NE. The facility produces enzymes for conventional and advanced biofuels.

²² See <http://www.epa.gov/otag/fuels/rfsdata/2013emts.htm>

- **Climate Change Emissions**

The vast majority of independent analysis (not directly or indirectly industry funded) confirms that most types of first and second generation biofuels reduce climate change emissions, in many cases by very large amounts, including analysis conducted by U.S. EPA, the California Air Resources Board, the U.S. Department of Energy and top energy labs such as Argonne and Oak Ridge National Laboratories.

For example, the latest peer-reviewed analysis coming out of the U.S. Argonne National Laboratory shows that all types of ethanol – the type of renewable fuel usually scrutinized for its GHG emissions – have significantly lower lifecycle greenhouse gas emissions than petroleum, even with penalty for indirect land use change. Advanced ethanol, in particular, is: (a) vastly more carbon reductive than petroleum; (b) vastly more carbon reductive than the baseline used to analyze the RFS – 2005 gasoline; and, (c) significantly more carbon reductive than technologies often regarded to be the most innovative (electric drive, hydrogen).

**Latest Well-to-Wheels Greenhouse Gas Emissions Reduction
Relative to Average Petroleum Gasoline**

WTW GHG emission reductions	Corn	Sugarcane	Corn stover	Switchgrass	Miscanthus
Including LUC emissions	19–48% (34%)	40–62% (51%)	90–103% (96%)	77–97% (88%)	101–115% (108%)
Excluding LUC emissions	29–57% (44%)	66–71% (68%)	89–102% (94%)	79–98% (89%)	88–102% (95%)

Source: Argonne National Laboratory²³

The carbon benefits of increasing the use of renewable fuels are actually even greater when you take into account the fact that renewable fuels replace marginal (rather than average) gallons of petroleum. To illustrate, Petrobras chief Jose Sergio Gabrielli has declared that “the era of cheap oil is over.” This means that oil companies are shifting very quickly to an increasing reliance on more expensive and riskier “unconventional” fuels – including tight oil (e.g. the Bakken), deep water (e.g. Gulf of Mexico, Deep Water Horizon) and Canadian tar sands (e.g. Keystone) – to meet the global demand for fuel energy.²⁴ These fuels are more carbon intensive than the “2005 average petroleum” legislated by Congress in 2007, and replacing RFS renewable fuel gallons with marginal petroleum gallons will result in backsliding with regard to both raw GHG emissions and the Obama Administration’s commitment to cut carbon emissions to “protect the health of our children and move our economy toward American-made clean energy sources that will create good jobs and lower home energy bills.”²⁵

²³ See http://iopscience.iop.org/1748-9326/7/4/045905/pdf/1748-9326_7_4_045905.pdf

²⁴ See http://www.eia.gov/forecasts/aeo/MT_liquidfuels.cfm#crude_oil

²⁵ See <http://www.whitehouse.gov/the-press-office/2013/06/25/fact-sheet-president-obama-s-climate-action-plan>

There are a number of recent studies that have looked at the real world “marginal” impact of increasing the use of renewable fuels. For example, a 2014 analysis conducted by Life Cycle Associates in California concluded that today’s corn ethanol – assessed by EPA in 2010 to be 21 percent better than 2005 petroleum with regard to lifecycle GHG emissions – is 32 percent better than 2012 average petroleum and 37-40 percent better than petroleum derived from tar sands and fracking. The report notes that using less renewable fuel will increase the use of these unconventional types of oil:

The majority of unconventional fuel sources emit significantly more GHG emissions than both biofuels and conventional fossil fuel sources ... [t]he biggest future impacts on the U.S. oil slate are expected to come from oil sands and fracking production ... significant quantities of marginal oil would be fed into U.S. refineries, generating corresponding emissions penalties that would be further aggravated in the absence of renewable fuel alternatives.”

Source: Life Cycle Associates, January 2014

These findings are consistent with recent (lower resolution) assessments by federal agencies. For example, a recent report released by the Congressional Research Service (CRS) found that Canadian oil sands are 14-20 percent more carbon intensive than the 2005 EPA baseline.²⁶ As such, it is an inescapable reality that any proposal to reduce renewable fuel blending is a proposal to increase U.S. consumption of high carbon intensity, unconventional oil.

4. Conclusion: Congress should not legislate on the RFS and allow the program to deliver on its economic and environmental record and promise

We are often asked by members of Congress if there are ways to accelerate the deployment of the advanced biofuels industry. We would like to respectfully suggest the following:

- **A Stronger Commitment to No Backsliding/Policy Certainty Would Help Attract Project Finance to U.S. Advanced Biofuel Markets**

The U.S. has a number of well-designed policies in place that are driving innovation in the biofuels sector, including but not limited to the RFS, several important tax provisions currently being considered for extension (e.g. the second generation biofuel producer credit, the special depreciation allowance for second generation biofuel plant properties, etc.) and the critical energy title programs in the farm bill. The issue around these policies is not their design; but rather, their dependability as related to legislated permanence (i.e. the perpetual risk of expiration) and funding (i.e. the perpetual risk that they are de-funded). By contrast, federal government support for the

²⁶ See <http://www.fas.org/srg/crs/misc/R42537.pdf>

fossil fuels industry – primarily through the federal tax code but also indirectly via infrastructure and other policies – is almost always permanent. This clear inequity has the practical effect of increasing the risk of investing in renewable versus fossil energy, which in turn drives the development of clean energy overseas to countries with more durable policy commitments (e.g. China, Brazil, etc.). Ironically, policy risk is often more perceptive than substantive and incumbents leverage this investment reality to create a perpetual cloud of uncertainty around landmark biofuel programs. As such, it is absolutely critical to our industry to protect landmark programs – RFS and farm bill energy title among them – at both the messaging and substantive levels. Changing the rules in the middle of the game for any of these policies – however framed politically – has the practical effect of spooking investors and making the U.S. less competitive globally. Ultimately, it will also be critical to reform the federal tax code to, at minimum, remove the inequities that distort investment markets.

- **Transparency in RFS RIN Trading Markets Would Help Reduce Unnatural Volatility in RIN Markets and Put the RFS on a More Stable Path Going Forward**

The RFS is designed to drive investment in advanced biofuels and more renewable fuel blending (including infrastructural development). The primary driver of additional biofuel market access within the RFS is the RIN. A RIN is an identification number generated when a gallon of RFS-qualifying renewable fuel is produced. The RIN is attached to the renewable fuel gallon at the point of sale to obligated parties (i.e. oil companies), but can be separated (from the liquid gallon) by obligated parties and sold for whatever price the market will bear. The primary value of the RIN program, other than facilitating compliance accounting and some level of compliance flexibility, is its ability to increase market access for renewable fuels. That is, when an oil company refuses to blend more liquid biofuel, they can buy a RIN on the open market instead. If a significant number of oil companies refuse to blend liquid gallons and seek RINs on the open market, RIN trading and values will increase as a result of their affirmative non-compliance. Higher RIN prices should not be considered a bug in the RFS; they actually provide an extra incentive for other obligated parties to blend liquid renewable fuel gallons, because they acquire a valuable and saleable RIN free of charge with each gallon of renewable fuel purchased. In essence, higher RIN values reward good behavior and facilitate the objectives of the RFS.

Some oil companies and refiners are trying to miscast higher RIN prices as a potential cause for higher gas prices. The Babcock analysis discussed above – which was not funded by industry – clearly shows that higher RIN prices do not increase gas prices primarily because: (a) RINs enter the marketplace free-of-charge with each gallon of renewable fuel; (b) RIN values are created by trading among obligated parties, so it is often the oil industry itself on the profit side of the RIN transaction;²⁷ and, (c) higher RIN prices actually *reduce* the cost of a gallon of renewable fuel at the wholesale level, which erases the threat of higher gas prices at the retail level.

²⁷ See <http://www.ethanolrfa.org/exchange/entry/what-do-big-oils-quarterly-earnings-say-about-the-real-impact-of-rins-on-u/>

That said, the current RIN trading marketplace lacks transparency to the point in which it is difficult for traders and obligated parties to make trades based on dependable, real-time information. While it is not clear what percentage of the 2013 spike in D6 RIN prices came as a result of the lack of transparency in RIN markets – either through hoarding from (blind) “shortage mentality” or other strategies – it is clear that a non-transparent RIN marketplace could be a liability for the program, and in turn, a point of uncertainty for advanced biofuel investing. We believe that federal agencies (e.g. EPA in collaboration with the CFTC) could set up an electronic trading platform – similar to those used in other commodity markets – to ensure that RIN positions and trades are disclosed in real time. We believe this can be done expeditiously and would have an immediate calming effect in the marketplace with regard to RIN volatility and predictability.

- **Market Access to Allow Fair Competition**

There are a number of incongruencies between the goal of increasing the production of advanced biofuels and the regulations that largely dictate outcomes in U.S. liquid fuel markets. It is a basic economic notion that emerging advanced bio-based fuels need a market (i.e. demand) to deploy at commercial scale. And yet, EPA has yet to resolve a number of roadblocks for the increased use of renewable fuels in gasoline.

For example, EPA has thus far refused to address regulatory inconsistencies with regard to vapor pressure for E15 that are contributing to the slower than necessary deployment of the fuel. There is no real substantive issue that supports treating E10 and E15 differently with regard to vapor pressure, but the practical effect is gasoline retailers cannot offer E15 year round. This discourages the utilization of pump infrastructure for marketing and selling of E15. We are also concerned about EPA’s ongoing refusal to provide proper credit for Flex Fuel Vehicles (FFVs) in the updated CAFE fuel efficiency standards. Ongoing devaluation and uncertainty with regard to FFV credits dissuades automakers from making simple adjustments to future vehicles to allow price-driven fungibility in gasoline/ethanol markets. Ensuring that every new car manufactured in the U.S. is an FFV would cost consumers next to nothing, but would open up new frontiers for the advanced ethanol industry. This is just one example applicable to ethanol, but it is important to understand that all petroleum alternatives currently face the challenge of having to go through their competitors to reach consumers. Regulatory agencies must be careful not to make market access more challenging.

It is both an exciting and challenging time for the cellulosic biofuels industry and the advanced biofuel industry as a whole. The technology is commercial ready and the industry is deploying at commercial scale. We are embarking on the process of securing efficiencies that can only be achieved via commercialization (i.e. the “experience curve”) and economies of scale. When the corn ethanol industry started building plants, their production costs exceeded their feedstock costs by a large margin. However, corn ethanol producers have reduced their production costs by

roughly 60 percent since the first commercial plants were built in the 1980s. Likewise, some solar companies have seen a similar 60-70% production cost reduction in just the last ten years, as capacity has increased significantly. The U.S. is in position to lead the world when it comes to the development of advanced, low carbon biofuels. And yet, we face as much policy uncertainty as we ever have before, almost always generated by fabricated claims about renewable fuels and the RFS. Incumbents in the fuel energy space are going after our tax provisions, our farm bill programs, and of course, the RFS. It is important to understand that this is happening because of the effectiveness, rather than ineffectiveness, of these programs to drive consumer choice at the pump.

We very much appreciate the opportunity today to highlight the fact that advanced biofuels are emerging, that renewable fuels are creating jobs and driving pump prices down, and efforts to undercut biofuel programs are occurring because these programs are working, not vice-versa.

Thank you for the privilege of speaking before you today. I look forward to your questions. We have attached some information below to shed light on much of the misinformation associated with implementation of the RFS. Thank you.

ATTACHED:

Attachment A: Easy Answers to a Number of Complex Allegations Made Against Biofuels

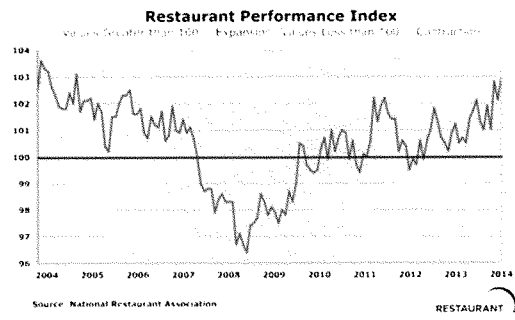
Attachment B: Further Analysis of Gas Price Impact of the RFS

Attachment A

Easy Answers to a Number of Complex Allegations Made Against Biofuels

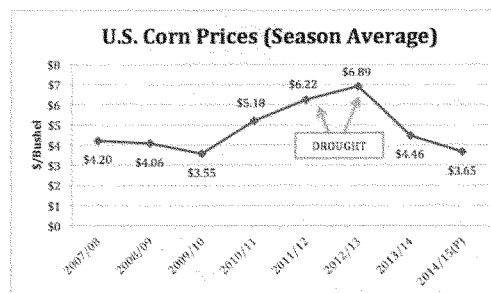
1. "Restaurants and the broader food industry are hurting as a result of the RFS."

The restaurant industry is not hurting. Chain restaurants, which are outspoken against the RFS, are actually posting some of the best returns in a decade (with the RFS in place).



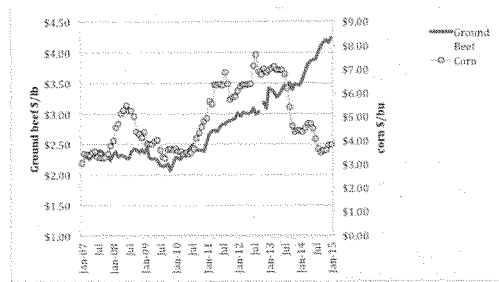
2. "Biofuel programs increase feed prices and hurt the livestock industry."

Corn prices today are lower than corn prices on the day that President Bush signed RFS2 in December 2007. And it does not appear that livestock is suffering. The gross farm value of livestock, dairy and poultry production has increased from an average of \$123 billion per year before passage of the RFS to roughly \$148 billion per year since 2008. The average profit margin for livestock and poultry values over purchased feed costs has increased by nearly \$6 billion per year on average.



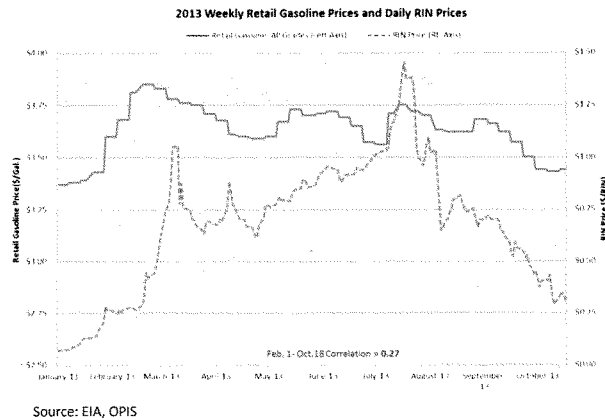
If livestock products like beef are so affected by the RFS and corn prices, why then is the price of beef not coming down with corn prices?

Corn Price vs. Ground Beef



3. The 2013 RFS-RIN price spike showed that the RFS is a liability when it comes to gas prices

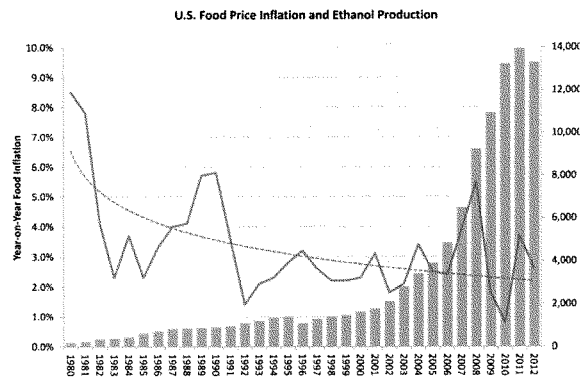
Higher RIN prices do not increase gas prices. Many oil companies are now on record on earnings calls attesting to the fact that they are the ones *profiting* from higher RIN values, because they get the RIN for free when they buy a gallon of renewable fuel and can sell it to other obligated parties.²⁸



²⁸ See: <http://www.fuelsamerica.org/blog/entry/something-funny-about-those-oil-company-profits>

4. "Biofuels have increased food prices in the grocery aisle."

Grocery aisle food prices are not increasing, and they are decreasing *against* increases in ethanol use.

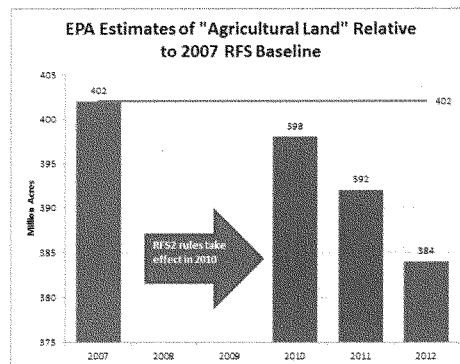


5. "E15 is a threat to boaters and small engines."

E15 is an option at the pump, as opposed to the new baseline fuel, and small engines and boats are not approved to use E15. Boaters and small engine users can simply fill up with other fuel to avoid higher ethanol blends.

6. "The increased use of biofuels has resulted in the plowing of virgin and pristine land."

The national agricultural footprint is not expanding, it's contracting due to efficiency gains.



Update: Total cropland was 336 million acres in 2013 and 340 million acres in 2014 (USDA, 2015)

There is always some regional variation with regard to agricultural land use, but recent allegations about prairie conversion are misleading:

- Critics of the RFS point to reduced acreage in the Conservation Reserve Program (CRP), but acreage in the program went down commensurate with the funding cut in the 2008 farm bill.
- Allegations about “15 million more corn acres planted” are true, but should be considered relative to the more than 20 million acres of wheat taken out of production during the same period. Crops are generally rotating, not expanding.
- Wheat acres dropped more than corn acres increased in the specific states that the Associated Press claimed were using pristine lands for corn ethanol production.

7. “Biofuels do not decrease climate change emissions.”

The vast majority of independent analysis (not funded by or associated with the oil industry) confirms that most types of first and second generation biofuels reduce climate change emissions, including analysis conducted by U.S. EPA, the California Air Resources Board, the U.S. Department of Energy and top energy labs such as Argonne and Oak Ridge.

**Latest Well-to-Wheels Greenhouse Gas Emissions Reduction
Relative to Average Petroleum Gasoline**

WTW GHG emission reductions	Corn	Sugarcane	Corn stover	Switchgrass	Miscanthus
Including LUC emissions	19–48% (34%)	40–62% (51%)	90–103% (96%)	77–97% (88%)	101–115% (108%)
Excluding LUC emissions	29–57% (44%)	66–71% (68%)	89–102% (94%)	79–98% (89%)	88–102% (95%)

Source: DOE Argonne National Laboratory²⁹

There are very few studies claiming that biofuels increase carbon emissions. These studies are often oil industry funded or associated with a group funded by the oil industry, and/or rely on questionable assumptions unsupported by the mainstream scientific community.

For example, the “Science” analysis used in recent oil industry television commercials is one conducted in 2008 by an analyst then affiliated with the German Marshall Fund and now affiliated with the World Resources Institute – both oil industry funded groups. The analysis drives a large land use carbon penalty by assuming in the modeling that the U.S. uses *double* the corn ethanol ever required by the RFS. The work is not part of the conversation anymore when it comes to accurate carbon accounting – as higher resolution, independent work has essentially debunked the report.

²⁹ See http://lopscience.iop.org/1748-9326/7/4/045905/pdf/1748-9326_7_4_045905.pdf

Attachment B

Further Analysis of Gas Price Impact of the RFS

The focal point of the oil industry's attempt to escape their obligations under the RFS is to cast their willful non-compliance with the law as involuntary (i.e. because of the blend wall) and in the interest of protecting consumers (i.e. because higher RIN prices are a "cost of compliance" that will be passed on to consumers). These arguments are not based in fact.

With regard to the ability to blend more renewable fuels, obligated parties can blend more E15 (15% ethanol by content; a high-octane premium fuel approved by EPA for use in two-thirds of the vehicles on the road today), E85 (85% ethanol by content), biodiesel (most engines are warrantied to handle higher biodiesel blends), and/or more renewable diesel. With specific regard to E85, there are enough "flex fuel" vehicles on the road to consume at least 3 billion additional gallons of ethanol if, according to independent analysis, price per mile costs aligned with E10.³⁰ As discussed, market conditions and higher D6 RIN prices (which happened as a result of the oil industry's affirmative decision not to blend more E85 and E15 notwithstanding the lower price of ethanol) combined to allow E85 prices to be significantly below the wholesale cost of gasoline (including the energy density adjustment). If the underlying question at hand relates to the cost of enforcing the RFS as designed, which we suspect it is, the administration should be reaffirming its commitment to the RFS to save consumers money.

EPA now acknowledges that high RIN prices do not increase gas prices. In a recent memorandum on the subject, EPA states that "the RIN market seems to be functioning generally as expected; providing an incentive for the continued growth of renewable fuels in the transportation fuel market *without causing overall increases to the retail price of transportation fuel.*"³¹

As discussed in the EPA memorandum, the RFS basically imposes two realities on the marketplace: (1) the potential cost of paying for RINs if obligated parties choose not to blend more renewable fuel; and, (2) the cost or savings of the qualifying renewable fuel required by the program. Looking at RINs first, higher RIN prices are not costing the American consumer money because RINs enter the marketplace free of charge. For example, a D6 "conventional renewable fuel" RIN is generated with every gallon of renewable fuel produced, and cannot be separated for sale by the renewable fuel producer. RINs are separated for sale *by obligated parties*, so the profit from sale (or cost incurred from purchase) exists within the oil industry. This is why so many oil companies are now on record on earnings calls attesting to the fact that they were the ones *profiting* from higher RIN values in 2013.³² It is also the reason why no correlation could be found between gas prices and RIN prices during the critical period in 2013 when RIN prices appeared to cause the Obama Administration to change its stance on the RFS. See next page.

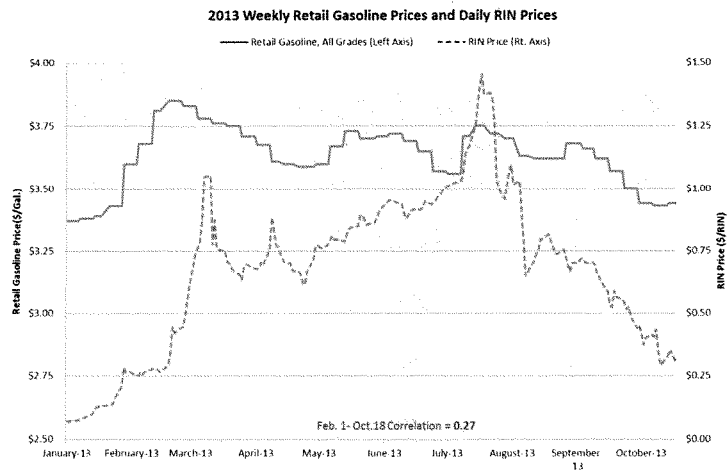
³⁰ See <http://www.card.iastate.edu/publications/dbs/pdf/13pb15.pdf>

³¹ Burkholder, Dallas. "A Preliminary Assessment of RIN Market Dynamics, RIN Prices, and Their Effects," U.S. EPA-Office of Transportation and Air Quality (May 14, 2015). Available at: <http://www.regulations.gov/#documentDetail;D=EPA-HQ-OAR-2015-0111-0062>

³² For summary of oil companies RIN profits, see: <http://www.fuelsamerica.org/blog/entry/something-funny-about-those-oil-company-profits>.

Examples of Oil Industry Earnings Call Statements Regarding RINs

American Petroleum Institute	The Mirage: Says its members are getting hit by high RIN prices, the costs of which are being passed through to consumers at a rate of \$14 billion per year
• "RIN prices are near an all-time high ... the RFS is a grave economic threat and must be stopped immediately." - Jack Gerard, testimony to Energy and Commerce Committee, July 2013	
BP	Says it has profited from RIN trading
• "We're net long RINs. We've been able to trade into this spike recently and done quite well out of it. I'm very pleased about that." (http://www.reuters.com/article/2013/07/30/bp-rins-idUSL1NOG00XG20130730)	
ExxonMobil	Says that the obligation to purchase RINs has not affected its earnings
• "No, not at all." - David Rosenthal, Vice President of Investor Relations & Secretary, when asked by an analyst if RINs had any material impact on ExxonMobil's quarterly financial performance (ExxonMobil 2nd Quarter Earnings Call, 8-1-2013)	
Murphy Oil	Says it has profited from higher RIN prices
• Murphy reported the increase in its refining/marketing income in the quarter was "...primarily due to better results for ethanol production operations and higher sales prices for ethanol renewable identification numbers (RINs) in the current period. ...Profit from ethanol RIN sales was higher in 2013 due to significantly stronger sales prices for these credits." (http://online.wsj.com/article/PR-CO-20130731-916461.html)	
Oil Industry Economist	Philip K. Verleger says renewable fuels have saved consumers at least hundreds of billions
• "The US renewable fuels program has cut annual consumer expenditures in 2013 between \$700 billion and \$2.6 trillion. This translates to consumers paying between \$0.50 and \$1.50 per gallon less for gasoline." (http://www.pkverlegerllc.com/assets/documents/130923_Commentary1.pdf)	



Source: EIA, OPIS

With regard to the cost of the qualifying fuel, higher RIN prices have the practical effect of increasing the available supply of affordable liquid fuel during a period of tightness in the global supply of petroleum. As discussed, energy economist Philip K. Verleger (who served as an advisor on energy issues to both the Ford and Carter administrations) recently said, “the U.S. renewable fuels program has cut annual consumer expenditures in 2013 between \$700 billion and \$2.6 trillion ... [t]his translates to consumers paying between \$0.50 and \$1.50 per gallon less for gasoline.”³³ Verleger adds:

Just as only Richard Nixon could ironically break the US taboo on trading with China, only George W. Bush could have successfully introduced measures to drive down crude prices. These prices today are between **\$15 and \$40 per barrel lower** than they would be had Congress not endorsed his proposals to boost ethanol production and blending with gasoline. Today, the Bush measures ***add the equivalent of Ecuador’s crude oil output to the world market at a time of extreme tightness.***” - Oil economist Philip K. Verleger, Jr. (September 23, 2013)

Other assessments have reached a similar conclusion.³⁴ The most comprehensive is a paper published by former EPA contractor Bruce A. Babcock and Sebastien Pouliet from the Center for Agricultural and Rural Development (CARD), with support from the National Science Foundation, which seeks to “to provide a transparent economic analysis of the impact on consumer fuel prices from mandates that increase the consumption of ethanol;” or, more specifically, “to estimate the impact of RIN prices on the pump price of fuel.”³⁵ CARD has developed a model to predict a range of different market impacts occurring as a result of the RFS. Among other findings, the paper concluded that:

- “... feasible increases in the ethanol mandate in 2014 will cause a small *decline* in the price of E10 [the predominant blend of gasoline in the market today].”
- “... one of the costs that does not need to be considered is an increase in the pump price of fuel, because we show that the most likely outcome from increasing ethanol mandates is a drop in pump prices, not an increase.”
- “The oil industry continues to rely on their own commissioned study (NERA 2012) that predicts gasoline producers will have no choice but to cut domestic sales of gasoline to reduce their obligations under the RFS ... [t]he study’s conclusions – that expansion of ethanol mandates would cause severe damage to the economy – are simply not credible unless EPA were to ignore set mandates at such a high level that they literally could not be met regardless of the level of investment in new fueling infrastructure.”

³³ See http://www.pkverlegerllc.com/assets/documents/130923_Commentary.pdf.

³⁴ See, for example, Cui, J., H. Lapan, G. Moschini, and J. Cooper. (2010). “Welfare impacts of Alternative Biofuel and Energy Policies.” *American Journal of Agricultural Economics* 93(5): 1235-1256.

³⁵ See <http://www.card.iastate.edu/publications/dbs/pdf/14pb18.pdf> at p. 5.

- “Our results should reassure those in Congress and the Administration who are worried that following the RFS commitment to expanding the use of renewable fuels will result in sharply higher fuel prices for consumers.”
- “The reason the oil industry and much of the livestock industry have joined forces against biofuels is one of simple industry economics: their industries would benefit from cheap corn and reduced competition from ethanol.”

There are numerous other examples of detailed analysis of the effect of RIN prices on gas prices:

- Irwin & Good of the University of Illinois examined 2012-2013 prices for CBOB, ethanol and D6 RINs to determine the impact of rising RIN prices on retail gasoline prices.³⁶ They found that “the basic zero sum nature of relationships in the supply chain and recent price trends for CBOB blendstock and ethanol suggests that the impact, if any, has likely been small, at most a few cents.”
- In a May 2015 update to a 2014 study, Informa Economics (Attachment 4) concluded that, “Changes in prices of renewable identification numbers (RINs) did not cause changes in retail gasoline prices from 2013 through the first quarter of 2015.”³⁷
- Analysis by economists at Iowa State University found that “the most likely outcome from increasing ethanol mandates is a drop in pump prices, not an increase.”³⁸ Further, they concluded, “Many in the oil industry have used the specter of higher pump prices to argue against increased mandates. ...These findings show that concern about the consumer price of fuel do not justify a reduction in feasible ethanol mandates.”
- Retired Yale and Calgary professor Philip Verleger conducted an economic study that concluded the “RIN price impact on retail prices is small and transient.”³⁹ He found that competition in the gasoline supply chain tends to diminish any price increases when refiners or blenders tried to embed the RIN price into E10 prices.
- EIA confirmed the absence of any connection between RIN prices and retail gasoline prices, stating: “To date, there is no evidence that retail gasoline prices have been affected by high RIN prices. While the cost of refined gasoline blendstock can be affected by high RIN prices, the increased cost to gasoline blenders is almost exactly offset in 2013 by their increased

³⁶ Irwin, S. & D. Good (Mar. 2013), “High Gasoline and Ethanol RINs Prices: Is There a Connection?” Link: <http://farmdocdaily.illinois.edu/2013/03/high-gasoline-ethanol-rins-prices.html>

³⁷ Informa Economics, Inc. (May 2015), “Analysis of Whether the Prices of Renewable Fuel Standard RINs Have Affected Retail Gasoline Prices.” Link: http://ethanolrfa.3cdn.net/f1c5dfa9ac9743e9f8_csm6bcb8e.pdf

³⁸ Pouliot, S. and B.A. Babcock (Jan. 2014). Center for Agricultural and Rural Development (CARD); Iowa State University. “Impact of Increased Ethanol Mandates on Prices at the Pump.” CARD Policy Brief 14-PB 18. Link: <http://www.card.iastate.edu/publications/synopsis.aspx?id=1218>

³⁹ Verleger, P.K., Jr. (Jan. 2014), “The Renewable Fuel Standard: How Markets Can Knock Down Walls.” Link: <http://www.pkverlegerllc.com/publications/papers/the-renewable-fuel-standard-how-markets-can-knock-down-walls-january-2014-1162/>

revenue generated from the sales of RINs separated when they blend ethanol into gasoline.”⁴⁰

- A former member of President Obama’s Council of Economic Advisers, who took part in the interagency review of the original 2014 RVO proposal, recently found that “...the price of E10 does not vary with RIN prices...” and that RIN prices actually serve to “...decreas[e] the price of fuels with high renewable content (like E85).”⁴¹

On the critical issue of cost, irrespective of its statutory relevance with regard to EPA’s proposal, it is clear that the RFS is engineered to achieve its objectives without increasing pump prices in the immediate term. The program is already creating – and will continue to facilitate – more systemic consumer benefits via its profound impact on reducing foreign oil dependence. Weakening the RFS, on the other hand, will cost consumers at the pump by tightening global liquid fuel supplies, reducing the availability of a cost reductive renewable fuel and exacerbating the impact of speculation.

⁴⁰ Presentation by Mindi Farber-DeAnda, EIA Office of Petroleum, Natural Gas, and Biofuels Analysis to Advanced Biofuels Association (Nov. 20, 2013). Washington, D.C.

⁴¹ Stock, James H. (April 2015). Columbia SIPA Center on Global Energy Policy. “The Renewable Fuel Standard: A Path Forward.” Available at: http://energypolicy.columbia.edu/sites/default/files/energy/Renewable%20Fuel%20Standard_A%20Path%20Forward_April%202015.pdf

R. BROOKE COLEMAN

17 Morley Street | Boston MA 02119 | 857.719.9766

Brooke Coleman co-founded and serves as the Executive Director of the Advanced Biofuels Business Council (ABBC), a coalition of industry leaders in the advanced biofuels and cellulosic ethanol sectors. Mr. Coleman also advises companies and campaigns in the clean energy sector.

Mr. Coleman has been involved with the energy and environmental sectors at the regulatory and policy levels since 1997. He began his career as the Energy Program Director at Bluewater Network, where he exposed the environmental and public health risks of the gasoline additive MTBE and led a national campaign to ban the chemical in transportation fuels. Mr. Coleman later founded or co-founded several organizations and/or projects, including the Advanced Ethanol Council, the New Fuels Alliance, the California Renewable Fuels Partnership, the Northeast Biofuels Collaborative, the Renewable Energy Action Project (REAP).

Mr. Coleman served as the chief strategist and spokesperson for clean energy advocacy campaigns during the 2008 and 2010 federal election cycles. He has also engaged in several state-level initiatives in recent years. He represented the advanced biofuel industry during the development of the California Low Carbon Fuel Standard (CA LCFS) and spearheaded an initiative in Massachusetts to pass the world's first cellulosic biofuels excise tax exemption.

Mr. Coleman is one of the leading national advocates for advanced biofuels at the state and federal level. He has testified before the U.S. House of Representatives and the U.S. Senate on various issues related to alternative fuels, including performance standards and tax. He has also testified before numerous state legislative committees. He has a deep level of expertise in a number of areas related to energy regulation, including the California Low Carbon Fuel Standard (CA LCFS), carbon lifecycle accounting, the federal Renewable Fuel Standard (RFS), the California and Federal Reformulated Gasoline (RFG) program, energy tax and various other energy-related programs at the federal and state level. He is one of the leading national advocates for advanced biofuels at the state and federal level.

Mr. Coleman is a graduate of Wesleyan University, the Northeastern University School of Law, and is a member of the Massachusetts State Bar. While studying law, he worked on several landmark environmental cases, including the largest ever settlement in Clean Water Act history and a common law climate change lawsuit filed on behalf of eleven state attorneys general.

Chairman BRIDENSTINE. Thank you, Mr. Coleman.
Mr. Drevna, you're recognized for five minutes.

**TESTIMONY OF MR. CHARLES DREVNA,
DISTINGUISHED SENIOR FELLOW,
INSTITUTE FOR ENERGY RESEARCH**

Mr. DREVNA. Chairmen Bridenstine and Loudermilk, Ranking Members Bonamici and Beyer, I am Charlie Drevna, Senior Fellow at the Institute for Energy Research.

You know, once Milton Friedman famously posited that one of the great mistakes is to judge policies and programs by their intentions rather than their results. If he were alive today, Friedman would point to the RFS as a prime example of his belief.

In the mid-2000s and even before, so-called industry analysts and renowned economists predicted ever-increasing gasoline demand as they simultaneously declared the United States to be energy-scarce. The Nation was on a path according to the self-anointed experts to reliance on ever-increasing foreign sources of energy, much of which came from potentially unstable regions of the world.

Congress and the Administration accepted the reviews, and in 2005 adopted the Energy Policy Act, which required refiners to blend 7.5 billion gallons of ethanol into the gasoline pool by 2012. In less than two years, this nuisance of free market interference became a full-blown anti-consumer, anti-free market debacle as EISA '07 mandated 36 billion gallons of renewable fuels, some of which actually existed, be blended into domestic transportation fuels by 2022.

In essence, the predictions of 2007 and earlier are the polar opposite of the realities of 2015. Confounding the problem is the undeniable fact that advanced biofuels production, the anticipated linchpin of the RFS, has fallen woefully short of the numerous promises made since 2007.

I'm sure the Committee is familiar with such names as Range Fuels, KiOR, Blue Sugars, Absolute Fuels, New Energy Fuels, Green Diesel, and a host of others, most of whom have squandered taxpayer dollars or committed fraud, or both, and yet today we continue to hear that the economic production of cellulosic fuels is "right around the corner." It's a big corner.

What's clear is that neither Congress nor EPA can mandate innovation or favorable economics, try as they may. The hard sciences of chemistry and physics remain immune to political science, and they remain formidable obstacles to economic production of commercial-scale cellulosic fuels. However, one should not discount the innovation provided by EPA to assist in this effort. EPA stipulates that ethanol produced from sugarcane qualifies in advanced biofuel. That's helping to meet the statutory volume requirements. What's ironic about this news is that ethanol produced from sugarcane is imported mostly from Brazil. So much for that homegrown stuff. And the intent—and what was the intent of the RFS to limit imported fuels? Okay.

So what State virtually imports all of this biofuel? Well, that would be California. And why California? The State's low carbon fuel standard requires refiners to use millions of gallons of advanced biofuel, and imported sugarcane is the only available prod-

uct that fits that definition, as unscientific as that definition is. Yes, that's correct. California prohibits ethanol from U.S. producers and imports it from Brazil. This allows California legislators and regulators to promote themselves as pioneers in the green movement.

So what happens to the ethanol from the U.S. producers that would've otherwise gone and been delivered to California? The Brazilians don't care if their ethanol comes from sugar or corn, so California and Brazil swap their ethanol, literally two ships passing in the night. The net outcome, higher shipping costs, and ironically, increases in GHG emissions.

Not satisfied with the overall results, EPA then decided to enhance the total production of cellulosic fuels not via scientific breakthrough. Rather, it would be much simpler to change the definition of cellulosic fuels to include a portion of biogas produced from landfills. If you look at the volume increases in cellulosic production 2014 through '15, it's nearly all attributable to EPA semantics. Why let pesky little details such as chemical structure and definition get in the way of a predetermined outcome?

If one were to be intellectually honest, the RFS was never about energy security, the environment, or national security. It's been accurately described as crony capitalism, although the use of the term capitalism in reference to the RFS is a basic non sequitur. It may be much more accurate to label the RFS and other anti-free market mandates, subsidies, and giveaways for what they really are: government attempting to pick the winners and losers in the marketplace. And the government's track record is most illustrative as its penchant for picking losers is quite outstanding.

Even if the intentions of the RFS were noble, the program must be judged on its results. It's past time for Congress to admit that the RFS has not delivered and will not deliver anticipated results. The law should be repealed and allow for American ingenuity, entrepreneurship, and free-market enterprise to do what it does best. They haven't failed the nation yet.

Thank you very much.

[The prepared statement of Mr. Drevna follows:]

**BEFORE THE HOUSE SCIENCE COMMITTEE
SUBCOMMITTEE ON OVERSIGHT AND SUBCOMMITTEE ON ENVIRONMENT**

**HEARING ON:
RENEWABLE FUEL STANDARD
A TEN YEAR REVIEW OF COSTS AND BENEFITS**

NOVEMBER 3, 2015

TESTIMONY OF CHARLES DREVNA

INTRODUCTION

The Renewable Fuel Standard was based on incorrect assumptions about oil production and consumption, as well as the ability of Congress and the administration to mandate and create incentives for innovation and vast technological and economic leaps in biofuel production. The RFS was intended to create greater energy and economic security, but as Milton Friedman famously posited, “One of the great mistakes is to judge policies and programs by their intentions rather than their results.”

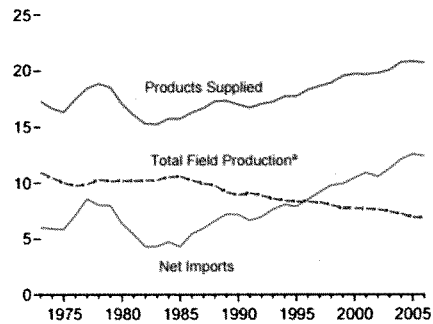
The results of the RFS are a failure for America. We have greater energy security today—not because of vast improvements in cellulosic biofuels as envisioned in 2007—but because of much greater domestic oil production coupled with a leveling off of demand. It is time we look at the actual results of the RFS and act accordingly. As a result, it is time to end the RFS and let American fuel producers focus on delivering the best products to American motorists.

HOW WE GOT HERE

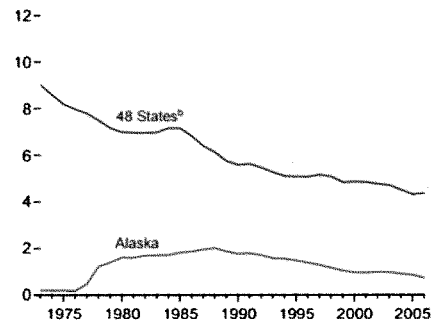
In the mid 2000’s, U.S. oil consumption was increasing but U.S. oil production was decreasing. It seemed to many people that these trends would continue. The Renewable Fuel Standard in the Energy Independence and Security Act of 2007 was passed to reduce our dependence on foreign oil while providing development opportunities to rural America. To achieve this, the law mandated the use of billions of gallons of cellulosic ethanol under the assumption that the technology would soon be cost competitive, that Congress and the administration could correctly predict the future, and that Congress could mandate innovation. These assumptions were very, very wrong.

These two charts are the Energy Information Administration's *Monthly Energy Review* for December 2007.¹ The point is clear—U.S. oil production was falling while consumption (essentially “Products Supplied”) was increasing. There was no end in sight for these trends.

Overview, 1973-2006



Crude Oil Field Production, 1973-2006



*Crude oil and natural gas plant liquids field production.

*United States excluding Alaska and Hawaii.

Note: Because vertical scales differ, graphs should not be compared.

The RFS was seen as a way to increase domestic fuel production, and people thought that cellulosic and other exotic biofuels could be cost effective. Unfortunately, Congress and the administration believed the hype that cost-effective cellulosic ethanol was “just around the corner.”

¹ Energy Information Administration, *Monthly Energy Review*, December 2007, p. 42, <http://www.eia.gov/totalenergy/data/monthly/archive/00350712.pdf>

CELLULOSIC HYPE

In 2006, the Worldwatch Institute opined the cellulosic and other biofuels would compete in the “medium term” with oil:²

The long-term potential of biofuels is in the use of non-food feedstock that include agricultural, municipal, and forestry wastes as well as fast-growing, cellulose-rich energy crops such as switchgrass. It is expected that the combination of cellulosic biomass resources and “next-generation” biofuel conversion technologies—including ethanol production using enzymes and synthetic diesel production via gasification/Fischer-Tropsch synthesis—will compete with conventional gasoline and diesel fuel without subsidies in the medium term.

In 2007, Bob Dineen, the head of the Renewable Fuels Association, said that within 3 years cellulosic would be cost competitive. He said, ““I don’t think anybody knows if it’s going to be 18 months, or two years or three years before you see the first commercially viable plant.”³

Also in 2007, the Department of Energy announced \$385 million in federal funding for six cellulosic plants. The DOE stated, “When fully operational, the biorefineries are expected to produce more than 130 million gallons of cellulosic ethanol per year. This production will help further President Bush’s goal of making cellulosic ethanol cost-competitive with gasoline by 2012.”⁴ (The reality is that in 2012, cellulosic producers only produced 20,069 gallons of cellulosic biofuel.)

After EISA passed in 2007, investor Vinod Khosla said that the goals were not ambitious enough. He stated, “We can do substantially better than what’s in the energy bill.”⁵

Within a couple years of the passage of the amendments to the RFS, the renewable fuels industry was claiming that cellulosic had arrived. Bob Dineen testified before Congress in May 2009, “It is important to understand that cellulosic ethanol and other advanced biofuels are no longer “just around the corner” or “just over the horizon” — they are here today.”⁶

Dineen was not alone in the ethanol industry. An Issue Brief from Ethanol Across America in fall 2009 claimed, “we are fast approaching warp speed and meeting the cellulosic ethanol targets in the nation’s Renewable Fuel Standard (RFS) appears to be reachable.”⁷

² Report: Biofuels Poised to Displace Oil, Worldwatch Institute, June 2006,

<http://www.worldwatch.org/report-biofuels-poised-displace-oil>

³ *Bush’s ambitious biofuels goals hinge on cellulosic ethanol*, E&E News, January 24, 2007

<http://www.eenews.net/greenwire/stories/50974/>.

⁴ <https://web.archive.org/web/20070304091902/http://www.doe.gov/news/4827.htm>

⁵ Congress places a big bet on cellulosic ethanol - E&E News, December 14, 2007

<http://www.eenews.net/greenwire/stories/59894/>

⁶ Bob Dineen, Testimony before the House Agriculture Committee - May 21, 2009

http://ethanolrfa.3cdn.net/5dc24f732b2e86d45d_ym6bqjcx.pdf

⁷ Ethanol Across America Issue Brief, Fall 2009

<http://www.cleanfuelsdc.org/pubs/documents/CellulosicEthanolIssueBrief11109.pdf>

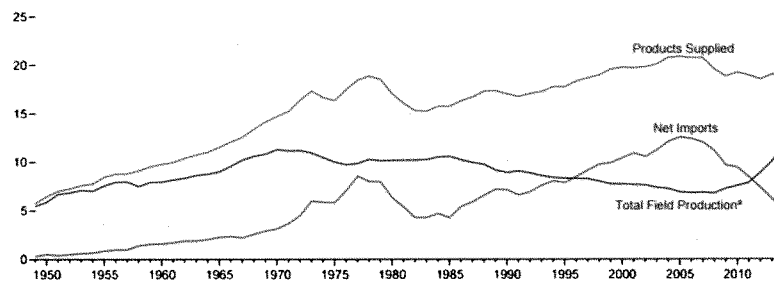
CELLULOSIC REALITY

The fuel future that Congress and President Bush envisioned in 2007 has not come to pass. U.S. oil production has dramatically increased and oil consumption has leveled off. Furthermore, the cellulosic ethanol revolution has not happened. The RFS requires the production of 3 billion gallons of cellulosic ethanol in 2015. So far this year, only 1.6 million gallons of cellulosic ethanol have been produced.⁸ That is a mere 0.06 percent of the mandated volume.

The predictions made in the mid-2000s about oil production continuing to decline and oil consumption continuing to increase have also proven incorrect. The following chart from EIA shows what has happened with petroleum use (ie. products supplied), domestic production, and imports.⁹ None of these changes were foreseen by the architects of the RFS.

Figure 3.1 Petroleum Overview
(Million Barrels per Day)

Overview, 1949–2014

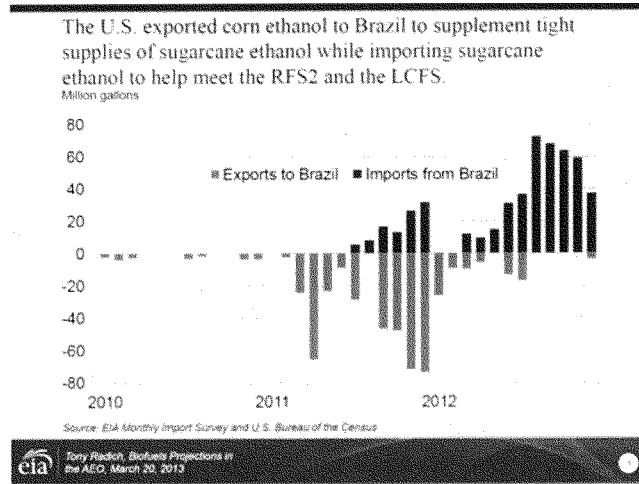


THE RFS WAS SUPPOSED TO BE ABOUT ENERGY SECURITY, SO WHY ARE WE IMPORTING ETHANOL FROM BRAZIL?

In 2007, Congress defined “advanced biofuel” in the RFS as biofuel other than ethanol derived from corn starch (ie. corn kernels) which EPA deems to have 50 percent lower lifecycle greenhouse gas emissions relative to gasoline. Currently, sugarcane ethanol is the only mass-produced product which EPA has certified that meets the definition of “advanced” biofuel. Sugarcane ethanol is also disproportionately used in the state of California for purposes of compliance with California’s Low Carbon Fuel Standard. As a result, we have an absurd situation where the U.S. imports sugarcane ethanol from Brazil and exports corn ethanol or gasoline to Brazil as these charts from the EIA show:

⁸ EPA, 2015 Renewable Fuel Standard data, Oct. 15, 2015, <http://www2.epa.gov/fuels-registration-reporting-and-compliance-help/2015-renewable-fuel-standard-data>. EPA also deems an additional 87 million gallons of fuel as cellulosic ethanol by counting some renewable compressed natural gas and renewable liquefied natural gas as cellulosic ethanol for purposes of the RFS.

⁹ EIA, Monthly Energy Review, <http://www.eia.gov/totalenergy/data/monthly/pdf/sec3.pdf>



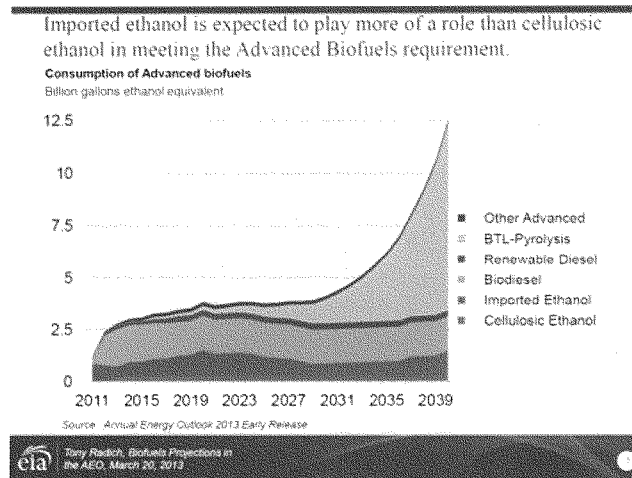
As EIA explains, “U.S. obligated parties [ie. U.S. refiners] prefer sugarcane ethanol over corn ethanol” because “sugarcane ethanol counts toward the RFS advanced requirement.”¹⁰ Brazilian ethanol users do not have a preference between corn ethanol and sugarcane ethanol.

¹⁰ <http://www.eia.gov/biofuels/workshop/presentations/2013/pdf/presentation-06-032013.pdf>

This situation is completely absurd. First, sugarcane ethanol is not technologically “advanced.” Sugarcane has been used to make ethanol in Brazil since the late 1920s.¹¹ The only reason sugarcane is deemed to be “advanced” is because EPA believes it has 50 percent lower lifecycle greenhouse gas emissions than gasoline. The Renewable Fuels Association, however, does not agree with EPA’s assessment of 50 percent lower lifecycle greenhouse gas emissions from sugarcane ethanol.¹²

Second, while sugarcane ethanol may have lower lifecycle greenhouse gas emissions, any reductions are wiped out by what happens with sugarcane ethanol in the real world. The preference that EISA sets up for sugarcane ethanol means that not only is sugarcane ethanol imported to the U.S., increasing its lifecycle greenhouse gas emissions, but corn ethanol or gasoline is then exported from the United States to Brazil to replace the fuel that was sent to the United States, further increasing the true lifecycle greenhouse gas emissions of sugarcane ethanol. When EPA deems sugarcane ethanol an advanced biofuel, they have to consider its true lifecycle greenhouse gas emissions, not only the greenhouse gas emissions required to get the sugarcane ethanol to the U.S., but also what replaces that ethanol in Brazil. Swapping Brazilian sugarcane ethanol with U.S. corn ethanol or gasoline simply wastes the energy used in transportation that would not occur in the absence of a mandate.

EIA believes that this absurd trade in ethanol will continue for the next 30 years, with imported ethanol expected to play a much more important role than cellulosic ethanol.

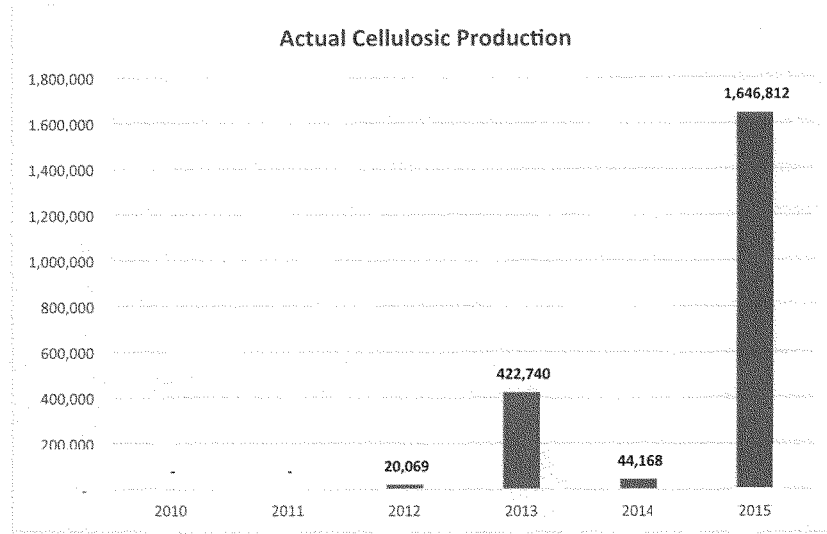


¹¹ USGA: Em 1927, O Primeiro Grande Empreendimento Brasileiro em Alcool Combustivel, <http://web.archive.org/web/20080319112800/http://www.aondevamos.eng.br/boletins/edicao07.htm>.

¹² <http://www.ethanolrfa.org/news/entry/rfa-to-epa-time-is-now-to-revise-lifecycle-ghg-analyses-of-corn-and-sugarca/>

MORE REALITIES OF CELLULOSIC BIOFUEL PRODUCTION

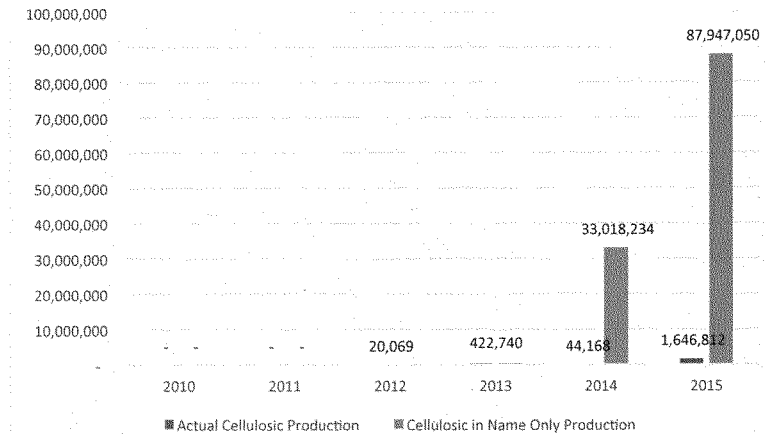
The following chart shows cellulosic ethanol production and the mandated amount of cellulosic production in the RFS. The first chart shows actual cellulosic ethanol production.¹³ We were told in 2006 and 2007 that cellulosic just needed a little help and that it would be cost effective. But by 2015, we only had 1.6 million gallons of cellulosic ethanol produced.



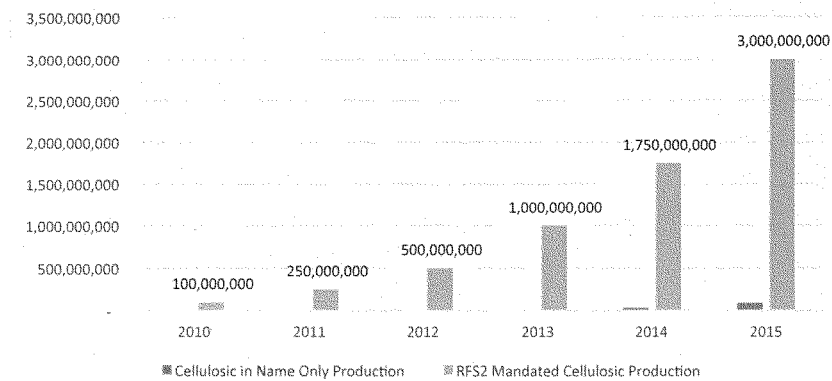
Why has production of cellulosic and advanced ethanol lagged? The answer is cost. The closing price on October 29 for November gasoline on the New York Merchantile Exchange was \$1.35 per gallon. The closing price for ethanol on that same date was \$1.59 per gallon. The cost of producing cellulosic ethanol is estimated to be in the range of \$6.50 per gallon. Since sugarcane ethanol from Brazil is the only mass produced advanced ethanol available today, and Brazil is net short of energy, imports from Brazil have the added cost of not only transporting the sugarcane ethanol from Brazil, but of transporting corn ethanol or gasoline back to Brazil from the United States. The mandate is being filled by and large with the most economical alternative, and that is neither cellulosic nor advanced ethanol.

Because actual cellulosic production has lagged, EPA changed the definition of what constitutes cellulosic ethanol to include some renewable compressed natural gas and renewable liquefied natural gas. As a result, there are now millions of gallons of "cellulosic" biofuel being produced, even though this isn't what the drafter of the RFS had in mind.

¹³ <http://www2.epa.gov/fuels-registration-reporting-and-compliance-help/2015-renewable-fuel-standard-data>

Cellulosic Production vs "Cellulosic" Production

Even with EPA's redefinition of "cellulosic" biofuel, production is far from the volumes mandated by the RFS. As of October, EPA reports that 88 million gallons of "cellulosic" biofuel has been produced so far this year. The RFS, however, calls for 3 billion gallons to be produced this year.

"Cellulosic" Production vs. Mandated Cellulosic Volumes

CONCLUSION

The RFS has not worked as planned for a number of reasons. First, the assumptions made about U.S. oil production and consumption were wrong. Many in Congress and the Bush administration did not consider that the U.S. could and would increase oil production. Second, oil consumption has leveled off as the economy has cooled since the mid-2000s and people are driving more fuel efficient cars. Third, Congress cannot mandate innovation. Too many in Congress and the Bush administration listened to trumped up claims from the ethanol industry and people like Vinod Khosla who wanted public money to finance their products.

The RFS is based on incorrect assumptions. It is time we repeal it and let fuel producers concentrate on fulfilling the needs of American motorists instead of bureaucrats administering a fatally flawed program.

Charles T. Drevna, Distinguished Senior Fellow, Institute for Energy Research (IER). Upon his recent retirement as AFPM President, Drevna has been named Distinguished Senior Fellow at the Institute for Energy Research (IER). IER is a not for-profit organization that conducts intensive research and analysis on the functions, operations, and government regulation of global energy markets. IER maintains that freely-functioning energy markets provide the most efficient and effective solutions to today's global energy and environmental challenges and, as such, are critical to the well-being of individuals and society. Since 2007 Charles T. Drevna had served as president of the American Fuel & Petrochemical Manufacturers, the national trade association that represents 98 percent of refining capacity in the United States. Drevna joined the association in 2002 as director of policy and planning and named executive vice president in 2006. Drevna managed a team that advocates on behalf of petroleum refiners and petrochemical manufacturers who are instrumental in strengthening our economic and national security, and support two million American jobs. Through his leadership, the association expanded, doubling in size and scope of work to meet the growing demand of a broad range of public policy issues. In 2012, Drevna supervised a rebranding of the association, formally known as the National Petrochemical & Refiners Association, to better identify the refining industry as high-tech manufacturers of virtually the entire U.S. supply of fuel and home heating oil, as well as the petrochemicals used to produce thousands of consumer products. Drevna has over 40 years of extensive experience in legislative, regulatory, public policy and marketplace issues involving energy and the environment. His previous positions include director of state and federal government relations for Tosco, Inc.; director of government and regulatory affairs for the Oxygenated Fuels Association; vice president at the Washington consulting firm of Jefferson Waterman International; several positions at Sunoco, including vice president for public affairs for Sun Coal Company; director of environmental affairs for the National Coal Association; and supervisor of environmental quality control for the Consolidation Coal Company. Drevna received his BA in chemistry from Washington and Jefferson College and performed graduate work at Carnegie-Mellon University.

Chairman BRIDENSTINE. Thank you, Mr. Drevna.

I now recognize myself for five minutes of questions.

I just wanted to go back for a second to Dr. DeCicco, looking at your bio, Research Professor at the University of Michigan Energy Institute, bachelor's degree in mathematics from Catholic University, master's degree in mechanical engineering from North Carolina State University, Ph.D. in mechanical engineering from Princeton University. You've been involved in research on energy and environment issues for a long time. Correct me if I'm wrong. You worked for the Environmental Defense Fund. Is that correct?

Dr. DECICCO. That's right, for nine years.

Chairman BRIDENSTINE. Would you be characterized as a conservative witness in general? Would you characterize yourself as that or somebody that's a hack for the oil industry or anything like that?

Dr. DECICCO. I certainly would not so—

Chairman BRIDENSTINE. Reading your bio and looking at your background, I think that is fairly safe to assume. In fact, when I read your bio, I was a little bit interested in why Republicans were bringing you to testify. But hearing your testimony, being somebody who's very concerned about the environment, somebody who's very concerned about carbon emissions, your testimony today—I heard you say 70 percent higher carbon emissions in some circumstances because of the Renewable Fuel Standard. Is that correct?

Dr. DECICCO. That's correct, Mr. Chairman.

Chairman BRIDENSTINE. How do you get to 70 percent higher with the Renewable Fuel Standard? Can you share with us how that happens?

Dr. DECICCO. Sure. The thing to keep in mind is that all of the claims for reduction on biofuels depend on this carbon-neutrality assumption. When that's not met, you start with essentially a wash when you're comparing, say, ethanol to gasoline or biodiesel to petroleum diesel. And then you have to look at the process emissions from that basis. And it's not nearly as efficient to process corn ethanol from biomass as it is to process gasoline from petroleum.

In fact, from a carbon-efficiency point of view, basic chemistry tells us that when you ferment the fuel—and this goes for any fermentation based ethanol, whether it comes from a cellulosic feedstock or starch like corn or sugarcane—for every molecule of ethanol that you produce, 1 molecule of CO₂ gets produced as beer bubbles. You know, when you ferment, you have a frothy thing. It creates CO₂.

So if you can no longer assume that that's free CO₂, free carbon enough fuel, which is false by my analysis of cropland data, then right there you lose a lot of carbon back to the atmosphere during processing. So when you add that back in, when you add in the emissions to make fertilizer, when you add in the emissions to run the bio refineries even for natural gas in a dry mill, which is a pretty efficient form of biorefinery, and take away this automatic credit that the lifecycle models assume, you can end up with 70 percent higher emissions.

And that's not the end of the story. I mean that's not the upper limit on the damage when you begin to look at the ripple effects.

Chairman BRIDENSTINE. So in your testimony I have heard you mentioned harmful to the environment. I just heard you use the word damage to the environment, higher CO₂ emissions, in some cases 70 percent higher. You mentioned water pollution, you mentioned algae bloom. Did you mention—I think yesterday when I talked to you, you mentioned deforestation. Can you talk to that for a second?

Dr. DECICCO. Sure. When you divert crops from the food and feed market, and what's going on in the country now, around 40 percent of our corn harvest is going into ethanol production. Now, some of that comes back as co-product, but it nets out to about 30 percent. Well, does that mean people are eating 30 percent less food or that we're having 30 percent less cattle? No.

We have a global commodity market, and what happens is that when grains are diverted into the fuel market, that grain that would otherwise be used for food has to get made up somewhere else. And if you trace that, as a number of scientific analyses have done in the past several years, and look at the ripple effect, the loss of grain from American field due to the biofuel mandate results, for example, in additional deforestation in Brazil and sub-Saharan Africa as the food markets try to compensate and have to put more land into production.

This is a highly uncertain effect, but there's no doubt because of the coupling of global commodity markets that this effect, which is known as indirect land-use change, is occurring.

Chairman BRIDENSTINE. Thank you, Dr. DeCicco. I am out of time, but it is important to note that if it's damaging to the environment, if it's putting more CO₂ emissions into the atmosphere, if it's adding to prices for both food and fuel, it leaves us wondering what are the reasons that we still have the Renewable Fuel Standard.

I'd like to recognize the Ranking Member, Ms. Bonamici, for five minutes.

Ms. BONAMICI. Thank you very much, Mr. Chairman, and what an interesting discussion this morning. I really appreciate the conversation.

Mr. Coleman, in his testimony, Dr. DeCicco states that the RFS has been harmful to the environment—I'm following up on the Chairman's question—and that only under limited conditions does substituting a biofuel for a fossil fuel neutralize tailpipe CO₂ emissions.

Now, it's my understanding that a number of analyses, including from the U.S. Department of Energy, indicate that most biofuels do reduce greenhouse gas emissions. We're getting ready for the Climate Change Conference in Paris and we need to do more, not less, to mitigate climate change.

So scientists at the Argonne National Laboratory, Purdue University, and the Federal Aviation Administration have responded to some of the criticisms Dr. DeCicco has raised in writing regarding the ability of biofuels to reduce greenhouse gas emissions. And, Mr. Chairman, I would like to enter this paper into the record.

Chairman BRIDENSTINE. Without objection, so ordered.

[The information appears in Appendix II]

Ms. BONAMICI. Thank you.

Mr. Coleman, one of the conclusions reached in this paper is that Dr. DeCicco does not take into account the carbon emissions that are avoided when a biofuel displaces the use of fossil fuels. This displacement seems fairly important. So can you please respond to the assertion that the RFS does not reduce carbon emissions and that it's broadly caused more harm than good for the environment, particularly focusing on the need to consider displacement of fossil fuels? And I do want to save time for another question.

Mr. COLEMAN. Sure. I'll go quickly. So we obviously don't agree with Dr. DeCicco, but I think it's important to understand who doesn't agree with him is EPA, the Department of Energy, U.S. Department of Agriculture, the national labs and Oak Ridge and Argonne National Laboratory, the California Air Resources Board, which is hardly pro-bio fuels.

What Dr. DeCicco does is he actually does something that's quite provocative in the carbon accounting world, so it may be different and might get your attention but it's not well supported. And it's called additionality. So he doesn't really—when you grow a plant, whether it's corn or switchgrass or whatever, it absorbs sunlight and CO₂ while it's growing, and that's one of the benefits of using bioenergy. Instead of having a solar panel to absorb the sunlight, you're transferring it into gasoline.

He wants to take that credit away under the assumption that the farmer would have done it anyway. And the problem with doing that is it removes the whole notion of supply chain emissions, and you can't account for it. So if you have a State—or you want to put solar panels on your roof and you have the government saying, oh, well, sorry, Ms. Bonamici, you would have done that anyway so we're not going to give you credit to do that, it's suspends reality with regard to carbon accounting. And that's why responsible regulatory agencies don't do it that way. It's an interesting academic exercise.

So I think we have to rely on the body of the evidence to support what's going on in this space, and biofuels are carbon reductive.

Ms. BONAMICI. Thank you. And then I have a two-part question. There's been some criticism of the EPA on its implementation of the RFS. Some of it is certainly well placed. The EPA has delayed the release of the volumetric obligations for the past couple of years, and I want to note that the proposed biometric obligations to be finalized this month were actually proposed in part in 2013. The Agency received more than 340,000 comments on the proposed rule that year, and evaluation of the comments led to a delay. It's unfortunate, but I still don't think it's acceptable that the program has experienced such delays.

And I want you to discuss how that has affected the biofuels industry. Do you agree that the consecutive delays have hurt investments in the industry and innovative technology and development?

And then I also want you to talk about—we've had a lot of conversations here about corn, but obviously, based on the work that your organization does, there's so much potential out there in this second generation. So if the RFS is repealed, as some are suggesting, what would that do to the advancement of all the alternative second-generation biofuels and particularly all the small

businesses and businesses across the country that are working to innovate and come up with new alternatives?

Mr. COLEMAN. Well, I appreciate the question. I spoke to this a little bit when I talked about the market. So we need policy because the market isn't free. And so when the policy is suspended or not enacted, we're in a tough situation because we don't know if the oil companies are going to buy our product. And if we don't know if the oil companies are going to buy our product, it's pretty hard to get financing to build those projects.

And so what happened in 2013 and what has happened for two years is a failure to finalize the rule has basically suspended investment in advanced biofuels. And we are confident that we can get back on track. The courts have actually required EPA to get the final rule out by November 30 of this year. The key, however, will be that EPA gets a good rule out and not just a timely rule out.

And so while we expect the timeliness problem to be fixed, EPA is also still proposing to have a waiver, a new waiver in there that would allow the program to be waived if the oil companies fail to distribute our fuel. And the whole purpose of the RFS is to force the oil companies to do it because they would not otherwise do it based on price because of the subsidies and the protections they have overseas that protect this industry.

And so if the RFS, to speak to your last question, were repealed, we would basically lose our place on the shelf if you will and would not have access to the consumer that would allow these financing mechanisms to go, and we would lose these projects overseas. DuPont, Enerchem, Abengoa, some of the companies that I mentioned, have all built their second plant overseas in places like China, Brazil, and France over the last six months. So we've already lost second plants. I think the goal now is to get the third, fourth, fifth plants back in the United States.

Ms. BONAMICI. Thank you. And my time is expired. I yield back. Thank you, Mr. Chairman.

Chairman BRIDENSTINE. I'd like to thank the Ranking Member. And Chairman Loudermilk is recognized for five minutes.

Mr. LOUDERMILK. Thank you, Mr. Chairman.

Real quickly, Mr. Coleman, what your profession? What's your education and your profession?

Mr. COLEMAN. I'm educated at Wesleyan University. I was educated in Northeastern School of Law. I run the Advanced Biofuels Business Council and represent the lowest carbon fuel companies in the world.

Mr. LOUDERMILK. Okay. And so you're an attorney?

Mr. COLEMAN. Yes.

Mr. LOUDERMILK. Is that—okay. And you work for—can you—

Mr. COLEMAN. Advanced Biofuels Business Council.

Mr. LOUDERMILK. Okay, the business council?

Mr. COLEMAN. Yes.

Mr. LOUDERMILK. Okay. Thank you.

Dr. DeCicco, your profession?

Dr. DECICCO. I'm a mechanical engineer.

Mr. LOUDERMILK. You're a mechanical engineer. And who do you work for?

Dr. DECICCO. I work for the University of Michigan at the Energy Institute.

Mr. LOUDERMILK. Before I go into questions, is there anything you would like to respond to to the claims that Mr. Coleman has said?

Dr. DECICCO. Sure. Thanks for the opportunity.

You know, there's—science is never static. It moves. We learn things as time goes on. I hate to admit this, but in the mid-1990s I was the author of the first paper, first academic paper to call for the use of lifecycle analysis and regulation as an incentive to produce advanced biofuels, cellulosic fuels in particular. And it was based on the early studies that are the precursors and set the template for all the government models now in use.

I didn't know then what I have since learned about the realities of the carbon cycle, and what I realized several years ago as I began picking apart the models and trying to understand, okay, why is there so much controversy here that never seems to get resolved? It's that the government models, the GREET model, which has been the basis for so many of these claims, effectively violate the law of conservation of mass. They effectively, in the computer, create carbon for the sake of offsetting the carbon out of the tailpipe without bothering to check whether additional carbon has been removed from the atmosphere.

Now, Mr. Coleman says, well, I'm raising some unproven theory about additionality. Additionality, you know, the need for additional carbon is just another word for conservation of mass. There's no such thing as free carbon. Carbon is the fuel of life. You know, we have to be careful when we say willy-nilly we need to de-carbonize the economy. I personally don't want to be de-carbonized, and I don't think any of us do. Our whole food chain and the whole carbon cycle by which plants at the base of the food chain take carbon from the air and utilize it to feed everything else is what's going on here. And if you take that, that's what I meant by you can't rob Peter to pay Paul. If you just take that carbon, it has to be made up somewhere else.

So I am in a situation of someone kind of saying, well, the emperor has no clothes because the emperor in this case is the Department of Energy and its models that became the template for the RFS, and EPA's models, which did its own modeling using a similar format, the same with the California Air Resources Board. And here I am coming along and saying, oops, you guys got it wrong. Your models violate conservation of mass. You haven't checked whether that carbon that you're crediting automatically against the tailpipe was actually additional carbon in the sense that it came out of the air without stealing from the food or feed system.

So I certainly realize that my criticism of these biofuel policies does fly in the face of piles of publications, but unfortunately, those publications got it wrong.

Mr. LOUDERMILK. One quick question, I'm trying to get my hands around this carbon neutrality theory. And in layman's terms, the idea the model was based on is we're going to grow more corn plants, plants absorb carbon output, so therefore, the increased output by burning ethanol or producing ethanol would be absorbed by

the increased production of corn plants. Is that a fair summary of the idea—

Dr. DECICCO. Oh—

Mr. LOUDERMILK. —and have we—are we growing more plants to absorb?

Dr. DECICCO. We are growing a bit more. The keyword that you said here is more. You know, in other words, if we had a barren piece of desert and then irrigated it, fertilized it, grew corn on it, then that piece of desert would be growing more corn in a way that takes more carbon out of the air than was previously being taken out. And then you could legitimately claim that that carbon in that corn feedstock offsets the emissions when the ethanol is burned. But I'm not aware that we're getting most of our corn from land that used to be barren deserts.

Mr. LOUDERMILK. So it was used for other purposes? Okay.

Dr. DECICCO. That's right.

Mr. LOUDERMILK. I see I'm out of time, Mr. Chairman. I think the world is turned upside down when we have the business community advocating for more government regulation and the environmental community advocating for not. So this is very interesting. Thank you, Mr. Chairman.

Chairman BRIDENSTINE. And real quick, just a point of privilege here if you'll allow me, Mr. Beyer.

The question I guess we're—I'm trying to understand is if you're replacing other crops with corn, then the carbon accounting that Dr. DeCicco is talking about would actually be more accurate than if you don't account for that, correct, Mr. Coleman?

Mr. COLEMAN. No. So this is—I mean the way carbon accounting works and the way the Clean Air Act works or the way that any regulation works is pollute or pay. You're accountable for what you do, right? And if you grow a plant to use in bioenergy that absorbs carbon more or less, a little bit, not very much, you get credit for doing that. Whether—

Chairman BRIDENSTINE. But if you're producing that plant, which in this case would be corn, and you're replacing another plant, then you really haven't done anything to change the accounting of the carbon removal. Am I incorrect on that?

Mr. COLEMAN. You are incorrect because the way that—the way agricultural markets work is you have demand—put it this way, agriculture they produce for price, okay? They don't say I'm going to grow this—I'm going to grow this corn for ethanol. They produce for price. And so you have—when you have regulations that are changing the behavior amongst farmers, you have—what you want in that industry is accountability for what you do, right? And so if you have acres where you want to do more corn this year and more wheat next year and your—that corn gets used for a certain product, that's the product you should be accountable for. That is it.

Chairman BRIDENSTINE. Okay. I'm taking time that I don't have. So, Mr. Beyer, you are recognized as the Ranking Member for five minutes.

Mr. BEYER. Thank you, Mr. Chairman.

Mr. Anderson, thank you for coming up to talk to us. And I'm sure I've eaten at many of your Wendy's over the years.

Dr. Dinan talked about with the existing fuel standard that corn price or overall food prices will only rise about 1/10 of one percent, and if repealed would fall less than 1/10 of one percent. With some excellent research we found that the price of corn per bushel was \$3.77 when President Bush signed the law in December of '07. It's \$3.68 per bushel right now, 9 cents cheaper. So how do you get \$34,000 in increased food prices directly related to RFS in your stores?

Mr. ANDERSON. PricewaterhouseCoopers did the study in 2012, and then based on that process determined that the impact was the \$34,000.

Mr. BEYER. But if you look at the USDA, you also see that the price is up to \$6.60 or something in 2012 when they did that study. So now we're back to \$3.68, so my guess is if PwC did the study again, you'd find literally no impact on your business.

Mr. ANDERSON. Literally no impact would be incorrect. Our prices are still up, and I would say also that we had two record corn crops, and this year we're going to be followed by an almost record corn crop. I think it's highly unlikely that we will continue to have record corn crops to keep the price of corn at that.

Mr. BEYER. And, Mr. Anderson, not to disagree with you at all, it may well be true, but I think we need to isolate increase in your food costs from the price of corn. They may not be 1 to 1.

Mr. ANDERSON. I would respectfully disagree with that.

Mr. BEYER. Mr. Coleman, what about Brazil? Mr. Drevna talked all about shipping ethanol from California there and bringing sugarcane back.

Mr. COLEMAN. Yes, so there—he—Mr. Drevna is talking about a different program when he talks about the low carbon fuel standard in California. That program drives the lowest carbon fuel. It does not have respect for State or country borders, and if you have a low carbon fuel, California was to show that there's a market for it. So Brazil is shipping sugar ethanol to the marketplace.

In terms of the RFS, again, so Brazilian ethanol does hit the advanced biofuel requirement. Ninety plus percent of the fuel used under this program, however, has been U.S.-produced. So the point of the RFS is to drive plant production and new industries in this country. We have 210 ethanol plants alone. We have another 60,000 jobs and hundreds of biodiesel plants in this country alone, and now we're getting that first wave of cellulosic plants that creates value-added agriculture. And so we're really seeing tremendous benefit inside the United States.

Mr. BEYER. Great. Thank you.

Dr. DeCicco, I want to give you one more chance to try to out me explain this carbon neutrality. When we look at fossil fuels, that was carbon taken out of the air millions and millions of years ago and now burned. So we're taking carbon that's been stored for these millions of years and putting it back into the atmosphere, putting it into the ocean.

When you talk to cellulose, you're taking carbon that was taken out of the atmosphere last year or this year and putting it back in. Why isn't that just on the surface of it—by the way, if I recall my physics, the first law of thermodynamics is the conservation of mass and energy there—because they're interchangeable, E equals

MC squared. So if we're taking carbon out of the atmosphere now to burn to put back in, why is that just on the surface of it not much less net carbon, then burning something that was taken out millions of years ago?

Dr. DECICCO. Well, the thing to keep in mind is to neutralize those emissions the way you're saying is that you need to come up with more carbon that was already being taken out of the air. Now, that can happen. So let me turn to an example. I think, you know, this DuPont—new DuPont facility that was—

Mr. BEYER. Can I interrupt for one second?

Dr. DECICCO. Yes.

Mr. BEYER. Why more carbon if you just take the same carbon that was coming out anyway, so get rid of this alternative land use—

Dr. DECICCO. Sure.

Mr. BEYER. —theory. It was going to come out in soy crops or forest or whatever, no—leave the desert. You're still not—you're still adding—putting carbon back into the atmosphere that was coming out naturally rather than carbon that's been stored.

Dr. DECICCO. Well, that's the rub here. In other words, if you have corn that already removed carbon from the atmosphere, it's quite true that that corn was already, you know, being digested and, you know, calories burned results in CO₂ being exhaled. If you take it and use it for fuel, that carbon still comes out of the air in the tailpipe. So the question then becomes, as I said before, does that mean that that calorie consumption, the corn that was being consumed by people and livestock, has disappeared? And the answer is no, it's certainly not disappeared.

And this is again why it is, you know, the conservation of mass. And yes, mass and energy were—we are fortunately dealing with non-relativistic velocities in the commodity markets, that you can't just assume that because the carbon was recently grown that it's sufficient to balance out the system, which is using huge volumes of carbon already for food and feed. And that's the—you know, the essence of how I, you know, have essentially picked apart and found the flaws in the lifecycle models.

Mr. BEYER. Thank you, Mr. Chairman. I yield back.

Chairman BRIDENSTINE. I'd like to thank the Ranking Member. I recognize Mr. Weber from Texas for five minutes.

Mr. WEBER. Thank you, Mr. Chairman.

And Dr.—is it Dinan?

Dr. DINAN. It's Dinan.

Mr. WEBER. Dinan. They've been ignoring you, and so I just wanted to come to you. I'm going to have a question for all five of you, and it's a simple yes or no. And I don't want you to give away the answer. Just do you know the answer? MTBE, do you know what that is?

Dr. DINAN. Yes.

Mr. WEBER. Mr. Anderson, since you run some Wendy's franchises, you may or may not know what that is.

Mr. ANDERSON. No, sir.

Mr. WEBER. Okay. And is it Dr. DeCicco?

Dr. DECICCO. [Nonverbal response.]

Mr. WEBER. Okay.

Dr. DECICCO. Yes, I know what MTBE is.

Mr. WEBER. All right. Mr. Coleman?

Mr. COLEMAN. Yes. I think I mentioned it. Yes, I know.

Mr. WEBER. Okay. Dr. Drevna?

Mr. DREVNA. Absolutely.

Mr. WEBER. Okay. So this is a push to do away with MTBE, a.k.a. methyl tertiary butyl ether, as I understand it, ostensibly because MTBE was found in groundwater, is that right, any of y'all? Dr. Drevna?

Mr. DREVNA. MTBE was found in groundwater because we had a leaking underground storage tank debacle in the country, and EPA passed a bill—I mean passed a regulation that gave underground storage tanks ten years to comply but then the RFG2 came into play and we had to put more oxygenate into the gasoline.

Mr. WEBER. Okay. Do we know what affect ethanol has in the groundwater?

Mr. DREVNA. If you have a leaking underground storage tank, by what I've seen in the studies would indicate that the ethanol will separate out first from the water and then it—as—whereas the bacteria would go after the BTEX compounds—benzene, toluene, xylene—in the underground water and the MTBE would traverse further, the bacteria likes their cocktails before dinner so they have the—they go for the ethanol first. But in essence, you know, I think we've fixed the underground storage tank problem in the country, which was the root of the problem.

Mr. WEBER. So according to Wikipedia—standby, Mr. Coleman, I'll come to you—

Mr. COLEMAN. Okay.

Mr. WEBER. —MTBE was not very soluble in water.

Mr. DREVNA. Okay, it was very soluble in water.

Mr. WEBER. It's very soluble in water?

Mr. DREVNA. Yes. Yes.

Mr. WEBER. Okay.

Mr. DREVNA. So is ethanol.

Mr. WEBER. And so ethanol is but you said it separates out quicker.

Mr. DREVNA. No, what happens—ethanol has an affinity for water.

Mr. WEBER. Okay.

Mr. DREVNA. That's why when one of the previous witnesses talked or maybe Mr. Chairman talked about the outdoor power equipment and the marine people. The marine folks don't like a lot of ethanol, if it all—

Mr. WEBER. So—

Mr. DREVNA. —in—to use in marine equipment because the ethanol will separate out and marine—

Mr. WEBER. That's because it's corrosive to the inside of a steel engine, is that correct?

Mr. DREVNA. Well, you know, it's corrosive to certain pumps and flanges and hoses and things—

Mr. WEBER. Okay.

Mr. DREVNA. —but, you know, again, the reason for the marine folks who don't want it is because ethanol has an affinity for water.

Mr. WEBER. Okay. Mr. Coleman, you wanted to weigh in.

Mr. COLEMAN. Yeah, just a quick thought. When ethanol—when MTBE went in gasoline, we had a massive drinking water problem because MTBE was highly soluble in water, and it actually extended the plume into drinking water aquifers. When we replace MTBE with ethanol, we no longer had that problem, and—

Mr. WEBER. Okay.

Mr. COLEMAN. —and Mr. Drevna's view is that all of a sudden the underground storage tanks are fixed, our view is that it's a better biodegradable product.

Mr. WEBER. Okay.

Mr. COLEMAN. And then I'll yield on the second part.

Mr. WEBER. Mr. Drevna, you had another—or Dr.—

Mr. DREVNA. Yes, I have a comment on that, and—some of the things that my colleague here Mr. Coleman has been talking about, a free market, MTBE, the RFG2 was a free market. The ethanol folks clamored because the consumer didn't want ethanol. The consumer still doesn't want it in massive quantities.

Mr. WEBER. Well, we've had another—in the committee that I chair, the Energy Subcommittee, we've had a group of—a gas station owned by farmers in Ohio area, I think, or maybe it was Iowa—I'd have to go back and look—who actually couldn't sell enough of this stuff in the very heart of corn country. So from an economic standpoint, it just wasn't really flying.

Mr. COLEMAN. Mr. Weber, could I just add one quick comment DD

Mr. WEBER. Sure.

Mr. COLEMAN. —if he is attacking our industry? So I know DD

Mr. WEBER. Well, if we have a difference of opinion, that's not an attack, right?

Mr. COLEMAN. No, no, no. Yes, yes, yes. But—

Mr. WEBER. Okay.

Mr. COLEMAN. —the record is open for two weeks. We would be happy to provide further information about this.

Mr. WEBER. So you'd be happy to counterattack?

Mr. COLEMAN. Perhaps counter-argue.

Mr. WEBER. Okay. All right. Well, I'm going to leave it at that. Mr. Chairman, I'm going to yield back.

Chairman BRIDENSTINE. Thank you. I guess we are out of witnesses on that end, so we'll go with Mr. Babin also from Texas.

Mr. BABIN. Yes, sir. Thank you, Mr. Chairman, and thank you, witnesses, for being here.

I—maybe I missed this a while ago but, Dr. DeCicco, can you tell me a little more about why corn ethanol is worse for air quality the gasoline? That may have already been asked and hashed but—

Dr. DECICCO. Sure. I would be happy to explain that. In particular, the part of air quality that I'm focusing on is the CO₂ emissions because that's the emissions that the ethanol proponents claim that would be reduced by the use of ethanol.

When it comes right down to it, it's a matter of chemistry for the fuel. Carbon, as I said, is the fuel of life and it provides energy both to people through calories and we can also use carbon-based fuels to provide energy for cars and trucks and airplanes. And it's a great energy carrier. So ethanol is a carbon-based fuel, and that is somewhat compatible with gasoline although, as we've heard,

there's limits and problems associated with putting too much of it into the gasoline.

But when you burn ethanol, the combustion still creates a CO₂ coming out of the tailpipe, same for biodiesel. And so a short way of thinking about it is that if biofuels were to have a benefit for CO₂, it's not when they're burned. I mean when you burn it, you have to burn that carbon, CO₂ comes out of the tailpipe.

So then you have to ask, okay, well, if the reduction of CO₂ does not occur at the tailpipe, where might it occur? And this is where you have to go back and say, well, did we remove more CO₂ when we harvested the feedstock than the plants were already absorbing from the air? And if you haven't done that—and the vast majority of biofuel that we grow—we are growing it on existing cropland, sourcing the corn and soybeans from existing cropland—you've not removed more CO₂ from the air.

Now, yields have gone up a little bit. My analysis accounts for that. But that's just a small increase in the removal. But the bottom line is, because there's no benefit to the atmosphere when the biofuel is burned, unless you pull more CO₂ out of the air, which you might do by harvesting stover, corn stover, residues, so there's a potential there to get a benefit that way, but unless you do something like that, if all you do is divert existing crop production into the fuel market, then right off the bat there's no benefit. And as I said before, then you have to add in all those excess emissions associated with processing the fuel, and the picture starts to look very bad very soon.

Mr. BABIN. Okay. Thank you.

And should corn ethanol be classified as a green fuel then, given this environmental impact?

Dr. DECICCO. Absolutely not.

Mr. BABIN. Yes. Okay. And now the Administration has proposed lowering the ozone standard, ambient air quality, to 70 parts per billion. In your opinion, would the RFS complicate efforts to attain a more stringent standard if that's the case?

Dr. DECICCO. Yes, it could. As you move into sort of the various parts of the low-blend realm, you can worsen evaporative emissions from ethanol. It's—I wouldn't want to say that it's a large effect, but it's an aggravating effect.

Mr. BABIN. But if you couple that with higher food prices and the other negatives of the ethanol industry, it certainly could have a detrimental effect, right?

Dr. DECICCO. Well, I'm sticking kind of myself on the environmental side here. I know there's different views on the—

Mr. BABIN. Well, okay.

Dr. DECICCO. —food price impacts.

Mr. BABIN. Okay. I was just thinking.

And, Dr. Dinan, what is your assessment of the impact of the RFS on blending of biofuels into the transportation fuel supply? And has the use of biofuels increased the cost of the RFS, or would we have seen ethanol production grow without a federal mandate? It's a three-part question.

Dr. DINAN. Okay. Well, we really don't actually answer the question did corn ethanol use grow because of the RFS. Our analysis is really about looking forward. So what we do look at is whether

or not the use of corn ethanol would decline very much if we had a repeal of the law. And we indicate that we don't think it would decline that much because there are other benefits that blenders received by blending in the corn ethanol. It helps them with octane requirements and with meeting carbon monoxide emission reductions requirements. So that's why we don't find a big drop in corn ethanol use.

But if the law was to push the amount of corn ethanol—of total ethanol, total renewable fuels up to the levels required under the law, EISA rather than the amount proposed by EPA, then there would be a significant problem with the blend law.

Mr. BABIN. Okay. Thank you. My time is expired. Thank you, Mr. Chairman.

Chairman BRIDENSTINE. Thank you, Mr. Babin. So if we're blending ten percent now, if we were to repeal the RFS, we would still be blending what according to your study?

Dr. DINAN. We think it would stay at roughly ten percent for at least—

Chairman BRIDENSTINE. So the idea that we're going to ruin all these jobs and destroy these markets, that's incorrect?

Dr. DINAN. Well, what we say is that there's a tension between keeping the costs down and pushing the technology. So if you were to repeal the RFS, you would reduce incentives to create more E85 stations and also for production facilities for more advanced biofuels.

Chairman BRIDENSTINE. Okay. The gentleman, Mr. Abraham, is recognized from Louisiana.

Mr. ABRAHAM. Mr. Coleman, I see you on the button. Give me your opinion if we repealed the RFS. What would that do to general farm prices right now? They're low already, the commodity prices. What would the total repeal of the RFS do to the—

Mr. COLEMAN. That's a question for—

Mr. ABRAHAM. Yes, sir.

Mr. COLEMAN. —myself?

Mr. ABRAHAM. I saw you wanted to answer.

Mr. COLEMAN. Yes, sure. The—well, if you repeal the RFS, you're taking away a value-added agriculture market for the agricultural community. And so I think the fundamental premise of the RFS is that we have enough corn and we have as many farms and as much agricultural product to do more than just one thing, and that's to feed animals, that we can make bioplastics out of them, we can make fuel, we can make a number of different things.

If you ask the agricultural community, they don't feel like they should be in a box of only producing food. And I think low corn prices today bear that out. And so what you would have is a situation where repealing the RFS would create more economic pain in the heartland, and that is not something that we want to see.

In terms of clarifying the jobs part of this, I represent the advanced biofuels industry, and I think what's at stake here, even though the debate that the oil industry tries to have this conversation around is about corn ethanol, what's at stake is the advanced biofuels part of the RFS.

And so if the thesis is that we're not going to lose corn ethanol by repealing the RFS, my feeling is isn't that what we're talking about? We're talking about innovation here.

Mr. ABRAHAM. All right. Let me go back to you first, Mr. Coleman. In view that we have RFS standards now, what's your opinion? Why are our corn prices so low now?

Mr. COLEMAN. A couple of reasons. The first is, is that we have plenty of supply against demand, and so we've come back to a situation where after a couple years of drought, which drove corn prices up, we are now in a healthy corn market and even an over-supplied corn market where we have so much supply that it's driving prices down.

The second reason is, is if you look at the correlation analysis of corn prices and oil prices, you will see very, very strong correlation because oil is a primary input for agricultural commodity production, and also it is a huge driver in terms of futures trading, et cetera. So you see corn and oil matching together, and any time you have corn—oil prices coming down, you almost always have agricultural commodity prices coming down. And so with lower oil prices, you have lower corn prices.

Mr. ABRAHAM. And Dr. Dinan had said in her testimony that the CBO report mentioned that fuel and food prices depend on a number of factors outside of the RFS. Do you agree with that statement, Mr. Coleman?

Mr. COLEMAN. Yes. I mean oil is the primary driver, and I should note about the CBO report—and I believe that the doctor did not set the program confines—but it did not analyze the economic benefits of reducing petroleum dependence in that report, and that's a little bit like looking at the economic benefits of a jobs program and not looking at the economic benefits of jobs creation.

And so we have a problem with that report and we think that needs to be fixed. So I think if you look at the actual central point of the RFS, which is to reduce petroleum dependence, if we add that into the equation, the economic benefits of the RFS would be astounding.

Mr. ABRAHAM. Thank you, Mr. Chairman. I yield back.

Chairman BRIDENSTINE. Mr. Westerman from Arkansas is recognized for five minutes.

Mr. WESTERMAN. Thank you, Mr. Chairman, and thank the witnesses for being here today. These are some fascinating subjects, and I'm struggling a little bit on which one to address here. We've got land use and a clean environment. With got the law of conservation of mass and energy and energy conservation or net energy gain or the carbon cycle and economics versus of real versus inflationary food costs. These are all things that I like to talk about.

But let's start off with the carbon cycle and land use. And, Dr. DeCicco, if I understand your argument that there's—and getting back to the law of conservation of mass and energy, there's only so much carbon in the world, and the question is where's that carbon going to be located? It's either going to be in the atmosphere or is going to be sequestered somewhere under the ground or in biomass here on the earth. And if we create a new crop source to make ethanol or corn, then you're going to be clearing more land to produce

this corn. So you're changing land-use and putting a crop there that's going to be planted and harvested every year.

I remember being at a conference on renewable energy where they were showing in South America where they had cleared this highly productive land to grow—I don't remember if it was sugar beets or corn, but in the photo there was timber from a rainforest stacked up in a perimeter around the land. It was used to keep animals out of the crop.

But as we look at that, something we haven't talked about is the energy gained from corn ethanol. And the research that I've looked at show that somewhere between 1 to 1.3, maybe even as high as 1.6 on the energy put into producing corn ethanol versus the energy that you get out. We've been talking more about the carbon balance on it. But if we look at other forms of cellulosic ethanol or biomass, even though the processes haven't been refined, the numbers on the net energy gain are much higher than what we see on corn ethanol.

So are you saying we should totally abandon all renewable fuels, or is there room for more research to develop some of these cellulosic ethanol technologies maybe from woody biomass that do have even a bigger carbon cycle effect?

Dr. DECICCO. Sure. I take issue with the mandating of the fuels from an environmental point of view. I think it's important to support the research side. In other words, as I've pointed out, there is a potential if it's done right, if technology materializes in an economically viable way at commercial scale for forms of cellulosic production in a way that has failed to materialize for nearly 40 years now—I mean, this is not a new area of research—then, you know, that could be a good thing provided the land use is properly managed and that there are guarantees that the actual production of whatever biomass is going to be going into the cellulosic fuel is done in such a way that it increases the rate at which carbon is removed from the atmosphere without depriving the food and feed system of carbon.

So there's two big ifs that have not been met, are not in my estimation close to being met for the commercial viability of so-called advanced biofuels. So, yes, you know, in terms of this committee's role in advising the research programs, we should continue research in this area and maybe make, you know, progress through that. But when it comes to intervening in the marketplace and trying to force fuels in that are not commercially viable that have a dubious carbon pedigree anyway because the analyses backing them were done incorrectly, I think that, you know, is very questionable—

Mr. WESTERMAN. And if we look at—

Dr. DECICCO. —due to mandated—

Mr. WESTERMAN. —in our forests across the country right now, we've seen hundreds of millions of tons of carbon going up in smoke every year from forests that are mismanaged. And if that carbon were captured and used for energy, it seems to me like there would be a net benefit from energy and the carbon cycle to do that.

Dr. DECICCO. That's correct. I mean, that's an example where if you're capturing carbon, harvesting carbon say from forest residues that are at risk of causing a fire and burning up anyway or corn

stover to the extent you can do that without overly degrading your soils, that would decay anyway, release its carbon, those are examples of what I mean by additional carbon. You know, you're getting additional carbon because you're taking carbon that otherwise would either burn or decay without being put to commercial use.

So those are potentially legitimate sources of carbon, but I don't think that that then justifies some kind of mandatory use. I think that you need to look at that situation carefully, and then I would go back to we need to have the right market signals here involved, and that's not something you get through a technology winner-picking mandate.

Mr. WESTERMAN. And I think I'm out of time, Mr. Chairman, but if you'll oblige me just a few minutes, or are we going to get a second round of questions?

Chairman BRIDENSTINE. I'll give you another minute.

Mr. WESTERMAN. All right. Thank you.

So if we look at where we're at on the cellulosic fuels, it seems to me it would make sense that while conventional energy prices are low, that we put more money into research to make these cellulosic fuels competitive in a free market so that when conventional fuel costs go up, we could use these renewable fuels in a market-based economy so that we're not subsidizing or mandating the use of them. But we just don't have the technology yet to make them cost-effectively to do that. Would you agree with that? Mr. Coleman, your finger is on the button.

Mr. COLEMAN. Yes. That's the industry I represent. And so, you know, I think I've made myself clear on this whole idea of a price-driven marketplace that we don't have. If you look at the history of ethanol use in this country, about 90 percent of the last ten years ethanol has been vastly cheaper than gasoline and the oil industry hasn't used more than it has been required by the government to use. If we had a price-driven marketplace, we would already have the things that we're talking about wanting now, consumer choice at the pump, an alternative to gasoline hedges against pump price spikes associated with petroleum, et cetera.

The second thing I would take issue with is this cost component of cellulosic. If you look at how much—we're at the end of the era of light sweet crude that just squirts out of the ground. We are at the deepwater, fracking, tight oil part of the evolution of crude oil that is infinitely more expensive than light sweet crude. And if you look at the costs of cellulosic biofuel versus the marginal oil gallon such as the money that was spent in the Bakken, we are cost-competitive with those oil plays.

And so what we need to drive competition in the marketplace is access to the marketplace that we are not going to get unless we have either the RFS or we break up the oil companies, which I don't think is very politically popular.

Mr. WESTERMAN. Yes. And, you know, most consumers, I think, care about what the price is on the gas pump, however it gets there.

Mr. Drevna, would you like to address that?

Mr. DREVNA. I don't know where to start. I just can't believe what I just heard in this hearing room. First of all, the—there still is—as the doctor said at the end of the table said, there's still a

ten percent maximum blend wall you can't meet. And that automobile or that lawnmower or that chainsaw doesn't give anything about where that ethanol comes from, whether it's cellulosic or whether it's corn or whether it's some still in West Virginia. It's ethanol. And we have blend wall. Even EPA, who I very rarely agree with, says there's a blend wall problem, and it will be for the distant future.

Number two, Mr. Coleman keeps on talking about this grand conspiracy of the big oil trying to stop penetration into the market. Well, the reality of the situation is big oil, little oil, independent refiner in, you know, in the middle of the corn belt, they do not control anything to do with the market. Ninety-five percent of the retail market is controlled by independent operators, just as my colleague down here, Mr. Anderson, is an independent operator for a franchise. It's the same thing. If those franchisees want to sell more ethanol or want to put in E85 pumps, have at it.

If my friends from the advanced biofuel or the corn ethanol folks want to invest rather than sup at the government trough year in and year out, they can put the money—they could talk to the owners of these—of the gas stations and say, hey, we're going to invest with you because it's got to be—it's not oil versus advanced.

Chairman BRIDENSTINE. I would like to—

Mr. DREVNA. It's what the consumer wants.

Chairman BRIDENSTINE. I would like to say how much I've enjoyed this exchange between Mr. Coleman and Mr. Drevna, but in the interest of the folks on the committee, we're going to go to our next questioner.

Mr. WESTERMAN. Thank you for that extended minute, Mr. Chairman.

Chairman BRIDENSTINE. You bet.

Mr. LAHOOD, you're recognized for five minutes.

Mr. LAHOOD. Thank you, Mr. Chairman. And, Mr. Chairman and Chairman Loudermilk, I look forward to working with you on this issue, and appreciate the testimony of the witnesses here today.

I'm brand new, come from Illinois, Ag is the number one industry in our state. And in hearing the testimony particularly from Dr. DeCicco and Mr. Drevna, I mean, it really seems incongruent when you look at the genesis of the law and going back and looking at the Energy Policy Act of 2005 and the EISA law of 2007. And at the signing ceremony there, the emphasis on why that was put in place, the RFS, you know, President Bush talked about protecting the environment, strengthening our energy security, supporting American farmers.

And you listen to that and also the Secretary of Energy at the time Samuel Bodman and Secretary Johanns, who's now a U.S. Senator, and you listen to what they said then and how that's played out and then you hear the testimony here today, they're in conflict. And I'm trying to rationalize that and figure out where the truth lies.

And I guess in looking at my own district, I have a very rural district in central and west central Illinois. And I think in my district—ag is the number one industry in the State of Illinois. We have—you know, we have some of the most fertile farmland in the

entire world. And I look at what it does in Illinois in terms of what it's done for our consumers.

I don't—to be honest with you, Mr. Anderson, I don't hear much complaints about food prices going up in my district. We have some big livestock operations there, you know, we have some of the highest yields we've had, energy prices and gasoline prices have been low in Illinois, and then you—our air pollution has gone down almost every year in Illinois.

So I look at those tangible benefits and I also look at the jobs that are created in Illinois through agriculture, whether that's John Deere or ADM or Caterpillar. There are lots of small and medium-sized businesses that have benefited from this law.

And I guess in looking at, Dr. DeCicco, the flaws that you laid out—and I have to admit I don't know much about carbon neutrality or violation of carbon mass—some of these flaws, but I guess in looking at the genesis of this bill and what was put forward and the rationale and how that's playing out, I guess I have not heard from—whether that's Secretary Bodman or Secretary Johanns—on acknowledging these flaws or making statements that the law somehow was incorrect and we need to amend that or revise that. Can you comment on that?

Dr. DECICCO. Sure. I think, as you pointed out, at the time that the law was passed and especially when EISA greatly expanded the renewable fuel mandate, there were really sort of three public policy rationales. You can kind of think of them as a three-legged stool that propped up this expansive requirement for renewable fuels. And as you point out, one is rural economy. And, you know, I'm certainly not going to question that. I mean there's—I don't think there's a doubt that creating additional demand for grains and other farm commodities is going to help those economies.

Then there's the energy security rationale. Well, I think that these commodity markets respond slowly, especially the oil market. And I think we've seen a lot more energy security come from increased petroleum than we have from relatively small and relatively costly biofuel. So I'm not so sure about that second leg.

The environmental lag, in spite of, I think, good intentions and Department of Energy-sponsored analyses and so on, that has not stood the test of time scientifically. I mean I would have to say, you know, the way I look at my analyses is I've essentially cut off that environmental leg.

So whether the RFS can stand on, you know, a rural economic development leg and perhaps an energy security leg—and I'll kind of let others debate it—there's certainly no longer an environmental rationale for a mandate like this.

Mr. LAHOOD. I would just follow up on that. So in looking at those flaws that you laid out and what you mentioned, I mean, can—are you aware of—you know, for instance, Secretary Bodman, who was a chemical engineer from MIT, that he has acknowledged those flaws or put anything on record to say that this was done inappropriately or the wrong way?

Dr. DECICCO. I'm not aware of that. I mean I do acknowledge that the criticism—environmental criticisms that have come to the fore in this policy in terms of the scientific literature are relatively recent. We know more now than we did some time ago.

I would say—and I'm happy to put this in the record—in 2002 I was at the Environmental Defense Fund and co-authored a brief position statement on the prospect of a mandate. And myself and the other colleague there, Tim Searchinger, now at Princeton University, we raised red flags. Not all the science was in place for me at that time to be able to give as strong a criticism on the environment as I'm able to do today, but we were certainly concerned and wary of the risks at that time.

Unfortunately, you know, it's taking some time for that to be assimilated, digested by a lot of people, the Department of Energy and elsewhere, who have been guided by analyses that we now know were incorrect.

Mr. LAHOOD. And the last thing I would say, Mr. Chairman, is, you know, I've tried to find evidence either from, you know, Secretary Bodman or the EPA Director at the time Stephen Johnson or from President Bush that somehow this was a flawed law and was not done the right way, and I've had difficulty finding that evidence.

Thank you very much, Mr. Chairman.

Chairman BRIDENSTINE. Thank you.

Mr. Beyer has been listening patiently to my side of the aisle for the better half of probably 30 minutes, so I'd like to recognize you for five minutes and then I'll close it out.

Mr. BEYER. Thank you, Mr. Chairman.

And with due deference to the Chairman of the Subcommittee on the Environment being from Oklahoma, I'd like to study—cite a study from the University of Tulsa National Energy Policy Institute that estimated that the United States has spent \$8 trillion from 1976 to 2010 defending access to oil supplies in the Persian Gulf.

So, Mr. Coleman, a rhetorical question, is the massive cost that U.S. taxpayers pay every year to defend these shipping lanes included in the price of oil?

Mr. COLEMAN. No, it's not and it's because we pay for it as taxpayers. And so this is part of the reason that this whole notion of let the market decide, which is probably the proper notion to have in 90 percent of the markets in this country, doesn't work for motor fuels. And so if the oil industry had to pay for getting itself through the Straits of Hormuz, the cost of gasoline would be much higher. But right now, the taxpayer pays for it.

And the oil industry also—and I will point out with regard to the Bakken and tight oil, one of the biggest lease-holders in the Bakken testified before Senate Finance in 2012 that the only reason that they were successful there is because of the tax subsidies that allowed them to keep their money and reinvest it.

And so when it comes to energy security, I think the government is properly engaged because it matters that we have enough energy to get to work and go to the grocery store, and we should—and the government should stay engaged. But this idea that the RFS is somehow distorting a free market is just not a serious allegation.

Mr. BEYER. And as we talked about, the great promise of advanced biofuels rather than simple corn ethanol, if we do away with the Renewable Fuel Standard and that first-generation eth-

anol plants goes away, what implication does not have for being able to develop an advanced biofuels market?

Mr. COLEMAN. Well, if you look at renewables writ large, so whether it's wind, solar, or any innovation product, you will find that revenues created by first gen get poured into innovation in second-generation. So first, the windmill companies that built the big windmills are the ones financing smaller windmills and distributed energy, same for solar, same for geothermal, et cetera, et cetera.

In our industry that is starkly clear. So if you look at the first movers in cellulosic ethanol, you will see Abengoa, you will see POET/DSM, you will see DuPont, you will see Quad County. Those are all first-gen corn ethanol companies who are taking revenue streams from the selling of corn ethanol, and because the RFS sends a clear signal to diversify feedstock and innovate, they are doing that.

And so a lot of this discussion about corn ethanol is really a distraction. The RFS stops requiring corn ethanol this year. It flatlines over time. It is a stalking horse for incumbents to come after the advanced biofuels industry, and that is the largest part of the RFS going forward, 90 plus percent of the RFS going forward. So if you repeal it or even change of law, which scares investors, we will be in a situation where we continue to build these next-generation plants overseas, and that would be a huge opportunity lost.

Mr. BEYER. Great. Great. Mr. Chairman, I yield back. Thank you very much.

Chairman BRIDENSTINE. You bet. So you mentioned Tulsa University, and you mentioned what we do in the United States Navy, of which I spent many years of my life. I would just like to let the record show that if terrorists or rogue nations wanted to take control of the corn market, we would defend the corn market as well.

Mr. Drevna, did you have a thought on that issue? I saw you—

Mr. DREVNA. Yes, I appreciate it, Mr. Chairman. This whole thing, you know—and Mr. Coleman is right. The—and he used the right term, too. He said the corn ethanol flatlines after this year, 15, you know, some billion gallons. The problem is is that the EISA '07 calls for 36 billion gallons of phantom fuel—or 22 billion of which are phantom fuels by 2022. What are we going to do? What's the refining industry—what are the obligated parties going to do between now and 2022 when, you know, if you look at the success/failure rate of these advanced biofuels, there's—you know, as I said in my testimony, if it weren't for EPA to change the—a scientific definition and you look at the testimony, the production from these facilities is minuscule, and it's going to be minuscule.

So are we supposed to say, well, it's right around the corner so you obligated parties keep sending money to the federal government and buying tax credit—or credits to keep this industry going, or do you want to let investors invest in this stuff just like every other entrepreneur in this country has done forever and make a better product and take the risk rather than have them being propped up by the government and then having the taxpayer end up paying for it? That's the choice you have to make. I appreciate the ability to respond.

Chairman BRIDENSTINE. Absolutely. So in summary what I learned, the Renewable Fuel Standard is damaging to the environment, which was new to me, by the way, in this hearing and it actually increases carbon emissions. Food prices have been increased, although there's some debate about that, but I think on average it will go up a little bit, which makes the standard of living for all Americans a little bit harder to achieve. And repealing the Renewable Fuel Standard would not, you know, get rid of jobs.

I do believe that there may be a place for the government to be involved in research and development for advanced biofuels, but creating a mandate is not the right solution.

With that, I thank the witnesses for their valuable testimony and the Members for their questions. The record will remain open for two weeks for additional comments and written questions from Members.

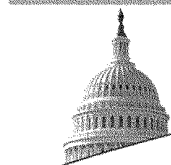
This hearing is adjourned. Thank you.

[Whereupon, at 11:55 a.m., the Subcommittees were adjourned.]

Appendix I

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Terry Dinan

Congressional Budget Office

DECEMBER 17, 2015

**Answers to Questions for the Record
Following a Hearing on the Renewable Fuel Standard
Conducted by the Subcommittee on Environment and the
Subcommittee on Oversight of the House Committee on
Science, Space, and Technology**

On November 3, 2015, the Subcommittee on Environment and the Subcommittee on Oversight of the House Committee on Science, Space, and Technology convened a joint hearing at which Terry Dinan, Senior Advisor at the Congressional Budget Office, testified about the Renewable Fuel Standard. After the hearing, Chairman Smith of the Committee and Chairman Bridenstine of the Environment Subcommittee submitted questions for the record. This document provides CBO's answers.

Chairman Smith

Question. CBO's analysis concluded that the RFS has had a minimal impact on the price of food over the 10 year lifespan of the law, and repeal of the law would not significantly reduce food prices. During the hearing, Mr. Ed Anderson raised the issue of corn crop yields as related to the current price of corn, which are significantly lower than the price in 2012. Mr. Anderson linked this price drop to three "record corn crops," and stated that this trend was unlikely to continue. Do you agree with this statement? If so, would more typical, lower yields of corn in the future be likely to significantly impact the price of food? Mr. Coleman also stated that the agriculture market is influenced heavily by the price of oil, with the price of corn dropping with lower oil prices. Do you agree with this statement? If so, could the current drop in oil prices be impacting the price of corn?

Answer. The Renewable Fuel Standard (RFS) affects the price of corn and thus the price of food. At present, roughly 40 percent of the U.S. corn supply is used to make ethanol. To the extent that changes in the RFS raise or lower the demand for corn ethanol, the RFS will raise or lower corn prices. However, because corn and food made with corn account for only a small fraction of total U.S. spending on food (roughly 1.5 percent in 2015), the effects of the RFS on overall food prices are small. For example, CBO estimated that food prices would be only slightly lower in 2017 (by less than 0.1 percent) if the RFS was repealed than they would be if the volumes of biofuels required under the RFS in 2017 were the same as those proposed for 2016.¹

1. Those standards, which the Environmental Protection Agency (EPA) proposed on September 29, 2015, were somewhat lower than the 2016 volumes that EPA mandated in its finalized rule, published on November 30, 2015. See Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017, 80 Fed. Reg. 33100, 33105 (proposed June 10, 2015), and Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017, EPA-HQ-OAR-2015-0111, ____ Fed. Reg. ____ (August 30, 2015) (to be codified at 40 C.F.R. pt. 80) (Final Rule to be published in the *Federal Register*).

To a considerable extent, the price of corn depends on the size of the annual corn harvest. For instance, the price of corn averaged about \$4.50 per bushel in 2013 and \$3.70 per bushel in 2014, when corn harvests reached historical highs of about 14.0 billion bushels each year. By contrast, the price of corn averaged \$6.90 in 2012 when the U.S. corn harvest totaled about 10.8 billion bushels—the smallest harvest since 2006. In general, greater production in any one year will reduce the price of corn in that year. However, because spending on corn accounts for such a small share of the total cost of food, variations in the price of corn—such as those resulting from changes in yields—are unlikely to significantly affect average food prices.²

Corn prices also depend on other uncertain factors, such as international supply-and-demand factors for corn and other agricultural products and the price of energy supplies. The cost of crude oil affects the price of corn and other agricultural goods because energy is an input into agricultural production. The decline in the price of oil in 2015—which has averaged about 45 percent below that in 2014—is one factor contributing to lower corn prices today. As with yields, variations in those factors can affect corn prices but are unlikely to significantly affect average food prices.

Question. During the hearing, Mr. Coleman questioned the quality of CBO's analysis related to the RFS, stating that the report "did not analyze the economic benefits of reducing petroleum dependence," and went on to assert that "that's a little bit like looking at the economic benefits of a jobs program and not looking at the economic benefits of jobs creation." Did CBO consider the economic cost or benefits of petroleum dependence? If not, why not?

Answer. CBO's testimony focuses on two considerations: the feasibility of complying fully with the Energy Independence and Security Act (EISA) and how several alternative scenarios to EISA's requirements would affect prices of food and fuel. In its testimony, CBO did not attempt to measure either the benefits or the costs of complying with the RFS. The benefits of complying with the RFS are generally described as the value of the reduction in greenhouse gas emissions that may occur as a result of substituting biofuels for petroleum-based fuels and the potential energy security benefits associated with consuming less petroleum. CBO has assessed both benefits in previous publications.

In particular, although researchers' predictions vary considerably, available evidence suggests that replacing gasoline with corn ethanol has only limited potential to reduce greenhouse gas emissions (and some studies indicate that it could increase emissions).³ Evidence indicates that the success of the RFS in reducing emissions from transportation fuels will depend mainly on the extent to which it causes people to substitute advanced biofuels—particularly cellulosic biofuels—for gasoline or diesel over the long run.

2. Underlying CBO's most recent assessment of the budget and economic outlook is the projection that 6.6 billion bushels of corn will be used directly as food or as animal feed in 2015. At a price of about \$3.80 per bushel, about \$25 billion will be spent on corn as food in 2015, which is about 1.5 percent of the roughly \$1.7 trillion expected to be spent on food. For CBO's overall outlook, see Congressional Budget Office, *An Update to the Budget and Economic Outlook: 2015 to 2025* (August 2015), www.cbo.gov/publication/50724.

3. See Congressional Budget Office, *The Renewable Fuel Standard: Issues for 2014 and Beyond* (June 2014), www.cbo.gov/publication/45477.

Reducing U.S. consumption of oil (for example, through the RFS) and offering consumers options to drive less during times of high prices (for example, by expanding public transportation service or promoting telecommuting) would make U.S. consumers less vulnerable to disruptions in the supply of oil.⁴ Such options would reduce the costs that households and businesses might bear as a result of spikes in fuel prices that such disruptions caused. (Because oil is traded in a global market, disruptions to oil production anywhere in the world raise the price of oil for every consumer, regardless of the amount of oil imported or exported by that consumer's country.) CBO has not estimated the magnitude of the benefit of marginal reductions in oil consumption.

The benefits associated with incremental reductions in consuming petroleum-based fuels are most appropriately compared with the incremental costs of achieving those reductions through the RFS. An estimate of those costs can be constructed from the prices that CBO estimated for renewable identification numbers (RINs), known as RIN prices, which indicate the marginal cost of adding one additional gallon of biofuel to the nation's transportation fuel supply, along with information on the amount of gasoline or diesel displaced by a single gallon of biofuel. EPA assigns a RIN to each qualifying gallon of renewable fuel; those RINs are used to enforce compliance with the RFS.

The marginal cost of adding one more gallon of biofuel to the fuel supply (and the corresponding RIN prices) rise as the volume requirements of the RFS increase. For example, CBO estimated that the RIN price for corn-based ethanol would be 40 cents if the volumes of biofuels required under the RFS in 2017 were the same as those proposed for 2016, which CBO refers to as the "2016 volumes scenario." Under more stringent standards—meeting the 2017 requirements for advanced biofuels (but not for cellulosic biofuels) and the cap on corn ethanol stated in EISA (the "EISA volumes scenario")—the RIN price for corn ethanol would be higher: CBO estimated that price would probably be between \$1.55 and \$2.10. Because ethanol has roughly two-thirds the energy content of the same amount of gasoline, the marginal cost of reducing gasoline consumption by one gallon through substituting corn ethanol would be 60 cents under the 2016 volumes scenario and would probably be between \$2.30 and \$3.20 under the EISA volumes scenario.⁵ Because the marginal cost of reducing gasoline consumption increases as the volume of biofuel required by the RFS rises, the average cost of each one-gallon reduction in the use of gasoline caused by the RFS would be less than the marginal cost.

The marginal cost of substituting advanced biofuels for petroleum-based fuels is higher than that of substituting corn ethanol for gasoline. For example, CBO estimated that the RIN price for advanced biofuels would be 55 cents under the 2016 volumes scenario and would probably be between \$3.00 and \$6.00 under the EISA volumes scenario. As a result, the marginal cost of reducing gasoline consumption by one gallon through substituting sugarcane ethanol (a form of advanced biofuel) would be roughly 85 cents under the 2016 volumes scenario and about \$4.50 to \$9.20 under the EISA volumes scenario. (The average cost of each reduction would be less than the marginal cost.)

4. See Congressional Budget Office, *Energy Security in the United States* (May 2012), www.cbo.gov/publication/43012. That report focused on the ability of U.S. households and businesses to accommodate disruptions of supply in energy markets. Other considerations, such as having the flexibility to choose not to import oil from countries that might seek to use their exports of oil to influence international affairs, were outside the scope of that report.

5. Those values are equal to the RIN price divided by 0.66 to account for ethanol's having less energy than gasoline: one gallon of ethanol replaces only two-thirds of a gallon of gasoline.

Chairman Bridenstine

Question. Dr. Dinan, in your testimony, you state that CBO's analysis shows that repeal of the RFS would have minimal effect on the price of transportation fuels. Does CBO's analysis take into account the elimination of RINs, the cost of which is currently shouldered by merchant refiners?

Answer. CBO's analysis of how repealing the RFS would affect the price of transportation fuels accounts for the elimination of the cost of acquiring renewable identification numbers (RINs). CBO's analysis accounts for the cost of complying with the regulation—including the cost of acquiring RINs and any increase in the cost of corn ethanol resulting from the mandate.

CBO estimated that repealing the RFS would have only small effects on prices in comparison with what would happen if the volumes of biofuels required under the RFS in 2017 were the same as those proposed for 2016. Specifically, CBO estimated that repealing the RFS would have essentially no effect on the 2017 price of E10, would lower the 2017 price of petroleum-based diesel by roughly 5 cents, and would increase the 2017 price of E85 by about 15 cents. (E10 and E85 refer to blends of gasoline with ethanol that are up to 10 percent ethanol and up to 85 percent ethanol, respectively.) The estimated effect on fuel prices of repealing the RFS is limited because the standards proposed for 2016 would increase the use of renewable fuels by a relatively small amount compared with the quantity that would be used without the mandate.

Repealing the RFS would have larger effects on prices of fuels if the requirements were more stringent, that is, if it mandated larger volumes of renewable fuels. For example, CBO found that prices for E10 and petroleum-based diesel would be significantly higher under a more stringent scenario—in which fuel suppliers would need to meet the 2017 requirements for advanced biofuels (but not for cellulosic biofuels) and the cap on corn ethanol stated in EISA—than if 2017 requirements were set at the volumes that EPA proposed for 2016.

Responses by Dr. John DeCicco

Date: December 11, 2015

To: Rep. Jim Bridenstine, Chairman, Subcommittee on Environment
Rep. Barry Loudermilk, Chairman, Subcommittee on Oversight
Committee on Science, Space, and Technology
U.S. House of Representatives

From: John M. DeCicco, Ph.D.
Research Professor, University of Michigan Energy Institute
DeCicco@umich.edu, 734-764-6757

Re: Response to Questions for the Record following the hearing of November 3, 2015 on
The Renewable Fuel Standard: A Ten Year Review of Costs and Benefits

1. In his testimony, Mr. Coleman referenced cellulosic ethanol that is "129 times better than gasoline on carbon emissions." Based on your research, is this a reasonable claim?

No, that is not a reasonable claim. It is possible that Mr. Coleman is referencing prospective analyses of certain hypothetical ethanol production methods. For example, for cellulosic ethanol as imagined to be produced in 2022 through biochemical processing of corn residue, EPA projected a negative value for lifecycle GHG emissions, viz., -29 kgCO₂e/mmBtu (Table V.C-4 of the RFS Final Rule, Federal Register 75(58), p. 14793). Relative to EPA's 2005 gasoline baseline value of 98 kgCO₂e/mmBtu, that value represents a roughly 129% GHG reduction, i.e., claiming not only to completely cancel out tailpipe CO₂ emissions, but also to provide an added level of GHG emissions reduction beyond that. Such analyses often claim a reduction credit for biomass co-generated electricity that replaces fossil-generated electricity.

However, as I emphasized in my testimony, the lifecycle analysis (LCA) methods used by EPA and other organizations claiming CO₂ mitigation benefits for biofuels are flawed because they fail to correctly assess prior carbon uptake on productive land. These methods use inconsistent system boundaries when comparing biofuels to fossil fuels (meaning, they do not make an "apples-to-apples" comparison of all carbon flows, both positive and negative). Therefore, they effectively double count a carbon credit for biofuels, leading to deceptive results.

Although I have not performed an independent analysis of the various methods proposed for producing cellulosic ethanol, a claim of net negative emissions is scientifically implausible at face value. Any rigorous accounting must start from the fact that directly measured tailpipe CO₂ emissions are essentially unchanged when substituting a biofuel for a fossil fuel. The accounting would then need to identify a measurable carbon offset, that is, a net increase in the rate of CO₂ uptake on land, that is large enough to not only negate the tailpipe emissions, but also negate the processing emissions and then beyond that the electric sector or other industrial CO₂ emissions for which the extra (negative emissions) credit is claimed. I am not aware of any credible analysis along those lines. Given that all biomass processing involves substantial losses along the way, it is very unlikely that a feedstock available at commercially significant scales could

generate an offset as large as needed to sustain a 129% GHG reduction. Such claims are based on the LCA methods that my studies have proven to be misleading for real-world ethanol production today, and those methods cannot be trusted to provide valid estimates for hypothetical fuels such as cellulosic ethanol.

That being said, it is theoretically possible for there to be some GHG reduction benefit from the use of cellulosic ethanol, in contrast to corn ethanol. If correctly assessed, the benefit would be smaller than commonly claimed by the technology's proponents, and certainly less than a 100% reduction. What is essential for any benefit is that the cellulosic feedstock be obtained in a way that generates a substantial and measurable carbon offset.

Existing levels of cellulosic ethanol production are so small that claims of their GHG impacts amount to little more than unsupportable suppositions. They are based on LCA models that are not only structurally unsound, but also rely on parameters that are at best no more than extrapolations of pilot or very small-scale production, and in many cases merely guesses made by an advanced biofuels R&D community that has made similar assertions for several decades without success in developing commercially viable operations for which real-world data might be obtained. In short, statements such Mr. Coleman's that claim extraordinarily high GHG emissions reductions for advanced biofuels are no more than speculations based on scientifically unsound methods of analysis.

2. *During member questions, Mr. Coleman claimed that considering prior land use on cropland converted to corn as a result of the RFS was an inappropriate way to examine the impact of the RFS on carbon emissions. Do you agree? Why or why not?*

No, I do not agree, and in fact, failure to consider prior land use results in inconsistent accounting that leads to gross errors in estimates of net carbon emissions impacts. A detailed explanation of the error is given in my paper:

DeCicco, J.M. 2015. The liquid carbon challenge: evolving views on transportation fuels and climate. *WIREs Energy Environ* 4(1): 98-114. [dx.doi.org/10.1002/wene.133](https://doi.org/10.1002/wene.133)

and a practical example is analyzed in our recent report:

DeCicco, J., and R. Krishnan. 2015. Annual Basis Carbon (ABC) Analysis of Biofuel Production at the Facility Level. Report. Ann Arbor, MI: University of Michigan Energy Institute, August. [dx.doi.org/10.2139/ssrn.2643155](https://doi.org/10.2139/ssrn.2643155)

parts of which were excerpted in my written testimony. My research blog also contains a post entitled "[Bringing Biofuels Back to Earth](#)" that provides a simplified explanation of why it is essential to require prior land use and the prior CO₂ uptake in plant growth when analyzing the carbon emissions impacts of biofuel use and policies that drive it such as the RFS.

- a. *Mr. Coleman also asserted that the structure of the Clean Air Act, carbon accounting, and the nature of agriculture markets discount your method of carbon emissions analysis. Is he correct? Why or why not?*

No. The RFS was legislated as an amendment to the Clean Air Act (CAA) and it requires EPA to account for lifecycle GHG impacts when evaluating renewable fuels for the policy. However, the legislation does not specify exactly how the lifecycle analysis should be carried out, and so gives the EPA Administrator substantial discretion on how to perform the carbon accounting. When implementing the RFS, EPA chose to use an approach that, at its core, is similar to the lifecycle analysis (LCA) that were in existence at the time, but which my studies (as well as others) have since found to have serious deficiencies.

To the agency's credit, EPA did diligently attempt to address many of the previously known problems associated with the LCA methods, and in my assessment EPA's work was of high caliber when considered within the framework of existing LCA methods, none of which had been previously used for, or even designed for, regulatory purposes. Nevertheless, that framework, including the unconditional use of an assumption of carbon neutrality for biofuel combustion and the related failure to explicitly evaluate prior carbon uptake on the land from which biofuel feedstocks are sourced, has now been shown to be scientifically flawed. EPA did not consider these issues, and therefore did not consider the new and scientifically correct methods my work has recently developed, when the agency performed its analyses, because the proposed correctives had not yet been published in 2010 when EPA finalized the RFS rule that codified the agency's lifecycle analysis. Although EPA had not considered my methods, it is misleading to say that the agency discounted them.

Similarly, carbon accounting methods as established for use in the Kyoto Protocol failed to consider the more recent science that identifies the flaws in such accounting. The Kyoto methods were established when the protocol was internationally adopted in 1997 (though it has not been ratified by the United States). However, it was not until 2009 that a definitive scientific critique of those methods was published by:

Searchinger, T., et al. 2009. Fixing a critical climate accounting error.
Science 326: 527-28, 23 October. [dx.doi.org/10.1126/science.1178797](https://doi.org/10.1126/science.1178797)

That work and mine are fully consistent, identifying how similar fundamental errors pervade both Kyoto-style carbon accounting and LCA methods such as those used for the RFS. Again, it is incorrect to say that the more recent scientific work was "discounted" by policymakers who established the carbon accounting methods now used in various energy and climate policies. Rather, mistakes were made when those carbon accounting methods were established, and the scientific community is now engaged in a debate that has ensued based on recent rigorous work, by a number of scientists including myself, which has identified the errors.

Finally, Mr. Coleman's statement that the "nature of agricultural markets" discounts or somehow invalidates my method of carbon accounting (or any method of carbon accounting, for that matter) merely distracts from the questions at hand; it is a red herring, so to speak. Market interactions can be assessed by any number of accounting methods; some will have integrity and

others may not, just as is the case for accounting methods applied to financial markets. My work points out errors in how EPA's RFS analysis and other LCA methods account for carbon flows on existing cropland, the use of which is mediated by agricultural markets. Those markets affect carbon flows, and so the real issue is whether a given accounting method evaluates those flows in accurately. I can only interpret this statement of Mr. Coleman's as an attempt to sidestep the fact that the accounting methods on which he relies fail to withstand scientific scrutiny.

3. *Was there anything else discussed at the hearing that you would like to correct for the record?*

Yes. I take issue with many other aspects of Mr. Coleman's testimony. For example, he asserts that the RFS has been effective in "breaking the oil monopoly," as he puts it. First of all, as a long-time energy policy specialist, I am not aware of an "oil monopoly" (at least not since the time when the Standard Oil Company of New Jersey was found in violation of the Sherman Antitrust Act several years after President Teddy Roosevelt initiated legal actions against the company).

The world oil market is subject to manipulation at times by a "clumsy cartel," as the late MIT economist Morris Adelman termed OPEC. Nevertheless, the fact that oil is the largest source of commercial energy in both the United States and worldwide is not a result of monopoly power; it is a result of the incredibly high value that consumers and global economies place on petroleum products. Moreover, it is clear that recent advances in oil and gas production technology have resulted in an expansion of oil supply that has greatly lowered prices, and that the resulting consumer savings have nothing to do with the RFS.

Mr. Coleman claims that "We need the RFS because we can't get shelf space." If biofuels were a worthwhile, economically competitive product that truly offered customers more value, they would readily find space in the fuel market. Based on objective evidence about their value, neither ethanol nor biodiesel would be in the market at all if the market were truly "free." It is biofuel policies (dating from long-time subsidies, contrived oxygenate mandates and other promotional programs up to and including the RFS) that have distorted the market and forced into it fuels that otherwise have no value, either economically or environmentally.

In Mr. Coleman's responses during the hearing, he said that my analyses use a "provocative" carbon accounting approach that is "not well supported. And it's called additionality." (hearing transcript, p. 47). That assertion only serves to underscore Mr. Coleman's lack of knowledge about carbon cycle science and Intergovernmental Panel on Climate Change (IPCC) guidelines. Here is an excerpt from the IPCC report on Land Use, Land-Use Change and Forestry:

5.3.2. Baselines and Additionality

A fundamental component of project assessment under the AIJ program has been the determination of the extent to which project interventions lead to GHG benefits that are additional to "business as usual" (UNFCCC, 1995; UNCCCS, 1997; Baumert, 1999). The concern about additionality also appears in Articles 6 and 12 of the Kyoto Protocol. Although additionality arguments have several different components and are based on multiple sources

of information, most additionality problems apply equally to projects in the energy sector as to those in LULUCF (Chomitz, 2000).

The first step in determining a project's additional GHG benefits (GHG emissions additionality) is the elaboration of a without-project baseline scenario against which changes in carbon stocks occurring in the project can be compared (see Section 5.3.2.1). It is then necessary to demonstrate that the purported GHG benefits are truly additional, not simply the result of incidental or non-project factors such as new legislation, market changes, or environmental change (see Section 5.3.2.2).

(continues; see original at www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=258).

This excerpt describes that additionality refers to how crucial it is to evaluate an action's GHG reductions relative to a baseline that reflects what would have happened if the action were not taken. It therefore pertains to the need to account for prior carbon uptake on cropland, as my analyses do. The failure to account for the extent to which carbon uptake is additional (i.e., above and beyond "business as usual") is a major deficiency of the LCA methods used to claim GHG reductions for biofuel use. Additionality is a well-established principle for accurate carbon accounting and there is an extensive literature on the topic; Mr. Coleman seems ill-informed in this regard.

Indeed, Mr. Coleman's whole discussion on pp. 47-48 the transcript is illogical and incoherent, as he makes analogies to solar panels, talks about credit for actions "the farmer would have done anyway," and brings up supply chain emissions, which are tangential to core questions of carbon uptake.

Mr. Coleman and some of the members pointed out that my findings are at odds with those of EPA, DOE, ANL and CARB among others, suggesting that my results should be dismissed because they contradict longstanding views about the benefits of biofuels. Yes, my results differ from and indeed challenge that existing technical and policy literature because I am among the set of independent scientists who have been systematically discovering errors in that hoary body of work. Some of the errors we are finding are far more serious than those that other scientists have highlighted over the years, disputes about the merits of biofuels hardly being new.

When questioning Mr. Coleman, Ms. Bonamici referenced and introduced into the record a comment on my work posted online by Argonne National Laboratory (ANL) [[link here](#)]. The claim is that my analysis "does not take into account the carbon emissions that are avoided when a biofuel displaces the use of fossil fuels" (hearing transcript, p. 47). That assertion begs the question; my analysis fully accounts for the reduced consumption of fossil fuels and rigorously finds that in reality, for the biofuel use driven by the RFS, there is no avoidance of carbon emissions and that instead, emissions increase overall. The referenced ANL comment expresses disagreement with my findings but does not offer any factual or scientific rebuttal.

Mr. Coleman also blames criticisms of the RFS on "the cloud of misinformation kicked up by the oil industry." However, my misgivings about the policy date back many years. For the record, attached here a position statement, which I co-wrote in 2002 when at the Environmental Defense Fund, that opposed an ethanol mandate bill introduced at the time. I was then very skeptical of the claims made on behalf of ethanol as well as very concerned about the risks of a renewable

fuel mandate. What we have since learned is that the claims of GHG reduction benefits are even more baseless than we had imagined and that the environmental risks -- indeed, the actual harms -- of biofuel mandates are even worse than we feared. Thus, my current statements critical of the RFS are even stronger, as articulated in a piece recently published on FoxNews.com that is also attached here for the record.

Closing comments

Finally, I want to emphasize that it is out of deep professional and personal concern regarding the risks of climate disruption, due primarily to an imbalance in the global carbon cycle caused by the way fossil fuels have been historically utilized, that I am raising these pointed criticisms of the RFS. The biofuel mandate is quite literally a policy that promotes a cure that is worse than disease, and as such violates the basic principle of "above all, do no harm."

Land, and in particular productive arable land, is one of the Earth's most precious resources, and is itself a finite resource. The fallacy of claims that "renewable" fuels are beneficial because their feedstock can be regrown can be traced to a disregard for the implications of the vast land areas required to grow crops at scales relevant for energy supply. Productive land also sustains forests and other habitats that absorb and hold carbon far more efficiently, and cost-effectively, than any attempt to use the land for biofuels at meaningful scale for the foreseeable future.

What this means as far as transportation sector CO₂ emissions are concerned is that, for all practical purposes, there are two high-priority strategies for environmentally sound mitigation. One is to improve efficiency, e.g., through ongoing increases in motor vehicle fuel economy standards, and the other is to offset emissions by protecting and rebuilding forests and other carbon-rich ecosystems.

At present, biofuel production represents a gross misuse of the nation's and the world's finite resources of high-quality lands, which are needed for food, feed, fiber and lumber as well as for the ecosystem services such as water quality, wildlife habitat and carbon storage. A time may come, once effective land-based carbon management strategies are established at large scales in a manner that balances critical economic and ecological needs, when it is possible to safely divert some biomass to make biofuels. But that time is very far away, at least several decades, and certainly much farther into the future than proponents of either conventional or advanced biofuels believe. Moreover, mandating biofuels is not the path to any version of a better future; rather, it is counterproductive because biofuels' large land demand squeezes out more crucial and beneficial uses of land.

Thank you again for the opportunity to provide these responses for the record, and I will be happy to answer any additional questions that you and your fellow members may have.



ENVIRONMENTAL DEFENSE
finding the ways that work

ENVIRONMENTAL DEFENSE POSITION ON PROPOSED ETHANOL MANDATE (JUNE 4, 2002)

The Senate version of the energy bill includes in its "renewable energy" provisions a mandate to triple ethanol use to 5 billion gallons by 2020, and a provision granting immunity from state laws for potential contamination caused by this ethanol use. Environmental Defense opposes this mandate and liability waiver.

Even without a specific ethanol mandate, oil refiners over the next few years are likely to increase their use of ethanol to meet clean-air standards and octane demands because many states have decided to replace MTBE, the alternative oxygenate. Even without the ethanol mandate, the Senate bill would further spur increased ethanol use by banning MTBE and eliminating the oxygenate fuels requirement and requiring that reductions in toxic air emissions achieved through the use of MTBE be preserved. These provisions alone therefore benefit ethanol producers. Environmental Defense supports these other provisions, and any increased ethanol that is driven by market forces, and bona fide environmental standards.

While ethanol therefore can contribute to better gasoline in some contexts, it also has significant environmental costs. As a general rule, ethanol helps combat carbon monoxide in the winter and can help displace more toxic gasoline components in the summer. But using ethanol in the summer also makes gasoline more likely to evaporate, which contributes to smog. (In some locations, refiners must compensate for this evaporative effect by lowering the evaporations from the other fuel components, but not fully or in all areas.) Significantly, some refiners have been able to produce a gasoline that exceeds the environmental performance in all respects of reformulated gasoline using ethanol. Over time, therefore, mandating the use of ethanol will cause unnecessary clean air challenges in some communities and block or limit the expansion of the most environmentally desirable gasoline formulas.

Most importantly, ethanol use comes at heavy cost to water quality and wildlife because corn provides the raw product for nearly all ethanol produced today. Corn uses more fertilizer and pesticides than any other major agricultural commodity. In some areas, it makes heavy use of scarce irrigation water. And under the most common cultivation techniques, it leads to heavy soil erosion. Corn production also requires large quantities of land, which displaces a variety of valuable habitats. Corn does make a vital contribution to the nation and world's food supply, but the environmental costs imply that its expansion should not be encouraged for light reasons or solely to benefit special interests. Expanding ethanol to 5 billion gallons from today's 1.7 billion gallons

would require an increase in corn production of more than 10 million acres. To put this acreage in perspective, it represents more than half the acres devoted to federal wildlife refuges in the contiguous United States.

Despite the claim from its advocates, ethanol from corn does not meaningfully contribute to a solution to the country's energy needs, nor does it significantly reduce emissions of greenhouse gasses. Most of the studies today suggest that it takes only slightly less than one btu of energy from fossil fuels to make one btu of energy from ethanol (.8 to 1 according to the most recent USDA estimates). According to some studies, ethanol leads to a comparable, modest reduction in greenhouse gasses, but under different and still reasonable assumptions, greenhouse gases could actually increase. We believe these are at best modest benefits considering the financial subsidies required and the environmental cost associated with the corn production.

Ethanol could play a larger and more beneficial role if it were produced from biomass products such as switch grass or garbage. Far less energy is required either to produce these biomass crops or to convert them to ethanol. The potential greenhouse gas benefits are far greater than for corn-based ethanol, and the environmental costs of growing them are much lower. Today, however, making ethanol from biomass is significantly more expensive than making it from corn, so a mandate to increase ethanol use alone is not likely to lead to significant expansions in biomass. We believe that government incentives for ethanol should be focused on such biomass-based production, and any renewal energy mandate should be tied to an environmental performance standard based on its greenhouse gas benefits.

A particular problem with the ethanol mandate in the Senate energy bill is that it is indefinite. Unless changed by further act of Congress, the mandate for refiners to use "renewable fuels" under the bill's definition will last forever – regardless of whether suitable croplands for producing ethanol become needed for food production and regardless of what other sources of energy production are developed. For example, hydrogen fuel for fuel cells could become a major fuel source and might be most profitably produced using solar energy, but it would not qualify as a renewable fuel under the Senate bill. Congress could obviously change the mandate in the future, but doing so would require changing a status quo of great benefit to special interests. It is inappropriate to include an unlimited mandate at a time of rapidly evolving technology.

We are also concerned that the Energy bill would preempt state law and waive potential liability for uses of ethanol. MTBE has contaminated groundwater throughout the nation that can only be remediated at enormous cost. The very desire of ethanol purveyors for a liability waiver suggests that they themselves perceive substantial environmental risks. Innocent communities should not have to bear the costs of contaminated groundwater and other environmental damage. For further information, please contact John DeCicco or Tim Searchinger at (202) 387-3500.

The Truth About Biofuels: Reality Bites

by John M. DeCicco, Opinion, FoxNews.com, December 7, 2015

<http://fxn.ws/1LYTA8A>

On November 30, as the Paris international climate conference was getting underway, the U.S. Environmental Protection Agency (EPA) announced a long-overdue update of Renewable Fuel Standard (RFS) requirements. Originally established in 2005 and then greatly expanded by the Energy Independence and Security Act (EISA) of 2007, the RFS mandates increasing use of ethanol, biodiesel and other biofuels in America's cars and trucks.

Two things were notable. For the first time, EPA set the overall mandate at levels significantly lower than targets Congress called for in 2007. Second, raising the hackles of the biofuel lobby, the Obama administration omitted the RFS from its official submission in Paris about actions the U.S. is taking to cut carbon emissions.



In other words, the EPA seems to realize that the nation's dream plan for green fuels was unrealistic, and the Obama administration is tacitly admitting that biofuels aren't better than fossil fuels when it comes to greenhouse gases. In fact, they are worse.

Nonetheless, in announcing the new standards, the administration used the usual biofuel-boosting rhetoric, reaffirming the political tripod on which the RFS is propped. By "cutting carbon pollution, reducing our dependence on foreign oil and sparking rural economic development," the RFS has made the biofuel industry "an incredible American success story," as one EPA official put it.

Well, it's a sad state of affairs if what constitutes "success" depends on billions of dollars of direct and indirect public subsidies for a wobbly industry that in reality has but one leg to stand on, namely, the political power of certain agribusiness interests.

How did we get here? The years leading up to the passage of the RFS saw rising fuel prices, war in the Middle East and irrational fears that world oil supplies had peaked, setting the stage for political opportunism by biofuel lobbyists and certain environmentalists.

This alignment of interests sold Congress and the George W. Bush administration on the unreal vision that "Growing Energy," as one green group's manifesto put it, would benefit the climate and provide an economically viable alternative to oil.

Indeed, much of Big Green was so enthralled at the notion of teaming up with Big Ag to roll Big Oil that no one performed due diligence on the climate impact of biofuels. Instead, they promoted the simplistic but scientifically unsound notion that biofuels are automatically carbon neutral because crops grown to produce fuel recycle carbon from the air.

continues ...

This assumption is now deeply embedded in the "carbon footprint" computer models used by EPA. It's also hard-coded into the Department of Energy model widely cited by biofuel lobbies to claim that the RFS cuts emissions. The same model is used by California for its so-called Low-Carbon Fuel Standard.

That assumption of carbon neutrality is deeply flawed. In fact, biofuels have no climate benefit when they're burned. Basic chemistry tells us that essentially the same amount of carbon gets emitted from tailpipes when using ethanol or biodiesel instead of regular gasoline and diesel.

The only way biofuels might have a greenhouse benefit is if crops used to make them take carbon from the atmosphere faster than it would otherwise be removed.

The problem computer models don't recognize is that farmland is already recycling copious quantities of carbon. Cropland doesn't absorb more carbon when the harvest is used for fuel rather than food. After adding in the pollution from processing corn into ethanol, and then the deforestation triggered by a need to make up for grain lost to the food market, ethanol's emissions are far worse overall than those of gasoline.

The energy security rationale for biofuels is likewise based on faulty reasoning. Over the past decade, advanced technologies and new investments have caused a big jump in oil reserves domestically and around the world. The result is burgeoning oil production, lower prices for consumers, and the reality that heavily subsidized biofuels are not needed as a security blanket.

At the same time, rising vehicle efficiency and decreased driving have trimmed gasoline demand, which also helped depress pump prices. Lower fuel demand means there's no room to force more ethanol into gasoline without breaking through the "blend wall," the 10 percent limit above which ethanol starts to wreak havoc with older vehicles as well as lawn, garden and recreational equipment, boat engines and other gasoline-powered devices.

The blend wall is the main reason why EPA trimmed this year's total RFS requirement to 3.6 billion gallons less than the 2007 Congressional mandate.

So what we now have is a one-legged tripod. All that's left to prop up the policy is a narrow agribusiness interest of soaking consumers for more money.

That leg might look solid, especially as we witness the upcoming, bipartisan electoral ritual of bowing to the Iowa corn gods.

But an increasing number of lawmakers from both parties are starting to realize that the Renewable Fuel Standard was a mistake. It might be ripe for reform if not outright repeal in 2017 -- which would undoubtedly be the best outcome for the planet. ■

John M. DeCicco is a research professor at the University of Michigan Energy Institute, where his work addresses the environmental implications of energy use.

Responses by Mr. Brooke Coleman

QUESTIONS FOR THE RECORD

The Honorable Zoe Lofgren (D-CA)

U.S. House Committee on Science, Space, and Technology

The Renewable Fuel Standard: A Ten Year Review of Costs and Benefits

Tuesday, November 24, 2015

Questions for Mr. Brooke Coleman

1. In advance of the climate negotiations taking place in Paris this December, I think it's important to note how domestic policies such as the Renewable Fuel Standard have helped cut our greenhouse gas emissions and our dependence on oil. Commercializing new technologies is not easy or fast, but long-term policies like the RFS have been a critical driver in the accelerated development of second-generation biofuels. In California alone there are dozens of innovative companies developing fuels from algae, municipal waste, and cooking oil, supporting nearly 60,000 jobs, and playing an important role in achieving the State's low-carbon fuel standard. Biofuels companies rely on the certainty of the RFS to disrupt the monopoly on the transportation fuel supply and ensure market access for renewable fuel producers.

a. Do you believe that the current RFS is sufficient to even the playing field?

Thank you for the questions, Congresswoman Lofgren.

First, you are right to highlight the carbon and energy security benefits of the Renewable Fuel Standard (RFS). If you look at the analysis of neutral parties – e.g. U.S. EPA, the California Air Resources Board (CARB), Argonne National Lab, etc. – you will see clearly that the RFS and renewable fuels have both displaced foreign oil and significantly reduced carbon emissions. With regard to carbon, *corn* ethanol is responsible for more than 60 percent of the credits generated under the California Low Carbon Fuel Standard (CA LCFS) to date. Many of these first generation ethanol producers – including California's own Pacific Ethanol and Aemetis – are among the leaders in the effort to commercialize cellulosic ethanol, the lowest carbon fuels in the world.

With regard to your question, the RFS is certainly the critical tool to help address the oil monopoly. Essentially, the RFS cracks open what would otherwise be a closed, non-competitive motor fuel supply chain by providing an economic reward for those oil companies that blend more renewable fuel (i.e. when an oil company acquires a renewable fuel gallon they also acquire a valuable RFS credit to sell to other oil companies who choose to comply with the RFS by buying credits instead of liquid gallons) and a compliance cost for those who refuse to blend more renewable fuel (i.e. because oil companies who do not blend more liquid renewable fuel must buy RFS credits to comply). Congress designed the program quite well; and, it works very effectively if administered properly.

The issue that we face currently is U.S. EPA's new approach to administering the program. Under pressure from the White House, U.S. EPA is for the first time taking into account the willingness of oil companies to make investments and other plans to distribute renewable fuel. The final rule published on November 30, 2015 formalized U.S. EPA's adoption of a new methodology for setting the annual blending requirements. This sudden, mid-program rule change is an issue for advanced and cellulosic biofuel development because: (1) any midstream rule change, especially one that comes as a result of political pressure like this one, spooks investors in innovation because politics cannot be predicted

reliably when it comes to future investments and markets; (2) this rule change provides an incentive for obligated parties (i.e. oil companies) to avoid making arrangements to secure and distribute more renewable fuel, because they control fuel distribution and can now appeal for RFS waiver if they fail to comply with the law. This new distribution-related waiver allowance threatens new markets for renewable fuels – and, more than 90 percent of the remaining gallons in the RFS through 2022 are advanced biofuels. Essentially, EPA’s rule change threatens market access for advanced biofuels.

Notwithstanding these issues, Congress should not re-legislate on the RFS. The problem is not legislative. The RFS is good law. The oil industry has prioritized RFS repeal precisely because the RFS works. At this point, it is up to the courts to correct course on the RFS. A broad coalition of renewable fuel groups are challenging U.S. EPA’s new waiver approach in court (the initial filings were made on January 8th, 2016). If the plaintiffs are successful, we will see the RFS reemerge as the best renewable fuel policy in the world.

Given the breadth of government support for the oil industry, it would be difficult to argue that the RFS completely levels the playing field. It is certainly enough to make the United States a world leader in the development of advanced biofuels, if administered properly by U.S. EPA. However, there remain massive inequities in liquid fuel marketplace when it comes to government support. The best example is the U.S. tax code. The tax code provides special treatment for investment in oil and gas in critical areas – e.g. percentage depletion, the expensing allowance for intangible drilling costs, Master Limited Partnerships – that shield these industries from expense and potential loss. There is no better explanation of how these special allowances benefit oil and gas investment than the testimony provided by Harold Hamm to the Senate Finance Committee in 2012: <http://www.finance.senate.gov/imo/media/doc/Hamm%20Testimony1.pdf>. Unfortunately, oil and gas subsidies distort energy investment globally as well, as shown in a recent IMF report (<https://www.imf.org/external/pubs/ft/wp/2015/wp15105.pdf> at p. 19). A truly balanced approach would require not only deploying good policies like the RFS to provide market access, but also addressing inequities in the U.S. tax code that further distort investment decision-making.

b. Can you discuss how the volume reductions in the EPA’s 2014-2016 proposed rule might affect the commercial scale up of advanced, low carbon biofuels?

Thank you for the question, as the interaction between the volume reductions and commercial deployment of new technology is not well understood. The now final rule negatively affects the commercial deployment of advanced, low carbon biofuels in the following ways:

1. *In order to promote innovation, governments need to set the policies and stick to them.* Broadly speaking, Congress established RFS blending requirements that are waivable in very specific circumstances. The fact that the standards are waivable if there are insufficient volumes of renewable fuel and/or the use of the renewable fuel will cause severe economic harm is not a problem for the commercial scale-up of advanced biofuels. These are standard Clean Air Act consumer protections. The problem is U.S. EPA introduced a new waiver interpretation halfway through a 15-year program to justify the latest round of volume reductions. As clearly articulated in an opinion piece published in *The Guardian* late last year (<http://www.theguardian.com/commentisfree/2015/nov/25/if-we-want-investment-in-sustainable-fuel-rules-cannot-constantly-change>), this type of midstream rule change shakes investor confidence because while innovators can account for things like technology risk and

market risk, they cannot predict rule changes based on acute, future (and potentially fabricated) political dynamics. When investors see sudden rule changes in policy-driven markets – like energy – the natural inclination is to avoid those risks/markets with future investments. So while, in this case, U.S. EPA changed the rules to enable cuts to conventional biofuel blending, the rule change itself chills investor confidence in next generation biofuels.

2. *Climate programs controlled by obligated parties are at least sub-optimal and in many cases may not work.* For the first time, U.S. EPA plans to reduce the volume requirements based on the infrastructure available to blend more renewable fuels. The path to this new interpretation requires them to reinterpret the phrase “inadequate domestic supply” from supply of renewable fuel to the oil industry to the willingness/preparedness of the oil industry to distribute renewable fuel blends to consumers. This redefinition – which essentially defines supply as demand – is legally dubious. But more importantly, it gives too much power to obligated parties/oil companies, which control fuel distribution (the very problem being addressed by the RFS). We expect the courts to recognize that Congress meant to allow for RFS waiver when there is inadequate domestic supply of renewable fuel to oil companies, as opposed to inadequate desire on the part of oil companies to comply with the law. And it would be enormously helpful if Congress further clarified its intent as part of the case (non-legislatively). But I believe the ruling is an important one for numerous climate program driven by the Clean Air Act (CAA) – as, it is difficult to imagine these programs working if the fossil fuels industry can avoid their legal obligations by simply refusing to do the things necessary to comply with the law.
3. *The business fortunes of first and second generation biofuel producers are inextricably linked.* Some policymakers and many NGOs see the first and second generation biofuel industries as separate endeavors. In reality, if you look at the first movers in (for example) cellulosic ethanol you will find many first generation ethanol companies leading the way – including Quad County Corn Processors, POET, Abengoa and DuPont to name a few. A recent Third Way report (<http://thirdway.org/report/cellulosic-ethanol-is-getting-a-big-boost-from-corn-for-now>) found that companies with an extensive background in corn ethanol are responsible for approximately 80% of the current commercial capacity of cellulosic biofuels. More specifically, there is an obvious link between first generation ethanol revenues and expenditures on second generation ethanol development. First generation ethanol producers have responded to the passage of the RFS in 2005 and RFS2 in 2007 by producing sufficient, cost effective, conventional ethanol to meet the statute. When EPA waives the statute – using legally dubious arguments generated by oil industry intransigence – first generation ethanol markets over-supply and ethanol price drops. This weakens ethanol industry revenues across the board and lessens the amount of capital available for innovation. Some regulators argue that reducing the conventional ethanol blending requirement creates room for second generation ethanol in the marketplace. This is a policy theory without basis in business reality. First generation ethanol companies are not going to invest first generation ethanol revenues to kill first generation ethanol markets. Wind and solar companies would not deploy cannibalistic business models either. These companies will, however, invest to supply new (advanced) ethanol and biofuel markets. This is the very reason that Congress passed an RFS that grows the renewable fuel marketplace additively.
4. *Waivers are critical to investment in any regulation; the issue with the cuts finalized in November is not so much the magnitude of the cut but rather how EPA gets there.* Waivers are critical to any regulation because they essentially define when the regulation will not be enforced and

investment could be stranded. As discussed, the cuts to the conventional biofuel standard run afoul of the statute and Congressional intent, which in turn chills investment based on system-wide uncertainty. But EPA must also be careful about waivers in the advanced/cellulosic pools. EPA clearly has the authority to waive gallons – as they have – in these pools. However, EPA is concurrently issuing what are called Cellulosic Waiver Credits (CWCs) that allow oil companies to buy credits instead of cellulosic biofuel gallons. EPA must make CWCs available by law when these standards are cut, but they are not required to offer them to oil companies unconditionally. EPA is also not required to offer as many CWCs as cellulosic gallons required for blending (e.g. EPA is not required to offer 100 million CWCs if the cellulosic blending requirement is 100 million gallons). Yet, the agency is doing both of these things. As a result, oil companies know that they have an “out” at the end of the year if they refuse to sign contracts to buy forthcoming cellulosic biofuel gallons. First movers in cellulosic biofuels are feeling the effects of EPA’s current approach to issuing CWCs already, in terms of both being leveraged by the oil industry on price and with regard to the oil industry’s general lack of engagement as customers in the early stages of cellulosic biofuel commercial deployment. Finally, there is also the issue of how EPA sets the adjusted (i.e. reduced) standards in the cellulosic pool from year-to-year. EPA has a very difficult task in trying to match the standard to forthcoming cellulosic biofuel production for any year in which they must partially waive the statute. But the agency has the authority to standardize an approach in which regulatory under- and over-estimates are trued-up either in the current or following compliance year. EPA is not utilizing this authority, and the result is unnecessary market uncertainty for advanced biofuel producers in the wake of volumetric adjustments/waivers. This is another area where members of Congress could be engaged with EPA (non-legislatively) to encourage the agency to make critical administrative adjustments that would accelerate the commercial deployment of advanced biofuels.

QUESTIONS FOR THE RECORD

The Honorable Bill Foster (D-IL)
U.S. House Committee on Science, Space, and Technology
The Renewable Fuel Standard: A Ten Year Review of Costs and Benefits
 Tuesday, November 24, 2015

Questions for Mr. Brooke Coleman

1. The renewable fuel industry has wide support from the academic community on the environmental benefits of utilizing biofuels in place of fossil fuels. Yet there has been strong opposition to increasing the volumetric standards under the Renewable Fuel Standard based on supposed environmental concerns. A large part of this opposition has been funded by the oil and gas industry. Can you provide some examples of how, in your view, the oil and gas industry is the driving force behind the campaign to weaken the RFS?

Thank you for the questions, Congressman Foster.

Broadly speaking, the oil industry attacks the RFS overtly and covertly. The overt part of the equation is easy to see, as the American Petroleum Institute (API) and other oil trades make no secret of their distaste for the RFS and have for many years prioritized Congressional repeal. The oil industry has openly declared RFS repeal as its top legislative priority in 2016.

However, the oil industry has also created a veneer of “independent” voices that criticize the RFS. In many cases, these independent voices and their work are openly funded by oil companies. In other cases, particularly in the case of not-for-profit organizations that do not have to disclose funding sources, the oil relationships are suspected but unconfirmed. More often than not, these industry-funded voices are treated as independent voices by the media and others. Some examples of both scenarios include:

- A group called the American Council for Capital Formation (ACCF) has emerged at the forefront of RFS attack over the last several months. The group has spent millions of dollars on television ads criticizing ethanol and the RFS in the past few months alone. The group says it is a free market advocate. But its sponsorship list is predominated by fossil fuel companies, including but not limited to ExxonMobil, ConocoPhillips, Occidental and the American Fuel and Petrochemical Manufacturers. The group has not ever called for an end to the oil subsidies that distort free markets.
- One of the chief antagonists of the RFS is a coalition called Smarter Fuel Future. This organization has sponsored many advertisements and events criticizing the program. The Smarter Fuel Future website shows a number of “partners,” including many oil-supported groups and the American Fuel and Petrochemical Manufacturers. The coalition does not disclose the relative contributions of its partners, but many believe the group is funded largely by oil.
- MIT Professor Chris Knittel is arguably the loudest academic voice against the RFS. He is also substantially funded by the oil industry. From 2007 to 2009, he received a \$370,000 grant from Chevron for biofuel research, in addition to two additional Chevron research grants for \$127,000 and \$77,000 (web.mit.edu/knittel/www/knittelCV.pdf). Knittel is currently an associate scholar

at the Harvard Environmental Economics Program, which is sponsored by BP, Chevron and Shell, among other companies (heep.hks.harvard.edu/sponsors). Knittel is also part of MIT's Energy Initiative, which has received millions from the oil and gas industry (<http://mitei.mit.edu/support/members>) and has established itself as an RFS critic. From 2003 to 2011, Knittel was a visiting research fellow (receiving \$50,000 for research in 2005-2006) at the University of California Energy Institute, which has received substantial funding from BP.

- University of Michigan Professor John DeCicco, who testified before me at the November RFS hearing, offered a report he co-authored as evidence of an alleged error in calculating the greenhouse gas (GHG) benefits of biofuels. The report was the subject of much debate during the hearing, but it was not disclosed that the paper was funded by the American Petroleum Institute (API) [<https://drive.google.com/file/d/0B7ZwDXl-m2O9TFiZXdRLUtsWlU/view>]. Certainly, the paper should be discussed on the merits. But it is nonetheless another example of the oil industry acting as “the driving force behind the campaign to weaken the RFS.”
- The oil industry funds anti-RFS discussions and panels at well-regarded institutes. Recent examples include an October 16th panel at the Brookings Institute, which claimed to be reviewing the environmental and policy performance of the RFS (<http://www.brookings.edu/events/2015/10/16-ten-years-of-the-renewable-fuel-standard>). But virtually the entire panel had ties to oil money. In addition to the aforementioned Professor Knittel, the panel was hosted by and moderated by a Brookings fellow (Brookings received \$430,000 from Exxon in 2014, <http://cdn.exxonmobil.com/~media/global/files/worldwide-giving/2014-worldwide-contributions-publicpolicy.pdf>). Tim Searchinger also participated as a fellow from the World Resources Institute – an organization that takes money from a number of oil companies including Shell and Statoil (<http://www.wri.org/annualreport/2014/#donors/corporations>). Searchinger was an ardent critic of the RFS for many years as a fellow at the German Marshall Fund, which counts BP, Chevron and Total as corporate donors among others (<http://www.gmfus.org/annual-report-financials>). Brookings posted support materials for the discussion a few days prior to the event, every one of which (besides the government piece) was at least co-authored by Chris Knittel.

2. My understanding is that advanced biofuels do not rely on corn grain, but this does not mean the investments to date in corn-based ethanol are not valuable or productive for our energy future. To what extent has the infrastructure and market for first generation fuels spurred by the RFS helped enable the development of second generation advanced biofuels?

There is no question that investments made to develop first generation biofuels – including those spurred by the RFS – have helped enable the development of advanced biofuels.

At the macro level, many of the leading developers of second generation biofuels are pioneers in the development of first generation biofuels. For example, a recent Third Way report found that companies with an extensive background in corn ethanol are responsible for approximately 80% of the current commercial capacity of cellulosic biofuels (<http://thirdway.org/report/cellulosic-ethanol-is-getting-a-big-boost-from-corn-for-now>). This makes sense on a number of levels. First, the RFS itself commits to 15 billion gallons of conventional biofuel – predominantly corn ethanol – and essentially sends the signal to the ethanol industry that if it wants to produce additional RFS-eligible gallons, they must be advanced biofuel gallons. The RFS volumetric commitment to advanced biofuels is robust by design, and this is

why so many first generation ethanol companies (e.g. Quad County Corn Processors, DuPont, Novozymes, POET, Abengoa, Aemetis, etc.) are first movers in the cellulosic ethanol sector. Second, first generation ethanol producers have a natural self-interest in diversifying on the feedstock side. Any plant that can produce ethanol from more than one feedstock, or more than one part of the corn plant, is better insulated from spikes in feedstock costs and has a more diverse product portfolio that may fetch additional value from policies designed to improve air quality and/or address climate change.

The same synergistic relationship exists on the infrastructure/market side. Much of the effort to open up motor fuel markets to competition from fuels like E15 (15% ethanol/gasoline blends) and E85 (85% ethanol blends) has been spearheaded by the first generation biofuels industry. But this market “head room” is absolutely critical to investment in next generation ethanol because investors in innovation need to see more price-based fungibility between ethanol and gasoline in the marketplace to invest significant dollars in new types of ethanol. Put another way, investors need to see that if their product competes with incumbents, they have a reasonable chance of accessing consumers at the pump. This is why the RFS is so critical to the emergence of consumer choice at the pump. The RFS cracks open what would otherwise be a closed, non-competitive motor fuel supply chain by providing an economic reward to those oil companies that blend more renewable fuel (i.e. when an oil company acquires a renewable fuel gallon they also acquire a valuable RFS credit to sell to other oil companies who choose to comply with the RFS by buying credits instead of liquid gallons) and a compliance cost for those who refuse to blend more renewable fuel (i.e. because oil companies who do not blend more liquid renewable fuel must buy RFS credits to comply). Congress designed the program quite well; and, works very effectively if administered properly.

Responses by Mr. Charles Drevna

Answers for the Record from Charles Drevna

The Renewable Fuel Standard: A Ten Year Review of Costs and Benefits

- 1. During the hearing, Mr. Brooke Coleman claimed that “the whole purpose of the RFS is to force the oil companies to [distribute renewable fuel] because they would not otherwise do it based on price because of the subsidies and protections they have overseas that protect this industry.” Do you agree with this statement? Why or why not?**

This statement is incorrect for a number of reasons. First, let’s start with the purpose of the RFS. President Bush gave a good explanation of what the Bush administration saw as the purpose of the RFS comes when he created the RFS in 2005. At the legislative signing ceremony, he summed up the RFS's objectives:

“Using ethanol and biodiesel will leave our air cleaner. And every time we use a home-grown fuel, particularly these, we’re going to be helping our farmers, and at the same time, be less dependent on foreign sources of energy.”

The Bush administration believed that the point of creating the RFS was to help clean the air, use home-grown and not foreign fuel, and to help American farmers.

In the absence of the RFS, oil companies would distribute renewable fuels if it makes economic sense. Without the RFS, billions of gallons of ethanol would be used in the U.S. because ethanol is a cost-effective oxygenate and octane booster.

- 2. During the hearing, Mr. Coleman made the statement that “Ninety plus percent of the fuel used under this program has been U.S. produced.” Does the data support this statement?**

Mr. Coleman’s statement is correct. Under the RFS, more than ninety plus percent of biofuel is U.S. produced. For example, in 2014, the U.S. imported 1,778,000 barrels of ethanol¹ and consumed 320,095,000 barrels.² That means that less than 1 percent of the fuel was imported.

- a. What about sugarcane ethanol produced in Brazil? What portion of fuels used to meet the advanced biofuel requirements under the RFS come from Brazil?**

¹ EIA, *U.S. Imports by Country of Origin*, https://www.eia.gov/dnav/pet/pet_move_impqus_a2_nus_epooxe_im0_mbbbl_a.htm.

² EIA, *Monthly Energy Review November 2015*, Table 10.3 Fuel Ethanol Overview, http://www.eia.gov/totalenergy/data/monthly/pdf/sec10_7.pdf.

In 2014, the advanced biofuel requirement was 2.67 billion. Of this, 90 million gallons came from sugarcane ethanol or 3.4 percent.

b. In your opinion, should sugar cane ethanol qualify as an advanced biofuel? Why or why not?

There is nothing new or technologically “advanced” about sugarcane ethanol. The point of the “advanced” portion of the RFS was to incentivize new technologies, not merely to provide a new market for old technologies such as sugar cane ethanol. Sugarcane ethanol has been produced in Brazil since at least 1927s.³³

One real problem with calling sugar cane ethanol an advanced biofuel is that the U.S. exports ethanol (generally corn ethanol) to Brazil and then imports sugarcane ethanol from Brazil. This trade negates much or all of the carbon dioxide reduction benefits of sugarcane ethanol.

Ethanol Trade Between the U.S. and Brazil				
	2011	2012	2013	2014
Ethanol exports to Brazil	9,419	2,046	1,084	2,646
Ethanol import from Brazil	2,399	9,625	7,665	1,328

Sources: https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=M_EPOOXE_EEX_NUS-NBR_MBBL&f=A
https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MFEIM_NUS-NBR_1&f=A

c. Do you believe the use of sugarcane ethanol from Brazil to achieve RFS volume requirements is meeting the intent of Congress to reduce reliance on foreign energy supplies under this law?

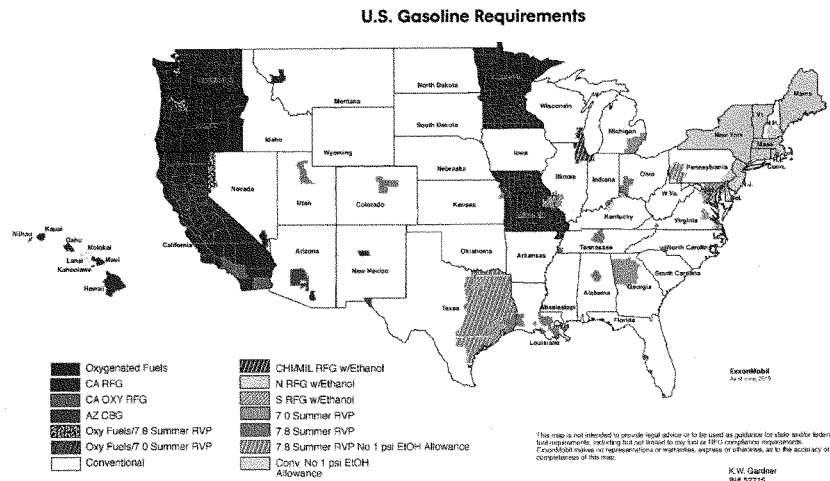
Definitely not. As noted in the answer to the first question, one of the original purposes of the RFS was to create new markets for American farmers and make the U.S. “less dependent on foreign sources of energy.” Importing sugarcane ethanol from Brazil is the same thing as importing oil from Brazil. If it is the policy of the United States to use less foreign sources of energy, sugarcane imports are contrary to that policy.

3. In your opinion, does the U.S. transportation fuel supply operate under a free market? Why or why not?

The U.S. transportation fuel supply is heavily regulated. The fuel itself is heavily regulated through a number of environmental requirements and refineries themselves are also heavily regulated.

³³ USGA: *EM 1927, O PRIMEIRO GRANDE EMPREENDIMENTO BRASILEIRO EM ÁLCOOL COMBUSTÍVEL*, <http://web.archive.org/web/20080319112800/http://www.aondevamos.eng.br/boletins/edicao07.htm>.

The RFS is but one of many regulations of fuel. The following chart shows U.S. gasoline requirements. From the chart, it is obvious that the market for transportation fuels is highly regulated and not exactly a free market.

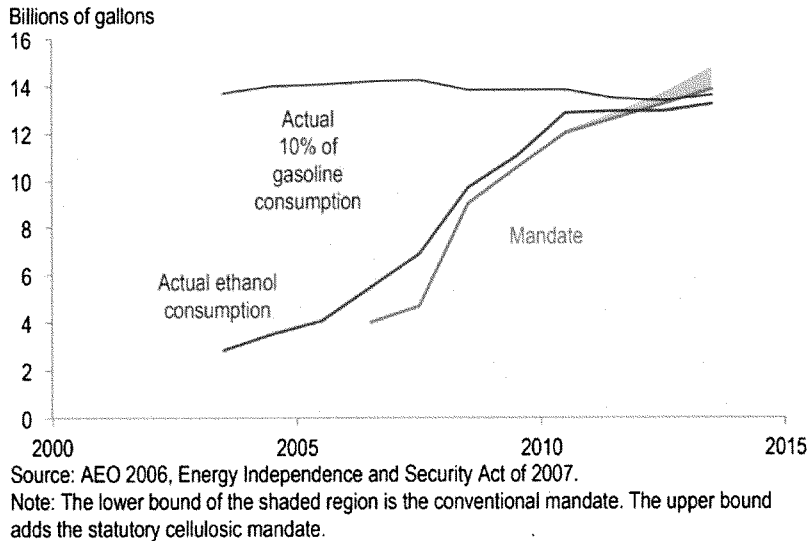


a. Is the RFS distorting the market? Please explain the market impact of the RFS.

Without a doubt the RFS is distorting the market. The most obvious distortions are the mandates for cellulosic and advanced biofuels. Despite the fact that Congress mandated the use of billions of gallons of these fuels, cellulosic and advanced fuels are still not cost-effective. Mandating the production and use of these fuels increases the cost of fuel for motorists.

It is more difficult to say that corn ethanol distorts the market today. For example, the chart below shows that in the early years of the RFS, ethanol consumption outpaced the RFS mandate.⁴

⁴ James H. Stock, *The Renewable Fuel Standard: A Path Forward*, p. 13, Apr. 2015, http://energypolicy.columbia.edu/sites/default/files/energy/Renewable%20Fuel%20Standard_A%20Path%20Forward_April%202015.pdf



Now that the ethanol infrastructure is in place, corn ethanol is a cost-effective way for fuel producers to boost the ethanol of their products. As a fuel (ie. as E85), ethanol is not cost-effective, just as an additive (ie. as a component of E10) ethanol is cost-effective.

Also, one more reason for the overcompliance in the early years of the RFS was that refiners foresaw the blendwall and wanted to have RINs on hand to ease compliance.

Regardless, the best answer is to end the RFS altogether and let motorists decide which fuels they want to use and let fuel producers figure out how best to meet the transportation needs of Americans.

4. During the hearing, Mr. Coleman stated that “90 percent of the last 10 years ethanol has been vastly cheaper than gasoline and the oil industry hasn’t use more than it has been required by the government to use.” Is this an accurate statement?

On a per-gallon basis, ethanol is cheaper than gasoline. It is equally true that on a per-gallon basis, water from the tap is cheaper than gasoline. Gasoline, however, is a better fuel than ethanol or water.

The point of fuel is to power a vehicle. A gallon of gasoline contains more energy than a gallon of ethanol (or a gallon of water). In fact, a gallon of ethanol contains 33 percent less energy

than a gallon of gasoline. As a result, while on a per-gallon basis, ethanol might be cheaper, gasoline is a better deal for the motorist because on a dollar for dollar basis, gasoline will take you farther.

Below is a chart from AAA's Fuel Gauge Report showing the BTU (or energy content) adjusted price of E85 versus the various grades of gasoline.⁵

National Average Prices

Prices updated as of 12/9/2015 3:45am

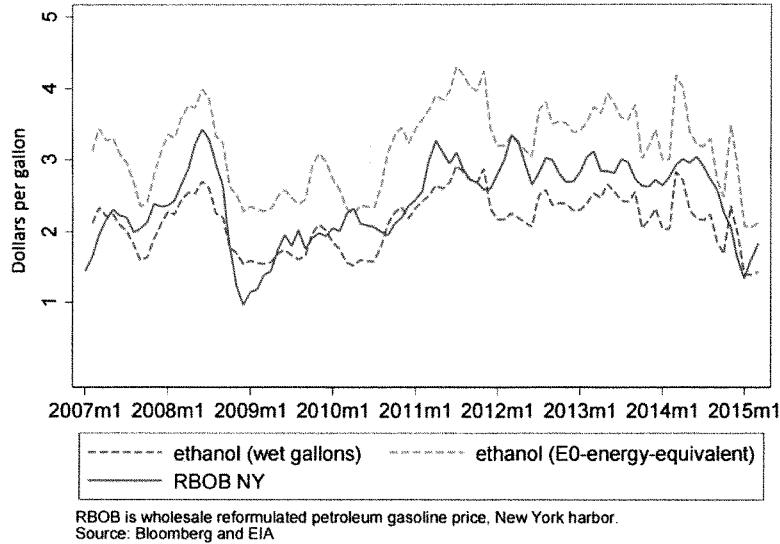
Select Market

	Regular	Mid	Premium	Diesel	E85	**E85 MPG/BTU adjusted price
Current Avg.	\$2.019	\$2.295	\$2.524	\$2.381	\$1.788	\$2.354
Yesterday Avg.	\$2.027	\$2.303	\$2.533	\$2.385	\$1.810	\$2.382
Week Ago Avg.	\$2.038	\$2.310	\$2.540	\$2.412	\$1.827	\$2.404
Month Ago Avg.	\$2.215	\$2.479	\$2.702	\$2.488	\$1.994	\$2.624
Year Ago Avg.	\$2.655	\$2.874	\$3.060	\$3.487	\$2.427	\$3.194

The chart below shows the energy adjusted price of ethanol versus RBOB (Reformulated Gasoline Blendstock for Oxygen Blending). Over the last 8 years the energy adjusted price of ethanol is almost always greater than the cost of gasoline.⁶

⁵ AAA Fuel Gauge Report, December 9, 2015, <http://fuelgaugereport.aaa.com/todays-gas-prices/>

⁶ James H. Stock, *The Renewable Fuel Standard: A Path Forward*, p. 13, Apr. 2015, http://energypolicy.columbia.edu/sites/default/files/energy/Renewable%20Fuel%20Standard_A%20Path%20Forward_April%202015.pdf



- a. Mr. Coleman went on to state that in order for renewable fuels to get equal access to the marketplace, the U.S. would have to maintain the RFS, or “break up the big oil companies.” Do you agree with this statement? Why or why not?

I do not agree with that statement. Ethanol already has equal access to the marketplace. Anyone can buy a gas station and start selling fuel with ethanol. Also, the large ethanol companies could start their own gas station brands and really promote ethanol.

Mr. Coleman does not appear to be talking about equal access to the marketplace, but preferential access. He apparently wants to force current gas stations to carry more ethanol products. This is anti-American. In America, the best product should win. Government should not be in the business of forcing gas stations to carry certain products.

- b. Do U.S. oil companies control the retail market for transportation fuels?

To answer this question, I’ll quote The American Petroleum Institute (API):⁷

⁷ American Petroleum Institute, *Service Station FAQs*, <http://www.api.org/Oil-and-Natural-Gas-Overview/Consumer-Information/Service-Station-FAQs/Do-the-major-oil-companies-own-all-the-service-stations-in-this-country>

Do the major oil companies own all the service stations in this country?

No. According to the latest information, the major integrated oil companies [such as Shell, BP, Exxon, Chevron] own about 2% of the 152,995 retail stations and operate about a third of the retail stations that they do own. When a station bears a particular API member's brand, it does not mean that the API member owns or operates the station. The vast majority of branded stations are owned and operated by independent retailers licensed to represent that brand. According to the National Association of Convenience Stores (NACS), 58% of the retail stations in the US are owned by an individual or family that owns a single store. Through various branding agreements, approximately 36% of the retail stations in the US sell fuel under API members' brands.

It is difficult to say that the oil companies control the retail market when the major integrated oil companies own such a small percentage of the retail outlets. The point is that there is real competition in the selling of gasoline.

5. **Was there anything else discussed at the hearing that you would like to correct for the record?**

Appendix II

ADDITIONAL MATERIAL FOR THE RECORD

DOCUMENT SUBMITTED BY REPRESENTATIVE BONAMICI

**Comments on and Discussion of
The Liquid Carbon Challenge: Evolving Views on Transportation Fuels and Climate**

Michael Wang¹, Wallace E. Tyner², Dan Williams³, and Jennifer B. Dunn¹

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March 2015

In *The Liquid Carbon Challenge: Evolving Views on Transportation Fuels and Climate*, DeCicco (2015) raised a few issues regarding evaluation of biofuel greenhouse gas (GHG) emission effects. He asserted that biofuel analyses thus far were done with “system boundary misspecification, flawed carbon cycle representation, and use of a static framework to analyze dynamic systems.” We provide here comments on some of the issues raised by DeCicco.

Greenhouse Gas Analytic Approaches

DeCicco provided a review of four individual GHG assessment approaches—fuel-cycle analysis (FCA), terrestrial resource assessment (TRA), GHG inventory accounting, and integrated assessment modeling (IAM)—to address GHG emissions in the context of biomass as a resource for biofuels. These assessment approaches have been developed for very different purposes. FCA, or life-cycle analysis (LCA) in general, was historically developed to address omissions in emission coverage from vehicle tailpipes to upstream fuel production by including the entire fuel supply chain, including fuel combustion. This full fuel-cycle coverage has been especially important as transportation-sector GHG policies have evolved in the past 25 years to address new fuels (such as electricity, hydrogen, and biofuels) as well as new vehicle systems. Without FCA, GHG emissions from fuel production for certain vehicle/fuel systems (such as electric drive technologies fueled with electricity and hydrogen) are omitted, as these systems’ emission burdens are simply shifted from vehicle operation to fuel production (such as electric drive technologies fueled with electricity and hydrogen). Further, regulatory agencies have recognized the need to reduce GHG intensities of fuels, as well as to reduce fuel use via vehicle efficiency improvements, to realize significant reductions in transportation GHG emissions (CARB 2009; EC 2009; USEPA 2010). With the advances in FCA over the past seven years in key areas such as LCA system boundary, treatment of co-products, and inclusion of indirect effects (such as changes in land use for biofuel production), FCA has become a helpful tool for developing policies to reduce the GHG intensity of transportation fuels.

The TRA method has been used to assess carbon mitigation in general and bioenergy potentials and their GHG reductions in particular. It examines carbon sinks and sources of terrestrial resources by considering the dynamics of carbon-stock changes in terrestrial systems over time. TRA results have been helpful in identifying opportunities for using global biological systems to

manage global GHG emissions. However, as DeCicco acknowledged, they have not been used to evaluate biofuel systems or to develop GHG reduction policies.

The GHG inventory accounting approach was adopted by the United Nations Framework Convention for Climate Change (UNFCCC 2006) for nations to develop GHG inventories. The UNFCCC protocol was adopted by the Intergovernmental Panel on Climate Change (IPCC 2006) for developing GHG emission assessments. In developing GHG emission assessments related to bioenergy production, the UNFCCC maintained that CO₂ emissions from biomass combustion (biogenic CO₂ emissions) should be assumed to be zero. This assumption was intended to avoid accounting for biogenic CO₂ emissions without considering CO₂ uptake during biomass growth. In fact, this so-called carbon neutrality assumption for biomass combustion was introduced precisely for the purpose of avoiding double-counting of biogenic CO₂ emissions. More discussion on this topic is presented in a later section of this commentary. The GHG inventory accounting itself is not a GHG analytic method and has not been used for GHG policy development. Rather, it is aimed at providing nations and regulatory bodies with information on the relative amounts of GHG emissions by sector.

There are many different kinds of IAM models, and they can be applied at scales ranging from local to global. Wicke et al. (2014) provide a characterization of the strengths and limitations of four categories of models, and they differentiate between IAM models and computable general equilibrium (CGE) models. However, DeCicco appears to cover only the aggregate IAMs. Therefore, we will discuss below only the aggregated models, which often have a CGE structure, and which we call IAM (CGE) here. The IAM (CGE) approach provides guidance to identify key sources for GHG reduction across different economic sectors and in different regions by linking sectors and regions. While IAM (CGE) can help assess effects of GHG reduction policies such as global-scale, all-sector carbon tax policies, this approach has not been used to develop GHG policies. The IAM (CGE) approach is based heavily on linkages among economic sectors that are often based on historical data (some of which are out of date), and great uncertainties exist in predicting future economic linkages (especially for emerging economic sectors that did not exist in the past). Because of the complexity of IAM (CGE) models, they are often not transparent to model users and policy makers in terms of how results are affected by which key parameters. This shortcoming weakens the application of IAM (CGE) to policy development. While DeCicco advocated this approach for energy systems, he did not offer suggestions on how IAM (CGE) could be used to design policies to pursue GHG reduction.

While verification of the impacts of FCA-based policies is challenging, FCA, mostly based on project-level data, at least offers understanding and insights regarding carbon sinks and sources and may result in eventual verification. On the other hand, it may be challenging to verify estimated policy impacts from IAM (CGE)-based models since they are built with direct and indirect linkages among different economic sectors and global regions.

FCA results are often normalized to simple numbers such as grams of GHG emissions per MJ of fuel for the purpose of developing specific regulations. This normalization is not an inherent feature of FCA. In fact, such normalization usually requires an arbitrary biofuel program lifetime.

For example, when normalizing biofuel GHG emissions to a g/MJ basis, the arbitrarily assumed lifetimes of biofuel programs—20 years (EU), 30 years (California Air Resources Board), and 30 years (USEPA)—may underestimate the true reductions achieved, since no government agency is suggesting that a biofuel program would last for that short a period. The Brazilian sugarcane ethanol program and the U.S. ethanol program have already lasted much longer than the arbitrary biofuel lifetimes assumed by the regulatory agencies. DeCicco was confused between the FCA method and the need for regulations to have a simple GHG metric for fuel carbon intensity.

Over the past eight years, the introduction of biofuel land use changes into biofuel LCAs has helped integrate the TRA method into the biofuel FCA method. For example, soil carbon changes due to land use changes are now often accounted for in biofuel FCAs. These analyses (e.g., Kwon et al. 2013) take into account prior land use, although DeCicco incorrectly pointed out that prior land use is not considered in the reference system boundary for LCA. Needless to say, further advancement and improvements of the integration of the two approaches (and other approaches) are needed in order for FCA to provide comprehensive results for transportation fuel policy development (see Wicke et al. 2014).

Carbon Neutrality Assumption for Bioenergy

The UNFCCC, in its GHG accounting protocol, directs nations that submit GHG emissions inventories to assign a value of zero to CO₂ emissions from biomass combustion (UNFCCC 2006). Further, the UNFCCC maintains that nations must account for carbon stock loss (reported as CO₂ emissions) due to biomass harvest in their reporting of emissions in the Land Use, Land-Use Change and Forestry (LULUCF) sector. UNFCCC aims to avoid double-counting of carbon stock loss from biomass harvest and combustion by maintaining this reporting convention. If nations reported *both* carbon stock loss from biomass harvest *and* carbon emissions from combusting that biomass, they would double-count emissions from using this biomass as an energy source. Searchinger et al. (2009) and Haberl et al. (2012) (as cited by DeCicco) critiqued this UNFCCC carbon accounting convention, which Searchinger and others termed “double accounting error.” But, to be precise, they should have used a different term such as “omission of biomass combustion CO₂ emissions.” It was exactly “double-counting” that the UNFCCC intended to avoid in its protocol.

International trade in bioenergy creates an opportunity for this UNFCCC convention to result in potential omission of CO₂ emissions from bioenergy use. Individual nations subject to Annex I report their annual GHG emissions; non-Annex I nations do not. Thus, if bioenergy (including biofuels) is produced in non-Annex I countries but exported to Annex I countries for use, CO₂ emissions from biomass stock loss in non-Annex I nations are not reported while bioenergy combustion in Annex I countries is assigned zero CO₂ emissions, resulting in a net omission of CO₂ emissions. Also, even though GHG emissions are required to be reported for all the sectors, including LULUCF, there is no guarantee that individual nations will always cover this sector and cover it thoroughly. Some researchers are concerned that there would be an omission or partial omission of GHG emissions related to bioenergy within a nation because of the cross-sector

nature of bioenergy production and consumption. Global accounting and thorough sectorial accounting should be implemented to avoid such omissions under the UNFCCC.

As an LCA tool, GREET (and many other models) covers many sectors along a fuel supply chain. Ten years ago, Argonne became concerned that assigning zero CO₂ emissions to biofuel combustion might create a belief among GREET users that biomass combustion did not, in fact, emit CO₂. As a result, Argonne changed the GREET model to explicitly assign CO₂ emissions to biomass combustion. Meanwhile, Argonne assigned a CO₂ uptake credit to biomass growth. This approach to separating CO₂ emissions and uptake in biofuel evaluation is discussed by Wang et al. (2012) (see Figure 4 in particular). The separation of emissions and uptake was intended to maintain transparency, so that GREET users could always question how much, if any, CO₂ uptake credit should be assigned to a given biomass feedstock. In our opinion, assignment of CO₂ uptake credits for annual crops, perennial grasses, and short-term-rotation trees is a reasonable assumption. The uptake credit for long-term forestry-derived feedstocks must be based on thorough, detailed analyses of the biomass harvest and growth cycle both with and without bioenergy production. We are currently undertaking such an analysis. If DeCicco believes that we have an “accounting error” (or, in our terms, “CO₂ omission”) for biomass combustion in GREET, he has simply missed the carbon accounting approach that we have built into GREET.

In summary, carbon uptake during biomass growth could offset the combustion emissions either completely or to a degree. The degree of offsetting depends on the growth cycle of given biomass types and detailed tracking of carbon sources for biofuel production. In fact, FCA is designed to track the carbon sources of a biofuel as well as CO₂ emissions from fossil energy use along the biofuel’s supply chain. DeCicco himself even acknowledged (p. 102) that “the carbon neutrality assumption is arithmetically correct within a biofuel lifecycle. It is also true globally if all biomass used in the world is the subject and terrestrial carbon stock impacts due to land-use change are accounted for separately.”

Biomass Additionality

The decision to assign a CO₂ uptake credit and to select its magnitude for bioenergy production is affected by the evaluation of biomass additionality for bioenergy. Biomass additionality expresses the idea that any bioenergy production should result in additional biomass growth in global terrestrial systems. Additional biomass growth is determined by economic conditions that help or hinder introduction of new technologies (such as better seeds and better farming practices, e.g., precision farming) and the biological potentials of ecosystems. That is, economics and biology are intertwined for addressing biomass additionality. Since 2008, many organizations, including Argonne, have been using economic models to address management of ecosystems and inter-relationships among different economic sectors and across different global regions both with and without bioenergy production. Also, economic drivers certainly affect biomass growth rates under these two scenarios. Elliott et al. (2014) demonstrated an example of how to evaluate this effect. DeCicco’s assertion that bioenergy production only results in one-to-one exchanges among different uses of biomass, without considering differences between natural and managed biomass growth, is erroneous.

Biomass additionality should be examined for different biomass feedstock types. We commend Searchinger and Heimlich (2015) for presenting six individual bioenergy cases to identify those that could result in GHG reductions. DeCicco did not offer this type of analysis in his paper.

In the context of biomass additionality, we offer the corn ethanol example. U.S. corn ethanol production has increased from 1.6 billion gallons in 2000 to 14.3 billion gallons in 2014 (RFA 2015). One would assume that this dramatic increase has resulted in additional corn production (together with production of the stalks and leaves known as corn stover), as compared to a counterfactual scenario without any corn ethanol production. That is, because of corn ethanol production, corn production has increased, resulting in the production of more biomass both in the grain that is actually converted to ethanol and animal feed and in the corn stover (see Mumm et al. [2014] for a detailed analysis). In other words, if we did not experience a corn price increase from below \$2 a bushel to \$4–7 a bushel in the past 15 years, we could not imagine the corn yield increase that the U.S. experienced in the same period. Growth in U.S. corn production has indeed come from intensification (e.g., intensive farming with advanced technologies) and extensification (i.e., additional corn farming acreage). While intensification should result in additional corn production together with additional stover production, the extent of additional biomass production due to extensification (switching from other crops and vegetation types to corn) requires modeling of different crop systems and other vegetation systems. A simplistic presumption that the carbon in corn ethanol is already sequestered in corn is not logical. Farmers grow corn for economic reasons; conversion of corn to ethanol is based on economics. Conversely, if corn prices drop to a very low level (say, below \$2 per bushel), farmers will not grow *additional* amounts of corn through a variety of means, including advanced technologies, since such behavior would not make economic sense. Again, this observation demonstrates the need to assess biomass additionality in both economic and biological contexts.

A key difference between biomass carbon and fossil fuel carbon is in the respective carbon cycles. Fossil fuel carbon comes from the underground fossil carbon stock created a few million years ago. In his proposed analytic framework, DeCicco did not take into account the avoided CO₂ emissions from the fossil energy displaced by bioenergy, even though he casually pointed out the avoided fossil CO₂ emissions in his discussion. Biofuels from additional biomass are introduced to displace fossil fuels. Thus, biomass additionality for biofuels should be examined *together* with the *fossil energy subtractionality* that is caused by biofuels.

On the other hand, biomass carbon derives from biogenic carbon stock and carbon flow via biomass growth. If biogenic carbon stock (both above- and below-ground) is tapped for bioenergy production, the time required for re-establishment of biomass carbon stock by biomass growth can affect bioenergy's carbon reduction significantly. But if bioenergy carbon comes from the annual carbon flow of biomass growth, bioenergy should offer GHG reductions. In practice, biomass is the currency for growers. The long-term economic viability of their business lies in sustaining biomass growth for harvest instead of depleting biomass carbon stock. That is, considerations of long-term economic viability should encourage growers to produce bioenergy from the carbon flow, not from permanent carbon stocks. Private forest management in the U.S.

offers a good example of the practice of biomass harvest from biomass flow, not stock, even though the biomass flow via forest growth could be subject to a 20- to 50-year time horizon. Of course, this time horizon is much shorter than the fossil carbon cycle.

In addition to the biomass additionality concept, DeCicco particularly questioned whether the carbon flow of ecosystems would be changed as a result of biofuel production. His question can only be answered by scientifically addressing the two key issues below:

- Would farmers/growers continue to grow biomass if there were no demand for biomass due to bioenergy production? In particular, if there were no cellulosic biofuel industry demanding cellulosic biomass, can one assume that farmers/growers would grow cellulosic biomass anyway?
- When bioenergy production results in managed biomass growth, how does the growth rate differ from that of natural biomass growth?

Biomass Additionality versus Consequential Life Cycle Analysis

Compared to the biomass additionality concept, the consequential LCA approach calls for estimating the consequences of biofuels technologies or policies (Earles and Halog 2011; Ekvall and Weidema 2004). Both the biomass additionality and the consequential LCA approaches imply a “with-without” comparison, but the implementation of each approach is quite different.

The additional biomass assumption is well expressed by Searchinger and Heimlich (2015): “The world’s lands are already growing plants every year and these plants are already being used” (p. 16). In other words, the assumption is that every hectare of land that goes to biofuels is deducted from other uses. Another related argument often embedded in the biomass additionality concept is that it would be better to use any available land to sequester carbon than to produce biofuels to displace fossil carbon. In addition, the food-fuel argument is often commingled with the biomass additionality concept (Searchinger and Heimlich 2015). There have been several studies that compare forest sequestration with biofuels and biopower (e.g., Mccarl 2007). Some use a carbon tax, with endogenous decisions on the amount of sequestration and biofuels that will be produced over a range of carbon prices (Suttles et al. 2014). The biomass additionality argument makes the assumption that all land is being used, that any plant material use for biofuels necessarily means less availability elsewhere, and that sequestration is more efficient than biofuels production. None of these assumptions are adequately justified by their proponents. In fact, some studies (e.g., Cai et al. 2010) find notable amounts of marginal, underutilized lands that could be converted to biomass production, ostensibly increasing their carbon content.

The consequential LCA approach normally uses as its system boundary the entire domain of any given policy (Taheripour and Tyner 2014). By default, the approach does indeed address biomass additionality. The consequential LCA approach normally makes use of CGE models to estimate the impacts of what are called market-mediated responses to the higher demand from biofuels (Hertel and Tyner 2013). Possible responses included the following:

- With a higher price, consumption (quantity demanded) would normally fall.
- With a higher price for a given commodity, there can be switching among crops to produce more of one crop and less of others.
- With a higher demand for a given commodity for biofuels, more cropland may be needed to meet that increased demand, and this cropland can come from conversion of pasture or forest. This is referred to as a change on the extensive margin.
- With a higher demand for a given commodity, the existing cropland might be farmed more intensively such as via double-cropping or irrigation or other investments in increased productivity and yield. This is referred to as a change in the intensive margin. An increase in intensive margin on existing cropland reduces demand for land conversion (from either forest or pasture to cropland).
- With a higher demand for a given commodity, there can be impacts on international trade of the commodity and of substitute commodities. In other words, a biofuel demand increase in one country can have repercussions anywhere in the world because the agricultural commodity markets are global.

It is important to note that many CGE models take into account limits on conversion of forests, high-carbon stock lands that merit protection, such as are contained within the renewable fuel standard (RFS). In its implementation of the RFS, the USEPA requires that the land used to produce biofuel feedstocks had been managed, fallow, and *non-forested* as of December 19, 2007. Furthermore, the USEPA checks the total area of agricultural land in the U.S. against the 2007 baseline of 402 million eligible crop-acres to assess whether agricultural land is increasing. If it is, biofuel producers must show that the land from which feedstock is produced was cleared or cultivated prior to December 19, 2007.

An important difference between the consequential LCA approach and the biomass additionality approach is that the former is driven by market forces to determine additional biomass production, whereas the latter simply assumes that any incremental demand reduces availability elsewhere. Biomass production is driven by market forces, and there is no simple one-for-one replacement among all uses of biomass as biofuels production increases.

References

Cai X, X Zhang, and D Wang 2010, Land availability for biofuel production, *Environmental Science and Technology* 45(1): 334–339.

CARB (California Air Resources Board) 2009, *Proposed Regulation for Implementing Low Carbon Fuel Standards, Volume 1, Staff Report: Initial Statement of Reasons*. Sacramento, CA: California Environmental Protection Agency, Air Resources Board, 374 pp.

Decicco JM 2015, The liquid carbon challenge: Evolving views on transportation fuels and climate. *WIRE's Energy and Environment* 4: 98–114.

Earles JM and A Halog 2011, Consequential life cycle assessment: A review. *International Journal of Life Cycle Assessment* 16: 445–453.

EC (European Commission) 2009, Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the Promotion of the Use of Energy from Renewable Sources and Amending and Subsequently Repealing Directives 2001/77/EC and 2003/30/EC. Brussels, Belgium.

Ekvall T and BP Weidema 2004, System boundaries and input data in consequential life cycle inventory analysis. *International Journal of Life Cycle Assessment* 9(3): 161–171.

Elliott J, B Sharma, N Best, M Glotter, JB Dunn, I Foster, F Miguez, S Mueller, and M Wang 2014, A spatial modeling framework to evaluate domestic biofuel-induced potential land use changes and missions. *Environmental Science and Technology* 48(4): 2488–2496.

Haberl H, D Sprinz, M Bonazountas, et al. 2012, Correcting a fundamental error in greenhouse gas accounting related to bioenergy. *Energy Policy* 45: 18–23.

Hertel TW and WE Tyner 2013, Market-mediated environmental impacts of biofuels. *Global Food Security* 2: 131–137.

IPCC (Intergovernmental Panel on Climate Change) 2006, 2006 *IPCC Guidelines for National Greenhouse Gas Inventories, Volume 1: General Guidance and Reporting*. Hayama, Kanagawa, Japan: Institute for Global Environmental Strategies.

Kwon H, Mueller S, Dunn JB, and Wander MM 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*, 55, 299–310.

Mccarl B 2007, How feasible are dreams of biofuels? Opinions and analysis with a view toward GHGs. Presented at *Forestry and Agriculture Greenhouse Gas Modeling Forum # 4: Modeling Ag-Forest Offsets and Biofuels in U.S. and Canadian Regional and National Mitigation*. Shepherdstown, West Virginia.

Mumm RH, PD Goldsmith, KD Rausch, and HH Stein 2014, Land usage attributed to corn ethanol production in the United States: Sensitivity to technological advances in corn grain yield, ethanol conversion, and co-product utilization, *Biotechnology for Biofuels* 7: 61

RFA (Renewable Fuels Association) 2015, Going Global, 2015 Ethanol Industry Outlook, <http://www.ethanolrfa.org/pages/annual-industry-outlook>.

Searchinger TE, SP Hamburg, J. Melillo, et al. 2009, Fixing a critical climate accounting error. *Science* 326: 527–528.

Searchinger T and R Heimlich 2015, *Avoiding Bioenergy Competition for Food Crops and Land*. World Research Institute Working Paper, 44 pages.

Suttles SA, WE Tyner, G Shively, RD Sands, and B Sohngren 2014, Economic effects of bioenergy policy in the United States and Europe: A general equilibrium approach focusing on forest biomass. *Renewable Energy* 69: 428–436.

Taheripour F and WE Tyner 2014, Corn oil biofuel land use change emission impacts: sharing emission savings between ethanol and biodiesel biofuels. *Biofuels* 5(4): 353–364.

UNFCCC (United Nations Framework Convention on Climate Change) 2006, *Updated UNFCCC Reporting Guidelines on Annual Inventories Following Incorporation of the Provisions of Decision. 14/CE.11*. FCCC/SBSTA/2006/9, Aug. 18.

USEPA (U.S. Environmental Protection Agency) 2010, *Renewable Fuel Standard Program (RFS2) Regulatory Impact Analysis*. 1120 pp.

Wang M., J Han, J Dunn, H Cai, and A Elgowainy 2012, Well-to-wheels energy use and greenhouse gas emissions of ethanol from corn, sugarcane and cellulosic biomass for US use. *Environmental Research Letters* 7: 045905.

Wicke B., FVD Hilst, V. Daigolou, et al. 2014, Model collaboration for improved assessment of biomass supply, demand, and impacts, *GCB Bioenergy*: doi: 10.1111/gcbb.12176.

DOCUMENT SUBMITTED BY REPRESENTATIVE BRIDENSTINE



November 2, 2015

U.S. House of Representatives
Committee on Science, Space, and Technology
The Subcommittee on Oversight
The Subcommittee on Environment

Distinguished Members of the Subcommittees,

We would like to give you Briggs & Stratton's written perspective on the issues raised by the EPA's implementation of the Renewable Fuels Standard at this 10 year anniversary hearing. I have been extremely impressed by both the Committees workmanlike approach to educate itself, and the public, on the challenge which the RFS presents to manufacturers, consumers and the environment. This letter, which is submitted strictly in my capacity as Chairman, President and CEO of Briggs & Stratton, will attempt to define the challenges as they pertain to small engine manufacturers and offer suggestions on how to protect consumers from significant economic and environmental damage.

Briggs & Stratton Corporation, which is headquartered in Wauwatosa, Wisconsin, is the world's largest producer of gasoline engines for outdoor power equipment. We are North America's number one marketer of pressure washers, and it is a leading designer, manufacturer and marketer of power generation, lawn and garden, turf care and job site products through our Simplicity®, Snapper®, Snapper Pro®, Ferris®, Allmand™, Billy Goat®, Murray®, PowerBoss®, Branco® and Victa® brands. The vast majority of our products are designed and manufactured in the United States and are marketed and serviced in over 100 countries. Of our over 6,000 employees, approximately 5,300 of those employees work here in the United States. As who makes over 85% of our products in the U.S., our company is proud to be celebrating our 108th anniversary this year.

Briggs & Stratton's long standing commitment to the environment remains a key focus for our business. We continue to manufacture our products with recycled materials that are highly





efficient and with reduced emissions. Since 1995, we have reduced emissions by 75% and, after completing the phase in of our new product offering, have achieved an additional 35% reduction in those emissions in January, 2014. In 2007, we signed a pledge with the Department of Energy to reduce our energy consumption by 25% over 10 years. Just 8 years later, we have already cut our consumption by over 25%. These are just a few of the many examples that demonstrate our commitment to the environment.

Below are five factors justifying rescission of EPA's conditional certification of E-15 :

1. Research has shown, and EPA has agreed, that use of E15 in small non-road engines can have harmful and costly consequences on small engines and outdoor power equipment. Briggs & Stratton has conducted extensive testing on levels of ethanol above 10%. Increasing levels of ethanol in gasoline result in increased levels of alcohol. Alcohol has inherent properties that cause issues with our engines and they become more acute with increasing alcohol content. Increasing the alcohol in fuel changes the air-fuel ratio (enleanment) in our carbureted engines. E-15 fuel, by definition would have an alcohol content ranging from 0 to 15%. Our engines would have great difficulty in meeting both emissions and performance expectations with this type of alcohol range. Enleanment will also result in higher operating temperatures that will lower engine life due to issues such as valve sealing, piston scoring, and head gasket leakage, just to name a few. Ethanol is also hygroscopic (absorbs water). Increased levels of water will cause the engine to run poorly, and will also cause corrosion by means of acidic attack, galvanic activity, and chemical interaction. Ethanol will also cause other problems such as reduced fuel storage life, starting issues and reduced fuel economy.

The Department of Energy (DOE) also conducted testing. After testing E-15 on a representative sample of small non-road engines, including Briggs & Stratton powered generators and power washers, the DOE found that small engines experienced a variety of difficulties with intermediate blends of ethanol. Most engines performed worse in several metrics when running on higher ethanol blends – engines often had higher operating temperatures, higher exhaust temperatures, and NOx emission rates. As noted earlier, higher operating temperatures, lead to increased wear and tear and more frequent maintenance. Moreover, 7 out of the 11 engines tested behaved



“poorly” or “erratically”, according to DOE’s report, with incidents of unstable speeds, stalling, and clutch engagement at idle. As a result of this testing, small engines were specifically excluded by EPA from the E-15 Waiver.

2. Research on warning label effectiveness suggests that an E-15 warning label will do very little to mitigate misfueling.

In response to our concerns and the concerns of other interested parties, EPA has issued a mandatory warning label for pumps that distribute E-15. Given the body of research on the effectiveness of warning labels, we believe that this warning will not prevent consumers from misfueling their engines with the E-15 blend, and, with no one else liable, will leave the equipment owner liable for the damage to their products. Warning labels have been the subject of many research studies, with results often showing little change in consumer behavior. To address this concern, there are standards and testing protocol that have been completed. The Association for Consumer Research further reports that warning labels are considerably less likely to be successful when applied to products that consumers use frequently and feel comfortable with, e.g. gas pumps. If consumers visit their local gas station and do not realize that the ethanol blend has been increased, this research would indicate that they are unlikely to heed the warning label on the pump. There has been no testing done by EPA to validate the effectiveness of the warning label, which is not consistent with recognized safety standards such as ANSI.

When the U.S. transitioned from leaded gasoline to unleaded gasoline in the 70s and 80’s, new cars running on unleaded gasoline were designed with different fuel tanks to be incompatible with older leaded gasoline in an effort to prevent misfueling. There is no such “transition” plan or tangible differentiation in place for E-15 and it is solely up to the consumer to know what fuel is appropriate for their automobile, lawn mower, generator, pressure washer, etc.

3. Behavioral studies of customers at the gas pump conclude that consumers overwhelmingly favor the lowest priced option, regardless of the consequences.

Historical evidence suggests that when faced with a range of prices at the pump, consumers are far more likely to choose the lowest-priced option despite potential damages to their engines. As previously mentioned, when the United States transitioned from leaded gasoline to unleaded



gasoline in the 70's and 80's, new cars running on unleaded gasoline were designed with different fuel tanks, to be incompatible with older leaded gasoline pumps. Additionally, car buyers were educated at the point of purchase about the new fuel. Even with those prevention and education measures, the EPA reported that in 1983 – ten years after the introduction of unleaded gasoline – misfueling rates remained as high as 15.5%. The New York Times reported that “customers would go out of their way to pump leaded gas if it was just a few cents cheaper. What they gain at the pump they lose at the repair shop in higher maintenance costs.” If high rates of misfueling still occurred when physical obstacles were in place, we believe that a simple warning label next to the pump will not yield better results. Similarly, the National Bureau of Economic Research reports very strong price elasticity of demand in its own study on the use of premium vs. regular gasoline during times of high gasoline prices. When gasoline prices increased, consumers switched to less expensive, regular gasoline even though premium gasoline was recommended for their vehicles. NBER concludes that households are nearly 20 times more sensitive to the income effect for gasoline than to equivalent effects from other sources.

4. Misfueling due to lack of education to consumers regarding the proper use of E-15 will be significant.

EPA has instructed stakeholders to “develop a broad public education and outreach campaign that provides both consumers and retailers with the information they need to avoid misfueling.” Briggs & Stratton and the Outdoor Power Equipment Institute is already taking steps to educate its customers about proper fueling for its products and has introduced additives and E-0 gasoline products to assist consumers with selecting the proper fuel. We do not feel it, nor the outdoor power equipment industry, should be held solely responsible for educating tens of millions of Americans of the dangers of misfueling, especially when many already own products which are incompatible with E-15. In a recent study, AAA found that 95% of Americans had not heard of the new E-15 waiver. In a separate study by the National Association of Convenience Stores, it was clear that consumers were confused by E-15; many believed that E-15 had higher fuel economy than E-10. And the study also found that of participants who said they would consider fueling their cars with E-15, 60% of them owned cars for which E-15 is incompatible and prohibited. Despite our best efforts at education and prevention, we believe the risk of misfueling will be substantial,



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and damage to our products will be irreversible. We risk losing decades of trust and our brand reputation as a manufacturer of quality, reliable products while owners will not get the value they expected when they purchased the product.

5. The use of Biofuels or “drop-in fuels” has been tested and could prevent misfueling.

Small engines and outdoor power equipment are not designed, warranted, or EPA-approved to operate on gasoline containing more than 10% ethanol. If biofuels continue to be in the public’s interest, Briggs & Stratton supports the development and use of biofuels, from any feedstock, which are “drop-in fuels”. Drop in fuels, by definition, meet existing gasoline specifications and are ready to “drop-in” to infrastructure, minimizing compatibility issues. These fuels are capable of satisfying the additional growth in biofuel use, while also providing a safe and highly performing general fuel for both legacy and newly manufactured small engines and outdoor power equipment. We have conducted extensive testing with a drop-in isobutanol blended gasoline which demonstrated evidence that such fuels can provide the performance and operational criteria necessary, without demonstrating any negative effects. Drop in fuels had not yet materialized when the RFS was developed in previous market conditions and the EPA was compelled to grant the partial waiver to meet the statutory targets using ethanol. E-15 will not provide compliance with current RFS targets and will require EPA to continue to revise fuel standards creating uncertainty in the marketplace and for manufacturers and increasing misfueling risks to consumers. Misfueling will result in economic harm to all parties and void product warranties. Ever changing targets will result in less efficient investment of manufacturing resources and more costly products.

Briggs & Stratton Corporation’s request to the committee

For the past five years we have worked closely with our Congressman, Jim Sensenbrenner, in an effort to rescind the certification of E-15 until such time as the National Academy of Science can convene a peer review panel to evaluate EPA’s action and recommend alternative approaches which protect consumers and the environment. Briggs & Stratton urges this Committee to work in a bi-partisan, bi-cameral manner to pass reform legislation through revisions to the RFS which will align domestic goals for biofuel use with the market’s ability to produce, distribute and



consume such fuels. At a minimum we recommend that the reform legislation rescind the partial waiver for E-15, and establish gasoline blended with up to 10% ethanol as the general purpose domestic fuel. The legislation should also require that all considerations to increase domestic biofuel levels in the future be subject to a formal EPA rulemaking whereby the market's ability to safely distribute, retail and consume such fuel is provided for.

Sincerely,

BRIGGS & STRATTON CORPORATION

Todd J. Teske

Chairman, President & CEO



STATEMENT SUBMITTED BY RANKING MEMBER EDDIE BERNICE JOHNSON

OPENING STATEMENT

Ranking Member Eddie Bernice Johnson (D-TX)
Committee on Science, Space, and Technology

Renewable Fuel Standard: A Ten Year Review of Costs and Benefits
Joint Subcommittee Hearing
November 3, 2015

Good morning and thank you Mr. Chairman for calling this hearing today. I would also like to thank our witnesses for testifying.

The issue we are discussing this morning is not cut and dry. As you have already heard, some are willing to throw away the Renewable Fuel Standard and forget the progress we have made. Just this past Friday in Iowa, DuPont opened the largest cellulosic ethanol plant in the world. This advanced biofuel is significantly cleaner than first generation biofuels, and of course far cleaner than petroleum.

The plant is projected to produce over 30 million gallons of fuel-grade ethanol every year. This progress would not be possible without the substantial investments and innovations we have made in first-generation biofuels – progress that was largely driven by the RFS. While I agree there are challenges associated with the production of corn ethanol that merit continued scrutiny, it has created a bridge to a cleaner future for our transportation fuels.

That said, the progress of advanced biofuels has not matched the expectations that were set in the 2007 law. However, with commercial scale production now picking up, as examples like the new DuPont plant in Iowa are demonstrating, it appears that many of the technical challenges have been addressed.

Now we must focus our attention on integrating these cleaner fuels into the market. This is precisely the role of the RFS.

The law itself has not come without challenges. I look forward to eventually hearing from the Environmental Protection Agency on how they will ensure a more consistent release of

volumetric standards for the RFS. If we expect the biofuels industry to grow and provide a larger portion of our domestic transportation fuel, we must give them the confidence that the market will welcome their product.

More broadly speaking, while I understand that there is not yet a scientific consensus on his findings with regard to the RFS, I am happy to see that the Majority invited a witness today who is focused on addressing the urgent challenge of climate change. We should all be on the same team when it comes to the goal of reducing greenhouse gas emissions. I hope Dr. DeCicco can not only provide insight on the RFS, but also convince my colleagues to spend more time and energy on addressing what may well be the biggest long-term problem facing the world.

Thank you Mr. Chairman and I yield back.