UP AGAINST THE BLEND WALL: EXAMINING EPA's ROLE IN THE RENEWABLE FUEL STANDARD

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY POLICY, HEALTH CARE AND ENTITLEMENTS

OF THE

COMMITTEE ON OVERSIGHT AND GOVERNMENT REFORM

HOUSE OF REPRESENTATIVES

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UP AGAINST THE BLEND WALL: EXAMINING EPA's ROLE IN THE RENEWABLE FUEL STANDARD

Wednesday, June 5, 2013,

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY POLICY, HEALTH CARE & ENTITLEMENTS,
COMMITTEE ON OVERSIGHT AND GOVERNMENT REFORM,
Washington, D.C.

The subcommittee met, pursuant to call, at 10:05 a.m., in Room 2154, Rayburn House Office Building, Hon. James Lankford [chairman of the subcommittee] presiding.

Present: Representatives Lankford, Gosar, Jordan, Chaffetz, Meehan, DesJarlais, Farenthold, Woodall, Issa, Speier, Norton, Duckworth, Davis, Cardenas, and Horsford.

Staff Present: Kurt Bardella, Majority Senior Policy Advisor; Richard A. Beutel, Majority Senior Counsel; Joseph A. Brazauskas, Majority Counsel; Daniel Bucheli, Majority Assistant Clerk; Caitlin Carroll, Majority Deputy Press Secretary; John Cuaderes, Majority Deputy Staff Director; Brian Daner, Majority Counsel; Linda Good, Majority Chief Clerk; Tyler Grimm, Majority Professional Staff Member; Ryan M. Hambleton, Majority Professional Staff Member; Scott Schmidt, Majority Deputy Director of Digital Strategy; Jaron Bourke, Minority Director of Administration; Nicholas Kamau, Minority Counsel; Adam Koshkin, Minority Research Assistant; and Rory Sheehan, Minority New Media Press Secretary.

Mr. LANKFORD. The committee will come to order.

I would like to begin this hearing by stating the Oversight and Government Reform mission statement.

We exist to secure two fundamental principles: first, Americans have the right to know that the money Washington takes from them is well spent and, second, Americans deserve an efficient, effective Government that works for them. Our duty on the Oversight and Government Reform Committee is to protect these rights. Our solemn responsibility is to hold Government accountable to taxpayers, because taxpayers do have a right to know what they get from their Government. We will work tirelessly in partnership with citizen watchdogs to deliver the facts to the American people and bring genuine reform to the Federal bureaucracy. This is the mission of the Oversight and Government Reform Committee.

Drivers across America today are going to fill up their gas tanks and they are going to complain about the price of energy. We are

Americans; that is what we do. We love to travel, but we hate to pay high gas prices.

But there is also a new complaint: the frustration of filling up your car with ethanol, which is made from food and doesn't burn as efficiently as gasoline; also, the variety of different options of what engine can take what fuel.

I didn't bring it with me today, but I have a 2011 vehicle that, when you open up the gas cap, on the door itself, on my vehicle, it has a big circle and a slash through it that says E15, telling me don't you dare put that fuel in this vehicle, even though it is a 2011 version.

Renewable Fuel Standard, the RFS, requires that 35 billion gallons of ethanol equivalent biofuels and 1 billion gallons of biomass-based diesel be refined by 2022. To get there, refiners must have increasing amounts of renewable fuels, like corn ethanol into gasoline, each year.

However, when this law was written, in 2005, and expanded in 2007, we were living in a different time, and the drafters assumed that gas demand would continue to increase. Since then, the recession and the increased CAFE standards have pushed down the demand for gasoline.

There is increasing evidence that RFS is not meeting the original bifold purpose to move the United States towards greater energy independence and security, and to increase the production of clean renewable fuels.

Another market change since 2005 and 2007 is the current domestic energy boom, leading us to greater energy independence and security by leveraging our domestic petroleum supplies. Second, corn-based ethanol may not be any cleaner than gasoline and has other negative environmental consequences, such as using more water for reducing corn-based energy than refining gasoline.

To account for these future uncertainties, Congress gave the EPA waiver authority to suspend RFS requirements for various reasons. EPA may waive requirements if there is an inadequate domestic fuel supply or if implementation of a requirement would severely harm the economy or environment of a State region of the United States. Last year, for example, in response to catastrophic drought conditions, several governors petitioned for a waiver. Although EPA found that the drought had created significant hardships, particularly for livestock producers, EPA did not grant the waiver.

Now we have a new challenge; it is called the blend wall. Because the law requires increasing amounts of renewable fuels be blended into gasoline each year, if demand for gasoline goes down, the only way to meet the standard is by blending a higher percentage of ethanol.

Currently, it is not uncommon to see E10 or 10 percent ethanol fuel. This year, however, refiners predict they will have to blend into E15. This presents two problems: it may be a defective product. Many automakers will void warranties if motorists use anything higher than E10 in their cars because of the engine damage it can cause, especially to older cars, boats, engines, and non-vehicle motors. As I have already mentioned, for my truck, at home as well, even though it is a newer vehicle.

Consumers don't want it at times. In my home State of Oklahoma, you will frequently find gas stations advertising pure gasoline containing no ethanol in response to consumer demand. It is not uncommon for a gas station in Oklahoma City with a giant banner out front of it that says we sell real gas.

By requiring refiners to produce a product that consumers can't use and don't want, it is only logical that this constriction of the market will increase fuel prices, causing economic damage as well. According to a study done by the economic consulting firm NERA, mandating E15 could increase the cost of gasoline by as much as 30 percent by 2015 and increase the cost of diesel by as much as 300 percent by 2015.

In addition to refiners and consumers, other stakeholders are affected by this market distortion. Because of the over-reliance on food-based ethanol as a renewable fuel, the RFS has a negative impact on our food supply and security.

The goal of this hearing is to see how we can alleviate the pressure on consumers. One way to do this is to change the law. That is the job of the Energy and Commerce Committee, not this committee. This committee oversees how the Executive Branch is implementing the current law.

Today we will seek to learn what EPA can do, has done, or maybe has not done to ease the burden on consumers.

I thank the witnesses, all of them, for their participation today and I look forward to hearing their testimony.

I now recognize the distinguished ranking member, the gentlelady from California, Ms. Speier, for her opening statement.

Ms. SPEIER. Mr. Chairman, thank you. I have a solution for you with your 2011 car. I just drove half way across the Country in my 2008 Prius that takes any amount of fuel from any of those gas stations and got me 45 miles to the gallon. So I highly recommend Priuses as potential cars for the future.

Mr. LANKFORD. I could actually, with my Ford truck, put that Prius in the back of it.

[Laughter.]

Ms. SPEIER. It is very roomy inside. I am going to take you for a ride in it.

Mr. Chairman, thank you. Let me start off by reading this quotation: Our prediction, if things go very, very well, is that renewables could supply somewhere in the order of 30 percent of the world's energy demands by the middle of this century.

Now, as you think about who might have said that, I am sure lots of ideas come to mind that they may indeed be biofuel producers. But, as it turns out, the person who made this statement was the president of Shell Oil Company, Marvin Odum, in Qatar, at a recent conference that took place there. This is Shell Oil Company talking about the benefits of renewables.

The majority has chosen today to focus this hearing on only one aspect of the Renewable Fuel Standard: our Nation's signature law promoting the transition to cleaner fuel futures that Shell Oil and others say is on the rise. The so-called blend wall is an important and pressing issue for agriculture, refiners, and consumers. However, as we address the blend wall, we must not lose sight of the forest for the trees.

The RFS, on the whole, is about national security, clean energy innovation, and job creation. As a matter of fact, domestic biofuels have created 400,000 jobs and $50 billion in new activity.

Mr. Chairman, I have a letter here from Congressman Bruce Braley that I would like to submit for the record, that references the fact that our hearing today does not have one renewable fuels producer testifying and, in his State, there are some 39 ethanol plants with over 3 billion gallons of annual fuel production offering jobs to 63,000 people, and about two of the first cellulosic ethanol plants in the entire Nation are under construction in his home State. Those two plants coming on line will generate 6 million tons of biomass available to convert to cellulosic ethanol. So I would like to submit this for the record.

Mr. LANKFORD. Without objection.

Ms. SPEIER. In light of calls from some quarters to repeal the RFS, I would remind my colleagues that the RFS originated as bipartisan legislation designed to achieve these critical goals. The RFS was first included in the 2005 Energy Policy Act under a Republican Congress and was signed into law by President Bush. In 2007, the law was expanded with passage of the Energy Independence and Security Act, also signed into law by President Bush.

To be sure, I have my own concerns over the impacts of the Renewable Fuel Standard on our vehicle fleet, on the food versus fuel problem, and on our environment. The law's implementation has been far from perfect, but make no mistake, the EPA is charged with administering the RFS according to the law that Congress passed, and the RFS is still a relatively new policy. The EPA must use the flexible authority Congress granted it to ensure the RFS stays on track to meet our national clean energy goals.

I look forward to hearing from the EPA today on how the agency intends to weed out any waste or inefficiencies in the programs and protect the integrity of its program moving forward.

Moreover, as business works to scale up the production of cellulosic and other advanced biofuels, now is not the time to throw the baby out with the bath water by undermining the law before it has a chance to succeed. We are only one-third of the way into the RFS program; yet, renewable fuels remain capable of creating 52 billion gallons of biofuels annually, decreasing dependence on foreign oil, reducing trade deficits, creating jobs, and reducing air pollution.

The path forward demands continued support for those innovative technologies to produce alternative fuels such as biobutenol, cellulosic ethanol, green diesel, and green gasoline in order to provide clean energy now and for future generations.

Thanks to the RFS, the first two commercial-scale second generation biofuel plants to be built in the U.S. are coming online this year, employing hundreds of Americans and injecting millions of dollars into local economies. Companies in Florida, Iowa, Kansas, Michigan, Nevada, Oregon, Texas, and Wyoming are leveraging the RFS to build the next wave of biorefineries in the years ahead, and not with one taxpayer dollar.

In short, keeping the Renewable Fuel Standard on track is critical if America is to succeed in the clean energy race of the 21st century. These are not Democratic goals or Republican goals; these are American goals. Our Nation's top scientists and military commanders have repeatedly and urgently signaled the need to move forward on alternative fuels.

At the end of the day, the question we need to ask is whether we want to produce real alternatives to oil in our fuel supply or not. American families who continue to suffer the consequences of a transportation system that is more than 95 percent dependent on oil know the answer to the question is yes.

Mr. Chairman, I also have a couple other documents to submit for the record. One is from the Biotechnology Industry Organization and the other from the Advanced Biofuels Association.

Mr. LANKFORD. Without objection.

Ms. SPEIER. Thank you.

Mr. Chairman, one more point. We also are in the middle of the mark on the National Defense Authorization Act, of which I am a member of, so I am going to have to move between committees for the next two hours, and I apologize in advance for my inability to be here for the whole hearing.

Mr. LANKFORD. We will make sure that when we are talking about you is when you are gone, then. How about that?

Ms. SPEIER. Thank you.

Mr. LANKFORD. Okay.

Members will have seven days to submit opening statements, as well, for the record.

We will now recognize our first panel.

Mr. Jack Gerard is the President and CEO of the American Petroleum Institute; Mr. Joel Brandenberger is the President of the National Turkey Federation; Dr. Jeremy Martin is the Senior Scientist of the Clean Vehicles Program of the Union of Concerned Scientists; and Mr. Lucian Pugliaresi is the President of the Energy Policy Research Foundation.

Gentlemen, thank you all for being here. Pursuant to committee rules, all witnesses are sworn in before they testify. If you would please rise and raise your right hand.

Do you solemnly swear or affirm the testimony you are about to give will be the truth, the whole truth, and nothing but the truth, so help you, God?

[Witnesses respond in the affirmative.]

Mr. LANKFORD. Thank you. You may be seated.

Let the record reflect that the witnesses have all answered in the affirmative.

In order to allow time for discussion, please limit your testimony to five minutes. Your entire written statement, of course, will be made part of the permanent record for this hearing.

Mr. Gerard, you are up first, it looks like. We will be honored to receive your testimony.

WITNESS STATEMENTS

STATEMENT OF JACK GERARD

Mr. GERARD. Great. Thank you, Mr. Chairman and Ranking Member Speier and members of the subcommittee. It is a privilege to be with you today. I appreciate the opportunity to share with you API's concerns regarding the renewable fuels standard.

API, as you are probably aware, represents all aspects of the Nation's oil and natural gas industry. We support employment for over 9.2 million Americans, constitute over 7.7 percent of our gross domestic product, and deliver more than $85 million a day to the Federal Government in the form of taxation, royalty, and other sorts of revenue.

With the limited time we have today, I would just like to move right to the point: The Renewable Fuel Standard is irreparably broken and poised to do significant harm to consumers, the economy, and the Nation's fuel supply. The impact of the mandate has been made worse by EPA's unwillingness to let science, court decisions, and common sense guide its implementation.

Now EPA is currently facing the biggest test of all that has been mentioned already this morning, the E10 blend wall. The renewable fuel mandates in the Renewable Fuel Standard increase yearly, while demand for fuel in the United States is dropping, creating a situation known as the E10 blend wall. When this happens, refiners will be forced to blend a fuel with more than 10 percent ethanol or reduce production to meet the mandate, thus creating a crisis for consumers, whose automobiles are built and warranted for E10. In fact, most consumer engines are designed for an E10 blend, including small engines, such as motorcycles, boats, and lawnmowers.

EPA's actions to approve E15 despite scientific evidence showing millions of automobiles could face engine and fuel system damage is an unnecessary risk to consumers, to automobiles, and to small engines.

Quite frankly, EPA's implementation of the RFS is galling. The agency has continued to set unrealistic cellulosic standards since 2010, resulting in refineries having to pay the Government a fee for a fuel that doesn't exist. Further, even after the industry successfully sued the Government for the return of our phantom fuel fees, EPA doubled down on its indefensible action by setting the 2013 target volume even higher, flouting a U.S. Court of Appeals decision issued just days earlier striking down their 2012 mandate.

To give you a big-picture view of the problem, let me summarize the study conducted by NERA Economic Consulting that Chairman Lankford mentioned earlier. The study found that once the blend wall is breached, the cost associated with diesel fuel would increase by 300 percent by 2015. Cost associated with gasoline would increase by 30 percent by 2015. In broad economic terms, the RFS could cause a $770 billion decrease in U.S. GDP by 2015 and reduce take-home pay for American workers by $580 billion. Staggering numbers.

Keep in mind all of this stems from EPA's dogged enforcement of an obsolete law, which was written at a time of assumed energy scarcity for our Nation and heavy dependence on foreign-sourced energy. That is not our reality today.

These impacts are unnecessary. The fact is the blend wall and its harmful impact on consumers could be prevented today if EPA would simply use the waiver authority, mentioned earlier, contained in the law to waive the RFS completely or to at least waive down the volumes below the 10 percent.

Bottom line, EPA must act now to avoid the impending blend wall crisis. Longer-term, in our view, the best solution is for Congress to repeal the RFS once and for all.

The stakes are simply too high for inaction, which could cost consumers millions of dollars, place at risk small engines and automobiles, and unnecessarily burden an already shaky economy.

Thank you very much for your time and attention. I look forward to your questions.

[Prepared statement of Mr. Gerard follows:]

U.S. House of Representatives

Committee on Oversight & Government Reform

Subcommittee on Energy Policy, Health Care and Entitlements

Up Against the Blendwall: Examining EPA's Role in the Renewable Fuel Standard

Testimony of Jack N. Gerard

President and CEO of the American Petroleum Institute

June 5, 2013

Good morning Chairman Lankford, Ranking Member Speier, and members of the Subcommittee. Thank you for the opportunity to address API's concerns regarding EPA's implementation of the Renewable Fuel Standard.

API represents all sectors of America's oil and natural gas industry, which provides most of our economy's energy, supports 9.2 million American jobs; 7.7 percent of the U.S. economy, and delivers more than $85 million a day in revenue to the federal government.

Let's get right to the point: The Renewable Fuel Standard (RFS) is irreparably broken and poised to do significant harm to consumers, the economy and the nation's fuel supply. The impact of the mandate has been made worse by EPA's unwillingness to let science, court decisions, and common sense guide its implementation.

Now, EPA is currently facing the biggest test of all - the E10 blendwall. The renewable fuel mandates in the RFS increase yearly, while demand for fuel in the U.S. is dropping, creating a situation known as the E10 blendwall. When this happens, refiners will be forced to blend a fuel with more than 10 percent ethanol or reduce production to meet the mandate, thus creating a crisis for consumers, whose automobiles are built and warranted for E10. In fact, most consumer engines are designed for an E10 blend, including small engines, such as motorcycles, boats and lawnmowers.

EPA's actions to approve E15 despite scientific evidence showing millions of automobiles could face engine and fuel system damage is an unnecessary risk to consumer safety, automobiles and small engines.

Quite frankly, EPA's implementation of RFS is galling. The agency has continued to set unrealistic cellulosic standards since 2010, resulting in refineries having to pay the government a fee for a fuel that doesn't exist. Further, even after the industry successfully sued the government for a return of phantom fuel fees, EPA doubled down on its indefensible actions by setting the 2013 target volume even higher – flouting a U.S. Court of Appeals decision issued just days earlier striking down the 2012 mandate.

To give you a big-picture view of the problem, let me summarize the study conducted by NERA Economic Consulting. The study found that once the blendwall is breached, the cost of diesel could increase by 300 percent by 2015. The cost of a gallon of gas could increase up to 30 percent by 2015. In broad economic terms, RFS could cause a $770 billion decrease in U.S. GDP by 2015 and reduce take home pay for American workers by $580 billion.

Keep in mind all of this stems from EPA's dogged enforcement of an obsolete law, which was written at a time of assumed energy scarcity for our nation and heavy dependence on foreign-sourced energy. That's not our reality today.

These impacts are unnecessary. The fact is the blendwall and its harmful impact on consumers could be prevented today if EPA would simply use the waiver authority contained in the law to waive the RFS completely or at least waive down the volumes below 10 percent.

Bottom line, EPA must act now to avoid the impending blendwall crisis. Longer-term, in our view, the best solution is for Congress to repeal RFS once and for all.

The stakes are simply too high for inaction, which could cost consumers millions of dollars, place at risk small engines and automobiles, and unnecessarily burden our still shaky economy.

Thank you for your time and attention today.

Mr. LANKFORD. Thank you.

Mr. Brandenberger.

STATEMENT OF JOEL BRANDENBERGER

Mr. BRANDENBERGER. Chairman Lankford, Ranking Member Speier, members of the subcommittee, my name is Joel Brandenberger. I am president of the National Turkey Federation, which represents 98 percent of the commercial turkey industry in this Country. I am testifying today on behalf of 148,000 growers and employees nationwide working at more than two dozen processors and 300 allied companies that comprise the $29 billion U.S. turkey industry.

Our members and I thank you for this opportunity to discuss the impact of the Renewable Fuel Standard and to examine the role EPA plays in managing this exceedingly rigid Government mandate. We will look at the way the RFS has distorted feed costs and how that has increased the prices consumers pay at restaurants and in grocery stores. We will also show you how EPA has ignored or certainly underutilized the significant power Congress gave it to prevent this very situation.

Everyone involved in the ethanol debate loves to cite facts and figures to support their case about what the RFS has or has not done, but the truth can be done in just a few key statistics.

When the RFS was created in the 2005 energy bill, livestock and poultry consumed about 55 percent of the corn crop and ethanol about 14 percent.

Today, by gobbling up 43 percent of a larger corn crop, compared to livestock's 41 percent, ethanol has become the Nation's top corn consumer. Ethanol consumption of corn has jumped by 3 billion bushels in that time and feed usage has dropped by 1.5 billion bushels.

Turkey production, which was on the rise in 2006, began plummeting in 2008 and remains today almost 10 percent below its 10-year high. Most others in livestock and poultry would tell similar stories.

The RFS is to blame, period. Corn is the major ingredient in turkey feed, as it is for almost all livestock and poultry. Higher corn prices led a North Carolina company earlier this year to announce it is ceasing turkey production after more than a half century in business. Last year, a California company declared bankruptcy, citing the RFS as the major factor in its decision. Under similar circumstances, in 2008, two turkey companies went out of business; a grower and cooperative in Iowa cut production by 50 percent and another cooperative in Mr. Chaffetz's district closed its doors for three months.

The turkey industry already has lost 750 jobs this year. You would have to build quite a few ethanol plants to replace those lost jobs. If the feed supply does not become more secure and feed costs do not stabilize, other companies could find themselves at risk.

Many economists and meat and poultry producers predicted this outcome. The only ray of hope at the time the RFS was created was Congress's decision to allow EPA to waive all or part of the mandate if economic circumstances warranted. Twice now States have petitioned the EPA for such a waiver and both times EPA has denied the request. The impact of the most recent waiver denial is still being felt today.

The failed waiver process is the biggest indicator of just how flawed and rigid the RFS really is. I am sure no one intended to craft a policy that picked winners and losers among the Nation's corn consumers and that hurt hardworking Americans, but that is what happened because the waiver process, as written, is not quick, is not efficient, and is highly politicized.

Though it anticipated the potential need for RFS flexibility, Congress did not anticipate the RFS, after nearly a decade, would remain the primary force behind ethanol production. The ethanol industry's extreme dependence on the RFS results in EPA facing enormous political pressure when a waiver request is submitted.

In 2008, EPA denied a waiver request from Texas, despite circumstances that would have led anyone to believe that the corn crop was going to be short. In the end, EPA's gamble paid off that year and the market adjusted. But last year, when several States, led by Arkansas and North Carolina, submitted waiver petitions, EPA went double or nothing on its bet and again denied the petitions, stating an RFS waiver would not impact ethanol production and thus "will have no impact on corn, food, or fuel prices." The agency claimed to have extensive analysis to support that decision, but it didn't actually release that analysis at the time it rendered its decision.

EPA also failed to follow the statutory requirement that it consider regional impacts of the RFS, stating it was required only to determine the mandate's national impact. With such a generalization, EPA effectively rendered the waiver mechanism meaningless.

Unlike 2008, the outcome of EPA's gamble is far from clear. The weather refuses to cooperate. In place of drought you have extreme rains in the heartland that are slowing corn and soybean plantings. Corn contracts for the month of May closed at more than $7 a bushel, more than two and a half times the price of corn pre-RFS.

The Government can't control the weather, or most factors that affect the corn supply, but it does have the power to take pressure off the corn markets. The consequences of not using that power are becoming more severe. Turkey companies and others that produce animal proteins are cutting production; income on livestock and poultry farms is declining; workers in meat and poultry plants face cutbacks; and every American is feeling the bite at the dinner table and at the gas pump.

It is time to repeal a significant portion of, or drastically reform, the RFS, and we thank you for the opportunity to be part of that process today. I would be happy to answer any questions.

[Prepared statement of Mr. Brandenberger follows:]

Written Testimony of Joel Brandenberger

President, National Turkey Federation

June 5, 2013

Chairman Lankford and Ranking Member Speier, my name is Joel Brandenberger, and I am president of the National Turkey Federation (NTF). NTF represents 98 percent of the commercial turkey industry, and I am testifying today on behalf of more than 148,000 growers, more than two dozen processors and more than 300 allied companies that comprise the $29.5 billion U.S. turkey industry.

Our members and I want to thank you for the opportunity to discuss the impacts of the Renewable Fuel Standard (RFS) and to examine the role the Environmental Protection Agency (EPA) plays in managing this exceedingly rigid government mandate. Our focus today will be on the way the RFS has distorted feed costs for turkey producers – as well as the rest of livestock and poultry producers – and ultimately how that distortion has unnecessarily increased the prices consumers pay for food at restaurants and grocery stores. We also will show how EPA has ignored the significant power it was given by Congress to prevent this very situation from occurring.

Everyone involved in the ethanol debate likes to trot out facts and figures to support their case about what the RFS has and has not done. I'm going to keep it exceedingly simple here at the start:

- When the first RFS was created in the 2005 Energy Bill, livestock and poultry were consuming more than 6.1 billion bushels of corn, or about 55.2 percent of the crop. Back then, ethanol used 1.6 billion bushels and that amounted to 14.4 percent of the corn crop.

- Today, livestock and poultry consume about 4.4 million bushels, or 40.8 percent of the crop. Ethanol today consumes 4.6 billion bushels of corn: that's 42.7 percent of all the corn produced in the country. On top of that, corn stocks are at near-record lows and corn prices at near-record highs.

- Turkey production, which was on the rise in 2006, began plummeting by 2008 and still remains almost 10 percent below its 10-year high. Most others in livestock and poultry would tell similar stories.

Those are pretty sobering statistics, and nothing but the RFS is to blame. Energy costs are higher than in 2006, but the increase in energy prices are only a fraction of the increase in corn prices. Corn is the major ingredient in turkey feed and almost all livestock and poultry. Corn is the primary reason why one turkey company went bankrupt in 2012 and why the industry already has lost 750 jobs in the last 12 months. You would have to build 10 to 15 ethanol plants to replace the jobs that were lost in rural America last year alone.

Almost everyone involved in meat and poultry production predicted this outcome when the first RFS was being debated. The only ray of hope we had at the time was that Congress allowed EPA to waive all or part of the RFS, if economic circumstances permitted. Twice now, states have petitioned the EPA for such a waiver, once in 2008 and again last year. Both times, EPA has denied the request. Though it was not apparent at the time EPA denied the 2008 waiver, the market corrected relatively quickly. In last year's case, though, it is unclear whether EPA's decision is not going to have long-lasting consequences. Six months have passed since the waiver was denied, and the consequences are still being felt in the turkey industry. The lack of flexibility on the part of EPA to waive a part or this entire mandate also is having real consequences on Americans from their dinner table to their paycheck.

The failed waiver process is only a symptom of what is a flawed, rigid government policy that is the RFS. While I am sure the decision makers at the time had good intentions to develop a policy that did not pick winners and losers or adversely hurt other industries unintentionally, the fact is it has done all these things. Current U.S. biofuels policy contains escalating corn-based ethanol blending requirements (RFS) that do not automatically adjust to energy and corn market realities. That same policy contains cellulosic ethanol requirements that do not reflect the fact that the biofuels industry, despite decades of effort and large subsides, has failed to develop a commercially viable process for converting cellulosic biomass to ethanol.

Corn-based ethanol blending requirements have pushed corn prices, and thus ethanol production costs, so high that the market for ethanol blends higher than 10 percent are essentially non-existent. That same policy has also destabilized corn and ethanol prices by offering an almost risk-free demand volume guarantee to the corn-based ethanol industry. Domestic and export corn users other than ethanol producers have been forced to bear a disproportionate share of market and price risk.

Additionally, consumers have seen food prices increase faster than general inflation since the current RFS was enacted in 2007. Food affordability, which had been improving for decades, now is deteriorating.

Job creation in the food sector has been substantially reduced by the diversion of corn to ethanol production. Almost 1 million potential food sector jobs that could have been created from 2007 to 2011 were not. Diversion of corn to ethanol production is one contributing factor to the prolonged recession in the U.S. labor market.

It can also be proven that increases in ethanol production since 2007 have made little, or no, contribution to U.S. energy supplies, or dependence on foreign crude oil. Domestic gasoline production and crude oil use have not been reduced. If the RFS is made more flexible, and ethanol production shrinks because of market forces, we can easily replace ethanol with gasoline currently being exported.

Corn users, such as the turkey industry, need assurance of market access in the event of a natural disaster like the one we experienced last year that lead to a significant reduction in corn production. Ethanol producers should fully share the burden of market adjustments, along with domestic food producers and corn export customers. Ethanol prices should reflect the fuel's energy value relative to gasoline, not a corn price that is both inflated and destabilized by the inflexible RFS.

Finally, the RFS schedule should be revised to reflect the ethanol industry's inability to produce commercially viable cellulosic fuels. Policy should reflect reality when undeniable barriers to achieving policy goals exist.

Despite the inflexible nature of the RFS, Congress did give the meat and poultry industry an out. When Congress enacted the expanded RFS in the Energy Independence and Security Act of 2007 (EISA), the structure was complex. Given the 15-year statutory schedule imposed by the law – including the specification of four different fuel mandates, each with a separate schedule – Congress wanted to ensure that certain "safety valves" for the RFS would be available. Thus, EISA retained and expanded Clean Air Act (CAA) section 211(o) (7). Among other provisions, CAA section 211(o)(7) allows the Administrator of the EPA to reduce the required volume of renewable fuel in any year based on severe harm to the economy or environment of a state, a region or the United States, or in the event of inadequate domestic supply of renewable fuel. This is the waiver I mentioned at the outset of this testimony.

We were assured back in 2007 that the waiver provisions in CAA section 211(o) (7) were an important part of Congress' intended implementation of the RFS. This waiver authority would help guarantee the domestic economy and environment were protected as production of conventional renewable fuels increased and we moved to broader use of advanced biofuels. Clearly, in 2007 Congress anticipated that unforeseen circumstances would require the EPA to exercise flexibility with the RFS.

Now, five year later, U.S. corn prices have consistently risen, and the corn market is increasingly volatile since the expansion of the RFS in 2007. This reflects the reality that more than 40 percent of the corn crop now goes into ethanol production. As noted, ethanol now consumes more corn than animal agriculture, a fact directly attributable to the federal mandate. While the government cannot control the weather or almost any other facture that can come to bear on the U.S. corn supply, it fortunately has one tool still available that has the potential to directly impact corn demand. By adjusting the normally rigid RFS mandate down to align with current market conditions, the federal government can help avoid dangerous economic situations caused by prolonged record high cost of corn.

This year, as we sit here today, the U.S. corn supply is facing dangerously low carryover stocks again and regardless of what ultimately will happen with the weather situation (currently the

largest corn producing state is underwater during planting season) later this summer – if there is a hiccup in planting we will see another significant increase in corn prices and we will truly be faced with shortages of corn or a drastic increase of corn imported from other countries to meet the demand for livestock and poultry production.
On November 16, 2012 the EPA rejected requests from the Governors of Arkansas, North Carolina, New Mexico, Georgia, Texas, Virginia, Maryland, Delaware, Utah and Wyoming who asked for waivers from the RFS. They were joined by members of Congress and a coalition representing farm groups, other industries and interest groups that oppose increased mandated corn ethanol production.

EPA turned down the request, stating "the body of information shows that it is very likely that the RFS volume requirements will have no impact on ethanol production volumes in the relevant time frame, and therefore will have no impact on corn, food or fuel prices." They went on to say that their, "extensive analysis makes clear that Congressional requirements for a waiver have not been met and that waiving the RFS will have little, if any, impact."

The troubling part of this statement is that to date, even after Congressional inquiries were made, the EPA has not made available to the public the "extensive analysis" so that Congress and the American public could review EPA's findings and if the facts do bear out their claims. Despite what we believed was a strong case for severe economic harm, EPA did not allow the waiver and corn contracts for the month of May closed around $7.60 a bushel which is over two and a half times the price of corn pre RFS.

One analysis of what the waiver might have done suggests that a waiver of the RFS in 2013 could have been a $52 per capita decrease in food and fuel cost for everyone man women and child if they would have granted the 100% reduction of the RFS for one year – that is $208 back in the pocket for a family of four. For U.S. consumers that's about a $16 billion dollar hit with a total economic impact of about $31 billion that will not go back to hard-working families.

In the turkey business alone, extrapolate that scenario out and we would expect about a $1.31 increase per bushel with soybean meal adjusting proportionate to corn. So, the impacts of the waiver being rejected to our industry would likely to be in the ballpark of a $435 million tax on turkey farmers this year. To put this in perspective, the turkey industry used approximately $2.4 billion in grain and oilseed meal in 2011. If last year did not have enough conditions present to prove "severe economic harm" then what catastrophic event has to happen in order to get EPA to grant this needed relief?

Contrast the facts surrounding the 2012 waiver request with the first time a state asked EPA for relief from the RFS back in 2008. The EPA Administrator Stephen Johnson, at that time, said "the government agency denied the waiver request because it did not find that the RFS caused "severe economic harm," continuing "the EPA's professional staff conducted a detailed analysis and found that the RFS mandate is not causing severe economic harm, but rather strengthening the nation's energy security and farm communities." A similar response and again very little of the EPA analysis ever reached the American people. The following year we saw how price spikes caused by this government mandate impacts turkey growers when corn prices reached almost $8 per bushel, U.S. turkey production declined by 9 percent, resulting in loss of rural jobs.

What followed was a nationwide reduction in protein production that had a negative impact on all companies and all segments of the turkey industry. Regardless of plant location, an average 9 percent cut in pay to the growers impacted not just the growers themselves but also their local communities and rural economies. Additionally, it is important to remember that 9 percent represents a national average; in some areas, the impact was more severe. Because of the increased 2008 corn prices, two companies, representing more than 50 individual growers made the difficult decision to close their doors for good. While some of those growers found new processors for whom they could work, others were forced out of the turkey business for good. That year, another western-state turkey operation stopped production for three months in an effort to wait out high prices. Finally, another company, a grower-owned cooperative, was forced to cut its production during that time by 50 percent.

Now, because of the structure of the turkey industry, a large portion of the economic harm incurred by the exponential rise in corn and soybean prices is absorbed by our companies or cooperatives. However, the harm to the turkey grower is often overlooked. The typical turkey grower relies on an average of 3-4 flocks of turkeys a year and in most cases is paid on the weight of those flocks at the time of processing. When corn prices rise and feed prices escalate beyond a certain point, most turkey companies will reduce production. On October 9, 2012 Zacky Farms, a California turkey processor, announced it had filed for Chapter 11 protection and cited increased feed costs as a key factor in the company's financial struggles. This year, a North Carolina based turkey company closed its doors to turkey production. If feed costs do not decline, other companies could find themselves at risk. While we have all heard the sound bites about how the RFS has put money back into farm families' pockets – just as many or more rural communities that rely on meat and poultry production have been negatively impacted with job loss or decreased profits due to the arcane and inflexible government mandate. We are paying the price now; ultimately everyone will end up paying more for this ill-conceived government policy.

Thank you Mr. Chairman for the opportunity to testify today, I will be happy to answer any questions at this time.

Mr. LANKFORD. Thank you.
Dr. Martin.

STATEMENT OF JEREMY I. MARTIN, PH.D.

Mr. MARTIN. Chairman Lankford, Ranking Member Speier, and members of the subcommittee, thank you for the opportunity to testify about the opportunities and challenges facing biofuel policy today. My name is Jeremy Martin. I am a senior scientist at the Union of Concerned Scientists. UCS is the Nation's leading science-based nonprofit putting rigorous, independent science to work to solve our most pressing problems.

The goals of the Renewable Fuel Standard are smart goals; not just more biofuels, but better biofuels that go beyond fuel-based fuels. The RFS is a practical policy to cut oil use and increase domestic production of clean, low carbon biofuels. It will provide rural economic development and ensure that the U.S. converts its leadership in science and technology into good jobs in the growing clean energy industry.

But there are certainly real problems posed by today's fuels, both oil and corn ethanol. The solution is not to lock in the status quo. We need to move forward with the next generation of advanced biofuels.

To get there, we need a stable Renewable Fuel Standard to serve as a foundation for investments in biofuels made from waste products, agricultural residues, and environmentally friendly energy crops. For this reason, we do not support legislative changes to the RFS.

According to our analysis, ample domestic biomass resources are available to support RFS targets, and developing these biomass resources will provide economic opportunities, rural developments, and good jobs not just in the corn belt, but all over the Country. What is needed is to scale up the industry that will convert this biomass into clean fuel.

The first commercial scale cellulosic biofuel facilities are now starting up in Florida and Mississippi, and several more are under construction in Iowa and Kansas. But while this progress is encouraging, it will take time to scale up a new industry, as it did for the oil and corn ethanol industries. In the meantime, the gap between the schedule laid out in 2007 and the actual scale-up means that EPA needs to adapt their implementation of the RFS to today's circumstances.

We have done extensive analysis, informed by the work of agricultural economists across the Country and around the world, on the options EPA has to administer the RFS consistent with the law that Congress passed in 2007. The smart approach is to limit the mandates for food-based fuels to 20 billion gallons in 2022. Under this approach, biofuels continue to grow, but at a slower rate than we have seen over the last few years, which will reduce pressure on food markets and slow agricultural expansion. Growth beyond this limit should come from non-food-based cellulosic biofuels.

Realizing the full 36 billion gallon ambition of the RFS is critical to delivering on the economic and environmental benefits of the RFS, but our analysis and experience over the last few years shows that expanding food-based biofuels is not the smart path to get there. Biofuels are now a major factor in U.S. and global agricultural markets, so the implementation of the RFS must be informed by, and responsive to, agricultural market factors. Failure to do so doesn't just raise food prices, it undermines the goals of the RFS itself.

We also need to acknowledge the challenges of adapting our vehicles and infrastructure to a changing set of fuels. What is called the blend wall is, in reality, more like a set of speed bumps. There is no reason we need to fuel up with at least 90 percent gasoline forever. But we do need to proceed with caution.

Today's RIN prices provide the economic driver to support expansion of drop-in biofuels and higher ethanol blends, but if we try to change our fuel mix faster than our vehicles and fueling infrastructure can accommodate, we may set back the transition we need to make.

Under the RFS implementation strategy, we advocate the scale-up of advanced biofuels will be more gradual than is presently anticipated. This means we have time to get it right, coordinating the transition of our fuel mix, our vehicles, and our fueling infrastructure.

Congress gave EPA the tools and flexibility it needs to administer the RFS in a smart way, adapting to changes that were unforeseen in 2007. Opening the RFS now will create regulatory uncertainty, delaying investment in the real solutions that the RFS is delivering.

Instead, EPA needs to work with DOE, USDA, and all the stakeholders to set ambitious, but realistic, goals for the next phase of the RFS, from 2016 to 2022, consisting with the constraints in agricultural markets and vehicle and fueling infrastructure, but moving forward on the oil saving and climate solutions we need. The infrastructure for gasoline and corn ethanol is already built out, and they will be around with or without the RFS. What is at stake is the next generation of biofuels, fuels that do not compete with food and offer dramatically lower carbon emissions.

We are not moving forward on these as fast as we hoped to be in 2007, but the RFS is pointing us in the right direction. We need to deal with today's challenges and keep moving forward towards better biofuels tomorrow.

Thank you again for the opportunity to be here today. I have provided additional details in my written testimony, and I would look forward to answering any questions.

[Prepared statement of Mr. Martin follows:]

Union of Concerned Scientists
Citizens and Scientists for Environmental Solutions

Written Testimony of Dr. Jeremy Martin
Senior Scientist, Clean Vehicles Program
Union of Concerned Scientists

Before the Subcommittee on Energy Policy, Health Care and Entitlements,
Committee on Oversight and Government Reform United States House of Representatives

June 5, 2013

Thank you for the opportunity to testify about the important challenges facing biofuels policy today. My name is Jeremy Martin. I am a senior scientist working on biofuels policy at the Union of Concerned Scientists. UCS is the nation's leading science-based nonprofit putting rigorous, independent science to work to solve our planet's most pressing problems.

My written testimony addresses the goals of the Renewable Fuels Standard (RFS) and describes the flexibility built into the RFS. My testimony also recommends an implementation strategy to address the significant challenges facing biofuels policy today, while maintaining support for investments in advanced biofuels that will move us beyond food based fuels and realize the goals of the RFS, albeit on a slower schedule than the current timeline of the RFS. We need to move forward these next generation better biofuels and to get there we need a stable RFS to serve as a foundation for investments. For that reason, we do not support legislative changes to the RFS.

The goals of the RFS are smart goals

It is important to start by acknowledging the important role that the RFS plays in achieving a cleaner fuel future, based on three important and well-crafted goals:

- **More Biofuels**: Expanded production of clean biofuels, together with improved efficiency, electric vehicles and other innovative technologies can cut our projected oil use in half over the next twenty years, and by reducing our oil use we reduce the problems our oil use causes our economy, our security and our climate.
- **Better Biofuels**: The RFS is not static, it requires the biofuels industry to get cleaner over time, so that the biofuels called for in the RFS over the coming years are different, and cleaner, than those of today. Moreover, the RFS is based on full lifecycle impact of biofuel production, including the impacts that large-scale biofuel use has on agriculture and land use change in the United States and around the world.
- **Beyond Food**: The RFS recognizes the limited potential to use food as fuel. For this reason the big target – the 36 billion gallon headline number – relies on cellulosic biofuel, made from non-food biomass, more than it relies on corn based ethanol.

The challenges caused by today's biofuels

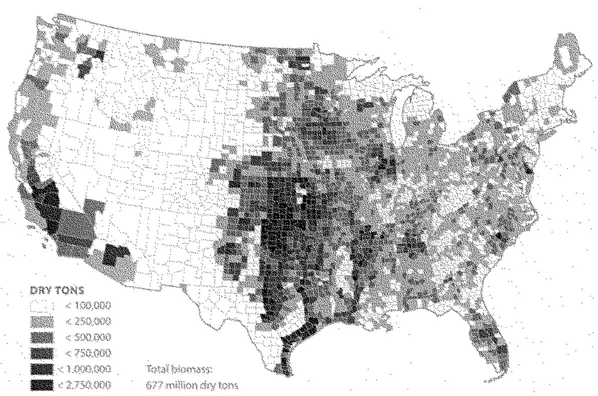
That said, it is also important to acknowledge that neither the RFS, nor its implementation to date, have been perfect. The rapid expansion of corn ethanol over the last decade, under a variety of policies culminating in RFS2, along with the expansion of vegetable oil-based biodiesel, primarily in the European Union, has profoundly altered global agricultural markets. These changes are contributing to higher food prices in the U.S.

and the developing world, accelerating deforestation, and exacerbating other problems like water pollution caused by corn farming.

Policy – including, and not just the RFS, but tax policy, trade policy, agricultural policy, and policy on fuel additives - certainly played a major role in creating these problems. However, reversing course on the RFS will not solve these problems. By most independent analyses, ethanol blends approaching 10% are here to stay, with or without the RFS. So failing to deliver on the full vision of the RFS means we stay where we are, with corn ethanol and gasoline, but with no prospect of moving to cleaner biofuels going forward. Rather than locking in the status quo, the smart choice is to keep moving forward on the longer-term goals of the RFS, the goals of better biofuels that go beyond food.

The role of biomass based fuels

In contrast to the challenges of food based fuels, the opportunities to expand non-food cellulosic biofuels are substantial. According to our recent analysis[1], the domestic resources to produce biomass are far in excess of what is required to meet the 16 billion gallon target for the RFS in 2022.



Using wastes, agricultural residues like corn stalks, and environmentally friendly perennial grasses to make fuel can expand the opportunities to produce biofuels beyond the corn belt to many more states, and can do so while playing a positive role in our agricultural system, helping to reduce pollution caused by intensive corn farming. The biomass resources are available, but to realize their potential, we also need a large scale industry to make them into useful fuel.

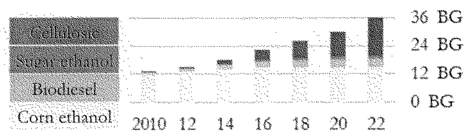
The first commercial scale cellulosic biofuel facilities are starting up now in Florida and Mississippi, and several more are under construction in Iowa and Kansas. This is a major milestone, and it would not have happened without the RFS. But while the progress is encouraging, it is delayed compared to the schedule described in the

[1] Union of Concerned Scientists (UCS). 2012. The promise of biomass: clean power and fuel – if handled right. Online at *http://www.ucsusa.org/assets/documents/clean_vehicles/Biomass-Resource-Assessment.pdf*.

RFS. It will take time to scale up a new fuel industry, as it did for both the oil and corn ethanol industries. And the economic headwinds of the last few years didn't help. But regardless of the reason, the gap between the schedule laid out in 2007 and the actual scale-up means EPA needs to adapt their administration of the RFS going forward to the circumstances today.

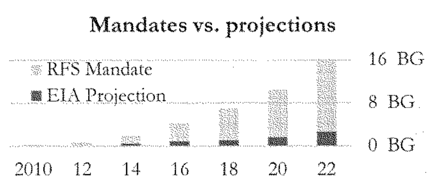
The RFS is a flexible policy framework

The RFS is a more flexible policy than many people appreciate, and Congress was smart to give EPA the authority to adapt the second phase of the policy to circumstances, and move us forward in a pragmatic way. Now EPA must use that flexibility and provide more clarity on the path ahead. To start with, EPA should acknowledge that 36 billion gallons (BG) is no longer a realistic target for 2022.



In fact, a careful reading of the RFS reveals that it not really a 36 billion mandate for 2022 at all. It is more accurately described as a mandate for 20 billion gallons, plus whatever level of cellulosic biofuel production is actually achieved, up to a maximum of 16 billion gallons (call it a 20BG + RFS for short). Of this, 15 billion gallons comes from conventional biofuels like corn ethanol, which is already built out and for the most part locked into fuel markets. There is also a mandate for non-cellulosic advanced biofuels, fuels like biodiesel, sugarcane ethanol, and some newcomers like ethanol from grain sorghum and biobutanol. This mandate grows steadily to 5 billion gallons in 2022, which may sound modest compared to 15 billion gallons of corn ethanol, but is actually a very rapid expansion from where these fuels are now. So that adds up to 20 billion gallons. But the largest part of future mandate growth was supposed to come from cellulosic biofuels.

However, the scale-up of cellulosic biofuels is not happening at the rate anticipated in the original RFS schedule. Even with robust investment and steady growth, cellulosic biofuel production capacity in 2022 will probably be closer to 2 billion gallons than 16 BG (projection data in the figure below is from the 2012 Annual Energy Outlook[2]).

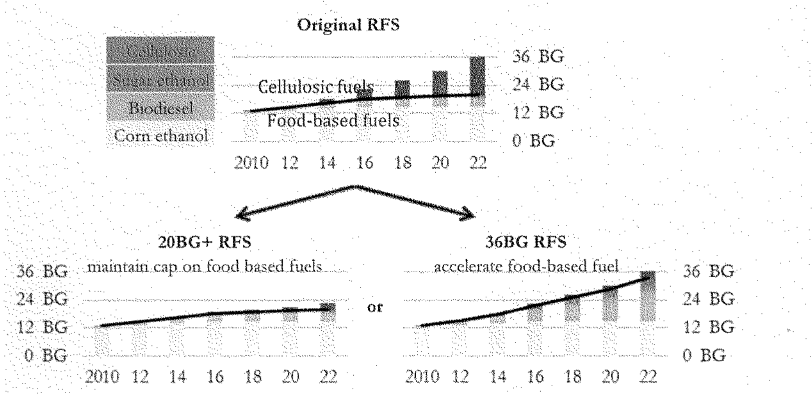


[2] Energy Information Administration. 2012. Annual Energy Outlook 2012. Online at http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf.

The RFS anticipated this possibility, and requires the EPA to adjust the mandates annually in line with projected capacity, a requirement reaffirmed in the recent court ruling[3]. So in total the real minimum mandate for 2022 is likely to be closer to 22 billion gallons than 36 BG, and it will be 2030 before we are likely to see a full 36 billion gallon mandate reached.

EPA has an important decision to make

EPA has the authority to backfill this cellulosic shortfall in part or in full, by expanding the mandates for biodiesel, sugarcane ethanol and other non-cellulosic advanced biofuels. This is described schematically in the figure below. On the left is the path forward if EPA adjusts the advanced and conventional mandates by the same amount as the cellulosic mandate. This maintains the same growth rate for non-cellulosic advanced biofuels, and the same impact on food markets, as in the original RFS schedule. But, with reduced production of cellulosic biofuel, the 20BG+ RFS will not reach 36 billion gallons in 2022. To reach the full 36 billion gallon target will likely take at least until 2030. On the right is the trajectory if EPA does not adjust the advanced mandate with the cellulosic mandate, and tries to stay on track for 36 billion in 2022 (the 36BG RFS). To accomplish this requires the food based advanced biofuels like sugar ethanol and vegetable oil based biodiesel to grow to more than 18 billion gallons, instead of the 5 billion gallons in the original schedule.



Doing this might seem to keep us closer to the original schedule, but it comes at the expense of dramatically expanding the use of food based fuels. Our analysis, and that of agricultural economists from Illinois to the Organization for Economic Co-operation and Development, demonstrates that the actual consequences of trying to make up for the missing cellulosic biofuels with biodiesel or sugarcane ethanol will lead to unintended counterproductive outcomes[4]. These include a massive circular ethanol trade with Brazil, exchanging billions of

[3] American Petroleum Institute v. U.S. Environmental Protection Agency, 12-1139, U.S. Court of Appeals for the District of Columbia Circuit (Washington).

[4] For more details, see our comments on U.S. Environmental Protection Agency's "Regulation of Fuels and Fuel Additives: 2013 Renewable Fuel Standards" 78 Fed. Reg. 9282 (February 21, 2013) [EPA-HQ-OAR-2012-0546]

gallons of our corn ethanol for Brazilian sugar ethanol, and mandates for biodiesel that exceed available resources in the U.S., and, indirectly, cause increases in production of palm oil in Southeast Asia that would accelerate deforestation with emissions that undermine the goals of the RFS. Trying to stay on the original schedule without the needed cellulosic biofuel production capacity also creates major problems for our vehicle and fueling infrastructure.

Smarter implementation helps to address the blend wall in a responsible manner

There are also real challenges adapting our vehicle and fueling infrastructure to a changing set of fuels. But what is commonly called the "blend wall" is, in reality, more like a set of speed bumps. There is no reason we need to fuel up with at least 90% gasoline forever. But if we try to change our fuel mix faster than our vehicles and fueling infrastructure can accommodate, we may undermine the transition we need to make. Under the RFS implementation strategy we advocate, the scale up of advanced biofuels will be more gradual than is presently anticipated. This provides time and flexibility for the market to adjust. Biofuel use can move past the blend wall through increased use of higher blends, as well as drop in fuels including butanol and renewable gasoline and diesel. Renewable Identification Number (RIN) prices make this economically viable, but the transition beyond E10 must be managed to ensure volumes grow in sync with the required vehicle and fueling infrastructure.

2012 corn ethanol waiver request

UCS submitted comments urging EPA to adjust the mandate for 2013 in light of the drought, and we disagreed with their decision not to grant any waiver[5]. The economic analysis EPA relied on for their decision found that at blending levels up to E10, changes in the mandate would not substantially change the actual amount of ethanol production, and therefore would not have resulted in significant relief for other users of corn. By in large we agree with this analysis, and several independent analysts came to similar conclusions. However, while the opportunity to provide relief was limited, the analysis suggested it was not insignificant. In light of this we encouraged EPA to make a modest 15% adjustment to the 2013 mandate. We argued that such an adjustment would have reduced the risk that the mandate hinders the market-based rationing of the diminished corn crop in 2013. However, we argued against a larger waiver, since larger adjustments wouldn't have provided additional relief, and would destabilize the RFS.

The analysis that EPA used to reach their decision to reject the 2012 waiver requests was particular to the circumstance in the ethanol market that year. Two key factors, the incentive of blenders to blend up to E10, even in the absence of a binding mandate, and the presence of a large stock of carry-forward RINs from over compliance in previous years provided compelling reason to doubt that a waiver would provide relief. Perhaps the most compelling evidence came in the form of the very low RIN prices for conventional ethanol that prevailed at that time, suggesting that even at those low prices obligated parties were not interested in avoiding heir compliance obligation.

The circumstances upon which EPA based its analysis in the 2012 waiver decision are unlikely to be repeated. The low RIN prices which prevailed at the time of the decision have given way to higher prices, which suggest that obligated parties would reduce ethanol use in the event of a waiver. This is to say that market conditions beyond E10 are different in important ways than they are with mandates below E10. The current RIN prices

[5] See our comments to US Environmental Protection Agency's "Request for Comment on Letters Seeking a Waiver of the Renewable Fuel Standard" 77 Fed. Reg. 52715 (August 30, 2012) [EPA-HQOAR-2012-0632; FRL-9721-7]

suggest that the RFS is starting to work as designed, to support the use of biofuel in excess of what would have occurred without the policy. This is a feature of the RFS design, rather than a bug. An implication of this feature is that under these circumstances EPA waivers will be expected to significantly alter fuel markets, which will give them the opportunity to provide relief in future crisis that their analysis suggested they lacked last year.

Because of the importance of biofuel policy to agricultural markets, it is important for EPA to be flexible in their implementation of the RFS, and to take into consideration of the impact of fuels policy to these markets. While last year's drought was a significant event, the decisions EPA has to make about the future course of the RFS are even more important. It is illustrative of the profound impact of EPA decisions on U.S. and the world agricultural markets that the Organization for Economic Co-operation and Development and the Food and Agriculture Organization of the United Nations devoted an entire chapter of their global long-term agricultural outlook to biofuels, and about half of that to evaluating the future of the RFS[6].

A Smart Path Forward

EPA should get out ahead of this challenge, and start using the flexibility Congress gave them in the administration of the RFS. The magnitude of the cellulosic shortfall was small in the last few years, but it grows rapidly from 2013 forward. In light of tight markets for agricultural commodities – not just corn but sugar and vegetable oil as well – and the infrastructure issues like the blend wall, there are major challenges coming by 2015 that will require EPA to show more flexibility than they have to date.

We are urging EPA to seize the opportunity, and do a significant rulemaking, looking not just at annual volume levels, but at resetting expectations for the next phase of the policy, from 2016 to 2022. Working with stakeholders, and in concert with DOE and USDA, EPA should develop a roadmap that delivers on the important goals of the RFS, but is realistic about where we are today, and about constraints in agriculture, the rate at which cellulosic production capacity can realistically scale up, and in our vehicle and fueling infrastructure.

We are not moving forward as fast as we hoped to be in 2007, but the RFS is still pointing us in the right direction. To keep moving forward we need to provide the regulatory stability that will protect the early investments in the advanced biofuels industry, and support further investment to bring the technology to larger scale.

Thank you, again, for the opportunity to be here today. I look forward to answering any questions you may have.

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[6] Organization for Economic Co-operation and Development (OECD) and Food and Agriculture Organization of the United Nations (FAO) Agricultural Outlook 2012-2021. 2012a. Increased productivity and a more sustainable food system will improve global food security. Online at http://www.oecd.org/site/oecd-faoagriculturaloutlook/.

Mr. LANKFORD. Thank you, Dr. Martin.
Mr. Pugliaresi.

STATEMENT OF LUCIAN PUGLIARESI

Mr. PUGLIARESI. Chairman Lankford, Ranking Member Speier, and members of the subcommittee, I want to thank you for this opportunity to testify on the Renewable Fuel Standard and EPA's management of this program. Of particular importance is EPA's use of its waiver authority, which will shortly become the most important policy instrument in determining the path of gasoline and diesel prices over the next two to three years. My testimony today includes an assessment of EPA's waiver authority under the RFS and why it will be the main determinant in driving up gasoline prices in the near future.

Go to the first slide.

[Slide.]

This is official data from the Energy Information Administration. This is really what is driving the high numbers in the NERA assessment, and, as you can see, the EIA shows that we just will not have these advanced biofuels until after 2020 do we start to see some real development. When you don't have the fuels, you have only one choice: to cut production or to raise prices, and this is what is driving the NERA analysis.

So we tried to look at an analysis in which we thought we could relax some of these real physical constraints.

Next slide.

[Slide.]

We said what happens if we have all the gas stations we needed for E85 and we could actually have access to it by the whole driving public? Even under this case, in which we waive all cellulosic requirements, all advanced requirements, and we only rely on E85 and, through some almost magic, we have enough marketing channels for it, the price of E10 goes up. The RFS causes a cost-shifting; it requires obligated parties to pay down the price of E85 and to put that cost on E10. This is why NERA gets such devastating consequences on the national economy. Rising gasoline prices are like an excise tax. A $0.50 increase in gasoline prices takes $70 billion out of consumers' wallets.

Next slide.

The fundamental problem with E85 is it is too costly. At no time since 2000 have we seen E85 be more cost-effective to E10. This is the fundamental problem. You can't get consumers to buy it for performance reasons, but you can't also get them to buy it because it is too expensive.

Next slide.

This is Minnesota, a place not unfamiliar to E85, a place in which ethanol is embraced. But, as you can see, even as the number of fueling stations and outlets for E85 continue to grow, consumer demand, consumption of E85 fell.

Next slide.

[Slide.]

One issue that some of the proponents of the mandate, by the way, we are not against ethanol. We think ethanol is a very valuable and important blending component for the production of gasoline. We need it. It helps us to meet our oxygenate and our fuel specification standards. But, as you can see, there is no real constraint in adding additional fueling options at American service stations. There has been enormous growth in electric outlets, enormous growth in CNG. E85 is not showing up at gasoline stations because the consumers don't want to buy it.

Next slide.

[Slide.]

I think we have spoken about this a bit, but, as you can see, the forecast of long-run demand for gasoline and for diesel fuel have fallen dramatically from when we first put this program in place. This is why we are running up against the blend wall so quickly.

Finally, the last slide.

[Slide.]

You know, all three conditions that were prevalent when the Renewable Fuel Standard was passed, which was rising imports, falling production, and rising demand, every one of those conditions are no longer with us today.

So where we are now is we have this enormous strategic opportunity. The developments we have seen in shale gas are now moving to liquids and our production path from now to 2022 is an enormous shift, it is a paradigm shift, and basically we are now at the position where we have a large number of regulatory programs which are running head-on against this renaissance. We can't figure out how to build out the midstream in a cost-effective way and have processing technologies that are cost-effective. We will push some of this crude back in the ground.

With that, I will conclude my testimony.

[Prepared statement of Mr. Pugliaresi follows:]

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Testimony

before

U.S. House of Representatives Committee on Oversight and Government Reform

Subcommittee on Energy Policy, Health Care, and Entitlements

Up Against the Blend Wall: Examining EPA's Role in the Renewable Fuel Standard

June 5, 2013
10:00 am
Rayburn House Office Building

Submitted by:

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Executive Summary

Chairman Lankford, Ranking Member Speier and members of the Subcommittee on Energy Policy, Health Care and Entitlements, I want thank you for the opportunity to testify on the Renewable Fuel Standard (RFS) and the U.S. Environmental Protection Agency's (EPA) management of this program. Of particular importance is EPA's use of its waiver authority, which will shortly become the most important policy instrument in determining the path of gasoline and diesel prices over the next 2-3 years. My testimony today includes an assessment of EPA's waiver authority under the RFS and why it will be the main determinant in driving up gasoline prices in the near future.

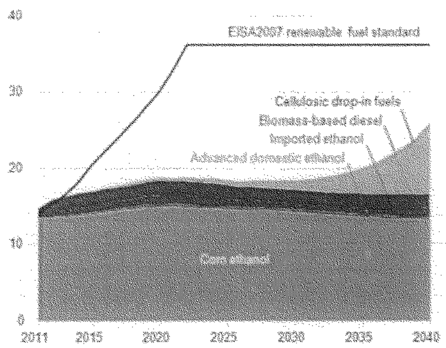
I am president of the Energy Policy Research Foundation, Inc. (EPRINC). EPRINC was incorporated in 1944 and is a not-for-profit organization that studies energy economics with special emphasis on petroleum and the downstream product markets. EPRINC researches and publishes reports on all aspects of the petroleum markets which are made available free of charge to interested organizations and individuals. We are recognized internationally for providing objective analysis of energy issues.

EPRINC has undertaken research and analysis on ethanol's role in the transportation fuels sector since 2006, including a major workshop with the Energy Information Administration (EIA) in 2008. Our full publication list on this topic is provided in the appendix. More importantly, as early as 2007, EPRINC published detailed assessments of ethanol's role in the transportation fuels sector.

From 2006-2008 EPRINC's research on the RFS concluded that it would not be feasible to implement the RFS at levels above 10% of the gasoline pool without significant disruptions to the transportation fuel supply network and without substantial increases in the cost of gasoline for American consumers. Similar outcomes are also likely for diesel fuel.

Our long-standing assessments of the RFS issue are now largely substantiated by work undertaken by EIA and also recent work undertaken by National Economic Research Associates (NERA). EIA is now forecasting that the production of cellulosic and advanced biofuels will not meet the volumetric mandates under the law (36 billion gallons per year by 2022) and, as a result, EPA will have to compensate for the expected deficit in the required volumes by issuing credits. The central point is that however EPA decides to address the shortfall, a large shortfall is coming. EIA forecasts (Figure 1) show that production of large volumes of cellulosic are not expected until after 2030.

FIGURE 1
Credits Earned from the RFS, EISA 2007
(billions of credits)



Source: EIA, AEO 2013

In this scenario, refiners and importers (so-called obligated parties) cannot obtain the volumetric requirements under EISA (RFS2) and therefore face rising costs from lack of supply and payments for credits issued by EPA. These rising costs lead to falling demand and lower production of transportation fuels. Reduced production brings about rising prices which resulted in NERA concluding that by 2015, diesel prices would rise by 300% and gasoline prices would rise by one-third if the program were not substantially reformed. Virtually the entire run up that occurs in the NERA analysis occurs through a loss of supply to the domestic market, which then leads to higher fuel prices, bringing about higher and more costly blending levels as demand for transportation fuels is suppressed.[1]

Even if we create an unrealistic and highly unlikely case in which large scale marketing channels are available for E85 (and one of the few legal means available to *generate* RINs after crossing the blend

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[1] *See Economic Impacts Resulting from Implementation of RFS2 Program, National Economic Research Associates (NERA). October 2012.*

wall), and we further assume no major decline in demand for transportation fuels, EPRINC's research shows that near term increases in volumetric blending above the blend wall (10% ethanol in gasoline) would only be possible by financially encouraging consumers to buy E85 and then shifting that cost onto the price of E10. Such a cost shift would cause a spike in the price of E10 with prices escalating as the volumetric mandate grows.

Under this best case scenario, the marginal cost to supply E10 gasoline will rise by about $0.18/g in 2014 and $0.36/g by 2022 through E85 sales, a cost to American consumers of $20-$40 billion per year. This relatively low cost compliance scenario also requires that advanced and cellulosic biofuels enter the market at scale so that E85 blending is not limited by the 15 billion gallon per year (bg/y) limitation on ethanol from cornstarch. We have not included biodiesel in this estimate. However, diesel supplied into the domestic economy currently generates a larger RIN deficit than gasoline. Therefore, the per gallon marginal cost to supply diesel will rise by a greater amount than E10 gasoline. I cannot emphasize enough that this is a very optimistic best-case scenario; the most likely outcome is a much higher price spike in gasoline.

One of the fundamental issues preventing greater adoption of ethanol beyond 10% concentration in the gasoline pool is cost. According to DOE's AFDC (Alternative Fuels Data Center) data, the nationwide retail price of E85 has always been higher than that of gasoline since 2000 when adjusted for energy content; at no point in the past 13 years has E85 been cost competitive with gasoline. The inherently high cost of ethanol is at the heart of the RFS blend wall problem. Any discussions to address the failed expansion of mid-level blends and related infrastructure should be mindful of this data. Fuel suppliers are unlikely to make large investments in mid-level blending infrastructure for a product which is inherently too expensive and unlikely to be adopted by consumers.

We are seeing the early signs of problems from rising RIN values. The higher cost for RINs is sending a strong signal that the cost of transportation fuels are likely to rise in the near future. Several ethanol producers have begun blending E85 themselves, thus keeping the increasingly valuable RIN to sell to obligated parties, and selling the blended E85 directly to retailers.[2] For obligated parties, these higher

[2] http://domesticfuel.com/2013/05/29/siouxland-energy-steps-up-to-step-down-gas-prices/

cost RINs mean that RFS compliance will require additional outlays. By law, obligated parties must adhere to the RFS mandate regardless of cost or cut production. Ethanol futures prices have converged with wholesale gasoline (called RBOB)[3] prices since the beginning of the year, significantly increasing the cost of producing E10. At the beginning of January 2012, ethanol sold at a discount of over $0.60/gallon to RBOB; June futures settled less than $0.10/gallon apart, a slight premium for RBOB on a volumetric basis but a steep discount when energy content is accounted for. This $0.50/gallon convergence raises the cost of E10 by approximately $0.075 per gallon on an energy equivalent basis. Ten gallons of E10 generate one RIN and D6 (ethanol) RINs are currently trading in a range of $0.70 - $0.80 each, therefore the rise in the price of ethanol relative to gasoline since January is mirroring the increased costs of RINs over that same time period. The cost of complying with the RFS is rising.

EPA does have the authority to waive the RFS, and has done so on four occasions between 2010 and 2013, but each of these instances was for reductions in cellulosic biofuels volumes due to a lack of production capacity.[4] However, the EPA waiver process as practiced by the agency has at least two important limitations. The first is that EPA may only issue a waiver for one year at a time. This provision was included in the legislation to deal with relatively short-term disruptions or economic dislocations from the RFS program. However, our research shows that to prevent a rapid increase in gasoline prices, EPA should not only immediately issue a waiver holding volumetric mandates for renewable fuels at no more than 10% of the gasoline pool, but also signal its intention to extend the waiver beyond one year.

As long as volumetric blending mandates and the cost of achieving those levels remain highly uncertain (and costly), short-term waivers do not address what is essentially a long-term systemic constraint in absorbing higher volumes into the gasoline pool. The high costs associated with blending ethanol above 10% of the gasoline pool as well as evaluating the technical feasibility of bringing large volumes of advanced biofuels into the transportation fuel sector will take time. EPA can only prevent large increases

[3] RBOB refers to reformulated blendstock for oxygenate blending. This is how the wholesale price of gasoline is often quoted before it is blended to meet national and state environmental specifications.
[4] See Schnept, Randy and Brent Yacobucci, *Renewable Fuel Standard (RFS): Overview and Issues*, Congressional Research Service, March 14, 2013.

in gasoline prices by issuing a waiver holding blending at 10% and indicating it will likely extend the waiver through 2015.

A second major flaw is that a waiver may be issued only if EPA determines that the RFS is causing "severe" economic damage. It is not clear how EPA defines severe economic damage. EPA set itself a high bar for "severe" when it denied drought-related waiver requests in 2012. As there is no nominal dollar value associated with EPA waiver criteria and EPA remains vague on how high gasoline prices will have to rise before a waiver might be issued, this opens up the domestic gasoline market to substantial price and dislocation risks. Keep in mind that rising gasoline prices act as an excise tax on consumers and each penny increase costs consumers $1.4 billion. A $0.50 per gallon increase in E10 is the equivalent of a $70 billion tax on consumers with all the subsequent harm to the national economy. All of these costs do not include the additional consumer losses from rising costs of corn which have moved from an average of $2/bushel in 2006 to $6-8/bushel in recent years.[5]

It is my view that EPA has two immediate tasks. If they are concluding that the blend wall is not a problem, EPA should provide Congress with a detailed analysis how the program can be implemented without substantially increasing the price of E10 and diesel fuel. EPA should also inform Congress and the public of how large a price increase it is willing to tolerate before the economic damage is "significant."

Understanding the Volumetric Fuel Mandate

The renewable fuel program was adopted in the Energy Policy Act of 2005 (EPACT), and was expanded in the Energy and Independence Security Act of 2007 (EISA). EPACT mandated that a minimum of 4 billion gallons be used in 2006, rising to 7.5 billion gallons by 2012. EISA expanded the mandate to 9 billion gallons in 2008 rising to 36 billion gallons in 2022 (placing a 15 billion gallon cap on ethanol

[5] USDA, ERS, Feed Grains Database.

production from cornstarch and requiring growing volumes of advanced and cellulosic ethanol as well as biodiesel).[6]

The program is administered by requiring all refiners and other obligated parties (such as importers) to document that they have blended ethanol into gasoline by acquiring RINs (renewable identification numbers). Ethanol producers generate RINs when product is produced. RINs are then acquired from ethanol producers by obligated parties when blended into gasoline. In recent years, the ethanol fuel mandate (also known as the Renewal Fuel Standard or RFS) permitted ethanol blending below 10% of the gasoline pool. Refiners and other obligated parties could, however, blend above their mandated requirement and then retain those extra RINs for sale to obligated parties who had not met their volumetric mandates.

The Clean Air Act allows the Administrator of EPA, in consultation with the Secretaries of Agriculture and Energy, to waive the requirements of the RFS under certain criteria. The waiver could be issued if the Administrator determines -- after a notice and comment period -- that implementation of the RFS requirements would severely harm the economy or environment of a State, a region, or the United States.

Ethanol, when blended into gasoline, can play an important and cost effective role in meeting both automobile and environmental fuel specifications. The use of corn ethanol or advanced biofuels in the gasoline pool, when adjusted for both market and technology limitations, presents no major economic or technical risks as a supplement to the production of gasoline. The fundamental policy challenge today is directly attributable to a regulatory regime that requires annual upward adjustments in volumetric targets in ethanol use, without regard to either its contribution to the cost of gasoline or technical limitations in the use of ethanol within the U.S. automobile fleet.

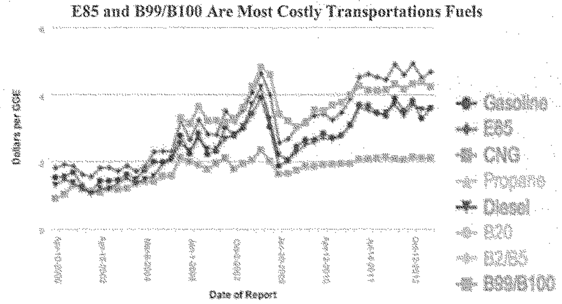
It is not ethanol per se that presents a risk of a price spike in gasoline or a major risk to automobile engines, but the federal mandate requiring ever larger volumes of ethanol into the gasoline pool. The

[6] The RFS program as modified by EISA (also called RFS2) divides the RFS requirement into four separate nested categories (total renewable fuels, advanced biofuels, biomass-based diesel, and cellulosic biofuels. Each of these categories comes with its own volume requirement. In addition, biofuels qualifying under RFS2 must meet lifecycle greenhouse gas emission performance standards.

current regulatory regime, if not reformed in some substantial manner, will likely spike gasoline prices. The high cost problems associated with the blend wall are exacerbated by the RFS requirement that ever larger volumes of cellulosic biofuels must be used even though only limited supplies exist.

As federal mandates take the U.S. gasoline pool above 10% ethanol by volume, increased use of ethanol can only enter the transportation fuels market through a separate gasoline product, E85 (60-85% ethanol). This fuel can only be used in so-called flex fuel vehicles. Consumers have been resistant to E85 because of its high cost when adjusted on a BTU basis to regular gasoline (E85's lower energy content corresponds directly to reduced fuel economy in flex-fuel vehicles), limited availability and higher frequency of refill. As shown in Figure 2 below, at no time since 2000 has E85, when adjusted for BTU content, been less expensive that E10 gasoline. This is a fundamental and potentially lasting condition in the domestic gasoline market and the principal reason it will be both difficult and costly to

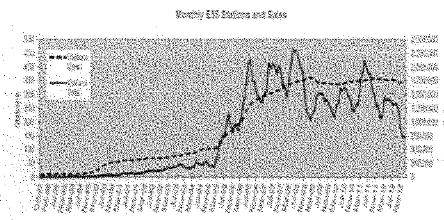
FIGURE 2
E85 and B99/B100 Are Most Costly Transportations Fuels



Source: Clean Cities Alternative Fuel Price Reports
Notes: Fuel volumes are measured in gasoline-gallon equivalents (GGEs), representing a quantity of fuel with the same amount of energy contained in a gallon of gasoline.

encourage consumers to purchase larger volumes of E85.[7] We know this because even with growing availability of flex fuel vehicles, consumers have been resistant to increasing consumption of E85 As shown in Figure 3 below, E85 sales have been declining as consumers find it too expensive.

Figure 3
E85 Sales Continue to Lag



Historical E85 Sales

Year	# Stations Year-End	Total Yearly Volume Est.
1997	11	6,607
1998	12	37,353
1999	17	99,514
2000	55	377,653
2001	64	704,120
2002	69	1,257,065
2003	84	2,168,305
2004	103	2,626,580
2005	181	8,154,977
2006	287	17,913,153
2007	320	21,412,588
2008	357	22,615,438
2009	339	15,925,119
2010	348	16,643,232
2011	357	19,504,100
2012	343	14,691,585
2013	342	711,380

Source: NREL

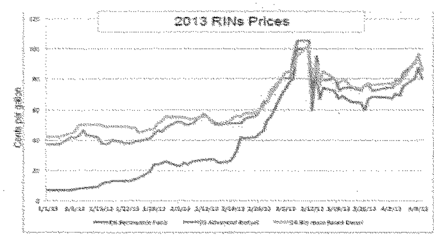
EPA has recently approved another gasoline product, E15 (gasoline blended with 15% ethanol), for a large portion of the U.S. automobile fleet. But neither the driving public nor the U.S. auto industry is prepared to use E15 in large volumes. E15 also faces the same cost constraints as E85, although to a lesser extent. For the most part, in the next few years, higher volumes of ethanol blending will require higher sales of E85.

Why the Blend Wall is a Problem

Historically, RINs have sold for a few pennies a gallon, but in recent months RIN prices have risen to as high as a $1 gallon or more as shown in Figure 4 below.

[7] As of March 2013, there were 3,028 fueling stations selling E85 in the U.S. Most stations were in the Corn Belt states. As of 2008 the leading state was Minnesota with 353 stations, followed by Illinois with 181, and Wisconsin with 114.

Figure 4
Ethanol RINS (in blue) Become Expensive



Source: Stillwater Associates

The cause of rising RIN prices is complicated, but is largely driven by expectations among obligated parties that they will soon face very high costs of blending ethanol at levels above 10% of the gasoline pool and will require RINs from an ever diminishing supply to meet the requirement. Historically ethanol RINs sold for pennies a gallon, but have not been quickly bid up to level equivalent to advanced biofuels and Bio-mass Based Diesel.

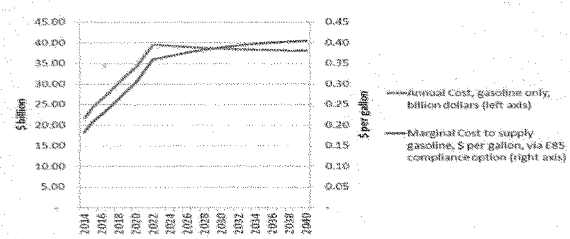
As the U.S. gasoline pool has approached 10% ethanol concentration over the past year, the supply of RINs has declined as U.S. refiners cannot physically blend above RFS mandated volumes to generate surplus RINs as they could in the past when volumetric mandates were far below the 10% threshold.

Other refiners who are already at (or will soon hit a 10% blending volume) are now entering the market to buy RINs to meet the newer and higher RFS volumetric blending requirements. RIN values are rising now because markets are forward looking and expectations remain that EPA will take the entire transportation fuels market head-on into the blend wall. Instead of purchasing high cost RINs, obligated parties could attempt to distribute increased ethanol volumes through E85 or E15, but this option is highly limited and expensive. The remaining options are: (1) cut throughput (gasoline production) so a refiner's or importer's renewable fuel obligation (RVO) can be lowered and bring requirements under 10%, (2) shift domestic production to exports so incremental capacity utilization is not captured by the mandated volume obligations, or (3) pay a large fine for not meeting the mandated blending volume.

These options reduce the supply of gasoline and diesel to the market while raising the cost of the product that is supplied into the domestic market. While the refining industry, and perhaps the ethanol industry, is likely to absorb some cost increases, much of these cost increases will be passed on to consumers in the form of higher pump prices.

Under our best case scenario, the marginal cost to supply E10 gasoline will rise by about $0.18/g in 2014 and $0.36 by 2022, about $20-$40 billion per year (Figure 5). This low cost scenario also requires that advanced and cellulosic biofuels enter the market at scale so the E85 blending is not limited by the 15 billion gallon/yr (bg/y) limitation on ethanol from corn. We have not included biodiesel in this estimate. However, diesel supplied into the U.S. currently generates a larger RIN deficit than gasoline. Therefore, the per gallon marginal cost to supply diesel will rise by a greater amount than E10 gasoline.

FIGURE 5
Cost Compliance Curve Under Best Case Scenario



Source: EPRINC Calculations

I cannot emphasize enough that this is a very optimistic scenario and the most likely outcome is a much higher price spike in gasoline. Adding to these consumer costs is an annual federal budget liability of $16 billion by 2022 from the cellulosic biofuels production tax credit of $1.01 gallon.[8]

[8] See Schnept, Randy and Brent Yacobucci, *Renewable Fuel Standard (RFS): Overview and Issues*, Congressional Research Service, March 14, 2013. P. 20.

This highly optimistic scenario provides some insight into what the low-end of the RFS price would look like. Obligated parties would have to take on billions of dollars of losses promoting the sale of E85 with the expectation that these costs could be passed through to E10 and other petroleum products. Most refiners do not own retail stations, so they cannot simply set the price at the retail level or order loss-making ethanol blending. Geographic and infrastructure constraints would limit the amount of E85 that could be sold and where it might be sold, giving some obligated parties a compliance advantage over others.

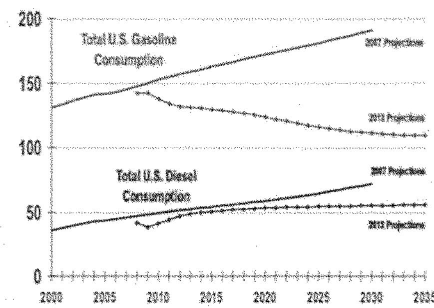
The blend wall affects each obligated party differently. Some have more carryover RINs than others. Midwest refiners have better access to ethanol supplies and E85 outlets, while coastal refiners have direct access to export markets. Obligated parties will take different steps to reduce their RVO (by exporting) or generate RINs (with E85) depending on their individual operations. But regardless of individual circumstances, the RFS sends all obligated parties the same message: the U.S. is going to be a very difficult and expensive place to sell gasoline.

EPRINC notes that a study recently completed by *Informa Economics* concludes that ethanol, instead of increasing the price of gasoline, has led to a reduction in the price of gasoline by 2-4 cents a gallon, and that in any case, gasoline prices are determined largely by crude oil costs and gasoline taxes. We agree that any kind of long-term assessment of gasoline markets will conclude that crude oil and taxes account for 80-90% of the cost of gasoline. The remainder is determined by refinery margins, distribution costs and retail margins. While in general feedstock costs and taxes determine gasoline prices, the *Informa Economics* study fails to explain ethanol's prospective role (and more importantly, the role of the RFS fuel mandate) in driving up refinery margins. The principal confusion in such analyses is that as mandated ethanol use exceeds 10% of the gasoline supply, a large differential opens up between the cost of purchasing ethanol and the much higher cost of "using" (or blending) ethanol into the gasoline pool.

How Did We Get Here

In the years preceding the passing of EPACT and EISA, a large segment of U.S. policy makers and analysts believed U.S. gasoline consumption would grow to well over 170 billion gallons from 2007 levels of 145 billion gallons, thus accommodating the conventional renewable fuel volumes proposed in EISA at ethanol blend rates below 10%. However, this forecast was not universally accepted among independent energy analysts nor was acceptance of this forecast necessarily evidence that fuel mandates were a wise decision. Note as shown in Figure 6 below, EIA projections in 2013 show that 2022 U.S. gasoline consumption will decline to slightly more than 120 billion gallons and diesel consumption is expected to remain flat. The difference in the outlook in U.S. transportation fuel use between forecasts made in 2007 and 2013 is stark. Clearly RFS2 targets were established in an era of expectations of rising gasoline demand and circumstances in which exceeding 10% of the gasoline pool was considered unlikely.

FIGURE 6
EIA Projections of U.S. Transportation Fuel Use



Source: EIA, Annual Energy Reviews, 2007 and 2013

The drawback of both EPACT and EISA is not that the legislation was based on a poor forecast. Any forecast is likely to be incorrect because advances in technology, changes in demand, automobile technology, and feedstock prices are all inherently uncertain. The fundamental flaw in the legislative program was that the fuel mandate provided for no flexibility for changes in either the technology or economics of producing gasoline should new conditions prevail in the marketplace. The legislation did provide for a waiver for economic harm, but this appears to be an extremely high threshold for EPA

A 2006 EPRINC report pointed out that, "At the very least, additional measures to promote ethanol should not aggravate supply risks by reducing flexibility in how the overall mandates are met." In addition, EPRINC research released in November 2007, before EISA was signed into law, had determined that ethanol could easily be absorbed into the gasoline pool at levels of approximately of 5%, but that volumes above 10% would be problematic. The study pointed out that:

> *There is an easy amount of ethanol that can be absorbed in the gasoline pool. That is about 5%, and that is where the market is now: about 8 billion gal/year, or 500,000 b/d. At that level, ethanol is a necessary and complementary component of the gasoline pool. It is the current situation. It represents the replacement of MTBE in an economic environment that accommodates ethanol prices higher than gasoline prices.*
>
> *...For years beyond 2012, there are proposals for ethanol sales mandates that assume concentrations in gasoline above the current 10% cap. How that might be achieved is an unanswered question, given that only US automakers espouse the plan, and they account for only about half of US vehicle sales. Proposals or sharply increased ethanol sales simply assume that auto manufacturers will warranty existing cars for fuel blends containing far more than the current 10% maximum...*
>
> *Depending on an agricultural commodity to accomplish these goals, however, just adds the risk of the crop cycle to present instabilities. That dependency will be a concern until ethanol from cellulose becomes economic and available in large amounts. More immediately, the ethanol industry faces the stresses of consistently high corn prices, weakening product prices, the consequent compression of margins, and the possibility of producer consolidation. How the immediate stresses affect the ultimate shape of an industry still in its formative stages remains uncertain. What is certain is that the modern energy economy has constraints on how much ethanol it can absorb.*

Three Myths About Ethanol and the RFS Mandate

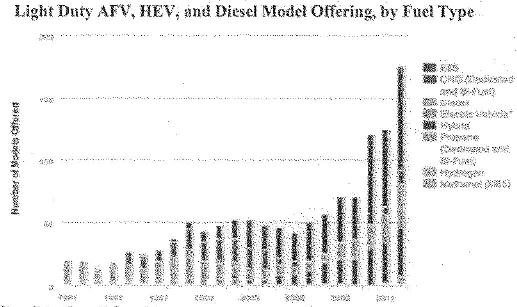
If the mandate did not exist no ethanol would be sold into the U.S. transportation fuels market.

Even if ethanol blending were determined strictly by cost and market conditions, total blending would be unlikely to fall below 400,000 bbl/d from current blending volumes of around 800,000 bbl/d, and depending upon market conditions could sustain levels close to current levels. Ethanol blending would continue because it remains a valuable blending component to meet octane requirements and other fuel specifications required by EPA. Higher blending levels would occur depending upon cost and market conditions. However, ethanol's role at concentrations above 3-5% of the gasoline pool are largely as a substitute for gasoline, but its value is limited by ethanol's lower BTU content, and ultimately, by limitations of the U.S. auto fleet to absorb ever higher volumes of ethanol. On a volumetric basis, ethanol is often cheaper than gasoline. When adjusted for energy content, ethanol is generally more expensive than the gasoline.

Consumers don't buy E85 because there are too few stations selling the fuel.

Although representatives of the ethanol industry blame the lack of E85 distribution infrastructure on oil producers and refiners, there is little evidence that the petroleum industry is a major impediment to the installation of E85 pumps. Most service stations in the U.S. are owned independently and have seen rapid growth in the installation of CNG and electric charge stations (Figure 7 below). The problem with E85 is a lack of consumer demand and not infrastructure.

FIGURE 7
Light Duty AFV, HEV, and Diesel Model Offering, by Fuel Type



Source: National Renewable Energy Laboratory
Notes: *EVs do not include neighborhood electric vehicles (NEVs), low speed electric vehicles, or two-wheeled electric vehicles. Conversion models were counted for natural gas and propane vehicles for the first time in 2012.

Ethanol has reduced the price of gasoline by nearly $1/gallon

U.S. government officials, including Secretary of Agriculture Tom Vilsack, representatives of the Renewable Fuels Association (RFA), and other supporters of expanded mandates for the use of renewable fuels in the transportation sector have argued that the growth in ethanol blending spurred by the RFS has contributed to large reductions in the price of gasoline.

These conclusions were taken from a series of studies from the Center for Agricultural and Rural Development at Iowa State University (CARD). The studies concluded that ethanol use had reduced gasoline prices by approximately $0.89/gallon in 2010 and $1.09 per gallon in 2011.[9] The results of the study were also circulated widely among members of Congress and were part of an extensive advertising program undertaken by RFA.

The authors of the studies undertook a series of econometric calculations evaluating how the U.S. refining sector and gasoline prices would adjust if growth in the use of ethanol in the transportation fuels sector were constrained. The studies evaluated the consequences of limiting ethanol use across several time periods, but most notable were the consequences of constrained blending between January 2000 and December 2010.

The econometric model tested by Du and Hayes did not adequately reflect operating conditions in the U.S. refining industry. The calculations undertaken by CARD prohibited any adjustments in refining capacity and then made a series of calculations on the consequences of limiting annual ethanol use to 1.6 billion gallons annually for the 2000-2010 and then 2000-2011 time periods. However, ethanol production has grown by billions of gallons per year and refining capacity grew by 1 mm bbl/d (million barrels per day) from 2000 to 2010 and by 1.2 mm bbl/d from 2000 to 2011. This is enough refining capacity to process over 15 billion gallons of crude annually.

Gasoline prices rise in the CARD calculations because demand can only be met through higher cost production from the existing installed capacity, either in the U.S. or abroad. Additionally, the CARD model does not account for demand rationing. If gasoline prices were $1.09 higher in 2011, a 30%

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[9] Xiaodong Du and Dermot J. Hayes, The Impact of Ethanol Production on U.S. and Regional Gasoline Markets: An Update to 2012. May 2012, Working Paper 12-WP 528. See http://www.card.iastate.edu/publications/dbs/pdffiles/12wp528.pdf

increase which would have sent prices to nearly $5/gallon, certainly demand would have been somewhat curtailed. It should also be remembered that gasoline is a globally traded commodity. The spot price of gasoline in the Gulf Coast is only a few cents per gallon different from the European spot price in Rotterdam. It is unlikely that the loss of 700,000 bbl/d of ethanol under the CARD model, 460,000 bbl/d of gasoline equivalent after BTU adjustment, would have the effect of raising prices $1.09/gallon globally. The CARD report specifies a price impact only in the U.S. market, but the U.S. market is perhaps the most globally integrated fuels market in the world.

A recent study by joint authors from MIT and UC Davis highlighted the limitations of the econometric approach undertaken in the CARD study. 10 The MIT/UC Davis assessment points out that the estimates of reductions in gasoline prices were inconsistent with the basic economics of the industry. The authors of this study concluded that, at best, they were only able to calculate a $0.13/gallon reduction in gasoline prices. In terms of their econometric model results, these conclusions are insignificant or essentially zero. As the authors of the MIT/UCSD study point out, using the same model as the CARD authors, eliminating ethanol use also would have increased natural gas prices by 65 percent and would have caused an increase in U.S. and European unemployment.

Conclusion

Ethanol is a very important component of gasoline supply at concentrations levels of approximately 5% of the gasoline pool. It replaced MTBE as the primary oxygenate for U.S. gasoline and serves as an octane booster. However, as blends approach 10% concentration, the relative cost of ethanol increases as its value declines. Mid-level blends such as E15 and E85 are simply uneconomic under current market conditions. Sustainable solutions will be those that promulgate strategies for renewable fuels that hold up well under a wide range of future market conditions.

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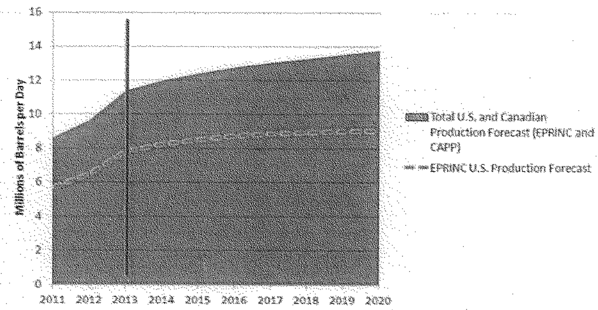
[10] Christopher R. Knittel and Aaron Smith. "Ethanol Production and Gasoline Prices: A Spurious Connection." July 12, 2002. MIT/UCSD criticisms of the CARD results were very specific, "We show that their (CARD) results are driven by implausible economic assumptions and spurious statistical correlations. In doing so, we show that the empirical results are extremely sensitive to the empirical specification; however, empirical models that are most consistent with economic theory suggest effects that are near zero and statistically insignificant."See http://web.mit.edu/knittel/www/papers/knittelsmith_latest.pdf

Regarding changes to programs that promote the use of renewable fuels into the gasoline pool, any policy remedy should provide adequate market flexibility for refiners and importers to adjust to large movements in feedstock prices, production costs, and automobile technology. Bringing flexibility to volumetric renewable fuel mandates, which cannot by definition, adjust to uncertainty in market conditions, is clearly an important starting point in any reform program.

Finally, the U.S. is in the midst of a renaissance in oil and gas production. As shown in Figure 8 below, EPRINC estimates that combined U.S. and Canadian oil production is likely to grow to 13.75 million barrels a day (mmb/d) by 2020, up from the 2010 level of 8 mmb/d in 2010.

FIGURE 8
North American Oil Production Forecast



in this outlook. Petroleum is no longer an instrument of economic distress, but a major driver of economic growth and a much improved strategic outlook for the U.S. When the RFS was established as law, the U.S. faced rising consumption of transportation fuels, declining domestic natural gas and crude oil production, and rapidly rising petroleum product imports. None of these conditions exist today. Given the vast changes in our energy landscape we should now revisit not just the RFS, but the entire regulatory programs that were put into place in a much different era.

APPENDIX (Selected EPRINC Publications on Ethanol and the RFS)

Montalbano, Ben. *Get Ready for a Bumpy Ride - It Could Be a Turbulent Year for Gasoline Prices*. Publication. N.p.: n.p., n.d. Web. 15 Mar. 2013. http://eprinc.org/pdf/EPRINC-GASOLINETURBULENCE-2013.pdf

Pugliaresi, Lucian. "Time to Rethink Renewable Fuel Rules." *www.cnbc.com*. N.p., 18 Apr. 2013. Web. http://www.cnbc.com/id/100653882

Pugliaresi, Lucian. "Ethanol's Hidden Gasoline Tax." *Www.washingtontimes.com*. N.p., 7 May 2012. Web. http://www.washingtontimes.com/news/2012/may/7/ethanols-hidden-gasoline-tax/?page=all

Montalbano, Ben. *Ethanol's Lost Promise: An Assessment of the Economic Consequences of Renewable Fuels Mandate*. 14 Sept. 2012. http://eprinc.org/pdf/EPRINC-ETHANOL-LOSTPROMISE-2012.pdf

Montalbano, Ben. *Implementation Issues for the Renewable Fuel Standard*. Publication. N.p.: n.p., n.d. Web. 28 Apr. 2011. http://eprinc.org/pdf/EPRINC-CornLimitsEthanol.pdf

Pugliaresi, Lucian, and Ben Montalbano. *Will the Ethanol Mandate Drive Up the Cost of Transportation Fuels?* Publication. N.p.: n.p., n.d. Web. Feb. 2009. http://eprinc.org/pdf/costofethanolmandate.pdf

A Report on the EPRINC-EIA Ethanol Roundtable Discussion That Took Place on April 15th. Publication. N.p.: n.p., n.d. Web. June 2008. http://eprinc.org/pdf/ReonEPRINCEIAEthRtDis.pdf

Kumins, Larry. "Energy System Limits Future Ethanol Growth." *Oil & Gas Journal* (2007) 2-5. 26 Nov. 2007. Web. http://eprinc.org/pdf/ETHANOLUPDATEOGJ.pdf

Kumins, Larry. *Ethanol II: Is Home-Grown Fuel Policy Undermining U.S. Energy Security?* Publication. N.p.: n.p., n.d. Web. Apr. 2007. http://eprinc.org/pdf/HomeGrownFuelUSEnergySecurity.pdf

Goldstein, Larry, and Ron Gold. *Update on Ethanol*. Publication. N.p.: n.p., n.d. Web. July 2006. http://eprinc.org/download/UpdateOnEthanol.pdf

MTBE, Ethanol - Sorting Through the Oxygenate Issues. Publication. N.p.: n.p., n.d. Web Dec. 2001.http://eprinc.org/download/oxyissues.pdf

Mr. LANKFORD. Thank you all for your testimony. We will work our way through questions here five minutes at a time, as we get a chance to pass these questions around. If we have a moment, we will get a chance to follow through on some of those as well, depending on our time period.

Mr. Gerard, let me just tell you a quick story, and this is for all of you, as well. You spoke specifically of fuel prices, several of you did, of the price of fuel as it goes. I spoke to an 8th grade class two weeks ago in Roosevelt Middle School, which is one of the poorest areas of Oklahoma City, and they submitted their questions to me in advance. And as I flipped through those questions, I was stunned at the number of them that asked the question about gas prices, and for their particular family to say what can be done because our family is having a tough time getting to work now and getting back and forth to school, and writing statements of I may have to walk in the days ahead because we cannot afford the gasoline.

The statements that were made about what is really coming on the consumer, both in the price, as Mr. Brandenberger mentioned, of food and of fuel, that is a real issue that we are facing right now for people that are the poorest and most vulnerable in our communities.

What can be done right now for EPA to provide some certainty in what is going to happen in energy prices for the next year?

Mr. GERARD. Well, there are probably a number of things EPA could do. The first and foremost, back to the Renewable Fuel Standard, though, send a signal to the marketplace that we are not going to put undue pressure, use the waiver authority to not put undue pressure on the prices that exist today.

Just very quickly, Mr. Chairman, I know that you understand this. The key drivers behind the price of gasoline are, first, crude oil trading on the global marketplace and second is taxation. Every State imposes somewhere between $0.35 and $0.70 a gallon on what it is that is produced. But what we are coming against under the Renewable Fuel Standard is the blend wall, where Government mandate is going to force us to make a decision as refiners. If we break through that blend wall and get forced to produce a fuel that the auto manufacturers have said don't put that in our cars, back to your car situation, because it is going to hurt the engine and they are not going to function well, or do we get compelled in the marketplace to begin to move back on our production? That is changing the fundamental supply and demand equation, putting upward pressure on the price.

So EPA needs to move quickly, with their waiver authority, to send a signal to the marketplace we are going to take this one variable out of play and not put upward pressure on the price of our fuels.

As NERA reports, and I would like to submit that for the record, if it is appropriate, Mr. Chairman, the potential here is staggering.

Mr. LANKFORD. Without objection.

Mr. GERARD. The reason those numbers only go to 2015 is because it is so staggering and so infeasible the model doesn't work after that. When you drive the price of diesel, the cost associated with diesel upwards of 300 percent, there is no place else to go in

2016; you have broken the system. That is how serious this is. epa's announcement to the marketplace we are going to relieve the Government pressure and get us back to a pure free market would go a long way.

Mr. LANKFORD. Okay.

Mr. Brandenberger, you mentioned some of the same things dealing with food, as well, and the price of food, but you also, in your testimony, a little earlier referenced the shift in jobs that is occurring; as we are seeing an increase in jobs in corn-based ethanol and cellulosic and some of the renewable fuels, we see a dramatic decrease in job in the agricultural industry as well. Can you go into greater detail on that?

Mr. BRANDENBERGER. Sure. Absolutely, Mr. Chairman. Even a small-to medium-sized turkey plant will provide several hundred jobs. A very large ethanol plant won't come close to providing the same number of jobs. So there has been a real shift in rural America.

As I mentioned, our production is still around 10 percent below its 10-year high; it is still about 6 to 7 percent below where it was in 2008. And those are real jobs that are lost. We have a lot of people about to be out of work in North Carolina, when the last turkeys run through the plant I mentioned there. There are a number of workers in California whose future is uncertain when the second largest turkey company there had to move to Chapter 11 protection. And this is going to continue.

And the problem comes, as well, just very briefly, is in both instances, when the RFS has had a real impact on corn prices, it has come at an exact moment when the meat and poultry industry already had other problems that affected it. So there comes a limit as to how much cost can be absorbed. You have to start passing it along to your customer. If the economy is not strong, the customer quits buying the product and then you get into a vicious cycle where supplies grow and plummet. It is a vicious, vicious cycle.

Mr. LANKFORD. We have faced this before. In 1979, the Government, at that point, Jimmy Carter was president, in the famous malaise speech made a speech to say that by the year 2000, because the Federal Government was going to coordinate all these efforts, 20 percent of the energy used in the United States would be done by solar power. And they were going to put a process in place to make sure 20 percent of the energy used in the United States was going to be solar by the year 2000. Obviously, that goal was not achieved. Not even close at that point.

You can make the plan and make the proposal and say this is what is going to happen, but if the technology is actually not there to do it, you can't actually get it there. As has been mentioned before, we can make this statement to say we are going to burn this much fuel, but if that fuel is not economically viable, if it is not really there, if the cellulosic fuel doesn't exist, as you mentioned before, the phantom fuel that is out there demanding to be used, we can make all the federal demands we want to make; that doesn't mean it actually exists in the real world. That is the challenge that we are facing currently right now.

As much as we would love, as Dr. Martin mentions, as much as we would love to get away from food-based fuel, it doesn't exist in the quantities that is needed to actually achieve that, and we have to find some solutions to this in the days ahead.

With that, I yield to the ranking member, Ms. Speier, for her questions.

Ms. SPEIER. Thank you, Mr. Chairman. You know, I am somewhat baffled by our discussion so far. It is almost like we are going to say we really can't move forward, we have to move backwards.

I think that Dr. Martin made an excellent suggestion about how we can fix your problem, Mr. Brandenberger, when he said you could cap the amount of corn ethanol that can be produced. That would then kind of up the opportunity for cellulosic. What do you think about Dr. Martin's proposal?

Mr. BRANDENBERGER. Well, the amount of corn-based ethanol is about two, three years away from being capped at 15 billion gallons, anyway, under the law. It is already approaching 14 billion gallons. We are already having enormous problems. If you are talking about capping it where it is today, or even capping it slightly below where it is today, there could potentially be some benefit. But if you are talking about following the cap already in law, I don't think that will give us or any of our brethren in the livestock and poultry world a whole lot of relief.

Ms. SPEIER. Okay, so there is some opportunity here for both to flourish, for corn ethanol and cellulosic ethanol, and for turkeys to be properly fed, and we just need to find a way to get to a happy medium here, because here is the problem: the oil production is going to cap, even with fracking, in very short order. So we have to be prepared with alternatives. We have oil companies saying they are moving in that direction. BP, for a while there, was saying beyond petroleum, although they have kind of abandoned that particular moniker today.

The military, the Navy wants to have 50 percent of its fuels coming from biofuel by 2020. So we cannot just dig our heads in the sand here.

Dr. Martin, can you comment on what Mr. Brandenberger has just said?

Mr. MARTIN. Sure. I would be happy to. I think the point here is to address some of the near-term challenges that people have raised, and there certainly are challenges with food-based biofuels, but to recognize that locking in place a status quo doesn't advance the oil savings and climate solutions that we really need to move our Country forward.

So I think my testimony pertained to a slightly longer view of this policy, but a longer view is necessary. You didn't build the oil industry overnight. You didn't build the corn ethanol industry overnight. So between now and 2015 we are not going to build a cellulosic biofuel industry that is the scale of the oil industry. So we need a steady path forward that allows investors the confidence to build this next industry and to create the jobs and opportunities that will come with it.

Ms. SPEIER. The reference that Mr. Brandenberger made to jobs I think doesn't square with some of the realities that we are seeing, so I would like to point out that the Ineos plant in Vero Beach, Florida, a cellulosic biofuel plant, will produce 8 million gallons of ethanol from municipal solid waste, create more than 400 jobs, and contribute more than $25 million into the Florida economy.

KiOR, in Columbus, Mississippi, will produce ethanol from woody biomass, yielding over 13 million gallons of gasoline, diesel, and other fuel oil blend stocks. The $220 million facility is expected to create several hundred jobs during operation and over 500 jobs onsite during peak construction.

Additionally, there are new plants either in the planning stages or under construction in as many as 20 States and Canadian provinces, including BlueFire Renewables in Anaheim, California, POET–DSM Advanced Biofuels in Scotland, South Dakota, and Fiberright in Lawrenceville, Virginia, to just name a few.

So here we have a real jobs engine being produced, real hopeful technology, an opportunity to reduce our dependence on foreign oil, and we are somehow suggesting we just have to cut this off and repeal the RFS.

Mr. Martin, can you describe the new technology that is allowing these facilities to produce these volumes of cellulosic biofuel?

Mr. MARTIN. Not in a few seconds, but one of the really exciting things is that there is not just one technology, there is quite a different variety of technologies. Some of them are biological, some of them are thermochemical, and they would take some time to get into, but different technologies are suitable to different feedstocks. So we have a lot of opportunities that can create different types of fuel using different types of resources all over the Country, so I think that is the opportunity that is in front of us and that is why it is so important to move forward.

Ms. SPEIER. Thank you, doctor.

I yield back.

Mr. LANKFORD. Thank you.

Mr. Chaffetz.

Mr. CHAFFETZ. Thank you, Mr. Chairman, and thanks for calling this hearing. This is something that actually affects every single American. It affects them at the table where they eat; it affects them in their pocketbook at a time when we are struggling with jobs and the economy. This is not something the American economy can continue to sustain.

Mr. Gerard, I would like to ask you a couple questions about the economic impact and the blend wall specifically. I know there was this NERA report. Could you talk to that? I believe it said it would result in a $770 billion decline in the GDP. Explain the economics behind that.

Mr. GERARD. Yes. What NERA did is they went back and they looked at the situation on the Renewable Fuel Standard, and I wish Ranking Member Speier were here because there is a key connection, I think, with some of her comments earlier, and that is that we can all hope for the new fuels, the cellulosics and other things Dr. Martin has talked about.

The reality is the statute mandates and it is forcing as if somehow it is going to compel technology to produce a fuel that doesn't currently exist. Cellulosic is a perfect example. I think everyone would help we have cellulosic fuel today. The oil and natural gas industry happen to be some of the largest investors in some of these renewable alternative forms of energy. The problem is it doesn't exist today in the quantities necessary, but the statute mandates the blending of them. We paid millions of dollars to the EPA under the statute, finally got a court to compel them to give our money back, paying for a fuel that doesn't exist.

So when you look at the NERA study, what they did is took the assumptions under the statute, what the law required us to do, and said what does this result in. And we have four fundamental options: we can either cut back production because we can't meet the statute, therefore, the volumes we are producing are limited and our requirement to certify we are using, called RIN, or Renewable Identification Number is met; or we can try to go to the E85 that Lu talked about, which the public has already said we are not going to buy that fuel, it is less efficient, essentially costs us more; we can go to E15, which is the approach the EPA has taken. Incidentally, all the research shows, and every automobile manufacturer asked by Congressman Sensenbrenner last year said we will not warranty our cars if you put E15 in them. And the last option is we can export the gasoline. Why? Because we don't have to blend the piece we export.

So you are driving us in a position in the United States where we have no alternative, no place to go. The NERA analysis says that greatly escalates price and, therefore, could add to the cost of producing diesel upwards of 300 percent, gasoline 30, taking $770 billion out of our economy as a result of the ripple effect.

Mr. CHAFFETZ. So what has happened to the ethanol RINs? My understanding is that this traded as a commodity. In early 2013 it was about $0.05 per gallon. It moved at one point north of $1.00 per gallon. It is now, at least on May 30th it was $0.89. What is the economic impact of that? What does it mean for a regular family who has a regular job and just trying to get by?

Mr. GERARD. Well, experts predict different things, but the bottom line is this: the price of the RIN, Renewable Identification Number, that we have to buy to certify we blended the fuel has increased over 1400 percent in the last few months, over the last four or five months; and that is being driven by the expectations of the market. The market can see the blend wall. The market understands the blend wall is upon us. And just like the EPA action, thinking they were going to take pressure out of the blend wall by forcing us to create a fuel that we understand will damage automobiles, that is where we stand as an industry. It is a hard thing to answer. The bottom line is it adds to cost. Clearly, everything this Government mandate will do prospectively, just like NERA concluded, significantly adds to cost and impacts the consumer.

Mr. CHAFFETZ. The cost of running an automobile, to running that tractor, to the airline tickets that you are going to buy, it is all going to be affected.

In my last few seconds here, Mr. Brandenberger, explain bigger and broader than just turkeys how feed is affected and what that does to the price. Turkey is one of the most consumable products we have out there, such a staple in the American diet. Go a little deeper in the economics on what this does to this industry.

Mr. BRANDENBERGER. Absolutely. Thank you for the opportunity. To sort of lay the foundation for that, two things to what we have been discussing here today. We are going to try to play it very straight with the subcommittee when we talk about jobs. We are talking about permanent, ongoing jobs in the plants themselves; not construction jobs that are created, not the many other jobs that are created in the support industry. We are talking about permanent jobs in the plants. And to give it a broader case, in all livestock and poultry, corn is the top feed ingredient. It is true for chickens, true for hogs, true for cattle in the feed lots.

We have created a situation where, when we have a year like last year, when there was such a severe drought, we have corn stocks down near historic lows, we have to compete in the market for that corn. But the Federal Government has said one person gets to go to the head of the line because their customers have basically a regulatory gun to their head; their customers, the ethanol industry's customers have to take their product. We don't have a turkey consumption standard or a chicken consumption standard or a beef consumption standard. Our customers don't have to buy our products; the ethanol industry's customers have to. That gives them an incredible advantage when competing for corn in a short market.

So I hope that maybe clarifies a little bit just exactly what the ripple effect is. We don't have an ability always to pass our costs along.

Mr. CHAFFETZ. I thank the chairman. Yield back.

Mr. LANKFORD. Thank you.

Mr. Cardenas.

Mr. CARDENAS. Thank you very much.

Well, lucky for the turkey industry, I have to buy your product because I don't eat pork or beef. So that is my main source of protein. So you have one big consumer here.

Mr. BRANDENBERGER. Thank you.

Mr. CARDENAS. You are welcome.

Dr. Martin, I would like to ask you a question. People might be thinking I am being facetious, but I am being serious. What scientists are concerned, why are they concerned, and what are they concerned about when you talk about concerned scientists?

Mr. MARTIN. Thank you. We are concerned about a variety of problems. Probably at the top of the list is climate change. But we are also concerned about other impacts that oil causes to our economy, to our security, and, as I already mentioned, to the climate. We have other programs working on issues related to food, to agriculture, to tropic deforestation, to global security. So we work on a variety of issues and we are concerned about all of them.

Mr. CARDENAS. Okay. Well, thank you for your concerns and the effort you are putting into that.

I have a question to Mr. Gerard. You mentioned earlier something about costs increasing by 300 percent. What were you referring to, under what time frame, and what is the potential cause of that?

Mr. GERARD. That is the NERA analysis I just mentioned to Congressman Chaffetz who was here. We are happy to provide that for the record. But what it does, congressman, is we come to this E10 blend wall where we are forced to make decisions because they are pushing us into creating fuels, if you will, that the market cannot accept for technological reasons. We then get put in the position where we have to find ways to justify or document that we are doing what the law requires. Therefore, the options to us are limited, but some of those options include to take fuel, for example, and to reduce the amount that we produce. The study itself, I believe, references this as rationing. So when you begin to impact the market by Government mandate like that, of course, others seeing this coming react to it and this particular economic group concluded that that would drive costs associated with diesel as high as 300 percent higher and gasoline 30 percent higher, in addition to the impacts on take-home pay and decrease in GDP activity.

Mr. CARDENAS. So basically those are potential increases, they are not charted actual increases; they are potential increases based on cause and effect, correct?

Mr. GERARD. Correct. Predicted to occur within the next two years.

Mr. CARDENAS. And you represent the American Petroleum Institute, so if they had to write a letter right now and say either they are going to put in their letter to Congress about RFS, would that letter be talking about eliminate RFS or modify RFS?

Mr. GERARD. Well, we take two approaches, congressman. First thing we do is we would suggest EPA act immediately under their waiver authority to send a signal to the marketplace, take the pressure out of it. The second approach we would take right now is a repeal request. The reason we pursue repeal, we believe the statute has become so complex and convoluted that we ought to step back and start over and look at the new reality we are faced with in the United States today, where we produce a lot of our own fuel right here at home and we are able to produce even more here at home in the forms of oil and natural gas. We should look at those realities to secure our own energy future.

Right now, part of the mandates required under the Renewable Fuel Standard require significant imports from Brazil of sugar cane ethanol. Well, if the statute was originally enacted to get us off foreign imports, all we have done is shift it from one commodity to the other.

So we would ask for repeal and then step back and say, okay, what is the vision of the Country as it relates to renewable fuel, cellulosic and others? We are big investors in those. If we had answers to that today, they would already be in the marketplace.

Mr. CARDENAS. I have one more question to you guys. My time is limited. I have been dying to ask this question all my life, well, since I was 15 years old and I got my driver's license and paid for my own gas. I always wonder that no matter what is going on in the world, whether there is a war going on, gas prices seem to jump up; whether the war ends, gas prices seem to stay stagnant or jump up; whether or not there is disasters or what have you going on affecting oil-producing countries, gas prices seem to either go up or stay stagnant, regardless. So in my personal experience, and many of my constituents, that seems to be the case. They go up a lot easier than they go down. So the question I have for you or your industry is do you document the spikes and let the public know the whys of those spikes as they occur, or is that too proprietary?

Mr. GERARD. Those movements in the price of gasoline, diesel fuel, whatever they might be, are all a matter of record by a number of agencies, particularly Government. But let me respond more generally, if I can, congressman. As you look at the price of gasoline and fuels generally, it is driven, as I mentioned earlier, primarily by the cost of crude oil. Now, what is significant about the new reality in U.S. production today? We are having a significant impact on the potential supply equation on a global scale. In the past two years, the United States is now the number one natural gas producer in the world. IEA, the International Energy Agency, has predicted that if we stay on this course of production increase, we will surpass Saudi Arabia as the number one world's oil producer in seven short years.

There was an article just as week or so ago talking about OPEC. OPEC is very concerned about what is going on in the United States today. This has geopolitical ramifications to it that will change the world as we know it. That is why we think we need to get back and refocus on reality, look at things like RFS that were put in place at a very different time, under very different assumptions, and deal with the reality today to maximize our potential as a Nation to become energy secure.

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

Mr. LANKFORD. Mr. Jordan.

Mr. JORDAN. Thank you, Mr. Chairman.

Mr. Brandenberger, let me first start here. I kind of want to just cut to the chase, if I can. The law says the EPA can waive the Renewable Fuel Standard if "implementation of a requirement would severely harm the economy of a State, region, or the United States."

Does the Renewable Fuel Standard increase the cost of producing turkey, Mr. Brandenberger?

Mr. BRANDENBERGER. Absolutely.

Mr. JORDAN. Does the Renewable Fuel Standard increase the cost, I know you are in the turkey business, but does it increase the cost of producers in the pork industry?

Mr. BRANDENBERGER. Absolutely. We have a lot of members who produce both turkey and pork.

Mr. JORDAN. Does it increase the cost of producing beef?

Mr. BRANDENBERGER. Yes.

Mr. JORDAN. And, therefore, would it be logical to assume that because the cost of production is up, that the cost to the consumer of those products, turkey, pork, and beef, is also going to be increased?

Mr. BRANDENBERGER. In most cases, yes.

Mr. JORDAN. And, Mr. Gerard, does the Renewable Fuel Standard increase the actual cost of fuel?

Mr. GERARD. Yes. Economists and experts say it does.

Mr. JORDAN. Mr. Brandenberger, does the Renewable Fuel Standard increase the cost of other non-protein, non-livestock food products, the cost of production, corns used in all kinds of food products, does it increase the cost of those other food products?

Mr. BRANDENBERGER. The people I talk to in those industries assure me it does.

Mr. JORDAN. They tell me the same thing.

Mr. Martin, I think you even said in your testimony you don't want to expand the food-based fuels and the Renewable Fuel Standard.

So I guess I go finally to Mr. Pugliaresi. So is all this adding to the cost of the American consumer, the American family, increasing the strain on their budget? Is it harmful to the economy?

Mr. PUGLIARESI. It is very harmful to the economy because it acts like a massive excise tax. But, more importantly, we are allocating resources to activities which have very low value added, and often harming activity in high value added activities which would help to foster high rates of economic growth. We now have 10 years of very low economic growth, less than 2 percent. We should take a very hard look at our entire regulatory program on the fuel sector, because that is one of the drags.

Mr. JORDAN. Okay, so, if I could just quickly sum up, then, every food product that uses corn is seeing an increased cost; fuel itself is an increased cost, which, according to the economists here, is going to make it difficult for every family. Every family's budget is being hit by this.

So the simple question is, Mr. Chairman, for the second panel, Mr. Grundler, from the EPA, or, frankly, the acting head of the EPA, Mr. Perciasepe, or the nominee who is slated to be the head of the EPA, the question is way haven't you waived the standard. I mean, the law is real clear: if implementation of the requirement would severely harm the economy of a State, region, or the United States, you can waive the standard. So these guys are all great and they are saying everything that I think a lot of us already knew, and I think the American consumer understands every time they go to the grocery store, every time they pull into a gas station.

So the real question is, from the EPA, why in the heck haven't you done what the law says you can do? And then we can think about how we are going to change the law, if we need to, but there is relief right now. I know we have to keep asking questions of these fine gentlemen, but I want the EPA guy up there to say what gives, what is the deal. This is as obvious and as plain and as simple as it can be. You guys have the authority to help every single family in this Country and you won't do it. We want to know why.

So I look forward to the second panel and I yield back.

Mr. LANKFORD. Would the gentleman yield his final one minute?

Mr. JORDAN. Be happy to.

Mr. LANKFORD. Mr. Gerard, you made a comment earlier I would like to follow up on. You made a comment about one of the alternatives is to export more gasoline in this structure. What did you mean by that?

Mr. GERARD. Well, what happens when we get forced into the blend wall, we have to make decisions about what we do with the product. Do we quit producing the product, thus leading to rationing, as some of the economic analyses suggest? Or the other out is you potentially export gasoline because you don't have to attach a RIN to it.

Mr. LANKFORD. Has that already started occurring?

Mr. GERARD. Over time, we, as a Nation, have always exported some refined product and gasoline.

Mr. LANKFORD. But that is being seriously considered to solve this problem, we could export?

Mr. GERARD. It is difficult. Where we are today and what is so difficult about where we stand, under the law, the EPA is supposed to tell us on November 30th of the previous year what the standard is going to be.

Mr. LANKFORD. Do we know that yet for this year?

Mr. GERARD. We don't know it yet.

Mr. LANKFORD. It is passed November 30, by the way.

Mr. GERARD. It is passed November 30 of 2012, when we were supposed to learn what is going to happen for 2013, what is required for us. So we hear, in January, what their proposal is. It has not yet gone final. We don't know, today, half way through 2013, what is expected of us in terms of where they are ultimately going to land, because they have the waiver authority that is being talked about on some of these standards. So as an industry, I can't speak for the individual companies, but let me tell you there is a lot of hand wringing going on right now, trying to understand the Government mind-set, trying to understand where EPA is, frankly, trying to understand where the Congress goes next on this. EPA has that authority year by year. Ultimately, this needs to be repealed. It is creating great anxiety in the marketplace; it is forcing decisions unrelated to market factors because of governmental interference, if you will, or drivers. It is a serious problem. I wish I could tell you with clarity what each other individual company is going to do. I am merely laying out what the options are, none of which are good until you fix the Renewable Fuel Standard.

Mr. LANKFORD. Thank you.

Mr. Jordan?

Mr. JORDAN. I thank the chairman for his indulgence.

Real quickly, if I could just run down the list. Why won't the EPA do what seems obvious to all of us? What do you think their motivation is for not doing what clearly needs to be done?

Mr. GERARD. I can't tell you what is in their head. What I can tell you, congressman, is if one believes that you can take a Government mandate and force the creation of a technology, which I believe is a silly notion, that is the only thing I can come to. Or they are literally trying to reorganize or re-craft, if you will, the entire fuel economy of the United States.

We look at this from, for example, our situation under cellulosic fuel. As I mentioned earlier in my comments, in 2010, when they came out with a mandate, the fuel didn't exist. We asked them, we said, please waive that down because the fuel doesn't exist. They said, no, we are not going to do that. We got to the end of 2011; we actually had to petition them with a waiver that says please, in a formal way, waive it down to zero, because now we have gone through the year. We all know it doesn't exist. Will you give us relief? And the response was no.

So we paid over $5 million to the EPA. I might add that is a new taxing authority, from our vantage point. Gave $5 million to the EPA for a fuel that doesn't exist. We came to the next year. What did they do? They raised the number on us, even though it didn't exist in the previous year. So we had to go back to the U.S. Court of Appeals here in D.C. and get a court to instruct the EPA to waive the standard down to zero. The fact is it is fascinating, I don't know if any of you would be interested, but in the particular court decision, here is what the court says: The EPA is not allowed "to let its aspirations for a self-fulfilling prophesy divert it from a neutral methodology."

Now, the court mandated that they say since there is no fuel, give the money back to the refineries. Within days the EPA issued their proposal for this year. They doubled down, they increased the mandate for us on cellulosic over what it was the previous year that the court had struck down literally five or six days earlier. So I can't tell you what they are thinking. That is a long answer. It is hard for us to predict. I can tell you it is raising havoc in the marketplace. And you have industries trying to provide consumers benefits and values of fuel at affordable, reliable cost, and now we have Government that is dictating that. It is a real problem.

Mr. LANKFORD. Thank you.

Mr. Davis.

Mr. DAVIS. Thank you very much, Mr. Chairman. I, too, want to thank you for calling this hearing because I think this issue is one of the most important ones that we face. Trying to strike the appropriate balance between protection of our environment and the health of the American people, and at the same time providing a reliable, safe product in terms of the production of oil and gasoline really is no easy task. So it is fraught with a tremendous amount of disagreement.

Mr. Gerard, let me ask you has the EPA approved E15 for use in any car or light truck model year 2001 or later?

Mr. GERARD. Yes, they have, Mr. Davis. In fact, what they did in two steps or in two processes, they granted two waivers. So now they have approved it for 2001 and later vehicles. Yet, going back to Mr. Lankford's comment, our research, the Coordinated Research Council, which is a combination of automakers and our industry and the EPA and DOE, I might add, have come to the conclusion, based on research, that with E15 you put millions of cars at risk, not to mention what you potentially do to small engines; chainsaws, lawnmowers, motorcycles, etcetera. So, yes, they have used waiver authority under the Clean Air Act to grant that opportunity, and it is a real problem. And every automobile manufacturer that responded to Congressman Sensenbrenner last year said they will not warranty their cars if they use E15. But the EPA has granted that.

Mr. DAVIS. Is it legal to use E15 in motorcycles?

Mr. GERARD. I don't think it is. I think they specifically excluded some of the smaller piece of that, perhaps motorcycles. Let me go back and find that specific detail. It is not legal in motorcycles, in small engines.

Mr. DAVIS. Did the DOE find any increased risk of engine damage from using E15?

Mr. GERARD. This is a great question I would encourage the committee to look at closely, because in the process of granting the E15 waiver, the EPA had underway an emission standard for catalytic converters on cars. When they decided to grant the waiver, they took that study that was unrelated to E15 at the time and used it to justify their decision on E15. The study that we were participating in, which originally had EPA part of it to design the study, they wouldn't wait for that study to come out. That study was concluded and shows that you put millions of automobiles at risk.

So we need to look closely at the science. We believe the science has not been done. In fact, California, the California Air Resources Board has said we will not use E15 in California; in fact, we believe it will take many years of study to determine if it should be used.

Mr. DAVIS. Did they find if there were no significant changes in vehicle tailpipe emissions, vehicle driveability, or small non-road engine emissions as ethanol content is increased?

Mr. GERARD. Well, their conclusions based on an emissions test about catalytic converters was they attempted to suggest that answered the fundamental question of auto durability and fuel systems. The analysis done by the Coordinating Research Council concluded it clearly showed impacts on fuel system and clearly showed impacts on some model years on durability, valves, etcetera. So while they attempted to extrapolate, in our view, an unrelated study for these purposes, real research that goes to the real question about the impacts of E15 shows there are serious problems.

Mr. DAVIS. Thank you.

Let me ask Mr. Pugliaresi a question here. Most consumers think that the numbers on the gasoline pumps, 85, 87, 89, are just synonyms for paying a low, medium, or high price for gas. What do these numbers actually represent?

Mr. PUGLIARESI. If you are referring to the octane numbers, they refer to the performance that this gasoline does for specific engine types. So certain kinds of high-end cars require much more compression, they require higher octane. But most automobiles in America today can operate on 87 to 89 octane.

Mr. DAVIS. Thank you very much, Mr. Chairman. I yield back.

Mr. LANKFORD. Mr. DesJarlais.

Mr. DESJARLAIS. Thank you, Mr. Chairman, and I thank the panel for being here today.

I wanted to talk about a couple different things. Mr. Brandenberger, in Tennessee we have a lot of poultry; Hubbard LLC in Pikeville, Tennessee. I don't know if you know Jay Daniels, the director of operations. We have sat down and had many discussions. I believe he said about 85 percent of the cost for them is in feed. So this has a huge impact. We also have Tyson in Shelbyville, Tennessee; and I know you are turkey, these are chickens. But what is the amount of corn that this needs compared to other livestock?

Mr. BRANDENBERGER. Well, you are right, I can speak a little more specifically to the amount of what feed costs in turkey production. For turkey it is about 70 to 75 percent of the cost of production, so pretty similar to the numbers you are quoting for chicken.

I think the most telling thing is there isn't any real substitute for the corn. Yes, there are some byproducts from ethanol production that can be blended in a little bit, but it is not a one-for-one substitution. When corn becomes less available, prices go up. I think it is very telling the way that the livestock and poultry industry have chosen to handle it. We are buying 1.5 billion fewer bushels of corn now than we were when the RFS was created.

Mr. DESJARLAIS. So that is your biggest competitor, really, to bring in lower cost to the consumer in the stores, is your competition with the ethanol program?

Mr. BRANDENBERGER. That is the way it has turned out. I am sure that is not what Congress intended.

Mr. DESJARLAIS. Okay. And you can't use the distilled dried grain or the DDGs with turkey and they really can't with chicken.

Mr. BRANDENBERGER. That is the byproduct. We can use it in a limited amount. Some would try to characterize this as, oh, well, it is no problem, we put the distiller's grains back into the market. That is not true. In turkeys, as a rule, 10 percent of the feed ration is about the maximum a distiller's grain can go. And distiller's grains are not of equal quality. In poorer quality grains, you are lucky to get to 5 percent you can blend in.

Mr. DESJARLAIS. Okay.

Mr. Gerard, I want to talk a little bit about small engines. This is a little bit of a pet peeve of mine. I just cleaned out my storage shed and I have a pressure washer, a weed eater, and a lawnmower, about $1,000 worth of equipment that were initially damaged by ethanol fuel, the 10 percent ethanol. It damaged the fuel lines. I have had all these repaired once. I try to buy pure gasoline for them, but I have teenage boys who I think have put the wrong kind in, and it has kind of worked on the weed eater because I have convinced my wife that spraying Roundup along the fence line is better than using the weed eater; it is certainly less labor intensive. But I am not sure she is still with me on that.

But really, if you own a leaf blower, a weed eater, a lawnmower, a pressure washer, I hail from Sturgis, South Dakota. We have a lot of motorcyclists who have talked to me about the ethanol in gasoline. Tennessee is a great hunting State; we have people who use four-wheelers, we have fishing boats. So can you talk to me a little bit about the impact on small engines and why people should be forced to deal with this?

Mr. GERARD. In that context, congressman, I am not an expert on small engines, but let me just say when you look at the breadth and scope of everybody that is very concerned and, in many instances, opposed to what the mandates of the Renewable Fuel Standard are, this is clearly a focus on many people's minds. In preparation for today, I was reading some material by some of the small engine manufacturers. For example, one piece of testimony, a direct quote from one who had a chainsaw that said these additional blends or these higher blends of ethanol make the machine run too hot, and on occasion his chainsaw would engage, whether he wanted it to or not, in the course of doing his work.

So clearly an adverse impact, particularly on the smaller engines, be they lawnmowers, weedwackers, whatever they might be. And we find in the marketplace, obviously, much like yourself, a lot of people come in and say I don't want any blend in my fuel, I want the gasoline, because as the small engine repairmen and others are telling them, it won't hurt their product or the equipment they have paid so much money for. So, generally speaking, yes, that whole group, the marine group, the motorboat group, the motorcyclists groups, they are all a part of a broader coalition seeking repeal and reform of the statute.

Mr. DESJARLAIS. I think you mentioned earlier the actual cost of producing a gallon of ethanol and blending it in is not cheaper than just regular gasoline.

Mr. GERARD. That is correct. The thing to remember there, when you look at it on an energy content, on a Btu basis, gasoline is generally always cheaper than ethanol. When you look at it on a volumetric basis, they will say, no, ethanol is cheaper, but the reality is you don't get as much energy out of it.

Mr. DESJARLAIS. Let me ask one thing. I was recently traveling to South Dakota and I had not seen these in Tennessee, but in Iowa, I saw my first pump that you could choose 10, 20, or 30 percent ethanol, and the 30 percent was the cheapest of the three. Does that make any sense at all to you, then, from what we just talked about from a cost standpoint?

Mr. GERARD. It is hard to predict, unless somebody has used that as a marketing tool, etcetera. As Lu talked about a little earlier, when you look at the heavier amounts of ethanol, like in E85, the consumer is telling us with their buying practices they don't want it. You look at Minnesota, you look at Iowa, the number of service stations that will sell the higher content fuels, the actual demand for the fuel is going down, even though you are increasing the number of service stations.

There is about 4 percent of our fleet today that are flex fuel vehicles that can burn it; only about 1 percent of that 4 percent actually use it on a day-to-day basis. So consumers are deciding what they are going to buy, and regardless what the statute mandate or the EPA regulatory mandate is, that is the marketplace. We need to be thinking consumers, number one, two, and three in this discussion.

Mr. DESJARLAIS. And that is what my consumers in Tennessee are telling me, so thank you for your input.

I yield back.

Mr. LANKFORD. Thank you.

I would like to submit for the record a study that was conducted by the National Renewable Energy Laboratory, done in 2011, specifically dealing with 4-stroke engines, small engines and such, and to be able to get this into the record as well. Without objection.

Mr. LANKFORD. Mr. Horsford, you are up to bat.

Mr. HORSFORD. Thank you. Good morning, Mr. Chairman.

Thank you to the witnesses who are here. I do want to just start. I know a previous colleague of mine, a couple questions back, kind of implied what is in the mind of the EPA and the regulators; why don't they just change their direction, I guess at the behest of the industry. I would note that while people may not agree, RFS is the law and it was a law that many Republicans and former President George Bush implemented. So to somehow suggest that the EPA should indiscriminately choose which laws it should properly implement and which ones it shouldn't I think is questionable.

Let me get to my question on ethanol production, which has been around for a long time. In the years since passage of the RFS, fuel blends of 10 percent ethanol to 90 percent gasoline have become deeply entrenched in the transportation fuel production apparatus.

Dr. Martin, if the RFS was repealed, is it likely that ethanol would no longer be blended with gasoline?

Mr. MARTIN. No, it is not at all likely. In fact, that was the substance of epa's analysis last year in considering this request for a waiver, and, in theory, there is complicated economic analysis behind that, but in practice these RIN prices tell you a story, and last year RIN prices were very, very low, only a few pennies, and that is evidence that people could have avoided complying with the law by purchasing those RINs, and there wasn't much interest in doing that. So I think that is reasonably clear evidence backed up by much more detailed analysis that, in fact, waiving the RFS would not reduce the amount of ethanol use dramatically, and I think that was an important part of their decision.

Mr. HORSFORD. So, as a follow-up, if the repeal of the RFS would not likely have a large impact on core production for ethanol, what would be its effects?

Mr. MARTIN. Well, it would certainly stop immediately investment in next generation biofuels, so that is precisely our concern. We are quite conscious of a lot of the problems with the expansion of corn ethanol, but at this point stopping the RFS, even trying to rewrite the RFS would stop investment in next generation biofuels and sort of lock in 10 percent ethanol, 90 percent gasoline. So we don't think that is the smart solution to the challenges that oil causes our economy. We think we need to move forward, but we do need to be conscious of some of the challenges and make sure that the policy is flexible to address those.

Mr. HORSFORD. Okay, so according to the EIA, total U.S. oil production peaks in 2019 and oil production extracted from tight formation through hydraulic fracturing will peak in 2020, as the Ranking Member talked about earlier. Then U.S. oil production begins a steady slide. In essence, the shale boom just delayed the inevitable by a decade or so. The EIA projects imports will continue to contribute roughly half of total U.S. crude oil supply. That means Americans will continue to spend roughly $300 billion per year on oil imports, a large share of which comes from politically unstable and hostile regions.

Mr. Gerard, since the RFS was adopted in 2007, the private sector has invested billions of dollars in the renewable fuel space. What actions, and at what level of investment, has the oil industry made in the past five years to ensure that our Nation's distribution infrastructure is ready to distribute higher blends and new fuels?

Mr. GERARD. That is a great question. We are the leaders in investment and technology, particularly as it relates to fuels, zero carbon, and many low carbon and many technologies. Let me give you one quick fact. I can't tell you the last five year number; I can tell you the last decade number. From 2000 to 2010, the Federal Government spent about $43 billion to develop these new technologies. The oil and natural gas industry spent about $71 billion over the same time frame, and the entire rest of the industry outside the oil and gas industry spent about what we did, and that is $74 billion. So when you look at those investing in new cutting-edge, breaking technologies, the oil and natural gas as a sector is the leader in making those investments and making things happen.

Now, there may be a second part of your question that is an important one, congressman, to answer, and it goes to the infrastructure question, and this is a myth I would like to dispel. Ninety-seven percent of all the service stations you see out there today are not owned by the oil and natural gas industry, they are small businesses, they are Ma and Pa operations. In fact, 58 percent of those service stations that are out there are single station owners, meaning they only have one station in their portfolio.

So when you look at potential costs associated with infrastructure attached to a Government mandate to distribute a fuel, you need to look at the actual ownership. It is estimated between $25,000 and $200,000 per retrofit of a service station to be able to implement, to change the station.

Mr. HORSFORD. Can I ask specifically, then, what have the oil companies, your members done to support those Ma and Pa station owners?

Mr. GERARD. We have relationships with most of them to produce the fuel that they request and ask for to make their business strive. That is the business we are in.

Mr. HORSFORD. But specifically and monetarily what have you done, what have your companies done?

Mr. GERARD. We have done everything that we should do to promote the use of the product longer-term, from promoting the product to producing the product to distributing the product. Everything associated with that we do, we continue to do, and we invest billions of dollars here in the U.S. doing it.

Mr. HORSFORD. Thank you. I know my time has expired. If you could please provide the committee with those examples in how the oil companies work with those small business owners.

Mr. GERARD. Happy to do so.

Mr. HORSFORD. Thank you.

Mr. LANKFORD. Dr. Gosar.

Mr. GOSAR. Thank you.

Mr. Gerard, I am going to ask you kind of a general question because you understand the dynamics of our economy. A family is having harder time putting food on the table, true or false?

Mr. GERARD. All economic indicators are true, they are having a difficult time.

Mr. GOSAR. More people are on food stamps, are they not, true or false?

Mr. GERARD. That is my understanding. I am not an expert in that area by any means.

Mr. GOSAR. Mr. Brandenberger, could you answer the same questions?

Mr. BRANDENBERGER. That is my understanding as well, and obviously, in the current budgetary times, snap is under a lot of pressure right now.

Mr. GOSAR. Gotcha.

Mr. Martin, true or false on both those questions?

Mr. MARTIN. I have no expertise in those.

Mr. GOSAR. Oh, come on, now. You are a consumer. Do you go to the store? Come on. You can't be a heartless scientist. Come on.

Mr. MARTIN. I am not a heartless scientist, but I try hard to stay within my area of expertise, and I don't have any special expertise in this area.

Mr. GOSAR. There is no need of expertise like this. Don't hide.

Mr. MARTIN. What is that?

Mr. GOSAR. Don't hide. You don't need expertise on this. This is general economics 101. There are more people on food stamps than five years ago.

Mr. MARTIN. I have read that in the newspaper.

Mr. GOSAR. Okay. Food prices are going up.

Mr. MARTIN. Compared to when?

Mr. GOSAR. Five years ago.

Mr. MARTIN. I really don't know off the top of my head.

Mr. GOSAR. Have you bought turkey lately?

Mr. MARTIN. You would have to ask my wife.

Mr. GOSAR. It has gone up. So it wasn't so hard.

Mr. Pugliaresi, can you answer those two questions?

Mr. PUGLIARESI. Yes.

Mr. GOSAR. Yes. Definitely gone up there.

The ranking member introduced this letter by Mr. Braley and he quotes that it has supported over 63,000 jobs in the State of Iowa with ethanol. I want to go back through this and just show the implications to this economy, because I want to put people to work under your numbers of $770 billion.

When converted to ethanol, a bushel of corn yields $1.80 per gallon for its energy content, which can produce up to 2.5 gallons of ethanol. Alternatively, a bushel of corn fed livestock can produce 6 pounds of beef, 13 pounds of pork, 20 pounds of chicken, and 28 pounds of catfish.

In terms of job growth, critics argue that 1 million tons of corn used to produce meat and poultry can produce 3600 direct jobs. However, 1 million tons of corn used to produce ethanol only supports 145 jobs.

If Mr. Braley is correct that these ethanol jobs created 63,000 jobs in the State of Iowa, he just gave up 1,564,000 jobs. That is the same number, because of what it would be in the industry. I am doing the calculation based upon what everybody else has given me as numbers.

So do we have a jobs crisis in this Country, Mr. Gerard?

Mr. GERARD. Absolutely. And I will tell you from the only gas perspective we are doing everything we can to create good paying jobs to provide stability to help families.

Mr. GOSAR. So I want to come back to this. So when we are trucking, most of this is trucked to little towns here and there, major fuels for trucks is what?

Mr. GERARD. Diesel fuel.

Mr. GOSAR. That is the great answer. So technically, in the next couple years, we may run, technically, out of being able to produce any diesel fuel, true?

Mr. GERARD. Under the RFS, it has clearly brought us to the brink of a crisis.

Mr. GOSAR. So we are not really asking for not to use these ethanol, it is expanding beyond that, right? So it is just common sense. So let me ask you another question. When we are talking about our economy, and I am from the State of Arizona, so a lot of it is tourism and recreation, right? So a lot of people take, just like my friend, Dr. DesJarlais was talking about, they take their four-wheelers, they go on a boat ride, all these things.

When you don't have access to that fuel, it causes a problem, which means cars will break down, because that is what it does. If I am not mistaken, alcohol lifts rust, right? It causes problems and it jams up the engine. That is one of the biggest problems that we have with ethanol. So when mom and pop are driving across the Country, cars break down; can't find the fuel, so they are on the boat, the boat breaks down; when they are in the woods, the four-wheeler breaks down; when they are on the road going to Sturgis, the bike breaks down. So we are spending more time trying to fix things than in actually enjoying the tourism industry, which is a huge impact.

So not only does this hit us at our food table, because more and more people are having harder times putting cost-effective food on the table, but when we try to have enjoyment of tourism, which is a huge industry in Arizona, it is going to make a major crimp into that. And I just want to make sure we are asking the right question. It is not about that we believe in the standard of the ethanol 10 rule, it is just to have some common sense in its application, because, as the science is, we are back-dropping ourselves into a catastrophic situation, which everybody loses, and what we are asking is some common sense. Isn't that true?

Mr. GERARD. That is our view. It just boils down to, in our view, common sense.

Mr. GOSAR. And do you think that Congress, when they gave, and you alluded to this court case, when Congress gave the rules to the EPA, did they intend to have common sense being used?

Mr. GERARD. I do not believe for a minute it was the intention of the Congress for this to get us to the point it is today.

Mr. GOSAR. I think that is one of the problems. We see this over and over, big government saying that they know better than the rest of us and common sense is being kicked out the window.

I yield back.

Mr. LANKFORD. I would like to submit for the record, as well, a written statement from Boat U.S., just talking specifically about the recreation engines and the effect of the RFS on boating in America. Without objection.

Mr. LANKFORD. With that, I would like to recognize Ms. Duckworth.

Ms. DUCKWORTH. Thank you, Mr. Chairman.

Thank you, gentlemen, for being here today to share your views about this very important issue.

Dr. Martin, I very much appreciate your thoughtful analysis and forward-looking recommendations for the Renewal Fuel Standard. I agree that while not perfect, the RFS is a critically important and promising policy for our Nation's energy future. The RFS is critical to U.S. energy security; it is a national security imperative; it promotes price stability at the pump and holds promise to significantly improve our environmental footprint. It is also a major driver of innovation and job creation. In fact, the biofuel industry supports 54,000 jobs in my home State of Illinois.

Many of these jobs are in the Chicagoland area for things like research and development, construction, engineering, grain purchasing, transportation logistics, legal services, financial services, and accounting; and we are at the forefront of innovation for advanced biofuel production. In fact, when I bought my F–150, I made sure there it was a flex fuel vehicle and I burned E85 for the entire 120,000 miles I have on my truck, and my engine runs very, very clean, and I happen to know, Mr. Gerard, where every single E85 gas pump is within a 100-mile radius of my house. And you are right, some of those are going away, but I am trying to drive up that demand as quickly as possible. In fact, my husband and I are strong supporters of aviation biofuel.

Dr. Martin, you state that the RFS has the right goals, and I agree. Can you provide more details about why these goals are so important and why it is worth sticking with a policy that even you have acknowledged is not perfect?

Mr. MARTIN. Yes, I would be happy to. Thank you. So when I look at the RFS, I see sort of three primary goals, more biofuels, but not just the same biofuels that we have, but moving on to better biofuels. And, really, when you look at the scale of what we are trying to achieve with bringing clean, low-carbon, domestically produced biofuels into the market, we can't get there with just expanding the current biofuels for some reasons that have been discussed today. So we really need to bring the next generation that are made from agricultural residues like corn stover and from perennial grasses; and there is a lot of work going on in Illinois in the science and agriculture of producing those fuels.

So that is where we are trying to get. That is what those key goals are. And the technology is really the foundation for the investments that are moving us in that direction and I think that is what I hear from people in the industry, is their ability to continue to raise money, to continue to innovate and to make the U.S. a leader in this technology, and to convert that technology and R&D leadership into actual fuel that we can use. That really rests on a stable policy foundation like the RFS.

Ms. DUCKWORTH. Thank you. I would rather my dollars at the gas pump go to American innovation and research, and supporting American biofuels than to Middle Eastern oil any day.

Dr. Martin, in your testimony you acknowledge that the cellulosic biofuels have not yet lived up to their potential. Why is that and can you explain how you see these fuel markets developing in the future and how your policy recommendations will help move the industry forward so that we get to a better place with them?

Mr. MARTIN. Sure. Well, if you look at the time it takes to develop any large industry, and the fuel industries are exceptionally large industries, it is clear that this is going to take some time, and I think one of the things that sometimes confuses people is you will hear somebody say we are five years away, and then five years passes and people say, where are you? But the guy that told you he was five years away brought that pilot plant, brought this technology from a laboratory and built a big factory, and is making, instead of gallons or tens or hundreds of gallons, they are making millions of gallons of fuel; and that is a huge step forward and that is where we are. We have really moved into the early commercial phase of this industry.

But millions of gallons of fuel doesn't get you to mandate levels that are in billions, so it just takes time for the next round of plants to expand capacity and to follow those investments. So the ability to scale up to really provide those opportunities really does rest on continuing to develop this industry and to kind of providing the stable regulatory framework that gives the investors the clarity about whether there will be a market for this fuel when they have made their investments.

Ms. DUCKWORTH. Thank you, Dr. Martin.

I am out of time, Mr. Chairman.

Mr. LANKFORD. Thank you.

Mr. Meehan.

Mr. MEEHAN. Thank you, Mr. Chairman.

Dr. Martin, I think I tried to understand. Did you make a point about the RINs, the cost being a couple cents, and there was an opportunity to purchase them?

Mr. MARTIN. Yes. The way the RIN system works, you don't need to blend ethanol; if you are an obligated party, you can purchase RINs instead of blending ethanol.

Mr. MEEHAN. And how does that work? What is the market, you said, it was a couple pennies per gallon?

Mr. MARTIN. The point I was making was that last year RIN prices had been very low, almost nothing, and that was indicative of a situation where the mandate wasn't binding. Essentially, nobody was needing to buy fuel because of the mandates, and if they didn't like to buy fuel, they could avoid that by buying RINs. So the mandate hasn't been binding until now.

Mr. MEEHAN. So has the market changed since the mandate has been binding?

Mr. MARTIN. Yes, absolutely.

Mr. MEEHAN. How has it changed?

Mr. MARTIN. Well, now RIN prices have real value, they are about $0.80.

Mr. MEEHAN. They are how much?

Mr. MARTIN. Eighty something cents, I think. Somebody said $0.89 today, which actually is not a bug, it is a feature.

Mr. MEEHAN. What do you mean it is a feature?

Mr. MARTIN. I mean that provides the economic support that makes drop-in fuels, that makes the higher blends more attractive; that is the design of the policy.

Mr. MEEHAN. The design of the policy? Let me go through this, because I am trying to understand when you are talking about the design of the policy. The design of the policy was that I have a refinery in my backyard that probably supports about 10,000 jobs and is critical to the airline industry, so critical to the support of, had they not been there, the implications of what happened during the storms in New York and New Jersey would have been significant. There are a lot of implications.

But just the other year, when they were dealing with these RINs, they were about $0.04 per gallon. They are now about $1.00 per gallon. So the implication for this refinery is it is now costing them $150 million more a year to operate because of these RINs. They purchased the refinery for that price. So, in effect, the regulatory policy is driving this refinery right back into a point in which it is non-competitive and is going to shut down. What do you tell the workers?

Mr. MARTIN. I don't have anything to say about the specifics.

Mr. MEEHAN. Have you ever been unemployed?

Mr. MARTIN. Yes, I have.

Mr. MEEHAN. All right.

Mr. MARTIN. So I think what is important here is that there are big opportunities in the next generation of fuels, and we need to manage the challenges.

Mr. MEEHAN. How do we manage it? I know there are big opportunities. And I share your goal of trying to get here, but this is the unintended consequences of compelling something to happen in a market when the market isn't able to do it. This has real-life consequences on the workers in my district and this is your quote. "We didn't build it overnight," but you can destroy it overnight.

You could destroy this industry. You could destroy the refineries in my backyard overnight because all they need is a couple years of losing $150 million or more and they shut down. And then when you close a refinery, it doesn't come back. So how do we work in this market, during this period of time, to adjust for the realization that people are manipulating this, this RIN market, to the disadvantage of people who are doing their best to keep the planes flying in the sky?

Mr. MARTIN. Clearly, as far as transparency and making sure the RIN market is working effectively, that is an important part of the policy working, because it is key to the policy.

Mr. MEEHAN. Mr. Pugliaresi, what do you say about this?

Mr. PUGLIARESI. Look, the RIN prices are rising because they reflect the high cost of crossing the blend wall, and this is the fundamental flaw in the program. So we are going to impose very large costs on the production of E10 jet fuel. We will raise the cost of producing petroleum products in the United States. So it is a very high cost program with very little yield. It is not a cost-effective way to advance our programs to bring on the fuels of the future.

Mr. MEEHAN. I am curious, are foreign airlines having to live by these same standards where they are?

Mr. PUGLIARESI. Absolutely not.

Mr. MEEHAN. So, in other words, what we are doing is we are subsidizing a situation in which it now becomes more competitive for foreign airlines to fly into our Country than it does for ours to operate globally.

Mr. PUGLIARESI. Absolutely. What is going to happen is we are going to raise the cost of all the petroleum products in the United States. By the way, when we export these products out of the U.S., our foreign purchasers are not asking for them to be blended with ethanol or cellulosic or anything. So you are going to impose a very large cost on the national economy and foreign operators and producers will not face that cost.

Mr. MEEHAN. So we are creating the proverbial sending jobs overseas.

Mr. PUGLIARESI. Absolutely.

Mr. MEEHAN. With the unintended consequences of policies that aren't doing anything to clear the air, because the bottom line is you will move some of that product overseas and it will be used over there at higher emission standards and won't really change anything in the overall atmosphere.

Mr. PUGLIARESI. Absolutely. It is actually more serious than that.

Mr. MEEHAN. So there needs to be some recognition, a workout in the meantime. And I share your goal, but this is where we are talking about the variance or the stop or the something, instead of this dead-ahead objective that the EPA is going to do it, regardless of the implications that are happening to real people, working in real communities, with real American jobs here at home, which this Administration and others pretend to stand up and want to fight for.

And I can't see another person who finally got back to work looking at the idea of that gate closing because somebody has a policy that might work somewhere 15 years down the road, while we are also, simultaneously, exporting the very same products that are impacting the air just as bad because they are being done in China or someplace else at an economic competitive disadvantage to us. Frustration with the fact that people aren't using common sense in the implication of where we need to go together.

Mr. Gerard, my time is up, but I don't know if you have a thought on that as a closing point.

Mr. GERARD. No, Congressman, I can't articulate as well as you did, but let me just thank you for your leadership. You have made a bit difference in those refineries up there. But you have hit the nail right on the head. We have a Government policy now that is bringing us to the brink of a crisis. EPA has the authority that you, the Congress, granted them to waive this and to take this pressure, in the short-term, off of the crisis, but ultimately the Congress needs to deal with that.

We don't disagree with all the noble goals that have been talked about in terms of energy production in the United States and, as I mentioned earlier, we are the leaders in trying to find the next breakthrough, but the reality is, getting back to people and jobs and what it is going to take to fuel this economy, we better get smart quick, or we are going to have a self-inflicted wound that is going to be very difficult to recover from in a lot of different ways.

Mr. MEEHAN. Thank you, Mr. Chairman. I thank you for your indulgence and I yield back.

Mr. LANKFORD. Thank you.

Ms. Norton.

Ms. NORTON. Thank you very much, Mr. Chairman.

Dr. Martin, like every red-blooded American, I am always looking for science to rescue us from the last dilemma, and I am afraid that when we embraced ethanol that was, for many, such a quick and ready, much too quick and ready an answer. Now, as far as I can understand, one of the reasons that environmentalists me wanted to do it was to save energy. I understand it costs, by the time we get to the finished product, it costs more in energy, or certainly as much as fossil fuels. So we are not meeting that goal.

So instead of just jumping to the next generation, that was the first generation of biofuels, let me ask you about the second generation, which looks so hopeful to me, but I have to ask somebody, and there you sit. And I am talking about the cellulosic biomass that apparently we have in plentiful supply. That is what we thought about ethanol, too, because we didn't think about the effects on the cost of corn and sugar, and especially not only here, where we can absorb it more easily, but has had a terrible effect in other parts of the world which are very dependent on such food stuffs now.

So when I look at this 1.3 billion in harvestable cellulosic biomass that we have "identified" in the United States, before I get my hopes up and grow too rosy in my expectations, since there are some estimations that that could more than meet a third of the domestic transportation fuel demand, before I go there, I need to know more about what I understand is happening.

You seem, in your testimony, not to believe that we have yet found an answer to the blend wall dilemma, and you speak very specifically about the effect of food-based fuels on food, to be blunt about it, and that is a major concern, that we don't jump from the frying pan into the fire itself. And you seem to call for rulemaking that would reset expectations. I need to know what that means, but specifically I need to know what it means in light of the fact that it looks like the private sector is finally getting into this new second generation energy supply, that there may be as many as 20 in 20 States maybe plants under construction, also in Canada. When you get private investment taking the risk, does that mean we are on our way to very significant use of second generation biofuels, and what could EPA do to adjust to that if it is a real answer? I am most interested in whether it is a real answer.

Mr. MARTIN. I think there is a big opportunity and, as you mentioned, there are facilities that are starting up all over the Country. But because the energy industry is so large, it is sort of important to kind of keep the time line and the expectations sensible.

Ms. NORTON. Look what natural gas has done.

Mr. MARTIN. What is that?

Ms. NORTON. Look what natural gas has done. Once it became true and viable, it shot up and has affected the supply here and across the world. That is why I don't want my expectations to be raised again.

Mr. MARTIN. Well, so if we look at where we are and what can be achieved when there is a stable investment environment, I think we see, over the next 20 years, that these next generation biofuels, together with more efficient vehicles and other technologies, can really help us to cut projected oil use in half in that time frame. So in that 20-year time frame we can make a very dramatic impact on the impact that consumers, because, of course, the biggest way to address the impact to consumers of fuel is to use less of it. And biofuels are a significant part of a comprehensive solution.

Ms. NORTON. What would be the effect on energy, on climate issues, any difference?

Mr. MARTIN. Absolutely. I mean, the next generation cellulosic biofuels have dramatically lower carbon emissions than the conventional biofuels, and even lower compared to the fossil fuels that we are relying on now. So that is why they are an important part of the strategy going forward.

Ms. NORTON. You say it could grow rapidly from 2013 forward. What do you envision?

Mr. MARTIN. I mean, well, obviously, it takes several years to build one of these facilities, and you don't build 100 of them at once.

Ms. NORTON. So if we already have 20 States, when do you think some of this could get to market?

Mr. MARTIN. Oh, it is going to get to market this year. I mean, the first facilities are commercial facilities that are completely built; that are starting up now. So the gallons will start coming in, but there is a difference between millions and billions and tens of billions, and it takes time to move up that scale.

Ms. NORTON. Well, thank you, Dr. Martin, and I will keep my expectations high for the moment.

Thank you, Mr. Chairman.

Mr. LANKFORD. Thank you.

Mr. Farenthold.

Mr. FARENTHOLD. Thank you very much, Mr. Chairman. I do want to thank the panel and do have a couple questions.

Dr. Martin, in your testimony you say that the goals of the RFS, Renewable Fuel Standard, are more biofuels, better biofuels, and beyond biofuels. If you take a step back, you want to talk about what some of the broader policy goals are besides just biofuel?

Mr. MARTIN. Sure. Absolutely. And it was beyond food-based biofuels, not beyond biofuels.

So the overall goal is to cut our oil use. As I was just alluding, the challenges that our oil use causes to our economy, to our security, and to our climate are substantial, and the best way to address those are to take practical steps to cut our oil use.

Mr. FARENTHOLD. So you are basically saying cleaner air, more domestic production, and doing away with the need for importing foreign oil, would that be fair?

Mr. MARTIN. We can cut our oil use dramatically, yes.

Mr. FARENTHOLD. So let me go to Mr. Pugliaresi. You are talking about coming up on the blend wall. So as we have less use of fossil fuels, we are coming up on the blend wall, which means we have to use more ethanol than we can blend at a reasonable percentage, is that correct?

Mr. PUGLIARESI. Yes.

Mr. FARENTHOLD. I guess what I am getting at is aren't we kind of on a collision course with ourselves as we promote more fuel-efficient vehicles and as we move to alternative electric cars or as we move to natural gas powered vehicles? It is going to get worse and worse over time, isn't it?

Mr. PUGLIARESI. I think we sort of get stuck on these volumetric or these mandates, instead of looking at how do we want the economy to function most efficiently to get the most economic growth. And if we try to wrench the economy too fast to very high cost, and often infeasible fuels, we are going to impose a very large cost.

Mr. FARENTHOLD. All right, let's talk a little bit about natural gas. I can go out and buy a natural gas powered pickup truck for about $6,000 to $9,000 more than a normal pickup truck; much more clean burning than oil-based and economical for me. Once I hit 90,000 miles on that truck, I will have paid for it and will be saving money every time. So why shouldn't we be focusing some of the efforts there?

Mr. PUGLIARESI. You are asking a very good question, because is this mandate really a cost-competitive or a low-cost strategy compared to the other things that are out there? And the answer to that is probably not.

Mr. FARENTHOLD. All right, Mr. Gerard, you represent the oil and gas industry. We have great technological breakthroughs in hydraulic fracking and we are all but giving away natural gas. What is gas today, in the $4.00 range?

Mr. GERARD. Yes, give or take.

Mr. FARENTHOLD. And do you see any substantial increase in that over the next few years?

Mr. GERARD. Well, if you look at the quick history of this, which has literally occurred in the past few years in the United States, once again, calling into question the assumptions under the Renewable Fuel Standard, which is a very different day, but when you look at natural gas today, going back to this broader objective, if we talk about climate issues and carbon, today we are at 1994 level for our carbon emissions. Why is that? Because of natural gas. That was driven by the marketplace, not by a Government mandate.

Mr. FARENTHOLD. Cleaner and domestic. We are within Kyoto standards now, right? Didn't we get there, even though we are not a signatory?

Mr. GERARD. We are getting very close to that as the leader in the world in terms of reducing our carbon emissions. But the market brought it about, and that is why we have to take away some of these efforts to compel technology. The movement to natural gas in vehicles is occurring.

Mr. FARENTHOLD. With no Government involvement.

Mr. GERARD. Precisely. And that will happen. That is what we need to inject back into this conversation.

Mr. FARENTHOLD. And just as far as projected reserves of natural gas, are we in trouble in five years?

Mr. GERARD. It depends on whose estimates you look at, anywhere from 100 to 250 years.

Mr. FARENTHOLD. All right, so we are talking a couple hundred years.

Mr. GERARD. At least.

Mr. FARENTHOLD. So it kind of takes the heat off developing.

Mr. GERARD. That number keeps growing every year.

Mr. FARENTHOLD. So it kind of takes the heat off of some of these numbers.

Let me go with one question with respect to food prices, these renewable food standards. They are affecting meat, poultry, your turkeys, chickens, you name it. It is also affecting just corn for people, isn't it, worldwide?

Mr. BRANDENBERGER. It certainly is. I think Ms. Norton made a very good point about the impact, and we would agree. We have talked a lot about the impact on our energy here, and we ought to talk about the impact on people who are facing food insecurity as well.

Mr. FARENTHOLD. And in other countries, particularly not as wealthy as we are, substantial increase in corn prices. Corn is a part of the staples in many countries. I think in Mexico there was one study that said since the Renewable Fuel Standard took effect, tortilla prices are up 69 percent.

Mr. BRANDENBERGER. There is actual civil unrest at times in Mexico over the corn prices; there have been demonstrations there. But it is other countries, but it is also the food insecure in this Country, as well, that are affected by this.

Mr. FARENTHOLD. I see I am out of time. I just want to conclude by saying we really do need to take a step back and see if we can solve some of our energy problems and our environmental problems in the marketplace with technology that is there today, rather than trying to force something.

I yield back.

Mr. LANKFORD. Thank you.

Gentlemen, thank you for being a part of this panel. We are going to shift to the second panel. All of you, great contributions in this. Lu, I think I counted mispronunciation of your name probably eight times through the course of this, so I appreciate all of you being here and for what you are contributing, both your prepared statements and your oral. Thank you.

We will take a short shift into the second panel.

[Pause.]

Mr. LANKFORD. We will have several other members that will come and join us as we get started here.

So we welcome our second panel in the continuation of this hearing. Mr. Christopher Grundler is the Director of the Office of Transportation and Air Quality, U.S. Environmental Protection Agency.

Pursuant to committee rules, all witnesses are sworn in before they testify. Mr. Grundler, thanks for being here. If you don't mind standing and raising your right hand so you can take the oath.

Do you solemnly swear or affirm the testimony you are about to give will be the truth, the whole truth, and nothing but the truth, so help you, God?

[Witness responds in the affirmative.]

Mr. LANKFORD. Thank you. You may be seated.

Let the record reflect that the witness has answered in the affirmative.

Glad that you are here. Obviously, you had the opportunity to be able to listen in on the first panel, as well, and we are looking forward to your testimony and getting a chance to dialogue a little bit back and forth on that. We will be honored to receive that testimony now.

STATEMENT OF CHRISTOPHER GRUNDLER, DIRECTOR, OFFICE OF TRANSPORTATION AND AIR QUALITY, U.S. ENVIRONMENTAL PROTECTION AGENCY

Mr. GRUNDLER. Thank you, Mr. Chairman, Ranking Member Speier, and other members of the committee. I appreciate the opportunity to testify on the Renewable Fuel Program today. I am the Director of epa's Office of Transportation and Air Quality, and I have been a career official at EPA since 1980.

The RFS program began in 2006 under the Energy Policy Act of 2005. The statutory requirements for the RFS program were then modified by the Energy Independence and Security Act of 2007, or EISA, which established new volume standards for renewable fuel, reaching a total of 36 billion gallons by 2022, including 21 billion gallons of advanced biofuels. The revised statutory requirements also include new greenhouse gas emission thresholds and a number of other provisions. After an extensive notice and comment process, EPA finalized regulations to implement EISA requirements, which went into effect on July 1st, 2010.

EISA requires EPA to publish annual standards for total advanced biomass-based diesel and cellulosic renewable fuels. These standards apply to obligated parties, typically refiners and fuel importers. The statute directs EPA to determine the projected volume of cellulosic biofuel production for the following year, and if that number if less than the statutory volume, EPA must lower the standard accordingly. EPA also has the discretion to lower the advanced biofuel and total renewable mandate up to the same amount. Before proposing annual volume standards, EPA conducts a thorough review of the cellulosic industry to determine the total production capacity. EPA also consults with our colleagues at the Department of Agriculture, the Energy Information Administration, and the Department of Energy's Bioenergy Technologies Office. We propose the annual standards through a transparent process, allowing for public comment and review.

The 2013 RFS volume standards were proposed in February of this year and would maintain a statutory level for total renewable fuel of 16.55 billion gallons. A public hearing on the proposed hearing was conducted on March 8th, 2013, and we are currently in the process of reviewing the public comments in preparing to develop the final rule.

Congress also tasked EPA with evaluating and qualifying new biofuels for use in the RFS program. We have already approved a significant list of advanced and cellulosic biofuels. We have a number of additional evaluations underway for new pathways. We continue to expand the number of approved fuel pathways, including the recent finalization of a rule that includes certain renewable fuels from camelina, ethanol from energy cane, and renewable gasoline from various feedstocks. We also just proposed a rule that included additional new advanced biofuels, including cellulosic fuels from landfill biogas and advanced biobutanol from corn.

Although both ethanol and non-ethanol biofuels can be used to meet the RFS, ethanol has and will likely continue to be the predominant renewable fuel in the market for the foreseeable future. As the volume requirements of the RFS program increase, it becomes more likely that the volume of ethanol projected to meet those requirements will exceed the volume that can be consumed in the common blend ratio of 10 percent ethanol and 90 percent gasoline, referring to as E10. Additional volumes of ethanol would then need to be used at higher blend levels, such as E15 or E85. As a result, to the extent that ethanol is likely to be used to meet RFS volume requirements, the volume of ethanol that can legally and practically be consumed is a limiting factor in meeting the statutory volumes. This is commonly known as the E10 blend wall and was discussed at length during the first panel.

Compliance under the RFS program is demonstrated through the use of Renewable Identification Numbers, or RINs, which document the production and distribution of the fuel. For 2013, we expect compliance for the RFS standards through the use of RINs generated in 2013, as well as the substantial number of RINs generated in 2012 that are available for compliance this year as carryover RINs.

In 2014, the situation could be different. First, the advanced biofuel and total renewable fuel requirements rise substantially under the law, to 3.75 billion gallons and 18.5 billion gallons, respectively. While non-ethanol biofuels are anticipated to continue to grow, an estimated 16 billion gallons or more of ethanol might still be needed to comply with the 2014 statutory target for the RFS program. Second, the number of carryover RINs from 2013 will also be a critical factor.

Given these facts, we will continue to look at the potential impacts of the E10 blend wall both now and in the longer term. We are currently reviewing comments submitted in response to our proposal for the 2013 RFS volume standards, and we will carefully consider and are carefully considering this input.

EPA is intensively engaged with all the stakeholders in this policy matter, and we are going to continue to further engage these stakeholders as we move to propose the RFS volume requirements for 2014. EPA will continue to work with our partners, stakeholders, and the public to implement the RFS program as directed by the Congress. EPA will also further evaluate and consider whether any further action under the authorities established by Congress is appropriate to help ensure orderly implementation of the program.

I thank you for the opportunity to serve as a witness and look forward to your questions.

[Prepared statement of Mr. Grundler follows:]

Christopher Grundler
Director
Office of Transportation and Air Quality
Office of Air and Radiation
U.S. Environmental Protection Agency

Subcommittee on Energy Policy, Health Care and Entitlements
Committee on Oversight and Government Reform
U.S. House of Representatives
June 5, 2013

Written Statement

Chairman Lankford, Ranking Member Speier and other members of the Committee, I appreciate the opportunity to testify on the subject of the renewable fuel standard program.

Overview of the Renewable Fuel Standard Program

The Renewable Fuel Standard (RFS) program began in 2006 pursuant to the requirements in Clean Air Act (CAA) section 211(o) which were added through the Energy Policy Act of 2005 (EPAct). The statutory requirements for the RFS program were subsequently modified through the Energy Independence and Security Act of 2007 (EISA). These provisions established new year-by-year volume standards for renewable fuel that generally must be used in transportation fuel, reaching a total of 36 billion gallons by 2022. This total includes 21 billion gallons of total advanced biofuels, comprised of 16 billion gallons of cellulosic biofuel, at least 1 billion gallons of biomass-based diesel, and the remainder consisting of "other" advanced biofuels. The revised statutory requirements also include new definitions and criteria for both renewable fuels and the feedstocks used to produce them, including new greenhouse gas emission (GHG) thresholds. On March 26, 2010, in response to EISA, EPA promulgated regulations to implement revisions to the national renewable fuel standard program. EPA applied the best available science, and conducted extensive analyses to implement these complex and challenging statutory provisions. The regulatory requirements went into effect on July 1, 2010 and apply to domestic and foreign production of renewable fuels used in the United States.

EISA requires that EPA each year, publish the annual standards for use of total, advanced, biomass based diesel, and cellulosic renewable fuels that apply to obligated parties, which are typically refiners and importers of gasoline and diesel. The statute directs EPA to determine the projected volume of cellulosic biofuel production for the following year, and if that number is less than the volume specified in the statute, EPA must lower the cellulosic standard accordingly. EPA also has the discretion to lower the advanced biofuel and total renewable mandate up to the same amount that the cellulosic biofuel volume is reduced. Before proposing annual volume standards, EPA conducts a thorough review of the cellulosic industry, including one-on-one discussions with each producer to determine its individual production capacity. EPA also consults directly with the Department of Agriculture, the Energy Information Administration, and the Department of Energy's Bioenergy Technologies Office to determine the status of production capacity and capabilities of the cellulosic sector. Since these evaluations are based on evolving information about emerging segments of the biofuels industry, and may result in the applicable volumes differing from the statutory targets, we propose the annual volume standard through a transparent rulemaking process, allowing for public review and comment, prior to finalizing the standards.

The 2013 RFS volume standards were proposed in February 2013. The standards as proposed would maintain the total renewable fuel requirement under EISA for 2013 of 16.55 billion gallons, including volumes for advanced biofuels, such as biomass based diesel and cellulosic biofuel. A public hearing on the proposed rule was conducted on the 2013 standards on March 8, 2013. The Agency is currently in the process of reviewing the public comments in preparing to develop the final rule.

Congress also tasked EPA with evaluating and qualifying new biofuels, where appropriate, for use in the RFS program. We already have a significant list of advanced and cellulosic biofuels approved in the current RFS. We have also established a process to evaluate new biofuels for use in the RFS program. We have a number of additional petitions requesting evaluation of new biofuel production processes and new feedstock pathways. EPA has expanded the number of approved fuel pathways, including the recent finalization of a rule that includes certain renewable fuels from camelina, ethanol from energy cane, and renewable gasoline from various feedstocks. More recently the Agency proposed a rule that will expand the opportunity for use of additional new advanced biofuels, including cellulosic fuels from landfill biogas and advanced biobutanol from corn. The Agency has and will continue to work on evaluating opportunities for additional qualifying feedstock to fuel pathways under the program to support attaining Congressional goals of the RFS program.

Ethanol E10 Blendwall

Both ethanol and non-ethanol biofuels can be used to meet the RFS requirements; however ethanol has and will likely continue to be the predominant renewable fuel in the market for the near and foreseeable future. As the volume requirements of the RFS program increase, it becomes more likely that the volume of ethanol projected to meet those requirements will exceed the volume that can be consumed in the common blend ratio of 10 percent ethanol and 90 percent gasoline, referred to as E10. Additional volumes of ethanol would then need to be used at higher blend levels such as E15 or E85. As a result, to the extent that ethanol is likely to be used to meet RFS volume requirements, the volume of ethanol that can be legally and practically consumed is a limiting factor in meeting the statutory volumes.

Compliance under the RFS program is demonstrated through the use of Renewable Identification Numbers (RINs), which document the production and distribution of renewable fuel. For 2013, we expect compliance with the RFS standards through the use of RINs generated in 2013 and those generated in 2012 that are available under the regulations for use (carryover RINs) in complying with 2013 standards.

In 2014, the situation could be different. There are a number of factors that will play a role in determining how regulated parties will demonstrate compliance with the applicable RFS volumes. First, the advanced biofuel and total renewable fuel requirements rise substantially to 3.75 billion gallons and 18.15 billion gallons, respectively. While non-ethanol biofuels are anticipated to continue to grow to help supply the advanced biofuel standard, an estimated 16 billion gallons or more of ethanol might still be needed to comply with the RFS program in 2014. Second, the number of carryover RINs from 2013 will also be a critical factor in determining how obligated parties show compliance with the 2014 RFS volume requirements. EPA will continue to engage with stakeholders on this issue as we move to propose the RFS volume requirements for 2014.

Given these facts, we will continue to look at the potential impacts of the E10 blendwall over the near and longer term. We are also reviewing comments submitted in response to the agency's proposed rulemaking for the 2013 RFS volume standards and we will carefully consider this input.

Closing

EPA will continue to work with our partners, stakeholders, and the public to implement the RFS program as directed by Congress. EPA will also further evaluate and consider whether any further action under the authorities established by Congress is appropriate to help ensure orderly implementation of the program.

Again, I thank you for the opportunity to serve as a witness at this hearing for the Subcommittee.

Mr. LANKFORD. Thank you for your testimony and thanks for your testimony as well.

Do you agree we are facing a blend wall in the coming months here?

Mr. GRUNDLER. Congressman, it is quite clear from the dynamics in the RIN market that the market is anticipating the blend wall. It is not clear exactly when we will face that blend wall. We know that some refiners, because each is in a slightly different situation, are likely to hit that blend wall this year; whereas, others are likely to face it in 2014. But the market clearly is anticipating its approach, which is why we see the increase in the value in these RINs.

Mr. LANKFORD. Once Goldman Sachs jumps in and starts actually trading in RINs, you know this has become a valuable commodity and it is spreading at that point. So the questions come up for us, and you heard all the testimony, as well, and some of the issues, and you are very aware of this, not that you are blind to all these issues. A couple of questions. One is is it good for our vehicles to continue to increase the amount of ethanol and require that, and to be able to push that out? Multiple vehicle manufacturers said that is going to void our warranty. So we have that one question. With the amount of gasoline decreasing and the amount that is required increasing, is that good for our vehicles?

And the second part of this is is it good for us to continue pushing food-based fuel when the hope was, at some point, non-food-based ethanol would rise up and we would have other products that would substitute for that? We are not seeing the rise as fast as we had hoped, so is it good to be able to press on both those?

Would you address both of those for me?

Mr. GRUNDLER. So with respect to your first question, congressman, is it good for our vehicles, the answer depends on what you are driving, of course.

Mr. LANKFORD. Correct. The majority of vehicles in America right now. We are talking 70 percent of the vehicles that are not tagged or that have a problem with using a higher amount of ethanol.

Mr. GRUNDLER. Yes. So with respect to E15, as you are aware, EPA did an extensive study, along with the Department of Energy, of the question of will E15 cause or contribute to a violation of the emission standards of those vehicles. We looked at something like 30 different studies. DOE did an extensive testing program and our determination was that E15 would be safe to use in 2001 and later vehicles. We did not allow it to be used in small engines or boats or off-road vehicles.

Mr. LANKFORD. I am aware the EPA allows that, but my warranty expires if I use E15. So in my 2011 vehicle I already have a notification and a sticker on my gasoline lid as it opens that reminds me, if I use E15 in this, my warranty is void, because the manufacturers tell me this is not safe for this vehicle. So while EPA says go ahead and use it, I take it at my own risk. If my vehicle breaks down, I am on my own. I don't anticipate EPA is going to fix my vehicle at that point.

Do you anticipate that?

Mr. GRUNDLER. No, we will not fix your vehicle.

Mr. LANKFORD. Okay, well, I am assuming that. So I am in a tough spot as a consumer on that.

Mr. GRUNDLER. Mr. Chairman, I appreciate that, but EPA is not requiring you to use E15. We are not requiring anyone to sell E15. We simply looked at our responsibilities under the law, did an extensive amount of science and data development, and reached the determination based on that data and based on the law that there was no evidence to suggest, after millions of miles of accumulated miles by the Department of Energy's test program, that E15 would harm engines or create a violation of emission standards.

Mr. LANKFORD. How many manufacturers out there disagree with you?

Mr. GRUNDLER. Most of them.

Mr. LANKFORD. And that is the spot that consumers are in. The Government says go ahead; the manufacturers say at your own risk, because this does not work in all of their testing. So now we are stuck between a Government mandate that is sitting out there and the consumer trying to determine where do I go at this point.

Mr. GRUNDLER. The Government is not saying go ahead. The Government is simply saying that this is a legal fuel to sell if the market demands it and if there are people who wish to sell it.

Mr. LANKFORD. But if the market is not demanding it, there is still a requirement we have to get more out there, is that correct? So let's say, for instance, in my State, in Oklahoma, you were not here earlier, but are lots of stations that promote that they sell all-gas gasoline. I mean, that is their selling feature. And they sell all the time on that. There are stations that sell both side-by-side; there is gasoline, there is gasoline blended with ethanol on it; and the consumers have the opportunity to choose. But at some point it gets tougher to give consumers the option to choose, because if they choose the all-gasoline, we can't meet the standards that have been set to sell out there, and we have to find some way to get that product to market. That is kind of where we are now. So what do we do?

Mr. GRUNDLER. You are exactly right. And I think when Congress wrote this statute, back in 2005 and particularly in 2007, it created a dramatic change in the transportation fuels market and anticipated these increasing volumes. It is clear Congress anticipated that the market would solve this problem. The blend wall is not a new issue. Clearly, the market has not solved this problem yet; there are market realities that we are very much aware of and need to address.

Mr. LANKFORD. So when does this get resolved from the EPA? I know you all are dealing with this all the time. This is not critical of that. You all have to live in this all the time. We have decisions for 2013 and decisions for 2014 coming down during the summer, I hope, but to be able to determine what are we going to do, is there going to be a waiver, are the numbers for 2014 going to be implemented? A lot of folks have to prepare for that and the market is trying to determine, as the price goes up, they are gambling you are not, you are going to keep the same number and these prices continue to rise, and manufacturers and individuals and suppliers of fuel are hoping that there is going to be some kind of gap. How does this get determined and when?

Mr. GRUNDLER. We are talking to all of these folks regularly. We raised this issue in our 2013 proposal as an issue; we sought comment, we got an enormous amount of comment. As you can appreciate, those comments span a diverse perspective based on where they sit and what they make, and it will be our job to sort through those and to look at the law and look at the data, and the administrator will need to make a determination. We feel a very strong sense of urgency to sort through this. We are doing a lot of analytical work and we hope to make a decision this summer on both 2013 and a proposal for 2014.

Mr. LANKFORD. Welcome to America. Okay, so let me come back to that again, because I want to be able to pass on to Ms. Speier, honoring her time as well.

We are talking about this summer, so we are talking about the end of August, we are talking about the end of July? Because this is important to us, to be able to determine when the decision is going to be made. The decision is important, obviously, what is made, but the when is also very important. So when will we know?

Mr. GRUNDLER. I appreciate that and I also understand why the market needs to know. I don't have a target date for you other than we are working as hard as we can.

Mr. LANKFORD. But all the comments are in.

Mr. GRUNDLER. Yes.

Mr. LANKFORD. Everything from outside is done; it is now sitting on your all's desk, and at this point there is nothing else pending out there to say we can't decide until we get this.

Mr. GRUNDLER. That is exactly right.

Mr. LANKFORD. So everything is in now; it is just time to make the decision.

Mr. GRUNDLER. That is right.

Mr. LANKFORD. Is there anything that we can do as Congress to help in this process?

Mr. GRUNDLER. I think you are doing it, sir.

Mr. LANKFORD. Well, there is a need for a decision. The certainty is very important to the consumer, to the producers, to the manufacturers. The certainty is very key to us, so getting the when will help us significantly; then there will be the large national debate on the what at that point, once you settle it. But the when cannot come fast enough if all the information is gathered in.

With that, I would like to recognize Ms. Speier.

Ms. SPEIER. Thank you, Mr. Chairman.

Mr. Grundler, thank you for the service you have provided to our Country for some how many years? Thirty-two years. Almost a lifetime. Certainly a generation. Anyway, thank you.

The first law that was passed and signed by President Bush, in 2005, was really a bipartisan bill; it was sponsored by Representative Barton of Texas, Representative Pombo of California, and Representative Thomas of California. And when President Bush signed it, he said it will strengthen our economy and it will improve our environment, and it is going to make the Country more secure. The Energy Policy Act of 2005 is going to help every American who drives to work, every family that pays a power bill, and every small business owner hoping to expand.

So, from your perspective, what has been the impact of that 2005 Act, and have President Bush's statements been seen to come to fruition?

Mr. GRUNDLER. Congresswoman, certainly the impact we have seen is a significant increase in the production of renewable biofuels in America. We have seen an enormous amount of private investment in advanced biofuel research and development and production; I would say in the billions of dollars of private investment in discovery and new innovation in this area and I think, as well, a new recognition about what the promise could be of having a more diverse fuel supply for America.

Ms. SPEIER. Okay. So for all the concern here, there are still a lot of positives, right? Dr. Martin had mentioned in the earlier panel, I don't know if you were present to hear him or not.

Mr. GRUNDLER. I was.

Ms. SPEIER. That there are some solutions that are pretty simple and could protect the turkey farmers and also still allow for continued exploration in terms of cellulosic ethanol and the developing of that and plants, and venture capital coming in, and the like. Do you have any comments on that? Do you see that as a pathway to resolving this issue?

Mr. GRUNDLER. I have not had an opportunity to talk to Dr. Martin about his recommendations in terms of his thinking with respect to the longer term strategy. I probably would disagree with that it is going to be simple in this policy debate comment.

Ms. SPEIER. That was my comment, not his.

Mr. GRUNDLER. But clearly we have heard through this public notice and comment period we are getting a lot of advice about how EPA can address this situation, address this blend wall situation; and some have suggested how we can do it in a way that could still preserve this advanced biofuel innovation promise. Others have come at it from a different point of view. We, right now, are doing the hard work analyzing those comments, looking at the law, looking at the data and giving recommendations to the administrator.

Ms. SPEIER. So last August Chairman Issa and Subcommittee Chairman Lankford had sent a letter expressing the concerns about RFS to EPA Administrator Lisa Jackson, and subsequently, in the review that EPA did, it found that there was not severe harm to the economy, of a State, a region, or the United States in waiting. Could you explain to us the analysis that EPA uses to arrive at that conclusion? From what I understand, it is not something where you just kind of see what way the wind is blowing, that there is a lot of data collection and expert testimony and review that takes place. Could you share that with us?

Mr. GRUNDLER. Yes. You are talking about the petitions we receive from a number of States in 2012 in response to the severe drought that America experienced and asked the administrator to waive the standard in whole or in part. First, in deliberating over that, we all recognize, and the administrator certainly said in her decision, recognized the devastating impact of the drought across all of America in many different sectors, in many different families that were impacted by that drought.

The question before the agency and the administrator at that time actually was a pretty narrow question, though, which is would waiving the RFS change any of that situation, would waiving the RFS change the supply-demand question. And after extensive analysis and modeling, we looked at 500 different scenarios using a satastic model and consulting with experts at the Agriculture Department and at the Energy Department, we found that it was highly unlikely that, if we waived the standard, it would have made any difference to the people suffering and the prices of corn, so the law required us to deny that waiver.

We were careful to say that this is a fact-specific question, a case-by-case situation, and it was based on the market conditions at the time; it was based on our estimate of how many so-called rollover RINs were available to refiners to meet their obligations, as well as how quickly a refinery within this waiver time period, this one-year period, could change their operation. The fact of the matter is that the U.S. refining industry and fuel distribution has optimized around the use of ethanol as a blending agent, and we found that the evidence suggested that there is a strong demand by the refining industry to use this product to blend their gasoline products and that, if EPA had waived that standard, that that practice would continue, certainly over the near term, and therefore would not have made any difference in feed prices or corn prices. So we were required to deny the waiver based on how the law asked us to exercise that authority.

Ms. SPEIER. Thank you. My time has expired.

Mr. Chairman, thank you.

Mr. JORDAN. [Presiding] The lady can have additional time if she would like here.

I ask unanimous consent to enter a couple reports and letters into the record. We have the API Energy letter and NERA economic impacts resulting from implementation from RFS2 program.

Without objection, those will be entered into the record.

Mr. Grundler, I apologize for missing your testimony. I have been trying to read it. Let me go back to where I was with the first panel. I went through and asked them and we sort of established the fact that the cost to produce turkey is up because of RFS and the impact on corn prices; the price to produce pork is up; the price to produce cattle is up; and, therefore, the cost to consumers who consume those products is certainly up. Other food products not in the protein or livestock area are up as well. The price of fuel is up, according to the witnesses on the first panel. According to the witnesses on the first panel, it is difficult for many cars to, as the chairman has pointed out, Mr. Lankford pointed out, can't use this type of fuel burned at levels that it is; and, therefore, every single family, according to the economist who was part of the first panel, every single family in the Country is going to have to pay more for food, fuel, and that obviously impacts their family budget and our overall economy.

As I said, we were looking forward to hear what you say, and I missed some of what took place here earlier, but are you going to waive it, and what is the time frame? Walk me through it again. Are you going to waive the standard as we move forward?

Mr. GRUNDLER. Thank you, congressman, for those questions. I can't tell you what the administrator is going to decide.

Mr. JORDAN. When are you going to decide?

Mr. GRUNDLER. This summer.

Mr. JORDAN. This summer. Next month?

Mr. GRUNDLER. Summer goes until September 21st.

Mr. JORDAN. So are we going to get a decision on September 20th or 21st, or are we going to get something sooner? People are driving; people are buying burgers for the grill and brats for the grill and everything else.

Mr. GRUNDLER. Sir, I want you to know that we are taking this very, very seriously. We have sought public comment. We are meeting with all the stakeholders who you have heard this morning and more. This is a very serious question. We are hearing them loud and clear. We are doing the analysis right now. We have a lot of advice on how EPA should proceed and address this blend wall both now and in the future, and we are going to be making a decision as soon as we can.

Mr. JORDAN. Okay, there were four witnesses on the first panel; the economist, the turkey, and the petroleum gentleman.

Ms. SPEIER. He doesn't like being called a turkey.

[Laughter.]

Mr. JORDAN. Well said. The gentleman representing the turkey industry. All agreed that there are real problems. Even the Democrat witness said the Renewable Fuel Standard for cellulosic fuel shouldn't be increased. So everyone understands this is a problem, so it seems to me you have the data. Even the witness on the other side. I mean, this is Congress; if you get four people, different sides inviting folks in and they all say there is a problem here, it seems to me that is pretty clear. So, again, any chance you can get this done sooner?

Mr. GRUNDLER. We are going to be working very hard to make that happen, sir, but this is a consequential decision. There are consequences on all sides of this question, which I am sure you can appreciate. There are consequences for the people who have invested millions of dollars in research and development costs and innovation to produce more advanced fuels. They have a particular point of view. We have heard very clearly from the oil industry what their perspective is. People who have invested in corn-based ethanol have a view.

Mr. JORDAN. Do you have the definition of what level of harm, severe harm? Do you have a definition, increase in cost to consumers of X percent? Do you have something that is tangible, measurable, or is it you are looking at it and bureaucrats and employees in the Environmental Protection Agency are going to make a decision? Is it based on objective criteria or is it just sort of what the experts in Government think it is?

Mr. GRUNDLER. Well, the Congress was quite specific and used the word severe. We don't have a definition of what severe means, but we read it as pretty significant.

Mr. JORDAN. Well, then how can you decide? Well, is it not severe harm when the price of food is up significantly, the price of fuel is up significantly, cars can't use the fuel that, as we get to the blend wall, some cars can't use it, the price is going to go up and the economist who was here said this is, in effect, a tax on families and overall harms our economy, not to mention some of the data we have been living with for the last several years, the high unemployment rate and everything else? Is that not severe?

Mr. GRUNDLER. All the things you mentioned, congressman, go into this consideration, go into this analysis, and it will be the administrator's judgment.

Mr. JORDAN. Let me ask it this way. If that is not severe, what is?

Mr. GRUNDLER. I can't answer that question, Mr. Congressman.

Mr. JORDAN. Well, that is the problem. That is our concern, because if there is no objective definition, if you can't tell me what severe is, if you can't tell me what I just described and what the four witnesses just described, you can't tell me if that is severe or not, then how in the heck are you going to make a decision?

Mr. GRUNDLER. We are going to do the best we can based on what the law states.

Mr. JORDAN. Are you developing a criteria? Are you developing some objective standards, some definition for what severe harm means?

Mr. GRUNDLER. Right now what we are doing, sir, is looking at all the information that the public has provided on those very questions.

Mr. JORDAN. But that is not what I asked. Is the EPA developing a definition, some kind of criteria, objective standards that would say you reach this, that is severe, we raise the standards; you don't reach this, it is not severe, we don't waive the standards? Then we can decide if you have a good standard or not. But if it is just we are going to tell you what we think and we don't think it is severe, well, how do we know? We don't know what info, what data, all the information you are using to make that decision. It would be nice if we had something objective. It would be nice if you had something objective so we could examine and see whether it makes sense or not.

Mr. GRUNDLER. Sir, first of all, I would say that this will all be based on, again, on a case-by-case basis, based on what the market conditions are telling us at the time this decision is made, and then there will be an extensive record that will be supporting that decision. I also want to point out that that is only one of our waiver authorities. We also have the authority to adjust the standard based on the total amount that we adjust for the cellulosic standard. So there are a couple of ways for the agency, a couple of tools.

Mr. JORDAN. Do you have standards for how you do that? Do you have criteria on when you are going to adjust the standard, not just waive it?

Mr. GRUNDLER. Yes, for the cellulosic standard, what we do is we go every year and we look at actual production estimates from people producing this fuel. That is why we have adjusted or waived the cellulosic standard.

Mr. JORDAN. No, what I am asking is do you have something that says if it reaches X level, we are going to make this change? Do you have some objective criteria?

Mr. GRUNDLER. There is no objective criteria that we have stated with respect to how Congress determines severe economic harm. We have this other authority where it is just a math problem, where we subtract from the statutory-based standard for cellulosic fuel how much is available.

Mr. JORDAN. Well, if you have no objective standard, how can you make a decision? One day you decide this is bad enough, we are going to change it; maybe it is not bad enough, we are not going to waive it. This law has been around a while, I think since 2005, 2006, and was revised in 2007. You don't have a standard?

Mr. GRUNDLER. So we have, with respect to this general waiver authority that you have mentioned, we have considered that twice, once in 2008 and once in 2012, and in those cases we went through an extensive set of economic analysis, working with the Department of Agriculture on impacts, working with the Department of Energy on impacts, using an economic model to estimate what these impacts would be, and based on that record and that evidence and the data that produced, we determined that it was not severe economic harm, based on the numbers that that showed, in relationship to the total economy or the total economy of that State. It is a judgment call.

Mr. JORDAN. I get what you are saying. I just don't know how you can say it is not severe if you don't have a definition for severe. I mean, don't you think that is a logical question for the American consumer, for families to ask? How do you decide whether it is severe or not? Because, well, in 2008, we said it wasn't, but we didn't develop any criteria; in 2012 we said it wasn't, but we didn't have any criteria, even though it was four years later, we just did some analysis. I mean, it can be some subjective analysis you throw together every year that you get faced with this question. Unless you have some objective standard, I don't know how anyone can determine what, if you don't know what severe is, how are we going to know, and how are you going to reach that level? To me, that is the $64,000 question.

Ms. SPEIER. Mr. Chairman?

Mr. JORDAN. The gentlelady is recognized.

Ms. SPEIER. Mr. Chairman, you have now extended another four minutes. Can we give Mr. Grundler an opportunity to just try to explain?

Mr. JORDAN. I have given him several, but I would be happy to give him another one.

Mr. GRUNDLER. It is a difficult question, sir. The Congress wrote this law and gave the administrator the ability to waive standards if he or she determined that implementation of the standard would create severe economic harm. We have used that in terms of the continuum of insignificant to extreme, at the far end of that continuum, but there is no hard and fast definition for it, and it has to be a judgment call that the administrator exercises.

Mr. JORDAN. Okay. And I went way over time, but I will just say this: Any other time there is a standard, there is some definition to it in the law. If there is a standard of proof, there are certain elements you have to meet to satisfy that standard in law, and anything else there is some objective measure, some number. When we write laws, typically, the agencies write rules to implement the law. What you are saying is you don't even have a rule or definition to define severe harm; it is whatever you think it is at that particular time. That is how we operate. Well, if that is the case, we will never know if this is ever going to get waived. No matter how close we get to the blend wall, what happens, we will never know; and that is a problem as we move forward.

The gentlelady is recognized.

Ms. SPEIER. Mr. Chairman, thank you. Let's be clear, we pass laws every day. Well, actually not, but occasionally.

[Laughter.]

Ms. SPEIER. Three hundred a year.

Mr. ISSA. You know, we can go back to naming post offices, then we can do them every day. But we are trying to stay off of that.

Ms. SPEIER. And I appreciate that, Mr. Chairman. But, in any case, we do pass laws that do not define certain terms. I am reminded that we passed a law that said that 501(c)(4) should be operated exclusively for social welfare purposes, and then the agency itself came up with a regulation that termed it primarily; and, frankly, we don't have a definition for either of those.

So I think Mr. Grundler has made the point that it is done on a case-by-case basis; and the term severe harm is one that is assessed at the time and that it is a judgment call. There are judgment calls that people within the bureaucracy make every single day. We hope that there will be good judgment used here, as there is often, and I think I will leave it at that time.

I yield back.

Mr. JORDAN. Well, if I could just respond. The gentlelady makes, I think, an excellent point. She cited the Internal Revenue Service and the lack of a clear definition. One thing we do know is when you have that situation people aren't given equal treatment. We found out that the only groups who were in fact targeted were conservative groups applying for 501(c)(4) status; no one else was targeted. So it would make sense to have a standard so it is not so subjective. That is exactly the point I am making here. What is the definition of severe harm? Without a definition, how in the world are we going to make a determination?

With that, I recognize the chairman of the full committee.

Mr. ISSA. I thank you, chairman.

Ms. Speier, you and I represent the same State, but not at the same time in the beginning. When I first arrived here, it was 52 and then 53 members of the California delegation, every single one, including Henry Waxman, who tried to get a waiver on the 10 percent ethanol, because at the time we were using MTBE because that was the oxygenate that we could get our hands on, and it was destroying our ground water. EPA never saw fit to consider the destruction of our watershed as sufficient, and the lack of availability of ethanol, and, of course, the fact that we didn't produce it in California.

Mr. Grundler, the fact is you don't have to have a perfect definition, but if you don't have anecdotal examples of what is, then you fail the most important test, and I think the chairman was making that very clear. You have to say this is out of bounds and this is inbounds. Even the IRS at least had some examples of things which would be excessive; they said you had to have at least 51 percent of something for it to be primary, because there is a noun.

We are in a situation right now in which the Stanford study still says that the cost in fuel of producing ethanol, for example, still rises to effectively the same amount of fuel as it generates in Btus, meaning there is not really a renewable fuel because it consumes mostly non-renewable fuels making the renewable fuel. So the idea that we are not going to grant a waiver simply because any damage it causes isn't offset by any benefit to speak of, that is not a new item; those studies have been around for a while. And I understand that the ethanol lobby is very effective at sort of demanding that we keep a subsidy going.

My question to you is isn't it true that if the goal of clean air, which is your mandate, your primary mandate, if the goal of clean air can be achieved with a different blend, don't you essentially have a fundamental obligation to grant the waiver, regardless?

And, by the way, if you say no, you won't be the first person from EPA to walk in saying no. It has always been kind of interesting. Before we ever talked about renewables or CO2 as a pollutant, EPA seemed to always want to have its ability not to grant waivers. But please answer.

Mr. GRUNDLER. Sir, I am not familiar with the specifics of the example you are relating to in terms of the MTBE question. I am not really prepared to address that.

Mr. ISSA. Perhaps you are not as old as I am. But we were trying to get rid of MTBE; we knew that it had damaged, in huge amounts, our watersheds. We knew it was a dangerous pollutant. There actually had to be waivers granted as they tried to get enough ethanol into California to replace it. Ultimately, it is a good piece of history for you to become familiar with because there was egregious harm being done to the drinking water of the people of California, and the years 2001, 2002, 2003 went by while we saw no willingness to say that even a small amount of damage to California's watershed should have been a sufficient danger to cause a waiver to be granted.

Mr. GRUNDLER. If I could, sir, I would like to address the rest of your question with respect to what situation we are dealing with today. You weren't here earlier, but we very much appreciate the seriousness of the situation. We have heard loud and clear from a number of different stakeholders in this policy question; advice in terms of how they think we ought to approach the science and the law and this decision, and we are going to be considering those very, very carefully as we make a decision and the administrator makes his or her judgment later this summer.

Mr. ISSA. But let me rephrase my fundamental question, though. Going from 10 percent to 0, that is a big decision; and I think the law assumes that it is going to take a big threshold. But going from 10 to 9, 10 to 8, 10 to 7, 10 to 6, aren't those incrementally decisions that could be made where the balance of harm, including economic harm, versus the benefit can be measured? In other words, why wouldn't you be considering blends that were not zero, but were significantly lower, with a lower standard for it, so that it will not be an all or nothing?

Mr. GRUNDLER. That is precisely the process we are going through right now; what are those considerations, what are those options before the administrator, and what is the best decision to be made. We have that discretion.

Mr. ISSA. Mr. Chairman, just one other piece of history. I was also here when we dealt with arsenic in States like your own, in the southwest, where incredibly small amounts in wells that had been around for decades and decades, in which there was no known science to actually come up with why the number that they came up with as an arbitrary number was necessary, but we knew the economic cost. And I think that Chairman Jordan said it very well: if you don't have a number, then the number is arbitrary. We have seen arbitrary numbers in the past in arsenic, where they didn't have science; they picked a hypothetical number. That hypothetical number cost hundreds of millions of dollars to people of New Mexico and other States. This is another situation in which the number that is currently there is costing a large fortune without having a known benefit, if in fact blends can be as clean with a different number.

I yield back.

Mr. GOSAR. [Presiding.] I am going to recognize myself for five minutes.

The EPA asserts that more E15 gasoline must be blended in order for producers to meet the RFS, true?

Mr. GRUNDLER. No.

Mr. GOSAR. Does EPA believe that the E15 is safe for all automobiles?

Mr. GRUNDLER. No.

Mr. GOSAR. Let me ask you, do you think we are headed for a train wreck, as currently defined by Congress?

Mr. GRUNDLER. I am not aware of the definition of train wreck by the Congress.

Mr. GOSAR. Well, let's look at the train wreck in regards to what we are coming here within this mandate. It is a train wreck left as is, right? If you are going to hold up the letter of the law, it is a train wreck.

Mr. GRUNDLER. Again, I am not sure of your definition of train wreck, but we realize that the blend wall is a significant issue.

Mr. GOSAR. Well, let me ask you a question. So if we continue on this standard, we will have a huge problem within diesel fuel production, true or false?

Mr. GRUNDLER. I would like to answer it this way, Mr. Chairman. We clearly see, particularly in 14 and 15, and the pace by which Congress anticipated the growth of this mandate, is confronting very real market barriers right now, and we are looking at all kinds of comments today in terms of what the best way to address that.

Mr. GOSAR. And how would you weight those comments?

Mr. GRUNDLER. How would I weight them?

Mr. GOSAR. How do you weight those comments? I am asking you because what I want to do is I want to see from the agency how you rationally start to look at those. You know, the consumer, food prices, transportation costs, because this has a staggering effect in which our economy could come to almost a deadlock.

Mr. GRUNDLER. That is certainly the conclusions of the NERA study, which was, I would note, a worst case scenario. There are other studies that we are looking at in terms of what is the actual impact on the consumers, and we are looking at those very, very carefully. All of these will go into this decision and what is the best thing to do for the Country, and the administrator will make that judgment. As I noted, there are consequences on all sides of this equation, and people are sharing with us directly and often what their views are, and they are not always the same.

Mr. GOSAR. I would agree. Let me ask you this. What science are you going to use? Because it seems like we are in absence, if we are looking at the E15, there is no science that really backs it. We have the automotive industry that says we are taking away warranties on cars. So it doesn't seem like we can go that way. So it looks like we are back-treading ourselves into a different position, true or false?

Mr. GRUNDLER. You asked the question what science will we use. It is really a matter of a judgment call in terms of what are the market conditions; how much complying fuel can be moved through this system and at what cost.

Mr. GOSAR. But it is more than that. It is just not an arbitrary aspect. You are talking about realistic, real world values, and it is based on science. So you have to point to science. Science helps set you free here. And in the absence of a study, you have to err in that aspect, because I think any time you are looking at the value of what scientists have given us, we actually used a methodology that has got us into a cleaner fuel. So with absence of science you are in no-man's land and you don't know if you can actually support a hypothesis.

Mr. GRUNDLER. Well, there is science as well as market reality. If the science told us, a couple years ago, that E15 would not harm certain kinds of vehicles, and yet we also need to consider, as we make this decision, what the likelihood is of increases in E15 fuel being produced and sold and bought by consumers. So we need to look at both, sir.

Mr. GOSAR. And when you look at the average consumer, do they have lots of dispendable money sitting around?

Mr. GRUNDLER. No, they do not.

Mr. GOSAR. I mean, I have an E15 vehicle, I have a flex fuel vehicle, so it makes it easy for me, but that is a little different than the average American. We can't just go around looking at the troubleshooting that will happen with 70 percent of the cars on the marketplace. The American economy, the American households just can't go buy another vehicle to surmount this. And I think that is my biggest key is, is that I see a lack of common sense here.

I am a dentist, by the way, impersonating a politician, so things have, to me, have to have a science base to me that I have to understand where am I going, what is my investment, and what is it going to have as results; and I don't think that that is what we are actually seeing, because I think if we saw a detrimental aspect to our economy when we look at return on investment, when you look at ethanol subsidies, which so many of the members talked about here, you don't have a true open market here. And number two is based on corn ethanol, you are taking an awful lot off the table in feeding your population and you are artificially raising everything on the table; not just beef, pork, turkey, chicken, you name it, and diesel fuel, all those aspects.

But I guess what my offer is is there is an un-clarity, if there is uncertainty by the EPA, why wouldn't you reach back up to this body to say could you help us in that clarification?

Mr. GRUNDLER. Sir, the way we are going to approach this decision, and I hope we will use common sense, we will ask ourselves three questions: What is the law saying? What does the science tell us? And what is the right thing to do here?

Mr. GOSAR. Let me ask you a question. If you were uncertain about what the law said, there was a gray area, so many times we pass a law that there is lots of gray areas, why wouldn't you entertain coming back to Congress and asking can you clarify?

Mr. GRUNDLER. That wouldn't be my judgment to make, sir, but I think the law is quite clear in terms of the levels of renewable fuels that the Congress mandated over the next few years.

Mr. GOSAR. But that was a different subset of an equation. They looked in the future and looking at there were going to be people utilizing more fuel. But when you use a finite and dwindling more supplies, it becomes an antiquated equation. So the rational mind says, listen, this wasn't anticipated; how do we review this? And I think that brings a better set of ideals and opportunity as a working relationship between a legislative body and an administrative body. Wouldn't you agree?

Mr. GRUNDLER. Sir, my job is to administer the law with as much common sense as we can muster, as the law is today. I have no position, EPA has no position today in terms of future legislation.

Mr. GOSAR. Well, that shows you the lack of what is happening in administrative law, that it has to be an enigmatic, dynamic type of interface. You want to strive for ideals, but you always sometimes have to come back to common sense applications. And I see a very big lack of that, particularly from your agency; not just in this aspect, but in numerous other aspects. I think sometimes we go a lot further when we start to work with other bodies like the executive branch, along with the legislative branch, to try to define how do we solve problems, instead of saying, listen, this is what we entertained, this is all we are going to do, and that is it.

Ms. SPEIER. Mr. Chairman?

Mr. GOSAR. Yes.

Ms. SPEIER. I have one last submission that I would like to ask unanimous consent be added to the record.

Mr. GOSAR. So ordered.

Mr. GOSAR. With that, we will adjourn the meeting.

Thank you very much, Mr. Grundler.

Mr. GRUNDLER. Thank you.

[Whereupon, at 12:55 p.m., the subcommittee was adjourned.]

APPENDIX

Material Submitted for the Hearing Record

BRUCE L. BRALEY
1st District, Iowa

Congress of the United States
House of Representatives
Washington, DC 20515

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June 4, 2013

Representative James Lankford
Chairman
Subcommittee on Energy Policy,
Health Care and Entitlements
U.S. House of Representatives
Washington, DC 20515

Representative Jackie Speier
Ranking Member
Subcommittee on Energy Policy,
Health Care and Entitlements
U.S. House of Representatives
Washington, DC 20515

Chairman Lankford and Ranking Member Speier:

As a Member from the state with the largest biofuels presence in the country, I wanted to provide some comments regarding your review of the Renewable Fuel Standard (RFS) during today's Energy Subcommittee hearing in the House Committee on Oversight and Government Reform.

The RFS has made more of an impact in my state than possibly any other in the country. In Iowa, there are 39 ethanol plants with over 3 billion gallons of annual fuel production capacity, supporting the jobs of over 63,000 people in my state. In addition, two of the first cellulosic ethanol plants in the entire nation are currently under construction in my home state. Once these two plants come online, my state will have over 16 million tons of biomass available to convert to cellulosic ethanol. In addition, a state-of-the art algae facility is already operating in Iowa.

Given the dramatic impact this policy has had not only in Iowa, but across the Midwest in states like Indiana, Kansas, Nebraska, and Minnesota, I am surprised that this hearing does not include a single renewable fuels producer. Ethanol biorefineries dot the countryside throughout much of the Midwest, transforming rural economies by creating renewable fuels and providing farmers with a stable marketplace so they can get their income from the market instead of government programs. The RFS has been the key driver in supporting an industry that helps employ over 400,000 Americans, providing over $40 billion in gross domestic product (GDP).

The RFS is a serious piece of energy policy that requires thorough input about how proposals to change or repeal the policy would impact employment and the economy. Examinations like the one being performed today, without the perspective of important stakeholders, do not meet this standard.

Thank you for allowing me the opportunity to comment. I hope that further review of the RFS will include data and input from those most affected by this statute.

Sincerely,

Bruce L. Braley

Bruce Braley
Member of Congress

Biotechnology
Industry
Organization

June 5, 2013

Statement submitted by Biotechnology Industry Organization (BIO) for the record of the House Committee on Oversight and Government Reform hearing entitled "Up Against the Blend Wall: Examining EPA's Role in the Renewable Fuel Standard" to be held on June 5, 2013.

The RFS is paving the way to a competitive market for transportation fuels in the United States. While the RFS set an ambitious target of 36 billion gallons of renewable fuel to be produced by 2022, this target is helping drive investment in the U.S. for the development of the next generation of cellulosic and advanced biofuels that will reduce our dependence on foreign oil and provide a cleaner burning product at the pump.

The RFS is driving U.S. job creation. Today, the domestic biofuels industry is already creating jobs, contributing more than 400,000 jobs and $53 billion in new activity to the nation's economy. A recent report found that additional job creation from advanced biofuels production under the RFS could reach over 800,000 by 2022. California's homegrown biotechnology industry has positioned the state as a leader in the development of advanced biofuel technology. More than 30 companies researching and developing advanced biofuels and other renewable technologies make California their home, locating research facilities in the state. About half of those companies have built pilot or demonstration advanced biorefineries as they scale up their production. Together, these companies employ just over 4,500 people in California.[1]

Despite multiple legal and administrative obstacles put in place by the oil industry to protect their monopoly over the nation's transportation fuel supply and halt the advancement of cellulosic and advanced biofuels from entering into the marketplace, American companies are making advanced biofuels a reality. This is made possible -- – at no cost to the American taxpayer -- by the stable policy foundation of the RFS. Companies in California and nationwide have leveraged the RFS and other federal programs to raise private investment capital and are now constructing the first commercial-scale next generation biorefineries, with the first of these facilities coming online this year. The RFS is also bringing foreign investment to the U.S. Companies from Brazil, Canada, Denmark, New Zealand, the Netherlands, Spain, and Switzerland have made multimillion dollar investments to commercialize advanced and cellulosic biofuels in the U.S. because of the policy certainty associated with the RFS.

The RFS has also benefitted consumers at the pump by ensuring that the transportation fuel market is open to alternatives to oil. At the same time, the EPA has proposed new and more stringent limits on auto tailpipe and evaporative emissions of nitrogen oxides and other particulate matter and sulfur content in fuel by 2025. These proposed Tier III limits would improve air quality for many Americans and save at least $8 billion in annual healthcare costs associated with asthma and other respiratory ailments by 2030. The EPA's proposed Tier III rules recognize that automakers can make use of higher blends of ethanol in gasoline, such as E30, to achieve both increased fuel economy and clean air goals.

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[1] BayBio, BIOCOM. "Survey of California Industrial Biotechnology Companies." San Diego: Oct. 2011.

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bio.org

The RFS is working to drive investment in R&D and commercialization of advanced biofuels; to create jobs in a biobased economy; to lower fuel prices at the pump; and to protect human health. Undoing the RFS, rather than letting EPA use the multiple safety valves in place to help refiners meet their advanced biofuel obligations, will only lead to greater dependence on imported oil, increased greenhouse gas emissions, and lost opportunity for hundreds of thousands of high quality U.S. jobs in clean energy economy. Our job as Congress must be to stay the course; to give advanced biofuels developers the policy certainty they need and deserve; and to leave the RFS alone.

BIO Member Companies Located in California

ABI
San Luis Obispo

Allylix, Inc.
San Diego

BioCatalytics, Inc.
Pasadena

Cellana, Inc.
La Jolla

ChemDiv, Inc.
San Diego

Cobalt Technologies
Mountain View

Codexis, Inc.
Redwood City

Delphi Ventures
Menlo Park

DNA 2.0
Menlo Park

Royal DSM
Berkeley

Genomatica, Inc.
San Diego

DuPont Corporation
Bakersfield
Danville
Fresno
Goleta
Hayward
Palo Alto
Redwood City
Santa Barbara
Torrance
Woodland

The Dow Chemical Company
Pittsburg
Rancho Cucamonga
San Diego
Torrance

LS9, Inc.
South San Francisco

Mendel Biotechnology, Inc.
Hayward

NexSteppe, Inc.
South San Francisco

Novozymes
Davis

Rennovia, Inc.
Menlo Park

Sapphire Energy
San Diego
Orange County

Senomyx, Inc.
San Diego

Solazyme, Inc.
South San Francisco

Synthetic Genomics
La Jolla

Verdezyne, Inc.
Carlsbad

Verenium Corporation
San Diego

Virdia, Inc.
Redwood City

Advanced Biofuels Association

Comments of the Advanced Biofuels Association

Committee on Oversight and Government Reform
Subcommittee on Energy Policy, Health Care and Entitlements
United States House of Representatives

"Up Against the Blend Wall: Examing EPA's Role in the Renewable Fuel Standard"
June 5, 2013

Executive Summary
On behalf of the Advanced Biofuels Association (ABFA), a collection of over 40 member companies who produce advanced biofuels and biofuels feedstocks, we welcome the opportunity to comment on the Committee's hearing "Up Against the Blend Wall: Examing EPA's Role in the Renewable Fuel Standard".

The Committee is focused on exploring the blend wall and issues surrounding mid-level ethanol blends. ABFA's response is targeted to the advanced and cellulosic biofuels industry.

The primary question is whether EPA has sufficient authority to deal with the issues surrounding the blend wall. Our answer is 'yes'. We believe EPA is able to make the necessary adjustments to the RFS based on the current authorizations. In supporting this statement it is important to understand the current ability of the advanced biofuels companies to meet and exceed the targets in the biomass based diesel and advanced pools this year. Critical to this point is the importance of the energy density and equivalency calculations as well as the practical effect of the nesting of the pools in the RFS. Finally we remind the Committee of the investments made to date, the accelerating growth, and how changing the rules in the middle of the game would be extremely damaging to the private sector.

Comments
On behalf of the Advanced Biofuels Association (ABFA), a collection of over 40 member companies who produce advanced biofuels and biofuels feedstocks, we welcome the opportunity to comment on the Committee's hearing "Up Against the Blend Wall: Examing EPA's Role in the Renewable Fuel Standard". In the current debate over the blend wall and RIN prices we seem to have lost sight of the intent of the RFS2 amendments to create an advanced and cellulosic biofuels industry. This debate should not only be about midlevel ethanol blends but about the future of the entire biofuels industry.

In testimony before the House Energy & Commerce Committee Subcommittee on Energy and Power last July, the ABFA noted that the advanced biofuels industry continues to make significant progress in commercial deployment. Last November one of our members delivered the first cellulosic renewable diesel into the commercial sector thereby receiving RINs on the EPA system. That same company, KiOR, also produced the first cellulosic drop-in gasoline which will provide obligated parties with compliant RINs. In addition, a number of other members who are currently producing gallons of advanced biofuels which can be used by obligated parties to meet their requirements under the RFS2 program. These gallons are significant and will immediately assist in attaining the proposed Renewable Volume Obligation (RVO) volume requirements in 2013 without regard to the blend wall.

For almost thirty years Congress enacted pieces of legislation including the RFS2 intended to create a corn ethanol industry. It has been a success with nearly 15 billion gallons of standing capacity built to date. The enactment of EISA and the provisions which amended the RFS were intended to stimulate and build an advanced biofuels industry moving well past corn ethanol to fuels with greater greenhouse gas reduction and full compatibility with existing fuel infrastructure. This effort, for the first time, created a 21 billion gallon target for advanced biofuels. The provisions creating the cellulosic pool specifically provided an actual floor price to encourage the development of these lower-carbon emitting fuels. In addition the EPA rules also specifically rewarded energy density as part of the criteria which RIN credits are awarded. Other advanced biofuel pools recognized the opportunity to create "drop in" fuels (hydrocarbon based fuels essentially the same as those from petroleum) such as renewable diesel, gasoline, heating oil, and jet fuels.

We would like to suggest the Committee consider the entirety of the RFS options and the full range of fuels available to meet the requirements of the statute in your deliberations. In just four short years since EPA's promulgation of the implementation rules we are seeing a wide range of facilities springing up all over the country who make advanced biofuels that generate RINs which obligated parties can utilize to meet their obligations, easing the blend-wall issue. Many of these fuels have no blend wall restrictions and in fact can be utilized as neat, drop-in fuels. Some are diesel fuels and do not require a drop of gasoline in which to be blended. Many of these advanced biofuels due to their energy density have significant multipliers (1.5 or 1.7 time the volume produced) in terms of RIN generation. These gallons count towards the overall targets in the advanced pools and count in the renewable pool, providing an economic option for the obligated parties in terms of meeting their compliance targets. Even in the case of cellulosic ethanol an obligated party who chooses to purchase a gallon is allowed to count that gallon in the cellulosic pool, the advanced pool, as well as the renewable pool. "Three for the price of one" so to speak.

With this in mind, the blend wall implementation challenge can be avoided in 2013 without changes to the RFS. Each year under the RFS statute the EPA is called upon to set the RVO for the coming year. The statute was intended to grant EPA the flexibility to utilize this process to adjust the size of the various pools in conjunction with the relative ability of the marketplace to meet the original targets. The recent federal district court case validated this view in finding that EPA could not "put its thumb on the scale" by setting the size of the cellulosic pool. In that same case the court made it absolutely clear EPA can grant cellulosic gallons above the cellulosic requirement to be included in the advanced pool requirement so long as gallons are reasonably available. The court determined that EPA is within its authority to continue such practice, as have they have done since 2010. It should be noted that as a result of the performance of the biomass-based diesel pool that EPA raised the volume number to 1.28 billion for 2013. Once again estimates suggest the industry will exceed the new level of 1.28 billion gallons in this calendar year.

On two occasions the EPA was petitioned by appropriate stakeholders who argued economic harm to their citizens as a result of the EPA RVO mandates. In both instances the EPA did not find sufficient economic burden to grant the waiver. The clear intention of Congress in writing the provisions, which required an annual setting of the RVO obligations, was to make sure the mandates and the markets were in line with each other and did not create undue economic impacts on the nation. Combined with the recent federal court opinion it is clear that EPA possess the ability to adjust the RVO pools as a result of changes in the size of various demand functions in the market place. RINs generated by advanced biofuels can help obligated parties avoid the blend wall. Therefore between the RVO process and comment period, the experience to date with the waiver process, and the recent court decision, we believe the EPA does have sufficient authority to address blend wall concerns should they exist. The flexibility Congress built into the RFS has worked and should allow EPA to continue to make the necessary adjustments to address acute market perturbations.

We believe when one views the RFS across the entire set of pools and takes into consideration the current biofuel production rates, energy density multipliers and nesting components of the various pools, the need to change the existing RVO's will not be required in 2013.

A number of stakeholder groups are attempting to create a view that the RFS is broken and should be wholesale repealed rather than allowing EPA to utilize their authority to make any required adjustments. That would be a step backward in America's energy future. Right now, many of the advanced and cellulosic companies are seeking to break ground or attempting to raise funds to build their first plants. This entire discussion has had a negative impact on these businesses and their financial community. For companies who cannot self-finance this is a heavy burden making commercial deployment difficult, thereby halting the addition of new RINs which the obligated parties could utilize. Already many companies have made significant investments and have broken ground to build new plants. Many of these are operating, or will come online in the next couple of years. The conversation as to whether to change the rules in the middle of the game is not equitable to those who played by the rules. This effort will wind up costing material capital investment to the investors who complied with the vision of the RFS as drawn up by Congress, particularly for the advanced biofuels sector. Congress' vision in creating RFS2 was to surpass the Energy Policy Act of 2005 to stimulate the creation of an advanced biofuels industry that would deliver larger greenhouse gas reduction, higher energy density renewable fuels, and "drop-in" fuel molecules that are totally compatible with our existing engines, pipeline system and fuel pumps. We continue to believe that the vision to create a diverse set of options for America's transportation fuels sector was a wise one. Advanced and cellulosic companies have broken ground and are moving forward with that vision. This is a time to stay the course and allow EPA to utilize its authority, when merited, to make the necessary adjustments to keep a sound program on solid footing and on a sustained path forward.

Submitted by:

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October 2012

Economic Impacts Resulting from Implementation of RFS2 Program

Prepared For:

American Petroleum Institute

NERA
Economic Consulting

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The findings contained in this report may contain predictions based on current data and historical trends. Any such predictions are subject to inherent risks and uncertainties. In particular, actual results could be impacted by future events that cannot be predicted or controlled, including, without limitation, changes in business strategies, the development of future products and services, changes in market and industry conditions, the outcome of contingencies, changes in management, and changes in law or regulations. Neither API nor NERA accept responsibility for actual results or future events.

The opinions expressed herein are those of the authors and do not necessarily represent the views of NERA Economic Consulting or any other NERA consultant.

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TERMINOLOGY

AEO	Annual Energy Outlook. An annual publication from the EIA that offers projections that can be used as a basis for examination and discussion of energy production, consumption, technology and market trends and the direction they may take in the future. This study used AEO2011.
CARB	California Air Resources Board
CGE	Computable General Equilibrium
Biodiesel	A type of biomass-based diesel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, and meeting the requirements of ASTM D 6751. A blend of biodiesel fuel with petroleum-based diesel fuel designated BXX, where XX represents the volume percentage of biodiesel fuel in the blend.
Biomass based diesel	Includes biodiesel and renewable diesel
Biofuel Producer or Importer	Generator of RINs at the point of biofuel production or the port of importation
Blending Percentage Standard	Ratio of renewable fuel volumes required by RFS2 and the total gallons of gasoline and diesel fuel that will be sold in the upcoming year
EIA	Energy Information Administration
EISA '07	Energy Independence and Security Act of 2007
EPA	United States Environmental Protection Agency
E0	Neat gasoline; 100% petroleum gasoline, does not contain ethanol
E10	A gasoline blend containing 10 percent ethanol by volume (E10)
E85	An ethanol/gasoline fuel blend containing a relatively high percentage of ethanol by volume and a relatively low percentage of petroleum hydrocarbons by volume. While its name connotes a blend of 85% ethanol and 15% gasoline, the ethanol content of E85 is seasonally adjusted to meet ASTM recommended specifications and to improve vehicle cold-start and warm-up performance. Following the EIA's practice, we will analyze E85 sales under the assumption that fuel sold as E85 consists of 74% ethanol and 26% gasoline by volume on a year-round average basis.

FFV	Fuel Flexible Vehicles: certified to use ethanol/gasoline blends containing up to 85 percent volume ethanol
N_{ew}ERA	NERA's proprietary macroeconomic model
Obligated Party	Companies that produce and/or import gasoline and/or diesel fuel
Reference Case	NERA Reference Case (no RFS2 mandate)
RFS2	Renewable Fuel Standard Per Energy Independence and Security Act of 2007
RINs	Renewable identification numbers (Credits for compliance with RFS2)
Scenario 1	NERA scenario with implementation of RFS2 and AEO Reference Case biodiesel supplies
Scenario 2	NERA scenario with implementation of RFS2 and AEO High Fuel Price case biodiesel supplies

Executive Summary

The American Petroleum Institute (API) commissioned NERA Economic Consulting (NERA) to conduct a study of the economics and compliance issues related to the implementation of the Renewable Fuel Standard (RFS2) per the Energy Independence and Security Act of 2007. NERA relied upon publically available information and NERA's proprietary economic modeling to develop the analysis. The study found that RFS2, in its current form, will likely become infeasible within the next three or four years, which would result in significant harm to the U.S. economy.

The RFS2 requires transportation fuel producers and importers (obligated parties) to incorporate specified volumes and categories of biofuels into their products annually. These mandates increase yearly, and collectively, require the use of 36 billion gallons of renewable fuels in 2022. Each year the annual total renewable fuel volume mandate is calculated as a percentage of the nation's total projected fuel consumption for the upcoming year. The renewable fuel volume obligation (RVO) for each obligated party is calculated by applying that percentage to the total annual volume of gasoline and diesel produced or imported by each obligated party during that year. Compliance with the RFS2 each year is demonstrated through "Renewable Identification Numbers" (RINs) which are unique identifiers attached to every gallon of renewable fuel produced or imported. Obligated parties submit RINs as evidence of meeting the annual RVO.

Table 1 lists the four primary mechanisms that obligated parties can use for compliance with the RFS2. In the early years of the RFS2 program, these mechanisms offered a workable means for compliance. However, as the RFS2 volume requirements increase, combined with higher vehicle fuel efficiencies, these mechanisms become less effective until the RFS2 reaches the point of infeasibility.

Table 1: Fuel Production and Blending Options for Meeting RFS2 Compliance

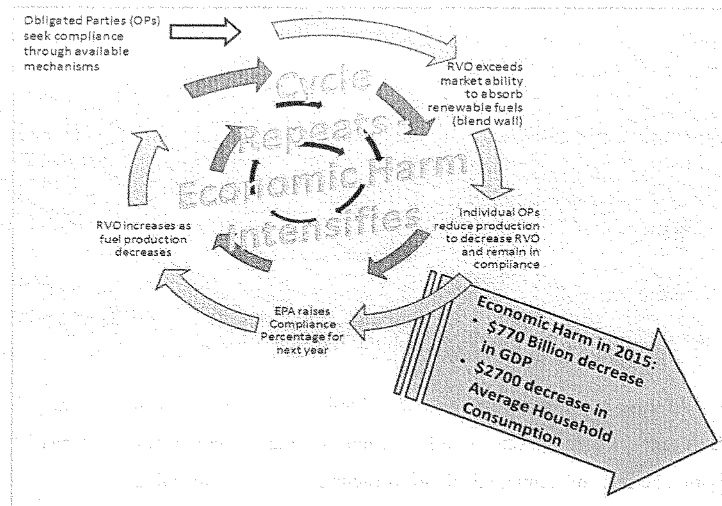
Compliance Mechanism	Limitation
Minimize production of E0	Demand for E0 will not completely disappear due to customer demand and limits on ethanol distribution
Increase production of E85	Demand for E85 will remain low due to limited E85 infrastructure, E85's low fuel economy, and consumer preference for conventional fuels
Increase use of biodiesel	The available volume of biodiesel is relatively small compared to the overall RFS2 requirement
Produce and market E15	Market penetration of E15 will be limited by vehicle warranty, retail infrastructure, misfueling, and general liability issues

As these mechanisms approach their limit, obligated parties will reach the point when biofuels cannot be incorporated into fuel products at the volumes necessary to meet the RIN obligation because of technological, infrastructure or market constraints.

This study finds that the RFS2 volume requirements will exceed the transportation fuel market's ability to absorb the biofuel volumes mandated within three to four years. At that point in time obligated parties will not be able to meet market demand for transportation fuel and still remain in compliance with the RFS2. Therefore, after exhausting all other available options for compliance, individual obligated parties, each acting independently, could be forced to reduce their RIN obligation by decreasing the volume of transportation fuel supplied to the domestic market – either by reducing production or exporting.

As domestic fuel supplies decrease, large increases in transportation fuel costs would ripple through the economy imposing significant costs on society. More specifically, as the RFS2 mandate is ratcheted up every year, the fuels market will be pushed into a death spiral shown in Figure 1. The death spiral depicts the economic harm that occurs as individual obligated parties act to remain in compliance with the program. Once the blend wall has been reached, the annual increase in the RVO results in decreased fuel availability and increased fuel costs to society. These increased fuel costs have a broad impact across the economy.

Figure 1: Economic Impact of Hitting the RFS2 Blend Wall: The Death Spiral



This process repeats itself yearly. As domestic supply continues to decline, the blending percentage obligation becomes increasingly untenable. Obligated parties rely on RINs acquired and carried forward from earlier years to meet compliance obligations. However, the findings and analysis of this report indicate that by 2015-2016 compliance with the RFS2 in its current form will likely be infeasible, which would result in significant damage to the economy.

The death spiral impact is seen most acutely in the diesel fuel market. The tightening of the diesel supply (up to 15% decline in 2015) causes large fuel cost increases to ripple through the economy, adversely affecting employment, income, consumption, and GDP. By 2015, the adverse macroeconomic impacts include a $770 billion decline in GDP and a corresponding reduction in consumption per household of $2,700.

I. Introduction

The American Petroleum Institute (API) commissioned a two-phase study of the economics and compliance issues resulting from the implementation of the Renewable Fuel Standard (RFS2) per the Energy Independence and Security Act of 2007. The RFS2 requires transportation fuel produces and importers (obligated parties) to incorporate specified volumes and categories of biofuels into their products annually. These mandates increase each year, and collectively, require the use of 36 billion gallons of renewable fuels in 2022. Each year the annual total renewable fuel volume mandate is calculated as a percentage of the nation's total projected fuel consumption for the upcoming year. The renewable fuel volume obligation (RVO) for each obligated party is calculated by applying that percentage to the total annual volume of gasoline and diesel produced or imported by each obligated party during that year. Compliance with the RFS2 each year is demonstrated through "Renewable Identification Numbers" (RINs) which are unique identifiers attached to every gallon of renewable fuel produced or imported. Obligated parties submit RINs as evidence of their compliance with the RVO.

A. Phase 1

API retained Charles River Associates (CRA) to conduct Phase I of the study.[1] The work concluded that the increasing volumes mandated by the RFS2 will eventually exceed the market's ability to absorb ethanol into petroleum fuel. That is, the RVO will eventually exceed the maximum feasible level of renewable fuel that can be contained on average in a gallon of petroleum transportation fuel given technological, behavioral, and infrastructure constraints. Using EIA's Annual Energy Outlook AEO 2011, the study estimated that the so-called blend wall (maximum concentration of ethanol of 10% that can be blended in gasoline and used by conventional gasoline-powered motor vehicles) will be reached by 2013.

To comply with the RFS2 mandates, obligated parties have increased production of E10 and E85 while minimizing production of E0 (pure gasoline). To the extent that biodiesel is available, obligated parties have blended biodiesel to produce B5. As the RFS2 mandated volumes for renewable fuels increase, however, these mechanisms reach their limit.

1 Phase I study report: "Impact of the Blend Wall Constraint in Complying with the Renewable Fuel Standard," Charles River Associates, November 2, 2011.

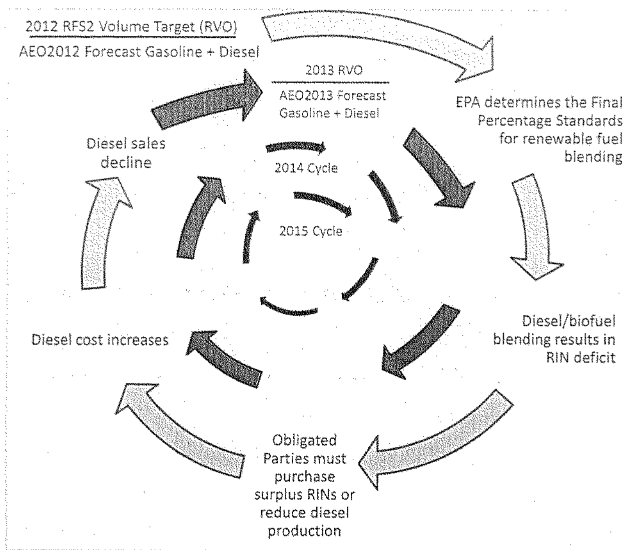
Table 2: Fuel Production and Blending Options for Meeting RFS2 Compliance

Compliance Mechanism	Limitation
Minimize production of E0	Demand for E0 will not completely disappear due to customer demand and limits on ethanol distribution
Increase production of E85	Demand for E85 will remain low due to limited E85 infrastructure, E85's low fuel economy, and consumer preference for conventional fuels
Increase use of biodiesel	The available volume of biodiesel is relatively small compared to the overall RFS2 requirement
Produce and market E15	Market penetration of E15 will be limited by vehicle warranty, retail infrastructure, misfueling, and general liability issues

The Phase 1 study concluded that as obligated parties exhaust these methods of compliance, they will eventually be forced to either decrease the production volumes or export product in order to reduce their individual biofuel obligation and meet RFS2 volume percentage requirements. These market shifts will initially result in a tightening of the diesel fuel supply followed by subsequent years of reductions in both the gasoline and diesel fuel supply. The shrinking domestic petroleum fuel supply coupled with expanding RFS2 requirements would result in making compliance increasingly more difficult and lead to significant economic impacts.

In Figure 2 this effect is depicted as a death spiral of the diesel fuel market. Each year obligated parties must absorb increasing volumes of biofuels into declining volumes of petroleum fuel without exceeding the approved percent blending limits. In each of the years under review in this study, the previous year's reduced forecast for diesel fuel demand exacerbates compliance hurdles for the following year, resulting in economic harm to trucking and commerce first and eventually impacting the U.S. economy as a whole.

Figure 2: Death Spiral Effect on the Diesel Fuel Market from the RFS2



This process repeats itself yearly. As domestic supply continues to decline, the blending percentage obligation becomes increasingly unattainable. Obligated parties rely on RINs acquired and carried forward from earlier years to meet compliance obligations. However, the findings and analysis of this report indicate that by 2015-16 compliance with the RFS2 would become infeasible and result in significant damage to the economy.

Phase II of the study builds on the findings of Phase I and quantifies the economic impacts of complying with the RFS2 requirements.

B. Phase II

For Phase II of the study, API retained NERA Economic Consulting (NERA) to analyze the potential impacts on the transportation fuels market and the U.S. economy resulting from complying with the RFS2. NERA relied upon publically available information and NERA's proprietary economic modeling to develop the analysis.

NERA used two proprietary models: NERA's transportation fuel model and the N$_{ew}$ERA macroeconomic model. These models were run[2] to quantify the economic impacts from implementation of the RFS2. Specifically, the transportation fuel model estimates the amount of fuel produced for and consumed by the transportation sector, and explicitly estimates the demand for E0, E10, E85, B0, and B5. The N$_{ew}$ERA macroeconomic model[3] simulates all economic interactions in the U.S. economy, including those among industry, households, and the government.

The macroeconomic impacts of the RFS2 mandate on the U.S. economy were estimated through the year 2015. These results show large increases in transportation fuel costs and disruptions to the transportation fuel supply that will ripple adversely through the economy. From 2012 to 2014, the higher transportation diesel fuel costs will have the biggest and most immediate impact on the economy. The cost to move raw materials and finished goods about the country will increase. This increased cost will be passed through to consumers in the form of higher costs on finished goods and services and, as a result, consumption per household will drop. Although labor earnings initially rise, such an increase is modest compared to the loss in consumption, as labor earnings are unable to offset the higher costs for goods. In the near term, investment and production is temporarily accelerated in anticipation of rising prices and GDP increases, but this shift is unsustainable and by 2014, GDP declines by more than $250 billion.

In 2015, the economic impacts worsen. In addition to the negative impact of higher costs for finished goods and services caused by rising diesel fuel costs, gasoline costs increase as a result of RSF2. Consumers are left with fewer dollars to spend on other goods and services, resulting in lower consumption. Lower levels of consumption lead to declining production of goods and services that consumers would have otherwise purchased. In 2015, the consumption per household declines by about $2,700 per year from baseline levels, with total U.S. consumption declining by about $340 billion. Since there is lower demand for finished goods

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2 The macroeconomic model was connected to the transportation fuel model through a one-way link in which the macroeconomic model incorporated the fuel cost increases of the transportation model.

3 The N$_{ew}$ERA macroeconomic model uses the resulting scenario fuel prices from the transportation fuel model. Then the N$_{ew}$ERA macroeconomic model is run to assess the economy wide impacts of the changes in fuel prices. Since the transportation model becomes infeasible in 2015 under Scenario 1, we could not run the N$_{ew}$ERA macroeconomic model over the 2012 to 2015 time horizon. Therefore, the following impacts are reflective of Scenario 2, but these should be considered as a lower bound of what might occur.

and services, the need for workers to provide those goods and services drops. As a result of the smaller size of the economy, workers would earn $580 billion less (Table 3). These negative impacts are also reflected by the loss in GDP of $770 billion dollars.

Table 3: Changes in Consumption, Labor Income, and GDP Relative to Baseline (2010$)

	2012	2013	2014	2015
Change in Average Consumption per Household	-$1,200	-$1,200	-$1,300	-$2,700
Change in Consumption (Billions)	-$150	-$140	-$160	-$340
Change in Labor Income (Billions)	$24	$42	$27	-$580
Change in GDP (Billions)	$43	$50	-$270	-$770

Source: NERA N_{ew}ERA model results.

The remainder of this report provides details on the models used, the reference cases, and the detailed results of the modeling analysis. The appendices provide descriptions of the RFS2 program and model details.

II. Background

A. RFS2

Congress first established a Renewable Fuel Standard (RFS) in 2005 with the enactment of the Energy Policy Act of 2005 (EPACT). Two years later, Congress passed the Energy Independence and Security Act of 2007 (EISA '07) which superseded and greatly expanded the biofuels blending mandate. This expanded RFS is referred to as RFS2, which applies to all transportation fuel used in the United States—including diesel fuel intended for use in highway motor vehicles, non-road, locomotive, and marine diesel.[4] RFS2 introduces four new major distinctions from RFS:

1. RFS2 increases the mandated usage volumes and extends the time frame over which the volumes ramp up to 2022;
2. RFS2 subdivides the total renewable fuel requirement into four separate but nested categories—total renewable fuels, advanced biofuels, biomass-based diesel, and cellulosic biofuel—each with its own volume requirement or standard;
3. Biofuels qualifying under each nested category must achieve certain minimum thresholds of lifecycle greenhouse gas (GHG) emission performance, with certain exceptions applicable to existing facilities; and
4. All renewable fuel must be made from feedstocks that meet the new definition of renewable biomass, including certain land use restrictions.

1. Nested Mandates

Because of the nested nature of the biofuel categories, any renewable fuel that meets the requirement for cellulosic biofuels or biomass-based diesel is also valid for meeting the overall advanced biofuels requirement. Thus, any combination of cellulosic biofuels or biomass-based biodiesel would count toward the advanced biofuels mandate, thereby reducing the potential need for imported sugarcane ethanol to meet the "other" advanced biofuels mandate. Similarly, any renewable fuel that meets the requirement for advanced biofuels is also valid for meeting the total renewable fuels requirement. As a result, any combination of cellulosic biofuels, biomass-

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4 Heating oil, jet fuel, and fuels for ocean-going vessels are excluded from RFS2's national transportation fuel supply; however, renewable fuels used for these purposes may count towards the RFS2 mandates.

based biodiesel, or imported sugarcane ethanol that exceeds the advanced biofuel mandate would reduce the potential need for corn-starch ethanol to meet the overall mandate.

2. Waivers

The EPA Administrator has the authority to waive the RFS requirements, in whole or in part, if, in his/her determination, there is inadequate domestic supply to meet the mandate, or if "implementation of the requirement would severely harm the economy or environment of a State, a region, or the United States."[5] Further, under certain conditions, the EPA Administrator may waive (in whole or in part) the specific carve-outs for cellulosic biofuel and biomass-based diesel fuel.[6] Furthermore, EISA '07 requires that EPA evaluate and make an appropriate market determination for setting the cellulosic standard each year.

3. Implementation

Under EISA '07, the U.S. Environmental Protection Agency (EPA) is responsible for implementing regulations to ensure that transportation fuels sold in the United States contain a minimum volume of renewable fuels in accordance with the four nested volume mandates of the RFS2. Compliance with the RFS2 is demonstrated by the use of RINs.[7]

A RIN is generated by a biofuel producer or importer at the point of biofuel production or the port of importation. Each gallon of ethanol generates one RIN. Biodiesel generates 1.5 RINs per gallon. RIN generators must register with the EPA. After a RIN is created by a biofuel producer or importer, it must be reported to the EPA. RINs are transferable.

Congress determines the total renewable fuel volume that must be incorporated into the nation's fuel supply each year—referred to as a RVO. The EPA translates the RVO into blending percentage standards that are used by obligated parties to determine their individual

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5 Clean Air Act section 211(o)(7)(A)(i).

6 For example, in February 2010 EPA waived most of the 2010 cellulosic biofuel carve-out—EISA '07 had set the mandate at 100 million gallons but EPA lowered the requirement to 6.5 million gallons, more than 90% less than scheduled by EISA '07. Then, in July 2010, EPA lowered the 2011 RFS for cellulosic biofuels to a range of 5 to 17.1 million gallons. EPA cited a lack of current and expected production capacity, driven largely by a lack of investment in commercial-scale refineries. In 2011, EPA waived more than 98% of the cellulosic biofuel volume EISA "07 required for 2012.

7 For tracking purposes, each RIN has a unique 38-character number that is issued (in accordance with EPA guidelines). Each RIN identifies which of the four RFS categories—total, advanced, cellulosic, or biodiesel—the biofuel satisfies. In addition, a biodiesel RIN has an equivalence value of 1.5 when being used as an advanced biofuel.

RVO.[8] This percentage standard represents the ratio of renewable fuel volumes required by RFS2 to the projected total gallons of gasoline and diesel fuel that will be sold in the upcoming year. The EPA relies on projections from the Department of Energy's Energy Information Administration (EIA) for the information to estimate the expected total gallons sold.

Companies that refine or import gasoline or diesel transportation fuel for the retail market are obligated to include a quantity of biofuels equal to the percentage of their total annual fuel sales. At the end of the year, each obligated party must have enough RINs to show that it has met its share of each of the four mandated standards.

If an obligated party has met its mandated share and has acquired surplus RINs, it can sell the extra RINs to another party or it can hold onto the RINs for future use (to be used the following year, but the previous year's RINs can comprise only up to 20% of the current year's obligation).[9]

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8 The blending percentage standard is computed as the total amount of renewable fuels mandated under RFS2 to be used in a given year expressed as a percentage of expected total U.S. transportation fuel use. This ratio is adjusted to account for the small refinery exemptions. A separate ratio is calculated for each of the four biofuel categories.

9 A RIN would not be viable for any year's RVO beyond the immediately successive year; thus giving it essentially a two-year lifespan. For any individual company, up to 20% of the current year's RVO may be met by RINs from the previous calendar year.

III. Description of the Models

This study used NERA's proprietary transportation fuel model and its $N_{ew}ERA$ macroeconomic model. These models were run interactively[10] to quantify the economic impacts from RFS2 that are reported in this study. This section describes both models. A more detailed description of the models, including a model formulation is provided in Appendix B.

A. Transportation Fuel Model

The transportation fuel model is a partial-equilibrium model designed to estimate the amount of fuel produced for and consumed by the transportation sector. The model maximizes the discounted present value of household consumption (a measure of household value) subject to meeting the RFS2 program fuel requirements and satisfying the transportation sector's demand for fuel while not violating any transportation sector infrastructure constraints.

The model is calibrated in the near term to the EIA's Short-Term Energy Outlook (STEO) for September 2011 and in the long term to the AEO 2011 forecast, with a few minor adjustments to ensure that the E10 blend wall is not violated.

1. The Transportation Fuel Model is designed to Model RFS2 Program Characteristics

The transportation fuel model was customized to simulate the impacts resulting from the RFS2 program. The model solves in one-year time steps, and has a flexible time horizon. For purposes of this analysis, the first endogenous year is 2012 and the last year is 2015. The model solves for the demand of the following finished fuels: E0 (100% petroleum gasoline), E10 (gasoline containing at most 10% ethanol by volume), E85 (assumed to contain 74% ethanol by volume), and diesel fuel may contain up to 5% biomass based diesel or B5. The model also solves for the following fuel components used in the production of the above finished fuels: petroleum gasoline, corn ethanol, sugar ethanol, cellulosic ethanol, petroleum diesel, and biodiesel.

The model combines the six fuel components into the four finished fuels, which can be consumed by motor vehicles subject to the following constraints:

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[10] The macroeconomic model was connected to the transportation fuel model through a one-way link.

- Minimum E0 use held to 5% of total transportation fuel consumption to represent incomplete market conversion to E10 and preference of some consumers for E0;
- Conventional vehicles can consume either E0 or E10;
- Flexible fuel vehicles (FFVs) can use E0, E10 or E85; and
- Commercial trucks/buses, ships, and trains are allowed to use up to a 5% blend of biodiesel.

2. RFS/RIN Constraints:

The model accounts for the minimum annual volume of biofuel sales required under the RFS2 program by including constraints on three types of biofuels:

- Biomass-based diesel;
- Advanced biofuel (includes cellulosic biofuels, biomass-based diesel, and sugar ethanol); and
- Renewable fuel (includes advanced biofuel and corn ethanol).

For this analysis, we assume that cellulosic biomass will continue to be commercially available only in very limited quantities, and as a result, EPA would continue to grant a waiver. This assumption avoids the debate about the economic and technical feasibility of producing cellulosic fuel[11] because this analysis assumes ample supplies of corn and sugar ethanol to meet the RFS2 mandates. As a result, there is no need for cellulosic ethanol to meet the non-cellulosic RFS2 targets.

As discussed in detail in Appendix B, the fuel supply curves capture all pertinent technological issues (penetration rate, availability, and cost) for the different fuels. Similarly, the fuel demand curves capture the loss in utility from having to reduce travel and also the loss in welfare from fuel scarcity. Different scenarios were modeled, as discussed in section E. The change in economic activity between the scenarios and the baseline provides the economic impacts of the RFS2 policy.

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[11] There is a secondary effect of assuming no measurable supplies of cellulosic biomass. Assuming no significant amount of cellulosic biomass production necessitates the production of additional amounts of biodiesel and sugar-based ethanol to meet the advanced biofuel requirement, and this affects costs.

The model also incorporates constraints on the availability of various finished fuels to account for both consumer acceptance and infrastructure issues. The sales of E85 are limited based on these issues. Biodiesel sales are limited by supply of biodiesel feedstocks.

B. N_{ew}ERA Macroeconomic Model

The N_{ew}ERA macroeconomic model is a forward-looking dynamic computable general equilibrium model of the United States. The model simulates all economic interactions in the U.S. economy, including those among industry, households, and the government. The macroeconomic and energy forecasts that are used to project the benchmark year going forward are calibrated to AEO 2011 produced by the EIA. Because the model is calibrated to an internally-consistent energy forecast, the use of the model is particularly well suited to analyze economic and energy policies and environmental regulations.

For this study, the N_{ew}ERA model runs from 2012 to 2015 in one-year increments. The model includes five energy and seven non-energy sectors: energy sectors include crude oil, oil refining, natural gas extraction and distribution, coal, and electricity; the non-energy sectors include agriculture, commercial transportation (excluding trucking), energy intensive sectors, manufacturing, motor vehicle production, services, and trucking.

The macroeconomic model incorporates all production sectors and final demands of the economy and is linked through terms of trade. The effects of policies are transmitted throughout the economy as all sectors and agents in the economy respond until the economy reaches equilibrium. The ability of the model to track these effects and substitution possibilities across sectors makes it a unique tool for analyzing policies such as those involving energy and environmental regulations. These general equilibrium substitution effects, however, are not fully captured in a partial-equilibrium framework or within an input-output modeling framework. The smooth production and consumption functions employed in this general-equilibrium model enable gradual substitution of inputs in response to relative price changes thus avoiding "all-or-nothing" solutions.

Business investment decisions are informed by future policies and outlook. The forward-looking characteristic of the model enables businesses and consumers to determine the optimal savings and investment while anticipating future policies with perfect foresight. The alternative approach on savings and investment decisions is to assume agents in the model are myopic, and thus have no expectations for the future. Though both approaches have their limitations, the latter approach can lead the model to produce inconsistent or incorrect impacts from an announced future policy.

C. Model Integration

The economic impacts of the RFS2 program were determined using the following methodology:

1. Using the transportation fuel model, the baseline and scenarios were run to determine the effect on fuel prices resulting from the RFS2 requirements for increased use of biofuels. The imposition of the RFS2 program leads to changes in fuel prices from the EIA baseline.
2. Using the N_{ew}ERA macroeconomic model, the resulting changes in fuel prices were translated into taxes (or subsidies) on gasoline and diesel that yield the same fuel price changes as seen in the transportation fuel model.

D. Analytical Methodology

All cases were run using NERA's transportation fuel model, which allowed us to simulate the dynamics of RFS2 compliance and the use of surplus RIN carryovers, and the methodology that EPA uses each year to determine the minimum percentages of the different categories of biofuels delineated in the RFS2 standard that fuel suppliers must use.

The transportation fuel model determined the impact of the RFS2 mandate on the quantities of finished gasoline (E0, E10, and E85) and diesel consumed in the transportation sector. In addition, the model calculated volumes of individual biofuels blended in the finished gasoline (corn ethanol, sugar ethanol, and cellulosic ethanol) and diesel. The N_{ew}ERA macroeconomic model then determined the impact on the U.S. economy of meeting the RFS2 mandate. The results were expressed in terms of well-known economic parameters: changes in consumer purchasing power, GDP, and labor earnings.

Implementation of the RFS2 may create a dynamic that can be characterized as a "death spiral," in which higher costs in the current year lead to lower demand, which in turn lead to higher costs in the next year and so on. NERA's transportation fuel model represents this process by solving in a recursive dynamic fashion. That is, the model minimizes the cost of compliance for the current year, through the use and value of surplus RINs that were carried forward. Therefore, the years are linked through the RINs. For example, the available surplus RINs at the beginning of 2012 represents 1.69 billion gallons of renewable fuel, which is the estimated amount of surplus RINs at the end of 2011 based on AEO 2011 fuel consumption data. After defining the RINs available at the beginning of 2012 and calibrating the model's supply and demand curves to the AEO's forecasted 2012 values, the model was solved with the RFS2 constraints and other infrastructure constraints for the year 2012.

The RINs available at the end of 2012, or the number of RINs carried forward to 2013, equals the RINs available at the beginning of 2012 (1.69 billion gallons) plus the difference between the number of RINs generated and the number of RINs submitted for compliance during 2012. The model will store RINs or use RINs in 2012 until either the value of a surplus RIN equals the marginal cost of complying with the RFS2 mandate or surplus RINs are depleted. This process is repeated for each successive year.

If any of the RFS2 or infrastructure constraints bind, then the average fuel price may rise to cause a switch in fuel consumption patterns which results in an increase of the percentage of renewable fuel sales to the level required by the RFS2 constraint. An increase in average fuel prices would cause a drop in the equilibrium level of fuel consumption from the EIA's forecast. The value of the elasticity of demand has a significant effect on the relationship between the increase in fuel price and decline in fuel demand. The more elastic the demand curve, the less prices need to move to induce consumers to reduce their demand and thus the easier and less costly it is to meet the RFS2 targets. As the absolute value of the elasticity of demand declines, demand becomes more inelastic and the cost of compliance increases.

Once finished with 2012, the model then solves for 2013. However, instead of using the EIA's forecast for 2013 energy consumption, the values to which the model calibrates its energy consumption are adjusted based on the model's 2012 solution values for energy consumption. Assuming that the RFS2 constraint binds for 2012, the forecasted fuel sales volumes will differ in 2012 from that of the EIA's forecast.

To be conservative regarding the costs of the RFS2 mandate, we allow surplus RINs to be exhausted over the model horizon. Retaining RINs for later years would raise program costs in the near term. This is because the transportation sector would need to consume higher percentage levels of biofuels in the near term instead of relying on the RINs generated in prior years to assist the sector in complying with RFS2. Allowing the RINs to be consumed in the near term (*e.g.*, 2014-2015 timeframe) rather than retaining RINs after 2015 allows obligated parties to meet the mandates with lower volumes of renewable fuels and hence reduces the burden of the policy.

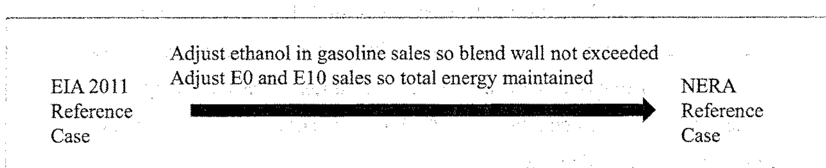
E. Description of Reference Case and Two Modeling Scenarios

To analyze the economic impacts of the RFS2 mandate, it was necessary to develop a Reference Case in which the RFS2 was not in force and a set of scenarios in which RFS2 was assumed to be fully implemented. Then by comparing the scenarios to the Reference Case it is possible to isolate the effects of the RFS2 mandate. This section first discusses the construction of the Reference Case and then describes the assumptions underlying each of the two scenarios.

1. Reference Case

The Reference Case is based upon AEO 2011 projections of transportation fuel supply, demand and prices, but with some modifications (Figure 3). Unlike EIA, our Reference Case limits the amount of ethanol in the gasoline pool to not violate the blend wall, and reduces the level of E0 sales. Our Reference Case includes the AEO 2011forecast for both biodiesel (which is less than that required under RFS2) and E85 consumption. Although the mix of fuel in our Reference Case differs from that in the EIA's AEO 2011 Reference Case, we maintain consistency with EIA's forecast of total energy (or vehicle-miles traveled, VMT) consumed in the transportation sector.

Figure 3: Development of the NERA Reference Case

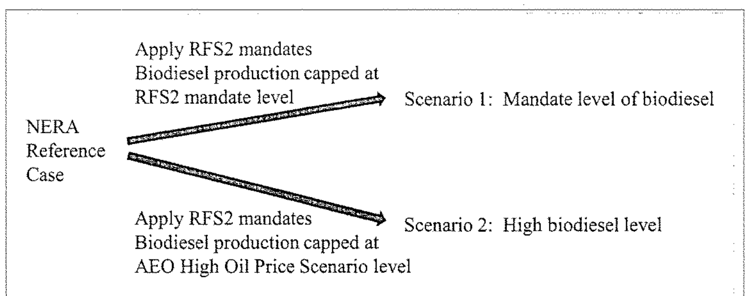


2. Modeling Scenarios

Our scenarios (Figure 4) used the same assumptions as the Reference Case with the added constraint that in each year obligated parties must comply with the RFS2 program requirements while still not violating the blend wall. A gallon of biodiesel is worth 1.5 RINs.

Also, the volume of biodiesel sales forecast in the EIA's Reference Case can only make up a percentage of biodiesel in diesel that is far below the B5 blending limit. Therefore, one way for obligated parties to increase the percentage of biofuels in their total fuel sales is to increase the amount of biodiesel they blend with conventional diesel. However, biodiesel production levels are quite uncertain.

Figure 4: Characterization of Scenarios 1 and 2



NERA developed two scenarios that differed only in their estimate of the availability of biodiesel supplies in the next four years (2012 through 2015). Scenario 1 limited use to no more than that proposed by EPA in their 2012 RFS2 NPRM. Scenario 2 limited biomass based diesel use to that forecast in the EIA AEO 2011 High Oil Price Scenario. These estimates are intended to bracket the likely range of biomass based diesel availability. The range of biomass based diesel availability is shown in Table 4.

- Scenario 1 – Biomass based diesel production is capped at the limit proposed by EPA in their 2012 RFS2 NPRM. This level reflects the levels used in the Phase I analysis.
- Scenario 2 - Biomass based diesel production capped at level in AEO 2011 High Oil Price Case.

Table 4: Range of Biomass Based Diesel Availability (Billions of Gallons per Year)

	2012	2013	2014	2015
Reference Case	0.92	1.07	1.07	1.23
Scenario 1	1.00	1.28	1.28	1.28
Scenario 2	1.35	1.74	1.66	1.90

Source: NERA analysis and EIA's Annual Energy Outlook 2011.

F. Model Parameters

1. Fuel Prices

All fuel prices are national, annual averages over multiple grades of fuel. Our Reference Case prices for finished products (gasoline and diesel) are the same as those forecast in the AEO 2011 Reference Case. The NERA Reference Case prices for individual types of biofuels were developed using a variety of sources and are expressed relative to petroleum gasoline or diesel prices. These relative prices are shown in Table 5, and the logic and sources upon which these relative prices are based are described below.[12]

Table 5: Reference Case Fuel Price Ratios for Blended Gasoline and Diesels (Ratio on a GGE[13] Basis of Biofuel to Conventional Fuel)[14]

	2010	2011	2012	2013	2014	2015
Gasoline	1.00	1.00	1.00	1.00	1.00	1.00
Corn Ethanol	1.86	1.78	1.72	1.61	1.58	1.49
Sugarcane Ethanol	2.08	2.00	1.92	1.81	1.77	1.67
Cellulosic Ethanol	2.62	2.48	2.41	2.23	2.13	2.01
Diesel	1.00	1.00	1.00	1.00	1.00	1.00
Soy-Based Biodiesel	1.74	1.66	1.7	1.66	1.65	1.64

Source: EIA's AEO 2011, EIA, California Energy Commission, IHS Glocal Insight, American Trucking Association, and NERA analysis.

12 The gasoline and diesel prices are taken from the AEO 2011 forecast.

13 Gasoline gallon equivalent basis; fuels GGE are adjusted by relative heating value to petroleum gasoline.

14 All price ratios are national, annual averages over multiple grades of fuel. For gasoline, the grades include regular unleaded, 89 octane unleaded, and premium unleaded.

Corn Ethanol:

- Ratio of corn ethanol to gasoline is from the AEO 2011 Reference Case, Table A12. We assumed a corn price equal to the average $/bushel price from January 1, 2008 through September 1, 2011 (or $5.00/bushel). We took the capital, operations, and maintenance costs from the EIA.[15] Summing up all of these costs yielded the forecasted price for corn ethanol.
- Sugar Ethanol: Ratio of sugar ethanol prices to gasoline prices taken from California Energy Commission statistics.[16]
- Cellulosic Ethanol: Ratio of cellulosic ethanol prices to gasoline prices based on EIA's cost build up.[17] To estimate this cost, we averaged two EIA forecasts – one based on the capital cost for cellulosic ethanol and the other based on the capital cost for biodiesel gasification. However, the future cost of cellulosic ethanol is uncertain.[18]
- Soy-Based Biodiesel: Ratio of soy-based biodiesel to petroleum diesel prices taken as average of historical spot prices. We calculated the averages based upon three sources: IHS Global Insight, the American Trucking Association's August 2011 comments on the EPA's proposed RFS2 rule, and the average ratio of spot SME B100 to spot ultra-low sulfur petroleum diesel from 2009 through 2011.[19]

2. Supply Elasticities

In addition, supply elasticities were derived by using fuel price and fuel supply information from EIA's AEO 2011 Reference and High Oil Price Cases. These two cases provided time series for the prices and quantities of the different fuels. The price elasticity of

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15 Statton, Mac, "Development of Production Costs as a Driver for the National Energy Modeling System," Energy Information Administration, Presentation at International Fuel Ethanol Workshop, June 29, 2011.

16 California Energy Commission, "2011 Integrated Energy Policy Report," February 2012.

17 Statton, Mac, "Development of Production Costs as a Driver for the National Energy Modeling System," Energy Information Administration, Presentation at International Fuel Ethanol Workshop, June 29, 2011.

18 Because we assume the RFS mandate for cellulosic ethanol will be waived, cellulosic ethanol is likely to be irrelevant in our analysis as long as its price is sufficiently greater than that of sugar ethanol, for sugar ethanol will be the ethanol of choice to meet the advanced biofuels mandate, and corn and sugar ethanol will be used in the production of E10 and E85 to help meet the overall biofuel requirement.

19 Kruse, John, "Biodiesel Production Prospects for the Next Decade," IHS Global Insight's Agriculture Group, March 2011; Moskowitz, Richard, "American Trucking Associations' comment on the EPA's proposed Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards," August 2011; and Chicago spot prices for ultra-low sulfur diesel and B100.

supply for each fuel is derived by dividing the percentage change in quantity of fuel demanded by the percentage change in fuel price. The percentage change in quantity and price are computed by comparing the difference between the fuel consumed and the price of fuel, respectively, in the AEO High Oil Price and Reference Cases. The elasticity of supply varies slightly from year to year, but on average, the elasticity of supply is about 0.4 for corn ethanol and 1.2 for sugar ethanol and soy-based biodiesel. The elasticity for petroleum fuels is 0.8.[20]

3. Demand Elasticities

The model has a demand curve for each finished fuel – E0, E10, E85, and diesel. The functional form of these curves is identical to that of the fuel supply curves. For the demand curves, the elasticity is the fuel's own-price elasticity of demand. Because this analysis concerns itself only with the next few years, the demand curves' elasticity equaled that of Dahl's estimate for short-term elasticity of -0.1.[21]

4. E85

Our characterization of the potential for E85 sales in the Phase II research is built upon the initial research on E85 performed as part of the Phase I study. The Phase I study evaluated the different factors affecting E85 demand. The Phase I research concluded that future demand for E85 is not limited by the number of FFVs, but instead factors such as consumer reluctance to purchase a new fuel and lack of infrastructure. Consumer reluctance stems from the lower fuel economy and limited range of E85. Economic theory suggests and the EPA acknowledges, E85 would have to be priced at a discount to gasoline to induce cost conscious FFV owners to buy E85 instead of gasoline. Progress in overcoming the lack of retail infrastructure is likely to be slowed by the relatively high investment costs and uncertain returns facing the parties that will be required to install the necessary infrastructure, particularly in the case of the numerous small and independent business people that own individual retail fuel stations.

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20 Paltsev, Sergey, John M. Reilly, Henry D. Jacoby, Rishard S. Eckaus, James McFarland, Marcus Sarofim, Malcolm Asadoorian, and Mustafa Babiker, "The MIT Emissions and Prediction and Policy Analysis (EPPA). Model Version 4," August 2005.

21 Dahl, C.A., "A survey of energy demand elasticities for the developing world," *Journal of Energy and Development* 18(I), 1—48, 1994.

For the Phase II analysis, our estimate of potential E85 availability is constructed based upon an optimistic set of assumptions about the issues affecting E85 sales. We assumed that there were no consumer acceptance issues. We assumed that new E85 retail stations would be strategically located in areas proximate to where FFV vehicles operated so that there was no distance penalty for FFVs to travel to an E85 station.

We based our estimates of potentially available E85 solely upon how quickly new E85 retail stations could be built. The Phase I research identified historical data on the level of new station construction. Table 6 shows the number of new stations built by year for the period from 2005 through 2011. During this period on average, there were about 340 stations built annually and the growth rate for new stations declined. For the period from 2012 through 2015 we optimistically assumed that new E85 station construction would grow at a rate of 25% per year. We also assumed that the volume of E85 sales per station would grow about 2.5 times during the period from 2012 to 2015. Table 7 presents our projection for maximum E85 sales as compared with the EIA's forecast of expected E85 sales.

Table 6: Number of E85 Stations Built Annually (2005 through 2011)

	# of E85 Stations	
	Total	Annual Change
2005	436	
2006	762	326
2007	1,208	446
2008	1,644	436
2009	1,928	284
2010	2,142	214
2011	2,442	300

Source: United States Department of Energy, Alternative Fuels Data Center, http://www.afdc.energy.gov/afdc/data/docs/alt_fueling_stations_fuel.xls.

Table 7: Sales of E85 (Billions of Gallons)

	2012	2013	2014	2015
AEO 2011 Forecast	0.06	0.07	0.08	0.09
Maximum Potential E85 Sales	0.54	0.99	1.7	2.6

Source: EIA's AEO 2011, NERA N_{ew}ERA model results.

5. RIN Banking

RIN banking in this report represents how surplus RINs can be carried from one compliance period to the next by an obligated party. Based upon EIA's AEO 2011 Table 11, we estimated that as of the beginning of January 2012, there were collectively 1.69 billion surplus RINs available. We refer to these RINs as the initial inventory of RINs available for compliance.

To arrive at this estimate, we first analyzed how many RINs were available at the end of 2010, which was the first year the policy was in effect and then assessed how many RINs were carried forward from 2010 to 2011 and then from 2011 to 2012.

The AEO 2011 shows that for 2010 13.64 billion RINs were generated in the U.S.[22] The mandate requires 12.95 billion RINs for 2010; hence there was a surplus of 0.69 billion RINs. Since 0.69 billion RINs represents less than 20% of the target renewable fuel volume, all surplus RINs could be banked or carried forward for use in the following year. Therefore, we assume that at the beginning of 2011, there were 0.69 billion RINs available to be used. In 2011, the EIA estimates that 14.95 billion RINs were generated in the U.S., while only 13.95 billion RINs were needed to comply with the regulation. Therefore, there would have been a surplus of 1billion RINs for 2013 (again this is less than 20% of the target so the full quantity could be banked). Adding this to the beginning of the year bank yields a 2011 end-of-year bank of 1.69 billion RINs. This figure becomes the number of RINs in the bank at the beginning of 2012 (Table 8).

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[22] AEO 2011, Table 11. Ethanol production is equivalent to 13.18 billion physical gallons (13.18 billion RIN gallons) and biodiesel production is equivalent to 0.31 billion physical gallons (0.465 billion RIN gallons).

Table 8: Computation of Available RINs at the Beginning of 2012 (Billions)

	2010	2011	2012
RINs Available at the Beginning of the Year	0.00	0.69	1.69
RFS2 Total Renewable Fuel required	12.95	13.95	15.20
RINs Generated	13.64	14.95	
Surplus RINs at End of Year	0.69	1.00	
20% Max RIN Carryover Allowed into Next Year	2.79	3.04	
RINs Available at the End of the Year	0.69	1.69	

Source: EIA's AEO 2011 and NERA analysis.

6. Cellulosic Biofuel

As discussed earlier, EPA can waive the RFS2 requirement, in whole or in part, if there is an inadequate supply to meet the mandate. With respect to the cellulosic biofuels mandate, there is an established track record by EPA of substantially reducing the cellulosic biofuel requirement because of the lack of commercially-available production. In 2010 and 2011, there were no cellulosic biofuel RINs generated. For 2012, EPA has reduced the requirement for cellulosic biofuels to less than 10 million gallons from the 500 million gallons required under RFS2.

As a result of the lack of progress in developing commercially-available supplies of cellulosic biomass and the technical and economic hurdles that remain with the production of cellulosic ethanol, and the time required to build and put into service biomass-to-liquids facilities,[23] we concluded that it was unlikely that cellulosic biofuels will be used in any appreciable quantities during our forecast horizon.

7. Other Fuel Constraints and Assumptions

The Reference Case imposed both the gasoline blend wall (no more than 10% ethanol) as well as the biodiesel blend limit (no more than 5% biodiesel). We allowed petroleum gasoline either to be blended with ethanol to make E10 or E85, or to be sold as neat gasoline (E0). A review of EIA data from May 2008 through April 2012 showed that E0 reached a low of about 5% in April 2012. The more gasoline that is used to produce E0 means that there is less to be

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[23] Phase I report, p. 16.

blended with ethanol, and hence the more difficult it would be to comply with RFS2. To be conservative in our assessment of the compliance costs of RFS2, we assume that in the Reference Case, the share of gasoline used to produce E0 can drop to as little as 5%. This is consistent with April 2012 data generated by EIA.[24]

G. Analytical Methodology

The two scenarios were analyzed using NERA's transportation fuel model, which allowed us to simulate the dynamics of the RIN banking and the methodology that EPA uses each year to determine the minimum percentage of the different categories of biofuels delineated in the RFS2 standard that fuel suppliers must use. The transportation fuel model determined the impact of the RFS2 mandate on the transportation sector using the quantities of finished gasoline (E0, E10, and E85) and diesel consumed. In addition, the model calculated volumes of individual biofuels blended in the finished gasoline (corn ethanol, sugar ethanol, and cellulosic ethanol) and diesel (biodiesel). The N_{ew}ERA macroeconomic model then determined the impact on the U.S. economy of meeting the RFS2 mandate. The results are expressed in terms of common economic parameters: changes in GDP, labor earnings, and consumer purchasing power.

[24] EIA Weekly Refiner and Blender Net Production data available at: http://www.eia.gov/dnav/pet/pet_pnp_wprodrb_dcu_nus_w.htm. Access date: May 31, 2012.

IV. Results

A. The Dilemma with RFS2

There is a fundamental problem with the RFS2 mandate: the blending percentage standard for total renewable fuel will eventually exceed the maximum feasible level of renewable fuel that can be contained on average in a gallon of transportation fuel given the technological, market, and infrastructure constraints in the economy.

In 2015, the total renewable fuels volume mandate requires that renewable fuels make up 11% of the total gallons of transportation fuel sold (see Table 9). This exceeds the volume that can be blended in E10 and diesel, which comprise more than 95% of the fuel market.[25] The only transportation fuel with a renewable fuel blending percentage above 11% is E85, but as was discussed earlier, it is unlikely that more than 2.6 billion gallons could be sold in 2015 when the total transportation fuel demand is estimated to be approximately 180 billion gallons.

Table 9: RFS2 Mandated Total Biofuels Percentage and the Maximum Percentage of Renewable Fuel in Finished Fuel in Diesel, E85, and E10

	2012	2013	2014	2015
RVO as Percentage of Total Finished Fuel Sales	8.4%	9.0%	9.8%	11.0%
Max Diesel Biofuel % (Blending biodiesel at 5% is accounted as 7.5% for compliance with total renewable fuel volume standard)	5.0%	5.0%	5.0%	5.0%
Max E85 Biofuel %	74.0%	74.0%	74.0%	74.0%
Max E10 Biofuel %	10.0%	10.0%	10.0%	10.0%

Source: NERA assumptions and analysis.

In order to meet the RFS2 target in 2015, RINs that were banked in prior years must be used. However, as the banked RINs become exhausted, the value of RINs will increase as will the cost

[25] E10 can contain no more than 10% ethanol. E85 is assumed to contain 74% ethanol on an annual average basis. Diesel can contain no more than 5% biodiesel. Biodiesel, however, earns 1.5 RIN credits for each gallon, so a 5% volumetric blend equates to 7.5% biodiesel on a RIN basis.

of gasoline and diesel. This will result in the drastic cut in sales of diesel, E10, and E0 so that E85 becomes a much larger share of the transportation fuel market.[26]

B. RFS2 Implementation

RFS2 requires that at the end of each year, obligated parties have enough RINs to meet their RVO. An obligated party can increase its number of RINs by increasing the amount of biofuels blended into its current fuel volumes. Additionally, an obligated party can acquire RINs by purchasing either biofuel from a biofuel producer or RINs from another obligated party. The lack of surplus RIN supply results in high RIN value and reduced total fuel demand so that the ratio of RINs to physical gallons increases. Conversely, if additional RINs are not available for purchase, an obligated party may have no option other than to reduce its total volume of fuel produced so that its current stock of RINs is sufficient to meet its RVO. It is likely that over time an obligated party would be forced to do some combination of both acquiring surplus RINs and reducing the volume of fuel produced to meet its RVO.

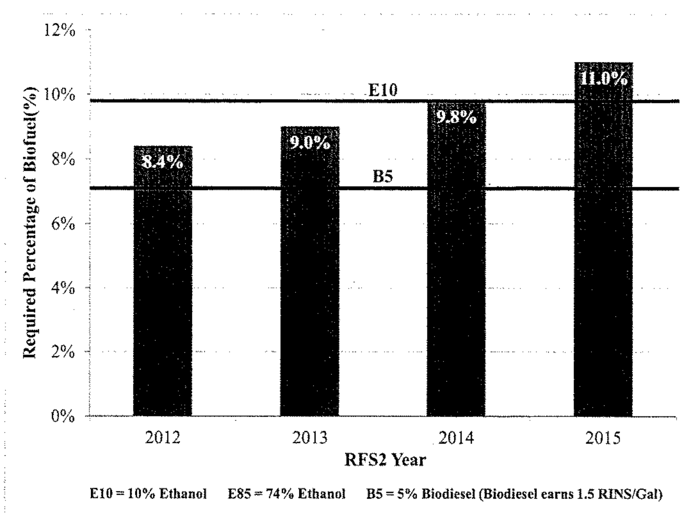
Each obligated party will choose its optimal compliance path based upon the cost of RINs, the market response to changes in fuel cost, technology limitations on blending biofuels with petroleum, and infrastructure and consumer acceptance issues surrounding increasing E85 sales. An obligated party may first try to blend more biofuels into its transportation fuels in order to acquire RINs. For the motor gasoline fuels, this increase is accomplished by increasing the share of ethanol in motor gasoline by blending more ethanol into conventional gasoline (limited by the blend wall), increasing production of E10 in the early years, or increasing production of E85. For diesel, increasing the content of biofuels means adding more biodiesel into the finished diesel fuel (limited by a 5% blending maximum). The ability of obligated parties to increase the blending percentage of biofuels is limited by the availability of biodiesel, blending and infrastructure constraints, and the size of the E85 market.

Producing E85 gives obligated parties the greatest surplus RINs per gallon of fuel sold. E10 gallons generate a small amount of surplus RINs through 2014. On the other hand, diesel

[26] In our analysis the ethanol blend wall is reached in 2012-2013. However, the severe economic impacts do not occur until 2015-2016. The reason is that in 2012 – 2014 obligated parties acquire as many RINs as is feasible in anticipation of being unable to meet the RFS2 requirements in later years. The result is that the excess RINs postpone the severe economic impacts that result when obligated parties can no longer acquire the number of RINS required to comply with RFS2 mandated volumes and thus are forced to limit supplies of gasoline and diesel.

always generates a deficit in RINs. Obligated parties that sell diesel in the U.S. must always acquire additional RINs beyond those generated through biodiesel blending because the percentage of biodiesel in diesel is below the total renewable fuels blending percentage obligation. Increasing the biodiesel content in finished diesel reduces the number of RINs that need to be purchased to offset the deficit. Hence all available biodiesel supplies are purchased by obligated parties, but biodiesel supplies are limited.

Figure 5: RIN Obligations



Source: NERA analysis.

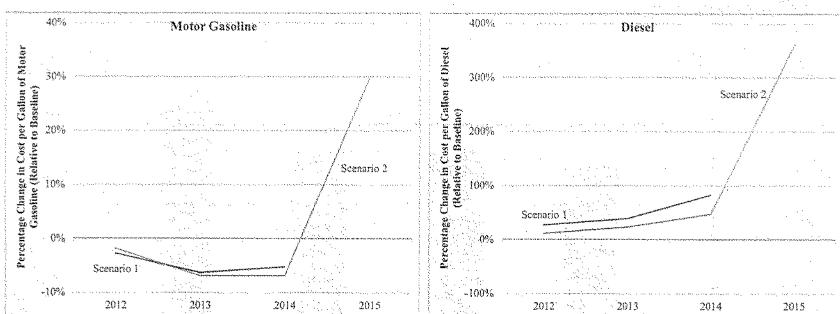
As a result, diesel can be thought of as incurring a RIN deficit and gasoline, for the first few years at least, as creating a surplus of RINs. The value of RINs that must be purchased separately is reflected in the cost of the finished gasoline or diesel.[27] If a fuel requires the purchase of RINs, such as with diesel, the cost of the finished product will increase. If the

[27] The value of a gallon of diesel equals the cost to produce diesel plus the price of additional RINs that must be purchased to meet the blending percentage standard. The value of gasoline (E10 or E85) equals the cost to produce E10 or E85 less the price of excess RINs that the fuel generates and can be sold. The RIN market equilibrates at the point where the marginal value of selling one more gallon of diesel equals the value of selling one more gallon of E10 or E85.

production of a fuel generates surplus RINs that can be sold, such as with E85 and E10 early on, then the cost of the finished product will decrease.

By 2015, however, E10 is no longer generating surplus RINs. In fact, it cannot generate enough RINs to meet its own blending percentage obligation. As a result, the gasoline cost increases significantly reflecting the shortage of RINs available (see Figure 6).

Figure 6: Percentage Change in Cost per Gallon of Motor Gasoline and Diesel



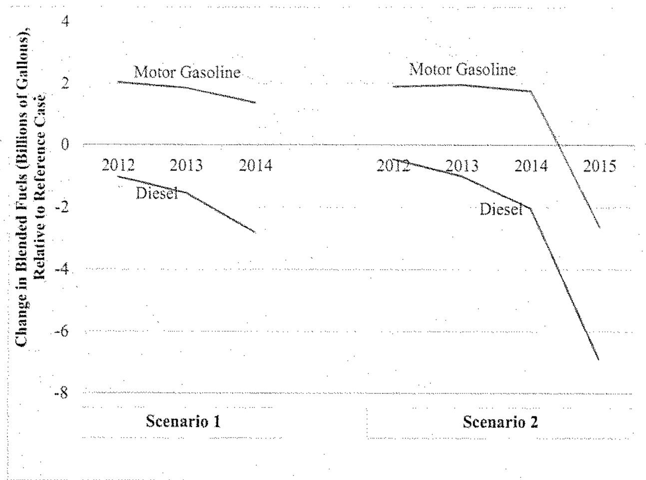
Source: NERA N_{ew}ERA model results.

As RINs become scarcer, fewer gallons of fuels that require additional RINs can be produced. Since the economy still demands these transportation fuels, the value of the RIN will increase to the point that the cost of the fuel, which includes the cost of the necessary RINs, results in the demand equilibrating with the supply of fuel. Consequently the cost to produce fuels that require the purchase of additional RINs increases (*e.g.*, diesel), and the cost to produce fuels that generate surplus RINs declines (*e.g.*, E85).

Diesel costs increase by 45% to 80% in 2014 for Scenarios 2 and 1, respectively; and the cost of diesel increases by over 300% in 2015 in Scenario 2. These cost increases match up with a drop in sales of 2 to 3 billion gallons in 2014 for Scenarios 2 and 1, respectively; and a decline of 7 billion gallons in 2015 for Scenario 2, which represents a decline of over 15% from the Reference Case.

On the other side, blended fuels that generate surplus RINs experience a decline in fuel costs, which induces greater sales. Motor gasoline sales increase by roughly 2 billion gallons from the Reference Case for all years between 2012 and 2014. In 2015, motor gasoline sales decline by at least 3 billion gallons from Reference Case levels (see Figure 7).

Figure 7: Change in Blended Fuels Sales (Motor Gasoline and Diesel)



Source: NERA $N_{ew}ERA$ model results.

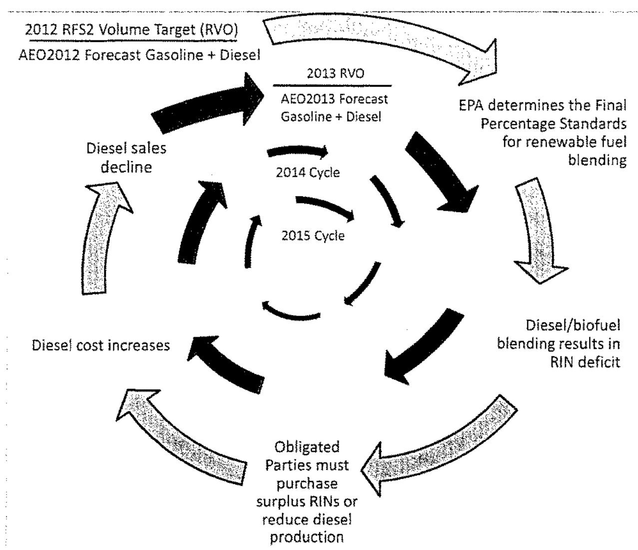
However with time this approach of increasing E10 sales and reducing diesel sales to comply is not sustainable. As illustrated in Figure 5, the originally targeted blending percentage standard for total renewable fuel[28] increases with time. From 2012 through 2014 the blending percentage standard is less than 10%, which is lower than the gasoline blend wall limit. But as the blending percentage standard increases, this contribution of E10 to producing surplus RINs shrinks. This shrinkage occurs at the same time that the gap increases between the total RVO and the total RINs collected from blending biodiesel. In other words, as fewer excess RINs are being generated more RINs are demanded. Thus to comply with the total biofuels mandate the reduction in diesel sales would become so large that it would lead to such severe rationing of diesel so as to cause extreme disruption in the commercial transportation sector. It is this growing gap between RIN supply and RIN demand that causes the approach to be unsustainable by 2015-16.

[28] Originally targeted blending percentage standard equals the total renewable fuel volume as required by EISA '07 divided by EIA's 2011 forecast for transportation fuel demand.

C. Diesel Death Spiral

An unintended consequence of the regulatory procedures for determining compliance is the potentially self-destructive way in which the annual blending percentage standards are determined. Figure 8 schematically presents the series of steps which result from EPA setting greater blending percentage obligations that cause an increasingly steep decline in diesel sales and lead to unattainable compliance obligations and supply disruptions.

Figure 8: Progression of the Diesel Death Spiral



As specified in EISA '07, each year EPA calculates the next year's blending percentage standards as the ratio of the targeted biofuel volumes to the EIA's forecast for total transportation fuel sales in the next year. To comply with the blending percentage obligations, obligated parties have several options:

- Sell more E85;
- Increase the ethanol content in gasoline;
- Sell less E0; and
- Increase the biomass-based diesel content in diesel.

Each of these options has limitations. As the Phase I study concluded, there is limited consumer acceptance of E85 and limited infrastructure from which to dispense E85. The blending of ethanol into gasoline is restricted by the blend wall. Higher ethanol blends such as E15 are unlikely to be widely sold in the near future. E0 sales are unlikely to fall below 5% of total gasoline sales in the next several years, and there is a limited amount of biodiesel that can be cost-effectively produced.

In order to meet the blending percentage obligation, obligated parties would be forced to change the mix of fuels they sell to the extent that is possible in order to acquire enough RINs to meet the RFS2 mandates. All obligated parties would sell as much E85 and blend as much biodiesel into diesel as possible because of the relatively high RINs per gallon these actions generate: 0.74 RINs per gallon of E85 (typical), which compares to only 0.1 RINs for E10 and zero for E0. Biomass based diesel earns 1.5 RINs/gallon, or 0.075 RINs, when blended to make a gallon of B5.

The difference between the renewable fuel volumes mandated by the RFS2 program and the RINs generated through blending of biofuels into finished products represents the surplus or shortfall in RINs. If obligated parties continued to supply the same volumes of gasoline and diesel fuel, they would not be able to blend enough biofuel, or purchase enough surplus RINs, to remain in compliance with RSF2. This shortage in RINs puts upward pressure on RIN values (Table 10). For Scenario 1, in 2015 the program becomes infeasible, so there is no RIN value listed in the table.

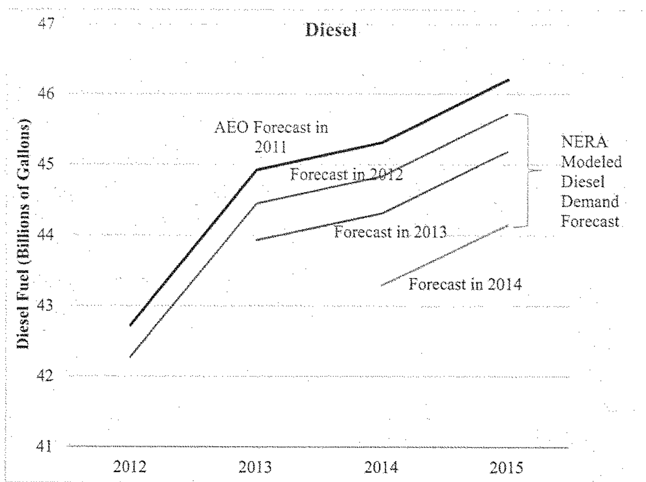
Table 10: RFS2 Mandated Total Biofuels Percentage and Associated RIN Values

	2012	2013	2014	2015
Renewable Volume Obligation as Blending Percentage	8.4%	9.0%	9.8%	11.0%
RIN value Scenario 1 (2010$/RIN)	$10	$14	$27	Note 1
RIN value Scenario 2 (2010$/ RIN)	$5	$10	$17	$100

Note 1: Model solution for Scenario 1 in the year 2015 was infeasible.
Source: NERA analysis and N_{ew}ERA model results.

The cost of the RINs is borne by the obligated party and leads to higher costs and lower sales (effectively rationing) for fuels that require additional RINs. The cost of RINs also depends on the supply of RINs, which depends greatly on the supply of excess RINs from gasoline sales. During the first few years, the result is that the cost of diesel increases because this fuel requires RINs and the cost of E10 and E85 declines since these fuels produce excess RINs. The higher cost dampens demand for diesel, which results in the EIA lowering its forecast for diesel sales. The lower forecast for demand, means that the next year's blending percentage obligation becomes higher than it would have been, resulting in additional pressure on obligated parties who blend diesel to acquire even more RINs. This process repeats each year. The reduced diesel demand forecasting is depicted in Figure 9. The top black line represents the AEO diesel demand for 2011. As the cost of diesel rises, demand declines in subsequent years. The declining demand forecasted through NERA modeling is shown in order for 2012, 2013, 2014 years by the blue, red, and green lines, respectively.

Figure 9. Declining Diesel Demand Forecasting (2012 – 2015)



Source: NERA N_{ew}ERA model results.

Eventually the RFS2 total renewable fuel target increases to the point that it is no longer possible to satisfy the mandate through the available compliance mechanisms. As a result, the blending percentage obligation becomes infeasible.

D. The Role of Banked RINs

Table 11 displays the shortfall or surplus of RINs from selling a gallon of diesel, E10, or E85. The shortfall for diesel depends on the scenario studied, because the amount of biodiesel differs by scenario. Under Scenario 2, more biodiesel is available and consequently blended with petroleum diesel to yield more RINs per gallon of finished diesel than in Scenario 1. Since the E10 blend wall is reached in both scenarios for all years, the RIN shortfall and surplus are the same across scenarios as is the E85 RIN surplus. The level of E10's RIN deficit or surplus suggests how great demand for previously banked RINs will be.

Table 11: RIN Deficit or Surplus per Gallon of Fuel Sold (RIN/Gallon of Fuel)

		2012	2013	2014	2015
Diesel	Scenario 1	-0.048	-0.045	-0.053	
	Scenario 2	-0.036	-0.030	-0.040	-0.038
E10	Both Scenarios	0.016	0.010	0.002	-0.010
E85	Both Scenarios	0.66	0.65	0.64	0.63

Source: NERA N_{ew}ERA model results.

One way obligated parties may lessen the problems created by the gap between maximum RINs generated by blending B5 diesel and the total renewable fuel blending percentage obligation is to purchase or use RINs that have been banked from previous years. Depending upon the circumstances in a given year, obligated parties may choose to either acquire additional RINs or use RINs that they acquired in the previous year. The availability of RINs reserved for later use depends critically on the surplus RINs generated through the production of E10.

Table 11 shows that the surplus RINs decline dramatically to almost zero in 2014 and becomes negative in 2015. Therefore, in the first two years, it may be possible to increase the number of banked RINs, but by 2014 only sales of E85 would contribute anything meaningful to the surplus RIN supply. From 2014 surplus RIN inventories would be drawn down in an effort to make up for the shortfall in RINs created by diesel sales.

Table 12 shows the decline of surplus RINs over time. The table illustrates that in the early years obligated parties will acquire more RINs than they need for compliance (*i.e.*, they will add RINs to their RIN bank) and use these banked RINs in the later years: from 2013 onward in Scenario 1 and from 2014 onward in Scenario 2. This market behavior is reflective of the value of RINs early on being relatively inexpensive compared to the value of RINs later when the RFS2 mandates become more stringent. The total of cumulative banked RINs increases until 2013 in Scenario 1. In Scenario 2 the total increases until 2014 because there are more RINs available from the blending of biodiesel into finished diesel in Scenario 2. The subsequent exhaustion of the RIN surplus portends an impending collapse in terms of the RFS mandate leading to an infeasible outcome in the fuels market.

Table 12: Cumulative Total of Surplus Banked RINs in Billions

		Scenario 1	Scenario 2
2012	Starting RIN Surplus	1.69	1.69
	Surplus RINs Produced	0.16	0.67
	RINS Used	0.00	0.00
	End of Year RIN Surplus	1.85	2.36
2013	Starting RIN Surplus	1.85	2.36
	Surplus RINs Produced	0.00	0.29
	RINS Used	0.40	0.00
	End of Year RIN Surplus	1.45	2.65
2014	Starting RIN Surplus	1.45	2.65
	Excess RINs Produced	0.00	0.00
	RINS Used	1.45	0.92
	End of Year RIN Surplus	0.00	1.73
2015	Starting RIN Surplus	NA	1.73
	Surplus RINs Produced	NA	0.00
	RINS Used	NA	1.73
	End of Year RIN Surplus	NA	0.00

Source: NERA N_{ew}ERA model results.

E. RFS2 Program Will Eventually Fail

With time the RFS2 requirements become more stringent and options for complying become more limited: the blend wall is encountered, E85 is sold at maximum levels, and biodiesel production is fully exhausted. The result is that the demand for RINs exceeds the supply, which causes RIN values to increase and obligated parties to draw down their bank of RINs. Eventually the surplus of RINs is depleted (Table 12).

With surplus RINs depleted at the end of 2014 for Scenario 1, obligated parties must meet the total biofuels obligation percentage of close to 11% in 2015 through the blending and sale of E0, E10, E85, and B5 diesel. There are no surplus RINs from previous years that can be used. The 11% RVO target exceeds the ethanol content in E10, which means that E85 sales must greatly increase to make up for the shortfall. But the market infrastructure and consumer acceptance limits E85 sales causing surplus RINs from E85 sales to be scarce. To remain in compliance, obligated parties would have to drastically curtail their sales of diesel and E10. Table 13 shows that if the supply of gasoline and diesel were reduced by over 50% from the EIA's Reference Case, then obligated parties could comply with RFS2. Clearly, this is an infeasible result. In addition, this result leads to far fewer biofuel gallons (9.4 billion gallons) being sold compared with the 2015 RFS total renewable fuel volume mandate of 20.5 billion gallons. As reported in Table 10, the model solution was infeasible for 2015 for scenario 1. Table 13 illustrates the unrealistic changes in fuel consumption that would have to take place for the RFS2 policy to be achievable.

Table 13: RFS2 Collapse for Scenario 1

	Renewable Fuel per Gallon (%)	Fuel Sales (Billion Gallons)	RINs (Billions)	EIA Reference Scenario 2015 Levels (Billion Gallons)	% Reduction in Fuel Scenario 1 vs. EIA
Obligation %	11.0%				
E85	74%	2.6	1.9		
Diesel	7.5%	20	1.5		
E10	10%	60	6.0		
E0	0%	3.0			
Motor Gasoline				140	53%
Diesel				46.2	57%
Total		85.6	9.4	186.2	

Source: NERA N_{ew}ERA model results.

In scenario 2, this infeasibility is delayed until 2016 because the additional biodiesel supplies allow about 1.7 billion RINs to be carried forward from 2014 and to be used in 2015.

Exhausting the bank of RINs in 2015 fails to prevent the escalation of diesel costs, and they increase by over 300% from the Reference Case.

F. Economic Impact of RFS2

The macroeconomic impacts of the RFS2 mandate on the U.S. economy were estimated through the year 2015. The estimates show that the increasing demand for and escalating cost of RINs causes dramatic increases in the cost of diesel and ultimately, the cost of gasoline by 2015. These higher costs ripple through the economy, collectively harming economic growth.

From 2012 through 2014, the higher diesel fuel costs increase the cost to move raw materials and finished goods about the country. This increased cost will be passed through to consumers of finished goods and services. As a result, consumption of goods and services declines. The lower gasoline prices in this time period slightly offset the negative impacts on consumption from the higher diesel prices.[29]

In the 2012 to 2014 time frame, labor earnings increase, but their increase is modest compared to the loss in consumption, as labor earnings are unable to offset the higher costs for goods.[30] In the near term, investment and production is temporarily accelerated in anticipation of rising costs, and GDP increases, but this shift is unsustainable. By 2014 GDP declines by more than $250 billion.

In 2015, the economic impacts worsen. In addition to the negative impact of higher costs for finished goods and services caused by rising diesel fuel costs, gasoline costs increase relative to the baseline as a result of RSF2. Consumers are left with fewer dollars to spend on other goods and services resulting in lower consumption. Lower consumption translates into less need for the production of other goods and services that consumers would have otherwise purchased.

The combined effect of less money consumers have available to spend with the higher cost for finished goods and services means that consumption declines even further. By 2015, consumption per household declines by about $2,700 per year and total consumption declines by about $340 billion. Since there is lower demand for finished goods and services, there is less need for workers to provide those goods and services. As a result, workers would earn $584

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[29] Consumers are affected by higher diesel prices which are reflected through increases in the costs of goods and services.

[30] Increases in biofuel production lead to increases in labor demand.

billion less as a result of the smaller size of the economy resulting from the implementation of RFS2 (Table 14). These negative impacts are also expressed by the loss in GDP of $770 billion.

Table 14: Changes in Consumption per Household, Consumption, Labor Income and GDP Relative to Baseline (2010$s)

	2012	2013	2014	2015
Change in Average Consumption per Household ($/Household)	-$1,200	-$1,200	-$1,300	-$2,700
Change in Consumption (Billions of $s)	-$150	-$140	-$160	-$340
Change in Labor Income (Billions of $s)	$24	$42	$27	-$580
Change in GDP (Billions of $s)	$43	$50	-$270	-$770

Source: NERA N_{ew}ERA model results.

V. Conclusions

The RFS2 mandate as currently written is likely infeasible given the current technological, infrastructure and market constraints of the transportation sector. The fuel capability of the existing fleet, the infrastructure of the fuel distribution system and limited compliance mechanisms are some of the factors that undermine the viability of the RFS2. As obligated parties seek to comply with the RFS2, the mandates lead to unintended consequences that have dramatic and potentially long-term negative impacts on the motor fuel industry's ability to meet market demand and on the economy as a whole. As it becomes increasingly difficult for obligated parties to generate sufficient RINs to comply with the blending percentage obligation targets from RFS2, very large increases in transportation fuel costs ripple through the economy causing negative macroeconomic impacts. Depending on biodiesel availability, this collapse occurs in 2015 to 2016 timeframe. By 2015, the adverse macroeconomic impacts include a $770 billion decline in GDP and a corresponding reduction in consumption per household of $2,700.

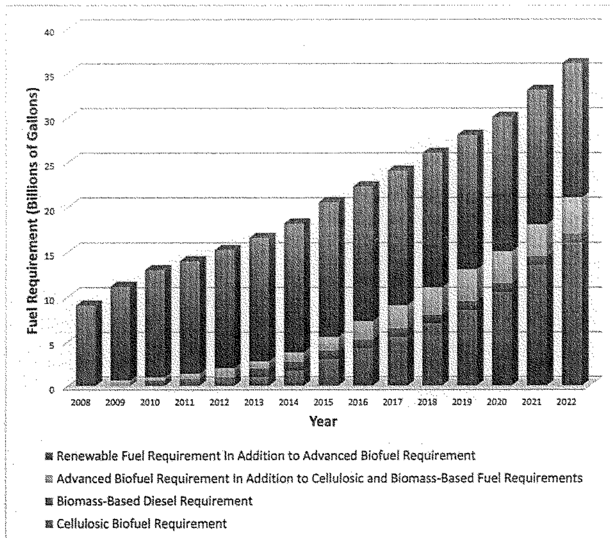
Appendix A: Renewable Fuels Standard Description

A. Renewable Fuel Standard (RFS2)

Congress first established a Renewable Fuel Standard (RFS1) in 2005 with the enactment of EPACT. Two years later, Congress passed EISA '07 which included RFS2 that increased the volume mandates of renewable fuels and expanded the transportation fuel mix beyond gasoline.

RFS2 became effective in 2010 and applies to all transportation fuel used in the United States—including diesel fuel intended for use in highway motor vehicles, non-road, locomotive, and marine diesel. As shown in Figure 10, RFS2 consists of four nested mandates for the minimum volume of renewable fuels contained in the transportation fuels sold in the United States. These mandates increase each year, and collectively, require the use of 36 billion gallons of renewable fuels in 2022.

Figure 10: EISA '07 Renewable Fuel Standard 2008-2022



Notes:
Cellulosic biofuel requirments were reduced per waiver approval by EPA for 2010-2012:
2010: 100 million gallons reduced to 6.5 million gallons
2011: 250 million gallons reduced to 6.6 million gallons
2012: 500 million gallons reduced to 8.65 million gallons

Biomass-based Diesel requirement for 2013-2022 has yet to be determined by the EPA but shall be no less than 1 billion gallons. This graph assumes 1 billion gallons per year in 2012-2022.

Each of the four nested mandates (biofuel categories) has its own lifecycle GHG minimum emission reduction requirements and annual volume mandate.

- Total renewable fuel is produced from renewable biomass and must reduce GHG emissions by at least 20% from the baseline value.
- Advanced biofuel is a subcategory of renewable fuel having a lifecycle GHG emission at least 50% less than the baseline value.
- Biomass-based diesel is a subcategory of advanced biofuel, and includes biodiesel or renewable diesel fuel having a lifecycle GHG emission at least 50% less than the baseline value.
- Cellulosic biofuel – a subcategory of advanced biofuel, and includes fuel produced from cellulose, hemicelluloses or lignin and having a lifecycle GHG emission at least 60% less than the baseline value.

Because of the nested nature of the biofuel categories, any renewable fuel that meets the requirement for cellulosic biofuels or biomass-based diesel is also valid for meeting the overall advanced biofuels requirement. Similarly, any renewable fuel that meets the advanced biofuel requirement is also valid for meeting the total renewable fuel mandate.

By November 30 of each year, EPA sets for the following year the blending percentage standard for total renewable fuel, advanced biofuel, biomass-based diesel, and cellulosic biofuel by dividing the volumetric mandates for each biofuel category by the projected annual transportation fuel demand forecasted by EIA.

Renewable fuel producers and importers generate credits in proportion to the amount and type of renewable fuel produced/imported – these credits are called RINs.

Transportation fuel producers and importers ("obligated parties") must acquire sufficient RINs to demonstrate compliance. Their compliance requirement is based on the amount of gasoline and diesel they refine or import. The number of required RINs, for each renewable fuel category, is calculated by multiplying the blending percentage standard for that year as set by EPA with the volume of gasoline or diesel obligated parties produce or import in that year.

Fuels sold that contain less than the blending percentage standard incur a RIN deficit, and fuels that contain more than the blending percentage standard accrue surplus RINs. The overall annual blending percentage standard is met if the surplus RINs generated from fuels containing greater than the required percentage are sufficient to offset the RIN deficits from fuels containing less than the required percentage. An obligated party is in compliance with RFS2 if its supply of RINs for each of the four renewable fuel categories equals or exceeds its fuel sales times the EPA's stated blending percentage standard for each renewable fuel category.

Fuels currently sold into the U.S. market include E0 and E10 gasoline, B0 and B5 diesel and E85, an alternative fuel containing greater than 50% ethanol by volume. E10 is the predominant fuel in the market, when the ethanol volume requirement is greater than what can be achieved by blending E10, the E10 blend wall has been reached, and the blend wall will restrict the greater use of renewable fuels.

Most biodiesel fuel is consumed in blended diesel fuels in which petroleum-based diesel fuel constitutes 95 percent or more of the blend by volume. The most common of such blends is B5 (five percent biodiesel by volume). Most diesel engine manufacturers and automakers continue to recommend the use of blends not greater than five percent. These requirements effectively create a B5 blend limit that is analogous to the E10 blend wall.

Original equipment manufacturers design and warranty engines and vehicles consistent with the E10 specification. Vehicle manufacturers have stated that use of fuels with higher ethanol content would void their warranty on existing vehicles with the exception of FFVs, which can accommodate ethanol gasoline blends with as much as 85% by volume ethanol.

EPA has approved two partial waivers, that together, allow E15 in vintage 2001 on-road vehicles and newer. For reasons described in the report, however, volumes of E15 are not considered to be materially significant. For example, the EIA in its recent Short-Term Energy Outlook assumed zero E15 demand in 2012 and 2013.[31]

[31] "This forecast assumes that E15 (gasoline blended with 15 percent ethanol by volume) does not yet reach the market. Consequently, U.S. ethanol production is projected to exceed the volume that can easily be used in the U.S. liquid fuels pool, so the Nation will continue to be a net exporter of ethanol over the next two years." Energy Information Administration, Short Term Energy Outlook, p. 10, May, 2012.

Appendix B: Detailed Model Description

This analysis used the linked system of NERA's proprietary bottom-up transportation fuel model and its N_{ew}ERA macroeconomic model. This section describes these two models.

A. Transportation Fuel Model

The transportation fuel model is a partial equilibrium model designed to estimate the amount of fuel produced for and consumed by the transportation sector with and without the RFS2 mandate in place. The model maximizes the sum of consumers' and producers' surplus subject to meeting the RFS2 program fuel requirements and satisfying the transportation sector's demand for fuel while not violating any transportation sector infrastructure constraints.

1. Input Data Assumptions for the Model Baseline

The fuel sales forecast for the gasoline market is based upon the AEO 2011 Reference scenario. Table 15 reports the EIA's forecast for petroleum gasoline and ethanol sales as well as E85. To be optimistic about the ability of obligated parties to meet the RFS2 mandate, we assume that the level of E0 sales is only five percent of the total petroleum gasoline sales. Until recently, this percentage has been above 10% (see Phase I report). Applying this assumption to the AEO's forecast yields the following forecast for E0, E85, and petroleum and ethanol in the remaining motor gasoline fuel (Table 15).

Table 15: September 2011 STEO and AEO 2011 Reference Scenario – Sales of Gasoline Fuels (Billions of Gallons, Unless Otherwise Noted)

Fuel (Billions of Gallons or %)	2012	2013	2014	2015
E0	6.28	6.29	6.28	6.27
Petroleum in E10	119.24	119.54	119.40	119.22
Ethanol in E10	15.01	15.25	15.48	15.72
% Ethanol in E10	**11.2%**	**11.3%**	**11.5%**	**11.7%**
E85	0.06	0.07	0.08	0.09

Source: EIA's AEO 2011 and EIA's STEO September 2011.

The fundamental problem with the EIA's forecast is that the percentage of ethanol in E10 exceeds the blend wall of 10%. In 2012, the share of ethanol in E10 is forecasted to be 11.2%. To eliminate this infeasibility, we adjusted the sales of ethanol and petroleum in E10 so that the modified E10 would comply with the E10 blend wall while the overall total energy content in motor gasoline remained the same. That is, the forecast used in the model maintains the total energy demanded on an MMBtu basis for travel (Table 16).

Table 16: NERA Reference Case Sales of Gasoline Fuels (Billions of Gallons Unless Noted Otherwise)

Fuel (Billions of Gallons or %)	2012	2013	2014	2015
E0	6.28	6.29	6.28	6.27
Petroleum in E10	120.35	120.77	120.79	120.78
Ethanol in E10	13.37	13.42	13.42	13.42
% Ethanol in E10	10.0%	10.0%	10.0%	10.0%
E85	0.06	0.07	0.08	0.09

Source: NERA Analysis.

The AEO's 2011 forecast without modifications is used for the petroleum diesel and biomass based diesel sales forecast (Table 17).

Table 17: NERA Reference Case Sales of Diesel Fuels (Billions of Gallons)

	2012	2013	2014	2015
Petroleum Diesel	41.8	43.9	44.2	45.0
Biomass based diesel	0.92	1.07	1.07	1.23
Effective Biodiesel %	2.2%	2.4%	2.4%	2.7%

Source: EIA's AEO 2011 and NERA analysis.

For the forecasts for the volume of biofuel components in motor gasoline, we disaggregate the ethanol production into corn, cellulosic, and sugar ethanol (see Table 18). Sugar ethanol consumption is based on the Food and Agricultural Policy Research Institute's (FAPRI's) 2011 Outlook. We use the EIA's forecast for cellulosic ethanol. Corn-based ethanol equals the sum of ethanol used in E10 and E85 less cellulosic and sugar ethanol consumption.

This assumption is optimistic because it gives higher volumes for sugar ethanol. Ethanol use in E10 and E85 is inferred from Table 18.

Table 18: NERA Reference Case Sales of Biofuels in Motor Gasoline (Billions of Gallons)

	2012	2013	2014	2015
Corn Ethanol	12.60	12.22	11.16	10.49
Sugar Ethanol	0.81	1.25	2.33	3.00
Cellulosic Ethanol	0.01	0.01	0.01	0.01

Sources: Food and Agricultural Policy Research Institute for sugar ethanol imports.
Note: Corn ethanol = Ethanol in E10 + Ethanol in E85 – Sugar Ethanol – Cellulosic Ethanol

The forecasts for fuel price ratios are based upon a number of data sources. The gasoline and diesel prices come from AEO's 2011 Reference forecast. For corn ethanol we built up the prices from the EIA's work. We assumed a corn price equal to the average $/bushel price from January 1, 2008 to September 1, 2011 (or $5.00/bushel). We took the capital, operations, and maintenance costs from the EIA.[32] Summing up all these costs yielded the forecasted price for corn based ethanol. The price of sugar ethanol is assumed to be $1.00 to $1.50 per gallon higher than neat gasoline based on recent actual price differentials between the two fuels.[33] The cost of cellulosic ethanol is uncertain.[34] To estimate this cost, we averaged two EIA forecasts – one based on the capital cost for cellulosic ethanol and the other based on the capital cost for biodiesel gasification.[35] For biodiesel, we made use of three sources: Global Insights, the American Trucking Association's comment on the EPA's proposed rule entitled: *Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards*, and the average ratio of spot SME B100 to spot ultra-low sulfur petroleum diesel from 2009 through 2011.

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32 Statton, Mac, "Development of Production Costs as a Driver for the National Energy Modeling System," Energy Information Administration, Presentation at International Fuel Ethanol Workshop, June 29, 2011.

33 California Energy Commission, "2011 Integrated Energy Policy Report," February 2012.

34 Because we assume the RFS mandate for cellulosic ethanol will be waived, cellulosic ethanol is likely to be irrelevant in our analysis as long as its price is sufficiently greater than that of sugar ethanol, for sugar ethanol will be the ethanol of choice to meet the advanced biofuels mandate, and corn and sugar ethanol will be used in the production of E10 and E85 to help meet the overall biofuel requirement.

35 Statton, Mac, "Development of Production Costs as a Driver for the National Energy Modeling System," Energy Information Administration, Presentation at International Fuel Ethanol Workshop, June 29, 2011.

All price ratios are national, annual averages over multiple grades of fuel. For gasoline, the grades include regular unleaded, 89 octane unleaded, and premium unleaded (Table 19).

Table 19: Baseline Fuel Price Ratios for Blended Gasoline and Diesels (Ratio on a GGE Basis of Biofuel to Conventional Fuel)

	2010	2011	2012	2013	2014	2015
Gasoline	1.00	1.00	1.00	1.00	1.00	1.00
Corn Ethanol	1.86	1.78	1.72	1.61	1.58	1.49
Sugarcane Ethanol	2.08	2.00	1.92	1.81	1.77	1.67
Cellulosic Ethanol	2.62	2.48	2.41	2.23	2.13	2.01
Diesel	1.00	1.00	1.00	1.00	1.00	1.00
Soy-Based Biodiesel	1.74	1.66	1.7	1.66	1.65	1.64

Source: NERA assumptions.

2. Fuel Supply Curves

To address the changes in fuel production from the baseline, we use separate supply curves for each fuel. The elasticity of the supply dictates how the prices of fuels change with changes in production. In particular, they help determine how costly it is to expand biofuel production above the Reference Case levels.

Each supply curve is benchmarked to the NERA Reference Case, which is a slight modification of the EIA's Reference Case. The Reference Case price and quantity are denoted by $(Q_0(t),P_0(t))$. Each supply curve is also defined by an elasticity that is estimated from several data points from the EIA's Reference and High Oil Price scenarios. Each supply curve has the following functional form:

$$Q(t)/Q_0(t) = (P(t)/P_0(t))^{elasticity}$$

Formulation of the supply curves is such that the model replicates the Reference Case if no RFS2 mandate is imposed. For each year, the benchmark datum point for the biodiesel supply curve is derived from the EIA's reference scenario projections for fuel quantities and prices. The benchmark datum point for the corn ethanol supply curve comes from our adjusted EIA reference scenario (NERA Reference Case) for quantities and the EIA's cost analysis. For sugar ethanol, we used the EIA's demand forecast and the ARB's cost ratio of sugar ethanol to corn ethanol. Table 17, Table 18, and Table 19 report the prices and quantities to which the supply curves were calibrated.[36]

The own price elasticity for each fuel is derived by dividing the percentage change in quantity of fuel demanded by the percentage change in fuel price. The percentage change in quantity and price are computed by comparing the difference between the fuel consumed and price of fuel, respectively, in the AEO high oil price and reference scenarios. The elasticity of supply varies a bit from year to year, but on average, the elasticity of supply is about 0.4 for corn ethanol, 1.2 for sugar ethanol and biodiesel. The elasticity for petroleum fuels was is 0.8.[37]

3. Demand Curves

The model has a demand curve for each final fuel – E0, E10, E85, and diesel. The functional form of these curves is identical to that of the fuel supply curves. For the demand curves, the elasticity is the fuel's own price elasticity of demand. Because this analysis concerns itself only with the next few years, the demand curves' elasticity equaled that of Dahl's estimate for short-term elasticity of -0.1.[38]

These curves are calibrated to the demand data in Table 16 and Table 17. The EIA's AEO 2011 Reference Case provides the gasoline and diesel prices to which the demand curves' initial prices are calibrated (Table 20). As with the supply curves, the demand curves are structured so that the model replicates the NERA Reference Case level of demand for each fuel in the absence of the RFS2 mandate.

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36 The previous section provides more detail on how the forecast prices were derived.

37 Paltsev, Sergey, John M. Reilly, Henry D. Jacoby, Rishard S. Eckaus, James McFarland, Marcus Sarofim, Malcolm Asadoorian, and Mustafa Babiker, "The MIT Emissions and Prediction and Policy Analysis (EPPA). Model Version 4," August 2005.

38 Dahl, C.A., "A survey of energy demand elasticities for the developing world," *Journal of Energy and Development* 18(I), 1—48, 1994.

Table 20: AEO 2011 Reference Case Fuel Prices ($/Gallon)

Fuel	2012	2013	2014	2015
Gasoline	2.82	2.97	3.05	3.13
Diesel	2.92	2.97	3.02	3.08

Source: EIA's AEO 2011.

4. Transportation Fuel Model is Designed to Model RFS2 Program Characteristics

The transportation fuel model was customized to simulate the impacts resulting from the RFS2 program. The model solves in one-year time steps and has a flexible time horizon. The first endogenous year is 2012. The model tracks the sale of the following fuels: E0 (100% petroleum gasoline), E10 (gasoline containing at most 10% by volume ethanol), E85 (assumed to contain 74% ethanol by volume), and diesel (containing at most 5% biodiesel). The model also tracks the use of the following fuel components in the production of the above finished fuels: petroleum gasoline, corn ethanol, sugar ethanol, cellulosic ethanol, petroleum diesel, and biodiesel.

The model combines the six fuel components into the four end-use fuels, which can be consumed by specific vehicle types:

- Minimum E0 use held to 5% to represent incomplete market conversion to E10 and preference of some consumers for E0;
- Conventional vehicles can consume either E0 or E10;
- FFVs can use E0, E10, or E85; and
- Commercial trucks/buses, ships, and trains are allowed to use diesel, which has up to a five percent mix of biodiesel (B5).

5. RFS/RIN Constraints

The model includes three biofuel constraints to account for the minimum annual volume of biofuel sales required under the RFS2 program:

- Biomass based diesel;
- Advanced biofuel (includes cellulosic biofuels, biomass-based diesel, and sugar ethanol); and
- Renewable fuel (includes advanced biofuel and corn ethanol).

For this analysis, we omit the RFS2 constraint for cellulosic ethanol under the assumption that the EPA would continue to grant a waiver because cellulosic biofuels will be commercially available only in very limited quantities. This assumption avoids the debate about the economic and technical feasibility of producing cellulosic biofuel[39] and is likely optimistic given the current difficulty procuring cellulosic biofuel supplies. Since this analysis assumes ample supplies of corn and sugar ethanol to meet the RFS2 mandates, there is no need for cellulosic ethanol to meet the non-cellulosic RFS2 targets.

Therefore, we model the following three RFS2 constraints, which are defined in the EPA's Final Rule for the Regulation of Fuels and Fuel Additives.

Figure 11: EPA's Formulas for the RFS2 Percentage Mandates[40]

$$Std_{BBD,i} = 100\% \times \frac{RFV_{BBD,i} \times 1.5}{(G_i - RG_i) + (GS_i - RGS_i) - GE_i + (D_i - RD_i) + (DS_i - RDS_i) - DE_i}$$

$$Std_{AB,i} = 100\% \times \frac{RFV_{AB,i}}{(G_i - RG_i) + (GS_i - RGS_i) - GE_i + (D_i - RD_i) + (DS_i - RDS_i) - DE_i}$$

$$Std_{RF,i} = 100\% \times \frac{RFV_{RF,i}}{(G_i - RG_i) + (GS_i - RGS_i) - GE_i + (D_i - RD_i) + (DS_i - RDS_i) - DE_i}$$

39 We note that there is a second- or third-order effect of assuming no measurable cellulosic supplies. Assuming no significant amount of cellulosic ethanol production necessitates additional amounts of biodiesel and sugar based ethanol to meet the advanced biofuel requirement, and this affects costs and compliance.

40 http://www.gpo.gov/fdsys/pkg/FR-2012-01-09/pdf/2011-33451.pdf, at p. 19.

The final standards for 2012 are provided below in Table 21.

Table 21: EPA's Final Rule for RFS standards for 2012[41]

Fuel	Percentage
Cellulosic biofuel	0.002% to 0.01%
Biomass-based diesel	0.91%
Advanced biofuel	1.21%
Renewable fuel	9.21%

Source: EPA.

6. Model Formulation

The following text describes the transportation fuel model – its objective function and constraints - at a high-level.

Maximize: Consumer Surplus + Producer Surplus + Value of RIN Bank

Subject to: RFS2 advanced biofuel constraint (% requirement)

RFS2 biodiesel constraint (% requirement)

RFS2 total biofuel constraint (% requirement)

Blend wall constraint for E10 not to exceed 10% ethanol

Blend wall constraint for diesel not to exceed 5% biodiesel

Limit on E85 sales based on Phase I findings for penetration of E85 stations

Lower bound on E0 sales as a fraction of total sales (calibrated to baseline levels)

Upper bound on biodiesel production

RIN bank(t) = RIN bank(t-1) + RIN Deposit(t) – RIN withdrawal(t) t = 2012, …, 2015

RIN bank cannot exceed 20% of biofuel sales…

Consumer Surplus = the area under the demand curve for each delivered fuel (*e.g.*, E0, E10, *etc.*)

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41 EPA's Section I on pg. 1323 of the EPA's Final Rule for the Regulation of Fuels and Fuel Additives: 2012 Renewable Fuel Standards. Table I.A. 3-2.

Producer Surplus = the area under the supply curve for each fuel component (*e.g.*, corn ethanol, biodiesel, *etc.*)

RIN bank in 2012 equals the carryover of RINs from 2011.

The supply curves capture the technological issues (penetration rate, availability, and cost) for the different fuels. The demand curves for fuel capture the loss in utility from having to reduce travel and also the loss in welfare from having to switch fuels. The RFS constraint is applied only in the RFS2 scenarios. The change in economic activity between the scenario and the baseline provides the economic impacts of the RFS policy.

The models for the reference and high biofuel scenarios differ only in the upper bound for the amount of biodiesel production. Table 22 reports these levels.

Table 22: Maximum Amount of Biomass Based Diesel That Can be Produced (Billions of Gallons)

Scenario	2012	2013	2014	2015
Reference Scenario	1.00	1.28	1.28	1.28
High Biodiesel Scenario	1.35	1.74	1.66	1.90

Source: EIA's AEO 2011 and NERA analysis.

The sales of E85 are limited by how quickly the E85 fueling infrastructure can be expanded. At the end of 2011, there were only about 2,400 stations that sold E85. This small volume resulted in E85 making up only about 1% of all potential FFV fuel purchases. By allowing the addition of E85 pumps in retail stations to increase at a rate far faster than that in recent history (1,000 stations per year versus about 400 stations per year from 2006 through 2010), yields about 6,400 stations by 2015. Given people's propensity to seek out E85 stations if they have a FFV, we assume that this level of stations translates into the following bound on E85 sales (see Phase I report for more details). Table 23 shows that this upper limit on E85 sales is quite optimistic relative to the EIA's forecasted E85 sales.

Table 23: Sales of E85 (Billions of Gallons)

	2012	2013	2014	2015
AEO 2011	0.06	0.07	0.08	0.09
Maximum	0.54	0.99	1.7	2.6

Source: EIA's AEO 2011 and NERA $N_{ew}ERA$ model results.

B. Macroeconomic Model in $N_{ew}ERA$ Modeling System

The $N_{ew}ERA$ macroeconomic model is a forward-looking dynamic computable general equilibrium model of the United States. The model simulates all economic interactions in the U.S. economy, including those among industry, households, and the government. The economic interactions are based on the IMPLAN 2008 database for a benchmark year, which includes regional detail on economic interactions among 440 different economic sectors. The macroeconomic and energy forecasts that are used to project the benchmark year going forward are calibrated to the most recent AEO produced by the EIA. Because the model is calibrated to an internally-consistent energy forecast, the use of the model is particularly well suited to analyze economic and energy policies and environmental regulations.

For this study, the $N_{ew}ERA$ macroeconomic model was set to run from 2012 to 2015 in one year time steps. We aggregated all the states into one U.S. region since the RFS2 program is a nationwide policy. We then aggregated the 440 sectors into five energy and seven non-energy sectors: energy sectors include crude oil, oil refining, natural gas extraction and distribution, coal, and electricity; the non-energy sectors include agriculture, commercial transportation (excluding trucking), energy intensive sectors, manufacturing, motor vehicle production, services, and trucking.

The $N_{ew}ERA$ model incorporates EIA energy quantities and energy prices into the IMPLAN Social Accounting Matrices. This in-house developed approach results in a balanced energy-economy dataset that has an internally consistent energy benchmark data as well as IMPLAN consistent economic values.

The macroeconomic model incorporates all production sectors and final demands of the economy and is linked through terms of trade. The effects of policies are transmitted throughout the economy as all sectors and agents in the economy respond until the economy reaches equilibrium. The ability of the model to track these effects and substitution possibilities across sectors and regions makes it a unique tool for analyzing policies such as those involving energy and environmental regulations. These general equilibrium substitution effects, however, are not fully captured in a partial equilibrium framework or within an input-output modeling framework. The smooth production and consumption functions employed in this general equilibrium model enable gradual substitution of inputs in response to relative price changes thus avoiding all or nothing solutions.

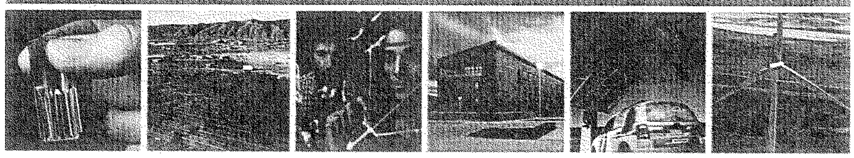
Business investment decisions are informed by future policies and outlook. The forward-looking characteristic of the model enables businesses and consumers to determine the optimal savings and investment while anticipating future policies with perfect foresight. The alternative approach on savings and investment decisions is to assume agents in the model are myopic, thus have no expectations for the future. Though both approaches are equally unrealistic to a certain extent, the latter approach can lead the model to produce inconsistent or incorrect impacts from an announced future policy.

The CGE computable general equilibrium modeling tool such as the N_{ew}ERA macroeconomic model can analyze scenarios or policies that call for large shocks outside historical observation. Econometric models are unsuitable for policies that impose large impacts because these models' production and consumption functions remain invariant under the policy. In addition, econometric models assume that the future path depends on the past experience therefore fail to capture how the economy might respond under a different and new environment. For example, an econometric model cannot represent changes in fuel efficiency in response to increases in energy prices. However, N_{ew}ERA macroeconomic model can consistently capture future policy changes that envisage having large effects.

The N_{ew}ERA macroeconomic model is also a unique tool that can iterate over sequential policies to generate consistent equilibrium solutions starting from an internally consistent equilibrium baseline forecast (such as the AEO Reference Case). This ability of the model is particularly helpful to decompose macroeconomic effects of individual policies. For example, if one desires to perform economic analysis of a policy that includes multiple regulations, the N_{ew}ERA modeling framework can be used as a tool to layer in one regulation at a time to determine the incremental effects of each policy.

C. Integration of Models

To estimate the economic impacts of the RFS2 program on the overall economy, we established a one way linkage between the bottom-up transportation model and the top-down macroeconomic model. We first ran the reference and high biofuel scenarios through the transportation fuel model. The imposition of the RFS2 program leads to fuel price increases from the baseline without this program. For the top-down macroeconomic model, we translated the resulting higher fuel prices by applying a tax on gasoline and diesel that yields the same fuel price increase as seen in the bottom-up transportation fuel model.



High Ethanol Fuel Endurance:

A Study of the Effects of Running Gasoline with 15% Ethanol Concentration in Current Production Outboard Four-Stroke Engines and Conventional Two-Stroke Outboard Marine Engines

June 16, 2010 – June 30, 2011

David Hilbert
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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

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High Ethanol Fuel Endurance

A study of the effects of running gasoline with 15% ethanol concentration in current production outboard four-stroke engines and conventional two-stroke outboard marine engines.

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Executive Summary

Objective:

The objective of this work was to understand the effects of running a 15% ethanol blend on outboard marine engines during 300 hours of wide-open throttle (WOT) endurance – a typical outboard marine engine durability test. For the three engine families evaluated, one test engine each was endurance tested on E15 fuel with emissions tests conducted on both E0 and E15 fuel, while a second control engine was emissions and endurance tested on E0 fuel for each engine family.

Summary of Results:

Results are based on a sample population of one engine per test fuel. As such, these results are not considered statistically significant, but may serve as an indicator of potential issues. More testing would be required to better understand the potential effects of E15.

9.9HP Carbureted Four-Stroke:

- The E15 engine exhibited variability of HC emissions at idle during end-of-endurance emissions tests, which was likely caused by lean misfire.
  - Both the E0 control engine and E15 test engine ran leaner at idle and low speed operation at the end of endurance testing compared with operation at the start of the test.
  - The trend of running lean at idle coupled with the additional enleanment from the E15 fuel caused the E15 engine to have poor run quality (intermittent misfire or partial combustion events) when operated on E15 fuel after 300 hours of endurance.
  - CO emissions were reduced when using E15 fuel due to the leaner operation, as expected for this open-loop controlled engine.
- The E15 engine exhibited reduced hardness on piston surfaces based on post-test teardown analysis.
  - The exhaust gas temperature increased 17°C at wide open throttle as a result of the leaner operation when using E15 fuel. Higher combustion temperatures may have caused observed piston hardness reductions. Lack of pre-test hardness measurements prevented a conclusive assessment.
- Several elastomeric components on the E15 engine showed signs of deterioration compared with the E0 engine.
  - Affected components were exposed to E15 fuel for approximately 2 months; signs of deterioration were evident.

300HP Four-Stroke Supercharged Verado:

- The E15 engine failed 3 exhaust valves close to the end of the endurance test.
  - Metallurgical analysis showed that the valves developed high cycle fatigue cracks due excessive metal temperatures.
- The pistons on the E15 engine showed indications of higher operating temperatures compared to the E0 engine's pistons as evidenced by the visual difference in carbon deposits.
- The E15 engine generated HC+NOx values in excess of the Family Emissions Limit (FEL) when operated on E15 fuel, but did not exceed that limit when operated on E0 emissions certification fuel.

- The primary contributor to this increase in exhaust emissions was NOx due to enleanment caused by the oxygenated fuel.
- CO emissions were reduced when using E15 fuel due to leaner operation, as expected for this open-loop controlled engine.

200HP EFI 2.5L Two-Stroke:

- The 200 EFI two-stroke engine showed no signs of exhaust emissions deterioration differences due to the fuel.
  - The E15 fuel caused the engine to run lean resulting in reduced HC and CO emissions. NOx was of little concern on this type of engine since NOx accounted for less than 2% of the total regulated HC+NOx emissions.
- The E15 engine failed a rod bearing at 256 hours of endurance, which prevented completion of the 300 hour durability test.
  - Root cause of the bearing failure was not determined due to progressive damage.
  - More testing would be necessary to understand the effect of ethanol on oil dispersion and lubrication in two-stroke engines where the fuel and oil move through the crankcase together.

4.3L V6 EFI Four-Stroke Catalyzed Sterndrive:

- Since E15 fuel was readily available in the test facility and an engine equipped with exhaust catalysts was on the dynamometer, emissions tests were conducted on a 4.3L V6 sterndrive engine to better understand the immediate impacts of ethanol on this engine family.
  - At rated speed and load (open-loop fuel control) E15 caused exhaust gas temperatures to increase by 20°C on average and the catalyst temperatures to increase by about 30°C.
  - More rapid aging of the catalyst system occur due to the elevated catalyst temperature when considering the high load duty cycle typically experienced by marine engine applications.

Conclusions and Recommendations:

Several issues were discovered in this study from an exhaust emissions and an engine durability standpoint as a result of running E15 fuel in outboard marine engines. Run quality concerns were also identified as a result of the lean operation on the carbureted engine.

Additional investigation is necessary to more fully understand the observed effects and to extrapolate them to all types of marine engines over broader operating conditions. Effects on operation at part load, transient acceleration/deceleration, cold start, hot restart, and other driveability-related concerns need to be evaluated. This test program was mainly testing for end-of-life durability failures, which would not likely be the first issues experienced by the end users. A customer would likely be affected by run quality/driveability issues or materials compatibility/corrosion issues before durability issues. The wide range of technology used in marine engines due to the wide range of engine output will complicate this issue (Mercury Marine produces engines from 2.5HP-1350HP).

More testing is needed to understand how ethanol blends affect lubrication systems in two-stroke engines that have fuel and oil moving through the crankcase together. Crankcase oil dispersion is the only mechanism by which two-stroke engines of this architecture provide lubrication at critical interfaces such as bearings and cylinder walls. Ethanol may have an effect on the dispersion or lubricity of the oil.

A better understanding of how long term storage affects ethanol blends in marine fuel systems would require more real-world testing. Marine vessels often go through long periods of storage that could affect the fuel systems given the fact that the ethanol portion can absorb water when exposed, especially in humid areas near saltwater.

Introduction

Project Background:

This project was a cooperative effort to assess the feasibility for marine engines of increasing the allowable ethanol concentration in gasoline above the current legal limit of 10%. Specifically, a 15% ethanol / 85% gasoline fuel blend (E15) was tested in current production and legacy outboard marine engines. Gaseous exhaust emissions and engine durability were assessed on a typical durability test cycle. Three separate engine families were evaluated. A 200HP EFI two-stroke engine was chosen to represent legacy product. A 9.9HP carbureted four-stroke engine and a 300HP supercharged EFI four-stroke engine represented current product. Two engines were tested from each family. One was operated on E15 fuel and the other was operated on E0 gasoline. Emissions data from each engine were obtained before, in the middle of, and after durability testing.

Summary of Marine Engine Considerations:

Marine engines require unique considerations when altering the fuel supplied to operate the engine. Considering these engines are frequently used in remote locations (offshore fishing for example), it is critical to ensure that the fuel does not cause or contribute to an engine malfunction. Changes in fuel formulations and the resulting effects on marine engine operability are of high importance.

Outboard marine engines span a large range of rated power output and technology which yields significant complexity when trying to understand the effects of changing the fuel supplied to the engine. When all of the typical Mercury production engines and the Mercury Racing products are included (inboards and outboards), engines from 86cc, 2.5HP up to 9.1L 1350HP twin turbo configurations are produced. Mercury outboards (the focus of this study) range in output and design from the 2.5HP splash lubricated carbureted four-stroke engines to 350HP supercharged EFI four-stroke and 300HP direct fuel injected two-stroke engines. If sterndrive/inboard engines are considered, the technology list gets even broader. The non-racing sterndrive products range from 135HP carbureted 4 stroke to 430HP closed-loop catalyzed EFI 4 stroke with onboard diagnostics. The sales volumes of marine engines may be much smaller than automotive or small offroad utility engines, but the range of power (nearly 3 orders of magnitude) and the range of available technology of marine engines is much wider than these other categories individually.

The marine application requires an engine that has high power density and remains durable at high speeds and loads. It is important to minimize the amount of weight added to the vessel from the powertrain to maximize the payload and minimize drag. Boat hull drag is considerable at typical boat operating speeds resulting in high engine speeds and loads for extended periods. The result of these factors leads to engines which are high performance and made from premium materials. Changing the fuel specification must be carefully considered to assure that durability is not sacrificed. Figure 1 illustrates the power density of the Verado engine (the 300HP supercharged EFI engine family used in this study) compared to automotive engines that were contemporary when the Verado engine was introduced for the 2005 model year. Figure 2 shows a relative comparison of the vehicle load curves of a boat with a planing hull to an automobile. The likelihood of experiencing problems as a result of extended operation at or near WOT are far more pronounced on a marine engine than an automotive engine due to the great difference in vehicle load curves.

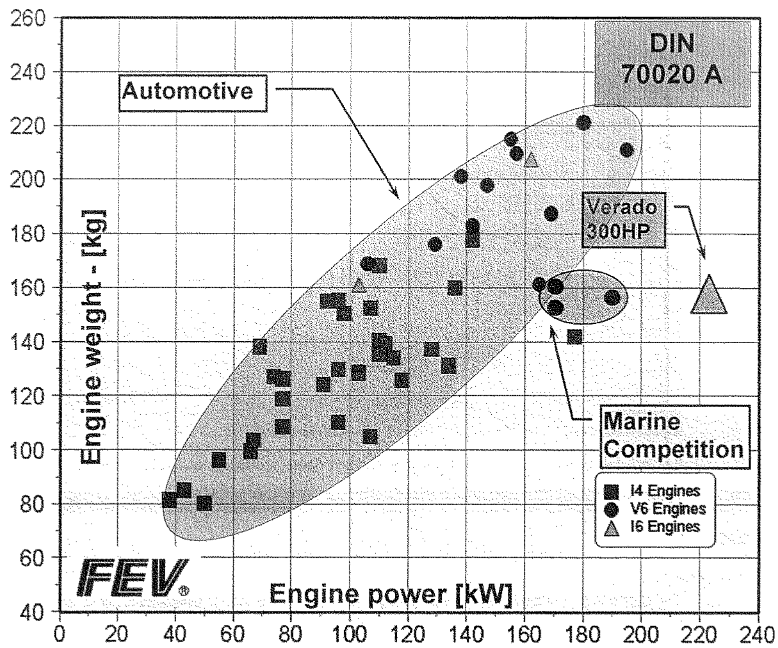


Figure 1: Power to Weight Comparison, Scatter Band Data Provided by FEV (FEV Motorentechnik GmbH)[1]

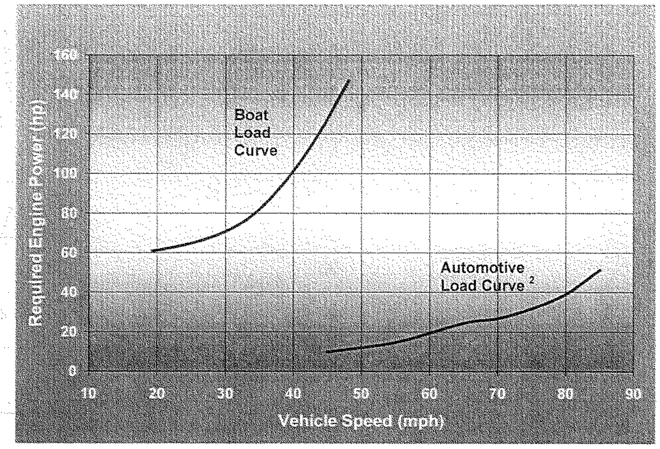


Figure 2: Example Load Curve Comparison (Automotive data – source 2, boat load data – internal Mercury source)

Investigation Details

Statement of Problem:

Procedure:

The engine testing process began by preparing each engine. This included instrumentation of the test engines as well as performing some basic checks (varied by engine type). The instrumentation process included installation of an exhaust emissions probe that met the requirements of the EPA 40 CFR Part 91 regulations.

Each engine was rigged onto an appropriate dynamometer and a break-in process was performed. The break-in consisted of increasing speed and load settings for approximately 2.5 hours total duration and was performed on E0 gasoline for all engines. This was followed by a power run to determine the wide open throttle (WOT) performance of each engine. The power run was performed on E0 gasoline on all engines and also on E15 fuel for only the E15 test engines. The power run included speed points from 2000RPM up to the maximum rated speed of the engine.

Once the WOT performance was checked, emissions testing was performed using reference-grade E0 gasoline (EEE fuel: EPA Tier II emissions reference grade fuel). The emissions tests were done in triplicate to check repeatability and were run in accordance with the EPA requirements set forth in 40 CFR Part 91. Emissions tests were also performed on the E15 engines in triplicate using the E15 test fuel. Although this E15 test fuel was not blended from the reference-grade E0 gasoline, these tests provide some comparison of exhaust emissions between E0 and E15 while minimizing engine-to-engine variability.

Following the above emissions checks, each engine was prepared for the durability testing. This included doing a basic visual inspection as well as some general engine power cylinder integrity checks (example: compression test and cylinder leak-down). These integrity checks were also repeated at the durability mid-point and end-of-life test point as well.

The first half of the durability test was then performed. Each engine was rigged in Mercury's Indoor Test Center, which consisted of large endurance test tanks, air supply systems, and data acquisition systems. Each engine was fitted with the appropriate propeller to operate the engine approximately in the midpoint of the rated speed range at wide open throttle. The engine instrumentation was continuously monitored and the data was recorded for the duration of the endurance test. Operational shutdown limits were placed on critical channels (min/max engine speed, max coolant temperature, etc) to monitor the health of the engine for the entire durability test period. Periodic maintenance was performed on each engine (as appropriate for the engine type: oil level checks and changes, accessory drive belts, etc). This maintenance was performed in an accelerated manner as compared with typical customer maintenance intervals since the durability testing causes accelerated wear as compared with typical customer use. These protocols are typical of those used by Mercury for any durability test.

Once the first half of the durability testing was completed, each engine was rigged on the dynamometer again. Emissions tests on the appropriate fuel(s) were performed according to the procedures described above. The tests were again performed in triplicate to be able to evaluate repeatability. Each engine also got a visual inspection and the general engine power cylinder integrity checks before being returned to durability testing.

After the midpoint emissions testing was completed, each engine was returned to the Indoor Test Center endurance tank to complete the second half of the durability testing. The testing was performed in the same manner as the first half of the durability portion.

When the durability testing was complete, each engine was returned to the dynamometer for post-durability emissions tests on the appropriate fuel(s). A post-endurance WOT performance power run was also performed to compare with the pre-durability power run.

Finally, after all running-engine tests were completed, each test engine underwent a complete tear-down/disassembly and inspection. This inspection included checks and measurements to assess the degree of wear, corrosion issues, cracks, etc. on power cylinder components. Emphasis was placed on components that would be at risk due to the differences in the fuels (exhaust valves due to exhaust gas temperature differences, for example).

Test Engine Description:

The engines used for this testing were all built as new engines on the production line and were randomly selected. They were not specially built or hand-picked. The choice of engine families to include in this program was based on representing a wide range of technology, a wide range of power output, and a significant annual production volume. The final engine family selection was approved by the Technical Monitor at NREL. Two 4-stroke engine families were selected to represent current production engines. A two-stroke engine family was selected to represent "legacy" products. Table 1 summarizes each test engine configuration.

The 9.9HP four-stroke engine is used on a wide range of applications from small fishing boats, inflatable boats, and as a "kicker" engine. A "kicker" engine is an auxiliary engine used for low speed boat maneuvering while fishing on a large boat which includes a larger engine (150+HP) for the main propulsion. The 9.9HP engine is considered a portable engine. It was selected for this testing due to high sales volume and the fact that it represents the typical architecture for many of Mercury's small carbureted four-stroke offerings. It should be noted that the settings for the carburetors on both of the 9.9HP test engines were set and sealed at the carburetor manufacturer. They were not tampered with by any Mercury personnel and were run just as they would if they were used by the end customer. The only adjustment allowed was the idle throttle stop to set the idle speed, which is the only adjustment a customer has access to.

The Verado engine is considered the "flagship" outboard product at Mercury Marine. The non-Racing version used in this study is available in power outputs ranging from 200-300HP. These engines are used on boats with single, dual, triple, and even quad engine installations ranging from multi-engine offshore fishing boats & US Coast Guard patrol boats, high speed bass boats, all the way to commercial fishing vessels and ferry boats. The supercharged 300HP Verado was selected for testing due to the high performance nature of its design and the demands of this market segment. The Verado engines had an open loop electronic fuel injection system with no user adjustment possible.

The 200HP EFI two-stroke engine represents the "legacy" two-stroke products. The 2.5L platform has been the basis for carbureted, crankcase fuel injected (which is the case for the test engines used), and direct cylinder injection models. The platform has roots that can be traced back to the 1970's. This engine was selected for testing because of the large number of engines that have been built off of this platform over the last several decades and that it represents the typical architecture for a variety of Mercury's two-stroke product. An engine configuration with an EFI fuel system was selected to improve consistency in testing. The 2.5L 200HP EFI engine had an open loop electronic fuel injection system with no user adjustment possible.

Table 1: Test Engine Specifications

Engine Family	9.9HP Four-Stroke	Verado	200HP EFI
Gas Exchange Process	Four-Stroke	Four-Stroke	Two-Stroke
Power Rating at Prop	9.9HP	300HP	200HP
Cylinder Configuration	Inline 2 Cylinder	Inline 6 Cylinder	60 Degree V-6 Cylinder
Displacement	0.209 Liter	2.59 Liter	2.51 Liter
Fuel Induction System	Single Carburetor w/Accelerator Circuit, 2 Valve per Cylinder, Single Overhead Cam	Supercharged Electronic Fuel Injected 4 Valve per Cylinder, Dual Overhead Cam, Electronic Boost Control, Electronic Knock Abatement Strategy	Electronic Fuel Injected with Oil Injection, Loop Scavenged Porting, Crankcase Reed Induction, Electronic Knock Abatement Strategy
Dry Weight	108 lbs / 49 kg	635 lbs / 288 kg	425 lbs / 193 kg
Fuel Octane Requirement	87 Octane R+M/2 Minimum Required	92 Octane R+M/2 Recommended, 87 Octane R+M/2 Minimum Required	87 Octane R+M/2 Minimum Required

Test Fuel Description:

The fuels used in the endurance testing were intended to be representative of typical pump-grade fuels that could be commonly available to the general consumer. The primary factors in sourcing the E15 test fuel were consistency of fuel properties for the duration of testing, consistency of ethanol content at 15%, octane performance that met specific requirements for each test engine, and a representative distillation curve to match charge preparation characteristics. The E15 test fuel was splash blended by our fuel supplier in one batch to ensure consistency throughout testing. The E0 and E15 endurance fuels were sourced from different suppliers; as such there were likely differences in the additive packages (including the concentration of additives) of the fuels. Since the primary duty cycle was wide open throttle endurance, the additive package differences likely had little influence on the test. Since the Verado engine had a premium fuel recommendation, the E15 fuel was blended at a target of 91 octane [R+M]/2. The blend stock used was a typical pump-grade fuel that the supplier used for retail distribution. The E0 fuels used for the endurance testing were also typical pump-grade fuels that the fuel supplier had available for distribution. Both a Regular (87 octane [R+M]/2) and a Premium (91 octane [R+M]/2) fuel supply were maintained at Mercury for testing on this program and all other internal Mercury test programs. The emissions tests on E0 fuel were all performed using EPA Tier II EEE fuel sourced from specialty fuel manufacturer Johann Haltermann Ltd.

Samples of several of the test fuels were sent to outside laboratories for analysis. The parameters that were considered were: the distillation curve (ASTM D86)[3], Research and Motor Octane (ASTM D2699[4] and D2700[5]), density, and API gravity. In addition, NREL measured ethanol content via the Grabner IROX 2000 Gasoline Analyzer and ASTM D5501[6] for the E15 fuel. The Grabner IROX 2000 measures ethanol via infrared spectroscopy (per ASTM 5845[7]) and is valid in the range of 0 – 25% ethanol. The ASTM 5501[6] method uses gas chromatography and is only valid for high levels of ethanol (93% to 97% ethanol); it was used here only as a reference. In-house fuel samples were also taken and analyzed on the Petrospec GS-1000 analyzer. This analyzer was used to estimate the octane and measure the oxygenate concentration. Like NREL's Grabner IROX 2000, the Petrospec GS-1000 operates on the infrared spectroscopy concept and determines the ethanol concentration (up to 15%) per ASTM D5845[7]. The results from the Petrospec machine were used as reference values only, primarily for quality control.

Table 2 shows the various measurements made on the test fuels from the different measurement laboratories. The majority of the parameters were within expected ranges for the tolerance of the measurements used. The ASTM D5501[6] procedure used at NREL showed that the ethanol concentration was 18%. The results from the 2 infrared spectroscopy measurements from both NREL and Mercury showed concentrations of approximately 14%. The results from the 2 methods bracket the target concentration of 15%, which was the actual concentration that the fuel was blended to at the fuel supplier. Only one sample of E15 was analyzed, which was valid since all of the E15 fuel was blended in one batch. The data sets from the 87 octane bulk/pump fuel and the 91 octane bulk/pump fuel used on endurance, and the data from the EEE were from one load of fuel of the multiple loads of fuel of each type used during the duration of the testing.

Table 2: Fuel Analysis Results

Fuel Analysis		E15 Fuel	EEE	87 Bulk Fuel	91 Bulk Fuel	91 Bulk Fuel Repeat
Sample Date		10/21/2010	10/8/2010	10/15/2010	10/15/2010	2/10/2011
Fuel Analysis Performed at Outside Laboratory						
Research Octane (ASTM D2699)	RON	95.7	97.2	89.6		93.4
Motor Octane (ASTM D2700)	MON	86.3	88.5	84.6		87.5
[R+M]/2	AKI	91.0	92.9	87.1		90.45
Density @ 15.5C	kg/L	0.752	0.744			
API Gravity	°API	56.5	58.7			
Fuel Analysis Performed at NREL						
Ethanol Content (ASTM D5501)	%	18+/-1%				
Ethanol Content (IROX analyzer)	%	14%				
Fuel Analysis Performed at Mercury Marine						
Petrospec analyzer (E15 data ave. of 2 samples)						
Ethanol Content	%	14.1%	0	0	0	
RON	RON	95.7	95.8	89.4	92.9	
MON	MON	84.7	87.7	83.3	87.2	
[R+M]/2	AKI	90.2	91.7	86.4	90.1	
Reid Vapor Pressure (Mercury analysis)	PSI	8.5	9.0	10.8	10.7	

The distillation curves for the various test fuels were also measured. The results can be seen in Figure 3 below. The data shown in Figure 3 were from the actual test fuels used in this testing. The distillation curve from the E15 fuel showed a large step change in the region of the boiling point of ethanol, as was expected.

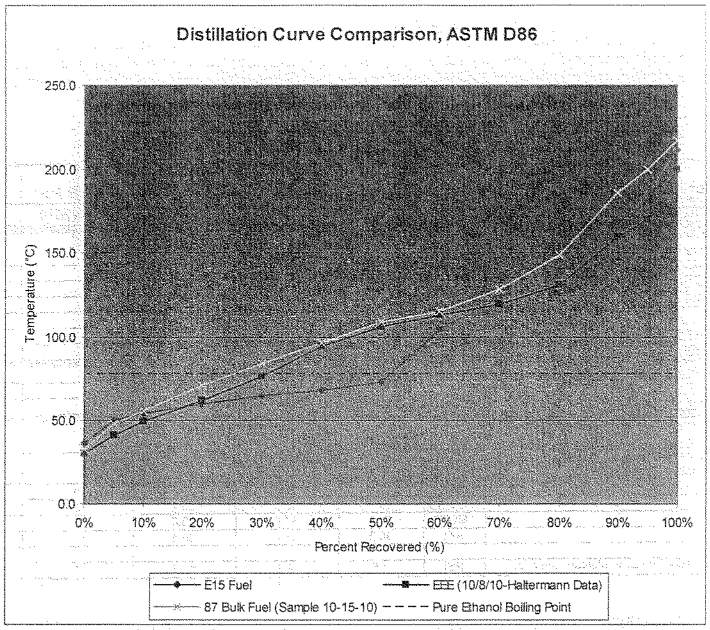


Figure 3: Distillation Curves of Test Fuels

Engine Testing Results

9.9HP Four-Stroke:

Endurance Test Results

The endurance testing on the 9.9HP engine family precipitated no significant failures. There were no incidents related to the test fuels reported on either engine. There were several parameters measured at the start, middle, and end of test to check the general health of the engine during the course of the endurance test. These included cranking compression, power cylinder leakdown, cam timing, and valve lash. All of these parameters remained relatively unchanged through the course of testing within the repeatability of the measurement techniques used. Several fuel-effect differences between the test engines, however, were discovered during the end of test teardown and inspection. These differences are summarized in the section below.

Emissions Testing Results

A summary of the emissions results are shown in Figure 4 below, with the 5 mode total weighted specific HC+NOx values plotted on the Y axis and the amount of endurance time on each engine plotted on the X axis. Each data point on the curve represents the average emissions value of the 3 emissions tests performed at each interval. The error bars represent the minimum and maximum values of the 3 emissions tests at each interval. The dashed yellow line shows the data from the E0 engine (serial number 0R364814). The solid red and blue lines show the emissions data from the E15 engine (serial number 0R352904) using E15 and E0 (EEE) fuels, respectively. Figure 4 shows that the E0 engine had significantly lower emissions than the E15 engine when run on the same fuel. After reviewing the history of the emissions audits on this engine family dating back to its introduction in 2005, both of these engines were within normal production variability.

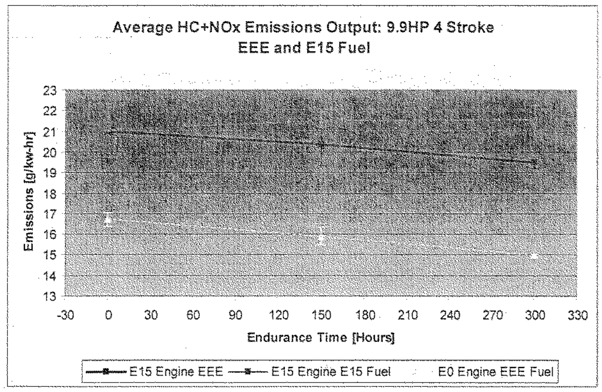


Figure 4: 9.9HP Four-Stroke HC+NOx Emissions Results Summary

In order to better understand the emissions output, the HC, NOx, and CO constituents were broken out and plotted separately in Figures 5, 6, and 7 respectively. The values for each constituent are the five mode totals of each.

Figures 5 and 6 show that the HC emissions predominantly defined the overall trends and variability in the total HC+NOx trends seen in Figure 4. The NOx data shown in Figure 6 had low test-to-test variability and the values were relatively flat (perhaps slightly declining for the E15 engine on E15 fuel) over the life of both engines.

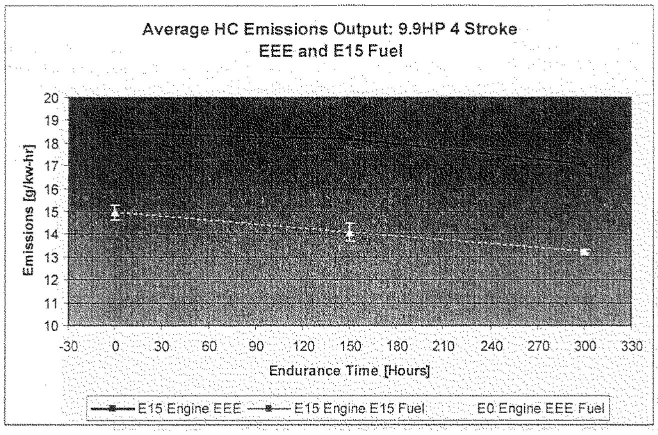


Figure 5: 9.9HP Four-Stroke HC Emissions Results Summary

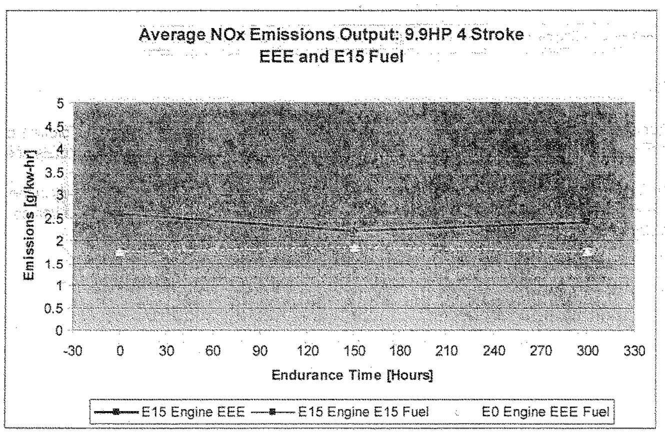


Figure 6: 9.9HP Four-Stroke NOx Emissions Results Summary

There was a general downward trend in CO over endurance time for the E15 engine on both fuels. The E0 showed some reduction in CO between 0 and 150 hours and remained relatively flat from 150 to 300 hours. The reduction in CO would suggest that the engines were running leaner since the primary driver for changing the CO emissions is typically the equivalence ratio.

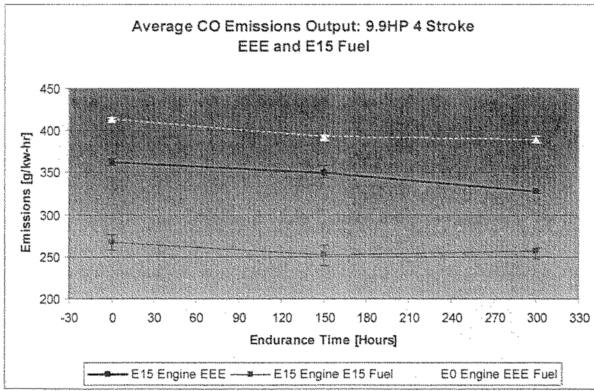
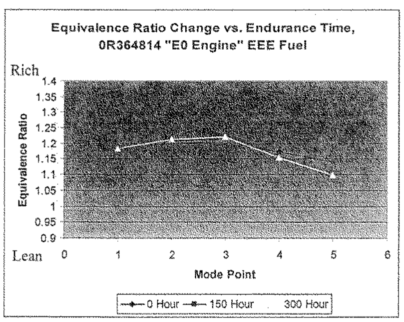
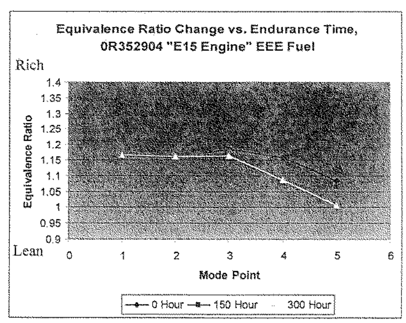


Figure 7: 9.9HP Four-Stroke CO Emissions Results Summary

The enleanment over time trend predicted from the CO data in Figure 7 was confirmed in Figures 8 and 9 for both the E0 and E15 engines operated on EEE-E0 fuel in both cases. The interesting thing to note was that the primary modes that became leaner were modes 4 and 5. During the end of test inspection on both engines, wear on the throttle plates was found on the sides where the throttle shafts went through the carburetor bodies. The wear caused gaps around the throttle plates which allowed excess air to enter the engines at low throttle opening positions (high manifold vacuum), which included Modes 4 and 5. The amount of wear found was considered normal for the amount of endurance time the engines experienced and was found on both engines.

It should be noted that the E15 engine ran leaner than the E0 engine when operated on EEE-E0 fuel, as can be seen in Figures 8 and 9 from a comparison of the "0 hour" equivalence ratios of both engines. This difference in equivalence ratio is considered to be in the normal production variability of this carbureted engine family.





Figures 8 & 9: Change in Equivalence Ratio vs. Endurance Time-EEE Fuel on E0 engine and E15 Engine

In addition, the equivalence ratio vs. endurance time data was plotted for the E15 engine when operated with E15 fuel in Figure 10. The graph shows the same trend of leaner operation vs. endurance time for Modes 4 and 5, as expected. However, when looking at the equivalence ratio values generated by the engine at Mode 5, it is clear that the engine ran very lean after 300 hours of endurance. This lean operation was the result of the inherent enleanment from the E15 fuel coupled with the trend of the engine to operate leaner with more endurance time due to the throttle plate wear.

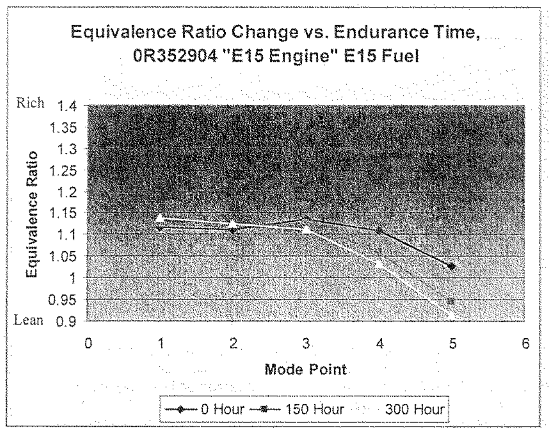
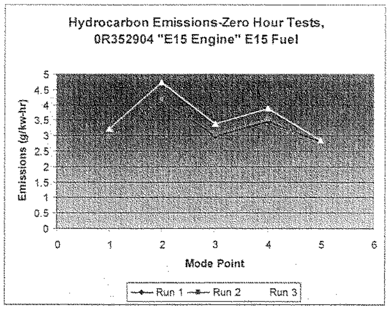
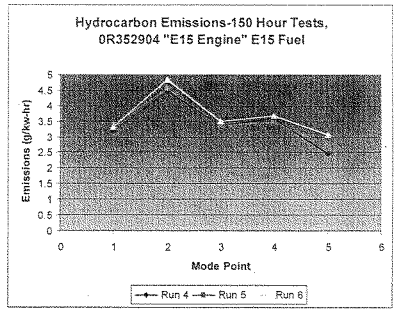
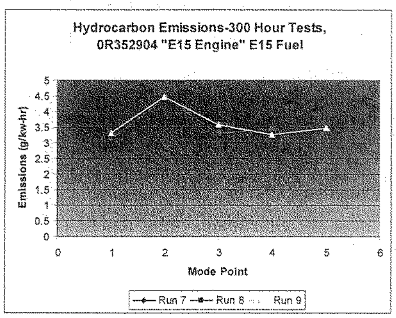


Figure 10: Change in Equivalence Ratio vs. Endurance Time-E15 Fuel on E15 Engine

It is clear that both engines ran leaner with more endurance time, yet the HC emissions increased (on average) for the E15 engine using E15 fuel (see Figure 5). To get more understanding, the hydrocarbon emissions results from each individual emissions test were plotted out in Figures 11-13 for the E15 tests at 0, 150, and 300 hours of endurance, respectively. The difference in HC at the 300 hour emissions check was caused by the Mode 5 (idle) point as Figure 13 shows. The high variability of HC emissions at Mode 5 may have been caused by poor run quality leading to intermittent misfire as the equivalence ratio trended further lean of stoichiometric (<0.925) with increasing run time.







Figures 11, 12, and 13: Hydrocarbon Emissions Outputs for Each Emissions Test, E15 Engine on E15 Fuel

Engine Performance Comparison

The power and torque data from the E0 9.9HP engine is shown in Figure 14 below. [Note: All power and torque curves were normalized to a set torque and power to make consistent comparisons possible across different engines, fuels, and amount of endurance time. The highest power and torque values generated on any of the tests were used as the reference power and torque setting and the runs were normalized back to these values.] There was a clear trend of increasing power and torque with more endurance time on the E0 engine. There was an increase of 3.2% in peak power and a 2.1% increase in peak torque when comparing the zero hour test with the 300 hour test. Similar graphs for the E15 engine are shown in Figure 15 on the E0-EEE fuel and in Figure 16 on the E15 fuel. Figures 15 and 16 show that there was generally a trend of decreasing power and/or torque with more endurance time on the E15 engine. On the E0-EEE fuel there was no change in peak power, but a loss of 1% peak torque when comparing the zero hour test with the 300 hour test on the E15 engine. Results on E15 fuel were similar, with a loss of peak power of 0.9% and a loss of peak torque of 2.1% when comparing the zero hour test with the 300 hour test. The mechanism that caused the E0 engine to have increasing power vs. endurance time and the E15 engine to have decreasing power vs. endurance time is unclear.

Figure 17 shows a comparison of the fuel's effect on the engine performance. The E15 fuel power run shows more torque generation throughout the speed range tested. There is approximately 1.75% more torque (and therefore, more power) on average throughout the speed range. Due to the enleanment from the fuel change, the engine may have been operating in a range closer to the Lean Best Torque on the E15 fuel and/or the volumetric efficiency may have been improved due to the additional charge cooling afforded by the heat of vaporization difference of the fuels. Figure 18 shows the difference in exhaust gas temperatures during the same power runs on the 2 different fuels. There was an approximately 17°C increase in EGT on both cylinders due to the enleanment from the E15 fuel.

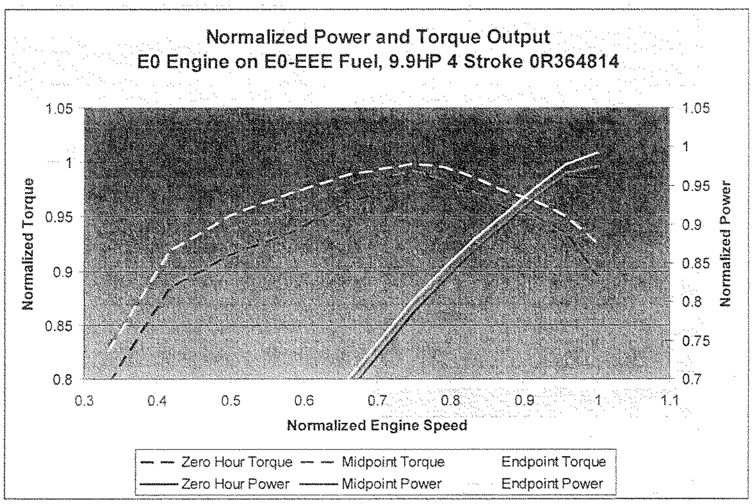


Figure 14: E0 Engine Power and Torque Output at Endurance Check Intervals

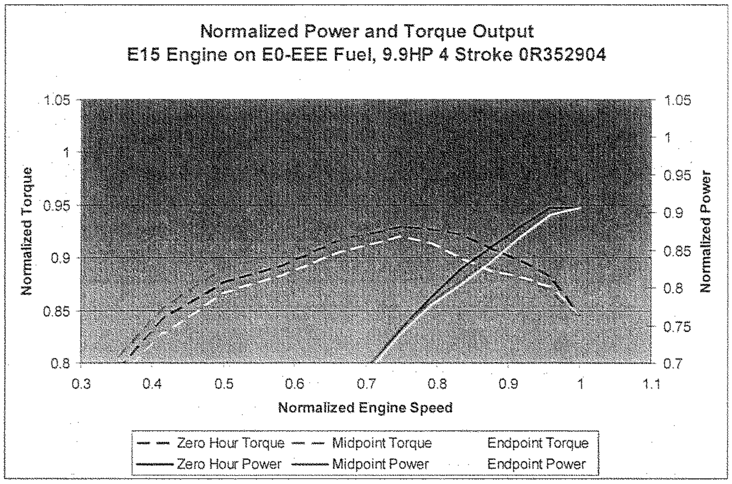


Figure 15: E15 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 Fuel

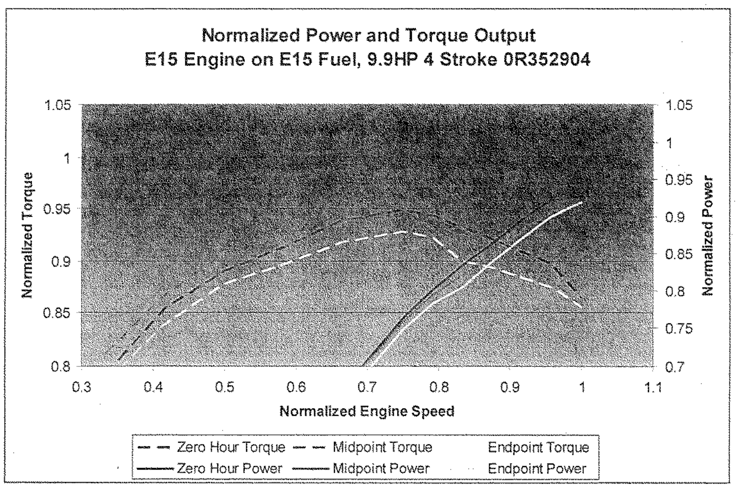


Figure 16: E15 Engine Power and Torque Output at Endurance Check Intervals-E15 Fuel

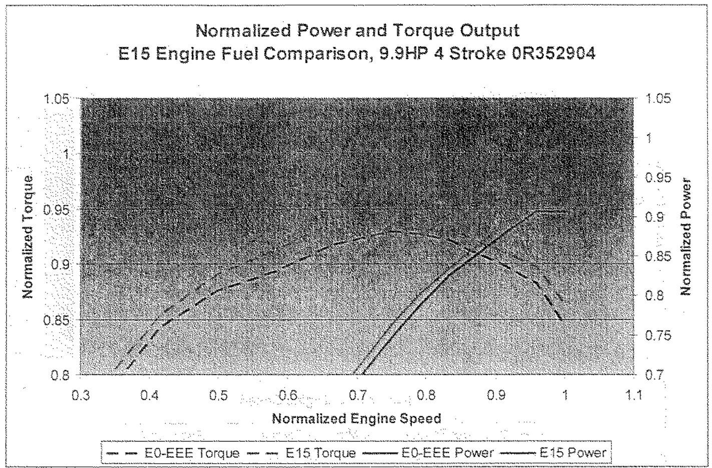


Figure 17: E15 Engine Power and Torque Output, Zero Hour Check-E0-EEE Fuel vs. E15 Fuel

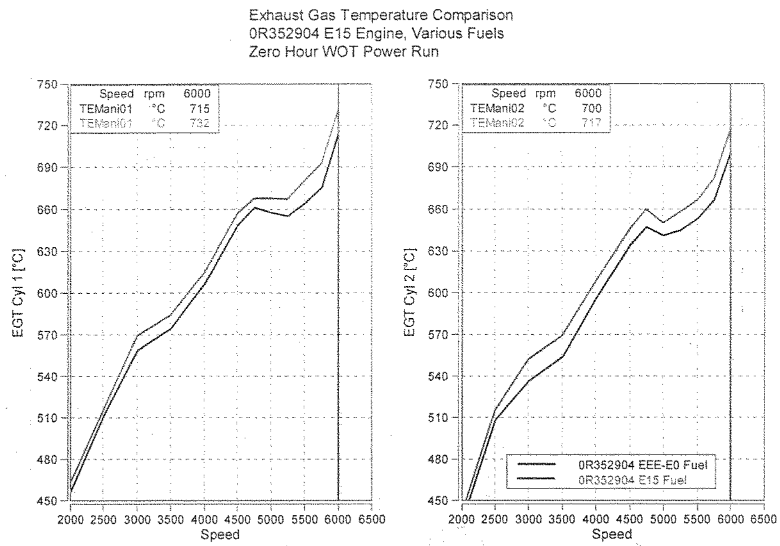


Figure 18: E15 Engine-Exhaust Gas Temperature Comparison, Zero Hour Check-E0-EEE Fuel vs. E15 Fuel

End of Test Teardown and Inspection

When the running engine testing was completed, the engines were disassembled and inspected. The main areas of focus were looking for signs of wear or deterioration and also material compatibility issues.

Upon initial inspection, there were indications that some of the main engine components on the E15 engine were subjected to higher operating temperatures. There were more carbon deposits observed on the undercrown area of the pistons and the small end of the connecting rod, suggesting that the pistons were operating at a higher temperature. Comparisons of the pistons and rods can be seen in Figures 19 and 20, respectively.

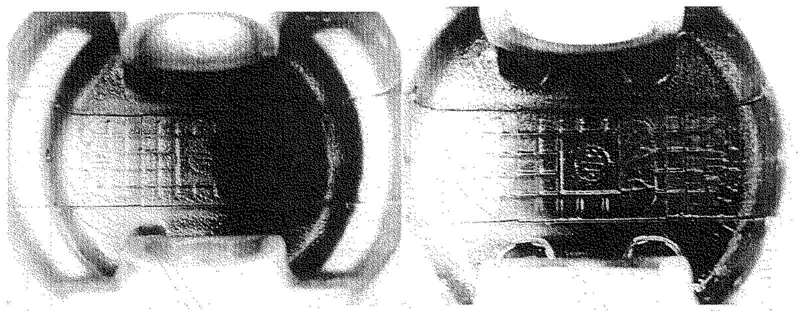


Figure 19: Piston Undercrown Carbon Deposit Comparison, Cylinder 1, E0 on Left, E15 on Right

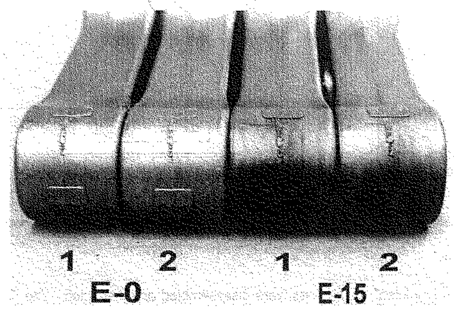


Figure 20: Small End of Connecting Rod Carbon Deposit Comparison, E0 on Left, E15 on Right

Although there were no indications of fuel pump failure during engine test, the mechanical fuel pumps were also disassembled and inspected following testing to look for abnormal signs of wear or degradation. The check valve gasket on the E15 engine showed signs of deterioration compared with that from the E0 engine. The gasket from the E15 pump had a pronounced ridge formed in the area that "hinged" when the check valve was in operation (see notes in Figure 21). The E15 gasket material in the area that sealed the check valve also had signs of wear that were more advanced than the E0 gasket. There was a significant amount material transfer from the gasket to the plastic check valve that it sealed as shown in Figure 22. Both fuel pumps were exposed to their respective test fuels for a period of approximately 2 months. More investigation is necessary to understand the effects of long term exposure of these components. It should be noted that the fuel pump flow performance was not tested. There were no indications that there was a problem with the fuel pump before disassembly. Once the deterioration was noted during teardown, it was determined that measuring the flow performance after disassembly and subsequent reassembly would have likely introduced error in the measurement.

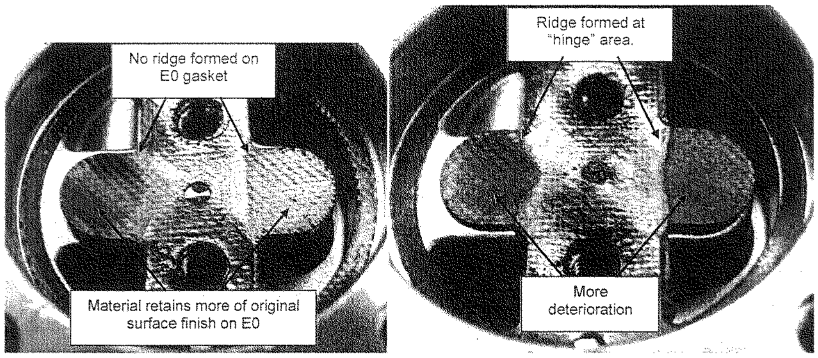


Figure 21: Fuel Pump Check Valve Gasket Comparison, E0 on Left, E15 on Right

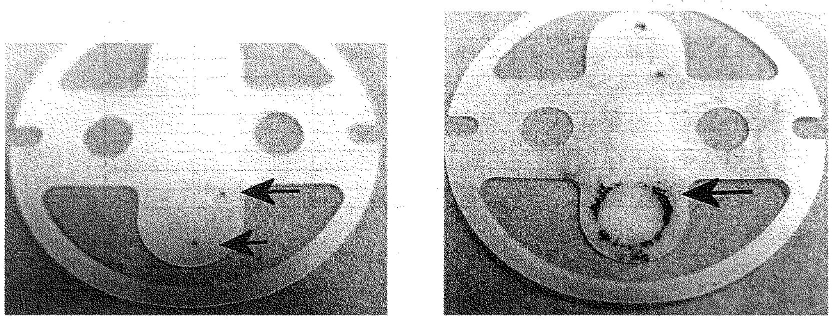


Figure 22: Fuel Pump Check Valve Comparison, E0 on Left, E15 on Right

Due to the visible differences in some of the engines' metal components, several components were sent to the in-house metallurgy lab for further analysis. Results of this analysis are included in Table 3. The Vickers hardness test was performed using a Clemet Microharness Tester with a conversion to the Rockwell C scale where applicable (on steel parts). The Brinell scale was used for the aluminum parts, as they are much softer than the steel parts. The values shown were the average of 3 measurements for each component with the exception of the valve bridge in the cylinder head where only 2 measurements were taken. However, due to the fact that only 1 component from each engine on the 2 fuels was tested the results have no statistical significance and should be taken as an indicator only. Also, no hardness measurements were taken on the components prior to testing so there was likely some normal part-to-part variability in hardness as the components were originally manufactured.

Taking all of these issues into consideration there were indications that some of the components had different hardness values. These differences were most likely related to the continuous operating temperatures of the components. The most notable differences were the pistons, the valve bridge in the cylinder head and the intake valve stems. The piston measured from the E15 engine had a hardness value approximately 13.2% lower than the piston from the E0 engine. This would suggest that the E15 piston experienced a higher operating temperature, as expected due to the lean operation. The carbon deposits on the underside of the piston due to oil coking also suggest the E15 pistons were running hotter as noted previously. The intake valve stem measurements showed an approximately 12% difference in hardness, with the E0 engine having the lower values. This difference would suggest that the E0 intake valve stems were running hotter during operation than the E15. This difference was likely due to the charge-air cooling effect of ethanol in the E15 fuel resulting in cooling of the intake port and leading to lower intake valve stem temperatures. The evaporative cooling in the intake port could also explain why the valve bridge hardness measurements indicated that the valve bridge on the E15 engine had lower operating temperatures evidenced by the roughly 11% higher hardness value. The other measurements showed differences that were likely within the repeatability of the measurements and the manufacturing variability so no conclusions could be drawn from them.

The piston is generally a higher-stressed component than the intake valve. The reduction in hardness of the intake valve for the E0 engine is not likely to increase failure rates since this engine family was qualified for E0 operation as a baseline. However, if the reduction in hardness of the piston with E15 fuel was found to be a statistically significant result, E15 fuel usage might increase the failure rate of this component.

Table 3: Hardness Measurements on Various 9.9HP Four-Stroke Engine Components

9.9HP Four Stroke	Hardness Scale	E0 0R364814	E15 0R352904	Percent Difference
Piston, Cyl 1	BHN	91.0	79.0	13.2%
Connecting Rod, Small End Cyl 1	BHN	112.0	112.0	0.0%
Exhaust Valve Stem, Cyl 1	Rc	21.7	22.1	-2.0%
Exhaust Valve Head, Cyl 1	Rc	30.1	30.7	-2.0%
Valve Bridge in Cyl. Head, Cyl 1	BHN	83.0	92.0	-10.8%
Intake Valve Stem, Cyl 1	Rc	33.0	36.9	-11.9%
Intake Valve Head, Cyl 1	Rc	39.6	39.1	1.3%

Verado 300HP Supercharged Four-Stroke:

Endurance Test Results

Several engine failures occurred during endurance testing on the Verado engines, two of which were not related to the fuel and one of which may have been associated with the use of E15 fuel. The two non-fuel-related engine failures included a casting defect and a test facility induced failure. A third engine failure, involving failed exhaust valves is believed to have been caused by the E15 fuel. Failure mechanisms are described in detail below.

E0 Engine #1-Casting Defect: The first engine to fail was the E0 Verado-serial number 1B812775. At 177 hours of WOT endurance (204.2 total engine hours) the engine was shut down for a routine oil check. An excessive amount of water was found in the oil. The engine was disassembled and the major components were pressure checked. A leak path was discovered from the water jacket to the intake port on one cylinder. The cylinder head was sectioned and an oxide fold line from the casting process was discovered. This defect was present from the time of the original casting process and took thermal cycling, load, and time to cause a leak. It was in no way associated with the fuel.

E0 Engine #2-Test Facility-Induced Failure: An additional engine was obtained to replace the original E0 engine and this engine was given the serial number 1B821775A. This engine did the initial dyno tests and was put on endurance. After 88.7 hours of WOT endurance (98 total engine hours), the engine was automatically shut down by the endurance facility control system for low exhaust gas temperature. Investigation showed water entering the exhaust stream. The engine was then disassembled and a significant amount of mineral deposits were found in the cooling passages, especially in the exhaust collector on the cylinder head. See Figure 23. [Note: For a coolant fluid, outboard engines draw in water from the body of water they are operating in, which in this case was the endurance test tank.] An interaction between the pH and hardness of the water in the test tank created conditions that precipitated out minerals (primarily calcite) when exposed to the elevated temperatures in the cooling passage, especially near the exhaust collector. The blocked passages prevented adequate cooling in the exhaust collector, which eventually failed the head gasket and allowed water to enter into the exhaust stream. See Figure 24. It should be noted that these water chemistry conditions were specifically caused by the test facility water conditioning and would not be something that the engine would experience in real-world use.

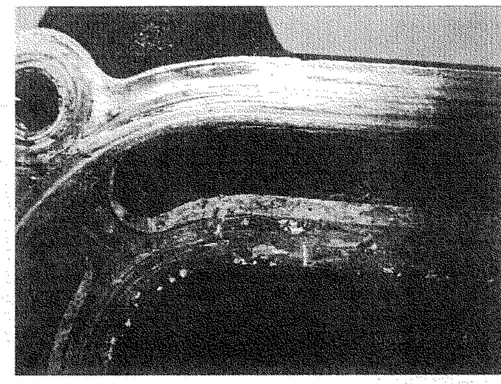


Figure 23: Mineral Deposits in Cooling Jacket, E0 Verado 1B812775A

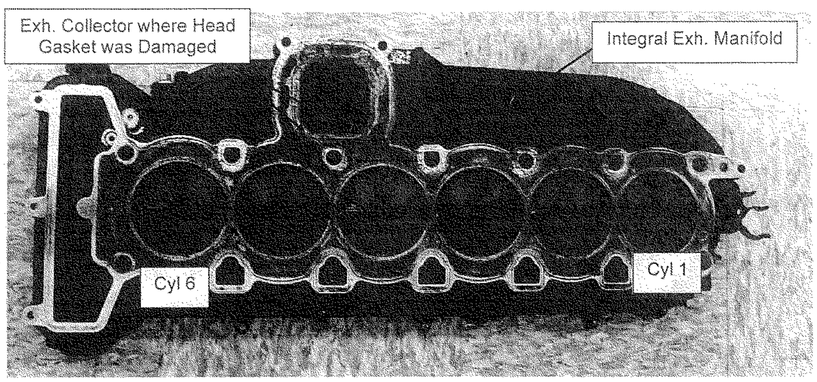


Figure 24: Verado Cylinder Head Indicating Where Head Gasket Failure Occurred, E0 Verado 1B812775A

E15 Engine: At 285 hours of endurance operation (323 total engine hours), the E15 Verado test engine (serial number 1B812776) was noted to have rough idle after restarting shortly after maintenance was performed. A compression check was performed showing no compression on cylinder 3. During disassembly a broken exhaust valve was found in cylinder #3. Further investigation found that the other exhaust valve on cylinder 3 had developed a crack, as well as one of the exhaust valves in cylinder 6. See Figures 25 and 26. NOTE: The images shown in Figure 26 of the cracked exhaust valves had been cleaned of deposits prior to photography.

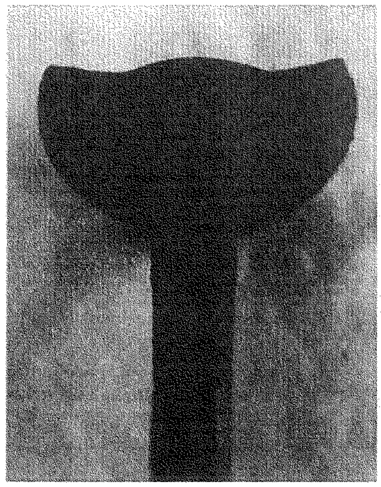


Figure 25: Broken Exhaust Valve from E15 Verado 1B812776, Top Valve in Cylinder 3

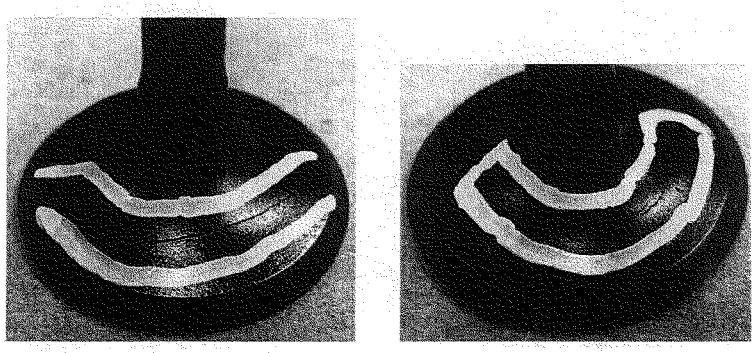


Figure 26: Cracked Valves from E15 Verado 1B812776, Bottom Valve in Cyl. 3 Left, and Top Valve in Cyl. 6 Right

The cracked valves and several valves without cracks from the E15 Verado were analyzed in Mercury's materials laboratory. The cracked valves were visually inspected with an optical stereoscope. The fatigue initiation sites were clearly identified. Figure 27 shows an example of the images of the initiation sites from the bottom exhaust valve from cylinder 3.

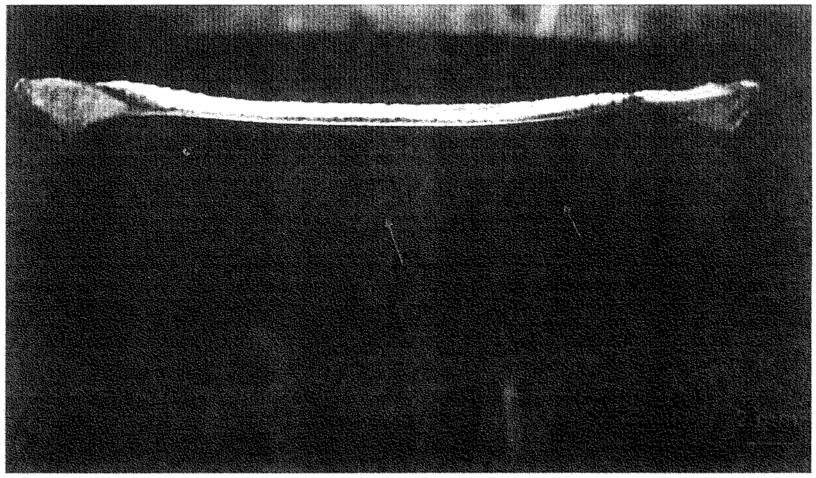


Figure 27: Fatigue Initiation Sites on Cylinder 3 Bottom Exhaust Valve, E15 Verado 1B812776

In addition to finding the fatigue initiation sites, the failed valves were checked for hardness. The cracked valves from the E15 engine were found to have hardness values much lower than new valves and below the minimum print specification of a new valve. Other sample valves were collected and analyzed from WOT endurance Verado engines that were run on E0 pump fuel during the same general timeframe as the E15 engine was run. In addition, samples of new valves were also acquired and analyzed. The hardness measurements showed that the valves from the engines operated on E0 fuel were actually harder than the new valves. The summary of hardness measurements are shown in Table 4. Note: All of the measurements were taken in the Rockwell A scale and converted to the Rockwell C scale due to the fact that the samples were mounted and polished to perform hardness measurements in the center of the cross section. This would negate any hardness effects from the mounting material.

Table 4: Verado Exhaust Valve Hardness Measurement Summary

Valve Description	Hardness (HRC)
E15: 1B812776 Cyl 3 Bottom	22
E15: 1B812776 Cyl 6 Top	22
E0: 1B812775 Cyl 3 Bottom	37.5
E0: 1B812775 Cyl 3 Top	36.5
E0: 1B812775A Cyl 3 Top	38
E0: 1B828629 Cyl 2 Top	37.5
New Valve #1	34.5
New Valve #2	34.5
New Valve #3	33
New Valve #4	33
New Valve #5	33.5

The Verado exhaust valves are made from Inconel 751, which is a heat-treatable alloy. This trait was used to estimate the metal temperatures experienced by the valves. The valve hardness data in Table 4 collected from the E0 engines suggested that the metal temperatures experienced during operation were in a range that allowed age-hardening of the metal to make the valves increase in hardness. The hardness values of the E15 engine valves suggested that they were operating in a temperature regime that significantly reduced the hardness. In order to understand the hardness versus temperature, the new valves that were hardness checked were heated in an oven for 24 hours at various temperatures and then hardness was checked again. Figure 28 shows the results from the oven heating operation on the new valves. In Figure 28, the blue line shows the hardness data of the new valves before heat treatment and the red line shows the hardness data of the valves after heating. At metal temperatures above 870°C, the valves showed a dramatic decline in hardness according to this test data. The data suggest that the exhaust valves from the E15 engine may have experienced temperatures nearing 900°C.

One possible mechanism by which the E15 exhaust valves may have experienced such high temperatures would be a disruption of valve cooling during the portion of the cycle where the valve should be fully seated. During inspection, it was noted that several cam lobes showed wear and marking on the base circle portion of the lobe indicating that the exhaust valves had run out of lash. This suggested that excessive wear or valve head deformation may have occurred during operation, which caused the lash to diminish. This would have prevented the valve from seating properly resulting in a significant valve temperature increase due to lack of cooling on the seat. The valves or seats may have also had accelerated wear to diminish the lash due to lack of lubricity of the E15 fuel or because of the elevated temperatures caused by the lean operation on E15 fuel. In addition, if the exhaust valves were experiencing higher operating temperatures due to the higher exhaust gas temperatures from using E15 fuel, the overall length of the valve would be slightly longer. This longer length during operation would also reduce the amount of lash in the valvetrain and make the engine more prone to base circle contact on the cam. Plots comparing the measured cold valve lash over the course of endurance between the E0 and E15 engines are shown in Figures 32 and 33 below.

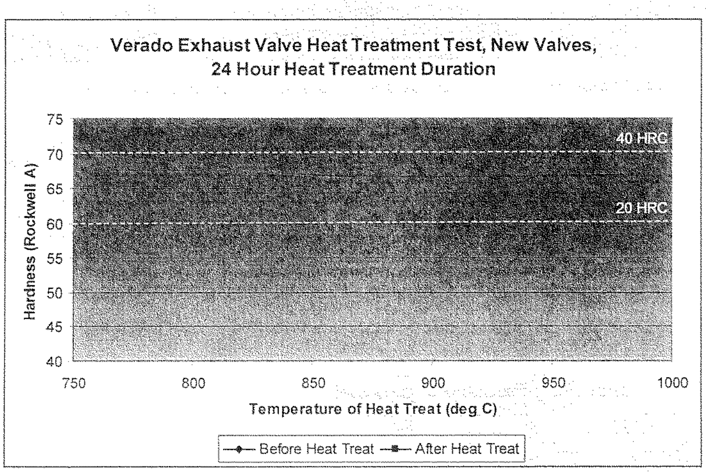


Figure 28: Heat Treatment Test of New Verado Valves

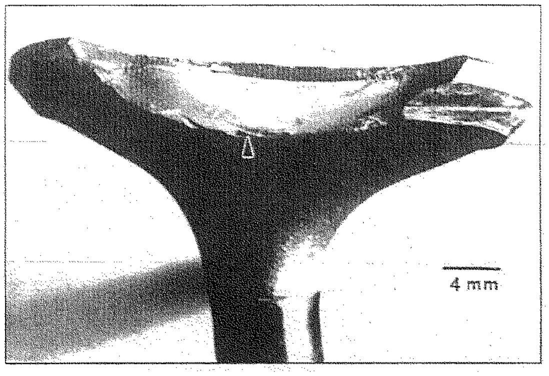


Figure 6.8 Example of valve fillet fractures due to overstress, at elevated temperatures, and a corrosive environment; the arrow shows the crack initiation site at the fillet (Wang et al.).

Figure 29: Exhaust Valve Failure from Literature Research Showed Similar Failure Mechanism [8]

Similar failure mechanisms were found in a literature search as shown in Figure 29. The failure is noted as a classic over-temperature failure. *"High temperatures and a corrosive environment at the exhaust fillet substantially weaken the valve strength."*[8] from: Introduction to Engine Valvetrains by Yushu Wang

Extensive development went into the valvetrain on this high-output engine. Upgrading the engine to account for higher exhaust gas temperatures due to a wider range of fuel properties would not be easily accomplished. The current production Verado exhaust valve is Inconel 751, which is categorized in the "superalloy" material classification.

It should be noted that the E15 engine (1B812776) was operating for a period of time when the mineral precipitation problem occurred on the second E0 engine (1B812775A). However, it is not believed that this contributed to the valve failure. The E15 engine (1B812776) did have some accumulation of precipitation flakes in the exhaust collector area, but not nearly to the extent that the E0 engine did. The E15 engine (1B812776) was not operating the entire time the E0 engine (1B812775A) ran when the mineral precipitation problem occurred. The head was sectioned and there were no mineral precipitation deposits on cooling jacket surfaces in cylinder 3 where the worst valve failure occurred. See Figure 30 for a picture of the sectioned head from the E15 engine (1B812776) showing no mineral deposits were present. Yellow spots in the cooling jacket were anti-corrosion coating from production where the paint did not fully coat interior surfaces of the cooling jacket. Figure 31 shows the same section of cylinder head from the E0 engine (1B812775A) that failed due to the mineral precipitation. This E0 engine (1B812775A) was also inspected for cracked exhaust valves and none were found. In addition, the hardness values of the exhaust valves were measured (see Table 4) indicating that the mineral precipitation issue did not affect the valve hardness on the E0 engine (1B812775A). There were several other Verado engines that were running endurance testing for a different project that failed due to the mineral precipitation issue. All other Verado engines that failed due to the mineral precipitation failed the head gasket in the exhaust collector area.

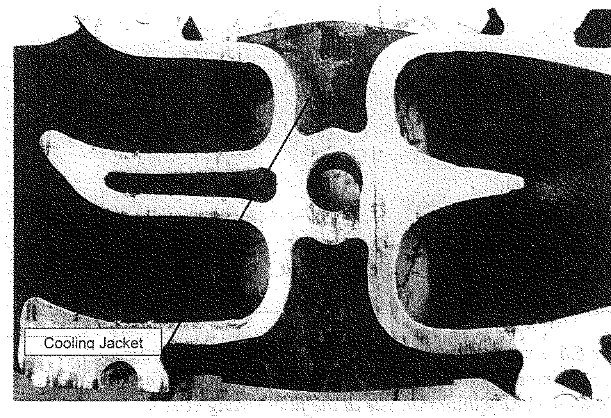


Figure 30: Photo of Section of Cylinder 3, E15 Verado 1B812776, Exhaust Ports on Left

Figure 31: Photo of Section of Cylinder 3, E0 Verado 1B812775A, Exhaust Ports on Left

E0 Substitute Engine: In lieu of a completed test on E0 fuel, a substitute engine was chosen that had already been through endurance testing (serial number 1B828592). The engine that was used as a substitute had completed 372 hours of WOT endurance testing and was still intact. It ran in the same test facility running under the same test procedure as all other endurance testing as part of this project. The engine was used for a gearcase durability test for a different project so the rest of the engine was completely stock and built on the production line as were the other engines in this project. As such, it provided a suitable replacement for the incomplete E0 tests. For reference, the replacement engine (1B828592) was on test between the following dates: 11/15/2010 through 12/14/2010. The E15 engine 1B812776 was on test between 9/21/2010 through 11/12/2010.

As part of routine maintenance and checks during endurance, several valve lash measurements were taken at various intervals on the E0 substitute engine. Figures 32 and 33 below show the lash measurements during the course of endurance for both the E0 substitute engine (1B828592) and the E15 engine (1B812776), respectively. The solid red lines in the graph indicate the upper and lower lash specification on a new engine. It is clear from the lash measurements on the 2 engines that the E15 engine had a significantly faster decline in lash than the E0 substitute engine. The E0 substitute engine had 1 valve with higher lash value at the end of testing. There may have been some carbon or other deposits holding this valve off the seat during the measurement.

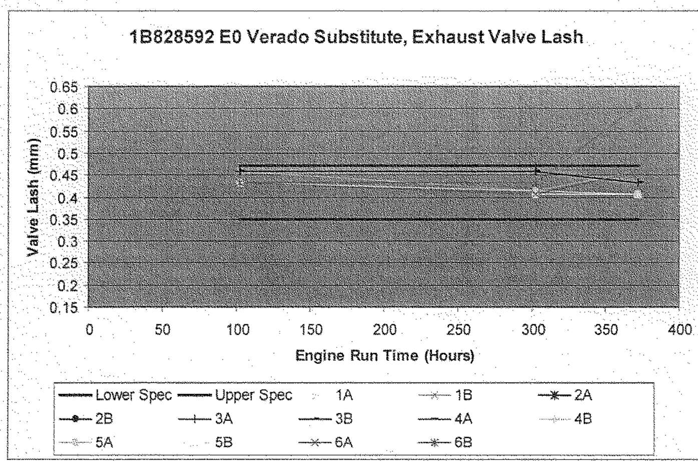


Figure 32: Exhaust Valve Lash (Measured Cold) vs. Endurance Time, E0 Substitute Engine

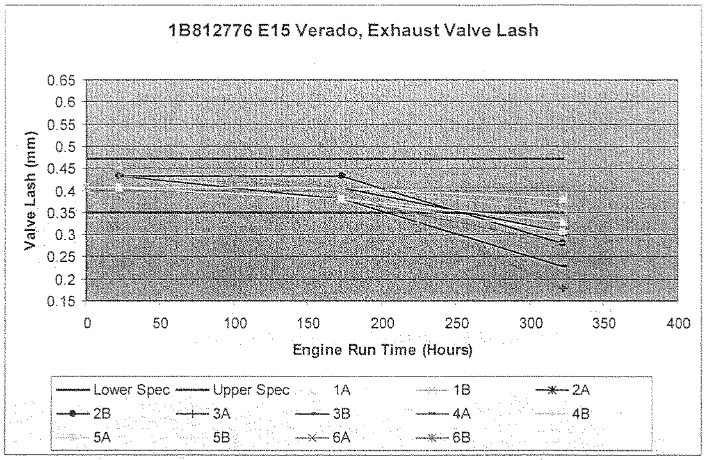


Figure 33: Exhaust Valve Lash (Measured Cold) vs. Endurance Time, E15 Engine

Emissions Testing Results

Due to failures of both the E0 and E15 engines, a complete analysis of the deteriorated emissions was not possible. However, with the data available several conclusions could be made. Figure 34 shows a graph of the Verado emissions that were collected. As was the case for the 9.9HP emissions data plots, each data point on the curve represents the average emissions value of the 3 emissions tests performed at each interval with error bars showing the range of the 3 emissions tests. The dashed yellow line shows the data from the original E0 engine (serial number 1B812775). The solid red and blue lines show the emissions data from the E15 engine (serial number 1B812776) using E15 and E0 (EEE) fuels, respectively. The single point in light blue at 372 hours shows the end of test emissions results for the substitute E0 engine (EEE fuel, serial number 1B828592). The graph shows a generally declining HC+NOx trend for the 2 original engines which is typical of Verado engines. The declining emissions trends on both engines would suggest that the ethanol fuel blend did not adversely affect the emissions deterioration on the Verado engine. The most notable aspect of the emissions output on the E15 engine was the fact that the total HC+NOx on E15 fuel was above 25 g/kw-hr, whereas the value on EEE-E0 was 21.5 g/kw-hr. The Family Emissions Limit (FEL) was set to 22 g/kw-hr for this engine family. A Verado engine generating 25 g/kw-hr would have failed an emissions audit. The increase in emissions can be primarily attributed to a significant increase in NOx due to the lean operation. Since the Verado is a highly boosted engine it is very sensitive to NOx generation due to changes in equivalence ratio. However, there was also an increase in HC emissions due to the E15 fuel, which would not be expected with a leaner equivalence ratio.

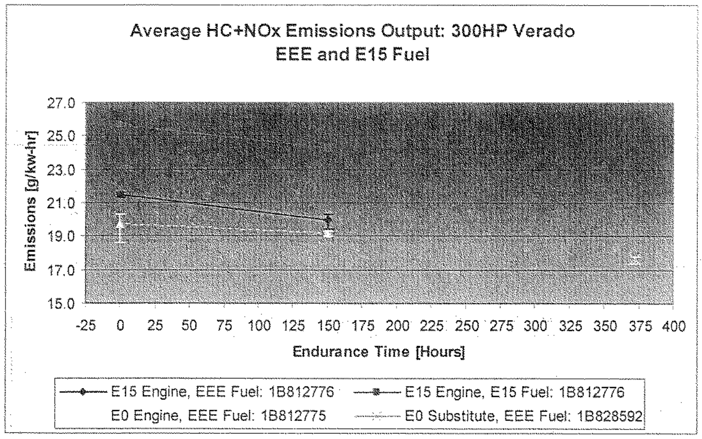


Figure 34: 300HP Verado HC+NOx Emissions Results Summary

In order to better understand the differences in the emissions outputs between the 2 fuels, graphs were made for each constituent of interest. Figures 35 through 37 show the NOx, HC, and CO emissions differences. The graphs were broken down by mode point for emissions tests performed prior to endurance on the E15 engine (1B812776). The values shown are the averages of the three repeated runs at "zero" hours.

Figure 35 shows the NOx emissions trends for the 2 fuels. The main differences were at Modes 1 and 2 which were both high load, boosted operating points. The fact that the NOx increased significantly with a lean shift due to the ethanol fuel blend was not surprising. Modes 3 and 4 did not show much difference because the engine was calibrated near an equivalence ratio of 1 on E0 fuel. The NOx trend with respect to equivalence ratio was near the peak at these points so a lean shift did not result in a significant change in NOx. Mode 5 was idle so the NOx generation at that point was essentially zero.

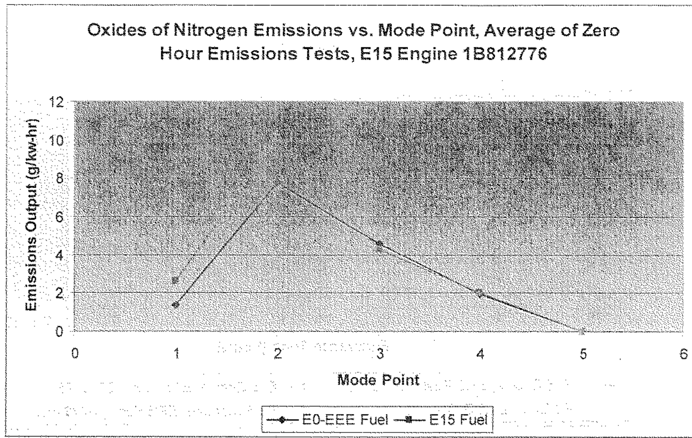


Figure 35: 300HP Verado NOx Emissions Results by Mode Point, Representative Zero Hour Test Data

The increase in HC output on E15 fuel was not an expected outcome of the test. Figure 36 highlights the difference in HC emissions between the 2 fuels. The main difference occurred at Mode 3, so further investigation was necessary into Mode 3 data specifically. However, it was also apparent that the HC output on E15 fuel was higher at Modes 1-4 despite the leaner operation from the fuel chemistry. This may suggest that the vaporization of the E15 fuel was inferior to that of the EEE fuel leading to poor fuel preparation. This is supported by data from Modes 1 and 2 where NOx and CO trends show that the engine did run leaner, yet had higher HC output when operated with E15.

The HC difference at Mode 3 was likely a result of the engine running substantially leaner than lean best torque (LBT). In this operating region, the Verado engine is calibrated slightly lean of the stoichiometric mixture on E0 fuel. With the use of E15 fuel, the engine operates significantly lean of LBT and, therefore, the torque production diminishes significantly. As a result, to achieve the specified torque set point for Mode 3 the throttle input had to be increased, yielding higher airflow and higher fuel flow. The fuel flow increased nearly 10% for essentially the same torque production with E15 fuel. In addition, it was noted that the intake air temperature was 12°C cooler at Mode 3 with E15 fuel. The cooler charge temperature was likely a result of the increased fuel vaporization cooling effect from the ethanol. The cooler temperatures in the intake may have impaired fuel preparation. The higher fuel flow combined with the inferior fuel preparation was likely the cause of the high HC output at Mode 3.

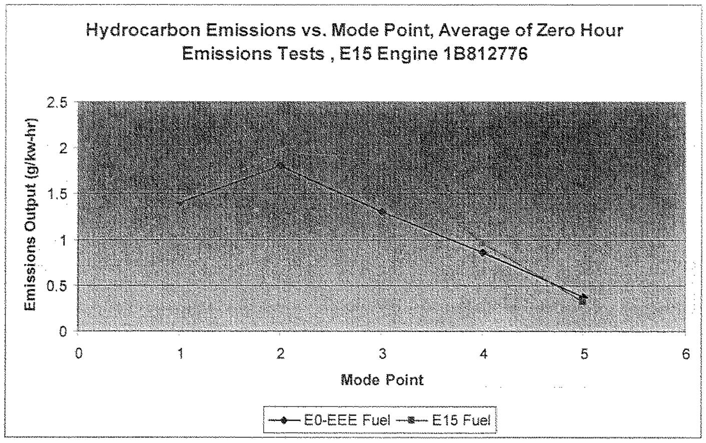


Figure 36: 300HP Verado HC Emissions Results by Mode Point, Representative Zero Hour Test Data

The CO emissions vs. emissions test mode point are shown in Figure 37. There was a significant reduction in CO emissions at Modes 1 and 2 when the engine was operated on E15 fuel, as expected. Modes 1 and 2 are calibrated rich of a stoichiometric mixture on E0, so the enleanment from E15 caused a reduction in CO. Modes 3-5 are generally insensitive in regard to CO because the operating points are calibrated near the stoichiometric mixture, so leaning the engine out due to the fuel had little effect at reducing CO relative to the changes seen at Modes 1 and 2.

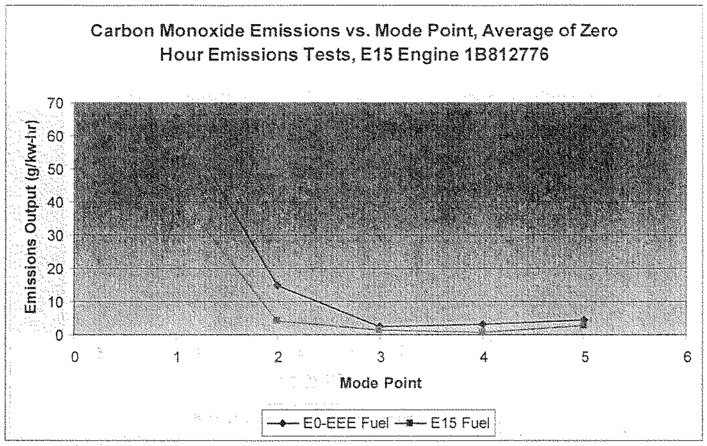


Figure 37: 300HP Verado CO Emissions Results by Mode Point, Representative Zero Hour Test Data

Engine Performance Comparison

Due to the engine failures, a complete comparison of engine performance vs. run time was not possible. The normalized power and torque data from the E0 Verado is shown in Figure 38. The changes from zero hours to 150 hours were less than 1% for peak torque (negligible) and a 2.3% reduction in peak power. The E0 engine produced less power output than the E15 engine when operated on the same E0 fuel. This difference of approximately 2% is considered normal production engine-to-engine variability.

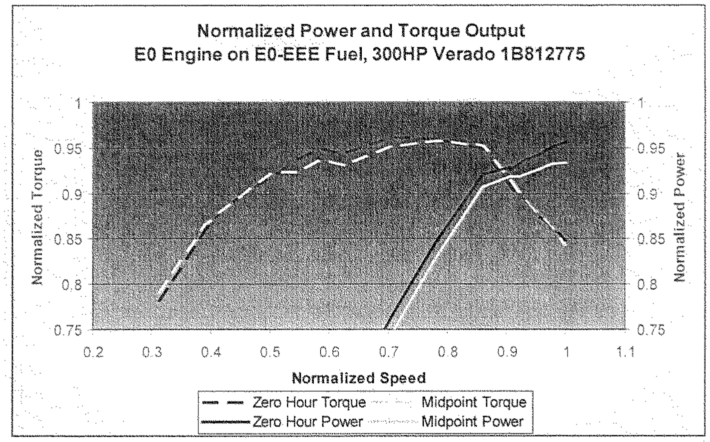


Figure 38: E0 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 Fuel

Power and torque data (normalized) for the E15 engine on both EEE-E0 fuel and E15 fuel is shown in Figure 39. There was an improvement in peak torque of 3.0% and in peak power of 1.5% when comparing the zero hour and midpoint runs on E0-EEE. The E15 engine showed negligible differences when comparing the midpoint power runs on E0-EEE and E15. It is unclear why this engine seemed unresponsive to the differences in charge cooling afforded by the ethanol blend fuel. Note: There was not a power run completed on E15 fuel at the initial zero hour measurement, which is why the midpoint data is compared in these figures.

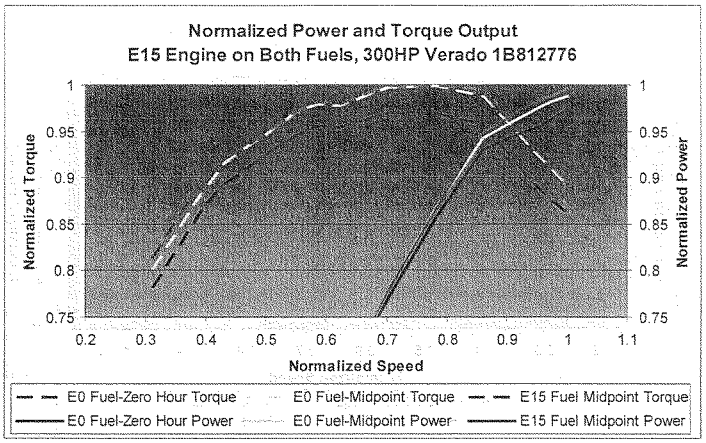


Figure 39: E15 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 and E15 Fuel

Figure 40 shows the difference in exhaust gas temperatures during power runs at the midpoint check on the 2 different fuels. There was up to a 30°C increase in EGT when operating on E15 fuel.

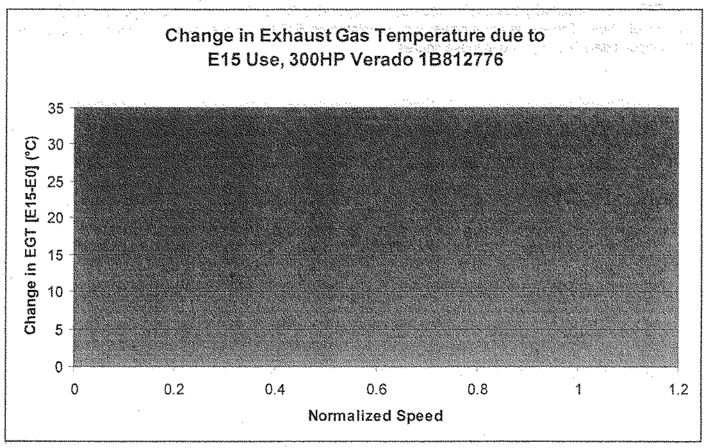


Figure 40: E15 Engine-Exhaust Gas Temperature Change at Wide Open Throttle, EEE-E0 to E15 Fuel

End of Test Teardown and Inspection

After all running engine tests were completed, the engines were disassembled and inspected. There was visual evidence that some of the internal components from the Verado E15 engine had experienced higher operating temperatures.

Upon disassembly, there were differences noted in the condition of the pistons from the 2 engines. Figure 41 shows pictures comparing the pistons from cylinder 2 from each engine. The piston from the E15 engine had a significantly higher amount of oil staining and carbon deposits than the piston from the E0 engine. The staining and deposits were noted on nearly every surface of the E15 piston compared with the E0 piston. Additionally, the pistons were sent to the metallurgy lab for hardness measurements. The hardness measurements were taken at several locations on the crown of the piston as well as a location on the internal portion of the piston just above the wrist pin bore after being sectioned. The average crown hardness of the E0 piston was 67.5 BHN (Brinell Hardness Number) while the E15 piston crown was 66.9 BHN. The internal piston hardness above the wrist pin bore was 74.1 BHN for the E0 piston and 71.5 BHN for the E15 engine's piston. Although the hardness measurements showed no effect of operating temperature on material properties, differences in visual appearance suggest that the E15 pistons operated at higher temperatures during running than the E0 pistons.

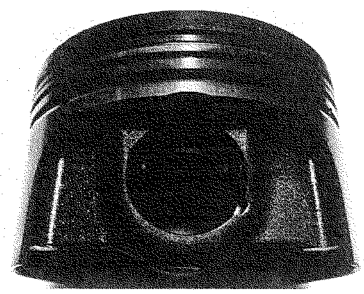


Figure 41: Piston Carbon Deposit Comparison, Cylinder 2, E0 on Left, E15 on Right

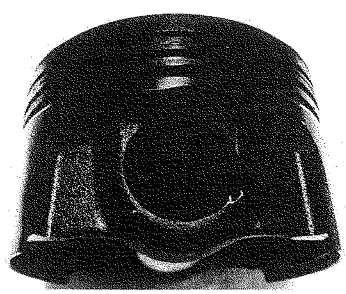


Figure 42 shows the small end of the connecting rods from each engine. The carbon deposits indicate that the E15 rods likely ran at higher operating temperatures. The carbon deposits on the rods are consistent with the carbon deposits observed on the pistons.

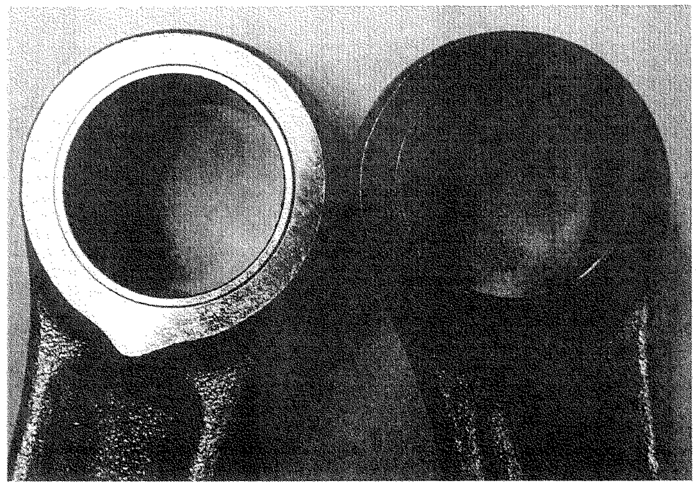


Figure 42: Connecting Rod Carbon Deposit Comparison, Cylinder 2, E0 on Left, E15 on Right

The exhaust valves were also closely inspected on the substitute E0 engine in order to compare with the valves that cracked on the E15 engine. With 372 hours of endurance aging time accumulated, no cracked valves were discovered during inspection under a microscope. The average hardness values of the exhaust valves from cylinder three of the E0 engine were 37.3 and 37.7 HRC. These values were consistent with other engines that were operated on E0 as indicated in Table 4.

During disassembly, the E15 engine was noted as having base circle contact on several of the exhaust cam lobes as noted above. The exhaust cam lobes from the substitute E0 engine did not show signs of base circle contact. The lash measurements shown in Figures 32 and 33 support these observations. A picture showing the difference in wear on the base circles of the exhaust cam lobes can be seen in Figure 43. The picture shows the E15 exhaust cam on the right and the E0 cam on the left. The wear pattern on the E15 exhaust cam lobe is apparent.

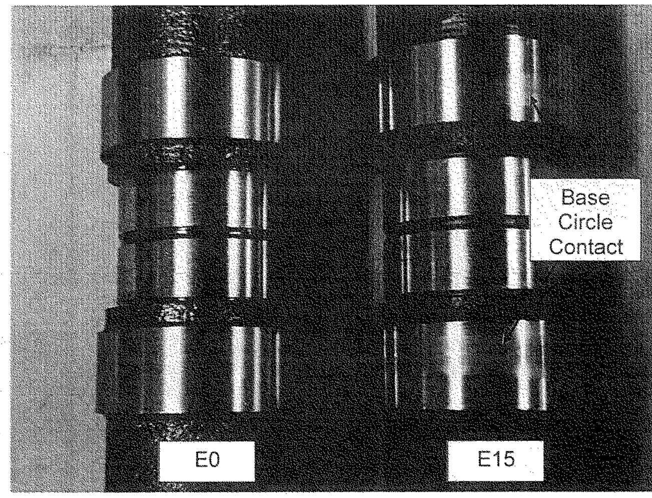


Figure 43: Exhaust Cam Lobe Base Circle Detail, Cylinder 3, E0 on Left, E15 on Right

200 EFI Two-Stroke:

Endurance Test Results

An engine failure prevented successful completion of the full endurance period for the 200 EFI E15 engine. The 200 EFI E15 engine failed a rod bearing before the completion of the endurance test. The 200 EFI E0 engine completed the 300 hour endurance test and all post-endurance dynamometer tests.

The E15 endurance engine failed at 283 total engine hours and had accumulated 256 hours of WOT endurance at the time of failure. Upon inspection it was found that the big end connecting rod bearing had failed on cylinder 3. The rod cap was still bolted to the rod after the failure. This engine family uses a fractured rod cap design with a roller bearing (typical for a two-stroke vs. a plain bearing in a four-stroke). Images of the remaining bearing cage and the damaged rod along with undamaged pieces for reference are shown in Figure 44. No rollers were found during teardown and were likely ejected from the bearing and made their way through the power cylinder and out the exhaust. There was extensive damage to the top of the piston on cylinder 3 indicating that the rollers went through the power cylinder. Due to the extensive damage to the bearing and connecting rod (since it failed at rated speed, full power) and the fact that not all of the pieces were recovered, root cause of the bearing failure was not conclusively determined. Little is known about the effects of ethanol blends on oil/fuel mixing and dispersion on total loss lubrication systems, such as the one on this engine family. More investigation is needed to understand if ethanol would negatively impact the lubrication systems on two-stroke engines.

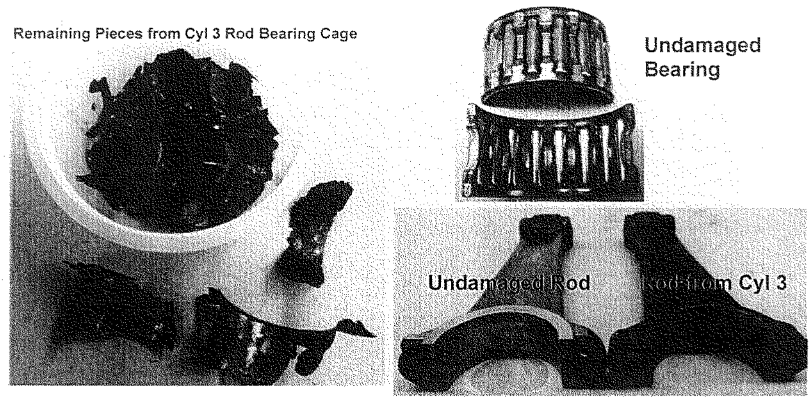


Figure 44: 200HP EFI Bearing Failure Pictures

Emissions Testing Results

As a result of the engine failure, a complete set of emissions data was not collected on the 200 EFI. However, conclusions can be drawn from the data that were collected. Figure 45 shows a summary of HC+NOx results from the emissions test on both engines. As Figure 45 shows, there was more variability in the E0 engine than on the E15 engine. E15 fuel did not have a detrimental effect on emissions degradation on this engine family. It is worth noting that of the roughly 120 g/kw-hr of HC+NOx, the NOx contribution is approximately 2 g/kw-hr. Since the HC is roughly 98% of the total HC+NOx, graphs depicting the changes in the individual constituents were left out of this report. The relative enleanment from the E15 fuel did slightly increase the NOx emissions, but that was not significant in comparison with the HC contribution.

The CO emission results from the 200 EFI engines are shown in Figure 46. The E15 fuel resulted in lower CO emissions, as expected due to the relative enleanment from the difference in fuel chemistry. Both engines and both fuels showed the same trend of increasing CO with more endurance time.

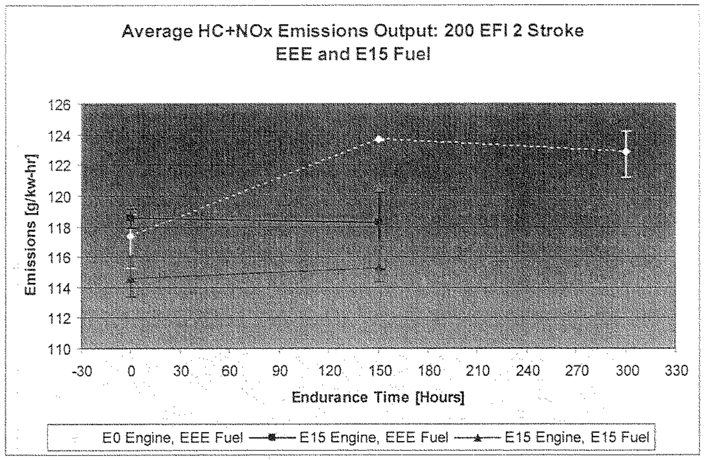


Figure 45: 200HP Two-Stroke HC+NOx Emission Results Summary

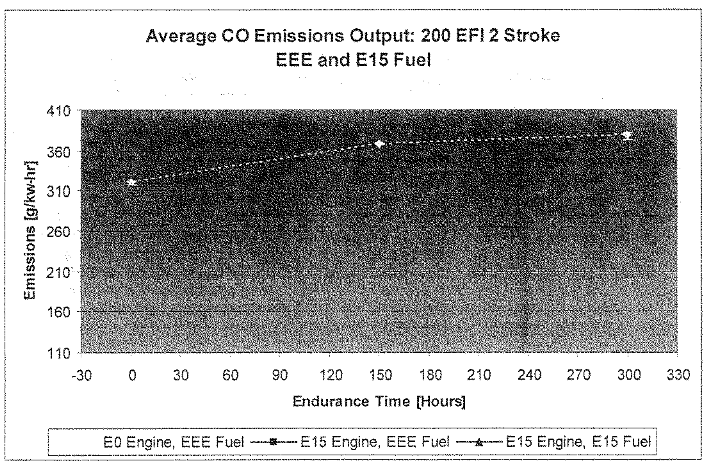


Figure 46: 200HP Two-Stroke CO Emission Results Summary

Engine Performance Comparison

The power and torque data (corrected per ISO 3046-1) from the E0 200HP EFI engine are shown in Figure 47. There were slight differences in the curves, but the changes from zero hours to 300 hours were less than 1% for both peak torque and peak power.

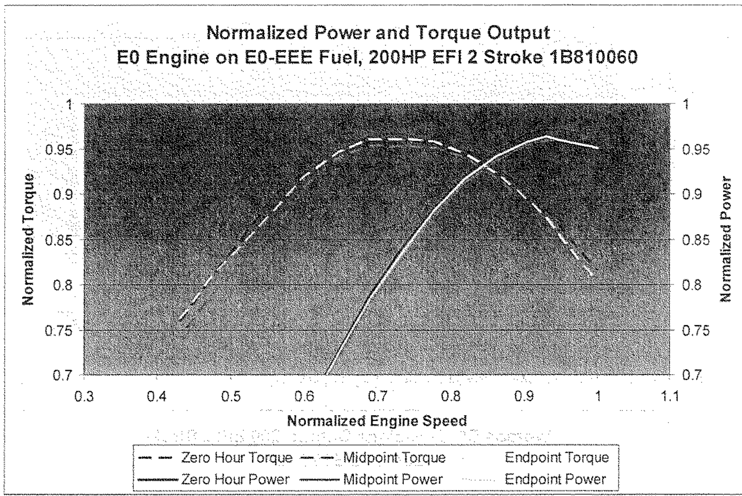


Figure 47: E0 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 Fuel

Data for the E15 engine on both EEE-E0 fuel and E15 fuel are shown in Figure 48. A comparison of the output at the zero hour and 150 hour checks are included. Similar to the E0 engine, there was less than a 1% change from the zero hour check to the 150 hour check for both the peak torque and peak horsepower for either fuel. There was an increase of approximately 2% in both peak torque and peak power when changing from E0 to E15 fuel. The engine may have been operating in a range closer to the Lean Best Torque on the E15 fuel due to the enleanment from the fuel change and/or the volumetric efficiency may have been better due to the additional charge cooling of the ethanol fraction. Figure 49 shows the difference in exhaust gas temperatures during the same power runs on the 2 different fuels. Since this was a 6 cylinder engine and individual cylinder measurements were possible, the average and maximum changes in EGT were plotted for clarity. On average use of the E15 fuel resulted in a 15-20°C increase in EGT in the range of frequent steady-state operation (>4500 RPM). The maximum increase in EGT for any individual cylinder when using E15 was 28°C.

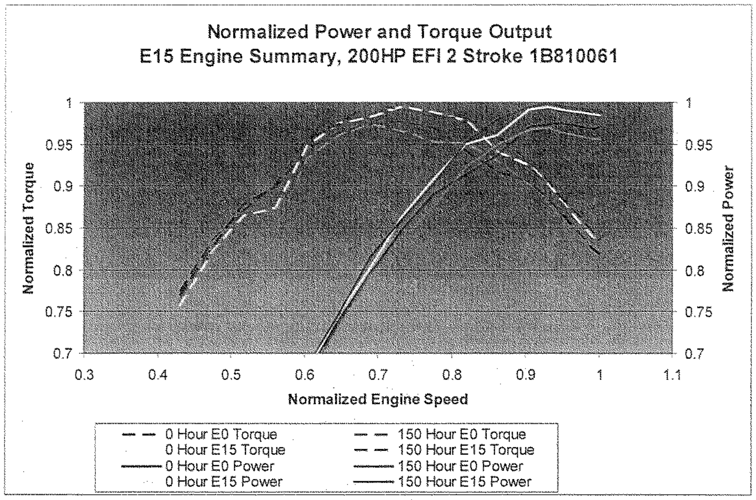


Figure 48: E15 Engine Power and Torque Output at Endurance Check Intervals-EEE-E0 and E15 Fuel

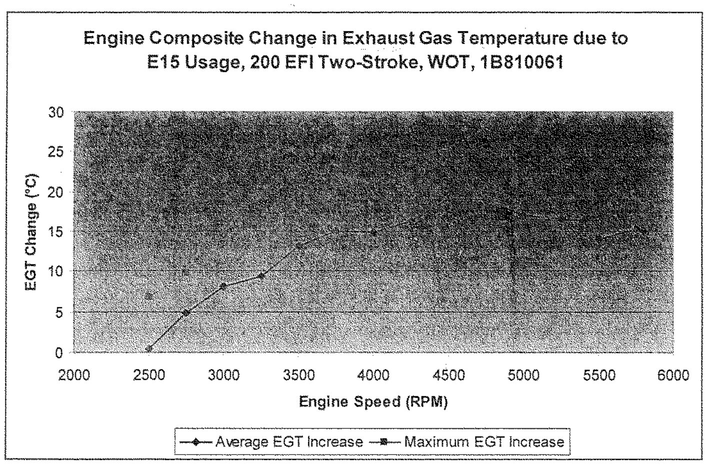


Figure 49: E15 Engine-Exhaust Gas Temperature Change at Wide Open Throttle, EEE-E0 to E15 Fuel

End of Test Teardown and Inspection

As was the case for the other engine families, the main areas of focus during teardown were looking for signs of wear and also material compatibility issues. Visual inspection of the components of the 2 engines did not suggest significant differences between them (aside from the rod bearing failure). In particular, the bore finish, carbon deposits, bearings from the small and big end of the rod, and main bearings were inspected for signs of mechanical or thermal distress and accelerated wear. No significant differences were noted aside from slight differences in the appearance of the wrist pins, as shown in Figure 50.

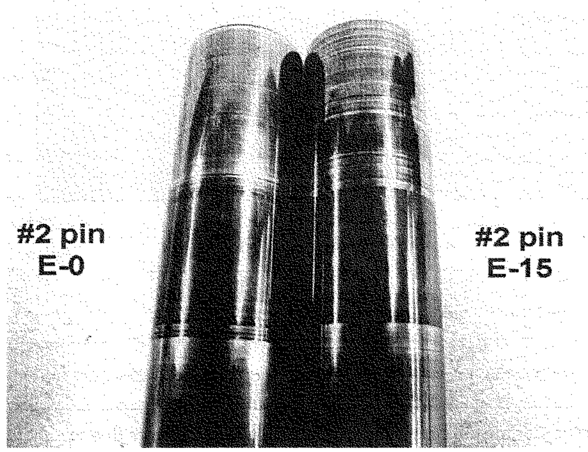


Figure 50: Cylinder 2 Wrist Pin Comparison, E0 on Left, E15 on Right

To provide a more in-depth analysis, selected components were further inspected. Using the same techniques as applied to the 9.9HP four-stroke components, the pistons and wrist pins from cylinder 2 on the 200HP EFI two-stroke engines were checked for material hardness. The results can be seen in Table 5. There were no significant differences in the hardness between the wrist pins, but there was a slight difference in hardness of the pistons (6.3%). The lower hardness of the piston on the E15 engine suggested it may have been running at higher temperatures. The nature of two-stroke engines causes them to be very sensitive to piston fit/piston temperature. An increase in piston temperature caused by fuel differences could cause increased propensity for power cylinder failures for customers. The slight difference in hardness was near the limit of repeatability for the test method so the results should be considered an indicator only. More testing would be necessary to gain confidence with a statistically significant sample size.

Table 5: Hardness Measurements on Various 200HP EFI Two-Stroke Engine Components

2.5L 200HP EFI	Hardness Scale	E0 1B860010	E15 1B810061	Percent Difference
Piston Wrist Pin, Cyl 2	Rc	54.7	54.1	1.1%
Piston Crown, Cyl 2	BHN	63.0	59.0	6.3%

In addition, the high pressure fuel pumps from both engines were sent to the pump manufacturer for flow testing. There were no significant differences in pump output between the 2 pumps, and they were within expected flow ranges for end of life components.

Additional Testing

4.3L V6 Catalyzed Sterndrive Emissions Comparison

Since the E15 fuel and a catalyzed engine were both readily available in the test lab, additional testing was performed beyond the test program requirements. Emissions tests were performed on E0-EEE fuel and E15 test fuel to determine any immediate impacts of increased ethanol for this engine family. No durability testing was performed. The 4.3L V6 sterndrive engine (General Motors V6 that was adapted and modified for marine use) was equipped with closed-loop electronic fuel injection and exhaust catalysts. The standard calibration for this engine in Mode 1 operation (rated speed and power) was such that the engine ran rich of stoichiometric to control exhaust gas temperatures. This is a common engine control approach to protect components during high power operation. For the type of exhaust gas oxygen sensor used on this engine, rich operation allows for no feedback control of the fuel air mixture. As such, the engine ran open-loop at Mode 1. All other modes ran closed-loop. The 5 mode HC+NOx and CO emissions totals were lower on E15 fuel due to the fact that the engine ran approximately 4.5% leaner on the E15 fuel at Mode 1. The HC+NOx at Mode 1 changed from 1.18 g/kw-hr on EEE to 1.10 g/kw-hr on E15. This small reduction was driven by the reduction of HC emissions. The NOx emissions increased on E15, but not as much as the HC decreased, yielding an overall lower total. The CO at Mode 1 was reduced from 45.6 g/kw-hr on EEE to 29.8 g/kw-hr on E15. The reduction of CO was attributed to the leaner operation at Mode 1. The HC+NOx and CO values for the remainder of the mode points were essentially the same since the closed loop fuel control allowed the engine to run at the same equivalence ratio. See Figure 51 for details of the emissions outputs.

The leaner operation at wide open throttle (Mode 1) caused an increase in exhaust gas temperatures when operating on E15 fuel. The exhaust gas temperature increase across all 6 cylinders was approximately 20°C. The elevated EGT during WOT operation could cause valvetrain durability issues. The catalyst temperatures were approximately 32°C higher at Mode 1 with E15 fuel. This increase in catalyst temperature at WOT would likely cause more rapid deterioration of the catalyst system leading to higher exhaust emissions over the lifetime of the engine. The full impact of E15 on catalyst life would depend on the duty cycle of this engine in actual application. Typical duty cycles of marine engines include considerable amounts of time at WOT operation (open loop) so the catalyst temperature increase is of concern.

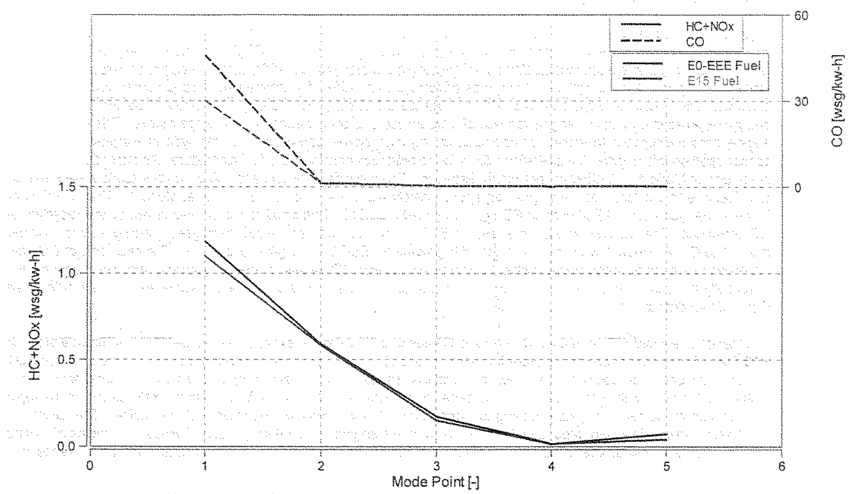


Figure 51: Emissions Comparison 4.3L V6 Catalyst Sterndrive, EEE vs. E15

The other aspect that was affected by running E15 on the closed-loop controlled engine was the fuel consumption. Since the closed-loop control system drove to an equivalence ratio, the fuel flow rate increased to account for the differences in fuel chemistry. Table 6 shows the fuel flow measurements by mode point along with the percent difference in fuel flow between the 2 fuels (positive values mean E15 fuel flow is higher). In closed-loop operation, the fuel flow increased 5.3% on average on E15 fuel. This increase in fuel flow causes concerns not just in fuel mileage, but also in useful range of the craft.

Table 6: Fuel Flow Comparison on 4.3L V6 Catalyst Sterndrive, EEE vs. E15

	EEE	E15	
Mode	Fuel Flow	Fuel Flow	Difference
	kg/hr	kg/hr	%
1	46.8	47.0	0.4%
2	24.2	25.5	5.3%
3	13.1	13.7	4.7%
4	7.1	7.5	5.2%
5	2.0	2.1	5.9%

Mode 2-4 Average 5.3%

Final Summary

Summary of Results:

EPA's recent announcement of a partial waiver approving E15 fuel for use in 2001 and newer cars and light trucks[9] will create an opportunity for consumers to misfuel their marine engines. This program indicates that misfueling currently available marine outboard engines may cause a variety of issues for outboard engine owners. These issues included driveability, materials compatibility, increased emissions, and long-term durability. There were also 2 examples of how the ethanol fuel caused an increase in fuel consumption.

9.9HP Carbureted Four-Stroke:

The E15 engine showed high variability in HC emissions at idle during the emissions tests at the end of the 300 hour endurance period. Both the E0 control engine and E15 test engine ran leaner at idle and low speed at the end of the endurance test. When operated on E15 fuel after 300 hours of endurance, the lean operation at idle coupled with the additional enleanment from the E15 fuel caused the engine to exhibit misfire and poor run quality (intermittent misfire or partial combustion events). A misfiring engine would cause customer dissatisfaction due to the inability to idle the engine properly, excessive shaking, and hesitation or possibly stalling upon acceleration. As it relates to this study, the misfire caused an increase in HC emissions at idle. This increase in HC variability at idle caused the average total HC+NOx to increase from the start to end of endurance, whereas the HC+NOx on E0 fuel on both engines showed a decreasing trend. As expected, the CO emissions were reduced when using E15 fuel due to the leaner operation.

The power and torque output of the E15 engine was higher with E15 fuel than with E0 fuel. The power and torque output of the E0 control engine increased slightly with more endurance time. The power and torque output of the E15 test engine showed a flat or declining trend with more endurance time.

The end of test inspection showed evidence of elevated temperatures on base engine components due to the lean running on E15 fuel. There were significantly more carbon deposits on several components of the E15 engine, indicating that these parts likely had higher metal temperatures during operation. Hardness measurements indicated that the pistons had higher operating temperatures on the E15 engine. The exhaust gas temperature increased 17°C at wide open throttle as a result of the leaner operation on E15 fuel.

The fuel pump gasket on the E15 engine also showed signs of deterioration compared with the E0 engine after approximately 2 months of exposure to E15 fuel.

300HP Four-Stroke Supercharged Verado:

The E15 Verado failed 3 exhaust valves prior to completion of the endurance test. One valve completely failed and 2 others had developed significant cracks. Metallurgical analysis showed that the valves developed high cycle fatigue cracks due to excessive metal temperatures. The majority of exhaust valves on the E15 engine lost a significant amount of lash which may have contributed to the observed valve failures. The exhaust gas temperature increased 25-30°C at wide open throttle due to the lean operation with E15 fuel.

In addition to the elevated temperatures on the exhaust valves, the pistons showed evidence of higher operating temperatures. The carbon deposit differences indicated that the E15 engine's pistons were hotter during operation.

The E15 Verado generated HC+NOx values in excess of the Family Emissions Limit when operated on E15 fuel, but did not exceed the limit when operated on EEE-E0. The primary contributor to the increase in exhaust emissions was the NOx due to enleanment caused by the oxygenated fuel. The CO emissions were reduced when using E15 fuel due to the leaner operation, as expected.

At emissions mode point 3, the lean combustion due to the E15 fuel caused the engine to lose torque output due to operation significantly leaner than LBT. As a result of the torque loss, the throttle input had to be increased 10% to maintain the same torque output as on E0-EEE fuel. The change in throttle input caused an increase in fuel flow of 10%. Mode 3 is representative of a typical cruising speed and load. The E15 fuel would cause the fuel consumption to be 10% higher at that operating point for a customer.

200HP EFI 2.5L Two-Stroke:

The 200HP EFI two-stroke engine showed no signs of exhaust emissions deterioration, though the emissions output after the full endurance testing was not measured due to a failure of the E15 engine. The primary driver of the HC+NOx emissions on this engine family was HC (approximately 98% of the HC+NOx total). As expected, since the E15 fuel caused the engine to run lean, the HC emissions were lower, as were the CO emissions. There was more variability of HC+NOx observed on the E0 engine than the change in emissions on the E15 engine. The deterioration of the CO emissions had similar trends between the 2 engines.

The endurance test of the E15 engine was stopped short of the 300 hour target due to a connecting rod bearing failure on cylinder 3. The root cause of the bearing failure could not be identified. More testing is necessary to understand the effects of ethanol on two-stroke engine lubrication mechanisms where the oil and fuel move together through the crankcase. The E0 engine completed the entire 300 hours of durability testing.

Other than the bearing failure, the end of test teardown and inspection did not show any visible significant difference between the 2 engines. Hardness checks performed on the pistons of both engines indicate that the E15 engine may have had higher piston temperatures, a concern on two-stroke engines where higher temperatures could lead to more power cylinder failures. The exhaust gas temperature increased 15-20°C on average due to the lean operation with E15 fuel.

4.3L V6 EFI Four-Stroke Catalyzed Sterndrive

Since E15 fuel was readily available in the test facility and an engine equipped with exhaust catalysts was on the dynamometer, emissions tests were conducted on a 4.3L V6 sterndrive engine. No durability testing was performed. At rated speed and wide open throttle the exhaust gas temperatures increased by 20°C on average and the catalyst temperatures increased by 30°C. This increase in catalyst temperature would likely cause more rapid aging and deterioration of the catalyst system at WOT. The overall effect of the increase in deterioration rate would be duty cycle dependent. The HC and CO values decreased at the Mode 1 (rated speed, rated power) emissions test point, which is an open loop operating point, due to leaner operation with E15 fuel, as expected. The fuel consumption increased by 4.5% at the operating points that were running in closed-loop fuel control.

Recommendations:

This test program was limited in scope in terms of operating conditions. More investigation is necessary to understand the effects over a broader range of conditions. Ethanol's effects on part load operation, cold start, hot restart/vapor lock, and overall driveability need to be evaluated. The wide range of technology available for marine engines due to the wide range of engine size will complicate this issue significantly. Mercury Marine produces engines from 2.5HP-1350HP with a wide array of technologies ranging from two-stroke or four-stroke; carbureted, EFI, or direct fuel injected; naturally aspirated, supercharged, or turbocharged; and more.

Ethanol's ability to absorb water into the fuel is of paramount concern for the marine market and this issue has not been addressed in this test program. The contaminants that water can bring with it, potentially saltwater, can cause severe corrosion in fuel systems. A leak or fuel system failure could cause the engine to be inoperable and leave the vessel stranded, which would obviously be a major dissatisfaction to the customer. In addition, a better understanding of the effects higher ethanol blends have on marine fuel systems in terms of materials compatibility and corrosion is needed. Marine vessels tend to have very long storage durations, can be stored in very humid environments, and will have more opportunities to have fuel system exposure to water, including saltwater.

More testing is needed to understand how ethanol blends affect oil dispersion in two-stroke engines that have fuel and oil moving through the crankcase together. Ethanol tends to be a good solvent and may break down lubrication at critical interfaces by cleansing these surfaces of the residual oil film.

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Written Testimony submitted by

Margaret Podlich, President, BoatU.S.

Regarding the Hearing entitled:

Up Against the Blend Wall: Examining EPA's Role in the Renewable Fuel Standard

June 5, 2013
2154 Rayburn House Office Building

June 4, 2013

Chairman Lankford, and Members of the Subcommittee,

On behalf of over half a million members of BoatU.S. (Boat Owners Association of the United States), I am submitting written comment to express my serious concerns with the impact that the Renewable Fuel Standard (RFS) has had, and will have, on boaters through the mandated use of higher blends of ethanol in our nation's gasoline supply.

Although the original expressed intent of the RFS was to utilize a suite of different renewable fuels, only corn-based ethanol has had the infrastructure to produce the volume required to meet the mandated consumption. Over 87% of the 2012 mandated 15.2 billion gallons was met with the use of ethanol. Although ethanol blended gasoline at the 10% level has proven to be a good oxygenate and acceptable fuel for automobiles, it has been a painful transition for marine engines.

While most BoatU.S. members believe strongly in energy independence and the importance of renewable fuels in our nation's fuel sourcing we have many members who have had significant engine malfunction. However, it is the chemistry of ethanol in particular that has plagued marine engines. Because ethanol is prone to binding to water molecules, it separates from the gasoline and sinks to the bottom of marine fuel tanks where the intake lines are generally located. With engines that don't get used everyday, and a fuel that attracts water, phase separation has been a reoccurring theme, resulting in an array of problems and engines that aren't reliable.

BoatU.S. has the nation's largest marine towing fleet for recreational boats that operates 600 towboats in 300 ports on a 24/7 schedule. Recently we asked our towers to share some of their experiences with ethanol gas at the 10% level. Here are a couple of their responses:

> "I would venture to say that maybe 20% of my tows are a result of ethanol fuel problems. Of the 20% of the ethanol tows probably 25% are urgent because the vessel is drifting out to sea or in peril with drifting hard aground."
> Dave Hoblin, ***TowBoatU.S.*** Old Saybrook, Clinton and Old Lyme, CT

> "I had a customer that called thru BoatU.S. Dispatch with reported engine failure. When I got to the disabled vessel, we cranked the engine but it won't start. It appeared to be starving for fuel. I then pulled the fuel/water separator and poured the contents into a glass jar I always carry. It was clearly a case of Phase Separation with the ethanol/water on the bottom and the remaining fuel on top. I then towed the customer back to his Home Port and advised him to have his fuel tank pumped out. I've seen this many times over the past couple of years. In this case the customer broke down in the middle of the shipping channel."
> Capt. Rich Busillo, ***TowBoatU.S.*** Delaware River Tow LLC, Philadelphia, PA

The boater's concerns are exponentially magnified with the possibility of 15% ethanol fuel (E15) blends, currently being implemented as a solution to the impending "blend wall."

- Current marine engines are not built to run on more than 10% ethanol. **There is not a single marine engine warranty that covers the use of gasoline containing more than 10% ethanol.** The failure of an automobile engine, although possibly dangerous, cannot compare to that of being stuck, alone at sea, or running through an inlet or channel and suddenly losing all power. This fuel issue could quickly become a matter of human safety.
- **In a 2010 study conducted by the National Renewable Fuel Laboratory and the U.S. Department of Energy, four new marine engines were tested on E15 and E-free gasoline.** These engines ranged from a $24,000 300HP to a $2600 9.9HP and included both inboard and outboard engines. **All four engines operated incorrectly in some way on E15.** Three of the engines suffered degraded emission results so that over the life of the engine, they would not meet California or Federal emission standards. Two of the engines had severe mechanical damage and one could not complete the test due to multiple valve failure.
- While some marinas are able to get ethanol-free fuel, many recreational boaters fill up their boats at roadside gas stations where the fuel is cheaper. In a poll of our members, over 58 percent fill up at a roadside gas station. Although EPA has prohibited the use of higher blends in boats, at the gas station different blends will dispense from the same hose, creating a distinct possibility at every fueling of putting the wrong fuel into a boat or a truck. **As higher blends of ethanol fuel come into the local gas station, we expect boat owners will start unknowingly misfueling their trailer boats, and potentially their legacy tow vehicles as well.**

We strongly believe that the EPA has a responsibility to ensure that the fuels in the marketplace – those now mandated through the RFS - are safe for the consumer and will not damage vital consumer goods. In fact, this concept is reiterated in the first part of the EPA Mission statement:

> "EPA's purpose is to ensure that:
>
> all Americans are protected from significant risks to human health and the environment where they live, learn and work....

In a letter written to EPA Administrator Lisa Jackson in August 2012, twenty-five U.S. Senators reminded the EPA that the Energy Independence and Security Act (EISA) which included the RFS, purposely contained "safety valves" that enabled the agency to adjust the RFS. These "safety valves" or waivers have already been used by the EPA in 2011 and 2012 to reduce RFS mandate levels on cellulosic biofuels - by 97%! Clearly EPA has a tool to use to adjust the RFS when real world factors indicate a need for it.

In the long term we ask the EPA to reevaluate the practicality of the RFS mandates while gasoline usage drops nationwide, and there is less fuel to blend with ethanol.

Today we ask that the EPA use their "safety valve" or waiver authority to fulfill their responsibility to the United States citizen and consumer, by reducing the RFS mandate of 13.8 billion gallons of ethanol for 2013. Reducing the mandate will prevent the artificial stimulation and promotion of 15% ethanol fuel - a fuel that is poison to all existing boat engines.

Thank you for allowing BoatU.S. the opportunity to weigh in on such an important issue. I have attached both the NREL Study and the U.S. Coast Guard Report to Congress which support the statistics illustrated in these comments. Please do not hesitate to contact me at mpodlich@boatus.com or 703-461-2878 ext. 3201 if I can provide further comment or background material.

National Renewable Energy Laboratory Study - High Ethanol Fuel Endurance:
A Study of the Effects of Running Gasoline with 15% Ethanol Concentration in Current Production Outboard Four-Stroke Engines and Conventional Two-Stroke Outboard Marine Engines - June 16, 2010 – June 30, 2011
David Hilbert

U.S. Coast Guard Report to Congress: Survey of Published Data and Reports on Blended Fuels in Marine Applications, January 12, 2012.
http://www.nmma.org/assets/cabinets/Cabinet213/USCGSurveyReportonBlendedFuels.pdf

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May 15, 2013

The Honorable David Vitter
Ranking Member
U.S. Senate Committee on Environment and Public Works
Minority Office
456 Dirksen Senate Office Building
Washington, DC 20510-6175

Dear Ranking Member Vitter:

The American Petroleum Institute (API) would like to correct the inaccurate and misleading statements about the research being conducted by the Coordinating Research Council (CRC) that were made by Ms. Gina McCarthy in her response to a question you submitted as part of her Senate Environment and Public Works Committee confirmation hearing for EPA Administrator. Your question, which follows, was about EPA's 2010 and 2011 approvals of E15 in 2001 and newer vehicles:

> **Question: Was EPA aware of ongoing CRC testing on engine durability, fuel pumps and other engine components? Why not wait until that test was complete before making a decision? Because in the aftermath it looks like the decision was, at best, premature. The CRC data shows millions of approved vehicles are in danger of engine damage.**
>
> Response: EPA has reviewed the limited portions of the CRC test program made available to the public. Unfortunately, complete information on the testing program has not been made available to the government, and the CRC expressly denied EPA or the Department of Energy (DOE) a role in the test program. As DOE has highlighted repeatedly (see for example here: http://energy.gov/articles/getting-it-right-accurate-testing-and-assessments-critical-deploying-next-generation-auto), the CRC E15 test programs have a number of significant scientific shortcomings, including failure to test components or vehicles on E0 and E10 to provide information on typical failure rates for baseline fuels.

Let me address the most egregious of her statements first, that "the CRC expressly denied EPA or the Department of Energy (DOE) a role in the test program". As explained below, the record shows that before and during the CRC mid-level ethanol blends research program EPA and DOE played significant roles, either directly or through the U.S. national laboratories (e.g., National Renewable Energy Laboratory (NREL)):

- First, at a June 2008 meeting with auto and oil industry stakeholders, Karl Simon of the EPA Office of Transportation and Air Quality (OTAQ), presented EPA's recommendations on the testing that needed to be done on ethanol blends like E15 in order for EPA to approve a waiver.

Attachment 1 contains the summary slide from that presentation with EPA's requirements. Because of the significant expansion of the renewable fuels mandates under the Energy Independence and Security Act (EISA) in 2007, auto and oil industry stakeholders wanted to know EPA's requirements before undertaking a mid-level ethanol blends research program. As shown in **Attachment 1**, EPA's requirements went beyond emissions and catalyst testing and included durability, materials compatibility, and operability issues. Shortly after the June 2008 meeting, the Mid-Level Ethanol Blends Research Coordination Group (Coordination Group) was formed to facilitate sharing of research plans and results among government (EPA, DOE, national labs, CARB, states, etc.) and industry stakeholders (CRC, auto associations, oil associations, ethanol associations, non-road equipment associations, etc.). The mission of the Coordination Group was to ensure data generation sufficient to allow EPA to determine if a substantially similar petition waiver can be granted on the use of ethanol blends above 10 percent by volume. The Coordination Group held seven additional meetings from 2008 to 2010 with the active participation of DOE and EPA staff and US government national lab staff (NREL actually hosted the January 28, 2009 meeting). **Attachment 2** lists EPA, DOE, and U.S. government national lab attendees at Coordination Group meetings.

- Second, as CRC undertook its research, EPA and DOE were kept apprised of research plans and results as they became available. In fact, National Renewable Energy Laboratory staff were active participants on CRC groups doing mid-level ethanol blends research and helped to write final reports. **Attachment 3** shows examples of pages from CRC reports which contain a listing of participants with the NREL staff highlighted in yellow. **Attachment 4** contains emails from CRC to DOE and EPA staff informing them of the availability of CRC research reports as they became available.

Finally, I want to correct assertions made by Ms. McCarthy about the nature of the CRC test results where she used DOE's comments as her basis. API's strong rebuttals to DOE's comments can be found in **Attachment 5**. But let me address a few key items:

- DOE and EPA comments about E0 and E10 baseline testing in the CRC test programs are highly misleading. E0 was tested whenever a response was seen from higher level ethanol blends and E10 was tested when deemed appropriate by the automotive engineers who sit on CRC committees and designed the test programs. CRC is a research organization that has been conducting research on fuels, engines and vehicles for more than 70 years. The CRC tests are developed and managed by the same company automotive engineers who design and build cars. We have great confidence in the ability of the automotive and fuels experts who sit on CRC committees to conduct well-conceived and thorough technical investigations of consumer acceptance and vehicle safety-related issues associated with the use of mid-level ethanol blends in vehicles operated by our mutual customers.
- In fact, CRC baseline testing is consistent with EPA's. EPA granted its second waiver with no E10 testing whatsoever, and in their first waiver decision stated that E0 was the reference fuel.
- As noted above, in a June 2008 presentation to stakeholders, EPA outlined for industry the testing it anticipated would be needed for a waiver to be approved. EPA's requirements at the time were consistent with CRC's comprehensive test plans, which include engine durability and materials compatibility testing. EPA did not follow through on its own recommended broader suite of testing, but instead relied almost entirely on DOE's catalyst durability test project. EPA

improperly used the DOE catalyst program to evaluate engine durability, materials compatibility and consumer acceptance and vehicle safety issues, which were outside the scope of the DOE catalyst study. And DOE/EPA's decision to use the catalyst study for these parameters was not even a well-thought-out or statistically designed process. It was a last-minute DOE decision made by then DOE Secretary Chu to tear down and inspect engines when the catalyst testing was almost completed and after he realized DOE/EPA would not have any key materials compatibility and component durability testing in time for a 2010 approval. And the only engines that were torn down were tested on E15 and E0, clearly demonstrating that the DOE and EPA are uninterested in E10 test results.

In fact, DOE staff and CRC committee members were having discussions about DOE funding parts of the CRC research program until Secretary Chu came up with the piggy-back idea, not because it was the best scientific approach, but because it would get DOE/EPA to the finish line before October 2010. DOE's piggy-back testing was the complete opposite of the CRC approach where automotive engineers designed the studies with detailed and scientifically sound methodologies and plans from start to finish. The CRC testing procedures were based on existing protocols that are widely used in the automotive industry to evaluate engine durability and fuel systems durability to predict product life. Many of the vehicles operated on E15 using these procedures with no problems, but others did not. This in itself shows that CRC used the proper test tools.

The key objective for the oil and the auto industries in undertaking the comprehensive CRC mid-level ethanol blends research program was to ensure that the safety and performance of our mutual customers' vehicles are not compromised or otherwise adversely affected by E15. CRC met those goals – EPA and DOE did not.

Thank you for this opportunity to set the record straight.

Sincerely,

Robert L. Greco

Robert L. Greco, III
Group Director: Downstream and Industry Operations

cc: U.S. Senate Committee on Environment and Public Works Members

Attachments

API is a national trade association that represents all segments of America's technology-driven oil and natural gas industry. Its more than 500 members – including large integrated companies, exploration and production, refining, marketing, pipeline, and marine businesses, and service and supply firms – provide most of the nation's energy. The industry also supports 9.2 million U.S. jobs and 7.7 percent of the U.S. economy, delivers $86 million a day in revenue to our government, and, since 2000, has invested over $2 trillion in U.S. capital projects to advance all forms of energy, including alternatives.

Mid Level Ethanol Blend Experimental Framework – EPA Staff Recommendations

Karl Simon
EPA Office of Transportation and Air Quality

API Technology Committee Meeting
Chicago
6/4/08

Attachment 1

Data submissions in support of a waiver request must include:

- Exhaust emissions
- Evaporative emissions
- Durability issues:
  - Materials compatibility
  - Driveability or operability
- All testing will need to be carried out over the useful life of vehicle or equipment

Attachment 2

Government Attendees and Participants at Mid-Level Ethanol Blends Research Coordination Group Meetings

June 4, 2008 Meeting Participated By: A= Attending, C= By Conference Call

Government		Affiliation	Phone	Email
Wendy Clark	A	National Renewable Energy Laboratory (NREL)	303-275-4417	Wendy_Clark@nrel.gov
Antonio Fernandez	A	US EPA		
Edward Nam	A	US EPA		
Karl Simon	A	EPA	202-343-9626	Simon.Karl@epa.gov
Kevin Stork	A	DOE – Vehicle Technologies	202-586-8306	kevin.stork@ee.doe.gov

September 24, 2008 Meeting Participated By: A= Attending, C= By Conference Call

Government		Affiliation	Phone	Email
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Joan Glickman	A	DOE – Office of Biomass Program	202-586-5607	Joan.glickman@ee.doe.gov
Ron Graves	A	Oak Ridge National Laboratory (ORNL)	865-946-1226	gravesrl@ornl.gov
Dave Kortum	C	EPA	202-343-9022	kortum.dave@epa.gov
Edward Nam	C	EPA	734-214-4613	Nam.Ed@epa.gov
Jim Peterson	A	CARB	916-327-1502	apeterso@arb.ca.gov
Steve Przesmitzki	A	NREL		
Karl Simon	C	EPA	202-343-9626	Simon.Karl@epa.gov
Kevin Stork	A	DOE – Vehicle Technologies	202-586-8306	kevin.stork@ee.doe.gov

January 28, 2009 Meeting [Hosted by NREL] Participated By: A= Attending, C= By Conference Call

Government		Affiliation	Phone	Email
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Jim Caldwell	C	EPA		Caldwell.Jim@epa.gov
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Antonio Fernandez	C	EPA	734-214-4431	Fernandez.Antonio@epa.gov
Joan Glickman	C	DOE – Office of Biomass Program	202-586-5607	Joan.glickman@ee.doe.gov
Ron Graves	A	Oak Ridge National Laboratory (ORNL)	865-946-1226	gravesrl@ornl.gov
Keith Knoll	A	National Renewable Energy Laboratory (NREL)		
Doug Lawson	A	National Renewable Energy Laboratory (NREL)		
Edward Nam	C	EPA	734-214-4613	Nam.Ed@epa.gov
Jim Peterson	A	CARB	916-327-1502	apeterso@arb.ca.gov
Steve Przesmitzki	A	National Renewable Energy Laboratory (NREL)		Steve_Przesmitzki@nrel.gov
Karl Simon	A	EPA	202-343-9626	Simon.Karl@epa.gov
Kevin Stork	A	DOE – Vehicle Technologies	202-586-8306	kevin.stork@ee.doe.gov
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Brian West	A	Oak Ridge National Laboratory (ORNL)	865-946-1231	westbh@ornl.gov

June 3, 2009 Meeting Participated By: A= Attending, C= By Conference Call

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Wendy Clark	A	National Renewable Energy Laboratory (NREL)	303-275-4417	Wendy_Clark@nrel.gov
Antonio Fernandez	A	EPA	734-214-4431	Fernandez.Antonio@epa.gov
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Dave Kortum	C	EPA		kortum.dave@epa.gov
Jim Peterson	C	CARB	916-327-1502	apeterso@arb.ca.gov
Steve Przesmitzki	A	National Renewable Energy Laboratory (NREL)		Steve_Przesmitzki@nrel.gov
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September 16, 2009 Meeting Participated By: A= Attending, C= By Conference Call

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February 2, 2010 Meeting Participated By: A= Attending, C= By Conference Call

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Antonio Fernandez	C	EPA	734-214-4431	Fernandez.Antonio@epa.gov
Keith Knoll	C	National Renewable Energy Laboratory (NREL)	303-275-4453	keith.knoll@nrel.gov
Dave Kortum	C	EPA	202-343-9022	kortum.dave@epa.gov
Doug Lawson	A	National Renewable Energy Laboratory (NREL)	303-275-4429	doug.lawson@nrel.gov
Robert McCormick	A	National Renewable Energy Laboratory (NREL)	303-275-4432	Robert.McCormick@nrel.gov
Steve Przesmitzki	A	DOE – Vehicle Technologies	202-586-6434	steven.przesmitzki@ee.doe.gov
Kevin Stork	A	DOE – Vehicle Technologies	202-586-8306	kevin.stork@ee.doe.gov
Brian West	A	Oak Ridge National Laboratory (ORNL)	865-946-1231	westbh@ornl.gov

May 5, 2010 Meeting Participated By: A= Attending, C= By Conference Call

Government		Affiliation	Phone	Email
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Brian West	A	Oak Ridge National Laboratory (ORNL)	865-946-1231	westbh@ornl.gov
Dave West	C	New Jersey Department of Environmental Protection	609-826-5467	dave.west@dep.state.nj.us
Tom White	A	DOE	202-586-1393	thomas.white@hq.doe.gov

October 19, 2010 Meeting Participated By: A= Attending, C= By Conference Call

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Tom White	A	DOE	202-586-1393	thomas.white@hq.doe.gov

Attachment 3

CRC Project CM-136-09-1B

INTERMEDIATE-LEVEL ETHANOL BLENDS ENGINE DURABILITY STUDY

April 2012

COORDINATING RESEARCH COUNCIL, INC.
3650 MANSELL ROAD·SUITE 140·ALPHARETTA, GA 30022

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CRC Project CM-136-09-1B Panel Members

B. Alexander, BP
J. Axelrod, ExxonMobil
W. Clark, NREL
F. Cornforth, Phillips 66
K. Eng, Shell
K. Freund, Volkswagen
J. Frusti, Chrysler
L. Gibbs, Consultant
M. Herr, Ford
J. Horn, Chevron
J. Jetter, Honda
C. Jones, General Motors
T. King, Chrysler
H. Kleeberg, FEV
K. Knoll, NREL
D. Lancaster, General Motors
D. Lax, API
M. Leister, Marathon Petroleum
S. Lindholm, Shell
T. McMahon, Chrysler
M. Miller, Sunoco
K. Mitchell,Shell
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C. Richardson, Ford
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J. Simnick, BP
W. Studzinski, General Motors
J. Szewczyk, Chrysler
M. Valentine, Toyota
M. Watkins, ExxonMobil
L. Webster, Nissan
A. Williams, NREL
J. Williams, API

FEV

CRC REPORT NO. 662

DURABILITY OF AUTOMOTIVE FUEL SYSTEM COMPONENTS EXPOSED TO E20

Coordinating Research Council
CRC Contract No. AVFL-15

National Renewable Energy Laboratory
NREL Task Order No. KZCI-8-77444-01

CRC AVFL-15 Project Panel
December 2011

COORDINATING RESEARCH COUNCIL, INC.
3650 Mansell Road, Suite 140, Alpharetta, GA 30022

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Acknowledgements

Special recognition to Jason Holmes and TRC for accommodating the necessary modifications and extensions to complete the project, as well as to the unwavering diligence and participation of the Steering Oversight Panel for the CRC AVFL-15 Project, which is comprised of the following members:

Bill Cannella, Chevron
Wendy Clark, NREL Technical Monitor
Dominic DiCicco, Ford, Project Co-Leader
King Eng, Shell
Mike Foster, BP, Project Co-Leader
Jeff Jetter, Honda
Stuart Johnson, VW
Coleman Jones, GM
Scott Jorgensen, GM
Keith Knoll, NREL Technical Monitor, Project Co-Leader
David Lax, American Petroleum Institute
Mani Natarajan, Marathon
David Patterson, Mitsubishi
Michael Teets, Chrysler
Sean Torres, Ford, Project Co-Leader
Marie Valentine, Toyota
Matt Watkins, ExxonMobil
Leah Webster, Nissan
Ken Wright, ConocoPhillips
Phil Yaccarino, GM

Brent Bailey, CRC
Jane Beck, CRC
Chris Tennant, CRC

Attachment 4

Brent Bailey

From:	Brent Bailey
Sent:	Thursday, August 30, 2012 4:04 PM
To:	'patrick.davis@ee.doe.gov'; 'Stork, Kevin'; Steve Przesmitzki (Steven.Przesmitzki@ee.doe.gov); West, Brian
Cc:	Chris Tennant; Jan Tucker; West, Brian
Subject:	FW: CRC Performance Committee - Gasoline Deposit meeting - Report on CRC Engine Durability study (CM-136-09-1B)
Attachments:	CRC Schedule - October 3 2012.doc; Return Form - October 3 2012.doc

Dear Pat, Kevin, and Steve,

See the message below and attachments from Jan Tucker. You are invited to attend this special meeting in Chicago where the recent CRC Engine Durability Study will be discussed. Kristy Moore of RFA and Shon Van Hulzen of Growth will be in attendance. Please let Jan know if you plan to attend. You may also designate someone from one of the labs or other DOE staff to attend on your behalf. I would be pleased to arrange a separate meeting with you in Chicago if there is interest in other discussions.

Regards,

Brent

To the Members of the
CRC Performance Committee

During the PC Gasoline Deposit meeting in Chicago on October 3 at 1:45 pm, there will be a report on the CRC Engine Durability study (CM-136-09-1B). This portion of the meeting will address any questions or comments on the project. Members of DOE and other outside agencies will be invited to attend this session of the committee meeting.

Attached is the full schedule with return form. If you plan to attend and have not returned the form, please do so as soon as possible so I can make proper meeting arrangements with the hotel.

Regards,

Jan Tucker
CRC Correspondence (not for public distribution)
COORDINATING RESEARCH COUNCIL, INC.
3650 MANSELL ROAD, SUITE 140
ALPHARETTA, GA 30022
TEL: 678/795-0506 ext.100 FAX: 678/795-0509
WWW.CRCAO.ORG

Brent Bailey

From:	Brent Bailey
Sent:	Thursday, May 10, 2012 9:19 AM
To:	Koupal, John
Cc:	Paul Machiele; Chris Tennant
Subject:	CRC Report No. CM-136-09-1b

John,
Just left voice message for you on this topic. Per previous agreement, we want to give you and Paul a heads up on any significant developments at CRC on mid-level blends. We will be posting a new final report on Engine Durability of E15/E20 blends in LDVs on May 16. CRC does not do press events, but there will be an industry press event in connection with the release of this report on that day. Please call me if you have any questions or would like to discuss.
Best regards,
Brent

Brent K. Bailey, Executive Director
CRC Correspondence (not for public distribution)
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Brent Bailey

From:	Jane Beck
Sent:	Wednesday, January 30, 2013 10:45 AM
To:	Rose, Ken; Williams, Jim ; Cannella, Bill; DiCicco, Dominic ; Dolch, Johanna; Eng, King ; Foster, Mike; Gunter, Garry; Jetter, Jeff; Johnson, Stuart; Jorgensen, Scott; Lax, David ; Natarajan, Mani; Patterson, David ; Sigelko, Jenny; Teets, Michael; Valentine, Marie; Webster, Leah; Woebkenberg, Bill; Wrigley, Krystal; Clark, Wendy; Fairbridge, Craig; Graves, Ronald L. ; Kubsh, Joe; Mabutol, Andy; McCormick, Robert; Mueller, Chuck; Sluder, Scott ; Smith, Dennis A.; Stork, Kevin ; Thornton, Matthew; Wagner, Robert; Zigler, Brad; Reed, Bowu
Cc:	Brent Bailey; Chris Tennant
Subject:	CRC Project AVFL-15a Final Report

Dear Members of the AVFL Committee, the AVFL Working Group, and Mailing List:

The final report for CRC Project AVFL-15a, "Durability of Fuel Pumps and Fuel Level Senders in Neat and Aggressive E15," by the AVFL-15a Project Panel members, January 2013, has been posted on the CRC website at www.crcao.org.

Regards,

Jane

Jane Beck
CRC Correspondence (not for public distribution)
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Attachment 5

Study: E15 Could Put Some Engines at Risk

http://energytomorrow.org/blog/study-e15-could-put-some-engines-at-risk/#/type/all

by Bob Greco
May. 18, 2012

More on the potential risk to America's car and truck fleet posed by E15 – gasoline containing 15 percent ethanol that has EPA approval: Just-released research indicates that more than 5 million existing cars and light trucks, which EPA says are OK for E15 use, could develop engine problems as a result.

Why this discrepancy? The Coordinating Research Council (CRC), a non-profit entity supported by the automotive and oil and petroleum industries, tested the durability of engines using tests that have been conducted for more than a decade to determine how well engines would hold up with a new fuel.

On the other hand, the Department of Energy (DOE) and EPA tested the catalyst system and then used the results of those tests to say the engine would be fine. It's a bit like taking a reading test to determine whether your heart is healthy.

A key finding in the CRC study:

- Of eight different tested engine types, one had a design that was (in retrospect) inappropriate for the test cycle, two failed on E20 (20 percent ethanol) and E15, and five passed on E20 and by assumption E15 and E0 (gasoline with zero ethanol content). The two engine types that failed E15 testing successfully completed reference testing on E0.
- The majority of the failures can be linked to issues with valve seats, either related to material or wear/deformation.

There are at least 5 million known engines on the road today with the same or similar characteristics to the two engines that failed on E20 and E15. Because testing was done on only a small proportion of the light-duty engine types currently in use, the number of at-risk engines probably is higher.

API President and CEO Jack Gerard, during a conference call with reporters this week:

"EPA's decisions in 2010 and 2011 approving E15 ethanol-gasoline blends for most American vehicles were premature and irresponsible. … Worse, as API noted in its press briefing two weeks ago, it approved the fuel even though government labs had raised red flags about the compatibility of E15 with much of the dispensing and storage infrastructure at our nation's gas stations. ... Not all vehicles in the CRC tests showed engine damage, but engine types that did are found in millions of cars and light duty trucks now on America's roads."

Mike Stanton, president and CEO of Global Automakers:

"We can build the cars for the fuels, but the EPA made this retroactive to 2001 and that is the problem. ... Our goal is to ensure that new alternative fuels are not placed into retail until it has been proven they are safe and do not cause harm to vehicles, consumers, or the environment. The EPA should have waited until all the studies on the potential impacts of E15 on the current fleet were completed."

Mitch Bainwol, president and CEO of the Alliance of Automobile Manufacturers:

"The study... indicates the risk for consumers is profound, with clear environmental, safety, fuel efficiency and financial implications. Cars were not built for E15. It's that simple – and now we have material evidence that validates our concerns."

Not surprisingly, the CRC study doesn't sit well with some folks. A DOE blog criticized the CRC study's methodology rather than focusing on the identified risks and concerns for consumers.

First, DOE seems to think that it has more expertise than the car designers and manufacturers who conducted the CRC tests. CRC has been doing work of this kind for more than 70 years, often with DOE's funding. Even more interesting: Through the National Renewable Energy Laboratory, DOE was an active participant in the technical oversight panel for the CRC study throughout its duration and at no point raised any concerns. Other points:

- Valvetrain-type engines that were tested were selected from among popular 2001-2009 models, not cherry-picked for failure. Indeed, five of the engines that were tested passed the E20 test. If someone was trying to pick engines that would fail testing they did a pretty poor job of it.
- The engine pass/fail determination was made after engine teardown and analysis. The use of the 10 percent cylinder leakage criterion to determine whether there may be engine distress is a well-established and accepted industry standard used in engine development and was used as a signal that teardown was required. The CRC study indicated use of E15 would damage the valves in some engines, leading to cylinder leakage, loss of compression and power.
- Nobody should be all that surprised that DOE found no discernible impact of E15 based on teardown inspections of engines used in its catalyst durability study. After all, its study was just that – an evaluation of the effects of higher levels of ethanol on a catalyst (i.e., the catalytic converter). It was never designed to specifically assess the stresses of mid-level ethanol blends on an engine. For DOE and others to draw conclusions about the effect of ethanol on an engine based on a test designed for a catalyst evaluation is not only scientifically unsound, it is just plain wrong.

See a more detailed rebuttal of DOE's comments, <u>here</u>. (See attached).

E15 is a perfect example of why the Renewable Fuels Standard is becoming unrealistic and unworkable. EPA made a rushed and premature decision to meet a political deadline in the fall of 2010. The CRC research shows that EPA didn't do its homework and is willing to put the consumer's vehicle at risk. EPA needs to base its decision on sound science, not political goals. The auto and oil industries conducted a scientifically sound and robust study, and the results from the CRC study should be concerning.

Gerard:

"The value of these vehicles along with the value of vulnerable gasoline dispensing equipment at the nation's 157,000 gasoline service stations could run into many billions of dollars. EPA's waivers put these investments at risk. The result could be more vehicle repairs for consumers and upward pressure on gasoline prices. … This is breakthrough research that should've been done by EPA. … Our data needs to be looked at."

Detailed Rebuttal of Critiques of the CRC Mid-Level Ethanol Blends Engine Durability Study

Background

- DOE in its critique, rather conveniently neglects to mention that, through the National Renewable Energy Laboratory (NREL), (a DOE contractor,) it was an active participant in the technical oversight panel for the CRC engine durability study throughout the duration of the program. At no point did NREL object to the tests, test cycles or the test procedures.
- DOE seems to think that it has more expertise than the car designers and manufacturers who designed and conducted the CRC tests. CRC has been doing work of this kind for over 70 years, often with DOE's funding. It is interesting that DOE now feels the need to critique this particular study.
- There is ample evidence that in the end, DOE's and EPA's testing and timing was driven more by the political time clock rather than a desire for a comprehensive test program:
  - Initially, in a June 2008 presentation, EPA outlined for industry the testing it anticipated would be needed for a waiver to be approved. EPA's requirements at the time were consistent with the auto and oil industry's comprehensive test plans. EPA did not follow through on its own recommended broader suite of testing, but instead relied almost entirely on DOE's catalyst durability test project. EPA has not offered an explanation for the change.
  - DOE initially contemplated co-funding this CRC study, but then changed their funding plans and decided to instead fund a tear down of the engines used in their catalyst program knowing full well their approach would not reveal anything because the study tested the catalyst, not the engine. This allowed EPA to do some hand waving at the end of the catalyst test and to say they also looked at engine durability and materials compatibility.
  - DOE made the political decision to inspect "critical engine parts" more than a year after the catalyst testing had already started. EPA and DOE realized that they were missing critical engine durability and materials compatibility data needed to approve a waiver, so instead of running meaningful tests to evaluate these parameters, they piggy-backed onto the catalyst study which was almost near completion. This is the complete opposite of the CRC project where automotive engineers designed the study with detailed and scientifically sound methodologies and plans from start to finish.
  - The driver in all of this was EPA's desire to make an October 2010 approval announcement. DOE's withdrawal of funding for CRC had nothing to do with test cycles and engine selection for the CRC project and everything to do about getting to the finish line before October 2010.
  - Coincidentally, mid-term elections were held November 2, 2010.
- Also, DOE looked for ways to accelerate the catalyst study since testing on one of the vehicles had been delayed. DOE changed the way the test was being run to accumulate miles more quickly so that the delayed vehicle could catch up with the rest. Auto and oil industry representatives strongly disagreed with this approach since this in effect made this one vehicle's test different from the other vehicles.

Rebuttal of specific critiques:

E0 Testing

It was unnecessary to test more than three engines on E0. The auto and oil industries do not believe in wasting resources on unnecessary tests. The fact that the test cycle was able to pass or fail the seven other engine models means we had a good test tool. The engineers who designed the engine that failed on all three fuels explained what happened during this testing – mainly that for this particular engine the test cycle did not cause the valves to rotate which resulted in abnormal wear for all three fuels. Even so, the E0 failure was less severe than E20 or E15.

E10 Testing

DOE complained that there was no E10 testing. This allegation is akin to "the pot calling the kettle black." Curiously, DOE fails to mention that, in its own evaluations of mid-level blends on marine engines, light-duty vehicle evaporative emissions testing, and teardown analyses of engines used in catalyst durability testing, E10 was not used as a control. These tests compared E0 with either E15 or E20. In its catalyst durability testing of Tier 2 vehicles DOE tested 19 vehicles on E0 and E15 but only 5 on E10. DOE chose to not tear down any of the vehicles tested on E10. In support of its initial E15 waiver decision, EPA prepared a Technical Memorandum which analyzed the DOE data and stated that "...since the waiver request is for E15, this analysis focuses on those vehicles that were aged on E15 compared to those vehicles that were aged on E0." DOE's testing in support of EPA's waiver of NLEV and Tier 1 emissions vehicles included not one E10 test. The fuels selected and tested in the CRC engine durability program are fully aligned with both the DOE and EPA work referenced above. The use of E0 and E15 in the CRC study avoids ambiguity as to the source of any effects that may be observed.

Engine Durability Test Cycles

Engine durability tests by definition stress the engine, unlike DOE's catalyst test – which stressed the catalyst and nothing else. We all know that when doctors test the durability of the human engine (i.e., our hearts), they put us on a treadmill and keep cranking it up. They and their patients are not just satisfied with a leisurely walk in the park type-test. The test cycle employed by CRC is a standard engine durability test cycle that has been in use for many years. The only modification made to it for this study was to limit the maximum engine speed to 3500 RPM. This modification was made to reduce the test severity, making it more likely that engines would complete the test without experiencing failures unrelated to the test objective, i.e., evaluating the effect of E15 on engine durability. Consumers should trust automotive engineers on this topic more than government regulators. EPA is the expert on devising regulations -- that is what they do. The automakers develop and build engines and emissions control systems -- that is what they do. We have great confidence in our scientific experts who design engines, emissions control systems and fuels.

Engine Pass/Failure Determination

The engine pass/fail determination was made after engine teardown and analysis. The 10 percent cylinder leakage criterion was used to determine whether there was engine distress and was used as a signal that teardown was required. The use of a 10% leakdown criterion is far from arbitrary. It is an accepted and standard industry practice/criterion for determining engine distress. Engines that exceeded the 10% leak down criterion in the CRC study were further examined by teardown. The failure was determined by inspection during engine teardown, this evaluation method has been used in the automotive industry for over 100 years. In fact, 3 engines exceeded the 10% leakdown criterion, but were deemed to pass after engine inspections and detailed review of the data.

The investigators in the CRC study evaluated the performance of several different compression and leakdown gauges and ultimately used one tool which provided extremely repeatable measurements (within +/- 1%) – much smaller than the range reported in the DOE program. In addition, the fact that DOE concluded that engine leakdown is "not a reliable indicator of vehicle performance" is not surprising given that the test cycle on which they base their allegation is itself not a reliable measure of changes in engine durability. In contrast to the driving cycle evaluated in the DOE study, the test cycle used by CRC produced dramatic and easily measurable changes so it provided an excellent basis for assessing engine durability.

Test Engine Selection

The real point to be made here is that all of the engines tested by CRC are engines that were waived by EPA and are expected by the general public not to have issues with the new fuel, E15. It is true that a couple of the engines tested by CRC were subject to recalls by the National Highway Traffic Safety Administration (NHTSA). However, none of these recalls were for engine-related issues associated with operation on E0 and E10. It also is worth noting that 25 of the 27 vehicle models which DOE had used in its catalyst durability test program were subject to a NHTSA recall of some kind.

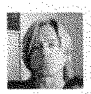
Aggressive Ethanol

Some who are not experts at fuels or vehicles have claimed that CRC used "aggressive ethanol" or "illegal fuels" in this study. That assertion is blatantly false. The ethanol used in this test program was not an "aggressive ethanol". It exceeded ASTM specifications, was made by an RFA member, and was representative of what can be found in the market place.

Usefulness of the CRC Study

The CRC study is the only real engine durability of its kind. The 240 million drivers of vehicles in the US need DOE, EPA and other government agencies to take responsible actions when it comes to regulating their fuels and vehicles.

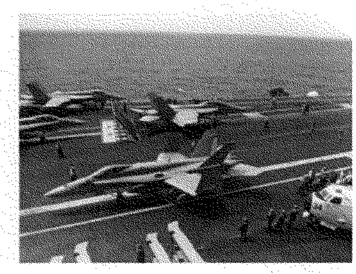
Forbes



Todd Woody, Forbes Staff
I cover environmental and green technology issues from San Francisco.

GREEN TECH | 7/19/2012 @ 3:10PM | 7,116 views

The Navy's Great Green Fleet Strikes Back



ABOARD THE USS NIMITZ – As a Royal Australian Navy helicopter lands on the deck of the USS Nimitz on Wednesday, two American destroyers, a cruiser and a fuel ship are steaming alongside the aircraft carrier some 100 miles north of Oahu. The ships in the carrier strike group and the 71 aircraft on the deck of the Nimitz, including fighter jets, helicopters and transports, are all running on a 50-50 mix of petroleum and biofuel derived from algae and used cooking oil. In fact, the Aussie Sikorsky Seahawk is the only military machine except the nuclear-fueled Nimitz not powered by biofuels.

But as Rear Admiral Tim Barrett of the Royal Australian Navy greets U.S. Navy Secretary Ray Mabus, deck workers run a fuel line to the helicopter and began pumping the biofuel blend produced by Solazyme and Dynamic into the Seahawk. Minutes later, Barrett and Mabus sign a statement of cooperation pledging the two nation's navies to collaborate on biofuels research and deployment.

"This is not just an American project," says Mabus. "It involves allies, it involves countries just as concerned as we are about energy independence and energy security."

With Congressional Republicans moving to derail Mabus' plan to obtain 50% of the Navy's energy from renewable sources by 2020 as a biofuels folly, the Navy struck back Wednesday with display of force in the first demonstration of its Great Green Fleet during the biannual Rim of the Pacific exercise involving 22 nations.

"This is very much an historic moment," says Vice Admiral Philip Cullom, the deputy chief of naval operations for fleet readiness and logistics, told a group of journalists brought aboard the Nimitz on the first biofueled transport plane, a C-2 Greyhound, to land on an aircraft carrier. "We're moving forward and we're not going to let up. We can't do nothing. Let's do this."

Says Richard Kamin, a civilian Navy employee who led the effort to certify biofuels for military use: "We're done testing. This is the first time biofuels are being used in actual operations."

The Navy aims to deploy a permanent green strike force in 2016.

As Mabus, top Navy brass and representatives from the airline and biofuels industries watched from a balcony above the flight deck, six biofueled F/A-18 Hornets screamed off the Nimitz on a sortie and conducted an in-fight refueling demo. Earlier, a biofueled E-2C Hawkeye, part of the Nimitz's Carrier Airborne Early Warning Squadron, launched to monitor air traffic as biofueled helicopters shuttled Navy officers to other ships in the fleet.

"The military has done a lot of things that starts a tidal wave throughout our culture and I think this is one of those things," says Lt. Commander Jason Fox, 35, a Hawkeye pilot.

The 900,000 gallons of the biofuel blend used during the Great Green Fleet demo cost about $13 million – four times that cost of petroleum. That has outraged some Congressional Republicans along with a few Democrats and subcommittees in the House and Senate have voted to bar the Navy from buying any fuel that costs more than oil. That would sink the Great Green Fleet as biofuels are unlikely to go into mass production and become cost competitive without a market that would be created by the military or industries like aviation.

But whether the nascent biofuels industry can scale up to provide the nearly 340 million gallons of fuel the Navy needs annually at a price it can afford is the big unknown.

"If you look at the reasons we're doing it, we're not doing it to be faddish, we're not doing it to be green, we're not doing it for any other reason except it takes care of a military vulnerability that we have," Mabus says at a news conference in the Nimitz's hanger, noting that the Navy got stuck with a billion-dollar bill in May because of rising oil prices. "We simply have to figure out a way to get American made homegrown fuel that is stable in price, that is competitive with oil that we can use to compete with oil. If we don't we're still too vulnerable."

Mabus notes that biofuel prices have fallen dramatically since the Navy began the renewable energy program in 2009. But he says, "We're not going to buy large amounts of any kind of fuel until it's cost competitive."

A fighter jet screamed by and interrupted Mabus' speech.

"You just heard biofuels," he says.

Below is video I shot of a biofueled F/A-18 fighter taking off from the Nimitz.