EXAMINING ADVANCEMENTS IN BIOFUELS: BALANCING FEDERAL RESEARCH AND MARKET INNOVATION

JOINT HEARING

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT &
SUBCOMMITTEE ON ENERGY

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED FIFTEENTH CONGRESS

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July 25, 2017

EXAMINING ADVANCEMENTS IN BIOFUELS: BALANCING FEDERAL RESEARCH AND MARKET INNOVATION

Tuesday, July 25, 2017

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

The Subcommittees met, pursuant to call, at 10:04 a.m., in Room 2318, Rayburn House Office Building, Hon. Andy Biggs [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
2321 RAYBURN HOUSE OFFICE BUILDING
WASHINGTON, DC 20515-6301
(202) 225-6371
www.science.house.gov

Subcommittees on Environment and Energy

Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation

Tuesday, July 25, 2017
10:00 a.m.
2318 Rayburn House Office Building

Witnesses

Dr. Paul Gilna, Director, BioEnergy Science Center (BESC) and Deputy-Division Director of Biosciences, Oak Ridge National Laboratory

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

Ms. Emily Skor, CEO, Growth Energy

Mr. Nicolas Loris, Herbert and Joyce Morgan Research Fellow, Institute for Economic Freedom and Opportunity, Heritage Foundation

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

HEARING CHARTER

July 21, 2017

TO: Members, Subcommittee on Environment and Subcommittee on Energy

FROM: Majority Staff, Committee on Science, Space, and Technology

SUBJECT: Joint Subcommittee Hearing: "Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation"

The Subcommittee on Environment and the Subcommittee on Energy of the Committee on Science, Space, and Technology will hold a joint hearing titled *Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation* on Tuesday, July 25, 2017, at 10:00 a.m. in Room 2318 of the Rayburn House Office Building.

Hearing Purpose:

The purpose of this hearing is to examine federal funding of biofuels projects and how it affects the private market. The hearing will also focus on the government's role in biofuels research and how to promote policies that drive innovation in the private sector.

Witness List

- **Dr. Paul Gilna,** *Director, BioEnergy Science Center (BESC) and Deputy-Division Director of Biosciences, Oak Ridge National Laboratory*
- **Dr. John DeCicco,** *Research Professor, University of Michigan Energy Institute.*
- **Ms. Emily Skor,** *Chief Executive Officer, Growth Energy*
- **Mr. Nicolas Loris,** *Herbert and Joyce Morgan Research Fellow, Institute for Economic Freedom and Opportunity, Heritage Foundation*

Staff Contact

For questions related to the hearing, please contact the Majority Staff at 202-225-6371.

Chairman BIGGS. Good morning. The Subcommittees on Environment and Energy will come to order. Without objection, the Chair is authorized to declare recesses of the Subcommittees at any time.

Welcome to today's hearing entitled "Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation." And I recognize myself for five minutes for an opening statement.

Good morning, and welcome to today's joint Subcommittee hearing entitled "Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation." Today, we'll examine federal biofuel funding and the effects of federal mandates on the market. We will also examine basic research in biology and biochemistry and the ways that it can be best utilized by industry to spur private innovation.

I thank each of our witnesses for being here today. Some of you have traveled a good distance, and we're very appreciative that you would take time to share your expertise on this important subject.

For far too long, the federal government has been picking winners and losers in the American energy market. Federal policies prop up unsuccessful or mediocre business ventures, limit opportunities for new or different business ideas, and stifle innovation in the private sector. It is time we focus on and pursue more market-friendly policies, rather than spending taxpayer dollars on misguided subsidies and inefficient commercial-scale projects. We should avoid intervening in the free market and focus instead on supporting federal funding for basic research that supports technological advances in biofuels and provides tools for businesses to deploy new technologies.

As an initial reform, I will be introducing the FUEL Reform Act tomorrow to fully eliminate the biofuel subsidies and related programs in Title IX of the farm bill. The FUEL in that bill title is an acronym that stands for "Farewell to Unnecessary Energy Lifelines," and I very much hope that our nation will follow that policy directive.

Over the last 30 years, the American taxpayer has paid out billions of dollars in federal biofuel subsidies. For instance, the 2014 Farm Bill energy titles alone cost taxpayers $879 million, funding things like the Bioenergy Program for Advanced Biofuels. This program in turn provides subsidies to advanced biofuels producers to increase their production levels without taking into account such basic market principles as real-world demand.

Senseless policies like this distort the market by forcing businesses to improvise rather than innovate, and the American energy consumer foots the bill. By continuing to force technologies into the market that are not competitive or in demand, we are doing the American people a disservice. Simply put, we don't get out of these programs what we are putting into them.

Furthermore, the federal government's biofuel policies have had an unintended adverse effect on food costs. The price of corn, soybeans, and related retail food products have all increased. Land is drawn away from competing crops, and input prices for livestock producers have gone up. I am, however, encouraged that research is underway to improve our ability to generate biofuels more efficiently, both from traditional sources like corn and soybeans, as well as from new sources like poplar trees and switchgrass.

We will hear today about research conducted by the BioEnergy Science Center at Oak Ridge National Laboratory, one of the Department of Energy's Bioenergy Research Centers. Researchers at Oak Ridge are discovering ways to generate advanced biofuels from new sources that are not also food stock. Partnering with industry stakeholders, they will pursue fundamental science that supports new technologies to increase the sustainability and economic viability of advanced biofuels.

While I stress very strongly once again that we should be working toward the goal of fully eliminating energy subsidies, I am interested in learning more about how current taxpayer dollars can be used more effectively and efficiently, particularly when it comes to basic and early stage biofuels research. The sooner this type of research comes to fruition and can be commercialized by the private sector, the better. When the free market operates, innovation breaks through, and the economy thrives.

I look forward to learning more from our distinguished panel and have no doubt that this will be a wide-ranging and fascinating discussion.

[The prepared statement of Chairman Biggs follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
July 25, 2017

Media Contact: Kristina Baum
(202) 225-6371

Statement of Chairman Andy Biggs (R-Ariz.)
Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation

Chairman Biggs: Good Morning and welcome to today's Joint Subcommittee hearing entitled "Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation. Today, we will examine federal biofuel funding and the effects of federal mandates on the market. We will also examine basic research in biology and biochemistry and the ways that it can be best utilized by industry to spur private innovation.

First, I would like to thank our witnesses for being here today. Some of you have traveled a good distance, and we sincerely appreciate you taking the time to share your expertise on this important subject.

For far too long the federal government has been picking winners and losers in the American energy market.

These federal policies prop up unsuccessful or mediocre business ventures, limit opportunities for new or different business ideas, and stifle innovation in the private sector.

It is time we focus on and pursue more market-friendly policies. Rather than spending taxpayer dollars on misguided subsidies and inefficient commercial scale projects, we should avoid intervening in the free market and focus instead on supporting federal funding for basic research that supports technological advances in biofuels and provides tools for businesses to deploy new technologies.

As an initial reform, I will be introducing the FUEL Reform Act tomorrow to fully eliminate the biofuel subsidies and related programs in title IX of the farm bill. The "FUEL" in that bill title is an acronym that stands for "farewell to unnecessary energy lifelines," and I very much hope that our nation will follow that policy directive.

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I look forward to learning more from our distinguished witnesses and have no doubt that this will be a wide-ranging and fascinating discussion.

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Chairman BIGGS. Now, I recognize the Ranking Member of the Environment Subcommittee, the gentlewoman from Oregon, for an opening statement.

Ms. BONAMICI. Thank you very much, Mr. Chairman, and welcome to all of our witnesses.

Our country's dependence on crude oil to fulfill our transportation needs is problematic in at least a few ways. It's made us subject to the boom-and-bust cycles of the volatile oil market, and it's the reason why, according to the EPA, the transportation sector accounts for about 27 percent of our country's greenhouse gas emissions. Those are excellent reasons why it's crucial for us to develop and use fuels that will reduce our carbon footprint while still reliably meeting our transportation needs.

The renewable fuel standard was passed in 2005 to diversify our energy portfolio and reduce our reliance on the unstable international fossil fuel market. Policies such as the RFS have multiple goals in addition to reducing our overreliance on crude oil. They include providing more sustainable sources of energy, reducing carbon emissions, encouraging rural economic growth, and bringing new job opportunities to our districts.

We will likely hear from some witnesses today that policies like the RFS have failed. The evidence, however, points to the contrary. Federal policies such as the RFS have grown our economy by providing market certainty for biofuels. It's allowed the private sector to continue to innovate and expand the renewable fuel industry. The Renewable Fuels Association found that ethanol supported more than 74,000 direct jobs in renewable fuel production and agriculture in 2016.

The production and use of ethanol also has net positive environmental effects through its lifecycle. The Department of Energy's Argonne National Laboratory has found, through lifecycle analysis, that corn ethanol can produce approximately 48 percent less greenhouse gas emissions than conventional gasoline. This is bolstered by sustainable farming practices in the United States that have led the same Argonne team to find that the production of a gallon of corn ethanol can use up to 50 percent less water than the production of a gallon of petroleum gasoline.

The importance of federal biofuels research at the Department of Energy cannot be overstated. These investments allow for further development of advanced biofuels by using the technology infrastructure from first-generation biofuels. Despite this vital ongoing work at our national labs, the draconian cuts to biofuels research programs in the President's budget threaten to derail current research priorities.

Regulations like the RFS are making a difference at the state level as well. When I was in the Oregon State Senate, we passed a bill to adopt a clean fuel standard to lower the carbon intensity of transportation fuels by ten percent over a ten-year period. And just this year, the Oregon Economic Council found that within the first three quarters of implementing the standard, more than 589,000 tons of climate pollution had been displaced. The standard has also helped grow area businesses like SeQuential in Portland, Oregon, which converts used cooking oil into biodiesel.

Also in my district in northwest Oregon, Summit Foods, they make delicious apple chips and they sell dried blueberries to places like Panera. Then, they use the food waste to make a fuel called Thunderbolt that they sell to racecar drivers. Companies in the region give their food waste to Summit, and they convert it into fuel. All of the products would otherwise go into the landfill.

Racecar and race boat drivers love this fuel. They get 30 to 50 percent more horsepower. One customer said he was never able to get his race boat to go over 200 miles an hour, but with Thunderbolt he can. And traditional petroleum race fuel costs $10-$20 a gallon, and Thunderbolt is about half of that. Racecar drivers are proud to purchase a product made in Oregon that's great for their cars and great for the environment.

And as I've said in the past, 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. The development of first-generation and advanced biofuels, whether through market innovation or federally funded research or both can help us achieve these goals and should be encouraged by this Committee.

I look forward to the discussion today about how both federal research and private sector innovation are helping our country move forward in the development of biofuels.

With that, I yield back the balance of my time. Thank you, Mr. Chairman.

[The prepared statement of Ms. Bonamici follows:]

OPENING STATEMENT
Ranking Member Suzanne Bonamici (D-OR)
of the Subcommittee on Environment

House Committee on Science, Space, and Technology
Subcommittee on Environment
Subcommittee on Energy
"Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation"
July 25, 2017

Thank you, Mr. Chairman. And welcome to our witnesses.

Our country's dependence on crude oil to fulfill our transportation needs is problematic in at least a few ways. It's made us subject to the boom and bust cycles of the volatile oil market. And it's the reason why, according to the EPA, the transportation sector accounts for about 27 percent of our country's greenhouse gas emissions. Those are excellent reasons why it's crucial for us to develop and use fuels that will reduce our carbon footprint while still reliably meeting our transportation needs.

The renewable fuel standard was passed in 2005 to diversify our energy portfolio and reduce our reliance on the unstable international fossil fuel market. Policies such as the RFS have multiple goals in addition to reducing our overreliance on crude oil. They include providing more sustainable sources of energy, reducing carbon emissions, encouraging rural economic growth, and bringing new job opportunities to our districts.

We will likely hear from some witnesses today that policies like the RFS have failed. The evidence, however, points to the contrary.

Federal policies such as the RFS have grown our economy. By providing market certainty for biofuels, it has allowed the private sector to continue to innovate and expand the renewable fuel industry, with the Renewable Fuels Association finding that ethanol supported more than 74,000 direct jobs in renewable fuel production and agriculture in 2016.

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I look forward to the discussion about how both federal research and private sector innovation are helping our country move forward in the development of biofuels. With that I yield back the balance of my time.

Chairman BIGGS. Thank you, Ms. Bonamici.

I now recognize the Chairman of the Subcommittee on Energy, Mr. Weber, for his opening statement.

Mr. WEBER. Thank you, Chairman.

Good morning and welcome to today's joint Environment and Energy Subcommittee hearing examining federal support for biofuels. Today, we will hear from witnesses on the cost and environmental impact of federal mandates and subsidies for biofuels production and their impact on the fuels market. We will also hear about the exciting basic and early stage research happening at our national labs that can provide the foundation for development of new, more efficient, advanced biofuels and bioproducts.

As we've heard before, the federal government is a poor substitute for the market when it comes to picking the most effective energy sources and technologies. I would add the federal government seems to pick more losers than winners. Federal subsidies, grants, loans, and loan guarantees may prop up an industry or give it a competitive advantage, but they can't and do not drive innovation. The biofuels industry provides a cautionary example of this misplaced government investment.

Unfortunately, the federal government hasn't accomplished much more than require the use of conventional biofuels that were already available in the commercial market. Did I mention the federal government picks more losers than winners it seems? Congress started with worthy goals, enacting mandates and authorizing subsidies with the hope of achieving energy independence and improving the environment. But as we will hear from our witnesses today, conventional biofuels cost the taxpayers money through the cost of federal subsidies and grant programs and don't actually benefit the environment.

The federal government has an important role to play in energy innovation but an abysmal track record on picking winners when we try to commercialize technology. It is clear that the best value for the taxpayer in scientific discoveries, new technology, and developing the next generation of science is found in basic and early-stage research. Industry can build on these early-stage research discoveries and use research infrastructure to create market-ready, next-generation energy technologies.

We can see this nexus between basic research and potential commercial technology in the Department of Energy Bioenergy Research Centers, or BRCs. Funded through the DOE Office of Science, these centers conduct basic research in genomic sciences and microbial systems biology to advance energy-relevant systems biology. Researchers at these BRCs provide foundational science to industry partners, who then can develop new products and biofuels based on their discoveries.

Along with three other centers around the country, the BRC at Oak Ridge National Lab—led by Dr. Paul Gilna, who joins our panel today—focuses on cutting-edge research to gain access to sugars in plants that do not compete with food crops. In a year where the Administration and Congress are making tough choices about DOE's funding, the bioenergy research centers were recently re-charted—re-chartered for five years by Secretary Perry, with $40

million in funding awarded in fiscal year 2018 to continue this basic research.

Dr. Gilna, thank you for joining us today, and we look forward to hearing about your important research.

By getting the government out of the way and allowing the market to determine the best approach, we can facilitate private industry's efforts to develop technology that will increase energy efficiency, reduce environmental impact, and actually save the American people money.

I want to thank our witnesses for testifying today, and I look forward to a discussion about the consequences caused by the federal government's intervention in the American energy market. Congress has the opportunity to fix these problems caused by government overreach and should advance legislation to repeal existing mandates and roll back expensive subsidy programs. This will allow us to invest in basic science research that will lead to real innovation in our energy supply.

Mr. Chairman, I yield back.

[The prepared statement of Mr. Weber follows:]

COMMITTEE ON
SCIENCE, SPACE, & TECHNOLOGY
Lamar Smith, Chairman

For Immediate Release
July 25, 2017

Media Contact: Kristina Baum
(202) 225-6371

Statement of Chairman Randy Weber (R-Texas)
Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation

Chairman Weber: Good morning and welcome to today's Joint Environment and Energy Subcommittee hearing examining federal support for biofuels.

Today, we will hear from witnesses on the cost and environmental impact of federal mandates and subsidies for biofuels production and their impact on the fuels market. We will also hear about the exciting basic and early stage research happening at our national labs that can provide the foundation for development of new, more efficient, advanced biofuels and bio-products.

As we've heard before, the federal government is a poor substitute for the market when it comes to picking the most effective energy sources and technologies.

Federal subsidies, grants, loans, and loan guarantees may prop up an industry, or give it a competitive advantage - but they can't and don't drive innovation.

The biofuels industry provides a cautionary example of this misplaced government investment. Unfortunately, the federal government hasn't accomplished much more than require the use of conventional biofuels that were already available in the commercial market.

Congress started with worthy goals, enacting mandates and authorizing subsidies with the hope of achieving energy independence and improving the environment. But as we'll hear from our witnesses today, conventional biofuels cost the taxpayers money through the cost of federal subsidies and grant programs, and they don't actually benefit the environment.

The federal government has an important role in energy innovation, but an abysmal track record on picking winners when we try to commercialize technology.

It's clear that the best value for the taxpayer in scientific discoveries, new technology, and developing the next generation of scientists is found in basic and early stage research. Industry can build on these early stage research discoveries, and use research infrastructure to create market-ready, next generation energy technologies.

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Congress has the opportunity to fix the problems caused by government overreach, and should advance legislation to repeal existing mandates and roll back expensive subsidy programs. This will allow us to invest in basic science research that will lead to real innovation in our energy supply.

###

Chairman BIGGS. Thank you, Mr. Weber.

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

Mr. VEASEY. Thank you, Mr. Chairman, for holding this hearing and thank you for the witnesses for taking the time to be here today.

Biofuels play an important role in diversifying our transportation fuel. They are produced right here in the United States, and they provide a much safer source of octane for our fuels than MTBE. By replacing MTBE, biofuels help prevent harmful contaminants from reaching our drinking water and soil.

The growth of conventional biofuels has helped launch the advanced biofuels industry, which has the potential to provide significant environmental benefits to supply our transportation fuels. However, I'm not suggesting there are no potential drawbacks to take into account. As we set our national biofuels policy, we should continue to consider the concerns regarding land use, potential degradation of certain engines, legacy fleets, recreational boaters, and a variety of different fuel types. We should accurately weigh these factors right alongside the benefits we receive in emissions reductions, energy security, fuel diversification, and economic growth. And it is my hope that we will hear a practical assessment of biofuels that accurately weighs these costs and benefits from today's panelists.

However, I do want to caution, as oftentimes when we talk about anything that's energy-related, including renewable fuel standards, are DOE's bioenergy research programs. That conversation unfortunately tends to turn to partisan ideology, and it's an ideology that would have us decimate our research enterprise as we have seen proposed in both the Trump budget and the Heritage Foundation's "blueprints." Abandoning our investments in innovation and emerging markets is not a recipe for economic growth. What it is, though, is a path to make the United States less competitive and less attractive for further business investments.

The other criticism of biofuels that we will hear today is a scientific one, and one that we should all welcome. Dr. DeCicco will inform us of his concerns with how we account for lifecycle emissions of corn ethanol. The debate is continuing to play out, and as policymakers, I think it's our responsibility to listen and do our best to follow the guidelines of the scientific consensus when legislating. This applies to something as broad as climate change or as narrow as emissions modeling for biofuels. And while I look forward to hearing and considering the scientific dissent offered during this hearing, it does not mean we should throw out the work of the collection that these scientists have amassed at these national labs and universities. I hope that we can hear from other scientists in the future that may provide additional perspectives on this issue.

On that note, I am very proud to offer my strong support to DOE's scientists, including those at the national laboratories and universities across the country. They are doing valuable work that has empowered researchers in the public and private sector to make the United States the leader in bioenergy research. I am sure

that we will also hear from Dr. Gilna from Oak Ridge on that very issue.

As we consider an appropriations bill this week that would provide funding for DOE, I strongly encourage my colleagues to stand against any attempts to cut vital research at the Department. If the House bill were signed into law as-is, the bioenergy research centers would receive a severe cut. The private sector will not be able to continue the research that has been left undone because the federal government cuts them. If we want to maintain U.S. leadership in this field, we need to advocate for consistent and robust R&D funding.

I will also look forward to hearing from Ms. Skor about where she sees the future of this industry and how we can accelerate the path to utilizing next-generation biofuels. As I am also sure that we're going to hear today, the market for transportation fuels is very competitive, but it is far free from an actual—but it's far from an actual free market. There are lots of barriers, hidden subsidies that the energy industry has enjoyed for many, many years and decades. And with that said, I'm glad to see that the U.S. biofuels industry is vibrant today, and I look forward to continuing to expand consumer choice across the transportation sector.

And, Mr. Chairman, I yield back the balance of my time.

[The prepared statement of Mr. Veasey follows:]

OPENING STATEMENT
Ranking Member Marc Veasey (D-TX)
of the Subcommittee on Energy

House Committee on Science, Space, and Technology
Subcommittee on Environment
Subcommittee on Energy
"Examining Advancements in Biofuels: Balancing Federal Research and Market Innovation"
July 25, 2017

Thank you, Mr. Chairman, for holding this hearing and thank you to the witnesses for being here today. Biofuels play an important role in diversifying our transportation fuel. They are produced right here in the United States and they provide a much safer source of octane for our fuels than MTBE. By replacing MTBE, biofuels help prevent harmful contaminants from reaching our drinking water and soil.

The growth of conventional biofuels, or corn ethanol, has helped launch the advanced biofuels industry, which has the potential to provide significant environmental benefits to our supply of transportation fuels. However, I am not suggesting that there are no potential drawbacks to take into account. As we set our national biofuels policy, we should continue to consider the concerns regarding land use change, potential degradation of certain engines, legacy fleets, recreational boaters, and access to a variety of fuel types. We should accurately weigh these factors right alongside the benefits that we receive in emissions reductions, energy security, fuel diversification, and economic growth. It is my hope that we will hear a practical assessment of biofuels that accurately weighs these costs and benefits from today's panelists.

However, I want to alert you all that we will hear ideological attacks on the Renewable Fuel Standard and even on the role of DOE's bioenergy research programs. These attacks are not based on rigorous analyses or thoughtful critiques. This is pure partisan ideology – an ideology that would have us decimate our research enterprise as we have seen proposed in both the Trump budget and the Heritage Foundation's "blueprints." Abandoning our investments in innovation and emerging markets is not a recipe for economic growth. It is a path to make the U.S. less competitive and less attractive for further business investments.

The other criticism of biofuels that we will hear today is a scientific one, and one that we should all welcome. Dr. DeCicco will inform us of his concerns with how we account for life-cycle emissions of corn ethanol. The scientific debate on this is continuing to play out. As policy-makers, I think it is our responsibility to listen and do our best to follow the guidance of the scientific consensus when legislating. That applies to as broad as climate change or as narrow as emissions modeling of biofuels. While I look forward to hearing and considering the scientific dissent offered during this hearing, it does not mean we should throw out the work of the collection of scientists at our national labs and universities. I hope we can hear from other scientists in the future that may provide additional perspectives on this issue.

On that note, I am proud to offer my strong support to DOE's scientists, including those at the national laboratories and universities across the country. They are doing valuable work that has empowered researchers in the public and private sector to make the U.S. the leader in bioenergy research. I am sure we will hear more from Dr. Gilna from Oak Ridge on that very issue.

As we consider an appropriations bill this week that would provide funding for DOE, I strongly encourage my colleagues to stand against any attempts to cut vital research at the Department. If the House bill were signed into law as is, the bioenergy research centers would receive a severe cut. The private sector will not be able to continue the research that has been left undone because the federal government cuts them. If we want to maintain U.S. leadership in this field, we need to advocate for consistent and robust R&D funding.

I look forward to hearing from Ms. Skor about where she sees the future of this industry and how we can accelerate the path to utilizing next generation biofuels. As I am sure we will hear from her testimony, the market for transportation fuels is incredibly competitive, but it is far from an actual free market. It has numerous barriers to entry and hidden subsidies that those in the energy industry have enjoyed for the past century.

With that said, I am glad to see the U.S. biofuels industry is vibrant today and I look forward to continuing to expand consumer choice across the transportation sector.

Thank you, Mr. Chairman. I yield back.

Chairman BIGGS. Thank you, Mr. Veasey.

I now recognize the Ranking Member of the Full Committee for a statement.

Ms. JOHNSON. Thank you very much, Mr. Chairman. And let me acknowledge and thank the leadership of both of these Subcommittees, as well as welcoming our witnesses today.

The issue we are discussing this morning is not cut and dry. As we have already heard on more than one occasion, some are willing to forgo almost any government role in promoting the development and use of renewable fuels, ignoring the progress we have made to date. This progress would not have been possible without the substantial investment and innovations made in first-generation biofuels, investments and innovations largely driven by the renewable fuel standard. While I agree that there are challenges associated with 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, it appears that many of the technical challenges have been addressed. Now, we must focus our attention on making these cleaner fuels more cost-effective and integrating them into the market. This is precisely the role of the RFS, as well as of the biofuels research supported by the Department of Energy.

Unfortunately, this Administration is proposing to drastically cut our investments area. If the proposed budget were enacted, the DOE Office of Science's Bioenergy Research Centers would each see their annual budget cut by 60 percent and the Bioenergy Technology Office would be cut by 72 percent. All of this has been proposed with little justification provided beyond a vague declaration that the Department is shifting its focus to early-stage research. I hope the Department will reconsider these cuts in light of testimony we received just last week from an excellent panel of witnesses who made clear that there is no clear-cut divide between the so-called basic and applied research. That panel also indicated that we need to be making investments across the innovation spectrum if our nation is ultimately going to remain competitive in these growing industries.

While I understand that there is not yet a scientific consensus on his findings with regard to emissions from biofuels, I am happy to see that the majority invited a witness to today's hearing who is focused on addressing the urgent challenge of climate change. I hope Dr. DeCicco also can not only provide his insights on our nation's biofuels policy but also can convince my colleagues to spend more time and effort on addressing what may well be the biggest long-term problem facing the world.

In closing, while there may be differing views on how best to guide our nation's biofuels policies, it is clear to me that DOE-supported research and the RFS are important tools for reducing our dependence on fossil fuels, reducing our nation's greenhouse gas emissions, and encouraging innovation that is leading to the development of advanced, more sustainable alternative fuels. I hope that today's hearing is not the end of our discussions on this matter.

I thank you and yield back.
[The prepared statement of Ms. Johnson follows:]

OPENING STATEMENT
Ranking Member Eddie Bernice Johnson (D-TX)

House Committee on Science, Space and Technology
Subcommittee on Environment
Subcommittee on Energy
"Examining Advancements in Biofuels:
Balancing Federal Research and Market Innovation"
July 25, 2017

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

The issue we are discussing this morning is not cut and dry. As we have already heard on more than one occasion, some are willing to forgo almost any government role in promoting the development and use of renewable fuels, ignoring the progress we have made to date. This progress would not have been possible without the substantial investments and innovations made in first-generation biofuels – investments and innovations largely driven by the Renewable Fuel Standard. While I agree that 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, it appears that many of the technical challenges have been addressed. Now we must focus our attention on making these cleaner fuels more cost effective and integrating them into the market. This is precisely the role of the RFS as well as of the biofuels research supported by the Department of Energy.

Unfortunately, the Trump Administration is proposing to drastically cut our investments area. If the proposed budget were enacted, the DOE Office of Science's Bioenergy Research Centers would each see their annual budget cut by 60%, and the Bioenergy Technology Office would be cut by 72%. All of this has been proposed with little justification provided beyond a vague declaration that the Department is shifting its focus to "early-stage" research. I hope that the Department will reconsider these cuts in light of testimony we received just last week from an excellent panel of witnesses who made clear that there is no clear divide between so-called "basic" and "applied" research. That panel also indicated that we need to be making investments across the innovation spectrum if our nation is ultimately going to remain competitive in these growing industries.

While I understand that there is not yet a scientific consensus on his findings with regard to emissions from biofuels, I am happy to see that the Majority invited a witness to today's hearing who is focused on addressing the urgent challenge of climate change. I hope Dr. DeCicco can not only provide his insights on our nation's biofuels policy, but also can convince my colleagues to spend more time and effort on addressing what may well be the biggest long-term problem facing the world.

In closing, while there may be differing views on how best to guide our nation's biofuels policies, it is clear to me that DOE-supported research and the RFS are important tools for reducing our dependence on fossil fuels, reducing our nation's greenhouse gas emissions, and encouraging innovation that is leading to the development of advanced, more sustainable alternative fuels. I hope that today's hearing is not the end of our discussions on this matter.

With that I yield back.

Chairman BIGGS. Thank you, Ms. Johnson.

I'll now introduce our witnesses. Our first witness today is Dr. Paul Gilna, Director of the BioEnergy Science Center, and Deputy Division Director of Biosciences at Oak Ridge National Laboratory. Dr. Gilna received his bachelor's degree in pharmacology and biochemistry, as well as his Ph.D. in pharmacology from the University—from University College Dublin.

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

Our next witness is Ms. Emily Skor, CEO of Growth Energy. Ms. Skor received her bachelor's degree in political science from Wellesley College.

Our last witness is Mr. Nicolas Loris, Herbert and Joyce Morgan Research Fellow at the Institute for Economic Freedom and Opportunity at the Heritage Foundation. Mr. Loris received his bachelor's degree in economics, finance, and political science from Albright College and his master's degree in economics from George Mason University.

And so I now recognize Dr. Gilna for five minutes to present your testimony.

TESTIMONY OF DR. PAUL GILNA, DIRECTOR, BIOENERGY SCIENCE CENTER (BESC) AND DEPUTY-DIVISION DIRECTOR OF BIOSCIENCES, OAK RIDGE NATIONAL LABORATORY

Dr. GILNA. Chairman Biggs, Chairman Weber, Ranking Members Johnson, Bonamici, and Veasey, and Members of the Subcommittees, thank you for the opportunity to appear before you today with this distinguished panel.

I am Paul Gilna, Director of the BioEnergy Science Center at the United States Department of Energy's Oak Ridge National Laboratory.

The Department of Energy has a long and successful history supporting the biological and environmental research tracing back to the Manhattan Project when scientists sought to understand the impacts of radiation fallout and the byproducts of nuclear energy production on human health and the environment. Research originating from this mission has played a central role in advancing our understanding of the structure and function of DNA and in 1986 prompted DOE to initiate the Human Genome Project, which has become the foundation of modern-day genomic research and a critical factor in the formation and growth of the biotechnology industry.

In 2007, DOE, through its Office of Biology and Environmental Research, established three bioenergy research centers, or BRCs, to address the scientific challenges of bottlenecks associated with achieving the cost-effective sustainable commercial production of fuels from cellulosic biomass. To help understand the problem, envision if you would a field of corn used for conventional biofuel pro-

duction where only the kernels are used to extract the starch or sugars that are fermented into fuel. Realize, then, that approximately 75 percent more sugar again can be obtained by utilizing the remainder of the plants, whether that be the stalks, leaves, and even leftover cobs, saving the kernels for food. The challenge has been to develop methods to cost-effectively extract those sugars deeply entrapped in the cell wall structures of any nonfood crops that we would seek to use.

The BRCs have consisted of multidisciplinary teams involving many national lab, university, and industry partners. Together, these three centers represent the work of more than 1,000 scientists at partners located in 19 States.

Over the past ten years, through the initial phase of the bioenergy research center program, we have created multiple fuel production breakthroughs. The three original centers led by the University of Wisconsin Madison, in partnership with Michigan State University, Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory have helped deepen the understanding of sustainable agricultural practices, have instituted the major reengineering of plant feedstocks, develop new methods for deconstructing those feedstocks, and have reengineered microbes for more effective fuel production.

In all, the BRCs have produced over 600 invention disclosures, which has led to 378 patent applications and over 90 patents issued to date. This intellectual property has attracted 191 licenses or options, and the centers' scientific productivity has resulted in over 2,600 peer-reviewed publications over the past decade. Thus, the BRCs of openly transferred their knowledge and data to the scientific community, and through their intellectual property activities, they have transferred substantial insight and expertise that is being translated into applications by industry.

To continue and expand this groundbreaking research following extensive peer review, DOE recently announced the establishment of four new bioenergy research centers beginning in fiscal year 2018. The four centers include two new centers led by Oak Ridge and the University of Illinois, along with the Wisconsin and California centers. These BRCs will follow on the successes of the original centers and lay the scientific groundwork for a renewed biobased economy that promises to yield a range of important new products and advanced fuels, those beyond ethanol, directly from nonfood biomass. The multi-institutional centers include research partners now stretching across 25 States.

An important example of what could be achieved in this next phase comes from research that will open up the potential for using lignin, until now, largely a waste product from the biomass pretreatment in the current cellulosic process. At Oak Ridge we have demonstrated that lignin can be converted directly into carbon fiber, which could then be used in applications such as lighter components to help make automobiles or aircraft more efficient. Thus, the new industry takes shape where many rural bio refineries analogous to oil refineries produce numerous value-added bioproducts, presenting new renewable options to chemical companies currently reliant on petrochemical sources.

In closing, the body of research from the last ten years, which, while originally motivated by biofuels policy and more specifically by the promise of cellulosic ethanol, has created value and based on that is now poised to head in the direction of developing value-added products from cellulosic biomass, products that could be easier to make or better than the same coming from petrochemicals. Ten years ago, we did not have enough scientific knowledge to do this. We do now, and this could not have happened without that initial investment in research.

Thank you again for the opportunity to provide this briefing. I welcome your questions on this important topic.

[The prepared statement of Dr. Gilna follows:]

Examining Advancements in Biofuels Research:
Progress and New Directions for the Department of Energy
Bioenergy Research Centers

Statement of Paul Gilna
Director, BioEnergy Science Center
Oak Ridge National Laboratory

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

July 25, 2017

Chairman Biggs, Chairman Weber, Ranking Member Bonamici, Ranking Member Veasey, and Members of the Committees: Thank you for the opportunity to appear before you today. My name is Paul Gilna, and I am the Director of the BioEnergy Science Center (BESC) at the U.S. Department of Energy's Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. It is an honor to provide this briefing today on the fundamental research in biofuels technology and the impact of federal research.

INTRODUCTION

ORNL is the Department of Energy's largest and most diverse science and energy laboratory. Our mission at ORNL is to deliver scientific discoveries and technological breakthroughs that will accelerate the research and development in solutions for clean energy and global security, thus creating economic opportunity for the nation. Our signature strengths in materials science and engineering, neutron science, nuclear science and engineering, and high-performance computing—the product of decades of investment by the nation—underpin an exceptionally broad set of core capabilities for delivering scientific leadership and discovery to address the Department's energy, environmental, and national security missions.

The Department of Energy (DOE) is the nation's only federal agency focused uniquely on energy-related research and development for clean energy innovation, nuclear security, and environmental stewardship of the nuclear weapons complex. DOE's history of providing the basic underpinnings for modern scientific breakthroughs has enabled important advances, from the advancement of nuclear energy for electricity, to the fracturing of shale for low-cost, reliable energy, to the sequencing of the human genome as a foundation for biotechnology.

DOE's Office of Science is the nation's largest funder of the physical sciences. Through its stewardship, science tools such as supercomputers and accelerators have become essential to explore materials and processes at the molecular level and to advance basic scientific understanding that can enable breakthrough technologies. The national laboratory system was

specifically designed for such research, and its capabilities are available to all who want to develop and scale basic science advances to the industrial level.

DOE's Office of Biological and Environmental Research

The Biological and Environmental Research (BER) programs within DOE's Office of Science support fundamental research to predict, manage, and control biological systems to support mission needs in bioenergy production, environmental remediation and stewardship, and understanding the environment. The operation of its unique scientific user facilities is critical to driving innovations in these areas for a secure energy future.

DOE has a long history of success in advancing biological and environmental research.

- The origins of this research trace back to the mission of DOE's predecessor agency, the Atomic Energy Commission.
- The advent of the Manhattan Project spurred scientists to understand the impacts of radiation fallout and byproducts of nuclear energy production on human health and the environment.
- Research originating from this mission has played a central role in advancing our understanding of the structure and function of DNA, and in 1986 prompted DOE to initiate the Human Genome Project which has become the foundation of genomic research including a host of practical applications in medical research, the biotechnology industry, and in the areas of agriculture and environmental protection.
- Acquired over decades, this historical knowledge and expertise is stewarded by the DOE Office of Biological and Environmental Research, and informs world-leading energy and earth systems research that it continues to support today.

THE U.S. ROLE IN LEADING BIOFUELS-RELEVANT FUNDAMENTAL RESEARCH

Bioenergy Research Centers

In 2007 during the Bush Administration, DOE-BER established three Bioenergy Research Centers (BRCs) to address the scientific challenges associated with achieving the cost-effective, sustainable, commercial production of fuels from cellulosic biomass—the fibrous woody and generally inedible portions of plant matter. A critical driver for the creation of these centers came from the findings of a DOE sponsored workshop that led to the report "Breaking the Biological Barriers to Cellulosic Ethanol." The report summarized that "key to energizing a new biofuel industry based on conversion of cellulose… is to understand plant cell-wall chemical and physical structures—how they are synthesized and can be deconstructed. With this knowledge, innovative energy crops—plants specifically designed for industrial processing to biofuel—can be developed concurrently with new biology-based treatment and conversion methods."

The BRCs were intended to leverage revolutionary breakthroughs in modern biological science, including those supported by the Genomic Science Program within BER. Each center sought to address a major, distinct bioenergy challenge:

- **BioEnergy Science Center** (BESC; Oak Ridge, Tennessee): to develop better understanding of how to modify plant cell wall components to facilitate deconstruction and conversion of biomass into biofuels by engineered highly-efficient microbes for advanced bioprocessing.
- **Great Lakes Bioenergy Research Center** (GLBRC; Madison, Wisconsin; Lansing, Michigan): to increase the energy density of grasses by understanding and manipulating the metabolic and genetic circuits that control the accumulation of easily digestible, energy-rich compounds in plant tissues.
- **Joint BioEnergy Institute** (JBEI; Emeryville, California): to apply synthetic biology to engineer microbes that convert sugars into advanced biofuels, and engineer plants that overproduce preferred polysaccharides.

The BRCs consisted of multidisciplinary teams involving many national lab, university, and industry partners. Together, these three centers represented the work of more than 1,000 scientists at partners located in 19 states.

PROGRESS FOR IMPROVED PRODUCTION OF CELLULOSIC BIOFUELS

The Bioenergy Research Centers have made significant progress in their goal to understand the fundamental science of cellulosic ethanol production as part of the three strategy areas. This same understanding has provided the foundation for the future development and production of advanced biofuels, and other, high-value, bio-based products.

1. *Develop next-generation bioenergy crops by unraveling the biology of plant development*
   In pursuit of better biomass crops, the BRCs have examined plant cell wall structure and biosynthesis at the molecular level to better understand recalcitrance, or the natural resistance of plants to being broken down for fermentation. It is a key economic barrier, adding cost and decreasing energy yield. Scientists have used genetic engineering to select favorable variants that result in lower recalcitrance and improved biomass characteristics.

2. *Discover and design enzymes and microbes with novel biomass-degrading capabilities*
   The BRCs have developed the most promising microbes, enzymes, and solvents for breaking down biomass into usable compounds such as sugars and conversion, leveraging their expertise in genetics, biochemistry, and other disciplines to select the best traits from other organisms and engineer them into commercially robust organisms. These microbes, enzymes, and solvents seek to lower the use of costly pretreatments and chemicals used in current biorefining.

3. *Develop transformational microbe-mediated strategies for advanced biofuels production*
   BRC researchers have developed a combination of methods and microbes to best produce biofuels. Advances have been made in engineering microbes to more efficiently convert plant biomass into biofuels. These breakthroughs result in a less costly process for converting plants into useful products.

The **BioEnergy Science Center (BESC)** led by ORNL, has made crucial progress toward understanding, manipulating, and managing plant cell wall recalcitrance and conversion. Notably, the BESC team has proven that multiple genes control plant cell wall recalcitrance and furthermore, that manipulation of these genes has the potential to yield perennial bioenergy feedstocks with enhanced deconstruction properties—that is, that the sugars entrapped in the cell wall structures can be released more efficiently. Further, BESC has successfully demonstrated the ability to combine the processes of cellulose digestion and fermentation of released sugars into biofuel in a single microbial organism. These discoveries represent significant progress toward the goal of developing improved feedstocks and microbial deconstruction methodologies for advanced biofuel production.

> At BESC, to improve bioenergy feedstocks, ORNL and its partners have built upon the work done to sequence the genome of *Populus*—a fast-growing perennial tree recognized for its potential in biofuels production—and have conducted the largest-ever study of natural diversity in these poplar trees. These achievements allow scientists to better find and select desirable traits like drought tolerance and lower resistance to processing. This work has led to the licensing of a number of genes that will be used by industry in the development of more easily digestible animal feed and biofuel feedstocks.

The **Great Lakes Bioenergy Research Center (GLBRC)** led by the University of Wisconsin and Michigan State University, has established a fundamental understanding of nitrogen and carbon cycling in the field, which is essential for creating sustainable biofuel landscapes. In the lab, GLBRC has pursued economic sustainability via biological and chemical routes to low-cost sugars. More recently, researchers have developed unique pretreatment methods that release lignin for potential conversion to fuel precursors and value-added co-products. Producing fuels and chemicals from both the sugar and lignin components of plant biomass offers added value and increases the profitability of cellulosic biofuels.

> As an example, to improve biomass conversion, GLBRC scientists modified the lignin biosynthetic pathway to enable design of plant cell walls that are easier and cheaper to convert into fuels and chemicals. In addition, they have shown how marginal lands can provide significant cellulosic biomass, along with substantial environmental benefits, allowing fertile lands to be reserved for food production.

The **Joint BioEnergy Institute (JBEI)** led by Lawrence Berkeley National Laboratory, has used the latest tools in molecular biology and chemical engineering, including computational and robotic technologies, to transform biomass sugars into energy-rich fuels. JBEI has successfully altered biomass composition in model plants and crops, reducing inhibitors that impact downstream processing and making lignin more readily converted into useful chemicals. JBEI research has shown that new solvents, such as ionic liquids, permit near-complete dissolution of plant biomass, thereby facilitating its enzymatic conversion to sugars. JBEI's pioneering work in synthetic biology has enabled microbes to produce a variety of molecules from these sugars that can serve as jet, diesel, and gasoline blendstocks.

> JBEI scientists, for example, to improve biosynthesis of new fuels, have worked on three biosynthetic pathways to produce drop-in fuel chemicals. Fatty acid biosynthetic pathways have been engineered to produce long hydrocarbon chains that can be utilized as diesel and jet fuels as well as surfactants and lubricants. The team has also engineered new biosynthetic pathways into microbes to digest pretreated biomass and to use the liberated sugars to produce a jet fuel precursor chemical.

In all, the three BRCs have produced 607 invention disclosures, 378 patent applications, 191 licenses or options, and 92 patents over the past decade, as well as 2,630 peer-reviewed publications. Thus, the centers have openly transferred their knowledge and data to the scientific community, and through their intellectual property activities have transferred substantial insight and expertise that is being translated into applications by the commercial biofuels industry.

MOVING TOWARD BIOPRODUCTS FROM BIOMASS: THE NEXT GENERATION OF BIOENERGY RESEARCH CENTERS

DOE-BER has recently announced the establishment of four new centers in order to build upon the underlying knowledge provided by the BRCs and to lay the scientific groundwork for a new robust bio-based economy. They will be focused on a new generation of sustainable bioproducts from non-food biomass—chemicals that can be made from plants that would otherwise come from petroleum refining. In addition, the centers will pursue the development of cost-effective specialty biofuels, i.e. advanced biofuels beyond ethanol that can serve as replacements to conventional petroleum and that can utilize the existing infrastructure.

The multi-institutional centers include research partners stretching across 25 states: Alabama, California, Colorado, Florida, Georgia, Idaho, Illinois, Iowa, Louisiana, Massachusetts, Michigan, Mississippi, Nebraska, New Hampshire, New Jersey, New Mexico, New York, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Washington, West Virginia, and Wisconsin.

Center for Bioenergy Innovation (CBI), led by ORNL

The vision for CBI is to accelerate domestication of bioenergy-relevant plants and microbes to enable high-impact, value-added co-product development at multiple points in the bioenergy supply chain. Conceived to foster a legacy of fundamental scientific understanding, enabling capabilities, and transformative innovations, CBI has identified research targets to overcome key barriers for a robust bioeconomy in (1) high-yielding, robust feedstocks, (2) lower capital and processing costs via consolidated bioprocessing to specialty biofuels, and (3) methods to create valuable byproducts from lignin residues.

Great Lakes Bioenergy Research Center (GLBRC), led by the University of Wisconsin-Madison and Michigan State University

Developing sustainable ways to produce the transportation fuels and products that are currently derived from petroleum is among society's greatest challenges. GLBRC envisions a future in which specialty biofuels and bioproducts derived from dedicated bioenergy crops can provide alternatives to those produced today. This approach will provide substantial environmental benefits and expanded economic opportunities for biofuel refiners, farmers, and communities. GLBRC will help realize this vision through research to address identified knowledge gaps in the production of specialty biofuels and bioproducts from dedicated bioenergy crops that are grown specifically on marginal, non-agricultural, lands.

Joint BioEnergy Institute (JBEI), led by DOE's Lawrence Berkeley National Laboratory

The vision of JBEI's follow-on phase is that bioenergy crops can be converted into economically viable, carbon-neutral biofuels and renewable chemicals currently derived from petroleum, and many other bioproducts that cannot be efficiently produced from petroleum. Providing a new source of domestic energy and feedstock chemicals from U.S. crops would further expand and diversify the US energy portfolio. JBEI's mission is to establish the scientific knowledge and new technologies in feedstock development, deconstruction and separation, and conversion needed to transform the maximum amount of carbon available in bioenergy crops into biofuels and bioproducts. When fully scaled, JBEI's technologies will enable the production of replacements for petroleum-derived gasoline, diesel, jet fuel, and bioproducts.

Center for Advanced Bioenergy and Bioproducts Innovation (CABBI), led by the University of Illinois at Urbana-Champaign

CABBI's vision is founded on the "plants as factories" paradigm, in which biofuels, bioproducts, and foundation molecules for direct application or conversion are synthesized directly in plant stems. CABBI will develop the predictive capability to determine which feedstock combinations, regions and land types, market conditions, and bioproducts have the potential to support diverse and ecologically and economically sustainable displacement energy options. CABBI represents a transformative research model designed to accelerate bioproduct development while retaining the flexibility to assimilate new disruptive technologies — whatever their source.

BIOREFINERIES OF THE FUTURE

In much the same way that petroleum refineries are situated where crude oil is either imported or produced in the United States, biorefineries could one day sit in rural areas, providing vital economic growth and a clean, reliable, supply of fuels and other useful products for the nation.

In this reality, fields and forests of specialty, nonfood crops are planted on underutilized lands—even lands deemed unsuitable for food crops. Farmers grow and harvest the crops, which are transported to nearby biorefineries where workers oversee modern, efficient methods to break down and process 100% of that biomass into bioproducts. There are no leftovers; even residues are converted to valuable specialty chemicals. Pipelines, trucks, and railroads transport biofuels to existing infrastructure where they are either blended with other fuels or distributed for direct use in vehicles and power plants.

Non-fuel bioproducts are likewise shipped to companies eager for new sources of specialty chemicals to meet the demand for high-value downstream products like electronics, polymers, and cosmetics. Robust, domestic production of specialty biochemicals means companies no longer must move overseas to access cheap petroleum-based feedstocks.

At ORNL, we are working to enable this diverse energy future by demonstrating more uses for bioproducts. Already, we have successfully used plant-based material developed at the lab to demonstrate advanced manufacturing using 3D printing of complex structures. For example, we have demonstrated that lignin and other bioderived materials can be converted directly into carbon fiber or its chemical precursors, which could then be used in applications such as lighter components for more fuel-efficient cars and airplanes.

CLOSING REMARKS

Federal leadership in scientific research has resulted in substantial progress toward a better understanding of the fundamentals behind the biofuels production process. That progress will continue with the new generation of BRCs, focused on new bioproducts and advanced biofuels. We have demonstrated that improvements in plants, microbes, and processes can lead to more efficient production of domestic biofuels, further diversifying the nation's portfolio of reliable, clean energy and making possible a new menu of bioproducts.

Currently, the U.S. is the leader in both research, development and deployment of the rural bio-based economy. However, others are accelerating their efforts. Together, we can succeed in bringing the best of our nation's scientific understanding and engineering prowess to bear on deploying the next generation of bioproducts and clean energy technologies for strengthening our economic foundation, U.S. competitiveness, and our way of life.

Thank you again for the opportunity to provide this briefing. I welcome your questions on this important topic.

Paul Gilna, Ph.D.
Director, BioEnergy Sciences Center
Oak Ridge National Laboratory

Tel: (865) 576-0567
gilnap@ornl.gov

Dr. Paul Gilna is the director of the BioEnergy Science Center (BESC) at Oak Ridge National Laboratory. As the BESC Director, Dr. Gilna leads a multi-institutional Department of Energy-funded research organization with 18 partners working together on performing basic and applied science dedicated to improving yields of biofuels by focusing on the fundamental understanding and elimination of biomass recalcitrance. This multidisciplinary research encompasses the biological, chemical, physical, and computational sciences, as well as mathematics and engineering.

Dr. Gilna's career has been spent at the intersection of computation and biology. After receiving his Ph.D. in pharmacology from University College Dublin, Gilna focused his research on the field of molecular biology. Papers summarizing his postdoctoral work on cloning and sequencing of human estrogen and progesterone receptors became the basis of genetic testing for predisposition to breast cancer. Gilna shifted his work to focus on the field of computation biology, taking a position at GenBank, the collection of publicly available gene sequences then managed out of Los Alamos National Laboratory (LANL). At GenBank, Gilna set up computational tools and annotated genetic-sequence databases, and was instrumental in developing the now widely accepted requirement that authors of journal articles submit gene sequences to GenBank in exchange for an accession number printed with the article. Gilna remained with GenBank until it transferred to the National Institutes of Health. He then took a position as a Program Director at the National Science Foundation's Division of Biological Infrastructure, spending two years there before returning to LANL.

Before coming to ORNL and BESC, Gilna was the Executive Director at the Community Cyberinfrastructure for Advanced Marine Microbial Ecology Research and Analysis project (CAMERA), a program funded by the Gordon and Betty Moore Foundation devoted to creating a community data resource focused on enabling microbial ecology research using next generation genomics technologies.

Gilna is a former Director of the Department of Energy's Joint Genome Institute (JGI) operations at LANL, has served in the management role of Group Leader of Genomic Science and Computational Biology at LANL and has also served as Division Director of LANL's Bioscience Division. He has served as editor of the journal DNA Sequence and Genomics, and has served on grant and project review panels for the National Science Foundation (NSF), the Department of Energy (DOE), the Defense Advanced Research Projects Agency (DARPA), the Office of Naval Research as well as a number of international review panels in the European Union. Gilna is currently a member of the Board of Directors of Leidos Biomedical Research, Inc. (formerly SAIC-Frederick, Inc.) and is also a member of the Novo Nordisk Foundation Research Cluster Advisory Panel (ReCAP).

Chairman BIGGS. Thank you, Dr. Gilna.

I now recognize Dr. DeCicco for five minutes to present his testimony.

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

Dr. DECICCO. I wish to thank the Chairs, Ranking Members, and other Members of the Committee and Subcommittees for the opportunity to testify.

The question being addressed today—that of the right balance between fundamental scientific research and government intervention in the marketplace—is crucially important. The focus on biofuels is telling because it involves so many aspects of the question. Indeed, federal biofuels policy provides a morality tale of how things can go wrong when the right balance is not struck.

Before delving into the problems, however, I want to emphasize the importance of maintaining a robust federal investment in research across all fields of study. Funding for science is crucial to maintaining American leadership and fostering innovation that leads to high-quality job growth. Federal support for university research in particular is crucial for training a new generation of Americans to fill those jobs.

To summarize my written submission, here are some key points. First, protecting the climate from a worsening disruption due to excess CO_2 in the atmosphere is now a top challenge for energy research and policy. But the choice of what technologies to deploy must be left to the marketplace, to industries and entrepreneurs who take risks with private money rather than rely on public funds. Policies to address nonmarket concerns such as CO_2 should therefore be technology-neutral and well-informed by independent science.

Moreover, the climate challenge should not be used as an excuse to pick winners through costly demonstration and deployment programs, subsidies, and technology mandates. Federal resources are best leveraged through fundamental R&D and technology-neutral regulation.

Unfortunately, federal biofuels policy has overstepped these bounds. The result is not only wasted tax dollars but excess costs for consumers and harm to the environment. Biofuels are making CO_2 emissions worse, and the renewable fuel standard has been damaging in that regard.

Finally, it's time to face up to the fact that the federal push for advanced biofuels has failed. DOE and other agencies have supported bioenergy research demonstration and deployment for many decades and with billions of dollars. None of the promised cellulosic fuels have become commercially viable, even with subsidies amplified by mandates. In short, it's time to go back to basics on these issues, to revisit biofuel policies that science and economics now show to have been ill-premised.

I realize that my work contradicts many long-standing assumptions about biofuels. Twenty years ago, I accepted the notion that biofuels were inherently carbon neutral, meaning that the CO_2 emitted when they are burned does not count because it's taken

from the air when crops are grown. In reality, however, all CO_2 emissions increase the amount of CO_2 in the atmosphere, regardless of where the carbon comes from. The correct question is whether feedstock production speeds up how quickly CO_2 is removed from the air. That does not happen when productive land is used for biofuels instead of food or even just used for forest to sequester carbon.

Last year, we published research to evaluate what actually happened as the RFS ramped up. We found that ethanol and biodiesel are not carbon-neutral. Their use provided no significant direct CO_2 reduction. Once indirect impacts are considered, it turns out that biofuels have caused higher CO_2 emissions than petroleum fuels.

We do need to address emissions for motor fuel use, along with those from the power sector and other sources, but the best ways to do that are by improving vehicle efficiency, controlling emissions during oil production, and offsetting tailpipe CO_2 emissions through reforestation. If biofuels policy were restricted to basic R&D, we would learn some things that help students build science and technology skills. Those are worthwhile outcomes even if the research does not yield successful products.

Research is risky by nature. Not all of it bears fruit, and that's why the portfolio should be diverse. University research is broadly beneficial in that regard. In contrast to when federal funds are used for subsidies and demonstrations, the funds go a long way when shared with many schools to support students and young scientists.

Thank you again, and I'll look forward to your questions.

[The prepared statement of Dr. DeCicco follows:]

Testimony on

Advancements in Biofuels: Balancing Federal Research and Market Innovation

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

Before the
Subcommittee on Energy and Subcommittee on Environment
Committee on Science, Space and Technology

U.S. House of Representatives
2318 Rayburn House Office Building
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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.

SUMMARY STATEMENT

I wish to thank the chairmen, ranking members and other members of the Committee and Subcommittees for the opportunity to testify.

The question being addressed today, that of the right balance between fundamental scientific research and government intervention in the marketplace, is crucially important. The focus on biofuels is telling because it involves so many aspects of the question. Indeed, federal biofuels policy provides a morality tale of how things go wrong when the right balance is not maintained.

Before delving into the problems, however, I want to emphasize the importance of maintaining a robust federal investment in research across all fields of study. Funding for science is crucial to maintain American leadership and foster the innovation that leads to high-quality job growth. Federal support for university research is especially crucial for training a new generation of Americans who can fill those jobs.

To summarize my written testimony, here are the key points:

1. Protecting the climate from a worsening disruption due to excess CO_2 in the atmosphere is now a top challenge for energy research and policy.
2. The choice of what technologies to deploy must be left to the marketplace, to industries and entrepreneurs who take risks with private money rather than rely on public funds. Policies to address non-market concerns such as CO_2 should therefore be technology neutral and well informed by independent science.
3. The climate challenge should not be an excuse to pick winners through demonstration and deployment programs, subsidies and technology mandates. Federal resources are best leveraged when through fundamental R&D and technology-neutral regulation.
4. Federal biofuels policy has overstepped these bounds. The result is not only wasted tax dollars, but excess costs for consumers and harm to the environment. Biofuels are making CO_2 emissions worse and the Renewable Fuel Standard has been damaging in that regard.
5. The federal push for advanced biofuels has failed. DOE and other agencies have supported bioenergy research, demonstration and deployment for many decades and with billions of dollars. None of the promised cellulosic fuels have become commercially viable, even with subsidies amplified by mandates.

In short, it's time to go back to basics on these issues, to revisit biofuel policies that the science and economics now show to have been ill premised.

I realize that my work contradicts longstanding assumptions about biofuels. Twenty years ago, I accepted the notion that biofuels such as ethanol and biodiesel were inherently carbon neutral, meaning that the CO_2 emitted when they are burned does not count because it is taken from the air when crops grow. In reality, however, all CO_2 emissions increase the amount of CO_2 in the atmosphere regardless of where the carbon comes from. The correct question is whether feedstock production speeds up how quickly CO_2 is removed from the air. That doesn't happen when productive land is used for biofuels instead of food or forests that sequester carbon.

Last year we published research to evaluate what actually happened as the RFS ramped up. We found that ethanol and biodiesel are not carbon neutral and their use provided no significant direct CO_2 reduction. Once indirect impacts are considered, it turns out that biofuels have caused higher CO_2 emissions than petroleum fuels. In short, biofuels are a false cure that is worse than the disease.

We do need to address emissions from motor fuel use along with those from the power plants and other sources. The best ways to do that are improving vehicle efficiency, controlling emissions during oil production and offsetting tailpipe CO_2 through reforestation.

If biofuels policy were restricted to basic R&D, we would learn some things and help students build science and technology skills. Those are worthwhile outcomes even if the research does not yield successful products. Research is risky by nature; not all of it bears fruit and that's why the portfolio should be diverse. University research is broadly beneficial in that regard. In contrast to when they are used for subsidies and demonstration projects, federal funds go a long way when shared with many schools to support students and young scientists.

Thank you again, and I'll look forward to your questions.

INTRODUCTION

Support for biofuels has been part of U.S. energy policy since the 1970s. It has included not only federal funding for biofuel research, development, demonstration and deployment (RD^4) but also subsidies and other programs to foster production of biofuel feedstocks as well as synthesis and production of various biofuels themselves. Although the dominant political support for biofuel programs is tied to the corn and soybean industries, the vision of biomass-based fuels as renewable replacements for petroleum fuels has broad support, including by many environmental organizations. These agribusiness and environmental rationales have been amplified by concerns about energy security, which provides a large part of the general rationale for the non-weapons programs of the U.S. Department of Energy (DOE). Given this triad of public policy support, biofuel programs have enjoyed significant federal funding (though at varying levels) for over 40 years.

The pinnacle of federal policy support for biofuels is the Renewable Fuel Standard. The RFS was originally 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 program was greatly expanded by the Energy Independence and Security Act of 2007 (EISA), which targets a total of 36 billion gallons of renewable fuel by 2022.

EISA also set specific requirements for certain categories of biofuels to meet given thresholds 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 meet a lifecycle GHG intensity ("carbon intensity" or "CI") threshold, specified as being 20% lower than that of baseline 2005 petroleum fuels. Starch-based ethanol (largely from corn) from existing facilities is "grandfathered" by the RFS and faces no LCA-based GHG requirements. Biofuels categorized as "advanced" (the nominal subject of today's hearing) are required to have a CI 50% lower than baseline fuels, a threshold shared by the requirements for certain volumes of biomass-based diesel fuel. The expansive mandate was justified by the promise of cellulosic biofuels, required to achieve a 60% GHG reduction with a Congressional target of 16 billion gallons by 2022. Such proposed fuels include cellulosic ethanol as well as "drop-in," i.e., fully fungible, fuels derived from biomass that can be readily incorporated into existing transportation fuel distribution and use systems. The economical production of such cellulosic biofuels has been the main goal of DOE's longstanding bioenergy research programs, as seen in the Bioenergy Technologies Office (BETO) and its predecessor offices over the years.

In energy policy, a common assumption is that renewable fuels are inherently "carbon neutral," meaning that the CO_2 emitted when they are burned is fully offset by CO_2 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 built into the LCA models used to compare the CI of various fuels. Such is the case for the GREET model[1] developed and maintained by Argonne National Laboratory (ANL) with support from DOE. It is also the case for the LCA models developed to administer the RFS, as seen in EPA's statement that "CO_2 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]

As explained in my testimony here two years ago, such LCA studies grossly overstate the environmental benefits of biofuels and in fact claim GHG reductions even in cases where biofuel production is making net CO_2 emissions worse. That is the finding of my recently published study that took a rigorous look at the CO_2 impacts of the RFS from 2005-2013.[6] Before delving into those issues, however, this testimony emphasizes the high value to the nation of maintaining federal support for fundamental science. Although research priorities should change as knowledge is gained and new problems emerge, the overall level of federal investment needs to be increased and made sustainable for the United States to maintain its global leadership and successfully confront the many challenges, both in the realm of energy and in other arenas, of the decades ahead.

THE IMPORTANCE OF FUNDAMENTAL SCIENTIFIC RESEARCH

Although Federal renewable fuels policy is itself in great need of reform, it remains crucial for the United States to maintain a robust level of investment in fundamental scientific research, not just in energy, but in many fields. Funding for scientific research and higher education is critical for ensuring continued American leadership in innovation, which will in turn foster productivity gains and create new products and services that lead to job growth.

Fundamental R&D is risky by nature, and that is why public investment is needed. The private sector conducts applied research focused on the maintaining a firm's competitive edge for the products and services it markets. A distinction is drawn between competitive research and what is known as "pre-competitive" research, and public R&D funding must remain in the pre-competitive realm. Market competition is itself risky, but it is that very risk -- the risk of losing money -- that is so critical from separating winning innovations from ideas that might good on paper or in the lab but are not good enough to deliver the market returns needed for commercial success. It is for that reason that public funding, which risks tax dollars rather than private dollars, should not be directed to R&D that has an objective of trying to commercialize certain

technologies. Moreover, commercialization efforts are very costly in comparison to basic research. Federal dollars are best focused on generating basic knowledge, monitoring the world around us, and pursuing R&D with long time horizons that industry often views as too risky.

It is basic research, particularly fundamental science -- including physical, biological and social sciences -- and engineering at universities that provides the knowledge base, new ideas and creative problem-solving that is the foundation for solutions to our country's many challenges. Federally supported basic research is crucial for addressing the problems that Americans face in health, in safety, in national security and other areas of concern in addition to energy and the environment. University research, as supported by DOE's Office of Science and often done in partnership with the national laboratories, pays the added dividend of training students and young researchers, which is essential for nurturing a new generation of skilled, science- and tech-savvy Americans who will provide the country with a competitive workforce in the years ahead. It is crucial for building the next generation of scientists and engineers; each year, many thousands of students, including undergraduates as well as graduate students and junior researchers obtain their most important experience through projects funded by federal research grants. It is that training experience that enables them to become sought-after employees needed by the technology-driven industries that enable our economy to grow.

Federal investments in basic research as well as in supporting the research infrastructure at universities and other institutions, provides the nation with capabilities essential for ongoing leadership and levels of deep expertise that would otherwise be unavailable to industry. It is such publicly financed fundamental research that leads to groundbreaking discoveries about the world around us, from levels subatomic through cosmological as well as in life science, earth science and social science. It is also the wellspring for technological innovations that enable private sector achievements and American competitiveness across the range of industries includes those related to energy production and utilization. Public funding for scientific research consistently pays large dividends, with an ongoing return on investment that benefits America's economy, health, environment and national security. A major share of economic growth can be attributed to gains in scientific knowledge and technological progress, much of which would not have occurred without federal investments in university-based research.

All of these general principles for supporting basic research apply to energy. Moreover, energy research is interdisciplinary in nature. Providing consumers with the energy they need in ways that are affordable, reliable and environmentally sound requires ongoing public investment in research not only to develop technologies, but also to monitor the performance of energy systems, to assess their ecological impact, to understand consumer perceptions and to evaluate the economics of the various options. Although I am an engineer by training, my work has always been interdisciplinary because I realize how critical it is to base energy policy on a firm foundation of both physical and social science.

THE CLIMATE PROTECTION CHALLENGE

As times change, so do the priorities for national energy strategy. Such changes happen slowly because the conversation about policy priorities must balance the concerns of diverse segments of the public through a process of discussion and debate of which hearings such as today's are a part. A longstanding tension in U.S. energy policy is the need to balance consumers' desire for energy that is affordable and reliable with industries' need to cover their costs and make a profit. Historically, much of energy policy has centered around fostering production of energy, whether the hydropower, coal, oil and gas that have been the primary sources for many years, the 20th century resource of nuclear power or the now expanding renewable energy technologies that are likely to become increasingly important in the 21st century.

As the nation and its energy demand grew over the past century, the scale of energy use and its side effects generated widespread public concern about its environmental impacts. Unlike the challenges of energy production to meet market demand, environmental concerns are not solved by market forces alone. Their solution requires government intervention to address the inadvertent harms associated with energy utilization as well as other economic activities. Thus, the environmental consideration has created a new dimension of the tension inherent in energy policy, which must now balance consumers' needs for reliable and affordable energy and their desire for a clean and healthy environment with the costs to industry for not only energy production but also environmental protection.

Although policy development always involves difficult and sometimes contentious negotiations, such discussions are part of our country's democratic process. The results include the bipartisan environment legislation of a generation ago which has done so much to clean the nation's air, ensure clean and safe water supplies, minimize public exposure to toxic substances and protect vital habitats. The regulations promulgated to implement these laws has imposed costs on industry that are in turn passed on to consumers in the costs of energy and energy-consuming products. Nevertheless, retrospective evaluations of U.S. environmental policy show that, overall, the public benefits exceed the costs by a wide margin.

The country is in the midst of another difficult debate, this time about whether and how to address global warming and the attendant climatic risks tied to CO_2 emissions. That debate is not the subject of this hearing and neither is climate science my own area of expertise. However, I have accepted the grave threat of climate change since Dr. James Hansen raised the alarm in his Congressional testimony of 1988. That was the year I completed my doctorate in engineering and I was one of the then-young scientists who became motivated to find solutions to the CO_2 problem. Within a few years I narrowed my focus to addressing the transportation sector, examining ways to reduce CO_2 and other greenhouse gas (GHG) emissions from fuel use by motor vehicles. It is through that lens that I evaluate options such as biofuels, which have been

justified by a belief that they will help reduce CO_2 emissions as well as improve energy security and increase income for many farmers and other agricultural firms.

Elevating climate protection as a priority for U.S. energy strategy does not, and need not, mean downplaying the traditional challenge of balancing the needs of the diverse energy consumers with those of energy-related businesses. Moreover, it is all the more reason to harness the power of markets to find solutions to society's problems including climate.

THE PRIMACY OF THE MARKETPLACE

All of the major goods and services enjoyed by the public are mediated by markets. Competition in the marketplace drives innovation that enables producers to gain greater profits even as consumers enjoy lower prices, better products and often a combination of both. This dynamic is and always has been the main determinant of the motor fuels market, much more so than for, say, the provision of electric power which was historically treated as a public service. Proponents of alternative fuels often claim that they need government policy support through subsidies or mandate to bring "more competition" to the fuels market. However, that is really just an excuse to support products that have lower value than hydrocarbon fuels. The reason why alternative fuels -- whether biofuels or other options such as gaseous fuels and electricity -- have not made headway in spite of decades of policy promotion is that they are fundamentally inferior to liquid hydrocarbons for the vast majority of transportation needs.

All of the measurable, large-scale progress made in reducing air pollution from motor vehicles and other forms of transportation has come from improvements in conventional vehicles and fuels. EPA set progressively more stringent standards without picking winners and the automotive and petroleum industries responded with improved engines, more effective emission control systems and cleaner reformulated fuels. The market was not left to its own devices, but neither did the government overstep its role. By setting technology-neutral, performance-based standards, the respective industries were able to innovate in ways that were least costly and most effective. Different firms often took different approaches, with the best technological solutions diffusing across the industry in typically decade-scale time frames. The standards now used to regulate both conventional smog-causing air pollutants and GHG emissions from vehicles, and the standards used to remove first lead and more recently sulfur from fuels, are examples of flexible, market-based regulations that focus on environmental outcomes while leaving the choice of technologies to achieve those outcomes to the private sector.

Alternative fuel vehicle (AFV) policies deviate from market principles because they attempt to pick winners -- with which technologies are the supposed winners often varying over political cycles -- and are indeed premised on attempting to make petroleum a loser in the market. After more than 40 years and many billions of dollars, it clearly hasn't worked. At the same time, competitively driven innovation in oil and gas production has opened up new sources of supply, restoring America to global leadership in production, and doing so rapidly when oil

price rose. Rather than the fears of running out of oil (a fear that was always groundless in my view), the world has again entered a period of oversupply, resulting in lower prices. At the same time, market forces continue to work, enabling newer oil production technologies such as hydraulic fracturing to fall in cost as the industry "learns by doing." Like any major industry, the oil and gas industry enjoys a level of subsidy through tax breaks; however, that industry has never been dependent on public subsidies to enable it to profitably supply consumers with high-quality fuel products.

Thus, the most cost-effective regulations are those that set technology-neutral standards based on objective metrics closely tied to measurable environmental outcomes. The traditional motor vehicle and motor fuel standards developed by EPA under the Clean Air Act (CAA) are exemplary in this regard, with costs to industry well under the margins of economic safety that enabled the automotive and petroleum industries to thrive while tailpipe emissions were cut to progressively lower levels. Even though the negotiations were tough every step of the way, the balancing of diverse interests that EPA brokered now proves that vehicles powered by internal combustion engines running on low-sulfur gasoline and diesel fuel no longer need be a threat to public health.

Corporate Average Fuel Economy (CAFE) standards, which since 2010 have been closely coordinated with the newer CAA-based motor vehicle greenhouse gas (GHG) emissions standards, are a similar success story. They have pushed fleet-average fuel economy to levels higher than the market would provide on its own, and keep fuel economy from sliding backward as far as it otherwise might when oil prices fall. The result has been lower car and truck CO_2 emissions rates, also accomplished in a highly cost-effective manner. In short, sound policies do not ignore the marketplace, but rather harness market forces in ways that address non-market problems ("externalities") while leaving maximum discretion to industry and consumers about how to reduce the adverse side-effects of economic activity.

FEDERAL BIOFUEL PROGRAMS VIOLATE PRINCIPLES OF GOOD POLICY

Unfortunately, federal biofuel policies have not followed these principles, and for that reason it should come as no surprise that, on balance, they have done more harm than good. Among AFV policies, the one that has had the greatest impact on the market to date -- and caused the most harm -- is the RFS. Building on many years of subsidies such as the Volumetric Ethanol Excise Tax Credit (VEETC, now phased out), the RFS has resulted in a large ramp-up of ethanol use and a significant increase in biodiesel use over the past decade. While its proponents hail the RFS as a success, it is a success only along the narrow dimension of raising incomes for the segments of agriculture, mainly corn and soybean producers and processors, that provide its main base of political support. The RFS has raised grain prices to levels higher than they would be without the renewable fuel mandates, thereby increasing costs to other segments of agriculture as well as American consumers and grain consumers throughout the world.

The RFS is a politically scripted mandate for particular biofuels that is partly masked by complex but only semi-scientific LCA provisions to qualify certain categories of renewable fuel according to claimed GHG reduction levels. However, LCA is a deeply flawed and misleading tool in this regard. It is nothing like the truly measurement-based methods used for the traditional vehicle emissions and fuel quality standards set by EPA. When applied in an attempt to quantify the GHG emissions of fuels, LCA yields numbers that are determined largely by subjective modeling assumptions rather than objective data. I addressed the serious shortcomings of LCA and its misleading results in my testimony here two years ago.[7] Since then, my subsequent studies have confirmed the finding that the RFS, and therefore U.S. biofuel use, has resulted in net CO_2 emissions higher than those that would have resulted from using petroleum fuels.[6]

ADVANCED BIOFUELS ARE A FAILURE

Many of you, and many in the public, have heard claims that the RFS is a success and that it is paving the way to an future of even more and better advanced biofuels. Nothing could be further from the truth. In spite of many years and many billions of dollars of federal spending, DOE's programs have yet to yield commercially viable advanced biofuel technologies. A sober look at the BETO's latest list of accomplishments[8] reveals that the program is still more about making promises than it is about delivering real value for the nation.

The failure is apparent in how cellulosic biofuel volumes have consistently fallen far short of the RFS targets. EPA's latest proposal, for 2018, is for 238 million gallons of cellulosic biofuel. That is only 3% of the 7 billion gallon target established by EISA. Moreover, much of even that small volume is comprised of biogas, rather than the liquid motor fuels that were the main objective of the program. This large shortfall continues a pattern, now seen every year since the program started, which demonstrates that the cellulosic biofuels in which DOE and others have invested many millions of both public and private dollars are not living up to what was promised by their proponents. The volumes of biofuels now classified as "advanced" by EPA amount to 4.2 billion gallons, of which biomass-diesel is a part. However, though qualified as advanced because they meet the 50% CI reduction threshold based on LCA, such fuels are still largely crop-based. Moreover, as pointed out below, the LCA methods used to qualify these fuels as advanced are unsound and so it is very unlikely that these so-called advanced biofuels actually result in net CO_2 reductions.

THE RFS HARMS THE ENVIRONMENT

Last year we published research to evaluate what actually happened as the RFS ramped up. We found that ethanol and biodiesel are very far from being carbon neutral and that the biofuels provided no significant direct CO_2 reduction. Once indirect impacts are considered, the result is that U.S. biofuel use has caused higher CO_2 emissions, more than if we had just been using petroleum fuels.

The research we conducted on this question provided the first retrospective, national-scale evaluation of the effect of substituting petroleum fuels with biofuels based on field data rather than computer modeling. All of the modeling used to justify and administer biofuel policies (including the RFS and California's LCFS) assumes that biofuels are inherently carbon neutral, meaning that only production-related GHG emissions need to be accounted for when comparing them to fossil fuels. This assumption was never tested; it was just presumed to be always true. However, farm data for testing this assumption are readily available from USDA, and those are the data on which we relied for our evaluation of the RFS. Our analysis directly evaluated both the CO_2 absorbed by crops and the CO_2 and other GHG emissions released when processing and burning both biofuels and fossil fuels. Instead of assuming that biofuels such as ethanol and biodiesel were completely carbon neutral, we compared CO_2 uptake on cropland to the biogenic CO_2 emitted during biofuel production and consumption. The analysis also accounted for motor fuel consumption, fuel processing operations and resource inputs, including the use of cropland for biofuel feedstocks. We found that instead of being completely (100%) carbon neutral, the gain in CO_2 uptake on cropland was enough to offset only 37% of the biofuel emissions over the 2005-2013 period. Once one factors in process emissions and the very large CO_2 emissions released from land conversion (which occurs because farmers must grow more crops elsewhere to compensate for the corn and soybeans devoted to biofuel production), the conclusion is that U.S. biofuel use has led to a net increase rather than a net decrease in CO_2 emissions relative to petroleum fuels.

These excess GHG emissions are not the only environmental harm caused by the RFS. Other researchers at University of Michigan documented how the cropland expansion due to the rising use of corn ethanol has destroyed habit for waterfowl and other wildlife.[9] The expanded corn production worsens water pollution, contributing to algae blooms and oxygen-starved zones in the Gulf of Mexico and Lake Erie.[10] Biofuel processing releases other forms of air pollution; for example, research has found that one of the country's largest corn ethanol refineries emits 30 times more air pollution than was assumed for the RFS regulatory analysis.[11] 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

Many aspects of federal biofuels policy are in need of major reform. From an environmental perspective, policies to subsidize or regulate biofuels into the market should be repealed or at least greatly scaled back. Reform is also needed in the DOE offices and affiliated national laboratory divisions involved in biofuels analysis. The LCA and related analytic tools they developed and promote are unsound scientifically and so a major effort is needed to have them critically examined by other scientists who do not have a vested interest in either the methods or

biofuel promotion. At the same time, there is a need to invest in developing and testing new tools that correctly address the dynamics of biofuel systems.

On the biofuel technology R&D side, DOE should face up to the fact that the advanced biofuel work has not only not failed to deliver commercially viable results, but also may be poorly grounded as an area to emphasize in support of climate mitigation. Bioenergy R&D should be greatly pared back and the resources shifted into terrestrial carbon management and other approaches for increasing carbon sequestration by ecosystems. Reforming biofuel research is a much-needed course correction for the federal energy research effort, which will be strengthened if ill-premised and poorly performing programs are phased out in favor of efforts more in line with the urgent need to mitigate CO_2 emissions.

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John M. DeCicco, Ph.D.

John M. DeCicco is a research professor at the University of Michigan Energy Institute (UMEI) where his work intersects physical science, engineering, social science and public policy. Over the years he has worked on energy efficiency in buildings, electric sector environmental impacts, consumer behavior and climate mitigation, with an increasing focus on transportation issues including vehicle efficiency and fuel-related CO_2 emissions. He leads the Energy Institute's Transportation Energy and Climate Analysis project and directs the University of Michigan Energy Survey. He is a founder of the U-M Beyond Carbon Neutral research initiative and serves on the management committee for the university's Mcity center on connected and automated vehicles.

Previously, Prof. DeCicco was a senior fellow at the Environmental Defense Fund (EDF, 2001-2009) and transportation director at the American Council for an Energy-Efficient Economy (ACEEE, 1990-2000). He has three books and over 150 published papers, reports, and formal public comments to his credit; has testified multiple times before the U.S. Congress; and participated in many other policy forums. He holds a doctorate in mechanical engineering from Princeton University.

Surname pronunciation: Dĕ·Chēē´·koe

Contact: DeCicco@umich.edu, office 734-764-6757, cell 313-727-7429

Profile: www.energy.umich.edu/faculty/john-m-decicco

Websites: www.carsclimate.com
www.umenergysurvey.com
www.energy.umich.edu (general)

Chairman BIGGS. Thank you, Dr. DeCicco.

And now, Ms.—I'll recognize Ms. Skor for her five minutes to—presentation.

TESTIMONY OF MS. EMILY SKOR,
CHIEF EXECUTIVE OFFICER,
GROWTH ENERGY

Ms. SKOR. Thank you, Chairman Weber, Chairman Biggs, Ranking Members Johnson, Bonamici, and Veasey, and Members of the House Committee on Science, Space, and Technology. Thank you for the opportunity to discuss today the advancement in America's biofuels industry.

My name is Emily Skor, and I am the CEO of Growth Energy. Growth Energy is America's leading biofuels trade association, representing 87 biorefineries and 83 companies in the biofuel supply chain. Our members produce fuel from grain, crop residues, algae, and woody biomass. In 2016 alone, our industry contributed more than $42.1 billion to the U.S. economy and supported almost 340,000 American jobs. And with stable and predictable policy, America's biofuels industry stands ready to deliver more biofuels that provide even greater environmental and human health benefits.

The development of the ethanol industry is a shining success story where the public sector supports private innovation. Ours is a competitive thriving renewable energy industry that continues to produce more with less, including significant reductions in greenhouse gas emissions, water usage, and energy usage. Our production process has become more sustainable and more efficient and uses a wider range of biomass feedstocks.

Today, ethanol is blended into 97 percent of our fuel supply, meeting more than ten percent of our motor fuel needs. Ethanol's naturally high octane enhances engine performance and increases fuel efficiency. As our country looks at ways to get more mileage from a gallon of fuel, high-octane fuels are a key component to that effort.

The key to all this progress is the renewable fuel standard. Following human health in groundwater contamination concerns with petroleum-derived MTBE, Congress sought a renewable, affordable alternative to deliver octane into America's gas tanks. Knowing we do not have a free and open fuel marketplace, the RFS helps correct an imperfect market to allow competition.

We cannot simply walk up to the pump and offer a higher-quality product at a lower price and compete for customers. Instead, the gasoline point-of-sale is very much controlled by the oil industry through direct ownership or franchise contracts that block new market entrants. The private sector response to the RFS has been dramatic and impactful because the policies set forth a long-term predictable energy strategy to blend more renewable fuel into our fuel supply.

In 2005, the United States produced 3.9 billion gallons of ethanol. This year, the industry is on pace to produce over 15.6 billion gallons. America's biofuels industry has followed the policy signal from the RFS to produce more advanced and cellulosic biofuels. We at Growth Energy have three operating commercial cellulosic mem-

bers—POET–DSM, DuPont, and Quad County—producing ethanol with dramatic greenhouse gas emission reductions. We have other members producing a diversity of fuels from a diversity of feedstocks. The RFS is driving this innovation.

Congress always intended for consumers to be able to buy higher ethanol blends at the pump. In 2011, the EPA approved the sale of E15 for all 2001 and newer vehicles. Since that time, Growth Energy has been working with fuel retailers to provide consumers access to higher levels of biofuels such as E15 and E85. Today, these higher ethanol blends are available at thousands of gas stations around the country, and they are saving consumers between 5 and 50 or more cents per gallon when compared to non-ethanol fuels.

I would be remiss if I did not mention a key policy hurdle with making E15 available across the United States year-round. In 1990, Congress limited evaporative emissions or Reid vapor pressure as part of a larger effort to combat smog during the summer fueling season. This law also provided ethanol-blended fuels an allowance because these fuels lower tailpipe and particular matter emissions. When E15 was approved as a new fuel, EPA did not extend that allowance. This means that 9 in 10 drivers can only legally purchase E15 for 8–1/2 months of the year. There's a bill pending before the House, H.R. 1311, that would fix this problem.

The American biofuels industry stands ready to move America forward. With a stable policy and access to drivers, we believe we can deliver more low-carbon, low-cost, high-performing, sustainable vehicle fuel solutions. This will save consumers money at the pump, increase vehicle performance, and improve our environment.

Thank you, and I'd be happy to take any questions.

[The prepared statement of Ms. Skor follows:]

TESTIMONY OF

MS. EMILY SKOR

BEFORE THE

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

JULY 25, 2017

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PHONE: 202.545.4000

SUMMARY

THE RENEWABLE FUEL STANDARD IS KEY TO BIOFUELS INNOVATION

- Ethanol is a staple of the United States fuel supply and 10 percent is blended in 97 percent of fuel today.
- The RFS provides the stability to ensure that biofuels have access to the marketplace, save drivers' money, and support nearly 339,000 American jobs.
- The RFS is driving investment and innovation in next-generation biofuels.

MOVING TO HIGHER-LEVEL ETHANOL BLENDS

- For the RFS to work as intended, consumers must be given access to alternative, higher biofuel blends at the gas pump.
- In 2011, the EPA approved the sale of E15 for all vehicles model year 2001 and newer after extensive testing.
- Today, higher ethanol blends like E15 and E85 are available at thousands of gas stations throughout the U.S., where they save consumers between $0.50 and $1.50 per gallon.

REID VAPOR PRESSURE (RVP)

- RVP restrictions are the biggest hurdle that prevents retailers from selling higher ethanol blends.
- Unlike E10, E15 does not receive a 1 psi RVP waiver in the summer months due to an outdated regulation, meaning retailers cannot offer it to consumers in conventional gasoline markets during the summer driving season from June 1 to September 15.
- Growth Energy supports bipartisan, bicameral legislation to simply extend the same RVP waiver to E15 that E10 receives.

IMPROVING THE ENVIRONMENT

- Corn ethanol reduces greenhouse gas emissions by an average of 43 percent.
- Ethanol displaces toxic chemicals in gasoline which have been proven to cause cancer and smog.
- Next-generation advanced biofuels like cellulosic ethanol can reduce greenhouse gas emissions by more than 100 percent.

BIOFUELS DRIVING FUEL EFFICIENCY

- Fuel economy standards are becoming increasingly stringent, and automakers need to move toward higher efficiency engines that require more octane in their fuel.
- Growth Energy has submitted data to the EPA and the California Air Resources Board demonstrating the clear benefits of moving to high-octane, midlevel ethanol blends, such as E30, to improve fuel efficiency and lower tailpipe emissions.

FOOD PRICE IMPACTS

- Ethanol helps balance the U.S. corn supply and does not use the type of corn that humans eat.
- Corn prices are down nearly a full dollar per bushel, and efforts to eliminate the RFS could cause a catastrophic rural recession.

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Emily Skor

CEO, Growth Energy

Chairman Weber, Chairman Biggs, Ranking Member Veasey, and Ranking Member Bonamici:

Thank you for the opportunity to appear today to discuss the importance of advancement in biofuels. My name is Emily Skor, and I am the CEO of Growth Energy. Growth Energy is the leading trade association for the ethanol industry, and we are proud to represent 87 producers, 83 companies involved in the ethanol supply chain, and tens of thousands of ethanol supporters around the country. We are working to bring consumers better choices at the fuel pump, grow America's economy and improve the environment for future generations. Our growing membership base now represents nearly half of all American ethanol plants, along with many of the largest and most prominent fuel retailers in the country. In 2016 alone, our industry contributed over $42.1 billion to the nation's GDP and supported more than 339,000 American jobs.

Ethanol is a homegrown biofuel that is now blended into 97 percent of our fuel supply, meeting more than 10 percent of our motor fuel needs. And, because ethanol blended fuels have the highest octane of any available liquid alternatives, it allows for better performing engines that have greater fuel efficiency. Furthermore, our industry today produces over 15 billion gallons of renewable fuel and over 44 million tons of animal feed, which helps meet our nation's need for fuel and food.

Every gallon of clean-burning ethanol decreases our dependence on foreign oil. One truckload of American ethanol displaces more than 60 barrels of imported oil. In fact, since 2005 – the year the RFS was enacted – we have helped cut our oil imports by more than half. But gasoline consumption has increased over the last five years and ethanol can help meet that growing demand. In 2016 alone, biofuels displaced 510 million barrels of oil. Overall, American ethanol has increased our energy security, reduced our dangerous dependence on foreign oil, created American jobs, and improved our nation's environment.

The American biofuels industry stands ready to move America forward. With a stable policy and access to drivers, we believe we can deliver low-carbon, low-cost, high-performing, sustainable vehicle fuel solutions. This will save consumers money at the pump, increase vehicle performance and improve our environment.

Today, I plan to cover a number of federal policy areas that we feel are key to delivering on the promise that biofuels can make our country more energy independent and help us improve the environment.

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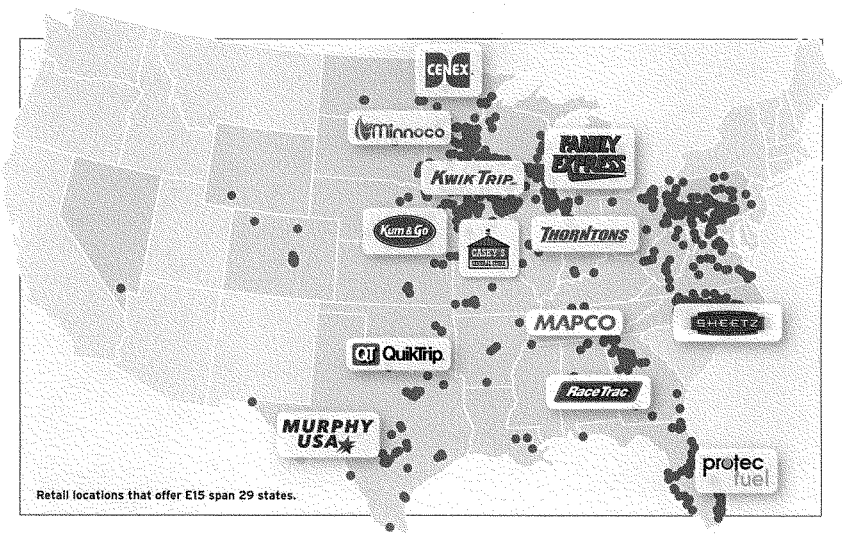

Retail locations that offer E15 span 29 states.

THE RENEWABLE FUEL STANDARD IS KEY TO BIOFUELS INNOVATION

In years past, consumers had limited choices when it came to alternative transportation fuels. Congress recognized the importance of having a more diverse and stable fuel supply and enacted the Renewable Fuel Standard (RFS) in 2005. Congress then revised it further in 2007 to specifically drive innovation and investment in biofuels of all kinds. The RFS set forth a long-term predictable energy strategy to blend 36 billion gallons of renewable fuel into our transportation fuel supply by 2022. With the stability provided by the RFS, our industry is now successfully producing more than 15 billion gallons of ethanol. In addition, the biodiesel industry produced 1.6 billion gallons in 2016.

The RFS is lowering our dependence on foreign oil, keeping our air clean, and providing consumers with more affordable fuel options that are also good for engine performance. The RFS is a critical component to the success of our nation's agriculture and rural economy. The policy supports nearly 339,000 U.S. jobs while saving taxpayers billions of dollars in farm program payments. In fact, moving to higher blends such as E15 will create an additional 136,000 jobs. It is obvious that ethanol production has provided an essential market for our nation's grain farmers and has revitalized rural communities around the country.

The RFS program is also driving considerable investment in the next generation of advanced biofuels, like cellulosic ethanol. These advanced biofuels can reduce emissions by 100 percent, and we are now seeing the first commercial-scale cellulosic ethanol plants bringing advanced biofuels to the market. These next generation biofuels are made today by turning corn kernel fiber, corn stover, and other leftovers into high-value

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energy. In the past, rulemaking delays by the EPA to enforce statutory targets set by the RFS have led to a halt in investment in advanced biofuels. Cellulosic ethanol production is now a reality, and it is vital that the RFS be implemented as Congress intended in order to reach the statutory goals set by the program.

MOVING TO HIGHER-LEVEL ETHANOL BLENDS

For the RFS to succeed as Congress intended, which included a continuous increase in both volume and percentage of renewable fuels into our transportation fuel supply, U.S. consumers need to be given an alternative fueling choice at the pump. In 2011 the EPA approved the sale of E15 for all 2001 and newer vehicles. Since that time, Growth Energy has been working with fuel retailers to build the marketplace for higher levels of biofuels, such as E15 and E85. Today, these higher ethanol blends are available at thousands of gas stations around the country, and they are saving consumers between $0.50 and $1.50 per gallon. In total, these renewable blended fuels cut consumer costs between $700 billion and $2.6 trillion in 2013. And, major retailers such as Sheetz, Kum and Go, RaceTrac, Kwiktrip, Quiktrip, Thorntons, Family Express, Murphy USA, Cenex, and Minnoco are making these cost-competitive ethanol blends available to more and more consumers by offering them at hundreds of high-volume fuel locations in states like North Carolina, Pennsylvania, Texas, Colorado, and Illinois.

E15 is approved for all 2001 and newer automobiles, representing roughly 90 percent of the vehicles on the road today. More testing was performed on E15 than any other fuel ever approved under the Clean Air Act. The U.S. Department of Energy's Oak Ridge National Laboratory tested 86 vehicles for more than 6 million miles before EPA approved E15 for use in 2001 and newer vehicles. That testing found no issues with emissions equipment and engine durability. In addition, consumers have driven more than 1 billion miles using E15 with no fuel-related problems. And NASCAR has logged more than 10 million miles of competition racing with E15 since adopting the fuel blend in 2011.

E15 is illegal to use in non-vehicle engines. In June, Growth Energy released a survey showing that U.S. small engine owners are pleased with the performance of their fuel and find it easy to pick the best option, including regular unleaded blends of E10. Biofuel critics like to claim that competition at the pump leads to confusion, but they obviously haven't checked with American consumers. Not only is picking the right fuel easy and worry-free, nearly every single respondent was satisfied with the performance of their fuel, including those using a standard 10 percent blend. Motorcyclists and boaters echo this confidence in their fuel choice. A poll of 500 motorcyclists found that 96 percent of motorcyclists find it easy to figure out the type of gasoline to put in their engine; 98 percent were satisfied with the gasoline they used; and 90 percent thought it was important to have a choice at the pump. A third survey conducted with CK Motorsports found that 94 percent of U.S. boat owners find it easy to pick the right fuel and are confident in their selection.

FLAWED STUDY

An oil industry funded study of E15 by the Coordinating Research Council is significantly flawed:

- CRC's engine durability testing was very limited – only testing eight vehicles, **while the DOE tested 86 vehicles.**
- CRC also **failed to test the engines on E10** – the standard consumer gasoline found throughout the United States.
- CRC testing put **undue pressure** on engine valves.
- CRC only tested three of the eight vehicles on ethanol-free gasoline – **and even one of those vehicles failed.**
- CRC chose two engines that already had durability issues – **one of which had even been recalled.**

REID VAPOR PRESSURE (RVP)

Reid Vapor Pressure, or RVP, is the term used to measure the evaporative emissions of a fuel. In 1990, Congress limited RVP to 9 psi as part of a larger effort to combat smog during the summer fueling season, which lasts from June 1 until September 15. Under this provision, fuel blended with 10 percent ethanol (E10) would be granted a 1 pound per square inch (psi) waiver from RVP requirements, allowing E10 to be the sold year-round nationwide.

This 1 psi waiver was extended in part because ethanol blended fuels reduce other types of emissions,

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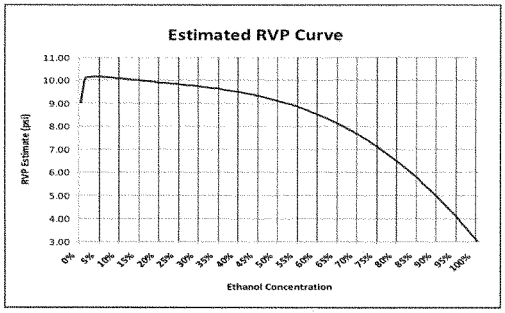
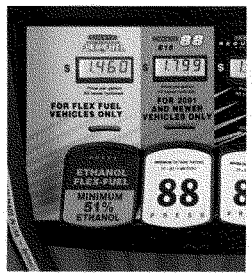
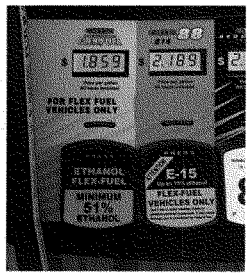




E15 labeling most of the year.



E15 labeling during summer months.

including carbon monoxide, tailpipe and particulate emissions. The waiver applied only to ethanol fuel blends E10 and lower and excluded ethanol blends above 10 percent, even though the overall RVP decreases as the percentage of ethanol blends increases. Therefore, when E15 was approved as gasoline for 2001 and newer vehicles, it did not receive the same 1 lb psi waiver that was extended to E10, and E15 cannot currently be sold year-round nationwide.

No other fuel product on the market is treated like E15. Every other large-scale, commercially available liquid fuel can be sold the same way year-round. However, in the case of E15, without the technical regulatory fix in H.R. 1311, fuel retailers are forced to change fuels or re-label E15 as flex-fuel only during the summer fueling season (June 1 – September 15).

The number of stations selling E15 is rapidly growing, resulting in more pumps that need to be re-labeled twice a year, at an approximate annual cost of $200 to switch labels at the beginning and end of the summer fueling season – on every single dispenser. With 917 retail stations in 29 states currently selling E15, it is estimated that roughly 11,000 fuel pumps sell E15. For 2017, this switching cost is almost $2.2 million. That is more than $2 million in lost revenue for other store upgrades. And that $2 million nets the U.S. zero additional environmental benefit. Given that there could be 2,000 active E15 stations next year, the switching cost alone in 2018 could be almost $5 million.

IMPROVING THE ENVIRONMENT

Biofuels provide a readily available, commercialized solution to decarbonizing the U.S. transportation sector. The United States Department of Agriculture (USDA) released a peer-reviewed report examining the lifecycle of greenhouse gas emissions from corn-based ethanol. The report found that corn ethanol reduces greenhouse gas emissions by 43 percent compared to conventional gasoline today, would further reduce greenhouse gas emissions by 50 percent by 2022, and has the potential to reduce emissions by as much as 76 percent.

Advanced biofuels can even reduce emissions by 100 percent or more over gasoline. Already, ethanol fuel use is estimated to reduce greenhouse gas emissions by 110 million metric tons annually – which is the equivalent of taking nearly 20 million vehicles off the road each year. Ethanol displaces gasoline's toxic chemicals that have been proven to cause cancer and smog by replacing harmful carcinogens and toxic additives, like MTBE and benzene, that can be found in petroleum-based fuels.

A review of real-world data over the last several decades shows significant decreases in emissions while ethanol blending has increased dramatically. Just in the last 15 years, ozone has decreased 17 percent while ethanol blending is above 10 percent, according to EPA data. Additional data from the Universi-

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ty of Illinois-Chicago show substantial reduction in particulate matter (PM) and benzene with the addition of ethanol. EPA and USDA conclude ethanol has not contributed to farmland expansion.

The RFS has also driven technological advancements and created further efficiency in the ethanol process. Our industry is now using less water and land than ever before while producing record-breaking higher yields.

According to EPA's Greenhouse Gas Inventory, there is no indication that native grassland has been converted to cropland since 2005, the year the RFS was enacted. Furthermore, ethanol production results in a coproduct (DDGs) that is used to feed livestock and reduce the amount of land used for feed.

In January 2017, the USDA issued a study based on direct evidence from the past 10 years – not projections – and found that between 2004 and 2012, at the same time U.S. corn ethanol production increased more than 200 percent, deforestation in Brazil's Amazon decreased from 10,200 to 2,400 square miles per year. Any recent reduction in U.S. acreage of Conservation Reserve Program land is the direct result of legislation – not ethanol production. The 2008 Farm Bill removed funding for roughly 7 million acres of CRP land. Based on this law, the number of enrolled acres has decreased to fit within the program's new, smaller budget. The 2014 Farm Bill additionally reduced the acreage of CRP land by another 8 million.

Lastly, oil development has had a negative impact on wildlife habitat. The University of Montana found that the extraction and production of fossil fuels destroyed 7.4 million acres of vegetation from 2000 to 2013 and severely jeopardized wildlife habitats. Surface mining is also responsible for the destruction of ecosystems and water pollution, harming fish and other wildlife.

BIOFUELS DRIVING FUEL EFFICIENCY

Worldwide fuel economy standards for vehicles are increasingly becoming more and more stringent. Automobile manufacturers are being forced to move toward higher efficiency engines that require high octane fuels to operate effectively, meet fuel economy standards, and lower greenhouse gases. Ethanol continues to be the most valuable and competitive source of octane in the world, and because it is also lower in greenhouse gas emissions, it would provide substantial benefits to automobile manufacturers.

Growth Energy has submitted data to the EPA and the California Air Resources Board demonstrating the clear benefits of moving to a high octane, midlevel ethanol blend, such as E30, including vehicle efficiency, lower tailpipe emissions, and increased use of renewable fuel. We believe that the use of midlevel ethanol blends will continue to drive investment in more efficient vehicles, as well as more advanced biofuels, such as cellulosic ethanol.

FOOD PRICE IMPACTS

Ethanol helps balance the U.S. corn supply, and to clarify, the corn used for ethanol production is feed corn – not the kind we eat. Corn is down nearly a full dollar per bushel and farmers are producing corn at near breakeven prices, but efforts to eliminate the RFS and market for biofuels could cause the worst rural recession since the Great Depression. The RFS provides sustainability for corn prices, and sustainable crop prices are vital to the success of an agricultural market. Additionally, a third of every bushel of grain used for ethanol is left over as coproducts heavy in protein and fat, and those coproducts are America's second largest source of animal feed. The ethanol industry is creating more coproducts, such as distiller grains for animal feed and corn oil for the feed market, and is even capturing carbon dioxide for use in beverage carbonation and frozen foods.

CONCLUSION

In just over a decade, the American ethanol industry has made tremendous technological advances and is at the forefront of breaking the competitive barrier in the transportation liquid fuel market.

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We are producing more than 10 percent of our nation's fuel supply, providing 339,000 American jobs and reducing our dependence on foreign oil. Under the RFS, ethanol production continues to become more efficient while advancing more toward second generation biofuels and increased sustainability, and we continue to find new, innovative ways to increase our product mix. Now is the time to give biofuels more access to the marketplace, so that we can compete and provide additional fuel certainty and stability. It is the wrong time to back away from the RFS, one of our country's most successful energy programs.

Doing so would only harm further investment, jeopardize the market for American farmers and producers, and potentially threaten the significant environmental progress that has been made with the introduction of ethanol and renewable fuels. The RFS policy works, and the development of our nation's renewable fuel industry has been a resounding success. This policy continues to deliver a clean, secure and affordable energy source to every American, and it is a crucial component to the future of transportation fuels in America.

I thank you for the opportunity to testify and welcome your questions.

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GROWTH ENERGY **CHIEF EXECUTIVE OFFICER**

Emily Skor

Emily Skor joined Growth Energy as CEO in May 2016. She leads the country's premiere biofuel trade association, representing 87 producers, 81 associated companies, and tens of thousands of ethanol supporters around the country. Together, Growth Energy's membership of producers and supporters of ethanol are working to bring consumers better choices at the fuel pump, grow America's economy, and improve the environment for future generations. The association's growing membership base now represents nearly half of all American ethanol plants, along with many of the largest and most prominent fuel retailers in the country, as well as affiliate members whose businesses support the ethanol industry.

Prior to joining Growth Energy, Emily served as the Vice President for Communications of the Consumer Healthcare Products Association (CHPA) and as the Executive Director of the CHPA Educational Foundation. At CHPA, a member-based trade association, she led teams that advocated for consumer healthcare products and served as a leader on regulatory and scientific issues for the industry. In this role, Emily oversaw public affairs campaigns, integrated strategic communications into legislative campaigns and coordinated ally development. Before joining CHPA in February 2011, Emily served as Senior Vice President at Dezenhall Resources, a nationally recognized crisis communications and issues management firm. For more than a decade, she helped Fortune 500 companies and industry associations manage issues affecting brand confidence and corporate reputation through media, advocacy, coalition-building and consumer-education campaigns.

Ms. Skor graduated Phi Beta Kappa from Wellsley College. She lives in Washington, D.C., with her husband and 2 children. She is a trustee of Aidan Montessori School and serves on the board of directors of Madeline Island Chamber Music.

UPDATED: 07/21/17

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Chairman BIGGS. Thank you, Ms. Skor.

And now, I'll recognize Mr. Loris for five minutes for his opening statement.

TESTIMONY OF MR. NICOLAS LORIS,
HERBERT AND JOYCE MORGAN RESEARCH FELLOW,
INSTITUTE FOR ECONOMIC FREEDOM AND OPPORTUNITY,
HERITAGE FOUNDATION

Mr. LORIS. Thank you. Chairman Biggs, Chairman Weber, Ranking Member Veasey, Ranking Member Bonamici, and distinguished Members of the Subcommittees, thank you for this opportunity to discuss U.S. biofuels policy. The views I express in this testimony are my own and should not be construed as representing any official position of the Heritage Foundation.

To justify biofuels programs, policymakers have promised reduced dependence on foreign oil, a new source of cleaner energy to lower gas prices, and an improved environment. None of this has materialized in any substantial way. More fundamental than that, the biofuels mandate and subsidies reveal the inability of the federal government to centrally plan energy markets and the unintended consequences that occur when doing so. No matter how brilliant or well-informed, politicians cannot predict the future of energy supplies and demand. It's difficult enough to know where gas prices will be six months from now, let alone projecting nearly two decades into the future.

With regard to the RFS, blend wall concerns with corn-based ethanol and Congress grossly over predicting the commercial viability of cellulosic ethanol demonstrate why the government should not set production quotas in the first place. And the RFS is far from the only mechanism that the federal government has used it to prop up the biofuels markets. Since 1980, federal taxpayers have spent more than $57 billion on ethanol subsidies. We've imposed tariffs on cheaper imported ethanol, provided loan guarantees for cellulosic ethanol, and provide a number of taxpayer subsidies on biofuels infrastructure through the energy title in the farm bill.

These policies concentrate benefits to a select few and disburse the costs among the rest of us. And those costs are substantial as we pay tens of billions of dollars more in higher food and gas prices each year. These policies harm low-income families who spend a disproportionately higher percentage of their budget on these goods.

While a select group of producers has certainly benefited, we can't ignore the groups in rural America that have been hurt by these policies and these subsidies as well. The federal government has supported corn and soybean growers at the expense of livestock and other crop producers. Some rural towns bet big on biofuels and lost big. A recent Utah State University study details how preferential treatment for ethanol shifted the business risk from companies to local communities where cities and towns would offer incentives that in some instances lasted multiple decades or would front the cost to build out ethanol infrastructure projects. When these projects failed and went bankrupt, state and local communities were stuck with the tab.

Furthermore, the mandate and complementary subsidies have not contributed to any meaningful reductions in oil consumption. Biofuels contributed a mere five percent of the U.S. transportation fuel market in 2016. By comparison, natural gas provided four percent with no such mandate in place.

Biofuels also have unintended environmental impacts. Even the Environmental Protection Agency acknowledges that the increases in soybean production as a result of the mandate can cause adverse effects to water quality, ecosystems, and habitats while increasing criterion pollutants like sulfur dioxide.

Furthermore, the alleged climate benefit from the RFS and biofuels policy is dubious at best. Even under the assumption that switching from biofuels—switching from oil to biofuels significantly reduces greenhouse gas emissions, which is a very generous assumption, the impact on global temperatures would be barely detectable. Broadly speaking, the mandate and subsidies provide valuable lessons about the problems when the federal government intervenes in energy markets. Bad policies that reward preferential treatment remain in place because the supposedly political importance trumps economic viability.

In Washington, it's rare to have a diverse mix of individuals and groups such as environmental organizations, world hunger activists, economists, free-market think tanks, and many in the agricultural community voicing their concerns over one single policy, and yet these policies remain in place to appease entrenched special interests.

But the issue is not with biofuels themselves but rather a set of policies and programs that pick winners and losers. This holds not true just for biofuels but for all energy sources. There's an enormous profit incentive that already exists for fuel producers that can benefit from a competitive industry without the aid of taxpayer money or a government-imposed mandate.

American motorists purchased nearly 400 million gallons of gasoline per day in 2016. Globally, the transportation fuel market is a multitrillion dollar opportunity for competitive industries to meet the world's energy demands. Congress should recognize the economic and environmental costs of biofuels policy and repeal the RFS and all biofuels subsidies. Congress should do so as part of fundamental reform that eliminates subsidies for all energy sources and technologies.

Now, there are ways in which Congress can drive alternative fuel competition such as implementing tax reform that allows for immediate expensing for all capital investments and using the Department of Energy's national labs as catalysts for innovation. In this scenario, the DOE should conduct the research to meet government objectives that are not being done by the private sector and enable a system that allows the private sector using their own money to tap into that research for commercial purposes. While this already occurs on some level and with some success, private sector access to the labs' assets and labs' employees and the ability to turn the research into market applications are stifled by cultural rigidity, funding issues, as well as complex and overly restrictive conflict-of-interest and intellectual-property-rights regulations. Enacting

such reforms will empower the private sector and innovative companies to drive fuel competition and choice.

Thank you, and I look forward to your questions.

[The prepared statement of Mr. Loris follows:]

The Heritage Foundation
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214 Massachusetts Avenue, NE • Washington DC 20002 • (202) 546-4400 • heritage.org

CONGRESSIONAL TESTIMONY

Examining U.S. Biofuels Policy

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

July 25, 2017

Nick Loris
Herbert & Joyce Morgan Fellow
The Heritage Foundation

My name is Nick Loris and I am the Herbert & Joyce Morgan Fellow at The Heritage Foundation. The views I express in this testimony are my own, and should not be construed as representing any official position of The Heritage Foundation. I would like to thank the House of Representatives Committee on Science, Space and Technology's Subcommittee on Energy and Subcommittee on Environment for the opportunity to address U.S. biofuels policy.

In the 1989 film *Field of Dreams* a voice in the sky tells Iowa corn farmer Ray Kinsella, "If you build it, they will come." Ray proceeds to destroy his corn crop to build a baseball field that gives a second chance to a number of professional baseball players. Despite skepticism from his family, Ray's plan saves the farm.

It seems as though politicians and regulators may have watched this film one too many times. Adapting from that famous line, Congress and the Environmental Protection Agency have taken the approach that "if you mandate and subsidize, the market will come."

Throughout the years, Congress has spent tens of billions of dollars by enacting special tax breaks, direct grants, government-backed loans, and loan guarantees. The most pervasive and pernicious biofuel policy is an outright mandate that guarantees biofuel producers a share of the transportation fuel market.[1] To justify biofuels programs, policymakers have promised reduced dependence on foreign oil, a new source of cleaner energy to lower gas prices, a stronger economy, and an improved environment. None of this has materialized in any substantial way.

The problem is not the use of biofuels themselves but rather a set of policies and programs that pick winners and losers—a subsidization of production that benefits a select few while spreading the costs among American families and businesses. Even within the agricultural community, biofuel handouts reward those who are connected to the policy and adversely affect large parts of rural America. Having politicians centrally plan energy decisions has caused market distortions and demonstrated the high costs and unintended consequences of government intervention. Biofuel subsidies affect commodity production, prices, the economy, and the environment and distort energy markets.

Policy reforms that remove preferential treatment for biofuels and eliminate all subsidies for transportation fuels and technologies will promote competition and fuel choice. Removing bureaucracies at America's national labs will empower entrepreneurs to use those vital labor and capital assets for innovative technologies. Ultimately, the market should determine what powers our vehicles, not politicians and regulators.

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[1]U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Alternative Fuels Data Center, "Federal Laws and Incentives for Biodiesel," http://www.afdc.energy.gov/fuels/laws/BIOD/US (accessed July 18, 2017).

What Are Biofuels and How Are They Used?

The Environmental Protection Agency (EPA) classifies biofuels as "fuels produced from renewable organic material."[2] Producers ferment sugar (sugarcane, sugar beets) and starch products (corn, potatoes) to create bioalcohols and ferment oilseed crops (soybeans, sunflower seeds) and animal fats to create biodiesel.[3]

Ethanol, the most common biofuel, is made from corn, sugarcane, potatoes, soybeans, and other biomass. In the United States, the most common form of ethanol is corn-based. Before any subsidies and the current biofuels mandates were put in place, ethanol already was a valuable additive to gasoline, allowing fuel to burn more cleanly and more efficiently.[4] The use of biofuels is not new and is not the product of any government policy jumpstarting an infant industry: Henry Ford originally planned for the Model T to run on ethanol, and in 1897, Rudolf Diesel showcased a diesel engine running on peanut oil.[5]

Fuel suppliers mix biofuels into gasoline and diesel at blending stations. The fuel system in most vehicles can only contain gasoline blended with 10 percent ethanol (E10) and 90 percent gasoline. In 2011, the EPA approved a blend of 15 percent ethanol and 85 percent gasoline for model year 2001 and newer vehicles, but it is damaging to engines in older vehicles.[6] In addition, ethanol has proven to be harmful to smaller engines, such as lawnmowers, motorcycles, and boats.[7] Another fuel blend is E85, used in flex-fuel vehicles, which contains "51%–83% ethanol, depending on geography and season."[8] Flex-fuel vehicles have engines that can run on a range of blends of gasoline, including E85. Some gasoline stations offer "blender" pumps that allow consumers to choose which blend to use.[9]

The federal government distinguishes between conventional, first-generation biofuels, and advanced, second-generation biofuels, also known as cellulosic ethanol. Producers generate advanced biofuels from non-food parts of crops and other biomass such as leaves, switchgrass, algae, and woodchips. However, commercial development of fuel from these resources has proven to be difficult.

The Renewable Fuel Standard and Biofuel Subsidies

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[2]U.S. Environmental Protection Agency, "Economics of Biofuels," last updated April 17, 2017, https://www.epa.gov/environmental-economics/economics-biofuels (accessed July 18, 2017).
[3]U.S. Environmental Protection Agency, Pacific Southwest, Region 9, "Learn About Biodiesel," June 30, 2016, http://www3.epa.gov/region9/waste/biodiesel/questions.html (accessed July 18, 2017).
[4]U.S. Department of Energy, Energy Information Administration, "Petroleum & Other Liquids: Oxygenate Production," June 30, 2016, http://www.eia.gov/dnav/pet/pet_pnp_oxy_dc_nus_mbbl_a.htm (accessed July 18, 2017).
[5]Biofuel.org.uk, "Biofuel Facts," http://biofuel.org.uk/biofuel-facts.html (accessed July 18, 2017).
[6]U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Alternative Fuels Data Center, "Ethanol Blends," http://www.afdc.energy.gov/fuels/ethanol_blends.html (accessed July 18, 2017).
[7]Ed Perratore, "Gas with Ethanol Can Make Small Engines Fail," *Consumer Reports*, March 22, 2013, http://www.consumerreports.org/cro/news/2013/03/gas-with-ethanol-can-make-small-engines-fail/index.htm (accessed July 18, 2017).
[8]U.S. Department of Energy, "Ethanol Blends."
[9]Ibid.

In response to the oil crisis of the 1970s, Congress passed the first ethanol tax credit—the Energy Tax Act of 1978—in an attempt to reduce dependence on foreign oil. Legislation such as the Biomass Research and Development Act of 2000, Healthy Forests Restoration Act of 2003, and American Jobs Creation Act of 2004 introduced or expanded an assortment of direct and indirect subsidies for biofuels. The federal government awards subsidies not just for the production of biofuels and ethanol plants, but also for biofuels infrastructure.[10] Since 1980, federal taxpayers have spent more than $57 billion on ethanol subsidies. The 2002 farm bill continued to force the growth of a market for biofuel production and use; many of these programs were expanded in the 2008 and 2014 farm bills.[11] State and local subsidies have also encouraged ethanol production and infrastructure.

TABLE 1

Biofuel Subsidies in the 2014 Farm Bill

Program	Function	Funding in 2014 Farm Bill (FY 2014–FY 2018), in Millions of Dollars	
TITLE IX PROGRAMS		**Mandatory**	**Discretionary**
Biobased Markets Program	Requirement for federal agencies to develop a bio-product procurement program, additionally requires contractors to use biobased products on purchases over $10,000	$15	$10
Biorefinery, Renewable Chemical, and Biobased Product Manufacturing Assistance Program	Loan guarantees for biorefinery construction to convert to biomass to advanced biofuels	$200	$375
Repowering Assistance Program	Payments to eligible biorefineries for use of biomass to operate refinery	$12	$50
Biorefinery Program for Advanced Biofuels	Contracts and payments from USDA to advanced biofuel producers for annual increases in production	$75	$100
BioDiesel Fuel Education Program	Grants to educate the public and governments on the benefits of biodiesel	$5	$5
Rural Energy for America Program	Grants and loan guarantees for development and construction of renewable energy systems, including bioenergy systems, in rural communities	$250	$100
Biomass Research and Development Initiative	Grants, contracts, and financial aid for research, development, and demonstrations of technologies and processes that lead toward commercializing biofuels, feedstocks, and biobased products	$12	$100
Feedstock Flexibility Program for Bioenergy Producers	Program in coordination with the Commodity Credit Corporation that allows the USDA to buy surplus sugar and resell at subsidized rates to bioenergy producers	Such sums as necessary	
Biomass Crop Assistance Program	Matching funds and annual payments to farmers and foresters who want to harvest and deliver biomass feedstocks	$120	$0
Community Wood Energy Program	Grants to state and local governments and "biomass consumer cooperatives" for biomass heating systems	$25	$0
TITLE IX TOTALS		**$694**	**$765**
TITLE VII PROGRAMS		**Mandatory**	**Discretionary**
Sun Grant Program	Grants to universities to research and advance biobased energy technology and other applications within the economy	$0	$75 (annually)

SOURCE: Randy Schnepf, "Energy Provisions in the 2014 Farm Bill (P.L. 113-79)," Congressional Research Service Report for Congress, March 12, 2014, https://fas.org/sgp/crs/misc/R42460.pdf (accessed July 22, 2016).

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[10]Taxpayers for Common Sense, "Understanding Federal Subsidies for the Biofuels and Biomass Industries," September 2015, http://www.taxpayer.net/images/uploads/articles/biofuel-report-sept-15.pdf (accessed July 18, 2017).

[11]Landon Stevens, Randy T. Simmons, and Ryan M. Yonk, "Ethanol and the Renewable Fuel Standard," The Institute of Political Economy (IPE) at Utah State University, http://www.usu.edu/ipe/wp-content/uploads/2016/02/Ethanol.pdf (accessed July 18, 2017).

The main source of U.S. biofuel policy is the RFS.[12] The Energy Policy Act of 2005 first mandated that renewable fuels be mixed into America's gasoline supply, primarily by using corn-based ethanol. The 2007 Energy Independence and Security Act increased the quotas significantly. By 2022, a total of 36 billion gallons of biofuels (with a cap of 15 billion for corn-based ethanol) must be blended into the nation's fuel supply. The program does not end in 2022; the EPA, in coordination with the Department of Energy (DOE) and Department of Agriculture, has authority to set yearly renewable volume obligations beyond the years included in the 2007 bill.[13]

The law also authorizes the Environmental Protection Agency (EPA) to adjust the statutory targets if the administrator deems there is an inadequate supply. As discussed later, the EPA has had to significantly reduce its targets for advanced biofuels as producers struggled to make commercially viable quantities. Administrator Scott Pruitt recently released the 2018 targets for the RFS, proposing the first decrease in total volume since 2006.[14] The total target of 19.24 billion gallons for 2018 is slightly lower than the 19.28 billion gallon target for 2017, with a 15 billion gallon conventional target and 4.24 billion gallons in advanced biofuels.[15]

The economic and environmental problems caused by the RFS have led a diverse range of environmental organizations, world hunger activists, economists, energy companies, and many in the agricultural community to oppose the mandate. Within the agriculture community, the National Chicken Council, National Cattlemen's Beef Association, National Pork Producers Council, National Turkey Federation, Milk Producers Council, and many other groups[16] have called on Congress to repeal the standard. Other prominent organizations like the American Petroleum Institute, National Resource Defense Council, American Fuel and Petrochemical Manufacturers, Environmental Working Group, Oxfam, and the United Nations have decried preferential treatment for corn ethanol.[17]

Besides the nearly universal outcry, the policy itself is reaching a breaking point as basic assumptions about the future on which it was built, such as national gasoline consumption and the commercial viability of advanced biofuels, prove to be invalid. Yet powerful biofuel lobbies have

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[12]Energy Independence and Security Act of 2007, 110th Cong., 1st Sess., § 202.
[13]Ibid.
[14]Environmental Protection Agency, Renewable Fuel Standard Program: Standards for 2018 and Biomass-Based Diesel Volume for 2019, https://www.epa.gov/sites/production/files/2017-07/documents/rfs-2018-standards-nprm-2017-07-05.pdf (accessed July 19, 2017).
[15]Ibid.
[16]Letter from Michael C. Formica, Chief Environmental Counsel, National Pork Producers Council, to Lisa Jackson, Administrator, Environmental Protection Agency, "RE: Petition for Waiver or Partial Waiver of Applicable Volume of Renewable Fuel," July 30, 2012, http://www.eesi.org/files/20120730-mf-Final-RFS-Waiver-Petition.pdf (accessed July 18, 2017).
[17]News release, "API and AFPM Tell EPA to Put Consumers First When Setting Ethanol Mandates," American Petroleum Institute, July 27, 2015, http://www.api.org/news-and-media/news/newsitems/2015/july-2015/api-and-afpm-tell-epa-to-put-consumers-first-when-setting-ethanol-mandates (accessed July 20, 2016); Natural Resources Defense Council, "Let the VEETC Expire: Save Billions in Tax Dollars Better Spent on Non-Polluting Energy Technologies," *Green Jobs Facts*, June 2010, http://www.nrdc.org/globalwarming/files/VEETCfs.pdf (accessed July 18, 2017); Sarah Kalloch, "Burning Down the House: Corn as Fuel, Not Food," Oxfam America, October 4, 2012, http://politicsofpoverty.oxfamamerica.org/2012/10/corn-as-fuel-not-food/ (accessed July 18, 2017); and news release, "EPA's Biofuels Mandates Are Unworkable," Environmental Working Group, February 7, 2013, http://www.ewg.org/release/epa-s-proposed-biofuels-mandates-are-unworkable (accessed July 18, 2017).

still been able to get Congress to withhold action on the RFS and its destructive economic and environmental effects.

Free Markets vs. Government Intervention in Energy Consumption

Americans undoubtedly take access to affordable, reliable energy for granted. Turning on the light switch or filling up a car with gasoline is second nature. Temporary power outages cause a great deal of frustration for families and businesses. Much worse, Americans realize the importance of reliable energy when a major natural disaster hits and they cannot power their schools and hospitals, keep their food from spoiling, or heat or cool their homes. Energy touches every aspect of their lives, from providing a daily sense of comfort to powering the global economy. Therefore, having an energy platform that provides choices at competitive prices will only enhance the well-being of families and businesses across the country.

On a larger scale, energy is a critical component to a nation's economic growth. A number of economic analyses have attempted to tease out the relationship between energy consumption and gross domestic product (GDP). Instead of merely pointing to correlation, econometric methods have shown energy consumption as a causal input to future economic growth.[18] For instance, an examination of Canadian data by Fraser Institute economists Ross McKitrick and Elmira Aliakbari find that "energy use in Canada is not a mere by-product of prosperity but a limiting factor in growth: real per capita income is constrained by policies that restrict energy availability and/or increase energy costs, and growth in energy abundance leads to growth in GDP per capita."[19] When the free market operates, resource extraction and production expand greatly and innovative technologies flourish, providing dependable power and competitive prices, creating new job opportunities and generating substantial economic growth.

On the other hand, federal energy policies have blocked access to opportunities, unnecessarily delayed projects, mandated expensive energy production, restricted choice, and given handouts to politically connected energy technologies. Politicians tout these programs as a way to usher in new technologies that will provide jobs and stimulate the economy. In reality, rather than providing an opportunity for all to compete, these policies allocate special benefits to the well-connected. Biofuel policy has certainly been an example of such favoritism.

Perhaps the most perverse consequence of these subsidies is that they obstruct the long-term success and viability of the technologies and energy sources they are ostensibly intended to promote. Instead of relying on a process that rewards competition, subsidies and mandates prevent a company from truly understanding the price point at which the technology will be economically viable. When the government plays favorites, it traps valuable resources in unproductive places and allocates labor and capital away from other potentially more promising investment investments.

The Biofuel Market Without a Mandate

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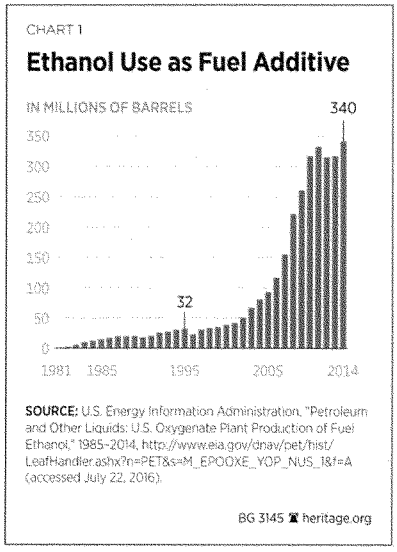
[18]Ross McKitrick and Elmira Aliakbari, "Energy Abundance and Economic Growth: International and Canadian Evidence," Fraser Institute, May 2014, https://www.fraserinstitute.org/sites/default/files/energy-abundance-and-economic-growth.pdf (accessed July 18, 2017).
[19]Ibid.

Evidence indicates that certain biofuels are cost competitive with traditional fuels and make a useful addition to gasoline—without special privileges from Washington. In the year before the federal government mandated the production of ethanol, American companies produced over 81 million barrels of ethanol.[20] Furthermore, ethanol is a cost-effective gasoline oxygenate, a gasoline additive that improves efficiency and helps to meet fuel emissions requirements.[21] A recent University of Tennessee Institute of Agriculture report estimates that in a market with no RFS and no ethanol tax credit, demand for corn ethanol as an oxygenate would have been 4.34 billion gallons in 2014, or about 30 percent of corn ethanol production that year.[22] Reducing government intervention in the biofuel sector and agricultural economy broadly would allow the most competitive elements of the biofuel industry to thrive in a free market. Competition driven by individuals would drive economic growth and benefit all of rural America, not just those special interests that are well-connected in Washington.



[20]U.S. Department of Energy, Energy Information Administration, "Petroleum & Other Liquids: Oxygenate Production."
[21]U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Alternative Fuels Data Center, "Ethanol Fuel Basics,"
March 30, 2016, http://www.afdc.energy.gov/fuels/ethanol_fuel_basics.html (accessed July 18, 2017).
[22]Daniel De La Torre Ugarte and Burton English, "10-Year Review of the Renewable Fuel Standard: Impacts to the Environment, the Economy, and Advanced Biofuels Development," University of Tennessee, Department of Agricultural and Resource Economics, Institute of Agriculture, October 14, 2015, http://www.ourenergypolicy.org/wp-content/uploads/2015/10/TenYrReviewRenewableFuelStandard_1015.pdf (accessed July 18, 2017). Commissioned by the American Council for Capital Formation.

If biofuels manage to succeed as a competitive source of transportation fuel, it will not be as a result of any taxpayer-funded handout or government-imposed mandate. Whether the industry flourishes or fails is for private actors, using their own resources, to determine. This holds true not just for biofuels, but oil, natural gas, battery technology, or any other fuel source and technology. An enormous profit incentive already exists for fuel producers without the aid of taxpayer money or a government-imposed mandate. American motorists purchased nearly 400 million gallons of gasoline per day in 2016.[23] American households spend $2,000 to $2,500 a year on gasoline. Globally, the transportation fuels market is a multitrillion-dollar opportunity for the most innovative technology to capture.

Chickens, Eggs, and Government Intervention

One common argument for government intervention into the transportation fuels market is the so-called chicken-and-egg problem. That is, auto dealers have a difficult time selling flex-fuel vehicles to consumers if there are no blender pumps in their vicinity. Moreover, gas station owners do not want to install blender pumps if there are no customers for the product. To "solve" the chicken-and-egg issue, both the federal government and state government shave offered generous targeted tax credits to install blender pumps at filling stations. The Biomass Crop Assistance Program (BCAP) and the Rural Energy for America Program, both housed in the U.S. Department of Agricultural (USDA), are other examples. BCAP provides handouts to farmers and ranchers who produce biomass for heat, power, bio-based products, or biofuels. USDA argues that:

> BCAP addresses a classic chicken-or-egg challenge around the start up of commercial-scale bioenergy activities. If commercial-scale biomass facilities are to have sufficient feedstocks, then a large-scale energy crop must exist. Conversely, if profitable crop production is to occur, then viable consumers must exist to purchase the crop.... Many bioenergy facilities need several years to reach commercial scale. BCAP serves as a catalyst to unite these dynamics by reducing the financial risk for landowners who decide to grow unconventional crops for these new markets.[24]

The reality is innovative ideas and technologies overcome chicken-and-egg challenges all the time without government assistance. Cell phones and cell phone towers is one of many examples. It does not matter how many cell phones there are if there is no place to obtain a signal, but producers built cell phone towers and sold cell phones without a massive subsidy or government program initiated by Washington. The same is true for gasoline-powered cars and traditional gasoline or filling stations.[25] These markets started small and became wildly successful. Solving the chicken-and-egg problem occurs routinely without government support. If biofuels (or natural gas vehicles or electric vehicles) are economically viable and meet consumer demands, the biofuel market could enjoy similar success.

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[23]U.S. Energy Information Administration, "Energy Use for Transportation," last updated: June 28, 2017, https://www.eia.gov/energyexplained/?page=us_energy_transportation#tab2 (accessed July 18, 2017).
[24]U.S. Department of Agriculture, Farm Service Agency, "Biomass Crop Assistance Program (BCAP)," *Fact Sheet*, May 2011, https://www.fsa.usda.gov/Internet/FSA_File/bcap_update_may2011.pdf (accessed July 18, 2017).
[25]Michael Sanserino, "Pittsburgh's Century-old Drive-in Gas Station First of its Kind," *Pittsburgh Post-Gazette*, November 30, 2013, http://www.post-gazette.com/business/2013/12/01/FILL-ER-UP/stories/201312010079 (accessed July 18, 2017).

Unintended Consequences of U.S. Biofuel Policy

U.S. biofuel policy is a case study in the unintended consequences of government intervention. In contrast to what politicians and special interests promised, biofuel policies have increased costs for taxpayers and drivers, had little to no impact on oil prices, hurt rural economies, and resulted in unforeseen environmental costs.

Higher Costs for American Taxpayers and Drivers. Federal biofuel policies cost taxpayers $7.7 billion in 2011 and $1.3 billion in 2012 after the expiration of the ethanol blenders tax credit, a 45-cent per gallon tax credit for blending ethanol into gasoline.[26] More than $57 billion in taxpayer dollars have been spent on ethanol subsidies.[27]

Furthermore, ethanol has done little or nothing either to keep fuel prices down, despite the arguments of proponents,[28] or to achieve the nebulous goal of independence from foreign oil. Even though ethanol production has increased as mandated and has accounted for nearly one-third of the increase in domestic fuel production over the past few years, biofuels still constitute a very small overall percentage of domestic gasoline consumption while increasing costs to consumers.

By its very nature, ethanol is not a perfect substitute for oil. Ethanol's energy content is only two-thirds the energy content of petroleum-based gasoline, and while biodiesel is closer to an even exchange at 92 percent of regular diesel's energy content, it is more expensive to fabricate.[29] The DOE's Energy Information Administration (EIA) estimates that gasoline's energy content has decreased 3 percent from 1993–2013 as ethanol use has increased because of federal mandates.[30]

The joint EPA/DOE website, FuelEconomy.Gov, provides telling documentation of these costs. The size of the additional costs varies depending on ethanol and gasoline prices, but the big picture is always the same: The higher the ethanol content, the worse a car's gas mileage is and the more drivers have to spend to go the same distance. As of September 2015, depending on make and model, the typical motorist could spend as much as an additional $600 per year to run his flex-fuel

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[26]Randy Schnepf, "Agriculture-Based Biofuels: Overview and Emerging Issues," Congressional Research Service *Report for Congress*, May 1, 2013, p. 29, http://nationalaglawcenter.org/wp-content/uploads/assets/crs/R41282.pdf (accessed July 18, 2017).

[27]Landon Stevens, Randy T Simmons, and Ryan M. Yonk, "Ethanol and the Renewable Fuel Standard," The Institute of Political Economy (IPE) at Utah State University, http://www.usu.edu/ipe/wp-content/uploads/2016/02/Ethanol.pdf (accessed July 18, 2017).

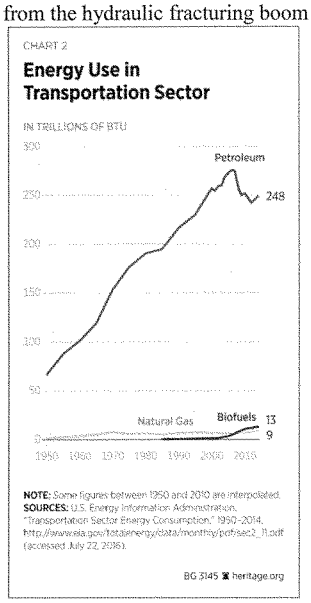
[28]Christopher R. Knittel and Aaron Smith, "Ethanol Production and Gasoline Prices: A Spurious Correlation," July 12, 2012, http://web.mit.edu/knittel/www/papers/knittelsmith_latest.pdf (accessed July 18, 2017).

[29]U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, and U.S. Environmental Protection Agency, Office of Transportation and Air Quality, "Ethanol," https://www.fueleconomy.gov/feg/ethanol.shtml (accessed July 18, 2017), and Dan Edmunds and Philip Reed, "E85 vs. Gasoline Comparison Test," Edmunds.com, updated April 29, 2009, http://www.edmunds.com/fuel-economy/e85-vs-gasoline-comparison-test.html (accessed July 18, 2017).

[30]U.S. Department of Energy, Energy Information Administration, "Increasing Ethanol Use Has Reduced the Average Energy Content of Retail Motor Gasoline," *Today in Energy*, October 27, 2014, http://www.eia.gov/todayinenergy/detail.cfm?id=18551 (accessed July 18, 2017).

vehicle on E85 rather than regular gasoline blended with E10.[31] Even when vehicles use premium gasoline, E85 is more expensive for drivers.

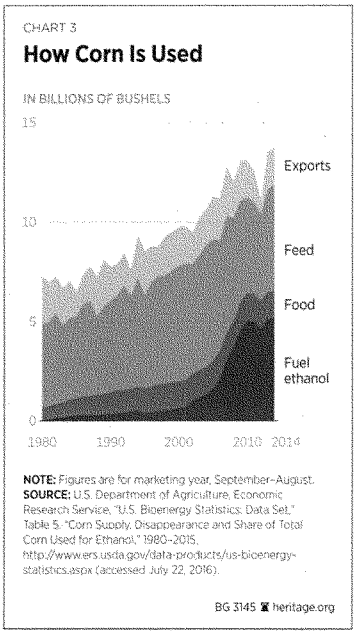
Failure to Reduce Dependence on Oil or Lower Prices. In addition to forcing drivers to pay for a less efficient fuel, the RFS has not delivered on the promise that it would reduce dependence on oil and afford protection from high prices. The large majority of transportation fuel has come from petroleum; even the relative explosion of growth in biofuels as a result of the mandate is dwarfed by the actual demand for fuel. Even with the generous subsidies and RFS mandating its use, biofuels contributed a mere 5 percent of the overall transportation fuel market in 2016.[32] Net imports of crude oil and petroleum products have fallen for a number of reasons, but in large part due to domestic oil production from the hydraulic fracturing boom in the U.S.[33]



Because biofuels contributes such a small percentage of the overall market, ethanol failed to tamp down prices, which mostly continued to climb from 2002 to 2012—despite increased mandated

[31]U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, and U.S. Environmental Protection Agency, Office of Transportation and Air Quality, "New Flex-Fuel Vehicles," http://www.fueleconomy.gov/feg/PowerSearch.do?action=noform&path=1&year1=2014&year2=2015&vtype=E85&srchtyp=newAfv (accessed July 18, 2017).
[32]U.S. Energy Information Administration, "Use of Energy in the United States Explained: Energy Use for Transportation," last updated May 17, 2017, https://www.eia.gov/energyexplained/?page=us_energy_transportation (accessed July 19, 2017).
[33]U.S. Energy Information Administration, "Increasing Domestic Production of Crude Oil Reduces Net Petroleum Imports," April 21, 2015, https://www.eia.gov/todayinenergy/detail.php?id=20892 (accessed July 18, 2017).

ethanol use and high oil prices that allegedly made ethanol more competitive.[34] Conversely, ethanol production has had little to do with the dramatic decrease in fuel prices that began in 2013 as a result of significant increases in domestic crude oil production, a decrease that highlighted the disparity in cost and efficiency between ethanol and petroleum-based fuel.

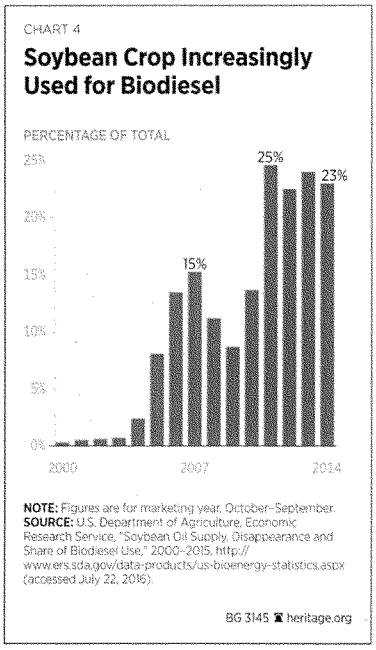


Negative Consequences of Diverting Food to Fuel. The federal government's biofuel policy has diverted food away for fuel, increasing the cost of corn, soybeans, and feedstocks, as well as overall food prices. While the impact of biofuels on fuel consumption is small, the impact on agriculture is large. This increase has hurt both rural America and the world's poorest citizens. The problem is that the diversion of land was a result of the mandates and subsidies. Market forces may very well have moved farmers in this direction, though not likely to such an extent. Nevertheless, the private sector will allocate those resources most efficiently.

From 2010–2012, 49 percent of the U.S. corn crop was used in the food industry and feed for livestock; another 12 percent was exported. Over 40 percent was used to fabricate ethanol fuel to

[34]U.S. Department of Energy, Energy Information Administration, "U.S. Regular All Formulations Retail Gasoline Prices (Dollars per Gallon)," July 18, 2016, http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=EMM_EPMR_PTE_NUS_DPG&f=A (accessed July 18, 2017).

meet the RFS standard.[35] In 2012, the amount of corn used to produce ethanol in the U.S. exceeded the entire corn consumption of the continent of Africa and in any single country with the exception of China.[36] While the majority of biofuel-related food price increases have resulted from the diversion of corn to fuel, diverting soybean crop to biodiesel has had similar effects.



Inflated demand created by the RFS and higher corn prices have incentivized farmers to grow more corn by adding acreage, increasing productivity, or devoting less existing farmland to other crops, but increasing supply to meet higher demand has its own costs. Pressure on the price of corn is exacerbated by the mandate, which requires the use of ethanol or available credits (called RIN credits) regardless of cost, while ranchers, farmers, the food industry, and motorists must take increased corn prices into account. Those who perhaps bear the costs of increased corn prices most

[35]Numbers exceed 100 percent due to rounding. Schnepf, "Agriculture-Based Biofuels," p. 10.
[36]Colin Carter, Gordon Rausser, and Aaron Smith, "Commodity Storage and the Market Effects of Biofuel Policies," University of California–Davis, Department of Agricultural and Resource Economics, http://arefiles.ucdavis.edu/uploads/filer_public/81/ba/81ba961d-fe7b-4629-8511-1b78fdf3b527/carter_rausser_smith.pdf (accessed July 18, 2017).

acutely are farmers and ranchers who use corn for feed and countries that import American corn, which accounts for over 50 percent of the world's corn exports.[37]

The USDA's Economic Research Service notes that "increased corn prices draw land away from competing crops, raise input prices for livestock producers, and put moderate upward pressure on retail food prices."[38] These side effects were all too apparent during the 2012 drought.

The 2012 summer drought destroyed a significant amount of America's crops, drove corn prices up 33 percent, and heightened concerns that the RFS and existing subsidies were needlessly diverting food to fuel.[39] Since corn is a staple ingredient for many foods and an important feedstock for animals, many in the food industry (from cattle and chicken farmers to restaurant associations) expressed concern regarding the mandate's effect on food prices. Rather than going to where market demand valued corn, roughly 40 percent of the corn crop in 2012 was used to create 12.98 billion gallons of corn-based biofuels, or 95 percent of the mandate.[40]

Between July 2012 and August 2012, governors from Arkansas, Delaware, Florida, Georgia, Maryland, New Mexico, North Carolina, Texas, Utah, Virginia, and Wyoming petitioned the EPA for a waiver of the RFS standards, which the EPA denied.[41] According to a recent study by economists from the University of Nebraska–Lincoln, "the drought's impact on corn prices could have been 'fully negated' by reducing the Renewable Fuel Standard by 23 percent that year."[42]

Higher prices resulting from government-created market distortions have a ripple effect well beyond the U.S. A number of organizations have demonstrated a link between biofuel policies and food prices and the adverse consequences of these policies for the world's poorest citizens. The Food and Agriculture Organization of the United Nations, ActionAid, the World Resources

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[37]U.S. Department of Commerce, U.S. Census Bureau, *Statistical Abstract of the United States: 2012*, p. 548, Table 852, "Selected Farm Products—U.S. and World Production and Exports: 2000 to 2010," https://www.census.gov/prod/2011pubs/12statab/agricult.pdf (accessed July 18, 2017).

[38]U.S. Department of Agriculture, Economic Research Service, "Bioenergy: Findings," last updated February 16, 2017, http://www.ers.usda.gov/topics/farm-economy/bioenergy/findings.aspx (accessed July 18, 2017).

[39]Steve Hargreaves, "Calls to Scrap Ethanol Mandate Intensify with Drought," CNN Money, August 6, 2012, http://money.cnn.com/2012/08/06/news/economy/ethanol-drought/ (accessed July 18, 2017).

[40]U.S. Department of Agriculture, Economic Research Service, "U.S. Bioenergy Statistics: Overview," Table 5, "Corn Supply, Disappearance, and Share of Total Corn Used for Ethanol," last updated July 11, 2017, http://www.ers.usda.gov/data-products/us-bioenergy-statistics.aspx (accessed July 18, 2017), and U.S. Environmental Protection Agency, "Fuels Registration, Reporting, and Compliance Help," April 28, 2016, http://www.epa.gov/otaq/fuels/rfsdata/2012emts.htm (accessed July 18, 2017).

[41]Letter from Michael C. Formica to Lisa Jackson, "RE: Petition for Waiver or Partial Waiver of Applicable Volume of Renewable Fuel."

[42]Sunil Dhoubhadel, Azzeddine Azzam, and Matthew Stockton, "The Impact of Biofuels Policy and Drought on the U.S. Grain and Livestock Markets," *Journal of Agricultural and Applied Economics*, Vol. 47, No. 1 (2015), pp. 77–103, http://journals.cambridge.org/download.php?file=%2F3152_77B27E1A13C3BE5D0D0D0E0518D7674B_journals_AAE_AAE47_01_S1074070814000066a.pdf&cover=Y&code=8cf94e31d1162a01454f2789ffa4ab4d (accessed July 18, 2017).

Institute, the Organization for Economic Co-operation and Development, and the World Bank have all listed higher food prices as a resultant concern.[43]

The magnitude of the ethanol mandate's effect on corn prices and overall agricultural products is difficult to determine, partly because of the uncertainty of estimates regarding how much ethanol would be used for fuel absent a mandate, the price impacts of other factors affecting the price of corn, and what other agricultural products farmers would grow absent the mandate. While the magnitude of the mandate's impact on corn prices may not be certain, however, the direction is clear: The RFS has increased demand for corn and consequently has increased prices. According to separate analyses by University of California–Davis economists and a Heritage Foundation economist, the mandate accounts for an increase in corn prices of 30 percent or even as much as 68 percent, respectively.[44] Though other factors such as weather, global markets, and changing food preferences are at work in the price of corn, the RFS has certainly contributed to increased prices.[45]

Biofuel Mandates and Subsidies Do More Economic Harm than Good. Higher food and fuel prices have had adverse economic effects that hurt families and businesses multiple times over. Energy is a necessary input for most economic activities; policies that drive up the price of fuel will not just affect consumers at the pump but through all the goods and services they purchase. Because corn is a staple input for agricultural products, higher food prices hurt other farmers as well as small businesses like restaurant franchise owners. One owner of four Wendy's franchises claimed the RFS cost each restaurant $20,000 to $30,000 per restaurant.[46]

Proponents of the RFS and preferential treatment for biofuels sold these policies as a way to support economic growth in rural communities. While a select few have certainly benefitted, one

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[43]See Aziz Elbehri, Anna Segerstedt, and Pascal Liu, *Biofuels and the Sustainability Challenge: A Global Assessment of Sustainability Issues, Trends and Policies for Biofuels and Related Feedstocks*, United Nations, Food and Agriculture Organization, Trade and Markets Division, 2013, http://www.fao.org/docrep/017/i3126e/i3126e.pdf (accessed July 18, 2017); Tim Searchinger and Ralph Heimlich, "Avoiding Bioenergy Competition for Food Crops and Land," World Resources Institute *Working Paper*, January 2015, http://www.wri.org/sites/default/files/avoiding_bioenergy_competition_food_crops_land.pdf (accessed July 18, 2017); Richard Doornbosch and Ronald Steenblik, "Biofuels: Is the Cure Worse than the Disease?" Document SG/SD/RT(2007)3/REV1, prepared for Organization for Economic Co-operation and Development, Round Table on Sustainable Development, September 11–12, 2007, http://www.oecd.org/sd-roundtable/39411732.pdf (accessed July 18, 2017); and World Bank, "How Global Biofuel Expansion Could Affect the Economy, Environment and Food Supply," *Data & Research*, June 27, 2011, http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/0,,contentMDK:22946809~pagePK:64165401~piPK:64165026~theSitePK:469372,00.html (accessed July 18, 2017).

[44]Colin A. Carter and K. Aleks Schaefer, "US Biofuels Policy, Global Food Prices, and International Trade Obligations," American Enterprise Institute *Economic Perspectives*, May 2015, https://www.aei.org/wp-content/uploads/2015/05/US-biofuels-policy.pdf (accessed July 18, 2017); David W. Kreutzer, "The Renewable Fuel Standard, Ethanol Use, and Corn Prices," Heritage Foundation *Backgrounder* No 2727, September 17, 2012, http://www.heritage.org/research/reports/2012/09/the-renewable-fuel-standard-ethanol-use-and-corn-prices.

[45]"[M]ost economists and market analysts…also are nearly universally agreed that the strong, steady growth in ethanol demand for corn has had an important and sustained upward price effect, not just on the price of corn, but in other agricultural markets including food, feed, fuel, and land." Schnepf, "Agriculture-Based Biofuels," p. 14.

[46]BusinessWire, "PwC Study: Renewable Fuel Standard Is Estimated to Cost Chain Restaurants Billions," November 28, 2012, http://www.businesswire.com/news/home/20121128005474/en/PwC-Study-Renewable-Fuel-Standard-Estimated-Cost (accessed July 19, 2017).

should not ignore the groups in rural America that have been hurt by the policies and subsidies. The federal government has supported corn and soybean growers at the expense of livestock producers and other crop producers and has diverted resources to an industry that is not self-sustaining. Furthermore, because of the RFS, fuel now competes indirectly with corn producers,[47] and this connection is not insignificant: Some 41 percent of the U.S. corn crop was dedicated to ethanol production in 2010–2012, compared to 14 percent when Congress mandated the original quota in 2005.[48]

Some small rural towns bet big on biofuels and lost. Utah State University's Institute of Political Economy details how preferential treatment for ethanol shifted the risk from companies to the local communities, where cities would offer incentives that in some instances lasted multiple decades or front the costs to build out the infrastructure. The report notes that:

> As demand for corn rose following the construction of these plants, both farmers and refineries felt an economic pinch. Ethanol refineries are reliant on low corn prices to generate profit, and experience losses during times of high corn prices. Following corn price spikes in 2008 and 2012, numerous corn ethanol plants went offline due to an inability to run profitably. While many believed that farmers were making off with huge profits, they too failed to gain substantially due to rising costs of input factors such as fertilizer. Heightened competition bolstered the price for land, driving tenant farmers out of business and contributing to what some called the "production treadmill." In all, the market structure of ethanol prevented farmers from realizing most of the intended benefit of the ethanol policies.[49]

Claiming that biofuels mandates and subsidies are an economic stimulus ignores the broken window fallacy. In his essay "That Is Seen, and That Which Is Not Seen," French economist Frederic Bastiat outlines a scenario in which a shopkeeper breaks a window.[50] The economic benefit is the money paid to fix the window, which circulates through the economy. What is not seen, however, is on what the shopkeeper could have spent his money, such as a new pair of shoes. If the window were not broken in the first place, the shopkeeper would have a window and new shoes. When the government subsidizes biofuels, what is not seen is that labor and capital could have been invested elsewhere in the economy. Private-sector investment that is not the result of regulations, subsidies, or mandates is the root of economic growth and genuine prosperity.

Ultimately, the biofuels policy has less to do with price or customer choice and much more to do with meeting a government quota regardless of costs. Although biofuel technologies may someday prove to be a preferred fuel choice, biofuels have proved to be expensive to produce and less energy dense than gasoline and diesel. Federal subsidies and mandates have shifted those costs to

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[47]U.S. Department of Agriculture Economic Research Service, "Bioenergy: Findings," http://www.ers.usda.gov/topics/farm-economy/bioenergy/findings.aspx (accessed July 18, 2017).
[48]Schnepf, "Agriculture-Based Biofuels," p. 9, and Carter, Rausser, and Smith, "Commodity Storage and the Market Effects of Biofuel Policies."
[49]Landon Stevens, Randy T Simmons, and Ryan M. Yonk, "Ethanol and the Renewable Fuel Standard," The Institute of Political Economy (IPE) at Utah State University, http://www.usu.edu/ipe/wp-content/uploads/2016/02/Ethanol.pdf (accessed July 18, 2017).
[50]Frederic Bastiat, "That Which Is Seen, and That Which Is Not Seen," July 1850, http://bastiat.org/en/twisatwins.html (accessed July 18, 2017).

motorists, the food industry, and sectors of the agriculture community that depend on corn and soy for feed, while benefits are concentrated among a select few.

Unintended Adverse Environmental Consequences. Policymakers sold biofuel programs and the RFS in part by promising several important benefits, including cleaner fuel and a reduction in the greenhouse gas emissions that allegedly contribute to climate change. Yet the ability of biofuels, particularly ethanol, to improve the environment and reduce greenhouse gas emissions—regardless of the benefits of such goals—has been unclear and controversial at best. According to the EIA, biofuel carbon-dioxide emissions are "considered to be part of the natural carbon cycle."[51] However, this assumption may be too broad. For example:

- After accounting for land-use conversion and the use of fertilizers, insecticides, and pesticides, as well as the fossil fuels used for production and distribution, biofuel production is quite carbon intensive.[52]
- The growing popularity of biofuel policies led the U.N.'s Food and Agriculture Organization (FAO) to focus on the issue in its 2008 *State of Food and Agriculture* report. Citing several studies published in *Science*, the FAO noted that converting non-cropland to the production of corn ethanol released at least 17 times more emissions than the amount that is cut in carbon-dioxide emissions by using biofuels, or a "carbon debt" of 48 years.[53]
- University of Michigan Energy Institute Professor Dr. John DeCicco finds that even without accounting for indirect changes in land use, biofuels increase the amount of carbon dioxide released into the atmosphere compared to regular gasoline.[54] University of Minnesota economists similarly found that the RFS, on net, increases greenhouse gas emissions and that "[o]nly the use of cellulosic biofuels with a carbon intensity 60% lower than that of gasoline reduces net GHG emissions."[55] Cellulosic ethanol is the least economically viable. A November 2016 Government Accountability Office report

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[51]U.S. Department of Energy, Energy Information Administration, "Emissions of Greenhouse Gases in the U.S.," March 31, 2011, http://www.eia.gov/environment/emissions/ghg_report/ghg_overview.cfm (accessed July 18, 2017).

[52]"Fundamentals of a Sustainable U.S. Biofuels Policy," Rice University, James A. Baker III Institute for Public Policy, *Policy Report* No. 43, January 2010, http://bakerinstitute.org/files/522/ (accessed July 18, 2017); Adam J. Liska, Haishun Yang, Maribeth Milner, Steve Goddard, Humberto Blanco-Canqui, Matthew P. Pelton, Xiao X. Fang, Haitao Zhu, and Andrew E. Suyker, "Biofuels from Crop Residue Can Reduce Soil Carbon and Increase CO_2 Emissions," *Nature Climate Change*, Vol. 4 (May 2014), pp. 398–401, http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1015&context=bseliska (accessed July 21, 2016).

[53]United Nations, Food and Agriculture Organization, *The State of Food and Agriculture: Biofuels: Prospects, Risks and Opportunities*, 2008, pp. 55–59, ftp://ftp.fao.org/docrep/fao/011/i0100e/i0100e.pdf (accessed July 18, 2017).

[54]John M. DeCicco, "Testimony on the Renewable Fuel Standard," before the Subcommittees on Interior and on Health Care, Benefits and Administrative Rules, Committee on Oversight and Government Reform, U.S. House of Representatives, 114th Cong., March 16, 2016, https://oversight.house.gov/wp-content/uploads/2016/03/2016-03-16-John-DeCicco-Testimony.pdf (accessed July 18, 2017).

[55]Jason Hill, LiailaTajibaeva, and Stephen Polasky, "Climate Consequences of Low-Carbon Fuels: The United States Renewable Fuel Standard," *Energy Policy*, Vol. 97 (2016), pp. 351–353, July 2016, http://www.sciencedirect.com/science/article/pii/S0301421516303962 (accessed July 18, 2017).

projects that the RFS is unlikely to meet its targets for reducing greenhouse gas emissions.[56]

- Despite once hailing biofuels as an important tool in mitigating climate change, the U.N.'s Intergovernmental Panel on Climate Change reversed positions and acknowledged in 2007 that biofuel policy negatively affects the lives of the poor, diverts land to the production of biofuels, has environmental consequences, and has dubious climate impacts.[57]

Meanwhile, Congress has seemingly ignored apparent increases in real pollutants attributed to the RFS. Land-use conversions can destroy wildlife habitat. Moreover, the EPA acknowledged that increased renewable fuel would result in higher emissions of air pollutants such as particulate matter and nitrogen oxides and stated that "[i]n addition to air quality, there are also expected to be adverse impacts on both water quality and quantity as the production of biofuels and their feedstocks increase."[58] A study by Iowa State University researchers concluded that incentivizing more biofuel production with government policies leads to more adverse environmental consequences caused by farming, the use of fertilizers, and land-use conversion for agricultural production, resulting in increased soil erosion, sedimentation, and nitrogen and phosphorous runoff into lakes and streams.[59]

The unwanted environmental costs of agricultural production are a solvable problem. Almost all industrial output results in unwanted byproducts, whether air pollutants or runoff and discharge from the use of fertilizers. These byproducts are not necessarily a reason to eliminate an activity; doing so could reverse hard-won prosperity and progress. The real problem is that biofuels have been sold to policymakers and the public as "green" fuels, whereas in practice, they can be more environmentally damaging than petroleum-based fuels.

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[56]U.S. Government Accountability Office, "Renewable Fuel Standard: Program Unlikely to Meet Its Targets for Reducing Greenhouse Gas Emissions," November 2016, http://www.gao.gov/assets/690/681252.pdf (accessed July 18, 2017).

[57]Intergovernmental Panel on Climate Change, Working Group II, *Climate Change 2014, Impacts, Adaptation, and Vulnerability*, IPCC WGII AR5, Final Draft, Chapter 13, "Livelihoods and Poverty," October 28, 2013, http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap13_FGDall.pdf (accessed July 18, 2017).

[58]U.S. Environmental Protection Agency, "Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program: Final Rule," *Federal Register*, Vol. 75, No. 58 (March 26, 2010), Part II, p. 14683, https://www.gpo.gov/fdsys/pkg/FR-2010-03-26/pdf/2010-3851.pdf (accessed July 18, 2017). Other studies have examined the impact of increased corn or cellulosic ethanol (independent of the mandate) on individual air pollutants like particulate matter or ozone. Jason Hill, Stephen Polasky, Erik Nelson, David Tilman, Hong Huo, Lindsay Ludwig, James Neumann, Haochi Zheng, and Diego Bonta, "Climate Change and Health Costs of Air Emissions from Biofuels and Gasoline," Proceedings of the National Academy of the Sciences, Vol. 106, No. 6 (February 10, 2009), http://www.pnas.org/content/106/6/2077.full.pdf+html (accessed July 18, 2017); and Diana L. Ginnebaugh and Mark Z. Jacobson, "Examining the Impacts of Ethanol (E85) Versus Gasoline Photochemical Production of Smog in a Fog Using Near Explicit Gas- and Aqueous-Chemistry Mechanisms," *Environmental Research Letters*, Vol. 7, No. 4 (November 6, 2012), http://iopscience.iop.org/article/10.1088/1748-9326/7/4/045901/pdf (accessed July 18, 2017).

[59]Amani Elobeid, Miguel Carriquiry, Jacinto F. Fabiosa, Kranti Mulik, Dermot J. Hayes, Bruce A. Babcock, Jerome Dumortier, and Francisco Rosas, "Greenhouse Gas and Nitrogen Fertilizer Scenarios for U.S. Agriculture and Global Biofuels," Iowa State University, Center for Agricultural and Rural Development *Working Paper* No. 11-WP 524, June 2011, http://ageconsearch.umn.edu/bitstream/107043/2/11-WP_524.Jun6Revise.pdf (accessed July 18, 2017).

The Folly of Central Planning

The Renewable Fuel Standard mandate demonstrates just how bad the government is at understanding what the market can bear in terms of production and consumption. As Austrian economist F. A. Hayek once said, "The curious task of economics is to demonstrate to men how little they know about what they imagine they can design."[60] No matter how brilliant or well-informed with data, politicians and bureaucrats cannot plan markets and consumer needs. Basic assumptions about the RFS have proven to be short-sighted, revealing the inability of government to plan energy markets.

The Blend Wall

As the RFS has reached the midpoint on the path to its final target in 2022, petroleum refiners have come up against what is known as the blend wall. Because overall gasoline consumption has leveled off as a result of a slower economy and increased fuel efficiency, and because the RFS mandates ever-increasing amounts of ethanol, continued compliance with the RFS would force refiners to blend more ethanol than the market will bear.

According to the RFS, each refiner in the United States has to meet a requirement that a certain percentage of domestic sales contain blended ethanol, called a renewable volume obligation (RVO).[61] Refiners have an option to meet part of their requirement by buying credits instead of blending more ethanol. In order to track the renewable fuel quotas, the EPA requires a 38-digit renewable identification number (RIN) to track the amount of biofuel reaching the market and to hold refiners accountable for blending enough ethanol. Refiners can either hold on to these credits and meet up to 20 percent of the RFS requirement in RIN credits or purchase RIN credits from other refiners when they fail to meet the requirement. Different RIN prices exist for different forms of biofuels.

The RIN trading system has resulted in numerous instances of fraud in which refineries bought fake credits with made-up RIN numbers for millions of dollars. Since refineries now face the blend wall, increased trading for RIN credits has driven up the price of the credit from pennies to over a dollar in 2013.[62] Bloomberg projects that overmandating (requiring the use of more ethanol than can be blended) and forcing the purchase of RINs could cost consumers an additional $13 billion at the pump—an artificial increase of 10 cents per gallon if RIN credit prices stay above one

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[60]Friedrich Hayek, *The Fatal Conceit: Errors of Socialism*, Vol. 1 of W. W. Bartley III, ed., *The Collected Works of Friedrich August Hayek* (London: Routledge, 1988), p. 76, http://www.libertarianismo.org/livros/fahtfc.pdf (accessed July 18, 2017).

[61]U.S. Department of Energy, Energy Information Administration, "RINs and RVOs Are Used to Implement the Renewable Fuel Standard," *Today in Energy*, June 3, 2013, http://www.eia.gov/todayinenergy/detail.cfm?id=11511 (accessed July 18, 2017).

[62]U.S. Department of Energy, Energy Information Administration, "What Caused the Run-Up in Ethanol RIN Prices During Early 2013?" *Today in Energy*, June 13, 2013, http://www.eia.gov/todayinenergy/detail.cfm?id=11671 (accessed July 18, 2017).

dollar.[63] But even if the price of RIN credits falls to 50 cents per credit, consumers will still be slapped with a multibillion-dollar bill.[64]

The economic consulting firm NERA warns that attempting to increase requirements to where the targets were set originally in the Energy Independence and Security Act of 2007 would result in intensified economic damage:

> When the required biofuel volume standards are too severe, as with the statute scenario, the market becomes disrupted because there are an insufficient number of RINs to allow compliance. "Forcing" additional volumes of biofuels into the market beyond those that would be "absorbed" by the market based on economics alone at the levels required by the statute scenario will result in severe economic harm.[65]

Higher economic growth, and therefore higher fuel consumption, could alleviate some blend wall concerns, but increased fuel-efficiency standards and higher volume targets for biofuels could cause the blend wall problem to persist. Flex-fuel vehicles capable of using E85 offer little economic relief for the blend wall. Demand for these vehicles is very low,[66] and drivers who own flex-fuel vehicles often fill their tanks with E10 as opposed to E85 because the energy content in E85 is lower. Adjusted for energy content, E10 makes more financial sense than E85.

Most important, no one knows what the future holds for economic growth and fuel consumption, which is why the government should not predict what markets will bear in 2022 with a law in 2005.

Market Problems with Advanced Biofuels

While corn-based ethanol production has outpaced the blend wall, the production of other biofuels to meet the RFS mandate has woefully underperformed.[67] The production of cellulosic ethanol, made from non-food sources, is nowhere near to meeting its targets, even though the RFS mandates that 16 billion gallons must be used by 2022. High capital costs and difficulty scaling up cellulosic biofuel conversion plants to meet large-scale demand have prevented non-food-sourced ethanol from being an economically viable option.

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[63]Bradley Olson and Dan Murtaugh, "Ethanol Upending Refiners Pushes $13 Billion on U.S. Drivers," Bloomberg, March 19, 2013, http://www.bloomberg.com/news/2013-03-18/refiners-pay-price-as-traders-hoard-ethanol-credits-valero-says.html (accessed July 18, 2017).

[64]For an up-to-date display of RIN prices and trading, see Progressive Fuels Limited, "PFL Weekly RIN Recap," http://www.progressivefuelslimited.com/web_data/PFL_RIN_Recap.pdf (accessed July 19, 2017).

[65]Nera Economic Consulting, "Economic Impacts Resulting from Implementation of the RFS2 Program," July 27, 2015, http://www.nera.com/content/dam/nera/publications/2015/NERA_FINAL_API_RFS2_July27.pdf (accessed July 18, 2017). Prepared for the American Petroleum Institute.

[66]U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Alternative Fuels Data Center, "Flexible Fuel Vehicles," last updated May 18, 2017, http://www.afdc.energy.gov/vehicles/flexible_fuel.html (accessed July 18, 2017).

[67]Purportedly, one of the reasons why Congress capped corn-based ethanol targets at 15 billion gallons annually was to address concerns that the mandate would divert corn used for fuel. Consequently, cellulosic biofuels were introduced into the mandate.

The EPA, which administers the RFS, has had to reduce Congress's original annual quotas for cellulosic ethanol every year since they were required by the mandate because not enough was available on the market. The EPA adjusted Congress's first cellulosic target down from 100 million gallons in 2010 to just 6.5 million. However, even the adjusted mandate was a stretch compared with reality: Zero gallons were produced that year and the following year.[68]

Consequently, refiners had to pay millions of dollars in waiver credits or surcharges for failing to comply with the EPA's minimum volume requirements, and they necessarily passed those costs on to the consumer. In January 2013, the DC Circuit Court of Appeals ruled that the EPA "let its aspirations for a self-fulfilling prophecy divert it from a neutral methodology" and that the target was an "unreasonable exercise of agency discretion."[69] The court vacated the cellulosic ethanol requirement required by the RFS for 2012. The EPA has since proposed cellulosic mandates for 2014–2016 that are equally as out of touch with market realities.

Private Benefits, Dispersed Costs. The strong lobbying of corn producers and the political importance of the geographic region where America produces corn make ethanol policy the perfect example of a focus on political profit as opposed to economic progress. They have been successful despite the unique and diverse mix of organizations opposed to the ethanol mandate.

The RFS essentially mandates a market for corn, soybeans, and biofuels that eliminates much of the risk of investing in biofuels—risk that every industry manages as a matter of doing business and that ultimately is necessary for a healthy and growing economy. Not only does it favor a select few commodities, but the mandate also benefits just a few states at the expense of the vast majority. Over 50 percent of ethanol production is concentrated in three states: Illinois, Iowa, and Nebraska.[70]

Ultimately, however, the benefits enjoyed by biofuel interests are limited and do not help the industry in the long run. The dependence on government to remain viable stunts the industry's long-term growth by propping up bioenergy and distorting the true price point at which biofuels will be competitive in the market.

Can the National Labs Be a Catalyst for Innovation?

The DOE national labs house exceptional staff, research, and facilities. The operating culture and business model of the national labs need to be transformed to engage more with the private sector. Increased access through contract agreements would unlock valuable research and resources for the private sector to develop advances in human knowledge and innovative technologies. It would also leverage private-sector investments to help maintain lab infrastructure.

However, both private-sector access to the labs' assets and research and lab employees' ability to turn research into market applications are stifled by complex and overly restrictive conflict-of-interest and intellectual-property-rights regulations. For example, current contract structures between labs and the private sector are rigid and complex, effectively discouraging private-sector

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[68]U.S. Environmental Protection Agency, "Fuels Registration, Reporting, and Compliance Help."
[69]*American Petroleum Institute vs. Environmental Protection Agency*, 906 F.2d 729 (2013) [D.C. Circuit Court].
[70]Schnepf, "Agriculture-Based Biofuels," p. 18.

engagement. Draconian intellectual-property rules are still on the books in some labs, disincentivizing individuals with patents from working in related fields at a national lab.[71]

In order to increase access to national lab resources, Secretary Perry should:

- Enact rforms to increase lab autonomy;
- Restructure contractual work with the federal government, private sector, nonprofits, and universities;
- Examine alternative financing options for lab infrastructure use; and
- Establish a strong culture in the labs of active engagement with the private sector.

More independence and flexibility at the national labs will extend the value of research funding and infrastructure further. Furthermore, additional managerial and financial authority to the lab contractors would empower them to effectively manage capabilities and create a quicker process for collaborative efforts with third parties, whether with another government agency, another lab, or the private sector. Although these activities are occurring now, such cooperation should become part of the culture of the national labs rather than the occasional exception.

Improving the efficacy at the national labs does not, however, mean the labs should focus on energy-related research and development (R&D). The DOE should engage in R&D only when meeting a clear government objective and when the private sector is not already involved. Government objectives could, for instance, include research, development, and demonstration of technology to meet national security needs, support nuclear stockpile cleanup efforts, or advance human knowledge through basic research where the private sector is not engaged.

No matter how diligent or transparent an administration is, federal funding for R&D beyond these basic conditions will pick winners and losers among companies and technologies. Activities with the purpose of commercialization, regardless of where they lie on the technological development spectrum, are not legitimate functions of the federal government.

On the other hand, if there are legitimate reasons for the DOE to engage in research chemistry, physics, ecology, biology, and biogeochemistry for national security needs or for basic scientific exploration and discovery, reforming the national labs could serve as a catalyst for innovation.

Opportunities for Reform

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[71]Matthew Stepp, Sean Pool, Nick Loris, and Jack Spencer, "Turning the Page: Reimagining the National Labs in the 21st Century Innovation Economy," The Information Technology and Innovation Foundation, The Center for American Progress, and The Heritage Foundation, June 2013, http://www2.itif.org/2013-turning-page-national-lab-executive-summary.pdf?_ga=1.238496128.1484445840.1442263666 (accessed July 18, 2017).

Longtime proponents of the ethanol mandate have come to recognize the problems of corn-based ethanol. In fact, several Members of Congress have introduced legislation to repeal only the corn requirement of the Renewable Fuel Standard.[72]
Removing corn's share of the requirement, perhaps the most economically viable part of the mandate, is problematic for several reasons. Biodiesel generated from soybeans presents the same food-for-fuel problem as the corn-ethanol mandate presents. Advanced biofuels from non-food-based sources are the least economically competitive of all such fuels and demonstrate just how incompetent the federal government is at centrally planning what the market can bear. And both the Renewable Fuel Standard and the federal government's promotion of biofuels create unintended environmental concerns.

To address the blend wall, legislative attempts have proposed to set the final ethanol mandate at no more than 9.7 percent of projected gasoline production. While a 9.7 (or 9.5 as some have proposed) percentage cap would be a step in the right direction, the reform ignores all of the other problems created by the RFS.

The fact that the EPA can use its own discretion to set biofuel targets after 2022 is all the more reason for Congress to act now.

Consequently, Congress should:

- **Repeal the mandate in its entirety and allow consumers a choice at the pump.** Biofuels existed long before the Renewable Fuel Standard and, if economically competitive, will remain long after it is gone. Removing the mandate would encourage a healthier market that promotes risk-taking and entrepreneurial activity rather than dependence on government for near-term survival through favorable policies and tax treatment. It is also important that policymakers not just repeal the corn-based part of the ethanol mandate and leave the least competitive part, the cellulosic requirement, intact.
- **Eliminate the bioenergy programs in the farm bill.** Congress should repeal all of the energy programs in the farm bill: Title IX as well as the Sun Grant program in Title VII.
- **Let producers drive alternative fuel innovation.** Use repeal of the mandate as momentum for greater reform in the energy sector. Such future reform should include a further leveling of the playing field for all energy companies and technologies. Congress should also remove preferential treatment for all transportation fuels and technologies.
- **Provide immediate expensing for capital investments.** Immediate expensing allows companies to deduct the cost of capital purchases at the time they occur rather than deducting that cost over many years based on cumbersome depreciation schedules. As part of broader tax reform that simplifies the code, immediate expensing should be made available for all capital investments.

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[72]News release, "Toomey, Feinstein Introduce Bill to Repeal Ethanol Mandate," Office of Senator Pat Toomey, February 26, 2015, http://www.toomey.senate.gov/?p=news&id=1496 (accessed July 18, 2017).

- **Use the national labs as catalysts to innovation.** The role of the DOE should be to conduct the research to meet government objectives and create a system that allows the private sector, using private funds, to tap into that research and commercialize it. Federal labs should allow research to reach the market organically.

Conclusion

Favoritism toward biofuels and bioenergy has promised much but delivered very little. While a select few benefit from special treatment, bioenergy policies have come at significant cost to taxpayers, energy consumers, the environment, the world's hungriest citizens, and the large segment of the agricultural community that does not profit from the subsidies and Renewable Fuel Standard. Even if biofuels policies worked exactly as intended, Congress should still eliminate them as they pick winners and losers and mandate the production and consumption of one product over another. Eliminating preferential treatment of biofuels is one critical component of what should be a larger initiative to eliminate all transportation fuel and technology subsidies.

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Nick Loris

Herbert and Joyce Morgan Fellow in Energy and Environmental Policy
The Heritage Foundation

Nick Loris, an economist, focuses on energy, environmental, and regulatory issues as the Herbert and Joyce Morgan fellow at The Heritage Foundation. A research fellow in Heritage's Roe Institute for Economic Policy Studies, Loris studies and writes about energy supplies, energy prices, and other economic effects of environmental policies and regulations, including climate change legislation, energy efficiency mandates, and energy subsidies.

He also covers coal, oil, natural gas, nuclear gas, and renewable energy policy and articulates the benefits of free market environmentalism. Loris has testified before House and Senate committees. He has been published and quoted in major newspapers such as The Wall Street Journal and The New York Times. His radio and television appearances include CNN, Fox News Channel, MSNBC, and National Public Radio.

He is a prolific contributor to the energy and environment section of The Daily Signal, Heritage's multimedia news organization. Before joining Heritage in 2007, Loris was an associate at the Charles G. Koch Charitable Foundation, immersing himself for a year in a market-based management program.

He received his master's degree in economics from George Mason University in Fairfax, Va. He holds a bachelor's degree in economics, finance, and political science from Albright College in Reading, Pa. Loris, who was born and grew up in Quakertown, Pa., currently resides in Washington, D.C.

Chairman BIGGS. I thank each of you for your testimony, and I recognize myself for five minutes to ask questions.

And I want to begin with you, Dr. DeCicco. In your statement you mentioned that once indirect impacts are considered, it turns out biofuels have caused higher CO_2 emissions, and I was wondering if you can tell us what some of those indirect causes are producing those indirect impacts.

Dr. DECICCO. Sure, Mr. Chairman. The heart of the problem is really three issues, three types of indirect issues that result in higher emissions for biofuels. One is the basic fact that all of the biofuel production, statistically speaking, when you look at the volumes, is really based on feedstocks, crops, primarily corn and soybeans that are harvested from existing land. In fact, Congress—part of the criteria to qualify for feedstock on the RFS is that, you know, feedstocks that come from existing land.

Now, that was essentially a well-intended provision, but just because we remove, say, nearly on a net basis after counting coproducts about 30 percent of our corn and the calories in that corn from the food market to make fuel doesn't mean that the country has consumed 30 percent less calories. I think we know that. It has to get made up somewhere else.

So, that leads to the next effect of concern, and that's land-use change. And that happens both in the United States and it's been documented by satellite imagery where cropland has expanded into other lands, particularly grasslands in the north central region, prairie States. That—when you convert that land, it releases enormous amounts of carbon that was locked up in those lands.

And then you have the international commodity market effects where, to compensate for the biofuel demand for starch, for corn grain, and for soybean, you end up having to make that up in international markets, and you have more crops planted on the frontier, resulting in deforestation, amplifying deforestation in the Amazon and other carbon-rich areas that creates an enormous release of CO_2.

Then, finally, the third indirect impact is that, yes, the use of biofuels does displace some petroleum fuels, so you reduce petroleum demand; that's true. That has a slight, you know, marginal depressing effect on the price of petroleum products that then induces greater petroleum product consumption elsewhere. That's been also a well-documented indirect effect that, by itself, can erase up to half of the alleged CO_2 emission benefit of biofuels, but since I believe there's no benefit to begin with, that's just additional excess emissions.

Chairman BIGGS. Thank you. Dr. Gilna, what's the primary difference between conventional biofuels produced primarily from corn and the advanced biofuels from nonfood sources that you're researching at Oak Ridge?

Dr. GILNA. Well, the primary difference is its source. As I described earlier, our goal and hopes have been to be able to generate initially biofuels such as ethanol but moving to beyond that to other fuels, higher-order hydrocarbons from plant sources again that do not compete with food and in fact use different non-marginal lands that cannot normally be ascribed or used for food, food production. So, for example, we've talked about and published on

crops such as switchgrass, rapidly growing trees such as populus as a new bioenergy feedstock that allows us to generate fuels, initially, ethanol but now more advanced fuels such as isobutanol. We use the term often drop-in fuels. These are fuels that can use the existing infrastructure, the pump structure and the piping structure. So, essentially, the directions that we're going is in advanced fuels that use the existing system from nonfood crops.

Chairman BIGGS. Thank you.

And then my last question, as I'm almost out of time, is back to you, Dr. DeCicco. You mentioned biofuel policies restricted to basic R&D. Where do you draw the line? How do we make that a bright-line boundary?

Dr. DECICCO. Sure. I think the type of basic R&D needed here is really on sort of the very fundamental mechanisms related to, you know, the manipulation, utilization of organic substances, so some of the very fundamental work that Dr. Gilna has himself done for many years looking at, you know, genetic biochemistry-related things, so stuff that is really enabling and could be potentially used for multiple purposes.

The other really important area of fundamental research in this regard has to do with things that essentially help plants, help natural systems pull CO_2 out of the air more rapidly because, as I mentioned, if there's to be any mitigation effect at all, it doesn't come downstream when you substitute the molecules. It comes upstream by mechanisms that increase the rate at which you pull CO_2 out of the air and then do something with it, which need not necessarily mean turning it into fuel. It could just mean sequestering it. So, fundamental research essentially helps plants sequester, build, rebuild soil carbon and things like that. I think some of that work also goes on at Oak Ridge perhaps in another division.

So, there are certain really fundamental biological sciences work that is crucially important for many reasons. Personally, I draw the line right after that. I think—I don't think the petroleum industry needs help figuring out how to synthesize fuel molecules. They will figure out how to make fuel molecules out of whatever feedstock is economically possible. That's their core competency.

Some of the earliest work on this cellulosic thing, which is over 40 years old, was started by Chevron in the '70s and other oil companies. They've invested in that. I don't think there's a need for federal investment in an area where, you know, the global oil industry has its huge core competency in chemical engineering and related things.

Chairman BIGGS. Thank you.

And now, I recognize the gentlewoman from Oregon, Ms. Bonamici.

Ms. BONAMICI. Thank you very much, Mr. Chairman. And, Ms. Skor, I want to follow up on the question that the Chairman was asking Dr. Gilna. In your testimony, you mentioned that advanced biofuels have the potential to reduce greenhouse gas emissions significantly. It could be up to 100 percent or more over gasoline. Can you please elaborate on why cellulosic biofuels are particularly advantageous, especially to reduce greenhouse gas emissions?

And then also, when comparing the lifecycles of fuels side by side, how would the lifecycle assessments of gasoline compare to the advanced cellulosic fuel that's becoming more readily available?

Ms. SKOR. To your question on the value of the cellulosic biofuel, yes, Argonne National Labs recently finished a study showing that when you're using cellulosic biofuel, you can reduce greenhouse gas emissions up to 100 percent depending on the type of feedstock that you're using. And so, you know, to have that—the research from other institutions, as well as demonstrating that there is a phenomenal increase in the amount of greenhouse gas emissions reduction that you can achieve when you go from the first generation to the second generation of biofuel.

And with regard to the distinction between the lifecycle of the two, I may—as a nonscientist, I may differ a bit more to Dr. Gilna and others in terms of that to answer that question, but I can say that when you look at the totality of research out there and you have to look at independent government research, what is coming out of USDA, Department of Energy, EPA, our national labs and our universities, there's a wide body of consensus from that scientific community when you look at a lifecycle analysis of cornstarch ethanol that is not only good for the environment, it's great for the environment. And depending on the study, that will find—the results are that—anywhere from a 30 to 60 percent reduction in greenhouse gas emissions with cornstarch. And as I said earlier, cellulosic you can get up to a carbon sink.

Ms. BONAMICI. Dr. Gilna, can you answer the question about when comparing lifecycles of fuels side by side how would lifecycle assessment of gasoline compare to advanced cellulosic fuel?

Dr. GILNA. I must confess I'm the pointy-headed scientist in this room, and so my world is more based on the—in the fundamental science, science research, and I would defer to my colleagues——

Ms. BONAMICI. Thank you.

Dr. GILNA. —who work on that.

Ms. BONAMICI. Thank you. Ms. Skor, in his testimony, Mr. Loris argues that when the free market operates, technologies flourish, leading to new job opportunities and economic growth. And he's suggesting that the renewable fuel standard should be repealed to encourage a healthier free market. Can you comment about why the fuels market is not a free market and whether this—the current renewable fuel standard is sufficient to level the playing field, and also importantly, what might happen to rural economies if the RFS was repealed?

Mr. LORIS. Wouldn't it be wonderful if our transportation fuel sector were a free market? Unfortunately, it is not. We are in a situation if you have a renewable source of energy that's higher quality, lower cost, we have to knock on the door to our competitor and ask our competitor to be our customer in order to access the consumer. And the consumer needs that to happen in order to have more choices at the pump to find and select the fuel that is best for their engine needs.

And so the renewable fuel standard doesn't entirely address the problems of this broken system, but it helps by saying that we have goals as a country. We will be blending more biofuels that introduces a bit more competition into the marketplace.

I will say, however, there still exists fuel policies and rules that date back to a time before you had alternative fuels like ethanol and do advantage the oil industry. So again, it starts to correct but does not fully correct that market. I would say one opportunity that is very much in the spirit of free market is lifting Reid vapor pressure restrictions on E15. That simply says consumers, you have the ability to purchase a currently legal fuel all months of the year and not 8–1/2 months.

Ms. BONAMICI. Thank you. And I know there was some concern raised about E15 and—it was a couple years ago in a hearing here that a lot of vehicles couldn't accommodate it. How old does the car have to be to not accommodate it?

Ms. SKOR. Well, let me start by saying E15 is the most tested fuel used in the country. EPA approved it for use in vehicles 2001 and newer. That's 9 out of 10 cars on the road. It has been used by—consumers have driven more than 1 billion miles on E15, and they are not registering complaints in terms of any fuel-related concerns on their engine performance.

Ms. BONAMICI. And also, you know, let's say there's a major event that disrupts the global oil supply. What could an increased supply of domestically produced biofuels do to insulate the United States from the consequences of that kind of event?

Ms. SKOR. One of the goals of the RFS is greater energy security, and so for us to have the ability to produce home-grown renewable fuel does protect us from uncontrollable events in the global marketplace, yes.

Ms. BONAMICI. Mr. Chairman, you did go two minutes over. I have one more question.

Chairman BIGGS. Actually, I completed my question with about 15 seconds to go and the answer took two and a half minutes, so your time is expired. Thank you.

I'll go to the gentleman from Texas, Mr. Weber.

Mr. WEBER. Thank you, Mr. Chairman.

Mr. Loris, in your testimony you talk about this, "chicken-and-egg," approach in energy innovation where supporters of government mandates and subsidies argue that if we want consumers to buy new products, the government should subsidize the infrastructure to deliver that product and then mandate its sale.

Now, let me just parenthetically say we want to be careful because the next thing you know the government will be mandating we all have to buy some form of health insurance. I'm just saying. Does any of this government meddling help that new product—in this case biofuels—become more cost-effective, efficient, or competitive? I won't ask you to opine on the insurance market.

Mr. LORIS. Yes, I appreciate that. In the long run, no; it promotes technological stagnation. And markets overcome chicken-and-egg problems all the time. As I said, it wasn't all that long ago in terms of historical senses where people didn't have access to cell phones and you need cell phone towers to have access to cell phones and use them appropriately. The market solved that chicken-and-egg problem where cell phones are so rapid and expansive that even homeless people have them now.

So, I don't know what technological innovations will come from the government's investing in these things. It may result in a few

refueling stations, but that shouldn't be the role of the government. You have Tesla, who's investing a lot in refueling stations for electric vehicles using their own money with some subsidies from State Governments, but they should be funding those refueling stations on their own, too, just as natural gas vehicles should be doing the same for their infrastructure. That's not the role of the federal government to solve this chicken-and-egg problem when markets do it all the time.

Mr. WEBER. You don't want the federal government setting up refueling exchanges?

Mr. LORIS. I'll pass.

Mr. WEBER. Okay. I got it. A smart man. So what you're saying is that the market itself, in the name of competition, manufacturers will produce a more efficient product, a more cost-effective product on their own, and if the government mandates and gets involved and subsidizes, then as I said in my opening statement, they have a habit of picking winners and losers, unfortunately, more losers than winners.

Mr. LORIS. That's right, and it creates a dependence on those programs. And when these companies are dependent on targeted tax credits or loan guarantees, they fail to recognize the true price point at which they're cost competitive with other fuels, and so that's absolutely right.

Mr. WEBER. Sure. You bet you.

Is it DeCicco?

Dr. DECICCO. That works.

Mr. WEBER. That works? DeCicco, okay. Okay. Well, I think I'm going to come to you here in a little bit, but I just want to make sure I have your name right.

Dr. Gilna, let me jump over to you real quick. In your prepared testimony, you mentioned the history of DOE biological sciences. It's my understanding that much of Oak Ridge National Lab's expertise in biological systems—and you've said this as much—came from early work related to the Manhattan Project. And I think it's interesting, you know, ironically so, that much of our discussion has nothing to do with nuclear fuel. It was based on national security. And you could say the nucleus of that—of this project developed from the Manhattan Project.

So, can you share some of the background on that expertise, how it got developed, how it's helping us today?

Dr. GILNA. Well, first, I may not have been clear. I think the point—one point to be made here is that there is a history that goes all the way back of biology research at the Department of Energy that stemmed from the scientific needs——

Mr. WEBER. Give me a year for that.

Dr. GILNA. So, back 50 years at least.

Mr. WEBER. Yes.

Dr. GILNA. So, there's been biology research in both ERDA and the Atomic Energy Commission dating all the way back to the early days of Los Alamos. Where—what that has led to has been now using those capabilities and that knowledge now focused on genomic aspects of microbial science, of energy science, and plant science in particular. So it's a long-standing history that really has—is now being applied to energy issues by and large.

Mr. WEBER. Thank you.

Dr. DeCicco, you said in your testimony some harsh—you had harsh words for DOE Office of Energy Efficiency and Renewable Energy programs, EERE. Quote, "DOE and other agencies have supported bioenergy research, demonstration, and deployment in many decades and with billions of dollars. None of the promised cellulosic fuels have become commercially viable, even with subsidies." Why do you think the programs in EERE have become so unsuccessful? You've got 30 seconds.

Dr. DECICCO. Well, they've simply failed to deliver on promises that we've now heard for decades. I mean, with all due respect to, you know, Dr. Gilna, I heard those same things that—you know, 25 years ago when I began focusing on these issues. It's a difficult problem, that's true, but at some point you have to recognize that we should move on to other areas of research that might be more promising.

Mr. WEBER. Mr. Chairman, I yield back.

Chairman BIGGS. Thank you.

I recognize the gentleman from Texas, Mr. Veasey.

Mr. VEASEY. Thank you, Mr. Chairman.

I wanted to ask Dr. Gilna a question. The Trump Administration has proposed to gut DOE research into bioenergy in its fiscal year 2018 budget request. Specifically, the DOE Office of Science's bioenergy research centers would see their annual budget cut by about 60 percent and the Bioenergy Technology Office would be cut by about 72 percent. Also, I think, which is equally concerning, is the House appropriation bills that come before the chamber later this week include similar severe cuts, and I wanted to know if you could describe the consequences of the proposed cuts in the budget request would have on the bioenergy research centers if enacted? And please be as specific as possible.

Dr. GILNA. Well, firstly, I should be sure to thank the Members of Congress for the fact that the BRC centers are in the appropriations this year. I think that's important and important to continue this work. I think to help calibrate all of the centers that have been selected for funding based on the DOE request for proposals came in at around $25 million a year, again, by design. So, at this point in time the effect of the proposed budget is that the centers are essentially reduced by 25 percent—50 percent, excuse me.

In essence, what this means simply is that some aspects of the work will simply not get done. The science will focus on specific issues but not the broad breadth of work that was called on from the centers. And I think people and essentially partners that I described earlier will get dropped.

I think the bigger issue will be if you think of the ten years of activity and a thousand scientists, we've reached the sort of critical mass of scientific production in this country, and I think that the potential consequence of this drop is a stutter step in that productivity.

Mr. VEASEY. More broadly, what would the proposed cuts do to federally funded bioresearch centers and the progress that we've made up to this point?

Dr. GILNA. Well, essentially, we would—we talked—I talked earlier—and I can speak more specifically to the Oak Ridge Center,

so we talked about continuing extensive research in two model cellulosic crops, either populus—or poplar trees and switchgrass as a grass. And, in essence, I think in order to fit to the lower constraints, we would essentially diminish if not indeed rule out at least one of those crops, switchgrass, which would drop some partners as well.

Mr. VEASEY. What about—you know, one of the things that you hear any time we get ready to have this debate is that if the federal government is not helping out in this area, if they're not—if funding is cut from the federal government, that there's just going to be this avalanche of money that's going to come in from the private sector, and America will keep its competitive edge because the private sector will want to just vigorously jump in and just—and put money into these projects. What—I mean, what is your opinion on the private sector funding research that is proposed for elimination, as some have suggested today?

Dr. GILNA. I don't—I didn't include this with my testimony and I should have, but we have produced a single graph that depicts all the logos from the different companies that have come to work with us. We call this our NASCAR slide because there's at least 100 logos on that slide. And in all those cases these represent companies that have come to us, the centers, for help, for increased knowledge, as well as obviously to license products that they can take forward. So, you know, if the issue is would industry simply do this itself, I think the evidence suggests no.

Mr. VEASEY. Thank you very much. And I wanted to ask a quick question to Mr. Loris. In your testimony, you stated unequivocally that, "Activities with the purpose of commercialization, regardless of where they lie on the technological development spectrum, are not legitimate functions of the federal government." Nowhere in that entire section that criticizes DOE's R&D investment do you cite any data, study, or report to back up that statement. To me it sounds like it's very political and out of touch with reality, and I wanted to know if you had any actual data to support that statement, that certain activities are not legitimate functions of the federal government, and not any anecdotes or political theories but just some real data to support what is a very broad statement.

Mr. LORIS. Well, I don't think the federal government should be involved in trying to predict what our future energy sources should be, so it is looking at that—whether or not it is a legitimate function of the federal government. I don't know what will be our energy future, whether it's fusion, whether it's batteries, whether it's biofuels. The market will sort that out. We've had a number of projects in which the Department of Energy provided loan guarantees to solar companies, to carbon capture and sequestration plants that have failed miserably on the backs of the taxpayers, and so I think there's plenty of evidence in which we've lost taxpayer dollars trying to predict what those technology futures will be.

And again, I don't think it's the role of the federal government to try to lower the cost to make these technologies competitive in the marketplace. There was DOE's SunShot Initiative which said it was going to take solar from the basic research level and make it commercially viable. That is the role of the private sector. It's not the role of the federal government.

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

Chairman BIGGS. Thank you, Mr. Veasey.

The Chair recognizes Mr. Dunn, the gentleman from Florida.

Mr. DUNN. Thank you very much, Mr. Chairman, and thank the panelists for being here as well. It's always fun to hear from so many very learned people.

Dr. DeCicco, the—there's a lot of timber in the 2nd Congressional District of Florida. It's the largest agricultural product that we have. It's a very agricultural district. It's a huge driver of our economy. We have about 4.5 million acres of timber under cultivation. The pulp and paper manufacturers in Florida's 2nd District also generate energy from their biomass, so I was going to ask you a biomass question. Is the minimally produced woody biomass that is burned to generate the bioenergy—and most of that is just scrap that they're generating themselves—to power these pulp and paper mills closer to carbon neutral than other renewables you've studied?

Dr. DECICCO. Yes, it is. In that case you have something, you know, pulp and paper, black liquor, things like that that are byproducts that might otherwise be dumped and then just decay. So, the reason that those are beneficial typically is because—take, you know, some of these residues and black liquor is concentrated—if that was just dumped, it would eventually and in fairly short order break down, and that means it gets gobbled up by organisms, and they exhale the CO_2 and that CO_2 goes into the air. So, by taking those things that would otherwise decay and then using them to make energy instead of, say, natural gas or some other fossil fuel, you have essentially reduced emissions by reducing the emissions of decay. You've not changed how much emissions come out when you burn it, but you've avoided those emissions from those waste products just kind of going back into the atmosphere through natural processes. So, that is an example of a potentially and likely beneficial bioenergy process.

Mr. DUNN. All right. Let me follow on if I may. So you—we talked about the DOE's research portfolio, and over time, that has shifted towards these advanced biofuels, the drop-ins and whatnot. And I mean, I guess I'm wondering do you think that these advanced new biofuels will actually become commercially competitive with petroleum-based products?

Dr. DECICCO. I see no evidence for that. I mean, again, that promise has been made in one form or another for decades. That was the premise—I mean, it was, you know, President Bush who, in his 2007—January 2007 State of the Union got up and talked about cellulosic ethanol, talked about switchgrass as a source of fuel, and the mandate that, you know—for the cellulosic products I did a back-of-the-envelope calculation based on EPA's most recent rule, and this year, the amount of cellulosic fuel is only three percent of what was targeted for the RFS, and most of that three percent is biogas. And again, when—he got up and talked about cellulosic ethanol. We're talking about a liquid fuel that everybody could use in all their cars. I don't think he was talking—you know, it was not sold to the American people to, you know, pardon the, you know, informality here to—that we'd be running our cars on cow farts. I mean, most of the cellulosic has been gaseous at this point.

So, it's just, you know, pretty consistently failed to deliver. Fundamental research is needed. As I said, I think the very fundamental work is legitimate, but then trying to turn, you know, stuff into molecules, I don't think the federal government needs to keep investing in that.

Mr. DUNN. So I wasn't going to wander into that area, the biogas, but we actually have one of the largest dairies in the country in the district, and they have 14,000 dairy cows, and they are recycling. They have this biogas plant that actually generates more energy than they can use on the farm, and I can't remember——

Dr. DECICCO. That's——

Mr. DUNN. —I think it was like two or four——

Dr. DECICCO. That's—I'm not saying that——

Mr. DUNN. —two to four megawatts of energy on this thing. And the guy is a real entrepreneur. He's really making this thing go, and it's exciting, if a little bit odorous to be there but——

Dr. DECICCO. Sure. No, I'm a big fan of biogas. I think it's a great thing. I just don't think that that is what, you know, we need a mandate for, you know——

Mr. DUNN. So, I think——

Dr. DECICCO. —billions of gallons of fuel——

Mr. DUNN. —we have 15 seconds left, and I just want to say I've seen—I was not a big fan of biogas, did not believe in it until I got to this farm and they do it. They do it on their own dime. There's no subsidies, there's no tax breaks, and he's running all of his farm—several farms on either side of him as well.

I yield back, Mr. Chair.

Chairman BIGGS. Thank you.

The Chair recognizes the gentleman from New York, Mr. Tonko.

Mr. TONKO. Thank you, Mr. Chair.

I come into this hearing without many predetermined conclusions. I do not have any major corn or oil interests in my district, so I appreciate all of our witnesses taking the time to better educate us today.

I do have a few principles on when it comes to thinking about biofuels and their use. First, I care deeply about fighting climate change, and we should consider how investment in biofuels are indeed—can impact greenhouse gas emissions.

Secondly, regardless of the blend of our liquid fuels, our vehicles should use those resources as efficiently as possible and always keeping in mind that they cannot be a substitute for our vehicle fuel efficiency standards.

And finally, in the long-term, I truly believe we must promote greater electrification of the transportation sector. It is necessary and probably inevitable, but I also recognize we are decades away from that becoming a widespread reality. But even with greater electrification, aircraft and ships and possibly heavy trucks will still require liquid fuels. It is critical that we continue to develop a domestic advanced biofuels industry. I understand the industry has not developed as predicted, but Congress should not undercut or disincentivize that industry's future development.

I also remain concerned about major cuts that the Trump Administration has proposed, especially how these cuts will affect the world-class research happening at our national labs. No matter our

individual thoughts on this specific issue, I hope my colleagues on both sides of the aisle can come together to agree that, as a nation, we must invest in research. To not do so would be costly in terms of innovation, in terms of job growth and our future workforce.

With that being said, Ms. Skor, what have been the biggest factors in holding back development of advanced and cellulosic biofuels?

Ms. SKOR. Thank you. The biggest factor has been a lack of stable policy guiding investors, guiding innovation. If you look at the EPA's implementation of the renewable fuel standard, it took three years to figure out the rules of the road. We then had an economic recession. And then in 2014 to 2016 for three years the EPA was not coming out with blending targets. And as a result, the—that had a very chilling effect. As a country, we lost more than $20 billion in investment and innovation during that time frame because the signal the government was giving to investors was we will turn back the clocks on renewable fuels.

Fortunately, we've gotten back on track. The blending targets are—have been in 2017 and proposed 2018 more in line with Congressional intent, and you are seeing an infusion in the private sector now into the investment and the technology and innovation.

So having said that, we've only been working on cellulosic for ten years. The government started investing in fracking technology and R&D back—as far back as 1975, and that took 30 years to get to the commercial point with that technology. So, I would say that we are very much at commercial scale with cellulosic. We aren't as advanced as we'd like to be, but we are making progress.

Mr. TONKO. Thank you. And would additional federal research monies help open pathways or lower costs for more feedstocks to become viable alternatives to corn ethanol?

Ms. SKOR. I think Dr. Gilna very beautifully articulated that, yes. And I would say, as a blanket statement, if our goal is energy innovation, energy diversity, energy dominance, energy stability, any of those goals require both public and private investment and collaboration. We have, as an industry, benefited from government support and R&D throughout the innovation spectrum and would continue to do so, yes.

Mr. TONKO. Thank you. And, Dr. Gilna, one of Mr. Loris' criticisms of the DOE national laboratories is that they need to transform in order to, I quote, "engage more with the private sector." Mr. Loris—and the Heritage Foundation also strongly advocate eliminating any research that they do not consider to be either basic or early-stage research. These two criticisms seem to contradict each other. Based on your experience, on what types of activities is the private sector most interested in collaborating with the national laboratories?

Mr. LORIS. Based on my experience, the most productive and valuable experience is when industry and the labs work together to solve problems in a collaborative fashion. Most often, it is recognition on the part of industry that a problem in the pipeline is basic research-based. And so coming to use the capabilities and knowledge base of universities and the national labs is the best form of synergy that can help solve industry's problems.

Mr. TONKO. Thank you. And——

Chairman BIGGS. Thank you, Mr. Tonko. Your time is expired. Thank you.

The Chair recognizes Mr. LaHood from Illinois.

Mr. LAHOOD. Thank you, Mr. Chairman.

And I want to thank the witnesses for being here today, for your valuable testimony on this debate.

And we've talked here today about the role of the federal government on this issue, and I think it's important to remember the genesis of the current RFS policy was put in place under the George W. Bush Administration under a Department of Energy led by Dr. Samuel Bodman, who was no shrinking violet when it came to energy policy and putting this forth. And while it may not be perfect, it has been a policy that, again, going back and looking at it, is one that was, you know, put in place with valid reasons for it.

And as someone that represents a district that's fairly rural, a lot of agriculture there, I look at the RFS and I see the real results of biofuels: innovation in a district like mine, also improving the environment, creating lots of jobs in rural America and driving fuel efficiency.

And we've heard a lot today and competing studies going back and forth on different initiatives and whether they've worked and of agro-companies benefiting specifically from this. I could just tell you, in a district like mine, rural communities, local jobs have been enhanced by ethanol and biofuels. We have the largest dry mill ethanol plant in the world in my district owned by a local family, all local jobs, all local businesses, not some carveout for a big company. And so, I also see the technology and the innovation that has gone in there in terms of constantly improving and modernizing this technology, and there's been real effects of that that have been beneficial to folks I think throughout, you know, the middle part of the country.

Ms. Skor, let me ask you a little bit about the RFS. A lot of this is implementation through the EPA, and I know you work with them on that. Can you talk a little bit about the problems in the past and the future—or I guess looking at the future on how—what EPA does impacts the RFS in terms of the biofuels industry?

Ms. SKOR. Yes, the EPA administers the RFS, and so the way in which they do that, being timely and being genuine and true to Congressional intent is mission critical for our ability to make the RFS successful, as envisioned by Congress. And some of the challenges in the implementation side that I talked about a bit before really go back to EPA's delays and coming out with targets, blending targets on time, consistent with Congressional intent in a way that gives certainty and stability to the marketplace because private sector will respond to the direction and the tone set forth by the Agency.

We've had several conversations with this Administration. Administrator Pruitt has consistently pledged to come out on time and comply with Congressional intent, and that's very encouraging news for us to hear that because that's the most important thing EPA can do to help make the renewable fuel standard as successful as possible.

Mr. LAHOOD. And when you look at the rollback of the RFS in 2014, 2015 and '16 in the new Administration, has the biofuels industry seen any improvement with the implementation of the RFS?

Ms. SKOR. The 2018 proposed RBOs were the first real test of this Administration's pledged support for biofuels, and we're encouraged at the blending targets, $15 billion for conventional corn, so yes, that's very encouraging to see that. We want to have greater conversation on some of the advanced and cellulosic target numbers and better understand. Those numbers are below 2017. We think the market is moving in a much more forward, positive direction, and so that's a conversation we'll have in the weeks and months ahead.

Mr. LAHOOD. And can you give us an update on where E15 sales currently are and what kind of impact it's making on consumers at the pump?

Ms. SKOR. There's been discussion this morning about picking winners and losers in the marketplace, and I think the goal for all of us is that the consumer picks the winner and the loser. And what you are seeing with the E15 experience that's now sold in 29 States is that when consumers actually have the chance to have greater choices at the pump, they are exercising that and they are reaching for E15 because they see the benefits to their pocketbook. They save 5 to 10 cents a gallon, the benefits to the environment and to their community.

Mr. LAHOOD. Thank you. Those are all my questions, Mr. Chairman.

Chairman BIGGS. Thank you.

The Chair recognizes Mr. Norman, the gentleman from South Carolina.

Mr. NORMAN. Thank you, Mr. Chairman.

Dr. DeCicco, in your testimony you mentioned that federally funded research and development should be precompetitive. What does that mean, and how would we prioritize this kind of R&D in the future?

Dr. DECICCO. Well, I think precompetitive, you know, speaks to some of the very issues where we have some, you know, disagreements here. You know, precompetitive really refers to the very basic research—again, some of the biochemistry, molecular, biology, genetic engineering, things like that—that provide new knowledge that can be used by industry to produce new products, produce better products, and all of the above. But when you get into trying to do something to make a specific product, you know, where the government is going to try to make a fuel, that is right there in the competitive realm.

The downstream industries, downstream petroleum industry is a very competitive industry in terms of the technologies. They're always looking for ways to make fuels, fuel molecules that meet the standards of high performance at lower cost. So, I do not think actual fuel synthesis is, you know, necessary in this—you know, for R&D.

Mr. NORMAN. Thank you.

Mr. Loris, policymakers have I guess made the argument that subsidized biofuel production will reduce the dependence on foreign energy sources. Do you agree or disagree?

Mr. LORIS. Yes, but marginally. I mean, again, as I mentioned in my oral remarks, the U.S. biofuels market represents only five percent of the entire transportation fuels market. We've seen a lot of penetration of natural gas vehicles, so if you're going to mandate the production of increased and offer more biofuels, that's going to in some senses reduce our dependence on oil and foreign oil, but it's a drop in the bucket compared to how much we use.

Mr. NORMAN. So, the yield on the—the return on investment is not there in your opinion?

Mr. LORIS. Not for the cost that we're paying, certainly not.

Mr. NORMAN. Thank you.

I yield, Mr. Chairman.

Chairman BIGGS. Thank you.

The Chair recognizes the gentleman from Indiana, Mr. Banks.

Mr. BANKS. Thank you, Mr. Chairman.

I'm new around here, so I'm trying to figure all of this out. And to jump right into the conversation, many conservatives argue that mandates like RFS, while intentioned for incorporating and advancing biofuel development into the market, has not accomplished what it set out to do in the first place.

So, as I look at—as I research a little bit about Growth Energy and look at the FEC campaign filings, which appear that Growth Energy PAC, which is associated with your organization, Ms. Skor, gives a lot of money away to candidates for federal office who support RFS. When I look at the list of board members on your website, it appears that your board members benefit quite handsomely from RFS.

I wonder—my question is actually for you, Mr. Loris. I wonder, as I look into that background, how much can we rely on research from an organization like Growth Energy—their research, their testimony, their studies—when it appears that they gain a pretty significant political benefit from RFS in the first place?

Mr. LORIS. Well, I won't speak to the credibility of their research, but I will say that when you point to job numbers created by the RFS and by government subsidies, what you don't see is the costs not just to the taxpayers but where those investments could have been made elsewhere. Yes, if you mandate something or subsidize something, you're going to get people to produce that, you're going to have jobs as a result, but those are investments and that's an opportunity cost where those investments could have been made elsewhere. You could use your taxpayer money elsewhere. Those private sector investments that chasing—that are chasing public money could have been invested elsewhere as well. So, you have—when you look at government-subsidized jobs, you also have to look at the opportunity cost of what that money could have been spent on.

Mr. BANKS. So, as I dig a little bit deeper, one of Growth Energy's board members said that "Mandating biofuels is the renaissance of rural America" is what he said. Is that true? Are mandating biofuels really the cure for American energy or the, "renaissance of rural America," or is this just another example of crony capitalism?

Mr. LORIS. Yes. I would say it's cronyism for sure. And then we do have a lot of cronyism in energy markets. It's not limited to

biofuels, but absolutely when there are certain select few that benefit in these rural communities. But as I mentioned in my oral remarks as well, there were certain rural communities that bet big on this promise and lost. There's a lot of local and state incentives, and when you had corn price spikes in 2008 and 2012, a lot of these companies went belly up. Contracts to farmers weren't paid. You had these small towns going through very difficult bankruptcy litigation. You had tenant farmers who were being squeezed out of the land because the land prices were increasing so much.

So, even in rural America I think there's been a lot of winners and losers, not to mention again all the livestock producers and the increased costs for animal feeds, which is why you have organizations like the Turkey Federation and the Chicken Council and the Restaurants Association, which are also a lot of small-business owners opposing this policy.

Mr. BANKS. So, you would agree then that actually we've—with RFS we've actually distorted the market?

Mr. LORIS. Absolutely.

Mr. BANKS. Okay. My next question, when I look at Growth Energy's website, they claim that the use of American ethanol reduces our nation's overreliance on volatile foreign energy markets. And Ms. Skor's own testimony states that every gallon of clean-burning ethanol decreases our dependence on foreign oil. But from my research, from a lot of sources, it seems that the United States has become in fact more reliant on foreign imports of soybeans and ethanol from South America to comply with RFS's goals.

So, Mr. Loris, can you speak a little bit about the accuracy of Ms. Skor's testimony about reliance on the RFS eliminating the reliance on foreign imports?

Mr. LORIS. Yes. Well, in terms of biomass diesel, we have seen a huge increase in imports from—I believe it was 7 million gallons in 2009 to over 900 million gallons in 2016. We are now a net importer of biomass diesel by about 600 million gallons. So, yes, we are relying on these other countries who can provide these fuels cheaper. And that's not to say in a world where we have the RFS we should limit our ability to import it. If other countries can make this product cheaper, then we should be able to import it, but that just slaps in the face of economic reality if we have to slap tariffs on our U.S.-based biofuel production to keep it competitive and keep it meeting America's market demand that's a result of the actual mandate.

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

Chairman BIGGS. Thank you.

Ms. SKOR. Mr. Chairman?

Chairman BIGGS. The Chair recognizes the gentleman from Illinois, Dr. Foster.

Mr. FOSTER. Yes. I guess I would like to use the first 45 seconds of my time to allow Ms. Skor to answer some of the things.

Ms. SKOR. Thank you. There were a lot of statements with respect to Growth Energy's credibility, and I just wanted to correct the record on a few things.

First of all, our industry does not enjoy any government-subsidized jobs. The biofuels industry today does not have any tax incentives. We once did, a blender's tax credit, that expired with our

support in 2011. I would say in contrast the oil and gas industry today enjoys more than $4 billion in annual tax incentives, so I just wanted to set the record there.

With respect to the question on the renaissance for rural America, it is very true and very important that the biofuels industry provides a wonderful marketplace for the American farmer. We, as a country, are so fortunate to have such a robust agricultural sector, and we—the—our American farmers are growing more with less every year, and they need a marketplace. Ethanol provides a wonderful marketplace for the farmer. So to the extent that my members and ethanol producers are successful, it is a result of being able to provide a marketplace for the American farmer, while also providing a high-energy, high-octane fuel.

Mr. FOSTER. Thank you. That was two points that I intended to make myself. And, you know, I think the distortion of the marketplace, you know, caused by the subsidies for fossil fuels that are not present for biofuels are really, you know, a painful distortion of the marketplace that's hurting rural America, and so I should—I put myself on the record as a strong supporter of ethanol.

I think a lot of the attacks against ethanol are based on really obsolete research, that if you look at a state-of-the-art ethanol plant, it has made impressive gains in its energy efficiency and reuse of DDGs, all that sort of stuff. If you actually scored the carbon footprint, for example, for a modern ethanol plant, it is a big win for the environment.

And I think that since we generally do not look at the social impact of CO_2 emissions in general in most economic analyses that it is appropriate to frankly distort our economy in the opposite direction to make ethanol—you know, make ethanol and biofuels generally, those with good carbon footprints, preferred.

I'd also like to talk a little bit about, you know, this question of whether you have—whether long-term federal research—you know, at what point you make the transition from that to just say, okay, let the market decide. And if you look at some of the things that are going to be transformative in biofuels for—in the next few years, there's no question that high on that list is CRISPR, you know, the ability to do genetic engineering of crops. This is going to be transformative for everything you can name. It avoids a lot of the discussions—you know, many people, you know, for good reasons or bad, are very reticent about using genetically modified food, but, you know, genetically—ethanol made with genetically modified organisms has little science-based objection to it.

And so this is something that was—went from being, you know, deep speculative federally funded research to just transformative to the medical industry and in the coming years to biofuels in very short order, and so I think it's a mistake to contemplate the sort of draconian budget cuts that we're seeing to federally funded, you know, quote/unquote, you know, curiosity-based research because of the speed at which that can go from being a laboratory curiosity to something that our future economy depends on.

And so I was wondering if any one of you wants to kind of—to, you know, speak, for example, on, you know, the massive budget cuts that we are seeing contemplated by the Trump Administration

in research that is long-term research but yet targeted in the long term towards energy? Yes.

Dr. DECICCO. Yes, I do want to make clear, you know, when I've been critical of the direction of some of the research oriented to making biofuels, that that should not be taken to think that I think that we should contract federal support for research overall, so I'm really talking about a need to reprioritize, perhaps focus more on fundamentals, focus more on other areas. So, I really think that the country needs to maintain a very high level and very robust level of federal investment in fundamental science and R&D, all the different areas of science to, you know, really help the country maintain competitiveness and give industry the new knowledge and the new insights that it can run with.

So, just—even though I'm—I feel like there's a need for reprioritization and to question some assumptions around the particular area of bioenergy, I think, you know, the country definitely should maintain a high level of federal research investment overall.

Mr. FOSTER. Thank you. And I believe my time is expired.

Chairman BIGGS. Thank you.

The Chair recognizes the gentleman from Texas, Mr. Babin.

Mr. BABIN. Thank you, Mr. Chairman. I appreciate it. Thank you, witnesses.

Dr. DeCicco, your testimony stated that biofuels mandates and subsidies have largely failed because they are designed to promote fuels that are, "fundamentally inferior to liquid hydrocarbons," for most transportation needs. What scientific breakthroughs would be necessary to change the potential of biofuels to compete on a performance basis with hydrocarbons?

Dr. DECICCO. Well, there was a lot of increasing emphasis, including direct federal subsidization of biofuel companies. One of the notable bankruptcies was a company called KiOR that received many tens of millions of dollars of federal grants. It also had private investment. And it promised to make fuels that were fully fungible, in other words, to take biomass, use a process known as pyrolysis, and convert it into the kind of molecules that we find in ordinary gasoline and diesel fuel.

Liquid hydrocarbons, when it comes to liquid fuel, they're pretty much as close to perfect as you can get for fuel. They don't really need to be improved upon. You can make octane—octane itself is a hydrocarbon, okay, so you can make it, make octane enhancing components of various kinds from many sources. Biomass is a potential source, but that should be really dictated by the economics.

Ethanol is an octane booster, there's no question about that, but it's not the only way to boost oxygen. And fuels no longer need oxygen in them. Ms. Skor mentioned, you know, the oxygenate mandate, which happened before the RFS after the MTBE phaseout. There was a time when it was thought that oxygen would be beneficial in a fuel. That time has long since come and gone with advances in reformulated gasoline, reformulated—well, you never want oxygen in diesel anyway.

So, you know, the point here is that, again, to go back to my earlier point, you know, the industry—the petroleum industry knows how to make a very excellent fuels, and I don't think there's anything to offer on the bio side to make a better fuel. But the banner

clean burning is just in my view—I'm sorry, it's just rhetoric. There's no scientific basis because you can burn gasoline now extremely cleanly.

Mr. BABIN. Thank you very much.

And, Dr. Gilna, do you agree with what he said, and why or why not? And what research are you conducting at BESC that would help accomplish this goal?

Dr. GILNA. Well, if you will allow me, I'd like to give a somewhat folksy answer to your question, and it's simply this. I—my wife and I have a granddaughter. She's two years old, Molly. And of this much I am certain, that whatever she uses when she's my age to fuel her hover car will not be fossil fuel-based unless at least it's synthetic. So I think from my perspective certainly we need and have the opportunity here to take a long view, and that is the role of government in basic research here is we need to develop options. It may or may not be biofuels. Right now, as far as I'm concerned personally, the investment of my time and my skills is best pointed at that. But I think as a country, we need to—we need a diversity of options for the consumer for fuels. That's my folksy answer.

Mr. BABIN. Okay. Well, let me ask you a little bit further, then. If she's 2 and when she's your age—and you look like a fairly young guy—are you saying that she will not be using fossil fuels because there—that won't be available or because there will be other developments besides biofuels, et cetera, et cetera?

Dr. GILNA. My basic premise here is that, no matter where they come from, our fossil fuel resources in this—on this planet are by definition finite.

Mr. BABIN. Now, we've had numerous, huge findings——

Dr. GILNA. We have.

Mr. BABIN. —around the world some people say that will last us for the next two centuries. Were you aware of that?

Dr. GILNA. Yes. Yes. But I actually—I still believe that alternatives and choices are needed.

Mr. BABIN. Yes, sir. Dr. DeCicco?

Dr. DECICCO. One of the things that people fail to understand in the renewable debate is that the resource for making biofuels is far more limited than the fossil resource because that resource is high-quality arable land. Talk about finite. That is finite. That's why, as the ethanol mandate or RFS has ramped up, sod has been—had to been busted. We've had to—had indirect effects moving into deforestation. Land is not renewable. It's one of our most precious resources. And how we use that land and what we use that for is absolutely critical, and in my view the science, which I know my science dissents from the many piles of studies that have been generated over the years talking about the benefits of biofuels, the issue here is the opportunity cost of land.

Natural arable land is by definition already removing CO_2 from the atmosphere. That's why it's productive. If we were to have the kind of breakthroughs to, say, grow algae in test tubes in the desert, well, that would be potentially beneficial. And really fundamental work—not trying to, you know, turn the algae into fuel but work on maybe organisms that can do that better than current algae, that's—falls within the very fundamental work that I think the government should be investing in.

But I just want to point out that this claim of renewable for biofuels is in many ways very misleading because land is a precious resource, and we are far closer to running out of good land with all the different needs for land than we are for running out of the fossil resource underground.

Mr. BABIN. Thank you.

Thank you, Mr. Chairman.

Chairman BIGGS. Thank you.

The Chair recognizes the gentleman from Kansas, Mr. Marshall.

Mr. MARSHALL. Thank you, Chairman.

I think I'll start with Ms. Skor. And I apologize for being late. We were talking about foot-and-mouth disease over in ag land and thought that was a pretty important topic, too.

I do live in the largest ag-producing district in the country, and when ethanol was first becoming of age, one of the biggest concerns was going to be the price of corn. We have lots of feedlots. And so what has happened to the price of corn since ethanol's came—come around and expanded and the price of corn and the cost of food as well?

Ms. SKOR. The price—first of all, one thing that the ethanol marketplace has done is provide stability in corn prices, which is extremely important for the corn farmer. I will say the price of corn today is actually lower than it was when the RFS was enacted and expanded. And so there is stability, but you aren't seeing off-the-charts corn prices right now.

With respect to food prices, if you open up Wall Street Journal or Bloomberg or Financial Times, you'll read stories about the fact that, as a country, we are experiencing an all-time low continuous trend in terms of food prices. I know the U.N. has an index looking at the price of cereal, and the price of cereal is lower than it was in 2007 when we expanded the renewable fuel standard. And so there is not a correlation in terms of the price of food and expansion in terms of ethanol production. The data clearly show there's not a correlation.

Mr. MARSHALL. Ms. Skor, I've visited with several ethanol plants, and they typically offer a nickel or dime more a bushel to the farmers. Is that a typical across-the-country situation or I think it's unique in Kansas?

Ms. SKOR. I think there are many ethanol plants that are co-op farmer-owned, and so they're very sympathetic to the farmer and they're comfortable—they would like to make a profit, and they're comfortable with the farmer making a profit as well. As an industry, we are public—we have publicly owned plants and privately owned and large and small, so we really reflect the country as a whole.

Mr. MARSHALL. Yes, it's been a great example of American ingenuity in my district. I think we're up to ten ethanol plants in the State now. Also, when the corn came along, I mean like ethanol came along, the cattle feeders had lots of concerns. And through modern technology, I have something called dry distillers grain that not only is used in the local feedlots but we're even able to export it. Could you comment a little bit on dry distillers grain and some of the other byproducts that we're seeing with our ethanol plants now?

Ms. SKOR. Many people don't know that an ethanol plant is actually a biorefinery, and we have many coproducts that we produce. One of them is distillers grains. It's a high-protein animal feed. It's actually the second-largest source of animal feed within the country, and it is so economical and so healthy for the animal that we do have a substantial export market for the distillers grains as well.

Mr. MARSHALL. Who are we exporting it to? Is it China or who gets most of it?

Ms. SKOR. China has been a wonderful trading partner for both distillers grains and ethanol. It's unfortunate this year that they are erecting some protective tariffs in place, and so that's a real challenge for the U.S. agricultural sector.

Mr. MARSHALL. I think I'll finish up with just my—you know, national security of course is on everyone's mind, and one of my goals I said on the campaign oftentimes was someday I hope my grandson never has to use gasoline from imported oil. And in fact we're saving, they say, maybe 2 billion barrels of foreign oil each year from being imported. The biofuel is—the first generation is corn ethanol and advanced biofuels. How do the—how do these greenhouse emissions differ from the corn ethanol versus advanced biofuels?

Ms. SKOR. You nearly double the greenhouse gas reduction when you go from first-generation cornstarch ethanol to second-generation, and you're starting at a pretty healthy baseline with a 43 percent reduction to begin with, so substantial savings when you're talking about the environment.

Mr. MARSHALL. Okay. I yield back the remainder of my time. Thank you.

Ms. BONAMICI. We don't have any, Mr. Chairman, but if you're willing to do a second round of questions, we'd be interested.

Chairman BIGGS. As much fun as this has been the first round, and I do think it's been very interesting and very, very informative, I think we'll pass on the second round of questions. Thank you, though.

I thank the witnesses. It's been very interesting and valuable testimony, very informative.

The record will remain open for two weeks for additional comments and written questions from Members. I appreciate the remarks regarding mandates, subsidies, innovations, basic versus fundamental research, been very interesting.

This hearing is adjourned.

[Whereupon, at 11:53 a.m., the Subcommittees were adjourned.]

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