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THE GAS IS GREENER: THE FUTURE OF BIOFUELS

HEARING

BEFORE THE

SELECT COMMITTEE ON
ENERGY INDEPENDENCE
AND GLOBAL WARMING
HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

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THE GAS IS GREENER ON THE OTHER SIDE: THE FUTURE OF BIOFUELS

WEDNESDAY, OCTOBER 24, 2007

HOUSE OF REPRESENTATIVES,
SELECT COMMITTEE ON ENERGY INDEPENDENCE
AND GLOBAL WARMING,
Washington, DC.

The committee met, pursuant to call, at 9:41 a.m., in room 2175, Rayburn, Hon. Edward J. Markey (chairman of the committee) presiding.

Present: Representatives Markey, Inslee, Solis, Herseth Sandlin, Cleaver, Hall, McNerney, Sensenbrenner, Shadegg, Sullivan and Blackburn.

The CHAIRMAN. This hearing is called to order. And I thank everyone for their participation in it.

With oil prices, oil imports and global warming pollution rising, we urgently need alternatives to oil that enhance our economy, our security and our environment. Biofuels offer an alternative to oil that could allow us to use grass to make a greener gas. And although the United States has supported biofuels since the oil embargoes of the late 1970s and is now the largest producer in the world, biofuels still account for only 3 percent of total U.S. fuel consumption.

In contrast, the potential of biofuel is great. The Department of Energy predicts that biofuels could displace 30 percent of current fuel consumption by 2030. To get from today's 3 percent to tomorrow's 30 percent is going to require smart policies that focus innovation, investment and infrastructure towards the next generation of biofuels.

Realizing the potential of biofuels to significantly reduce our oil dependence and global warming pollution will require unlocking the energy in the parts of plants currently considered too tough to use. Developing technologies to produce the so-called cellulosic ethanol and other advanced biofuels will open up an array of sources from which to produce alternatives to oil. Everything from agricultural and municipal waste to native prairie grasses could power our vehicles in the next few years and decades.

In the future, the corner gas station might advertise that they can put a tulip in your tank rather than a tiger. By expanding the fuel possibilities, the next generation of biofuels will also expand the opportunity for all regions of the country to produce the fuels that meet their needs the best.

Massachusetts once played a critical role in the U.S. energy supply back when Melville was writing by whale oil lamps about Cap-

tain Ahab's pursuit of Moby Dick. With the deployment of technology now being developed in the State, Massachusetts could once again begin to meet its own fuel needs and help other parts of the country do the same.

Despite the promise of biofuels, we can't let them become our white whale of energy policy. We can't relentlessly pursue them and lose sight of the larger goals that combat global warming, preserve clean air and water and protect wildlife and human health.

The 18th Century whalers almost hunted their fuel source out of existence. We must learn from them as we literally grow the fuel of the 21st Century. We have a chance to help develop a whole new industry that is good for people, their pocketbooks and the planet.

As we reconcile the Senate and House energy bills this fall, we have the opportunity to steer the United States in a new energy direction. The Senate language would expand America's commitment to renewable fuels from 4.7 billion gallons required today to 36 billion gallons by 2022, more than half from new cellulosic and other advanced biofuels. This would save almost 1.6 million barrels of gasoline equivalent per day. Combining this with an increase in fuel economy and the rest of the best of the House and Senate legislation, Congress could send an energy bill to the President that has the potential by 2030 to save more than twice the amount of oil we currently import from the Persian Gulf, reduce U.S. global warming pollution by up to 40 percent of what we must do to save the planet and create over 1.5 million new jobs.

Our witnesses today represent a broad spectrum of stakeholders in the biofuels industry from innovators to producers to consumers. I look forward to their testimony in hearing from them how Congress can help guide the development of a fuel source that reduces our oil imports and the dangers of global warming. I would now like to recognize the ranking member of the committee, the gentleman from Wisconsin, Mr. Sensenbrenner.

[The prepared statement of Mr. Markey follows:]

Opening Statement for Edward J. Markey (D-MA)
"The Gas is Greener: The Future of Biofuels"
Select Committee on Energy Independence and Global Warming
October 24, 2007

With oil prices, oil imports and global warming pollution rising, we urgently need alternatives to oil that enhance our economy, our security and our environment. Biofuels offer an alternative to oil that could allow us to use grass to make a greener gas.

Although the United States has supported biofuels since the oil embargoes of the late 1970s and is now the largest producer in the world, biofuels still account for only three percent of total U.S. fuel consumption. In contrast, the potential of biofuels is great. The Department of Energy predicts that biofuels could displace 30 percent of current fuel consumption by 2030. To get from today's 3 percent to tomorrow's 30 percent is going to require smart policies that focus innovation, investment and infrastructure towards the next generation of biofuels.

Realizing the potential of biofuels to significantly reduce our oil dependence and global warming pollution will require unlocking the energy in the parts of plants currently considered too tough to use. Developing technologies to produce this so-called "cellulosic" ethanol and other advanced biofuels will open up an array of sources from which to produce alternatives to oil. Everything from agricultural and municipal waste to native prairie grasses could power our vehicles in the next few decades. In the future, the corner gas station might advertise that they can put a tulip in your tank, rather than a tiger.

By expanding the fuel possibilities, the next generation of biofuels will also expand the opportunity for all regions of the country to produce the fuels that meet their needs the best. Massachusetts once played a critical role in the U.S. energy supply… back when Melville was writing by whale oil lamps about Captain Ahab's pursuit of Moby Dick. With the deployment of technology now being developed in the state, Massachusetts could once again begin to meet its own fuel needs and help other parts of the country do the same.

Despite the promise of biofuels, we can't let them become our white whale of energy policy. We can't relentlessly pursue them and lose sight of the larger goal to develop fuels that combat global warming, preserve clean air and water, and protect wildlife and human health. The 18th century whalers almost hunted their fuel source out of existence. We must learn from them as we literally grow the fuel of the 21st century. We have a chance to help develop a whole new industry that is good for people, their pocketbooks, and the planet.

As we reconcile the Senate and House energy bills this fall, we have the opportunity to steer the United States in a new energy direction. The Senate language would expand America's commitment to renewable fuels from the 4.7 billion gallons required today to 36 billion gallons by 2022, more than half from new cellulosic and other advanced biofuels. This would save almost 1.6 million barrels of gasoline-equivalent per day. Combining this with an increase in fuel economy and the rest of the best of the House and Senate legislation, Congress could send an energy bill to the President that has the potential by 2030 to,

- save more than twice the amount of oil we currently import from the Persian Gulf
- reduce U.S. global warming pollution by up to 40 percent of what we must do to save the planet, and
- create over 1.5 million jobs.

Our witnesses today represent a broad spectrum of stakeholders in the biofuels industry from innovators to producers to consumers. I look forward to their testimony and hearing from them how Congress can help guide the development of a fuel source that reduces our oil imports and the dangers of global warming.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman. I would first like to start out by thanking you for today's hearing. I believe that any discussion of energy policy must include a thorough examination of current and future technologies. And today's hearing on biofuels should give my colleagues and me the opportunity to explore the future of transportation fuels. I urge the Chairman to schedule more hearings on technologies that can help address energy independence and global warming. By creating fuel from crops and other biological materials, biofuels hold great potential to help we, in the United States, from dependence upon foreign oil and to help reduce our greenhouse gas emissions.

While biofuels do offer some answers to both of these problems, one question is whether biofuels offer the right answers. They could very well. But at this point, the questions biofuels raise outnumber the answers. For instance, how much does the Federal Government need to subsidize corn-based ethanol, which seems to offer slight improvement in CO2 emissions but also seems to put more pressure on food prices, water supply and quality and land use. Or would it be better to make biofuels from soybeans, sugarcane or switchgrass? In August, The Wall Street Journal reported the cultivation of a plant called Jatropha, a shrub found in India that can grow in almost any climate and can potentially produce biodiesel fuel at a cost cheaper than any of the other plants that I have mentioned today.

Is the Jatropha plant an answer? And what about the alternative, such as hydrogen fuel cells? This technology has the potential to propel cars and trucks without creating any carbon dioxide emissions. But is it better than the biofuels currently under development? I don't know the answers to these questions, and I suspect the Congress doesn't either. This is another situation where I worry that instead of letting the markets decide which product or technology is best, the government will try to pick winners and losers.

In July, this committee held a hearing on the plug-in gasoline electric hybrid car. At that time, I raised some questions but said, the free market should be free to figure this out on its own. Just yesterday, it appears that the market forces are starting to produce the answer. While General Motors and Toyota intend to keep developing hybrid technology, executives from Renault, Nissan and Honda said they see gasoline electric hybrid technology as flawed and will apparently invest in all electric car technology instead. Fortunately these executives made their decision without having to ask us in Congress what we think or us in Congress telling them what to do. An undercurrent of today's hearing is that the Federal Government should increase its mandated use of biofuels through a renewable fuel standard. Congress enacted such a standard in 2005, and witnesses today tell us that biofuel production has already exceeded the production requirements.

Some will say that we need to raise the government's mandate even higher because the free market isn't responding. I am not so sure that it isn't. General Motors is aggressively advertising its fleet of flexible fuel vehicles. Both Chevron and British Petroleum are proudly highlighting their research on biofuels. The larger question is how we move from petroleum to alternative fuels with-

out disrupting our economy. One way or another, the free market will give us an answer, and I will anxiously await the results. Thank you, and I yield back the balance of my time.

The CHAIRMAN. Great. The gentleman's time has expired. The chair recognizes the gentlelady from California, Ms. Solis.

Ms. SOLIS. Thank you, Mr. Chairman. And I want to commend our panelists for coming here this morning as well. I want to talk a little bit differently on another subject matter, and I know we are going to hear from you on the importance of biofuels and researching renewable energy.

But I want to talk about what is happening right now in Southern California and the communities surrounding my district. Unfortunately, many people still don't believe that climate change is affecting States like California where, right now, we have 20 fires that are out of control. The fires have burned well over 420,000 acres, destroyed more than 1,200 homes and have forced evacuations of 1 million people who right now we are seeing the most devastating effects of climate change in the history of the State of California.

Residents, as we know right now, are being sheltered at Qualcomm Stadium in San Diego, a military installation, and at high schools. The California Guard and Marines are being deployed to both help with the fires and provide security and assist in evacuations. Resources are also being volunteered by our friends south of the border, from Mexico. And these fires are devastating families, our communities, our economy and our State.

And in June 2006—I just want to reiterate this—Science Journal researchers concluded that more than land use changes or forest management practices, the changing climate was the most important factor driving the increase in the average number of large wildfires in the western United States. Human activity has caused climate change. And only through human action can we mitigate and adapt these changes. Now more than ever I believe that we must have the courage to take swift action to implement an energy policy that relies less on greenhouse-gas-emitting fuels and a mandatory emissions reduction policy that quickly brings down emission levels. And I hope all my colleagues here on the dais and from all regions of the United States will join me in supporting our communities in Southern California as we struggle to stop the spread of these wildfires and cope with the devastation that they are leaving in their wake. And I hope my colleagues will join me in supporting efforts to combat global warming before its dangerous impacts become irreversible and more communities will suffer. I yield back the balance of my time.

The CHAIRMAN. The gentlelady's time has expired, and we thank you for reminding us all of that here today. The gentleman from Arizona, Mr. Shadegg.

Mr. SHADEGG. Thank you, Mr. Chairman. And in the interest of getting to our witnesses' testimony, I will abbreviate my statement and ask unanimous consent to put my whole statement into the record. I want to begin by thanking you for holding this hearing on the importance of biofuels to both our environment and our economy. I strongly believe we need to reduce our dependence on

oil and diversify our sources of fuel, especially our transportation fuels.

I would note, however, a cautionary concern. This Congress in the past mandated MTBE without fully knowing the consequences of that additive, and as we all know, it has caused concern to our environment in terms of the migrating of that fuel out of tanks and damage to the environment. It seems to me we should use that experience as a guide here, learn as much as we can about alternative fuels, learn as much as we can about ethanol, encourage its use but encourage the use of those kinds of fuels in a way that will spur innovation. I think the Congress is not particularly well suited to predict the scientific future and to look into the future and to know what in fact are the best fuels and what in fact are the safest fuels and will cause the least environmental damage. But that is what this process is about, and I applaud the Chairman for holding the hearing.

I do want to add as a point that, earlier this year, in the markup of the energy bill along with my colleague Mr. Melancon, I offered an amendment to require the EPA to both study higher concentrations of ethanol to determine what effect they will have on safety, air quality, engine operability in vehicles. And we also required in the amendment that the EPA take public comment and consider studies and review the impacts of higher blends of ethanol before those are used. My amendment was not intended to be anti-ethanol. It was intended to enable us to be fully informed before we proceed with the use of those higher concentrations of ethanol. The Australia version of the EPA has found in its studies that mid-level ethanol blends can cause problems in terms of—in current engines, obviously, hopefully, we can modify those, resulting in failure of exhaust components, engine damage, engine stalling, failure of engine cut-off switches and fuel leakages and blockage of fuel lines.

Let me be clear, I am not suggesting that we ought not move forward with both ethanol and other alternative fuels. What I am urging is that we do so in a cautious and thoughtful way so that we get input; we get science; we hear from experts like we have before us here today. The amendment was supported by, among others, the American Lung Association, Clean Air Watch and the Natural Resources Defense Council.

So I look forward to our witnesses' testimony today. I look forward to encouraging as much as we possibly can alternative fuels in a way which does benefit both the economy and the environment of the Nation and the world.

The CHAIRMAN. Great. The gentleman's time has expired. The chair recognizes the gentlelady from South Dakota, Ms. Herseth Sandlin.

Ms. HERSETH SANDLIN. Thank you very much, Mr. Chairman. I want to thank you for holding this hearing and for your leadership on this issue. As you and I think the rest of the members of the panel know, this is an issue about which I am quite passionate. I believe that a strong commitment to biofuels production and use in this country must be one of the linchpins of our National Energy Policy in the decades to come and helps provide a significant part of the solution to global climate change.

With that in mind, I am especially pleased and appreciative we have invited one of the most innovative biofuels entrepreneurs in the country here to testify before us today. Don Endres of Brookings, South Dakota, is the founder of VeraSun Energy, which has, in the few short years since its creation, grown to be one of the largest ethanol producers in the country. Don is one of my touchstone contacts on all matters pertaining to energy and biofuels, and I consider him one of the foremost experts in the country on biofuels issues. I think you will find his testimony and experience to go directly to some of the comments already made by other members of the panel as it relates to the importance of technological advancement, not only for corn ethanol but cellulosic ethanol and the work that he and others in the industry are doing to reach the goals that we have been advocating. I am very pleased he was able to attend the hearing today, commend his testimony to all of my colleagues. I think he will offer a description of the current market conditions, which support the need for fostering the market further with a more aggressive Renewable Fuels Standard. I also am pleased to inform you that there will be a biofuel vehicle demonstration following the hearing.

I drive a Chevy Impala that runs on E85 and a Jeep Liberty that runs on biodiesel. So I am pleased that other Members of Congress will get a chance to learn more about those vehicles today and the importance of infrastructure for distribution of biofuels and the production of flex fuel vehicles. So, thank you, again, Chairman Markey, for holding the hearing. I thank all of our witnesses for their testimony this morning.

The CHAIRMAN. The gentlelady's time has expired. The Chairman recognizes the gentlelady from Tennessee, Mrs. Blackburn.

Mrs. BLACKBURN. Thank you, Mr. Chairman.

I also thank you for holding the hearing today. And I thank the witnesses for being with us today. I will submit my full statement for the record. And we are all anxious to move on to what they have to say. But just very briefly, we are all concerned about energy security. We are glad that there are entrepreneurs who are looking at the issue and looking at the use of biofuels. We all understand the nature of biofuels from which they are derived. We also know that there are some inventive processes, like Mr. Gardener's, that are taking place with some mixed usage. We are looking forward to hearing a little bit more about that. We do have some concerns. Water, land, availability, the cost, the impact that it has on food, figuring out what works and what doesn't work, looking at waste products, seeing what is going to be economically and commercially viable are all issues that we will want to talk with you about.

Looking at the distribution and infrastructure systems of those, hearing a little bit more from you about that commercialization and distribution process is going to be of interest to us. We know that there is no silver bullet, but we appreciate the perspective that you bring to us. And with that, Mr. Chairman, I will yield back and look forward to the question-and-answer session.

[The prepared statement of Ms. Blackburn follows:]

Opening Statement for Marsha Blackburn (R-TN)

Mr. Chairman:

I want to thank you for holding this hearing, and I want to thank the witnesses for taking their time to come and testify before this committee.

Concerns about energy security are driving entrepreneurs to explore a variety of ways to produce transportation fuels, and most of the focus has been on the use of biofuels.

Biofuels, by their nature, are derived from biomass which is usually grown by farmers. Corn, soybeans, flaxseed, rapeseed, and sugar cane are all agricultural products that are capable of producing ethanol, and they are grown throughout the world.

Some biofuels are also formed when vegetable oils, used tires, and animal wastes are processed into biodiesel, which is part of the services offered by Mr. Gardner's company Reverb.

Biofuels can be easily replenished, and this key feature of biofuels helps them play a part of renewable energy development in the U.S. and enable agricultural producers to play a role in promoting American energy independence.

I, however, have some concerns about the growth of biofuels, such as ethanol.

As more and more land is dedicated to this industry, water availability and water quality is decreasing. Significant amounts of water are needed to make ethanol, and numerous reports have shown that these water demands are starting to deplete local aquifers.

Ethanol can play a small and important part to diversify our sources of fuel, but also, as part of a strategy to make the U.S. energy independent, Congress should allow the market to explore potentially more productive sources of conventional and unconventional domestic oil that reside in existing public lands.

Mr. Chairman,

Biofuels are not the "silver bullet" for America energy security, but can play a substantial role. I look forward to hearing the testimony from today's witnesses on this role and yield the balance of my time.

The CHAIRMAN. Great. The gentlelady's time is expired. The chair recognizes the gentleman from Missouri Mr. Cleaver.

Mr. CLEAVER. Thank you, Mr. Chairman. I appreciate your leadership and the vision you have for the work of this committee. I will reserve my time primarily for questions from these experts who are before us.

I do recognize that biofuels are a part of the solution to the tailpipe CO_2s that are generating the greenhouse gases that helped fuel the fires in California. Even though I recognize, as I operate out of no illusion, biofuels will not solve the enormous challenges before us, but I do believe that we can and should maximize the use of sustainable sources of domestic energy. And so I am looking forward to hearing from our panelists and finding out from them what the challenges they face in producing and developing biofuels. Thank you very much, Mr. Chairman. And I yield back the balance of my time.

[The prepared statement of Mr. Cleaver follows:]

U.S. Representative Emanuel Cleaver, II
5th District, Missouri
Statement for the Record
House Select Committee on Energy Independence and Global Warming Hearing
"The Gas is Greener: The Future of Biofuels"
Wednesday, October 24, 2007

Chairman Markey, Ranking Member Sensenbrenner, other Members of the Select Committee, good morning. I would like to welcome our distinguished panel of experts to the hearing today.

My hometown of Kansas City, Missouri is the largest city in the state in terms of land area. However, there is only one E85 station in the entire city. The accessibility of biofuels in our country must be expanded in we are to achieve real energy independence and environmental protection. Home-grown energy like biofuels is part of the solution, and their use should be encouraged by means of Congressional action. Currently, the producers' tax credit for biofuels is set at one dollar per gallon, and this is a good start in moving towards domestically produced energy.

Many energy experts look to Brazil and its 29-year-old ethanol fuel program as evidence that sugarcane is a sustainable resource for automobile fuel. Brazil gets over 30% of its automobile fuels from sugarcane-based ethanol. Although ethanol has been quite successful for Brazil, our country lacks sufficient resources to power the large number of cars on American highways. For this reason, we must include biofuels as part of a comprehensive national energy portfolio. Domestic, renewable energy like biofuels can enable our country to achieve real energy independence in a sustainable way. Congress needs the expertise of today's witnesses to convey the feasibility of expanding the use of biofuels, and to suggest to Congress the next course of action on the subject.

I thank the panel for their insight and their suggestions concerning the future of biofuels as Congress moves ahead with a new national energy and environmental policy.

Thank you.

The CHAIRMAN. Great. The gentleman yields back the balance of his time. The chair recognizes the gentleman from Oklahoma Mr. Sullivan.

Mr. SULLIVAN. Thank you, Mr. Chairman. And I just want to thank the witnesses for being here today, and I look forward to hearing what you have to say about this very important issue, biofuels. And I yield back.

The CHAIRMAN. Great. The gentleman's time has expired. The chair recognizes the gentleman from Washington State, Mr. Inslee.

Mr. INSLEE. Thank you. I think it is a very important hearing. I appreciate the chair having it. I have been travelling a lot the last couple of months, talking about clean energy issues. And what strikes me is the people's love of biofuels, which is also matched by their anxiety about what happens if we don't move forward in biofuels. And I think it is very important to share with the public the potential of the next several generations of biofuels so that we can continue this train on the tracks. So I appreciate this hearing and opportunity to do that. Thank you.

The CHAIRMAN. Great. The gentleman yields back the balance of his time. The chair recognizes the gentleman from New York State, Mr. Hall.

Mr. HALL. Thank you, Mr. Chairman.

With oil headed toward the astronomical height of $90 per barrel, the skyrocket gas prices in the home heating season rapidly coming upon us, it is clear that there could be no better time to have a serious discussion of biofuels.

In my own home, I am burning the highest possible blend of biodiesel in my heating oil. In my district, there are several commercial and private producers of biofuels, and nationally, an aggressive investment in biofuels technologies could have tremendous results for our economy, our independence, our fight against global warming and our sovereignty.

I just heard in a briefing this morning by Lee Hamilton, half of the leadership of the Baker-Hamilton study, of course, about how our options in terms of promoting democracy in Saudi Arabia is severely and seriously limited by our being held over a barrel, literally, a barrel of oil by the Saudis because of our current need for their product. We should be doing more to increase the production of cellulosic biofuels and biodiesel at home, providing more Federal investment to help the existing production grow and financing research and development of new types of biofuels.

We need to make it easier for these fuels to come to market. I had a constituent call one of our offices in New York all excited because he had just bought a flex-fuel vehicle, and she wanted us to tell her where the nearest pump was. And we were sorry to tell her there were only two E85 pumps in New York State, out of the 1,300 or so in the country. So even if you have a flex fuel car, the odds are you are not going to be able to get the benefit from it. Thirdly, we need to make it easier for the average consumer to use these products, which means making furnaces that can burn biofuels and more cars that can run on them more available and more affordable. Working towards these goals, we also need to be careful that we are sure that we are getting the most out of our investment by making sure that we maximize our greenhouse gas

reductions and produce biofuels in a way that is consistent with land use and does not adversely affect the cost of fuel or feed. I look forward to hearing from our witnesses and yield back.

Mr. Chairman, thank you.

The CHAIRMAN. The gentleman's time has expired. All time for opening statements from members of the Select Committee has expired.

[The prepared statement of Ms. Miller follows:]

Select Committee on Energy Independence and Global Warming
October 24, 2007
Rep. Candice S. Miller

Mr. Chairman, thank you for holding this hearing and thank you to the witnesses for sharing their expertise. I am pleased to see that we are taking a closer look at the potential for biofuels.

I have long been a supporter of advances in the biofuel industry. Biofuels not only provide a cleaner energy for cars and trucks but also open up new markets for agriculture and rural communities.

Our domestic car companies have been working hard to create vehicles that use biofuels. For example, General Motors has

produced more than 2 million E85 capable vehicles that are on the road today. For the 2007 model year, there are 16 flex fuel models that include the whole range of vehicles.

America's three domestic auto companies, General Motors, Chrysler and Ford, announced last year that they would double production of vehicles capable of running on renewable fuels by 2010. That amounts to more than two million E85 and biodiesel-capable vehicles a year by the end of

the decade. Consumers have expressed their interest in cars powered by alternative fuels and the domestic auto industry is responding.

Also in 2006, the three companies announced that they were prepared to make half of their annual vehicle production biofuel capable by 2012, as long as there was ample availability and distribution of the fuel as part of an overall national energy strategy. To this end, the domestic auto industry has helped to expand the distribution network for

biofuels through various partnerships. One of the partnerships has been with VeraSun which I am happy to see represented here today by Mr. Endres.

The potential of biofuels to significantly impact our oil dependence is not far off in the future. Our American motor companies are working to develop vehicles and a distribution system that will create a cleaner environment. While this will not be the final

answer to the problems, the development and expanded use of biofuels are key parts.

The commitment to biofuels by the domestic auto industry is clear. What is needed is a similarly large show of support by the energy industry to build the infrastructure to make these fuels readily available.

I look forward to the testimony of our witnesses.

The CHAIRMAN. We will now turn to our witnesses. And our first witness is Adam Gardner. Even though Adam now calls Portland, Maine, home, he and his bandmates from Guster are indeed favored sons of my home State of Massachusetts. They formed a band while at Tufts University and sold their CDs in Harvard Square. Today, Guster has sold over a million records and has become one of the Nation's leading touring bands, playing sold out shows from Radio City Music Hall to Farm Aid to the Boston Symphony Hall, where they performed with the famous Boston Pops.

Four years ago, Adam and his wife, Lauren, decided to start Reverb, a nonprofit that educates fans and other musicians about environmental sustainability. They have greened 42 touring bands and, among many initiatives, encouraged touring musicians to switch to biodiesel bus travel.

Mr. Gardner, whenever you are ready, please begin.

STATEMENT OF ADAM GARDNER, CO-FOUNDER, REVERB, AND MUSICAL ARTIST, GUSTER

Mr. GARDNER. Check, one, two. Is this on? Hello? Sorry. This is always what we do when we play gigs.

Chairman Markey, Ranking Member Sensenbrenner, and ladies and gentlemen of the committee, thank you for inviting me to testify today. It is truly an honor to be part of this dialogue on global warming. As a musician who spends most of his time either on the road in a tour bus or on stage in a t-shirt, I also want to thank you for the opportunity to wear this suit today to something other than a wedding or a funeral.

My band Guster started touring 14 years ago from our home base in Boston. We started in a small van and eventually graduated to a tour bus and an 18-wheel truck for our equipment.

We knew our tours consumed a lot of fuel, and you can only nickname your tour bus The Earth Eater for so long before making a change. We wanted our actions to match beliefs and I thought there were a lot of other bands out there that felt the same way but just didn't know where to begin. In response, my wife, Lauren Sullivan, who has been working in the environmental community as long as I have been playing in a rock band, decided to create Reverb, a nonprofit organization dedicated to educating and engaging musicians and their fans to promote environmental sustainability.

Over the past few years, we have worked with over 45 major national tours to implement a laundry list of greening efforts that reduce waste and carbon emissions backstage while simultaneously educating and activating concertgoers through a festival like Eco-Village out front. Reverb also launched The Campus Consciousness Tour, now in its third year, to bring our unique environmental program to college campuses across the country while adding daytime activities, such as open town hall forums with students, band members, environmental groups on campus, faculty and administrators, to discuss sustainability on campus and what students can do to make a difference.

To date Reverb's efforts have reduced CO_2 emissions by more than 25,000 tons, facilitated the use of over 250,000 gallons of biodiesel, involved more than 1,400 local and national environmental

groups in the Reverb Eco-Village and reached over 4.4 million concert goers face to face.

Reverb does green tours for Dave Matthews Band, Norah Jones, Red Hot Chili Peppers and many, many more. Reverb's biodiesel efforts seemed to spark the most interest in conversation on the road with everyone from truck drivers to record label executives. I suppose this is because biodiesel appeals to so many different stakeholders and has a wide array of possible uses and benefits. Biodiesel allows us to power vehicles while also protecting the environment, facilitate our independence from dangerous foreign oil dictatorships and can support jobs in local and rural communities. The use of biodiesel is radically changing the music touring industry. And there is no reason why we couldn't continue to broaden its reach. Ideally, some day soon, our fans will drive to concerts in biodiesel cars of their own, maybe even plug-in hybrids. That would be cool.

For Guster, making strides towards kicking our own oil addiction hasn't been easy. We had to leave our first bus company to find one that would allow us to put B20 in the tanks. At the time, there were only one or two such companies in existence. Finding biodiesel pumps on tour has been hard. With just 1,100 around the country, Reverb has to coordinate local suppliers to deliver fuel to bands on the road. But since we have started, we have seen biodiesel skeptics quickly convert to advocates. Drivers found that engines ran cleaner and cooler, and bus and truck companies have been responding to the increased demand from artists.

While our Nation has made great strides in biodiesel production, there are a number of ways we could continue to improve. The energy bills that the House and Senate passed this summer are a great start. Increasing production from renewable energy sources like sugar, wood and algae, while beefing up infrastructure, allowing consumers better access to biofuels at the pump is a key component. I encourage you to keep this energy bill green, allowing Congress to take its first real step in the fight against global warming.

Corporations can do more as well. I would like to see auto companies encourage the use of biodiesel in higher blends all the way up to pure B100 rather than holding the line at a 5 percent blend.

I would also hope that the agricultural community could come together. Guster was thrilled to play with Willie Nelson at Farm Aid where we heard firsthand from small family farmers who want to be part of the solution. There I had the pleasure of meeting the founders of the Sustainable Biodiesel Alliance. The SBA is a nonprofit group whose mission is to promote sustainable biodiesel practices from harvesting to production to distribution, keeping both environmental and social considerations to heart. It would be awfully ironic to go from reliance on irresponsible oil companies to a biofuels industry dominated by large-scale commercial farming at the expense of small farmers, community economics and the environment.

If done right, biodiesel offers the unique opportunity for a field product that is not just less bad than petroleum diesel but is an actively good fuel that can reinvigorate our local economies and actually replenish and revive the environmental damage that we have caused.

On my path I have encountered so many inspiring, motivated and truly selfless individuals who are determined to create and propagate positive change. From pioneer artists like Neil Young and Bonnie Raitt, who have been circling the country using biodiesel for several years now, to the City of Milwaukee's Venu Gupta, who powers his fleet municipal fleet with millions of gallons of biodiesel made right in Mr. Sensenbrenner's home State of Wisconsin.

Most inspiring are the countless conversations held with the millions of music fans at the Reverb Eco-Village. I invite you all to the next Reverb show, so you can take part in this dialogue where talk of global warming doesn't center around doom and gloom but rather optimism, commitment and creative solutions. It is a generation that stands ready to stare down the greatest challenge they will have to face, but they also look to you on your stage to lead the way.

I see this moment in time, a relative flicker when considering the earth's age, as a critical one. The growing wave of momentum to defeat global warming during this small window of opportunity could very well determine what life will look like on the other side of that flicker. Thank you.

[The prepared statement of Adam Gardner follows:]

Testimony of Adam Gardner

Co-Founder of Reverb and Vocalist/Guitarist for Guster

Before the Select Committee on Energy Independence and Global Warming

"The Grass Greener: The Future of Biofuels"

October 24, 2007

Chairman Markey, Ranking Member Sensenbrenner and ladies and gentlemen of the Committee, thank you for inviting me to testify. It's an honor to be part of this dialogue. As a musician who spends most of his time either on the road in a tour bus or on stage in a t-shirt, I also thank you for the opportunity to wear my suit to something other than a wedding or a funeral. As you know, my name is Adam Gardner and I'm a member of the band Guster. Four years ago, my wife and I began to provide information on environmental sustainability to the live music community as we toured. Our concerns and actions on this front have expanded ever since.

My band Guster started touring from our home base in Boston in 1993. Whether an artist immediately hits it big on the radio and MTV or builds their audience from the ground up like my band did, touring is critical to growing and sustaining every band's career– a process that calls for a great deal of travel as we meet and play music for people across the country in venues ranging from small-town bars and clubs to big city sports arenas and stadiums. In the early days we started with a small van, but have grown to include a caravan of tour buses and 18-wheel trucks for our equipment.

As we toured, we met and talked with people of all ages and from all walks of life about the importance of environmental sustainability and energy independence. Traveling to

numerous campuses, we observed that students were hungry for information about environmental sustainability – and that they were eager to work with us to spread the word about climate change. Once we calculated how much fuel the buses and trucks that we and other bands rely on to travel drink up, we knew that we wanted our actions to match our beliefs. We were sarcastically nicknaming our tour bus the "Earth-Eater" and were ready to make a change. We began to think about the energy footprint of the venues in which we played. Out on the road I discovered that many other bands also lamented the negative environmental impact of their tours but didn't know how or where to start.

In response, my wife Lauren Sullivan, who has been working in the environmental community as long as I've been playing in a rock band, and I decided to create Reverb, a non-profit organization dedicated to educating and engaging musicians and their fans to promote environmental sustainability. This partnership was a literal and figurative marriage of the music industry and the environmental movement. Over the past few years, we've collaborated with over 45 major national tours to implement various greening efforts including waste reduction and recycling, using biocompostable and reusable catering supplies, providing eco-friendly merchandise for fans, reducing and neutralizing carbon emissions from power used at venues, hotels, and travel, adding environmental addendums to bands' contracts with venue promoters requesting eco-friendly products and practices, setting up a fan outreach Eco-Village of local and national non-profit groups at shows, and coordinating local biodiesel suppliers to come out to concert venues and fill up bands' touring fleets with biodiesel. Reverb also launched the "Campus Consciousness Tour," now in its third year, to bring all the elements listed above to college campuses across the country while adding daytime activities such as open Town Hall Forums with band members, student groups, faculty and administrators to discuss sustainability on campus, and what students can do to make a difference.

To date, Reverb's efforts have reduced CO2 emissions by more than 25,000 tons. We've also coordinated the use of more than 250,000 gallons of cleaner, safer biodiesel fuel in touring fleets, involved more than 1,400 local and national environmental groups in the

Reverb Eco-Village and reached more than 4.4 million concertgoers face-to-face. This year, Guster released a carbon neutral CD—a first for the major label conglomerate Warner Music Group, and Reverb is currently working with Warner Music Group to reduce and neutralize the carbon footprint of their headquarters in New York City. In addition to my own band, Reverb has "greened" many other tours including Grammy-award-winning artists such as Dave Matthews Band, Alanis Morrisette, John Mayer, Norah Jones, and Red Hot Chili Peppers.

Key to the approach in our efforts, we avoid preaching to people. It's not really our style. But more importantly, it's not really necessary. By providing a forum to connect activists with eco-friendly businesses and community leaders in a fun, compelling setting at concerts, we can generate interest and raise awareness not only among those looking to learn more, but even those who are there just to get a free sample of an organic yogurt smoothie. We also inspire people to change by showing them simple ways to achieve real results. The drive to defeat global warming and create greater energy independence is real on the grassroots level. I have seen it first hand. We are trying to do our part, but we want to be part of a larger, broader effort.

Of all of the soup-to-nuts eco-friendly efforts Reverb provides for bands, biodiesel is the one that seems to spark the most interest and conversation on the road with everyone from truck drivers to high-powered record label executives. I suppose this is because biodiesel appeals to so many different stakeholders and has a wide array of possible uses and benefits. Biodiesel allows us to power vehicles while also protecting the environment, facilitate our independence from dangerous foreign oil dictatorships, and can support jobs in local and rural communities. The use of biodiesel is radically changing the music touring industry, and there's no reason why we couldn't continue to broaden its reach.

For Guster, making strides toward kicking our own oil addiction hasn't been easy. We had to leave our first bus company to find one that would allow us to put B20 in the tanks! At the time, there were only one or two such companies in existence, and many, many times that number of skeptics. One of the biggest hurdles was, and continues to be,

finding places to refuel – Reverb's most requested service from bands is the coordination of local biodiesel suppliers to deliver and fuel them up at venues. This is because around the country there are still too few biodiesel pumps –just around 1,100. But along the way, we've met people who are working hard to change that. For example, Venu Gupta, Superintendent of Buildings and Fleet for the City of Milwaukee, is fueling a million gallons this year of B10 biodiesel in his municipal fleet and plans to increase that blend to B20 in 2008.

Through Reverb, Guster has been able to share what we've learned and open the door for many bands to learn about green touring. We've also created a demand and converted our former skeptics into vocal advocates. We now work with a number of different bus and truck companies, drivers, and mechanics who believe biodiesel is cleaner for engines and can work just as well or better than traditional diesel fuel. By the way, there is no modification necessary to use biodiesel, with the exception of some older vehicles that may need fuel lines replaced, any diesel engine can run on biodiesel—you just put it in. Pioneering artists like Neil Young, Willie Nelson and Bonnie Raitt have been circling the country using biodiesel for several years now. My fellow musicians and I are eager for the day when we can take our biodiesel bus to play a concert in front of fans who drove there in their own biodiesel or plug-in hybrid powered cars.

While we've made great strides in biodiesel production and use in this country, there are a number of ways we could continue to improve. The energy bills that the House and Senate passed this summer have several provisions that are vital to promoting the availability of biodiesel. The Senate bill increases the production of advanced renewable fuels like biodiesel from sugar, wood, or plant material. Without this increase, it will be extremely difficult to expand Reverb and encourage others to use biodiesel on a regular basis. The House bill has several provisions that develop a greater infrastructure for biofuels and permit franchise retail fuel station owners to advertise and place E85 and biodiesel pumps at their stations. Congress must allow retailers to respond to consumer demand.

In addition to Congressional improvements to biodiesel productions, corporations can do more as well. Some auto companies, for instance, still void the warranty of owners who use biofuels. Most biodiesel is used in a blend with petroleum diesel of somewhere between B5 and B20 – we need to break down barriers that are holding us back from using pure B100. It's also important to encourage the development of this industry in ways that are compatible with good environmental stewardship – it would be horribly ironic to go from reliance on irresponsible oil companies and vehicle manufacturers to a biofuels industry dominated by large-scale commercial farming at the expense of small farmers, community economics and environmentalism.

This year, Guster was thrilled to play with Willie Nelson at Farm Aid, where we not only heard firsthand from small family farmers who want to be part of the solution to our climate and energy security problems, but where I also had the pleasure of meeting the founders of the Sustainable Biodiesel Alliance. The Sustainable Biodiesel Alliance (SBA) is a non-profit group whose mission is to promote sustainable biodiesel practices, including the harvesting, production and distribution of biodiesel fuels in collaboration with a wide array of partners from farmers to renewable energy experts, the SBA drafted Sustainable Biodiesel Principles, that include both environmental and social considerations. I'd like to share with you an overview of these principles:

Environmental Considerations:

- Reduce greenhouse gas emissions caused by fossil fuels -**both direct and indirect** forms that contribute to **growing, transporting and processing** biofuels.
- Energy and resource conservation principles that cut back on **total consumption**.
- Production should not **degrade soil, contaminate water resources**, or **add to air pollution**.
- Biofuel production should not lead to the **destruction, degradation or declassification of high conservation value areas**, areas of high biodiversity; habitats of rare, threatened or endangered species; or rare, threatened or

endangered ecosystems. Protected areas, including forested areas, should not be declassified or appropriated for biofuel crop production.

- Biofuels should ideally be **derived from non-Genetically Modified Organisms** feedstocks. Until then, the use of GMOs for production should be made transparent, so that buyers can make informed decisions about their feedstock.
- Biofuel crop production should minimize, and eliminate whenever possible, the use of **dangerous agrochemicals**. Agrochemicals that are hazardous to the environment, workers, and local communities should be used only as a last resort.

Social Considerations:

- **Food security**, making sure local communities play an integral part of the development of the biofuel industry.
- **Family and smallholder farmers should not be displaced** to grow or harvest biofuel feedstocks. Farmers should receive **fair compensation** for biofuel feedstocks and the products they produce.
- The **health and safety of workers** and communities should be protected. In addition, fair wages for agricultural workers and workers at biofuel production facilities should be ensured.
- Communities and farmers producing biofuels should have, to the greatest extent possible, **ownership of biofuel production** and processing facilities. Income generated from biofuel production should be kept to the greatest extent possible, within local producing communities from the feedstock to processing facilities.
- Strategies for **local consumption** should be prioritized over transporting or exporting biomass or biomass energy and products away from the communities and regions that produce them.

Far too often, our country's approach to protecting the environment is to do "less bad" which slows the harmful destruction rate down, but doesn't prevent it. Sustainable biodiesel offers the unique opportunity for a fuel product that is not just "less bad" than petroleum diesel, but is an actively good fuel that can reinvigorate our local economies

and actually replenish and revive the environmental damage we've caused. Of course, this is only if biodiesel and all biofuels adhere to principles such as the ones laid out by the Sustainable Biodiesel Alliance.

The challenge and the response to biodiesel has been uplifting. On my path I've encountered so many inspiring, motivated, and truly selfless individuals who are determined to create and propagate positive change. I'd like to say two things in closing. First, I want to clearly express that the desire for a new direction in our country's energy policy is out there. It's strong--and it's growing. College kids, who are typically at the center of advocacy and activism, look at politicians and entrenched interests and see only our slowness to act in the face of a global climate crisis. Excuses, whether they're about the importance of large automakers or the difficulty of producing clean and renewable energy technologies, don't really register. Young people want change, and they expect it from us. If we lead, they will eagerly follow.

Second, our efforts at Reverb have shown that it's possible to make a difference. The only things required are vision and commitment. Admittedly, the music industry was receptive to change, but there are other heavy carbon producing industries that will require more than voluntary actions and goals, and that is where leadership from Congress needs to play its part. It's easy to get lost in abstraction when discussing major policy shifts -- if we do this, then what about that? If we mandate percentages of plug-in hybrid cars, or mandate the use of biofuels, what will happen to the auto industry? Like the live music scene, commercial industries will adapt if they are shown a compelling reason to do so—and a legislative push from Congress would send a strong message, setting forth guidelines for positive change.

It's human nature to preserve the status quo unless something motivates a change. Vice President Gore and his quest to save the planet have made admirable inroads in raising the public consciousness, but we can't stop there. We need practical solutions to these problems. I hope that by sharing our practical solutions with you, that we might broaden your reach and deepen our fight. All it takes is a commitment. Strong legislation from

the American government on this issue could change the face of the world forever, and immensely for the better.

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The CHAIRMAN. Thank you, Mr. Gardner, very much.

Our next witness is Don Endres, who is the CEO of VeraSun Energy, the second largest ethanol producer in the United States, 250 million gallons a year and growing. Only ADM is beating you. They have also developed a technique to produce biodiesel from distillers grains, one of the byproducts of corn ethanol. VeraSun has plants in Ohio, Indianapolis, Minnesota, Iowa, Michigan and Mr. Endres's home State of South Dakota.

Recently VeraSun and Enterprise Rent-A-Car announced that the two companies will work together to use VeraSun E85 brand in Enterprise's flex-fuel vehicles wherever E85 is available.

Mr. Endres, when you are ready, please begin your testimony.

STATEMENT OF DON ENDRES, CEO, VERASUN ENERGY

Mr. ENDRES. Good morning, Mr. Chairman, members of the committee. Thank you for inviting me to testify today on behalf of VeraSun.

I grew up on a farm in South Dakota, and I am pleased to be representing one of the Nation's largest biofuels companies. We have four operating facilities in production today. We have four more under construction and one more facility under development. Once we are complete with these new facilities, VeraSun will have an operating capacity of approximately 1 billion gallons per year. We believe ethanol from cellulosic feed stocks will complement corn-based ethanol in meeting the growing demand for renewable fuels. VeraSun has have invested in SunEthanol, a Massachusetts-based company working to cellulosic ethanol production technology.

The ethanol industry has grown significantly in recent years due to the demand from the market in part because of the policies put in place by the Federal Government. Today, approximately 50 percent of the Nation's gasoline is blended with ethanol. Because of the growth of the ethanol industry, it appears now that there will be enough ethanol to blend 10 percent and 100 percent of the U.S. gasoline business.

Clearly, the expansion of the ethanol industry is a success story. It is the most significant step this Nation has taken to diversify our liquid transportation fuel since the advent of the automobile a century ago. But we are just beginning. Today the industry is still too small. Our 7 billion gallons of current capacity makes up only 5 percent of the 140 billion gallon gasoline market.

Now is the time to springboard from the solid foundation of the ethanol industry to diversify both the feed stock used to produce renewable fuels and how they are used in our transportation fleet. If we are going to make game-changing steps towards energy independence, addressing global warming and creating new economic opportunities, three very important items have to come together.

First, enterprise must be empowered to work. Second, the Federal Government must lay the framework to enable the industry to succeed. And third, consumers must have both the access and the incentive to join our commission.

Oil is now regularly breaking new record highs. This has caused a lot of players to jump into the race to find alternatives. In the past, their enthusiasm in investment rose and fell with the cost of

a barrel of oil. While this could happen again, I believe that world events have created a fundamental change.

Walter Wristen, the former chairman of Citibank, once famously said that capital goes where capital is well treated. And the worst way to treat capital is to throw it into uncertain situations. It is critical now more than ever that we have Federal support to help achieve ethanol's potential.

Our first objective should be to look at every opportunity in Congress to achieve the certainty that vital investment capital is looking for, product demand. I experienced firsthand the importance of government policy when we took VeraSun public in 2006. It became very clear very quickly that people participating in the financial markets understood the importance of renewable fuels, and they were excited about investing in something that could do so much good for our national security, our economy and our environment.

Their big questions were about policy. What role would the government play in promoting renewable fuels? Would the Renewable Fuels Standard work as promised? The same questions about government policy that faced VeraSun in 2006 are facing those seeking investment in cellulosic technologies from the financial markets today. How much demand will there be for ethanol beyond 14 billion gallons of demand created through the E10 market? Will the Federal Government expand the RFS? How can E85's availability be jump started?

It is critical that the Federal Government act this year to pass an energy bill that begins to address these questions if we want to see continued growth of the ethanol industry. The ethanol industry is outpacing the current RFS schedule. Under the current law, if RFS mandates the use of 4.7 billion gallons of ethanol in 2007. And according to the Renewable Fuels Association, the ethanol industry is on pace to produce nearly 6.5 billion gallons of ethanol this year. Because of this, the RFS is not acting as a market driver at the present time. That being said, with ethanol selling at $1.55 per gallon and conventional gasoline selling at over $2 a gallon, ethanol clearly is lowering fuel cost at the pump. By blending ethanol and gasoline today, some refiners are passing considerable savings to consumers.

Unfortunately, not all refiners are capitalizing on the economic advantages of blending ethanol. One of the most effective things Congress and the President can do in the short term is to enact an energy bill this year that increases the RFS. The Senate-passed RFS calls for 8.5 billion gallons in 2008; 10.5 in 2009; and 12 billion gallons in 2010. These early increases are critical to fostering the continued development of the ethanol industry.

Beyond addressing these near-term issues, the Federal Government should send a clear long-term message to the industry to support continuing investment in growth. We support the Senate's call to expand the RFS to 36 billion gallons by 2022, including a significant call for ethanol production from cellulosic material. We believe this is a very achievable goal but one that will require widespread adoption of E85 usage. Without E85 demand, the market will not support the early-stage development that is necessary to unlock the potential that cellulosic ethanol holds.

As one of the largest biofuels producers, we assumed large responsibility to ensure a robust E85 market occurs. Today, only 1,350 stations of 180,000 offer E85. We must do better. In early 2005, VeraSun launched the Nation's first blended E85 product. We began the program in May of 2005 with the conversion of 35 pumps in Sioux Falls, South Dakota. At the time, we launched a marketing program to raise awareness to the benefits of flex-fuel vehicle ownership, E85 use and enlisted the support of GM. E85 sales rose. Demand for flex fuel vehicles increased, and consumers have been very pleased.

Today, VeraSun has a total of 110 retail locations around the country selling E85, including one right here in the District of Columbia. From this experience, we have gained significant insight about what is necessary to develop E85 in the United States. As VeraSun works to expand the number of stations——

The CHAIRMAN. If you could summarize, that would be great.

Mr. ENDRES. Sure. I would like to just conclude by saying, ethanol today represents a great early solution to the biofuels industry. It doesn't come clearly formed, complete in perfect form. But in fact we very much believe that ethanol today represents a great opportunity to reduce reliance on foreign oil, reduce greenhouse gases and improve fuel economies around the country.

[The prepared statement of Don Endres follows:]

Statement of Don Endres
CEO, VeraSun Energy

For

The United States House of Representatives Select Committee on Energy Independence and Global Warming
Hearing Entitled The Gas is Greener: the Future of Biofuels

October 24, 2007

Good morning, Mr. Chairman and Members of the Committee. I appreciate the opportunity to testify on behalf of VeraSun Energy today.

Having grown up on a farm in eastern South Dakota, I am pleased to be representing one of the nation's largest producers of renewable fuels. The company has four operating ethanol production facilities located in Aurora, SD, Fort Dodge, IA, Charles City, IA, and Linden, IN. Four facilities are currently under construction in Albion, NE, Linden, IN Hartley, IA, Welcome, MN, and Bloomingburg, OH. An additional plant is under development in Reynolds, IN. Upon completion of the new facilities, VeraSun will have an annual production capacity of approximately one billion gallons. The Company also has perfected a process to extract oil from dried distillers grains, a co-product of the ethanol process, for use in biodiesel production.

We believe ethanol from cellulosic feedstocks will complement corn-based ethanol in meeting the growing global demand for renewable fuels. VeraSun has invested in SunEthanol, a Massachusetts-based company working to commercialize cellulosic ethanol production technology. If successful, their technology holds the promise to covert a variety of feedstocks, such as wood chips, corn stover, or switchgrass, into ethanol.

Additionally, VeraSun markets E85, a blend of 85 percent ethanol and 15 percent gasoline for use in Flexible Fuel Vehicles (FFVs), directly to fuel retailers under the brand VE85(TM). VeraSun's branded E85 is now available at more than 110 retail locations in 11 states and the first E85 fueling location in the District of Columbia.

Ethanol Industry a Success Story

I choose to invest in the ethanol industry because I believe ethanol is a clean high octane component that has value to refiners and ultimately is a promising business opportunity for our investors. But I also invested in this business because of the promise it holds for our nation – energy security, economic opportunities for rural communities, and improving our environment.

The ethanol industry has grown significantly in recent years due to demand from the market and in part because of policies put in place by the Federal government. The industry has grown from a 900 million gallon industry in 1990 to an industry with 131 ethanol bio-refineries with nearly 7 billion gallons of production capacity today. Enactment of the Renewable Fuels Standard in 2005 supported unprecedented growth of the domestic ethanol industry. Today there are 73 new

plants under construction and ten others are being expanded. When complete, these efforts will add over six billion gallons of ethanol production capacity, more than doubling current production within the next two to three years. Today, approximately 50 percent of the nation's gasoline is blended with ethanol. Because of the growth of the ethanol industry, it appears there will be enough ethanol to blend 10 percent ethanol in 100 percent of the nation's gasoline.

Clearly, the expansion of the ethanol industry is a success story. It is the most significant step this nation has taken to diversify our liquid transportation fuel since the advent of the automobile over a century ago. Each of these bio-refineries creates over $100 million in local economic activity, generates $20 million in additional household income, and supports the creation of as many as 650 permanent new jobs throughout a rural community. And, with current commercial ethanol production technologies, we are reducing greenhouse gas emissions over fossil fuels by nearly 30 percent. But we are just beginning.

Today, this industry is still too small. Our 7 billion gallons of current capacity makes up only 5% of the 140 billion gallon domestic gasoline market. We see great promise in the future of renewable fuels in the transportation sector. Now is the time to springboard from the solid foundation of the ethanol industry to diversify both the feedstock used to produce renewable fuels and how they are used in our transportation fleet.

If we are to make game changing steps towards energy independence, addressing global warming, and creating new economic opportunities, three very important items have to come together.

One … private enterprise must be empowered to work.

Two … the Federal government must lay the framework to enable the industry to succeed.

Three … consumers must have both the access and the incentive to join our mission.

Private Enterprise must be Empowered to Work

Oil is now regularly breaking new record highs. This has caused a lot of players to jump into the race to find alternatives. In the past, their enthusiasm and investment rose and fell with the cost of a barrel of oil. While that could happen again, I believe that world events have created a fundamental change.

Walter Wristen, the former chairman of Citibank, once famously said that capital goes where it is well treated. And the very worst way to treat capital is to throw it into uncertain situations. It is critical, now more than ever, that we have Federal support to help us achieve ethanol's potential.

Our first objective should be to look for every opportunity in Congress to achieve the certainty that vital investment capital is looking for – product demand.

I experienced first hand the importance of government policy when we took VeraSun public in 2006. It became very clear, very quickly that people participating in the financial markets understood the technology and believed in the demand. They understood the importance of renewable fuels, and they were excited about investing in something that could do so much for our national security and for our economy.

Their big questions were about policy. What role would the government play in promoting renewable fuels? Would the Renewable Fuels Standard work as promised in mandating the percentage of motor fuel in the US that will be obtained from renewable sources? Could foreign-sourced ethanol be allowed to undercut US production?

The same questions that faced VeraSun in 2006 are facing those seeking investment in cellulosic technologies from the financial markets today. How much demand will there be for ethanol beyond the 14 billion gallons of demand created through the E10 market? Will the Federal government expand the Renewable Fuels Standard? What ways will they help expand E85?

It is critical that the Federal government act this year to pass an energy bill that begins to address these questions if we want to see continued development of the ethanol industry.

Federal Framework to Spur Demand and Use of Renewable Fuels is Necessary

The ethanol industry is outpacing the current RFS schedule. Under current law, the RFS mandates the use of 4.7 billion gallons of ethanol in 2007 and 5.4 billion in 2008. According to the Renewable Fuels Association, the ethanol industry produced 4.9 billion gallons in 2006 and is on pace to produce approximately 6.5 billion gallons this year. Because of this the RFS is not acting as a market driver at the present time.

That being said, with ethanol selling at $1.55 per gallon and conventional gasoline selling at over $2 per gallon, the market should still be steering use of ethanol to lower the prices that consumers pay at the pump. By blending ethanol in gasoline today, refiners could save consumers up to 10 cents per gallon and mitigate the increase in gas prices as a result of record oil prices. Unfortunately, not all refiners are capitalizing on the economic advantages of ethanol blending.

One of the most effective things Congress and the President can do in the short-term is enact an energy bill this year that expands and increases the Renewable Fuels Standard (RFS). The Senate-passed RFS calls for 8.5 billion gallons in 2008, 10.5 billion in 2009, and 12 billion gallons in 2010. These early year increases are critical to fostering the continued development of the ethanol industry.

Building the Future of Biofuels – Increasing Demand and Availability to Consumers

Beyond addressing these near-term issues, the Federal government must continue to focus on creating new demand into the future. We support the Senate's call to expand the RFS to 36 billion gallons by 2022 including a significant call for ethanol production from cellulosic sources.

We believe that this is a very achievable goal, but one that will require widespread adoption of E85 usage. Because of the successful growth of the ethanol industry, reports indicate that we will meet the demand of the current 10 percent blend market with corn-based ethanol within the next few years. We believe the market must see a path toward E85 in order for cellulosic ethanol to evolve. Without E85 demand, the market may not support the early stage development that is necessary to unlock the potential that cellulosic ethanol holds.

Simply put, the Federal government must focus efforts on growing demand. A strong commitment to E85 will ensure the success of cellulosic ethanol production in the United States.

As one of the largest biofuels producers, we assume a large responsibility to insure that a robust E85 market occurs. VeraSun has pursued an aggressive strategy in cooperation with GM and Ford to increase the availability of E85. Today only 1,350 of the nearly 180,000 (or 6/10th of 1%) retail gasoline stations in the United States offer E85. We must do better.

In early 2005, VeraSun launched the nation's first branded E85, VeraSun E85 or VE85 for short. We began the program in May 2005 with the conversion of 35 pumps at seven stations in Sioux Falls, South Dakota. At the same time, we launched a marketing program to raise awareness to the benefits of flexible fuel vehicle (FFV) ownership and E85 use, and enlisted the support of General Motors to assist with the rollout of the program. As a result of the program, local E85 awareness increased, E85 fuel sales rose, and the demand for flexible fuel vehicles increased in the local market.

In early 2006, we replicated this effort in conjunction with GM to bring VE85 to Chicago and Minneapolis. In June 2006, we worked with Ford to create an E85 corridor from Chicago to St. Louis. In July 2006, we announced with GM at the Major League Baseball All-star Game the first retail availability of VE85™ in Pittsburgh. In June of this year, we announced with GM the first E85 refueling station in the District of Columbia. More recently we announced a partnership with Kroger to offer VE85 at more than 20 locations across the country.

All told, VeraSun's branded E85 is available at more than 110 retail locations across 11 states and the District of Columbia. We plan to continue to work to expand the number of fueling stations offering VE85 from coast to coast.

From this experience, we have gained significant insight about what is necessary to develop E85 in the United States. In order to see a robust E85 market in the United States, VeraSun believes the Federal government must address the following items.

1. Improve E85 economics through the creation of an E85 Blenders Credit;
2. Create an auto incentive for the production of advanced FFVs; and
3. Address terminal infrastructure issues.

As VeraSun works to expand the number of fueling stations offering VE85, the most significant issue we face is blender economics. Traditionally, the market values ethanol more highly for E10 blending than it does for the E85 market. Allow me to explain; FFV's are currently not designed to take advantage of E85's high octane. Since refiners are able to take advantage of ethanol's high octane to increase refinery output and improve the economics of gasoline production, the product is valued more highly as a blend component in E10. These economics significantly reduce the availability of E85 because today's FFVs achieve lower miles per gallon when run on E85 than on conventional gasoline. This has direct impact on consumers and, therefore, requires that E85 be sold at a discount to gasoline.

For fuel retail owners to install E85 infrastructure, they must have confidence that E85 will be priced appropriately and that there will be sufficient consumer demand.

To improve E85 economics, Congress should create a blenders credit for ethanol blended into E85 within the existing VEETC system. This credit would compensate for the discount resulting from the loss in miles per gallon efficiency. Establishing this incentive serves two purposes. First, it will level the playing field for ethanol blended into E10 versus E85, and will lead to additional E85 pump infrastructure. Second, it will ensure that E85 is priced properly at the pump for consumers. By providing a credit to blenders who select to market E85, we will level the playing field and increase the availability of E85. This will help make a fuel retailers decision to offer E85 more straightforward.

In addition to increasing the supply of E85, we must also increase the number of FFVs on the road. Today, less than three percent of the vehicles on the road are E85 compatible. Without a significant ramp up in the production of FFVs, E85 use will remain relatively small. To this point, we very much appreciate GM, Ford, and DaimlerChrysler's commitment to increasing production of E85 and biodiesel capable vehicles to 50% by 2012. This is a significant step forward.

But we believe the automakers must work to improve FFV technologies to better take advantage of E85's high octane. To spur the production of more fuel-efficient FFVs, Congress should provide incentives for automakers that produce FFVs with E85 fuel economy comparable to conventional vehicles. Additionally, Congress should provide a consumer tax credit for the purchase of these more fuel efficient FFVs.

Conclusion

Isaac Newton said that things continue in a straight line unless they are compelled to change by outside forces.

When you look at the direction of energy consumption in the United States, outside forces have grown and aligned to create an historic upheaval. Global demand. Dwindling supply. Political instability. Environmental damage.

All of these forces come together to form a single, essential truth. The straight line we have traveled for more than a century must change. It is not a choice. It's a fact. And the sooner we

accept that fact, the sooner we can get serious about dealing with a situation that is on an inevitable path from a national problem to a national crisis.

It's fitting that one of the solutions to America's energy crunch comes out of our first industry – agriculture.

But the solution isn't going to arrive fully formed, any more than the first airplanes were powered by jet engines, or the first cars traveled a system of interstate highways. Achieving each possibility starts us thinking about new ones... and achieving those opens our minds and our abilities to new advances.

The steps we are taking now – complete with the inevitable false starts and lessons learned – are the pieces of a future that is just now coming into focus.

Those pieces include:

- A stable supply of renewable fuels grown and produced here at home from corn, soybeans, switchgrass, woodchips, and other materials.
- The new generation of FFV vehicles provided by the auto industry.
- The active and visionary participation of government to help knock down barriers and provide a framework for success.

That is a lot to bring together. I have no illusions about that. But the need is great and the time is short. Renewable fuels are a real solution, and a workable one. We all share the responsibility to get it right – and to do it now.

Thank you.

The CHAIRMAN. Thank you, Mr. Endres, very much. Our second witness, Steven Gatto, is the Chairman and CEO of BioEnergy International, a company that has two 108 million gallons per year of corn ethanol plants in Pennsylvania and Louisiana. They are also planning to build a smaller scale cellulosic pilot plant.

Mr. Gatto, we are very pleased to have you with us today. Whenever you are ready, please begin.

STATEMENT OF STEPHEN J. GATTO, CHAIRMAN AND CEO, BIOENERGY INTERNATIONAL, LLC.

Mr. GATTO. Thank you, Mr. Chairman, members of the committee. Thank you for inviting me here today to talk about a very important issue. I applaud your leadership in recognizing the urgent need to change our energy paradigm.

To the Chairman in particular, your leadership has inspired me over the last 15 years. When I would come to Washington back in the late 1990s to discuss ethanol, I was occasionally referred to as the village idiot. Gasoline was selling for about $1.30 a gallon, and no one had ever heard of the word cellulose. Mr. Chairman, you were one of the few who listened and inspired me to make a difference, and for that, I profoundly thank you.

Since then, I have had the privilege of serving on the Biomass Technical Advisory Board under President Clinton and President Bush. I have also worked with some congressional committees, helping to create the Energy Policy Act, particularly the cellulose component.

As the Chairman knows, I came to this industry somewhat circuitously in the late 1980s. I have a cousin who is an avid environmentalist who took me to New Hampshire to talk about composting of municipal solid waste. And about the same time frame, I was introduced to a technology that had just gotten patent number 5 million. It was a little bug that loved to eat all the sugars from biomass. I figured it had to be a hell of a lot more profitable for us to make booze instead of making dirt. As a result, I launched what was one of the first cellulosic ethanol companies in the country.

BC International, which later became Celunol and is now Verenium, proved the technology was viable after developing and operating three successful pilot plants. We arranged financing for what would have been the first commercial cellulosic demonstration on sugarcane, bagasse and rice hulls in Louisiana; 9/11, a change in administration, the deal fell apart, the industry set back a decade, set back not because of a failure in technology but because of lack of incentives, and moreover, a lack of vision of what was to come.

Today, with oil pushing $90 a barrel, the tragic loss of so many lives in the Middle East and hydrocarbons fueling the climate crisis, we cannot afford another decade of delay. My message is simple yet urgent. The ethanol industry is at a tipping point. We are at the brink of the next industrial revolution, on the verge of transforming our economy from a carbon-based society to a carbohydrate-based program with next-generation biorefineries. I would suggest this is the year we either commit ourselves to an all-out offensive to reduce our dependency on oil, to stop funding radical

countries that continue to do us harm and to reduce our insatiable use of fossil fuels to stem our climate crisis.

I don't want to tell my grandchildren we failed because of lack of will. We need bold leadership to replace foreign oil with domestic production, first from corn, then cellulosic feed stock, such as agricultural waste and municipal waste.

This effort is no different than the challenge faced in the 1960s by President Kennedy. He wanted to put a man on the moon. However, we did not attempt to do this all at once. We had a program sparked by vision, propelled by leadership, but grounded and faced yet ambitious milestones. We shot a rocket in the air, circled the earth, flew around the moon and finally landed on the moon. It changed history forever. We need that kind of vision and commitment from you all today.

Let there be no doubt, the energy bill this year is the fight of our generation. Clearly, with all the discussion of a glut, the biofuels industry has met the call to action and surpassed the current RFS for all the right reasons: energy independence, global climate change, jobs and American prosperity. The question and opportunity is, what do we need to do to provide America with a self-sustaining program that has an evolution with a beginning, a middle and an end? Home-grown fuels initially from corn, then biomass, which is available from every region of this country. The earth's ability to produce sugar from biomass is virtually unlimited. The story sounds too good to be true, but it is real and has already committed to an economic boom in this country, as other sectors, such as housing, lag.

Today I serve as Chairman and CEO of Bioenergy International, a science and technology leader in the development of multiproduct biorefineries that produce a wide range of biofuels and bio-based specialty chemicals.

We just launched the first-of-its-kind research facility in Woburn, Massachusetts, after spending the better part of the last 2 years assembling a world renowned team and developing a strategic vision, routed in the integration of three specific initiatives. First was the creation of a secure cash flow stream from traditional corn plants. It pays the bills. It gets the business started. These are our cheap sugar platforms. Second is the use of BioEnergy's novel biocatalyst to manufacture green chemicals and biopolymers from the very same cheap sugar. This diversifies revenue. And lastly, with the integration of our cellulose technology, retro-fitting existing and building future plants that drive down costs and move away from food-based raw materials.

These three collective steps we believe are essential to ensure long-term financial success and continue to drive investment and interest in this sector. I believe we are very close to a day when a pound of sugar can replace a barrel of crude in the manufacture of everything from the fuel we put in our cars to the plastics and fabrics we use in our everyday lives. I am especially proud of the ethanol industry and its extraordinary progress in the fight to reduce our Nation's dependence on imported oil.

The CHAIRMAN. If you could summarize, please.

Mr. GATTO. With an expanded RFS, we achieve energy independence, combat global warming and provide American jobs in commu-

nities throughout the country. The bottom line is, corn has and cellulose technology will change the game forever, and it will spur $2 to $3 trillion in new investment. Today we not only have the responsibility to transition away from fossil fuels; with ethanol, we have the ability to do so. The immediate challenge for all of us here today is not to get bogged down in the incidental issues of first-generation corn plants but to focus the real challenge to this committee and all of us to wean ourselves off the perils of oil as quickly as we can. Thank you.

[The prepared statement of Stephen J. Gatto follows:]

BioEnergy International, LLC

Testimony of Stephen J. Gatto
Chairman and CEO of BioEnergy International LLC

Before the Select Committee on Energy Independence & Global Warming
US House of Representatives

October 24, 2007

Mr. Chairman, Members of the Committee -- thank you for inviting me to testify here today. I applaud your leadership in recognizing the urgent need to change our energy paradigm. To the Chairman in particular, your leadership inspired me over the last 15 years. When I would come to DC in the early 1990's, I was occasionally referred to as the village idiot, however the Chairman was one of the few Members who listened, and drove me to make a difference. I profoundly thank you.

Since then, I have had the privilege of serving on Presidential Committees (The Biomass Technical Advisory Board under President Bill Clinton and George W. Bush), as well as Congressional Committees helping to craft the Energy Policy Act and in particular the cellulosic components. As the Chairman knows, I came to the ethanol industry in the late 80s somewhat circuitously. Some believed we were going to face a crisis with mounting pressures on landfills and a need to find a home for our ever expanding waste streams, so my cousin, an avid environmentalist took me to New Hampshire for a meeting on composting municipal solid waste. As fate would have it, I was introduced to a technology from the University of Florida which just received Patent # 5,000,000 which was a little organism that likes to eat sugars from all types of cellulose and make ethanol.

I figured it had to be more profitable to convert waste into booze rather than dirt and launched what was one of the first cellulosic ethanol company's in the country.

BC International, which later became Celunol, and now Verenium proved the technology was viable after developing and operating 3 successful pilot plants. We arranged financing for what would have been first commercial cellulosic demo, a 23 million gallons per year facility based on sugar cane bagasse, rice hulls. 9-11, a change in administration and priorities, the deal fell apart, the industry set back a decade. Set back not because of a failure in technology, but the lack of incentives and moreover, a will and vision of what was to come. Gasoline at the time was still less than $1.30 per gallon.

With a barrel of oil pushing $90, the tragic loss of lives in the Middle East, and hydrocarbons fueling a climate crisis, we cannot afford another decade of delay.

Mr. Chairman, my message is simple yet urgent – the ethanol industry is at a tipping point. We are on the brink of the next bio-industrial revolution, on the verge of transforming our economy from a carbon based society to a carbohydrate based program with next generation biorefineries. The Earth's ability to produce sugar from biomass is virtually unlimited and sustainable.

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However, I would suggest, this is the year we either commit ourselves to an all out offensive to reduce our dependency on foreign oil, to stop the funding of radical countries that continue to do us harm, and to reduce our insatiable use of fossil fuels to stem our climate crises.

Or, this is the year we will point to with dismay, and ask why. Why we failed when the technology was here, and a workable blueprint in the Senate-passed bill, with phased expansion of the Renewable Fuel Standard (RFS) and incentives which drive us toward cellulosics as the future.

I don't want to tell my grand children we failed because of a lack of will.

We need bold leadership to replace foreign oil with homegrown fuel first from corn, then cellulosic feedstock's such as agricultural wastes and municipal waste. This effort is no different than the challenge issued in the 1960's. President John F. Kennedy wanted to put a man on the moon. We did not attempt to land on the moon the first time. We had a program, sparked by vision, propelled by leadership, but grounded in phased, yet ambitious, milestones. First we shot a rocket in the air. Then we circled the earth. Then we flew around the moon. Finally, we landed on the moon. It changed history forever. We need that kind of vision and commitment from you all today.

Let there be no doubt, the energy bill this year is the fight of our generation.

Clearly, with all the discussion of a glut, the biofuels industry has met the call to action, and surpassed the federal mark for all the right reasons -- energy independence, global climate change, jobs and American prosperity, and regaining our morale leadership among world of nations.

The Question, and opportunity, is "What do we need to do to provide America with a self sustaining program that has an evolution with beginning, middle and end. We have an extraordinary opportunity to change how we derive our fuels based economy. Home grown fuels initially from corn, then bio-based waste such as switchgrass, wood chips and even municipal landfill waste from every region of the country.

The story sounds too good to be true – but it is real, and has already been an economic boom to the country as other sectors such as housing lag. The Governor's Ethanol Coalition in December 2006 suggested that the goal of providing only 20% of the nation's gasoline supply from biofuels would deliver extraordinary economic and security benefits to the nation, including:

- Approximately 60 billion gallons of annual ethanol production, an amount equal to about 25 % of projected future gasoline demand in 2030;

- $52 billion a year in avoided oil imports, creating lasting reductions in our trade deficit;

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- $110 billion of direct economic activity each year with the total impact to the nation's economy of $368 billion a year; and

- 2.4 million new jobs.

In addition to the enormous economic benefits of the US leading the emerging global biofuels industry, ethanol from corn today is contributing significantly to reducing harmful greenhouse gas emissions. The benefits of ethanol fuel alone are staggering according to the Natural Resource Defense Council, which predicts the following environmental benefits from increasing the use of cleaner burning fuels, made from plant materials, to power our cars:

- **Biofuels can slash global warming pollution.** By 2050, biofuels -- especially those known as cellulosic biofuels -- could reduce our greenhouse gas emissions by 1.7 billion tons per year. That's equal to more than 80 percent of current transportation-related emissions.

- **Biofuels can be cost competitive with gasoline and diesel.** By 2015, we could produce biofuels at costs equal to between $0.59 and $0.91 per gallon of gasoline, and $0.86 per gallon of diesel. These prices are competitive with average wholesale prices over the last four years -- $0.91 per gallon for gasoline and $0.85 per gallon for diesel.

- **Biofuels will provide a major new source of revenue for farmers.** At $40 per dry ton, farmers growing 200 million tons of biomass in 2025 would make a profit of $5.1 billion per year. And that's just the beginning. Experts believe that farmers could produce six times that amount by 2050.

- **Biofuels can provide major air quality benefits.** Biofuels contain no sulfur and produce low carbon monoxide, particulate and toxic emissions. Using biofuels should make it easier to reach air pollution reduction targets than using petroleum-based fuels.

- **Biofuels offer major land-use benefits.** Switchgrass, a promising source of cellulosic biofuel, is a native, perennial prairie grass that has low nitrogen runoff, very low erosion, and increased soil carbon, and also provides good wildlife habitat.

Today, we not only have the *responsibility* to transform our economy away from fossil fuels – but with ethanol -- we have the *ability* to do so. Let us not allow a well funded campaign by Oil to stop us from the critical progression toward next generation biorefineries.

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Toward this end, I serve as Chairman and CEO of BioEnergy International, LLC. BioEnergy is a science and technology leader in the development of biorefineries that produce both biofuels and bio-based specialty chemicals from renewable resources. We just launched a first-of-its-kind research facility in Woburn after spending the better half of the last two years assembling a world renowned team and developing a strategic vision that is rooted in the integration of three specific initiatives – our 3 legged stool:

(1) is the creation of a secure cash flow stream through conventional ethanol facilities – one in Pennsylvania and the other in Louisiana – we must look at these as cheap sugar platforms but very similar to the early oil refineries;

(2) is the diversification of our product portfolio through the introduction of BioEnergy's novel biocatalysts for the manufacture of green chemicals and biopolymers; and

(3) the optimization and commercialization of cellulose technology for retrofitting into existing and future plants to drive down costs and move away from food based raw materials.

These three steps we believe will ensure financial success and continue to drive investment and interest in the biorefinery sector.

I believe we are close to the day when a pound of sugar can replace a barrel of crude in the manufacture of everything from the fuel we put in our cars to the plastics and fabrics we use in our everyday lives. I am especially proud of the ethanol industry, and its extraordinary progress in the fight to reduce our nation's dependency on imported oil – from phasing out MTBE to surpassing current RFS. A feat that many in the oil patch said could never happen.

But, there is much work to be done and we must recognize corn has limitations.

It's not perfect, but the status quo of oil, especially foreign oil driving down environmental standards while driving up costs is unacceptable and unsustainable. Today, ethanol is as much as $1.00/gallon cheaper than gasoline yet the market refuses to use the product where it can, which could consume another 4-5 billion gallons.

Let's be clear, if it is not ethanol today, it is oil and if we fail to create a robust market for the product then all attempts to move to the next generation of cellulosic ethanol will fail. As my good friend Bob Dineen from the Renewable Fuels Association has said many times; "If not now, when, if not this, what".

It is poetic justice that we are launching our INDEPENDENCE ethanol project in north central PA, near Titusville, where Edwin Drake ushered in the US petroleum industry with the first successful commercial oil well that has led to today's modern multi-cut petro-refineries. At BioEnergy, we aim to commercialize cellulose with an integrated

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plan to usher in the first *commercial cellulosic* biorefineries – first mimicking and then replacing petrochemical based refineries.

As a low cost renewable sugar platform, traditional corn-based ethanol is the low hanging fruit to get biofuels into the consumer market, strengthen existing systems, generating new jobs and revenues for economic patriotism. In Pennsylvania, we are developing one of the first integrated corn/cellulose biorefineries with the help and extraordinary leadership of Governor Rendell and his Penn Secured Fuels Initiative – an initiative to manufacture one billion gallons of in-state production.

With an expanded RFS, we achieve energy independence and combat global warming with distributed biomass plants that provide American jobs in communities throughout the country – not just in the farm belt. This in turn will lead to the expansion of more advanced fuels and bio-based chemicals that would provide optionality and a range of new environmentally friendly products. The Bottom line is corn has and cellulosic technology will change the game forever and spur $2-3 trillion in new value.

According to the 2003 *White Biotechnology Refinery* report by McKinsey, biorefineries could generate $2-3 trillion in new value worldwide. Rapid advances in drug development, cancer research, and gene therapy are creating the genetic tools required for innovative "Industrial Bioprocessing" techniques that compete with traditional production technologies. This has spurred improved industrial applications of newly discovered enzymes that have additive benefits to tolerate extreme hot, saline, acidic or alkaline conditions. I highlight this data as a testament that going green for the environment translates into green dollars for profitability. The US can lead this new environmentally friendly global industry.

The Department of Energy (DOE) states in a 2003 report, *Industrial Bioproducts: Today & Tomorrow,* that fully integrated facilities will process grain or biomass crops into a full range of products that will represent 20% of production, yet account for 80% of profits. By operating with a highly flexible and profitable product output, the biorefinery will be able to get the most value from a bushel of biomass, while optimizing overall profitability. In 2004, the DOE further identifies twelve building block chemicals that can be produced from sugars via biological or chemical conversions in the National Renewable Energy Laboratory (NREL), *Top Value Added Chemicals From Biomass.* These twelve can then be converted to high-value bio-based chemicals or materials with tremendous opportunity for the US according to the following excerpt:

> America is fortunate to possess abundant and diverse agricultural and forest resources, unused cropland and favorable climates. Together with a remarkable talent to develop new technologies, we have a tremendous opportunity to use domestic, sustainable resources from plants and plant-derived resources to augment our domestic energy supply.

The Biomass Program, in the Energy Efficiency and Renewable Energy Office in the Department of Energy directly supports the goals of The President's National Energy Policy, the Biomass R&D Act of 2000 and the Farm Security and Rural Investment Act of 2002. To accomplish these goals, the Program supports the integrated biorefinery, a processing facility that extracts carbohydrates, oils, lignin and other materials from biomass, converts them into multiple products including fuels and high value chemicals and materials.. Already today, corn wet and dry mills, and pulp and paper mills are examples of biorefinery facilities that produce some combination of food, feed, power and industrial and consumer products.

This report, the first of several envisioned to examine value-added products from all biomass components, identifies a group of promising sugar-derived chemicals and materials that could serve as an economic driver for a biorefinery. By integrating the production of higher value bioproducts in the biorefinery's fuel and power output, the overall profitability and productivity of all energy related products will be improved. Increased profitability makes it more attractive for new biobased companies to contribute to our domestic fuel and power supply by reinvesting in new biorefineries. Increased productivity and efficiency can also be achieved through operations that lower the overall energy intensity of the biorefinery's unit operations, maximize the use of all feedstock components, by products and waste streams, and use economies of scale, common processing operations, materials, and adequate equipment to drive down all production costs.

With speeding this vision to market, BioEnergy is excited to launch our Woburn research center to advance and optimize our IP to convert current and future ethanol plants to biorefineries. This will improve efficiencies on the front end – allowing for low cost waste feedstocks – and on the back end -- to diversify product portfolio through novel biocatalysts such as higher value products like biobutanol, lactic acid, and succinic acid to increase profitability per pound of sugar. Our lab will build on our exclusive worldwide rights to non-ethanol technology developed at the University of Florida by Dr. Lonnie Ingram that covers all bacteria and yeast modified by this process to ferment every sugar in biomass including the previously unfermentable C5 sugar into biopolymers, as well as the process of integrating genes into chromosome of host organisms. With a core competency from our sponsored research in the development of new compounds, we intend to extend our technological lead in biomass refinery process technologies by pursuing IP that would lower the cost of sugar from cellulosics using enzymes, for strains capable of producing beneficial enzymes.

This will achieve rapid deployment with minimal capex by taking excess capacity first, and affords a twenty-five percent growth within trillion-dollar markets. For biopolymers, BioEnergy has already received two milestone payments from licensing lactic acid technology to Purac, the world's largest lactic acid producer, and is advancing successful strain development for L-Lactic, Succinic, Malic, Alanine, Xylitol, and Pyruvate. In essence, BioEnergy's novel IP "software" will convert today's "hardware" (conventional ethanol platforms) into tomorrow' Biorefineries.

In closing, I offer these comments to present a compelling story that American's corn-based ethanol plants of today, provide the bridge to tomorrow's next generation cellulosic biorefineries that will use domestic waste and renewable resources. It is imperative that we expand the RFS this year to support ongoing robust growth of the US domestic ethanol industry to combat global climate change, fuel energy independence and power a new economy. Gene shuffling and metabolic engineering have given way to dramatic technological advances that soon will allow us to use a broad array of waste feed stocks that will drive down costs and transition us from corn plants to more efficient biorefineries of the future.

The immediate challenge before us all is not to get bogged down in the incidental issues of first generation corn plants but to focus on the real challenge to this committee and all of us – to wean ourselves from the perils of Oil as quickly as we can.

Toward this shared commitment, I urge the committee to support the biofuels provisions included in HR 6 as passed by the Senate, specifically the framework to expand the RFS and provide for cellulosic incentives.

Thank you .
Stephen J. Gatto

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The CHAIRMAN. Thank you, Mr. Gatto, very much.

And our next witness is Dr. Suzanne Leschine, who is a professor of microbiology at U. Mass–Amherst and codirector of the Biofuels Research Institute. She is also the founder and chief scientist of a cellulosic ethanol company, SunEthanol.

We welcome you, Doctor. Whenever you are ready, please begin.

STATEMENT OF SUSAN LESCHINE, FOUNDER AND CHIEF SCIENTIST, SUNETHANOL, AND PROFESSOR, U. MA–AMHERST

Ms. LESCHINE. Good morning, Mr. Chairman, and members of the committee. I thank you for giving me this opportunity to speak today on the subject of biofuels and the impacts of biofuel development on energy independence and global warming. I am a professor of microbiology at the University of Massachusetts, Amherst, and a founder and chief scientist at SunEthanol, a new biofuels technology company headquartered in Amherst.

I also serve as codirector of the Institute of Massachusetts's Biofuels Research at U. Mass–Amherst, which was established by an interdisciplinary team of scientists and engineers to develop cost-effective technologies for producing biofuels and other value-added materials from biomass. Our goal is to establish the scientific and technological basis to enable the U.S. to meet the Department of Energy 30/30 goals, 30 percent gasoline reduction by 2030.

The link between fossil fuel combustion and global warming is compelling. We urgently must begin to limit greenhouse gas emissions. The need to limit greenhouse gas emissions has become even more critical with recent results reported this week in the proceedings of the National Academy of Sciences; first that carbon dioxide emissions are growing at a much faster rate than anticipated, and secondly, the ability of the land and the oceans to absorb carbon dioxide from the atmosphere has actually diminished.

Clearly, as we look to the future in meeting our transportation fuel needs, we must limit the use of fossil fuels. The only form of energy that can contribute substantially to fulfilling transportation fuel requirements at costs competitive with fossil fuels is solar energy captured by photosynthesis in plants and stored in the form of biomass. At present, plant biomass is the only significant source of liquid transportation fuels that may replace the world's finite supply of oil.

Ethanol derived from biomass is one of the most promising biofuels. In addition to reducing our dependence on imported oil, thereby improving domestic energy security and lowering the U.S. trade deficit, biomass ethanol production will also yield environmental benefits in the form of reduced greenhouse gas emissions. In addition, the increased value of agricultural crops, crop residues, new energy-specific crops will benefit rural economies through higher incomes and increased employment opportunities. Economic modelling studies suggest that simply integrating cellulosic biomass crops into the agricultural rotation of existing cultivated acreage could increase the net income of U.S. farmers by 32 percent or $23 billion.

In Massachusetts, where forest growth exceeds wood harvest, biomass from wood is a sustainable resource. The total woody bio-

mass supply in Massachusetts has been estimated to be 4.4 million tons per year, which could theoretically yield more than 400 million gallons of fuel ethanol.

The relative benefits of biomass ethanol compared with fossil fuels have been passionately debated. Important questions have arisen concerning the energy return on investment, the ratio of ethanol energy output compared to nonrenewable energy input required to produce ethanol fuel. It is very important to note that several peer-reviewed studies have concluded that the energy return on investment for fuel ethanol production is favorable. Corn ethanol energy yields are favorable, and cellulosic ethanol energy yields have the potential to be even more favorable.

Clearly, the production of ethanol from cellulosic biomass, such as wood chips, switchgrass, corn stover and other agricultural waste, has a clear advantage over gasoline. In large part, this energy advantage arises from the fact that biomass ethanol production makes use of the whole plant. The useable fermentable components of a plant, cellulose, which we now know what that means, and other polysaccharides are separated from the nonfermentable liquid component, which then can be burned and used as fuel to power ethanol production facilities.

It is very important to point out that the corn ethanol industry will play a central role in the future development of biofuels in this country. New technologies for cellulosic fuels are being built upon the pioneering expertise developed by the corn ethanol industry. Also, the industry has demonstrated that the agricultural sector of our country can play a key role on our path to energy independence.

Cellulosic ethanol is a reality. Demonstration plants are in operation and full-scale commercial plants are in construction. At the same time, new technologies are being developed and must be developed for more efficient and more cost-effective conversion of biomass to ethanol biofuel, specifically to overcome the resilience of cellulosic biomass.

Plants are tough things. Plant biomass is composed of highly ordered sugar polymers, such as cellulose. These plants' components are shielded by a matrix of other complex plant polymers. The recalcitrants of cellulosic biomass to processing, for example, by enzymes poses a significant obstacle to developing cost-competitive cellulosic ethanol technologies.

The CHAIRMAN. If you could please summarize.

Ms. LESCHINE. Yes. I just want to conclude by saying that, at SunEthanol, we are developing a strategy to overcome the recalcitrants of cellulose using a microbe actually discovered in Massachusetts, a microbe from Massachusetts. And we hope that by using this technology, we will be able to bring down the costs of cellulosic ethanol production and make this a reality.

In conclusion, cost-effective cellulosic ethanol production is achievable in the near term. This will be a monumental task. It is essential that there be significant resources invested for research and development at both the applied and basic science levels. Such investments will have enormous positive impacts on the environment and the economy, especially benefiting rural economies. Given that biomass is a regional resource, the impacts will be

broad and widespread across the country. Perhaps most importantly, it is essential that we begin to limit greenhouse gas emissions. Renewable and sustainable biofuel production must be a key component of our energy future. Thank you.

[The prepared statement of Susan Leschine follows:]

SunEthanol

Susan Leschine, Ph.D.

Professor, University of Massachusetts, Amherst
Founder and Chief Scientist, SunEthanol

Testimony
Before the

Select Committee on
Energy Independence and Global Warming

Hearing on

The Gas is Greener: the Future of Biofuels

October 24, 2007

Testimony of Susan Leschine

Professor, University of Massachusetts, Amherst
Founder and Chief Scientist, SunEthanol

I thank you for giving me this opportunity to testify today on the subject of biofuels and the impacts of biofuels development on energy independence and global warming. My name is Susan Leschine. I am a Professor of Microbiology at the University of Massachusetts, Amherst, and Founder and Chief Scientist at SunEthanol, a new biofuels technology company headquartered in Amherst. I also serve as Co-director of The Institute for Massachusetts Biofuels Research (TIMBR) at UMass Amherst, established by an interdisciplinary team of scientists and engineers to develop cost-effective technologies for producing biofuels and other value-added materials from biomass. Our goal is to establish the scientific and technological basis to enable the U.S. to meet the Department of Energy "30-30" goal, 30% gasoline reduction by 2030.

The link between fossil fuel combustion and global warming is compelling. We urgently must begin to limit greenhouse gas emissions. The need to limit greenhouse gas emissions has become even more critical with research results reported this week in the Proceedings of the National Academy of Sciences that carbon dioxide emissions are growing at a much faster rate than anticipated, and the ability of the land and the oceans to absorb carbon dioxide from the atmosphere has diminished.

Clearly, as we look to the future in meeting our transportation fuel needs, we must limit the use of fossil fuels. The only form of energy that can contribute substantially to fulfilling transportation fuel requirements at costs competitive with fossil fuel is solar energy captured by photosynthesis in plants and stored as biomass. At present, plant biomass is the only significant source of liquid transportation fuels that may replace the world's finite supply of oil.

Ethanol derived from biomass is one of the most promising biofuels. In addition to reducing our dependence on imported oil, thereby improving domestic energy security and lowering the U.S. trade deficit, biomass ethanol production will also yield environmental benefits in the form of reduced greenhouse gas emissions. In addition, the increased value of agricultural crops, crop residues, and new energy-specific crops will benefit rural economies through higher incomes and increased employment opportunities. Economic modeling studies suggest that simply integrating cellulosic biomass crops into the agricultural rotation of existing cultivated acreage could increase the net income of U.S. farmers by 32%, or $23 billion. In Massachusetts, where forest growth exceeds wood harvest, biomass from wood is a sustainable resource. The total woody biomass supply in Massachusetts has been estimated to be 4.4 million tons per year, which could theoretically be used to produce more than 400 million gallons of fuel ethanol.

The relative benefits of biomass ethanol compared with fossil fuels have been passionately debated. Important questions arise concerning the "energy return on investment" (ROI): the ratio of ethanol energy output compared to the nonrenewable energy input required to produce ethanol fuel. It is very important to note that several peer-reviewed studies have concluded that the energy return on investment for fuel ethanol production is favorable. Corn ethanol energy yields are favorable, and cellulosic ethanol energy yields have the potential to be even more favorable. Clearly, the production of ethanol from cellulosic biomass, such as wood chips, switch grass, corn stover or other agricultural waste has a clear advantage over gasoline. In large part, this energy advantage arises from the fact that biomass ethanol production makes use of the whole plant. The fermentable components of plants – cellulose and other polysaccharides – are separated from the non-fermentable lignin component, which can be burned and used to power ethanol production facilities.

It is very important to point out that the corn ethanol industry will play a central role in the future development of biofuels in this country. New technologies for cellulosic fuels are being built upon the pioneering expertise developed by the corn ethanol industry. Also, the industry has demonstrated that the agricultural sector of our country can play a key role on our path to energy independence.

Cellulosic ethanol is a reality. Demonstration plants are in operation and full-scale commercial plants are in construction. At the same time, new technologies are being developed – and must be developed - for more efficient and more cost-effective conversion of biomass to ethanol biofuel, specifically to overcome the resilience of cellulosic biomass. Plants are tough! Plant biomass is composed of highly ordered sugar polymers such as cellulose. These plant components are shielded by a matrix of other complex polymers. The recalcitrance of cellulosic biomass to bioprocessing (e.g., by enzymes) poses a significant obstacle to developing cost-competitive cellulosic ethanol technologies.

To overcome this biological hurdle, at SunEthanol we are developing a microbial bioprocessing technology. This technology arose from research in my laboratory at the University of Massachusetts Amherst.

For many years I have been investigating bacteria that decompose plant material or biomass. I am interested in these microbes because they play a very important role in the environment, in the global carbon cycle, and also because they have the potential capacity to convert plant biomass into useful products such as ethanol.

One such microbe was first isolated from forest soil near Massachusetts' Quabbin Reservoir. This microbe turned out to be particularly interesting because it decomposes nearly all of the components of biomass, and it produces ethanol as its primary product. We determined that this isolate from forest soil is a novel microbe, and we gave it a name, *Clostridium phytofermentans*. We continue to study the unique biological properties of this microbe in my lab at UMass.

We also described a new technology for producing cellulosic ethanol, which makes use of a strain of this bacterium, the Q microbe. This new technology involves the

direct conversion of biomass to ethanol, consolidating several steps into one, a technology known as **C**onsolidated **Bio**processing (CBP). This technology has the potential to greatly improve the economics of ethanol production from biomass. For example, the separate production of costly enzymes may be completely eliminated in the Q microbe cellulosic ethanol process. The Department of Energy Biofuels Roadmap (June 2006), "Breaking the Biological Barriers to Cellulosic Ethanol," recognizes CBP as "*the ultimate low-cost configuration*" for cellulosic ethanol production.

Currently at SunEthanol we are taking this technology from the lab to the marketplace, developing an economically viable process using the Q microbe to produce ethanol from biomass as a renewable and sustainable transportation fuel.

In conclusion, cost-effective cellulosic ethanol production is achievable in the near term. This will be a monumental task. It is essential that there be significant resources invested for research and development at both the applied and basic science levels. Such investments will have enormous positive impacts on the environment and the economy, especially benefiting rural economies. Given that biomass is a regional resource, the impacts will be broad and widespread across the country. Perhaps most importantly, it is essential that we begin to limit greenhouse gas emissions. Renewable and sustainable biofuel production must form a key component of our energy future.

Appendices

Appendix 1. "*Biomass to Biofuel Technology: A Novel Bacterial Catalyst for Consolidated Bioprocessing of Biomass to Ethanol*," a white paper by Susan Leschine. January 2007

Appendix 2. "*In Microbe, Vast Power for Biofuel*," by Steven Mufson. Washington Post, October 18, 2007.

Biomass to Biofuel Technology:

A Novel Bacterial Catalyst for Consolidated Bioprocessing of Biomass to Ethanol

Susan Leschine, Ph.D.

The Institute for Massachusetts Biofuels Research (*TIMBR*)
University of Massachusetts Amherst

January 2007

Plant biomass, produced in nature using solar energy captured by photosynthesis, is generally regarded as the only source of liquid transportation fuels that may replace the world's finite supply of oil. Ethanol derived from biomass is one of the most promising such fuels. In addition to reducing our dependence on imported oil, thereby improving domestic energy security and lowering the U.S. trade deficit, biomass ethanol production would also yield environmental benefits in the form of reduced greenhouse gas emissions and air pollution. Moreover, the increased value of agricultural crops, crop residues, and new energy-specific crops would benefit rural economies through higher incomes and increased employment opportunities. Economic modeling studies suggest that simply integrating cellulosic biomass crops into the agricultural rotation of existing cultivated acreage could increase the net income of U.S. farmers by 32%, or $23 billion (3). In Massachusetts, where forest growth exceeds wood harvest, biomass from wood is a sustainable resource. The total woody biomass supply in Massachusetts has been estimated to be 4.4 million tons per year (1), which could theoretically be used to produce more than 400 million gallons of fuel ethanol.

Over the past twenty-five years, the relative benefits of biomass ethanol compared with fossil fuels have been passionately debated. Important questions arise concerning the "energy return on investment" (ROI). Because traditional ethanol production involves a series of steps, nonrenewable energy must be expended during processing. Therefore, the ratio of ethanol energy output compared to the nonrenewable energy input required to produce ethanol fuel is a critical metric. Two recent, peer-reviewed analyses concluded that the energy ROI of fuel ethanol production is favorable (2, 4). However, not all ethanol is created equal: existing methods for production of ethanol from corn yield only a marginally favorable energy return. On the other hand, production of ethanol from cellulosic biomass, such as wood chips, switch grass, corn stover or other agricultural waste has a clear advantage over gasoline. In large part, this energy advantage arises from the fact that biomass ethanol production makes use of the whole plant. The fermentable components of plants – cellulose and other polysaccharides – are separated from the non-fermentable lignin component, which can be burned and used to power ethanol production facilities.

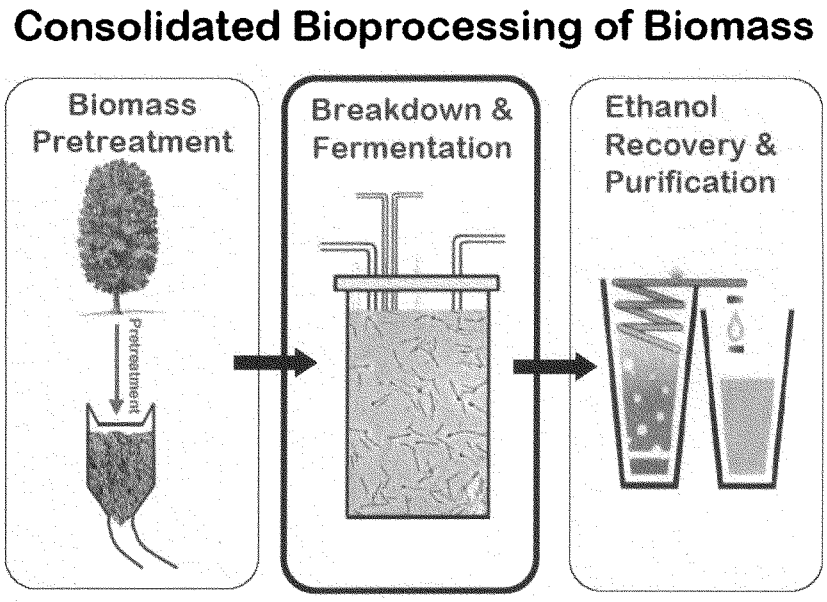

Fig. 1. Consolidated bioprocessing (CBP). Production of cellulase enzymes, cellulose breakdown, and fermentation are consolidated in a single step in a bioreactor ("Breakdown & Fermentation"). Shown in the reactor are cells of the bacterium *Clostridium phytofermentans*, which serve as biocatalysts in the CBP process. Bacterial cells were imaged using phase-contrast light microscopy.

New Technology for Biofuel Production

Large-scale use of ethanol for fuel will require new technologies for the efficient conversion of biomass to ethanol biofuel. The recalcitrance of cellulosic biomass to enzymatic bioprocessing poses a significant obstacle to the development of these technologies. Cellulosic biomass is composed of highly ordered sugar polymers, which are shielded from enzyme attack by a matrix of other complex polymers. A microbial bioprocessing strategy can be employed to overcome this biological hurdle. In this regard, technology under development at the University of Massachusetts Amherst involves the use of a novel bacterium, which was first isolated from forest soil near Massachusetts' Quabbin Reservoir.

The bacterium *Clostridium phytofermentans* actively and efficiently decomposes cellulose and produces ethanol. Cellulose-fermenting cultures of *C. phytofermentans* produce prodigious amounts of ethanol and they also form H_2. In addition, *C. phytofermentans* possesses exceptional nutritional versatility and is capable of decomposing more components of biomass than most other known

microbes. Furthermore, we have recently discovered that *C. phytofermentans* ferments unusually high concentrations of cellulose with increased ethanol production.

Our recent investigations have revealed several unusual and unexpected properties of *C. phytofermentans* that indicate it would be an ideal organism for use in the commercial development of large-scale direct conversion of cellulosic biomass to ethanol. This direct conversion biomass-processing scheme is referred to as consolidated bioprocessing (CBP) because production of the cellulase enzymes, cellulose decomposition, and fermentation are all consolidated in a single step (Fig. 1). Patent applications have been filed, including a US utility application and an international (PCT) application. These applications relate to the compositions, systems, and methods for producing biofuels such as ethanol, and other chemicals from cellulosic biomass.

How does the *C. phytofermentans* CBP technology compare with other technologies for biomass ethanol production?

The overall conversion of biomass to ethanol can be viewed as a multi-step process involving the enzymatic decomposition of complex cellulosic materials (polysaccharides) into simple sugars, and the fermentation of these sugars to ethanol. To date, most research has focused on biomass processing schemes that separate the process of cellulase enzyme production from the hydrolysis (breakdown) of complex cellulosic materials, and subsequent fermentation. An advantage of the *C. phytofermentans* CBP technology is that enzyme production, hydrolysis of biomass polysaccharides, and fermentation of the resulting simple sugars occur simultaneously in a single bioreactor.

The inherent simplicity of the *C. phytofermentans* CBP technology presents an obvious advantage, but in addition, the technology obviates the need for separate and costly enzyme manufacture. A recently published study estimates that production of ethanol by CBP would reduce costs by 25% or more as compared with processes involving separate enzyme production (6). Additionally, microbial activity may facilitate cellulose breakdown in ways that are not yet fully understood. For example, it has been suggested that the presence of insoluble cellulose might trigger an increase in cellulase enzyme production by a cellulose-fermenting microbe (9).

At present, a major limitation to the development of biomass refineries is the lack of appropriate microbial catalysts that are capable of fermenting the wide range carbohydrates found in biomass, particularly five-carbon sugars and five-carbon sugar polymers, such as xylose and xylan, which make up the hemicellulosic portion of biomass (5, 6). This is a critical limitation, given that the hemicellulosic portion of biomass may constitute 20 to 35% of plant dry weight (7). Most cellulolytic bacterial strains are incapable of fermenting five-carbon sugars and five-carbon sugar polymers due to the narrow growth substrate range of these strains. Researchers pursuing potential solutions to this problem are investigating recombinant DNA techniques to genetically modify strains in order

to expand their substrate range, or coculturing cellulolytic bacteria with other microbes that are capable of fermenting five-carbon sugars and polymers (7).

The alternative approach we have followed taps the natural diversity that exists in anaerobic biomass-decomposing microbial communities. *C. phytofermentans* was isolated from such a microbial community in forest soil near an intermittent stream. An advantage of the CBP technology we are developing is that it employs the properties of naturally-occurring *C. phytofermentans*, which has an uncommonly broad range of growth substrates including such five-carbon sugar polymers as xylose and xylan (8). We have recently discovered that *C. phytofermentans* is able to simultaneously ferment different polymeric components of biomass (e.g., cellulose and xylan), a property that would be particularly useful for the efficient production of ethanol from biomass.

The natural fermentation characteristics *C. phytofermentans* are uniquely well suited to cellulosic ethanol CBP technology currently under development at UMass Amherst. Future advancements in this technology might involve genetic modifications of the microbe to further improve its fermentation properties. As part of ongoing research, we are exploring genetic engineering strategies to modify the metabolic properties of *C. phytofermentans* in order to maximize the cellulosic ethanol yield and increase the microbe's tolerance to ethanol. These strategies are anticipated to enhance cellulase activity while at the same time eliminating unwanted byproduct formation. In support of this research, the genome sequence of *C. phytofermentans* has been determined in collaboration with the U.S. Department of Energy Joint Genome Institute. The availability of genome sequence data for *C. phytofermentans* is a significant advantage that will greatly facilitate future development of this ethanol-from-biomass consolidated bioprocessing technology.

References

1. **Fallon, M., and D. Breger.** 2002. The woody biomass supply in Massachusetts: A literature-based estimate. Division of Energy Resources and Department of Environmental Management, Bureau of Forestry, Commonwealth of Massachusetts.
2. **Farrell, A. E., R. J. Plevin, B. T. Turner, A. D. Jones, M. O'Hare, and D. M. Kammen.** 2006. Ethanol can contribute to energy and environmental goals. Science **311:**506-508.
3. **Greene, N.** 2004. Growing energy: How biofuels can help end America's oil dependence. Report. Natural Resources Defense Council.
4. **Hammerschlag, R.** 2006. Ethanol's energy return on investment: a survey of the literature 1990-present. Environ. Sci. Technol. **40:**1744-1750.
5. **Karhumaa, K., B. Hahn-Hagerdal, and M. F. Gorwa-Grauslund.** 2005. Investigation of limiting metabolic steps in the utilization of xylose by recombinant *Saccharomyces cerevisiae* using metabolic engineering. Yeast **22:**359-368.
6. **Lynd, L. R., W. H. van Zyl, J. E. McBride, and M. Laser.** 2005. Consolidated bioprocessing of cellulosic biomass: an update. Curr. Opin. Biotechnol. **16:**577-583.
7. **Lynd, L. R., P. J. Weimer, W. H. van Zyl, and I. S. Pretorius.** 2002. Microbial cellulose utilization: Fundamentals and biotechnology. Microbiol. Mol. Biol. Rev. **66:**506-577.
8. **Warnick, T. A., B. A. Methé, and S. B. Leschine.** 2002. *Clostridium phytofermentans* sp. nov., a cellulolytic mesophile from forest soil. Int. J. Syst. Evol. Microbiol. **52:**1155-1160.
9. **Zhang, Y. H. P., and L. R. Lynd.** 2005. Regulation of cellulase synthesis in batch and continuous cultures of *Clostridium thermocellum*. J. Bacteriol. **187:**99-106.

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http://www.washingtonpost.com/wp-dyn/content/article/2007/10/17/AR2007101702216_pf.html

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Thomas Warnick, a University of Massachusetts lab technician, near the spot in the Quabbin Reservoir where he filled a jar with dirt that turned out to have a cellulose-chomping, ethanol-producing microbe.

Photo Credit: By Steven Mufson -- The Washington Post Photo

In Microbe, Vast Power For Biofuel

Organism's Ability To Turn Plant Fibers To Ethanol Captures Investors' Attention

By Steven Mufson
Washington Post Staff Writer
Thursday, October 18, 2007; D01

QUABBIN RESERVOIR, Mass. Ten years ago, an assistant from a microbiology laboratory took a hike near the shore of the vast Quabbin Reservoir, which supplies water to Boston. At one point, he crouched alongside a brook in the shade of towering hemlock trees, dug up some moist dirt, put it in a jar and took it back to the lab.

Today, some investors are betting that the jar of dirt could help change the biofuels industry.

Inside the jar, microbiology professor Susan B. Leschine found curious lollipop-shaped microbes with an uncommon ability to break down leaves and plant fibers into ethanol. For 30 years, Leschine has been researching this sort of thing and writing about it for publications such as the International Journal of Systematic and Evolutionary Microbiology.

Some venture capitalists in the area have convinced Leschine that her tiny microbe could be very big business. Now Leschine, who teaches at the University of Massachusetts at Amherst, is also chief scientist at SunEthanol, a start-up firm with about a dozen employees.

The firm has attracted an equity investment from VeraSun Energy, one of the nation's biggest producers of ethanol derived from corn and used as motor fuel. It is VeraSun's first investment in the next generation of ethanol, known as cellulosic ethanol, made from switch grass, wood chips and other plant fibers. Now SunEthanol is racing to gear up for commercial production of the microbe so it can move from the cloudy test tubes in Leschine's cluttered lab into the giant vats at VeraSun's refineries.

SunEthanol is just one of countless firms searching for ways to make cellulosic ethanol a commercially viable business. At the moment, they have a way to go. Unlike ethanol made from corn, not a drop of cellulosic ethanol is being commercially produced. Half a dozen pilot projects are being built -- with the help of $385 million in Energy Department grants -- but no one claims to have a sure thing.

"We're optimistic, but we're also realistic that this is an early-stage company and it still has many hurdles to cross," said Bill Honnef, VeraSun's vice president for strategic initiatives. "We will look at the program over the next year and figure out how we're doing. At that point, we will decide whether to make further investments."

Congress is working to prime the cellulosic ethanol pump. The Senate version of the energy bill being considered would require the oil industry to use 21 billion gallons annually of "advanced biofuels," including cellulosic ethanol, by 2022. A tax break would allow companies to deduct half the cost of a new plant in the first year of operation. And cellulosic ethanol would draw generous subsidies for oil refiners who mix it into their gasoline.

Still, many technological hurdles remain, and much of the venture capital poured into the cellulosic ethanol industry is going into companies like SunEthanol that are searching for ways to make the manufacturing process more efficient and profitable.

A key part of the challenge is figuring out how to better break down cellulosic material -- such as cornstalks or wood chips -- into ethanol. Many firms are trying to do that in two

steps, first breaking down cellulose into sugars and then fermenting sugars to produce ethanol for use in motor fuel.

Many companies are genetically engineering enzymes to do the first task. Those enzymes tend to be expensive. On Monday, Genencor, a division of Danisco, announced that it had developed a new product, Accellerase 1000, that it said contains a combination of enzymes that reduces cellulosic biomass into fermentable sugars.

"Lots and lots and lots of groups and companies are looking for new cellulases," or enzymes that process cellulose, said J. Craig Venter, who raced the federal government in mapping the human genome. Venter's company, Rockville-based Synthetic Genomics, is searching for naturally occurring chemicals that can turn sugar into diesel fuel. "A key part of nature is breaking down plant debris," he said. "So we find all kinds of environments with unique cellulases in them."

Leschine says her microbe has the advantage of performing both the breakdown of plant fibers and the production of ethanol. "Creating one microbe that does what enzymes and fermentation do is regarded as the Holy Grail because of the savings in costs," she said.

For the microbe, the plant fibers are food while ethanol and carbon dioxide are waste products. "These are tiny little cells we can't even see. They don't have mouths. How do they do it?" she said with a sense of wonder.

Whether SunEthanol will succeed remains unclear, but it is a good example of the hopes and hurdles for companies in the cellulosic biofuel business. Many of those firms rely on the research, and serendipity, of scientists like Leschine.

For years, Leschine scoured soil samples from around the world in search of the perfect microbe, one that would excel at breaking down what nature casts on the ground in damp places like the reservoir. When friends or colleagues traveled, she would ask them to bring back soil in jars or old plastic film canisters.

Yet the best microbe may have been here all along, lurking near some ferns and an old stone dam just 20 minutes from her university lab. She has dubbed it the Q microbe for the Quabbin Reservoir.

Apart from its lollipop appearance, it didn't stand out at first. But the more she tested it, the more unusual it seemed. Most microbes have about 20 machine-like proteins for absorbing sugars; the Q microbe has more than 100 for various nutrients, half of them for sugars, she says. The Q microbe also works in moderate temperatures, making it useful for manufacturing.

Leschine's interest predates the current fervor over biofuels. Since her graduate school days, she has been interested in the role of microbes in the carbon cycle. On the shelves of her office sit beanbags in the shapes of microbes. In a corner stands a bag of dirty cornstalks.

"The last thing in the world I wanted to do was start a company," Leschine said as she stood next door to her lab, where an assistant heated mixtures in test tubes. "It seemed like more of a distraction."

Then she talked to someone teaching business at the university, and he and a group of venture capitalists persuaded her to commercialize it. She came to feel that it was her obligation because she had received Energy Department research grants.

Next came lengthy negotiations with the university, which owned the intellectual property rights for work done in its labs. SunEthanol negotiated an exclusive licensing agreement with the university, which owns the patent.

The Q microbe's future hinges on the SunEthanol founders' skill at navigating talks like this to raise more money and persuade ethanol makers to use the Q microbe instead of a competing bug or enzyme. A small business is like Leschine's test tube samples, and scaling it up is no science. SunEthanol's chief executive Jef Sharp knows that from experience. He started a successful clothing firm. Later, he started X-S Capacity, which he called a sort of eBay for excess manufacturing capacity. It flopped. More recently, he launched Tech Cavalry, which provides computer support for individuals and businesses. This time, he says, "the wind is at our backs."

SunEthanol has received help from the Energy Department in mapping the genetic code of the Q microbe. The firm also hopes to receive an Energy Department grant through a program to help small businesses. "It could be lifeblood for us," said Jonathan Gorham, SunEthanol's marketing director.

SunEthanol's founders fear that the regulations are written in a way that will restrict federal funding to enzyme development, not microbe development. They have lobbied the Energy Department and members of Congress to make sure their work will be considered.

Next SunEthanol must figure out how to go from working with a liter or two of Q microbes in the lab to churning out millions of gallons of the microbe. VeraSun, for example, has fermentation vats that are more than 100,000 gallons each. SunEthanol must also test temperature and acidity conditions for the Q microbe, which will be expected to break down plant material very different from what it consumes near Quabbin's shore.

VeraSun's Honnef hopes that cellulosic ethanol plants can be built next door to the company's corn ethanol distilleries. Those distilleries use kernels and leave the rest, known as corn stover. The corn stover is largely waste material now but shows cellulosic possibilities.

"The conversion of cellulosic material to ethanol has been proven out in a lab," Honnef said. "The challenge is that it can't be done today on a commercial basis on a large scale."

Leschine is hopeful. "What we've demonstrated is that if you go out and look in nature, you can find a microbe that does what you want to do," she said. "The advantage of working with a natural microbe is that . . . you don't have to do all the complicated genetic engineering."

But she knows that she doesn't know much about engineering or big industry. She notes the dirty cornstalks in her office. They are there, she said, "to remind me that this is a daunting task."

The CHAIRMAN. Thank you, Doctor, very much.

And our final witness, Nathanael Greene, is a senior energy policy specialist working on issues that relate to renewable energy for the NRDC, the National Resource Defense Council.

We welcome you, Mr. Greene. Whenever you are ready, please begin.

STATEMENT OF NATHANAEL GREENE, SENIOR POLICY ANALYST, NATURAL RESOURCES DEFENSE COUNCIL

Mr. GREENE. Thank you, Mr. Chairman, and members of the committee.

As was noted earlier, in the fight against global warming, there is no silver bullet. At best, there is a silver buckshot. I believe that biofuels can be an important contributor to the fight against global warming, one of those pieces of buckshot.

But as opening statements of all the members of the committee noted, there is also the potential for biofuels to backfire, to make global warming worse and to threaten our lands, forests, water, wildlife and the public health. New crops and technologies that are being developed today and moved from the lab to the marketplace, such as the technologies we have heard about from some of the other witnesses, will make it easier to produce a lot of biofuels with a smaller environmental footprint. But just because we can use those technologies in a more sustainable way doesn't mean that we will. I think it is a critical mistake to assume that technologies or feed stocks are a quick fix to the challenges of biofuels.

I think these new technologies are very promising, but just as it is a mistake to assume that they will fix our problems, it is a mistake to assume that the existing corn ethanol technologies are somehow inherently flawed just because they only provide marginal benefits. We can make corn technologies much better, and we can use advanced technologies in very unfortunate and flawed ways.

To address this issue, we really need strong environmental safeguards and performance standards. It is time to shift our bioenergy policies and our global warming policies really away from a "more is better" strategy to a "better is better" strategy. This means moving away from a simple volume-related standard and the flat per-gallon tax credit to policies that reward performance.

Congress should adopt a low-carbon fuel standard, as California is planning to do. The low-carbon fuel standard rewards progressive reductions, requires progressive reductions in the average greenhouse gas emissions from our transportation fuels. This approach rewards gallons of renewable fuels, electricity, hydrogen, any transportation fuel that can help reduce the average greenhouse gas emissions of transportation fuels.

In the context of the current comprehensive energy bill that is being debated and reconciled between the House and the Senate, we should include an expanded Renewable Fuels Standard, but we should make sure that it includes the environmental safeguards and performance standards that will move it towards this better-is-better approach. The industry is at a critical juncture at this point. As we have heard earlier, investors, university labs, entrepreneurs are all working to see if the United States is committed

to reducing our addiction to oil and starting to reduce our global warming emissions.

We are at risk of losing a lot of the momentum that the industry has gained in the last few years, but we are also at risk of pushing the industry forward in the wrong direction. And that is why we need the environmental safeguards and performance standards to be built into the Renewable Fuels Standard.

My testimony goes into a fair amount of detail about the types of safeguards and standards that we would recommend. But at a high level, I would say, we need to make sure that we are making a downpayment on global warming reductions. This means setting a global warming emissions performance standard as a central part of the Renewable Fuels Standard. We need to make sure that we are not going into critical sensitive habitats and lands held in public trust. We need to make sure that we are growing our new crops with the same best practices that we require of our existing commodity crops. We need to make sure that we are protecting public health by setting rigorous air quality standards that require these new fuels that combust in different ways than our traditional petroleum-based fuels to be at least as clean at the tailpipe as our old fuels are. We need a labelling program to actually understand how these fuels are made, what their performance characteristics are and then to link our incentives to those labels.

It is very clear from your opening remarks that you are all aware of how complicated biofuels are. They are probably, in my opinion, the most complicated and important solution to global warming out there. But because of the urgency of global warming, we need to struggle through these challenges. And so I urge you to continue with these sorts of hearings and really grapple with this problem because your leadership on this issue will be essential. Thank you.

[The prepared statement of Nathanael Greene follows:]

NATURAL RESOURCES DEFENSE COUNCIL

Statement of

Nathanael Greene

Senior Policy Analyst

Natural Resources Defense Council

Before the

Select Committee on Energy Independence & Global Warming

United States House of Representatives

October 24, 2007

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- An increase in the RFS should be done as an amendment to the existing RFS under the Clean Air Act and implemented by EPA 17
- The use of bioenergy must reduce greenhouse gas emissions. 17
- Bioenergy feedstocks must not be grown or extracted from public forest lands or environmentally sensitive lands. 18
- All feedstocks should be produced and harvested in compliance with a conservation plan to promote environmentally protective agriculture practices and avoid conversion of natural ecosystems. 19
- Before the "advanced biofuels" requirement goes into effect, there should be an assured market for fuel made from lignocellulosic feedstocks 20
- Prevent backsliding on air quality by requiring vehicles using renewable fuels to be no dirtier than vehicles using conventional fuels. 21
- As an additional safeguard to the critica protections articulated above, the EPA should study the impacts as the RFS is implemented, and use its existing statutory authorities to mitigate any impacts, and waive further compliance with the RFS if significant impacts cannot be avoided. 22
- Labeling, independent certification, and performance-based incentives will speed the development of advanced biofuels and encourage the adoption of the best technologies and practices. 23

Conclusion 24

Appendix. Basis for Figure 3. 25

Summary

- Biomass feedstocks produced with environmental safeguards, processed efficiently and used in efficient vehicles can reduce our dependence on oil for transportation, reduce emissions of heat-trapping carbon dioxide, and contribute significantly to a vibrant farm economy.
- Pursued without adequate guidelines, large scale biofuels production carries grave risk to our lands, forests, water, wildlife, public health and climate.
- New crops and conversion technologies are developing rapidly that will make it easier to produce lots of biofuels with a smaller environmental footprint, but the technologies are not a guarantee of good environmental performance. We need strong environmental safeguards and performance standards guiding the market so that innovation and competition will drive biofuels to provide the greatest benefits.
- If half of the alternative fuels mandate proposed by the administration were satisfied with coal-derived liquid fuels CO_2 emissions would be 175 million tons higher in 2017 than targeted by the administration. To offset this increase through automobile fuel efficiency standards would require an increase in CAFE standards of 8.6 percent per year, rather than 4% per year as suggested by the administration.
- Congress should cap total greenhouse gas emissions from transportation fuels and require progressive reductions in the average greenhouse gas emissions per gallon of transportation fuels sold, as California is planning to do.
- The comprehensive energy bill being reconciled between the House and the Senate should include an expanded renewable fuels standard that is an amendment to the Clean Air Act, administered by EPA, and:
    - Requires conventional biofuels to achieve at least a 20% reduction in lifecycle greenhouse gas emissions compared to conventional gasoline and advanced biofuels to achieve at least a 50% reduction.
    - Defines lifecycle greenhouse gas emissions to include the full cultivation, production, and combustion cycle of fuels and both the direct and indirect emissions caused by this cycle.
    - Excludes biofuels produced from biomass harvested off of public lands[1], old-growth forest, native grasslands, and "imperiled" ecosystems pursuant to a State Natural Heritage Program.
    - Requires the biomass used to produce biofuels be cultivated and harvested according to a management plan similar to existing commodity crops and that avoids conversion of natural ecosystems.
    - Establishes a straightforward no-backsliding requirement to protect air quality by directing EPA to adopt regulations requiring that the emissions of any air

[1] Biomass obtained from the immediate vicinity of buildings and other areas regularly occupied by people, or of public infrastructure, at risk from wildfire should be excepted from this restriction.

pollutant from vehicles using renewable fuel shall be no greater than the level of such emissions from vehicles when using conventional gasoline.

Introduction

Thank you for the opportunity to share my views regarding implementation of the Renewable Fuels Standard (RFS) and possible modifications to achieve greater energy security and environmental benefits. My name is Nathanael Greene. I'm a senior policy analyst for the Natural Resources Defense Council (NRDC) and one of our main experts on renewable energy technologies. NRDC is a national, nonprofit organization of scientists, lawyers and environmental specialists dedicated to protecting public health and the environment. Founded in 1970, NRDC has more than 1.2 million members and online activists nationwide, served from offices in New York, Washington, Los Angeles and San Francisco.

Mr. Chairman, as you know, U.S. energy policy must address three major challenges: reducing America's dangerous dependence on oil, reducing global warming pollution, and providing affordable energy services that sustain a robust economy. Biofuels have the potential to contribute significantly to all three of these goals. Sustainably produced biomass feedstocks, processed efficiently and used in efficient vehicles can reduce our dependence on oil for transportation, reduce emissions of heat-trapping carbon dioxide, and contribute significantly to a vibrant farm economy. Pursued without adequate guidelines, however, biofuels production carries grave risk to our lands, forests, water, wildlife, public health and climate. Any policy to expand the use of renewable transportation fuels should incorporate effective performance standards and incentives to ensure that biofuels are part of the solution, rather than part of the problem.

For example, unmitigated, expansion of corn cultivation driven by the demand for ethanol threatens to deplete water tables, magnify contamination by fertilizers, pesticides, and herbicides, and undermine vital conservation programs such as the Farm Bill's Conservation Reserve Program. Increased use of ethanol could also impair air quality depending on how it is blended and used. On farms and in forests across the country and abroad, imprudent biomass harvesting would cause soil erosion, water pollution, and habitat destruction, while also substantially reducing the carbon sequestered on land. Advancing a biofuels policy that leads to clearing forests for fuel production, at home or abroad, and hence increased emissions of carbon dioxide would be a particularly perverse result for a policy that is intended, at least in part, to reduce global warming pollution.

The Environmental Impacts of an Expand RFS Could Be Large

Modeling projects done by the United States Department of Agriculture (USDA) and the World Resources Institute (WRI) show how a dramatic increase in the demand for corn to make ethanol can have substantial impacts on soil quality, water quality and the climate.[2] Both projects rely on USDA's Regional Environmental and Agricultural Production (REAP) model coupled with the Environmental Policy Integrated Climate (EPIC) model. USDA looked at increasing from a baseline of 12 billion gallons of corn derived ethanol in 2016 to either 15 billion or 20 billion gallons. WRI analyzed a range of scenarios for 2008, and its analysis is particularly useful for understanding the disproportionate impact of bringing virgin land into active crop management.

[2] USDA, *An Analysis of the Effects of an Expansion in Biofuels Demand on U.S. Agriculture*, May 2007 (http://www.usda.gov/oce/newsroom/chamblissethanol5-8-07.doc), and Marshall, L. "Thirst for Corn: What 2007 Plantings Could Mean for the Environment," WRI, June 2007 (http://pdf.wri.org/policynote_thirstforcorn.pdf).

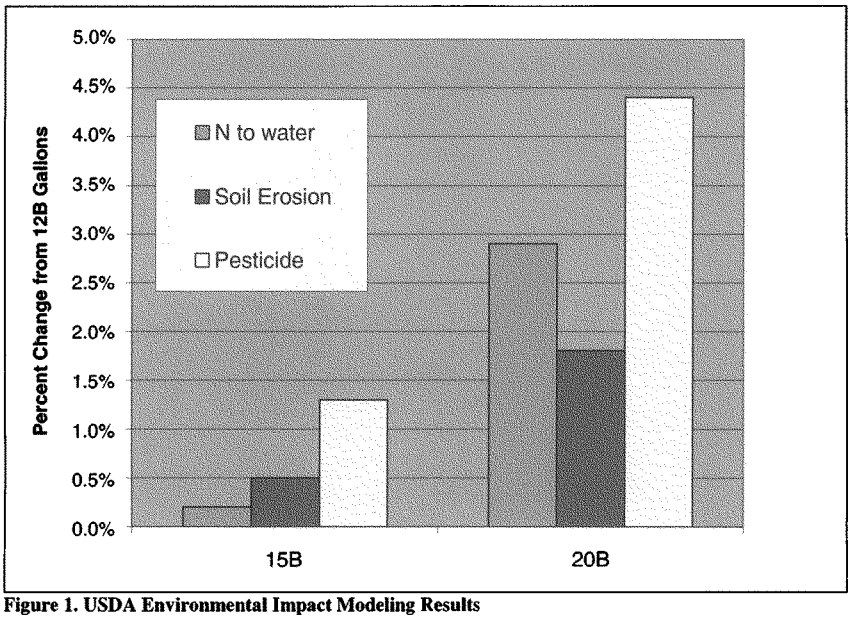

Figure 1. USDA Environmental Impact Modeling Results

The USDA modeling clearly shows that under business as usual, an increase in corn production to meet larger ethanol production goals will mean more fertilizer pollution in our water ways, increased soil erosion, and greater use of pesticides. This conclusion is also supported by the recent report from the National Academy of Science, which stated:

> Staying the current policy path would likely result in the continued trend of expansion of corn-based ethanol production, driven by the economics of input costs and ethanol prices supplemented by the subsidy.[3]

And elsewhere:

> All else being equal, the conversion of other crops or non-crop plants to corn will likely lead to much higher application rates of nitrogen ... Given the correlation of nitrogen application rates to stream concentrations of total nitrogen, and of the

[3] "Water Implications of Biofuels Production in the United States," National Research Council, Committee on Water Implications of Biofuels Production in the United States, page 45 (http://www.nap.edu/catalog/12039.html).

> latter to the increase in hypoxia in the nation's waterbodies, the potential for additional corn-based ethanol production to increase the extent of these hypoxic regions is considerable. Since the dead zone in the Gulf of Mexico is already on the order of 10,000 [sic] square kilometers, the economic stakes are high.[4]

The WRI modeling considered a range of ethanol production levels for 2008 and analyzed them using different assumptions about the amount of virgin land that could be pulled into crop production. Before cultivation, new land must be cleared, which results in a range of impacts not captured in the modeling including habitat destruction and the release of carbon contained in plants both above and below the ground. Furthermore, new land is generally not as productive or conducive to agriculture. The soil is typically not as fertile and the grade may be steep. The net result is that the more virgin land used, the greater the impacts will be.

[4] "Water Implications of Biofuels Production in the United States," National Research Council, Committee on Water Implications of Biofuels Production in the United States, Page 23 (http://www.nap.edu/catalog/12039.html). Note that the dead zone is actually closer to 20,000 square kilometers. This appears to have been a typo in the NAS report.

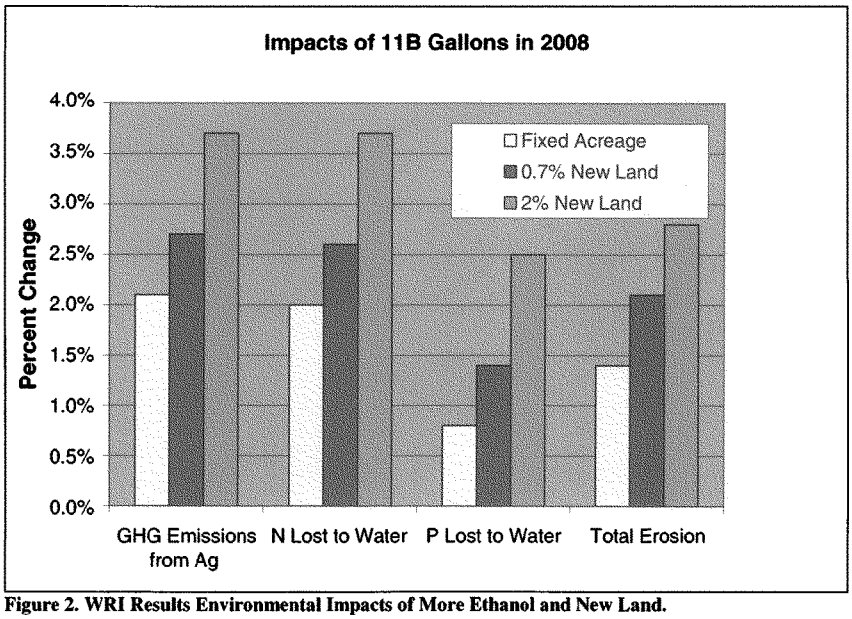

Figure 2. WRI Results Environmental Impacts of More Ethanol and New Land.

The impacts identified in these modeling projects are not an inevitable result of increasing biofuels production or the RFS. To avoid them we must match our increase in corn ethanol production with an increase in funding for Farm Bill conservation programs and reform these programs to get more conservation per dollar. We also need to ensure that biofuels policies do not simply increase the volume of production, but also improve the environment, protect public health, and enhance energy security. Supporting research, development, and deployment of advanced biofuels technologies is also critical, but as I'll discuss later, while these technologies make it easier to sustainably produce biofuels, they are not a silver bullet.

The Need for Performance Standards

To achieve the full potential of biofuels, policies must focus on the benefits that can be achieved by the policies rather than just the feedstocks, conversion technologies or the number of gallons produced. Current federal biofuels policies, from the RFS to the various tax credits, simply reward volume and are based on the assumption that "more is better." Moving forward, it is critical that these policies mature to a "better is better" approach and start to reward good performance.

Nowhere is the need for better performance more evident and urgent than when considering the global warming pollution impacts of biofuels. It is possible to produce ethanol derived from corn in a way that produces less than half of the lifecycle greenhouse gas emissions of gasoline (per BTU of delivered fuel). Conversely it is possible to produce ethanol from cellulosic feedstocks in a manner that produces far more CO_2 than gasoline. Unless our policies value, encourage and ultimately require biofuels to produce greenhouse gas reductions, the market will provide whatever is cheapest and fastest. There is no reason to believe that such fuels will be better than gasoline.

Consider, for example, a dry mill corn ethanol plant. Greenhouse gas emissions from corn production can be minimized by obtaining the corn from a farm that practices no-till cultivation. In addition, by collecting a portion of the corn stover along with the grain the ethanol plant can meet its thermal energy needs with this biomass energy source rather than fossil fuels. Finally, fermentation produces carbon dioxide in a pure stream that can be easily captured for geologic sequestration. Using Argonne National Laboratory's GREET model, we estimate that the lifecycle greenhouse gas emissions from ethanol produced at such a plant would be 7.5 pounds per gasoline gallon equivalent, or more

than 70% lower than gasoline. NRDC has examined the greenhouse gas emissions from a wide variety of feedstock and conversion process combinations using the Argonne GREET model (see Figure 3 and Appendix). EPA conducted a similar analysis for a fact sheet released in conjunction with its final rule for implementing the Renewable Fuels Standard enacted in EPACT 2005.[5] EPA's results are shown in Figure 4 and are very similar to ours (note that EPA displays results relative to conventional gasoline, which is set to zero on their chart.)

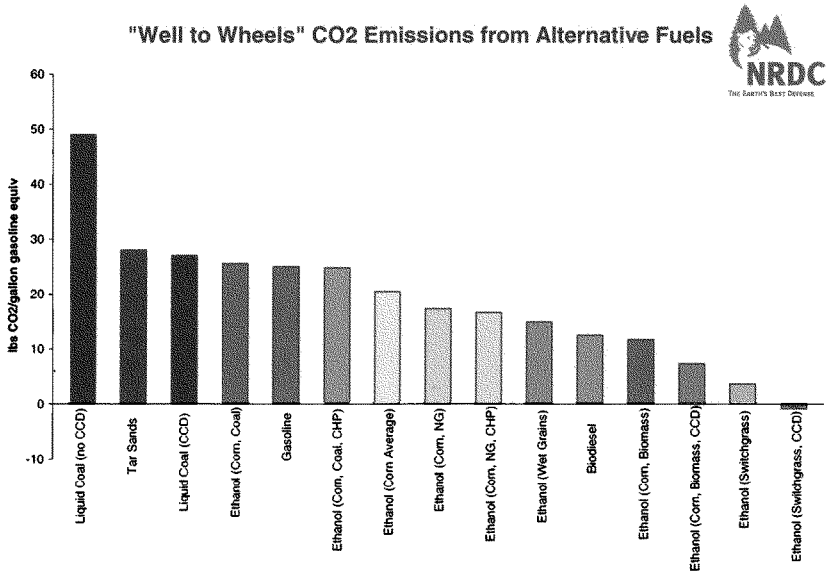

Figure 3. NRDC Lifecycle Greenhouse Gas Analysis

[5] http://www.epa.gov/otaq/renewablefuels/420f07035.htm

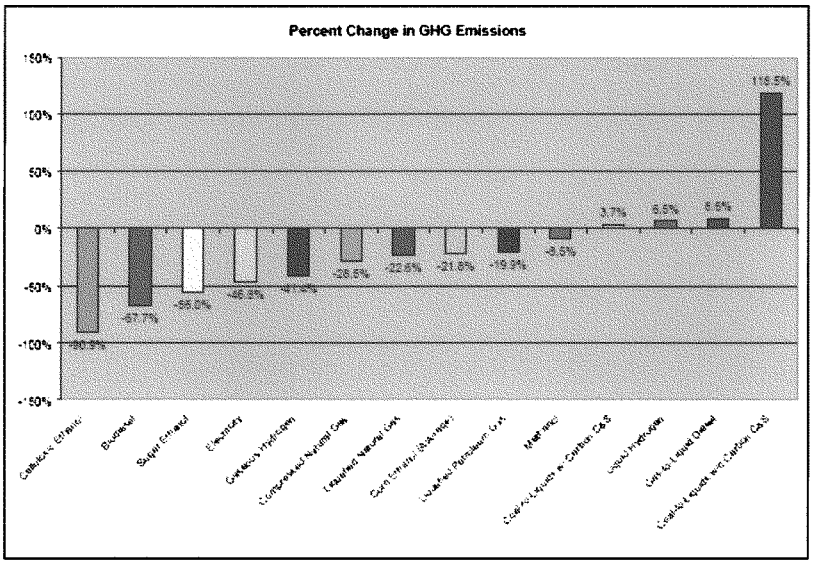

Figure 4. EPA Lifecycle Greenhouse Gas Analysis

Now consider a cellulosic ethanol plant. While such plants are often considered to be environmentally superior to corn ethanol plants, this is not necessarily the case, depending on how the cellulosic feedstock is produced. For example, if the biomass for the cellulosic ethanol plant is obtained by converting to biomass production land that had been enrolled in the conservation reserve program (CRP), then the forgone conservation benefits and carbon benefits must be accounted for. The CRP has enrolled more than 1 million acres in forest cover, including hardwoods, longleaf pine, and other softwoods. These forests provide both important ecological services and sequester a substantial amount of carbon. Converting such lands to biofuels production would not only rapidly return to the atmosphere the carbon sequestered since the trees were planted, but would also forgo future carbon sequestration on this land. The net result would be CO_2

emissions to the atmosphere many times greater than the annual greenhouse gas benefits from cellulosic ethanol production on this land.

Land conversion need not be this direct to undermine the environmental benefits of biofuel production. Devoting an increased share of U.S. agricultural output to fuel production rather than grain exports will result in increased demand for animal feed from sources abroad. If any significant portion of this additional feed is obtained by converting mature forests into pasture or cropland the CO_2 emissions from this land use change could greatly exceed the emission reductions from the use of biofuels. The Argonne GREET model and most lifecycle analyses conducted to date have either ignored these land use related emissions or minimized them. These emissions, however, are unavoidably caused by using certain crops and types of land for biofuels feedstocks and they have the potential to negate all of the global warming benefits of an expanded RFS.

Advanced Technologies – Promising but not a Panacea

Much has been written and said about the promise of advanced, second generation biofuels technologies. These technologies do appear poised to greatly increase the amount of biofuels we can produce and make it easier to produce them in a sustainable way. It is critical to realize, however, that these technologies will not be available overnight and just because we can produce biofuels sustainably does not mean that we will.

When I first started looking at biofuels in 2002, all of the cutting edge expertise was in academia and the national energy labs. You could talk to these experts and they would tell you where the technology stood. Over the last 2 years, however, all of the cutting

edge research has moved into the private sector and is proprietary. So while it's now much harder to know where things stand, we know that a lot of investor dollars are being bet on near-term commercialization. The research is being driven by venture capitalists and private investors.

Combine these developments with the very impressive number of projects proposed in response to recent government solicitations, and it's hard not to believe that things are moving along quickly. Within the past year, New York issued a solicitation for two pilot cellulosic biofuels projects and DOE issued a solicitation for six small commercial scale cellulosic projects. Both of these solicitations required significant private sector investment and a number of major market players responded. Cellulosic biofuels projects announced in recent weeks inlcude a new pilot cellulosic plant in Nebraska that will be built by Abengoa, a plant using switchgrass as a feedstock that will be constructed in Tennessee by Mascoma, and a commercial line of cellulose processing enzymes by Genencor. International developments include a recent announcement by Royal Nedalco in the Netherlands that it will skip the pilot scale and go straight to building a small commercial scale 50 million gallon a year cellulosic plant. There are also advances being made in radically different technologies including the use of microorganisms in existing ethanol facilities to produce fuels similar to gasoline such as biobutanol, bacterial and catalytic conversion of biomass into renewable diesel and gasoline, and the use of algae to make a synthetic diesel fuel.

It is my understanding, however, that none of these projects will come on line until 2010. Assuming a few of them perform very well, they could be expanded, but it is really the second generation plant that investors will consider a potential cookie-cutter model.

Being optimistic, assume that we go into 2013 with three different technologies that can compete with corn ethanol or gasoline, each with an operating second generation plant of about 50 million gallon per year capacity. Even if the technologies are so promising that orders for more fuel are actually placed in 2012, how fast will capital and engineering capacity flow into the sector? How long will siting and permitting lead times be? One billion gallons of capacity by 2016 seems reasonable to me assuming we have at least one clear success on line by 2010. Three billion would be absolutely fantastic. Such a result would require that by 2013 the cellulosic industry grows as fast as the corn ethanol industry grew from middle of 2006 to middle of 2007.

The ability to convert cellulose into fuels opens up the possibility of using new feedstocks such as cellulosic crops, including switchgrass, that use significantly less chemical inputs and water, agricultural residues and organic waste. However, as we discussed earlier, it is also possible to cultivate and harvest cellulosic biomass in extremely destructive and carbon intensive ways. One of the easiest ways to do cellulosic biofuels wrong is by harvesting feedstocks from inappropriate areas such as our public forests, old growth forests, or other imperiled and fragile ecosystems. While I'm not aware of any projects proposing to use such feedstocks, federal policies should not incentivize the future use of such feedstocks. Environmental safeguards and performance standards are necessary to ensure that federal policy promotes the best production standards for biofuels, such as well-managed cultivation of corn or switchgrass.

The Administration's Proposal

The administration has proposed replacing the existing renewable fuels standard with an "alternative fuels" standard that increases to 35 billion gallons by 2017. The

administration has asserted that this standard, in combination with their proposed changes to Corporate Average Fuel Economy standards, would return greenhouse gas emissions from light duty vehicles to current levels in 2017, a reduction of about 170 million metric tons below business-as-usual projections. Unfortunately, nothing in the Administration's proposal would ensure this result. First, while the administration's analysis assumes that ethanol would be used to comply with the standard, their actual proposal opens the door to a variety of fossil fuels as well as renewable fuels, some of which could have lifecycle greenhouse gas emissions as much as twice as high as petroleum-derived fuel. Second, because of the very aggressive schedule for increasing the use of alternative fuels, the administration's proposal would create enormous pressure to convert forests and conservation reserve program lands to biofuels production, potentially contributing a pulse of carbon dioxide emissions that would take many decades to offset through reduced oil consumption. Third, the schedule is too rapid to allow potentially more beneficial processes for producing biofuels, such as cellulosic ethanol and biobutanol, to satisfy most of the alternative fuel mandate, as I discuss above. Fourth, while the administration assumed a 4% per year increase in CAFE standards in their projections, the administration's CAFE proposal does not actually guarantee any increase.

These deficiencies in the administration proposal mean that it could lead to an increase, rather than a reduction, in global warming pollution compared with business as usual. For example, if half of the alternative fuels mandate proposed by the administration were satisfied with coal-derived liquid fuels (liquid coal synfuels) then CO_2 emissions would be 175 million tons higher in 2017 than targeted by the administration. To offset this

increase through automobile fuel efficiency standards would require an increase of 8.6 percent per year, rather than 4% per year as suggested by the administration.

Liquids from Coal v. Electricity from Coal for Transportation

Even if liquid coal synfuels plants fully employ carbon capture and storage, full fuelcycle greenhouse gas emissions from using these fuels will be somewhat worse than conventional gasoline (see Figures 1 and 2). There is a straightforward reason for this. Liquid coal synfuels are hydrocarbon fuels with about the same carbon content per BTU as conventional gasoline or diesel fuel, so vehicle tailpipe CO_2 emissions from using liquid coal would be nearly identical to those from using conventional fuels. Any CO_2 emissions released from the synfuels production facility have to be added to the tailpipe emissions. The residual emissions from a liquid coal plant employing CCS are still somewhat higher than emissions from a petroleum refinery, hence lifecycle emissions are higher.

While I believe that there are better alternatives, if coal is to be used to replace gasoline, generating electricity for use in plug-in hybrid vehicles (PHEVs) can be far more efficient and cleaner than making liquid fuels. In fact, a ton of coal used to generate electricity used in a PHEV will displace more than twice as much oil as using the same coal to make liquid fuels, even using optimistic assumptions about the conversion efficiency of liquid coal plants.[6] The difference in CO_2 emissions is even more dramatic. Liquid coal produced with CCS and used in a hybrid vehicle would still result in lifecycle greenhouse gas emissions of approximately 330 grams/mile, or **ten times** as much as the

[6] Assumes production of 84 gallons of liquid fuel per ton of coal, based on the National Coal Council report. Vehicle efficiency is assumed to be 37.1 miles/gallon on liquid fuel and 3.14 miles/kWh on electricity.

33 grams/mile that could be achieve by a PHEV operating on electricity generated in a coal-fired power plant equipped with CCS.[7]

Getting Biofuels Right in the Energy Bill

The benefits of biofuels can be realized, and the potential pitfalls avoided, through carefully crafted policy. The RFS in the Senate energy bill passed last June mandates 36 billion gallons of biofuels production by 2022. Biofuels are divided into two categories, "conventional" and "advanced", based solely on the type of feedstock from which the fuel is produced. "Conventional biofuels" are defined as ethanol derived from corn starch, and "advanced biofuels" are essentially fuel derived from any other form of renewable biomass. In an important first step, the Senate adopted a greenhouse gas performance standard for new biofuels facilities requiring at least a 20 percent reduction relative to gasoline in global warming emissions over the fuel lifecycle from feedstock production through processing and use. The bill would also require that an increasing proportion of the overall renewable fuels standard come from "advanced biofuels", but it does not establish a higher performance standard for such fuels. Structuring the RFS to ensure the diversification of feedstocks used for biofuels production is helpful, but is not an adequate substitute for stronger greenhouse gas performance standards and sustainable feedstock sourcing requirements, such as those included in the Advanced Clean Fuels Act of 2007 introduced by Senators Boxer, Collins, and Lieberman.

Here I outline key principles that should be incorporated into any expansion of the renewable fuels standard through a combination of robust performance standards, careful

[7] Assumes lifecycle greenhouse gas emission from liquid coal of 27.3 lbs/gallon and lifecycle greenhouse gas emissions from an IGCC power plant with CCS of 106 grams/kWh, based on R. Williams et al., paper presented to GHGT-8 Conference, June 2006.

definitions of what qualifies as renewable fuel, and incentives to promote voluntary management practices that protect ecological values.

- ***An increase in the RFS should be done as an amendment to the existing RFS under the Clean Air Act and implemented by EPA***

EPA cannot carry out its job of protecting public health and welfare without having the authority to regulate the quality of our nation's fuel supplies under the Clean Air Act. Among federal agencies, EPA has the most experience and expertise related to transportation fuels, and is already responsible for implementing the current RFS program. Furthermore the Clean Air Act provides important checks and balances, including specific statutory requirements regarding record keeping and public participation in rulemaking, as well as administrative and citizen enforcement measures. Therefore it is critical to keep the renewable fuels standard under the Clean Air Act and EPA's authority.

- ***The use of bioenergy must reduce greenhouse gas emissions.***

To assure benefits, new incentives and requirements for increased use of biofuels need to be tied to significant reductions in the greenhouse gas intensity of these fuels. As discussed above, this requires explicit greenhouse gas performance standards rather than an implicit assumption that certain feedstocks will produce greater benefits than others. The most effective approach is to cap total greenhouse gas emissions from transportation fuels and require progressive reductions in the average greenhouse gas emissions per gallon of transportation fuels sold, as California is planning to do. In the context of the expanded RFS being considered in the energy bill, conventional biofuels should be

required to achieve at least a 20% reduction in lifecycle greenhouse gas emissions compared to conventional gasoline, as adopted by the Senate. This level of performance can probably be achieved with efficient corn ethanol plants as shown in Figure 1. Advanced biofuels should achieve at least a 50% reduction in lifecycle greenhouse gas emissions, which can be accomplished through several different feedstock and conversion process combinations. Critical to obtaining any meaningful climate benefits, the definition of lifecycle greenhouse gas emissions must also be improved over the Senate language. To ensure that the emissions from land use changes are included, we recommend that the following definition be used:

> *LIFECYCLE GREENHOUSE GAS EMISSIONS. – The term ``lifecycle greenhouse gas emissions" means the aggregate quantity of greenhouse gases attributable to the production, transportation, and use of fuel, including the production, extraction, cultivation and related land use change, distribution, marketing, and transportation of feedstocks, as modified by deducting, as determined by the Administrator of the Environmental Protection Agency—*
> *(i) any greenhouse gases captured at the facility and sequestered; and*
> *(ii) the carbon content, expressed in units of carbon dioxide equivalent, of any feedstock that is renewable biomass.*

- ***Bioenergy feedstocks must not be grown or extracted from public forest lands or environmentally sensitive lands.***

Some areas should simply be off limits for biofuels production. First, high conservation value areas, including native grasslands, old growth forests, important wildlife habitat, and ecosystems that are intact, rare, high in species richness or endemism, or exhibit rare

ecological phenomena, pursuant to a State Natural Heritage Programs designation should be clearly designated as inappropriate for harvest. *Second,* our public lands cannot be seen as a source for large-scale, sustained biomass harvesting. Feeding biofuels refineries would quickly exhaust any potentially responsible biomass available within economic haul-distances, and place untenable pressure on our public forests which are held in the public trust and not for use as biofuels farms. Biofuels should not qualify toward compliance with any renewable fuels standard if the biomass is obtained from public forest lands or these high conservation value areas.[8]

- ***All feedstocks should be produced and harvested in compliance with a conservation plan to promote environmentally protective agriculture practices and avoid conversion of natural ecosystems.***

Habitat loss from the conversion of natural ecosystems represents the primary driving force in the loss of biological diversity worldwide. Activities to be avoided include those that alter the native habitat to such an extent that it no longer supports most characteristic native species and ecological processes. In particular, wetlands drained and forest plantations established after the RFS is enacted should be excluded from the definition of allowable sources of biomass. Secondly, crops grown as feedstocks for biofuels used to comply with the RFS production need to meet a valid conservation plan similar to what commodity crop farmers must in order to qualify for commodity payments. While EPA should implement the RFS overall, approving plans and monitoring compliance with these plans is more appropriately done by USDA. Specifically, we would recommend that all planted crops and crop residues be produced and harvested in compliance with a

[8] [8] Biomass obtained from the immediate vicinity of buildings and other areas regularly occupied by people, or of public infrastructure, at risk from wildfire should be excepted from this restriction.

conservation plan that meets the standards, guidelines and restrictions provided for by Subtitle B of Title XII of the Food Security Act of 1985, as amended, and with the restrictions provided for by Subtitle C of Title XII of the Food Security Act of 1985, as amended.

- ***Before the "advanced biofuels" requirement goes into effect, there should be an assured market for fuel made from lignocellulosic feedstocks.***

Shifting the definition of "advanced biofuels" to include all renewable fuels with a lifecycle greenhouse gas emissions 50% below gasoline ensures that the RFS will provide greater global warming benefits overtime. It does not, however, provide a guaranteed market pull to technologies that can convert lignocellulosic feedstocks into transportation fuels. (We recommend that the definition be strictly limited to these feedstocks and not include conversion facilities just on the basis of not using fossil fuels for process energy. While using renewable energy for processing biofuel is an important for reducing greenhouse gas emissions, it does not necessarily address the technical challenges of deriving fuels from lignocellulosic biomass.) As discussed earlier, these technologies promise to make it easier to produce biofuels sustainably and are essential if biofuels are to make a major contribution to energy security and fighting global warming. To ensure that these technologies are pulled into the market through the RFS, we recommend that the advanced biofuels requirement of the RFS include a provision assuring a market to transportation fuels produced before the advanced biofuels requirement starts in 2016. This provision would require that up to the initial 3 billion gallon starting amount of the

advanced biofuels requirement, all transportation fuels produced from lignocellulosic feedstock before 2016 would have to be purchased by blenders.

- ***Prevent backsliding on air quality by requiring vehicles using renewable fuels to be no dirtier than vehicles using conventional fuels.***

It is widely recognized that when ethanol, whether derived from corn or cellulosic biomass, is mixed with gasoline and burned in today's vehicles, some emissions go up and others go down. Further, it is understood that the magnitude of these emissions is significantly affected by both the parameters of the fuel in which the ethanol is used and the air pollution control and other equipment on the vehicles that burn the fuel. NRDC has focused most on the emissions that contribute to ground-level ozone, but we must not ignore the potential for increases in particle pollution and toxic air pollutants. I would like to emphasize that the latest scientific research indicates that our current National Ambient Air Quality Standard for ground-level ozone does not provide an adequate level of safety. Therefore, it is critically important that we continue to reduce the emissions that contribute to ozone even as we promote ways to transition our nation's transportation system to low-carbon biofuels.

EPA's Regulatory Impact Analysis that accompanied its recent RFS rulemaking found that, particularly in the areas that do not use gasoline with special limits to volatility, the use of the mandated levels in the current RFS will increase ozone emissions 4-6 percent with the possibility that NOx emissions might increase as much as 10 percent. Clearly the prospect of adopting an RFS that more than quadruples the amount of ethanol mandated to be used in the nation's fuel supply demands an examination of such fuel use on ozone impacts.

The RFS should establish a straightforward no-backsliding requirement to protect air quality by directing EPA to adopt regulations that require the emissions of any air pollutant from vehicles using renewable fuel be no greater than the level of such emissions from vehicles when using conventional gasoline. We recommend the following language:

> *Not later than two years after enactment of this Act, the Administrator shall promulgate regulations to ensure that standards issued under this Act shall not cause any increase in emissions of any air pollutant per vehicle mile over emissions resulting from the use of fuel meeting all standards required or adopted under provisions of the Clean Air Act in effect before the date of enactment of this Act.*

- ***As an additional safeguard to the critica protections articulated above, the EPA should study the impacts as the RFS is implemented, and use its existing statutory authorities to mitigate any impacts, and waive further compliance with the RFS if significant impacts cannot be avoided.***

The RFS being contemplated as part of the energy bill would require an unprecedented scale-up of biofuels production, which will create an unprecedented shift in land use and result in many additional impacts to our natural resources. While providing safeguards now is essential to avoid swapping one set of environmental harms for another, it is also highly likely that there will be unexpected and unintended consequences from this increase. Some of the consequences may be good, but to ensure that bad ones are identified and addressed, EPA should study the impacts of the RFS on environmental and public health issues, including:

1. air quality;
2. effects on hypoxia;
3. pesticides, sediment, nutrient and pathogen levels in waters of the United States;
4. acreage and function of waters of the United States;
5. soil environmental quality;
6. resource conservation issues, including soil conservation, water availability, and ecosystem health and biodiversity, including impacts on forests, grasslands, and wetlands.

If the Administrator determines that the RFS is resulting or is reasonably likely to result in significant adverse impact in any of these areas, the Administrator should be required, using EPA's existing statutory authorities, to promulgate regulations to remedy these impacts to the maximum extent achievable or prevent them from occurring. If the impacts are unavoidable at a given level of the RFS, the Administrator should reduce the RFS volume to a level that avoids the negative impacts.

- ***Labeling, independent certification, and performance-based incentives will speed the development of advanced biofuels and encourage the adoption of the best technologies and practices.***

EPA should develop a labeling program so that consumers and policy makers can reward biomass farmers and biofuels producers who use the most environmentally responsible practices. The USDA, working with the EPA, should develop certification standards for biomass from private lands that address key environmental and social objectives, such as protection of wildlife habitat, prevention of erosion, conservation of soil and water resources, nutrient management, selection of appropriate feedstock species, and biologically-integrated pest management. We also recommend that the energy bill include two incentive programs tied to the labeling and certification. The first should

reward the initial 1 billion gallons of advanced biofuels and the second should focus on those renewable fuels produced with the best possible voluntary management practices.

An expanded RFS should also be updated to accommodate renewable electricity used for transportation in emerging vehicles, such as Plug-in Hybrid Electric Vehicles (PHEVs). This can be accomplished by allowing electricity providers to opt into the program as fuel providers as long as they use smart meters to track separately renewable electricity supplied for transportation purposes. With the emergence of PHEVs and other electric vehicles, renewable electricity can be an important additional option to augment renewable biofuels to supply non-petroleum, low greenhouse gas fuels for transportation.

Conclusion

Renewable fuels hold great promise as a tool for reducing global warming pollution, breaking our dangerous oil addiction, and revitalizing rural economies, as long as appropriate standards and incentives are used to shape the nascent bioenergy industry to provide these benefits in a sound and truly sustainable fashion. I look forward to working with the Committee to accomplish this important goal.

Appendix. Basis for Figure 3.

Figure 3 compares the well-to-wheels (or full fuel cycle) emissions from alternative transportation fuels in pounds of CO2-equivalent per gallon of gasoline energy content equivalent. These estimates are largely based on GREET 1.7 beta, which does not include greenhouse gas emissions from indirect or induced land-use changes. The basis for each bar is described briefly below:

Liquid Coal (no CCD): Fischer-Tropsch fuel produced from coal without carbon dioxide capture and disposal (CCD). Based on a stand-alone plant (R. Williams, Princeton University).

Tar Sands: Gasoline made from synthetic petroleum produced from Canadian tar sands. (Based on Oil Sands Fever, Pembina Institute, November 2005)

Ethanol (Corn, Coal): Ethanol produced from corn using coal for process energy at the ethanol plant. (Based GREET 1.7 beta as modified by Turner et al.)

Liquid Coal (CCD): Fischer-Tropsch fuel produced from coal with carbon dioxide capture and disposal (CCD) from the production plant and assuming a stand-alone plant. (R. Williams, Princeton University).

Gasoline: Conventional gasoline, including upstream emissions. (Based on GREET 1.7 beta)

Ethanol (Corn, Coal, CHP): Ethanol produced from corn using coal for process energy in a combined heat and power system at a new dry mill ethanol plant. (Based GREET 1.7 beta as modified by Turner et al.)

Ethanol (Corn Average): Estimate of the national average emissions rate from the current mix of fuel used for ethanol production and the current mix of dry and wet mills. (Based on GREET 1.7 beta as presented in Wang et al., "Life-Cycle Energy and Greenhouse Gas Emissions Impacts of Different Corn Ethanol Plant Types," presentation to 16th International Symposium on Alcohol Fuels, November 2006.)

Ethanol (Corn, NG): Ethanol produced from corn using natural gas for process energy at a dry mill ethanol plant. (Based GREET 1.7 beta as modified by Turner et al.)

Ethanol (Corn, NG, CHP): Ethanol produced from corn using natural gas for process energy in a combined heat and power system at a new dry mill ethanol plant. (Based on GREET 1.7 beta as presented in Wang et al., "Life-Cycle Energy and Greenhouse Gas Emissions Impacts of Different Corn Ethanol Plant Types," presentation to 16th International Symposium on Alcohol Fuels, November 2006.)

Ethanol (Wet Grains): Same as "Corn, NG," except that plant sells wet distiller grains as a coproduct, saving the energy of drying the grains. (Based GREET 1.7 beta as modified by Turner et al.)

Biodiesel: Biodiesel derived from soy oil through fatty-acid methol-esterfication estimate including upstream emissions. (Based on GREET 1.7 beta)

Ethanol (Corn, Biomass): Same as Corn No Till, except that biomass is used for process energy. (Based GREET 1.7 beta as modified by Turner et al.)

Ethanol (Corn, Biomass, CCD): Ethanol produced from corn using biomass for process energy at a dry mill ethanol plant with capture and disposal of the CO2 produced from the fermentation process. Corn is grown with no-till practices and plant sells wet grains. (Based GREET 1.7 beta as modified by Turner et al. subtracting fermentation CO2 of 6.6 pounds of CO2 per gallon of ethanol per http://www.kgs.ku.edu/PRS/Poster/2002/2002-6/P2-05.html.)

Ethanol (Switchgrass): Ethanol produced from the cellulose in switchgrass using the lignin for process energy. (Based GREET 1.7 beta as modified by Turner et al.)

Ethanol (Switchgrass, CCD): Ethanol produced from the cellulose in switchgrass using the lignin for process energy with capture and disposal of the CO2 produced from the fermentation process. (Based GREET 1.7 beta as modified by Turner et al. subtracting fermentation CO2 of 6.6 pounds of CO2 per gallon of ethanol per http://www.kgs.ku.edu/PRS/Poster/2002/2002-6/P2-05.html.)

Sources:
The Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model, GREET 1, Version 1.7, developed by the UChicago Argonne, LLC as Operator of Argonne National Laboratory under Contract No. DE-AC02-06CH11357 with the Department of Energy (DOE).

Turner et al., "Creating Markets for Green Biofuels, Measuring and Improving Environmental Performance," UC Berkeley Transportation Sustainability Research Center, publication pending.

The CHAIRMAN. Thank you, Mr. Greene, very much. That completes the time for opening statements from the witnesses.

And the Chair will now recognize himself for a round of questions.

Mr. Gardner, you are out there on an ongoing basis, talking with the young people across the country. Can you give us a sense of what this green generation is calling for Congress to do? Or its government to do?

Mr. GARDNER. Sure. Well, it has just been exciting to talk to all these folks. When we came up with the idea for Reverb—I am first and foremost a musician—and we thought we would take advantage of the relationship that bands have with their fans to spread environmental awareness. And it turned out to be a really positive side effect that it actually strengthened that relationship to be talking about these issues to our fans. And their response has been enormous; it has been enthusiastic. I have learned about so many young people out there working hard already, whether they are on campuses, working on biodiesel plants right there on campus, converting waste, probably vegetable oil, from their dining halls to biodiesel in their science labs and running their buildings and grounds vehicles on the stuff, to coordinating and rallying a large number of youth groups across the country.

I was just recently in Michigan with a rally—it was actually a Campus Climate Challenge rally around environmental issues on campus. And just it was amazing to see the excitement and energy that young people have around these issues. They definitely want leadership. They are leading themselves, but they are certainly looking to all of you to help.

The CHAIRMAN. Thank you, Mr. Gardner.

Mr. Gatto, you have been through the ups and downs of the biofuels industry. Entrepreneurs always talk about this valley of death between the time of development of the technology and commercialization.

What recommendations do you have for us in terms of congressional policies that we can put on the books that would help entrepreneurs to make it through that valley of death?

Mr. GATTO. Thank you. I think that is a question that has been most often asked, and I think there are three very important elements. One is market-based incentives that have the ability to pull the use of the products that we intend to make. So, in this particular case, talking about an expanded RFS, specifically to cellulose versus corn components, is an important element here; policy that effectively opens the playing field to accept the products. I mean, let's face it, in the case of cellulosic ethanol or corn ethanol, the oil guys dictate what goes in their pump and what comes out of the pump. So I think it is very important to have an open playing field so that the products we seek to make and put into the marketplace can be utilized. And then I think the third thing is to educate. What is a key imperative here, and we talk an awful lot about ethanol, but the reality is what these plants are all about are creating new biorefineries. Why? Because what they all have in common is they all make cheap sugar. And the very same science that is today being used to convert the sugars that come from cellulosic materials, the organisms that are needed to replace yeast—

so if any of you have ever made beer or wine at home, you take your yeast; you add it with your hops; that is how you are making your ethanol. Here we create new organisms, and they accomplish the same thing. Interestingly, however, we can take those very same fundamentals and apply them to all sorts of things, like plastics, fabrics. DuPont, for example, coming out with 1,3-propanediol from an organism now made at an ethanol plant, now producing textile fibers and products that can be used in everyday life.

The CHAIRMAN. Let me just ask a quick question of everyone on the panel, if I may. In the legislation that passed in the Senate there is a mandate of 3 billion gallons of cellulosic fuel being produced by the year 2016, but there are no earlier deadlines in the legislation, there are no earlier timetables for 1 billion, 2 billion, heading up to 3 billion.

Do you think there should be earlier targets in any legislation which would pass for cellulosic? Are we more likely to hit the 3 billion gallon goal by 2016?

Mr. Endres.

Mr. ENDRES. That is a very good point. In fact, there has been a fair amount of discussion within industry about that point. It is hard to project what the number will be, so it is difficult to try to put a number down on a piece of paper. All of the projections are very hard to know, but clearly it would be helpful to consider potential to include cellulosic ethanol as it is produced. That might be a consideration. As the product becomes available, it is required to be blended in the fuel stream. That would give investors security that it would be needed in the fuel stream.

The CHAIRMAN. Do you think we need earlier targets?

Mr. ENDRES. I think it is possible, that early signs are positive, I think it would be very helpful to increase.

The CHAIRMAN. Quickly, yes or no. Earlier targets, Mr. Gatto?

Mr. GATTO. Absolutely.

The CHAIRMAN. Mr. Gardner.

Mr. GARDNER. Yes.

The CHAIRMAN. Doctor.

Ms. LESCHINE. Yes.

The CHAIRMAN. Thank you. Mr. Greene.

Mr. GREENE. Absolutely. It is important to note that the 3 billion gallon advance biofuels target is not explicitly cellulosic, it is open to any technology basically that is not corn starch, which is a rather arbitrary definition. I think your interest in advancing cellulosic early is well put, but you need to understand it is a different fix than just bringing that forward.

The CHAIRMAN. Thank you, Mr. Greene.

The Chair recognizes the gentleman from Wisconsin, Mr. Sensenbrenner.

Mr. SENSENBRENNER. Thank you very much. Mr. Chairman, I will start out by saying I am not a real big fan of ethanol. Most of the counties in my Congressional district in the Milwaukee suburbs are under a reformulated gas mandate, a few of them are not. And the experience that we have had is that if you use nonreformulated gas, meaning none with ethanol or gas with no ethanol in it, the mileage goes up about 10 percent during the summer and about 15 percent during the winter. So that any fuel savings

through the use of reformulated gas ends up being eliminated as a result of the lower gas mileage and by burning more fuel to get to where you are going. My constituents end up putting more particulate pollution in the air.

The result of the market working is that there are a number of entrepreneurs that have put gas stations in right across the county line in the nonreformulated gas area, and they started going from four pumps, and now a couple of them are up to 16 pumps because again the market is working, even though there is not that much of a price differential. So it is a quality differential that causes my constituents to drive a few more miles to get fuel outside there.

I think we are getting hooked, particularly on corn-based ethanol, and I would like to first ask Mr. Endres and Mr. Gatto whether you favor a repeal of the $0.54 a gallon tariff that we put on sugar-based ethanol that largely comes from Brazil. And if so, why and if not, why not?

Mr. ENDRES. Well, first let me address the issue.

Mr. SENSENBRENNER. No, I've got 5 minutes. Please answer my question.

Mr. ENDRES. No. The reason the $0.54 tariff is in place is to protect the taxpayer. There is a blended credit in place to incent blenders to put ethanol in the fuel.

Mr. SENSENBRENNER. Mr. Gatto.

Mr. GATTO. No. Again, I think there is a misnomer that Brazil is this panacea. The reality in Brazil is that Brazil operates 6 months a year, and during the growing season down there they are consuming much of the product that they are manufacturing, and that that is left available for export they do find a way to either send it here or overseas.

Mr. SENSENBRENNER. Now, my next question is addressed to both Mr. Endres and Mr. Gatto. Do you favor a repeal of the $0.54 a gallon subsidy that we apply at the wholesale level for ethanol production?

Mr. ENDRES. It is $0.51 today. And no, I don't favor it. It is an important market driver today.

Mr. GATTO. I do not as well. Again, this is one of the most important drivers to show that the United States has a commitment to the long-term success of this program.

Mr. SENSENBRENNER. Let me just respond with this observation. When the government puts a protective tariff on and then grants a subsidy over and above that, that might be nice when a market is starting out.

The ethanol market I think is now well matured, and I get very, very fearful when I hear major ethanol producers saying, we need both a continued subsidy and we need to have the protection that prevents sugar-based ethanol from coming into this country without a rather large tariff applied on it. This is kind of double protectionism and the consumer ends up paying for that in the end.

Now, you know, I personally think that the subsidy that the taxpayers give the ethanol production is corporate welfare; you are a beneficiary of that corporate welfare. The corn farmers who end up selling a lot of corn to you folks end up having a price advantage because of the tariff that we place on the import of sugar-based ethanol in Brazil.

Now, if this is such a panacea, why can't we let the market work without a protective tariff and without a taxpayer subsidy?

I have 37 seconds left, Mr. Endres and Mr. Gatto.

Mr. ENDRES. Yes. First of all, the ethanol industry is not receiving the blender's credit. The market is such that the oil companies are keeping that, which is in fact to help create new markets. So it is an important element to open these new markets up. Again, we don't receive the benefit of that today. The long term, I believe actually you will see that biofuels can be produced for less than gasoline, less than ethanol, less than a gallon of gasoline.

Mr. SENSENBRENNER. Shouldn't we have been able to get to that point now with the tremendous emphasis with ethanol, particularly in the nonattainment areas under the Clean Air Act with the reformulated gas mandates?

Mr. ENDRES. Well, biofuels development has increased more rapidly than what the RFG markets need ethanol to satisfy the action requirement.

Mr. SENSENBRENNER. Thank you, my time is up.

The CHAIRMAN. The gentleman's time has expired.

The gentlelady from California, Ms. Solis, is recognized.

Ms. SOLIS. Thank you. I wanted to ask all the panelists this question, if you could, each of you, respond. We know that biofuel production spans the entire globe. Unlike fossil fuels it seems as if every country can produce its own fuel, biofuels. However, I would like to know from you, is there a push to transition to biofuels? And some of the concerns that I want to raise, is there a risk that the push to biofuels can create the same type of market problems associated with fossil fuels? That is one question. And if yes, how can we prevent this from occurring?

And then two, how do we separate biofuels productions from fuels used from the agricultural market needed for foodstuffs and to combat hunger?

We will start with Mr. Endres.

Mr. ENDRES. Thank you. It is a very good point. First of all, the ethanol industry is continuing to fragment. There's 131 ethanol biorefinery facilities running today. So it is a very fragmented market, very different than the oil industry that has consolidated over many years.

I think that is really great news. A lot of farmers have invested in the technology and the production facility, so we see that fragmenting.

So on the food front it is very interesting the 25-year food inflation rate is about 3 percent, the food inflation rate on products directly or indirectly derived from corn is only 3.4 percent from June of '05 to June '07. So the data doesn't show increased food costs.

As it relates to people starving in the world, unfortunately, we have had people starving in the world where we have had grain rotting in bins, so I don't think that is the issue.

We think that in fact the additional protein that the corn ethanol facilities produce will actually increase milk production, livestock production. There is a delayed effect, but in fact we believe there will be significant new protein available that will address the food versus fuel issue.

Ms. SOLIS. Mr. Gatto.

Mr. GATTO. I would have to agree with Don, and just further, that what we are talking about is a transition to next generation programs. When you start to look at the impact of cellulosic ethanol, for example, you see a dramatic shift in terms of how these facilities are sited, where these facilities are sited. One could never imagine, for example, in Massachusetts building an ethanol plant that would be able to service the community there. Today we can talk about whether it is wood waste, cranberry bogs or a variety of other materials.

Congressman Sensenbrenner talks about the fact that corn ethanol has had some issues with respect to Wisconsin. Interestingly, when we start looking at paper mills, and sawmill waste, and logging opportunities that have been going on in this country and the jobs that have been lost as a function thereof, this is an opportunity for us to gain back those jobs, to reinvest into those areas. So we are talking about a broad proliferation of these facilities.

So to the market issue, let us put this in perspective. If it is 20 billion gallons which is associated with cellulosic ethanol, and the average ethanol plant today, new plants, are about 100 million gallons, cellulosic ethanol plants will probably be in the 30 to 50 million gallons at the outset. So we are talking about some several thousand plants that would need to be built throughout the United States, not giving any one company necessarily the specific strength to dictate price terms or otherwise.

Mr. GARDNER. I think it is important to emphasize the triple bottom line whenever we are talking about fuel production and sales. People profit and plan it. Some of the principles that are outlined in my written testimony from Sustainable Biofuels Alliance actually outline what we can be doing to avoid the pitfalls of transferring our issues from petroleum oil to biofuels.

I do have to agree with, you know, as far as food—having varied feedstocks is the way forward. So what we were referring to is advanced biofuels. It is certainly I think the way forward and where we can end up in a way that we are not putting anything in danger and only creating a positive.

Ms. LESCHINE. Well, I agree with what has been said. I just want to emphasize that this is a very complex problem that will be solved through lots of different channels. And the biomass is a regional issue. Different regions will develop different strategies for converting biomass into renewable fuel. And has been said, we are on a path, this is the path we are on, to this advanced biofuels where the issue of competition with food will be solved.

Mr. GREENE. The only thing I can really add to the excellent comments that have come so far is it is important to understand that as of today there has been no market really for cellulose, so there has been no effort by farmers to figure out how to integrate the production of cellulose into the production of other food crops or the forest industry thinking about how to produce cellulose for fuel either.

So I think as the market develops we will see a potential for integration that it is hard for us to imagine, which is why I think it is important to focus on the benefits.

Ms. SOLIS. Thank you.

The CHAIRMAN. The gentlelady's time has expired. The Chair recognizes the gentleman from Arizona, Mr. Shadegg.

Mr. SHADEGG. Thank you, Mr. Chairman. I want to thank all the witnesses. It is very educational testimony and very helpful.

I have all kinds of concerns and all kinds of questions. It seems to me and maybe, Mr. Endres and Mr. Gatto, you can help me a little bit, critics of corn-based ethanol engage in a debate about whether or not the marginal energy gain is worth the effort. I would be interested in two general questions. Do you see cellulosic ethanol as having a greater spread between the energy consumed to produce it and the energy it produces? And if you do see that, do you see corn-based ethanol as a transition to cellulosic ethanol?

Mr. ENDRES. There has been a lot of talk about it. Unfortunately, it is amazing that even though nine different groups have studied the energy balance, eight of the nine for the last 10 years have concluded that ethanol has a positive energy balance for all BTUs put in versus BTUs out.

Mr. SHADEGG. Yes, the question is, is it enough? My question is, is cellulosic better?

Mr. ENDRES. Yes. The early returns is it looks as though because you can burn the lignin there actually is a further extension of energy, but we get about six times the energy out of ethanol than what we put into it from a liquid fossil fuels perspective. So we are getting a 6X extension by making ethanol. So I think it is something that is missed—it is a very good point. I think cellulosic ethanol has a chance because you are burning lignin to increase the——

Mr. SHADEGG. Mr. Gatto.

Mr. GATTO. It is a very good question. In fact, the Energy Policy Act of 2005, one of the key essential elements that you will note was the opportunity to create incentive under the mandate of basically two and a half to one and that was really an implication as to the environmental benefits provided, that were provided as a function of cellulose compared to, say, traditional corn. So this was looked at. A great amount of discussion and debate has really been had about the global warming implications, and so forth.

Cellulosic ethanol first generation plants obviously are going to have issues, but I think overall we are going to see a transition over time. Very much the same way that we have seen a transition in the countryside. If you look at ethanol plants built in the 80's versus the ethanol plants today, we have seen a dramatic improvement. Just in the water consumption alone, for example, we have seen anywhere from 5 to 6 gallons of water per gallon of ethanol drop down now to new, latest and greatest, at 1-1/2.

So all of these implications, I think, for both the transition from ethanol, corn ethanol, and then later to cellulose are going to be fairly dramatic.

Mr. SHADEGG. My colleague referred to the tragic forest fires burning in California right now. Mr. Gatto, you talked about the use of other feedstocks. In northern Arizona we have a lot of forests and a lot of potential to use forest undergrowth as a feedstock, and we are trying to move forward with that right now.

Dr. Leschine, you answered the other question. The enzymes that you are working on and developing, do you see those as being able

to increase essentially the margin of gain in energy over cellulosic, for cellulosic ethanol over corn-based or sugar-based?

Ms. LESCHINE. Yes. Actually what we are working on is a microbial strategy where a microbe makes its own enzymes, and so what that does is it will eliminate the need for separately produced enzymes, which is one of the cost considerations in cellulosic ethanol. So this is one advance—an example of one advance we hope to see in the future, that just as the corn ethanol industry has developed new technologies and new ways to improve efficiency and the energy gain in cellulosic ethanol, it is just in its infancy and there are many technologies being considered, and, yes, this is one.

Mr. SHADEGG. I am almost out of time. Let me ask a quick question. I expressed concern earlier about Congress having mandated MTBE and having caused some damage by not being able to see far enough down the road. I am interested in any advice you can give to us on how we might foresee unanticipated consequences and avoid—Congress doesn't move very quickly, the science you work in actually moves quicker than we do. So that is one question that I would like to see you address, how can we avoid that.

Mr. Greene.

Mr. GREENE. I mentioned earlier in my statement the idea of a low carbon fuel standard and I think the risk of picking a number of gallons, as you bring out, you pick the wrong number, and that is almost invariably it. If instead we focus on the amount of benefit that we want and let the market figure out the cheapest, best way to get there, I think we would have better results.

Mr. SHADEGG. One quick question and the chairman is going to jerk my chain, should we be mandating a separate standard for cellulosic as opposed to other ethanol? I understand from the testimony the Senate bill doesn't say just cellulosic. Should we be separating those out? Anybody who wants to comment. Mr. Gatto, you wanted to speak to that last question.

Mr. GATTO. Yes, if I could just add to one point you made with respect to forest fires, it is very interesting because the State of California actually had the Quincy Library Group get together, it was loggers, it was oil folks, it was people in the cellulose community, and really tried to focus on this issue and clearing out the underbrush and doing an effective job on trying to manage what was really fueling these fires. So I point out that was a key component to this and represents extraordinary opportunity.

With respect to cellulosic ethanol, and the differentiation between corn and/or ethanol, I guess my view is ethanol is ethanol. What we want to do is to create incentives and we want to drive the markets to next generation biorefineries by using the latest and greatest technologies.

What we don't want to do is destroy the fundamentals of the ethanol industry. I guess my foundation would reside in the following way, and that is that if it is not ethanol it is oil. And so today what we want to try and do is transition this to the most effective, cleanest, most diligent way of getting to the bottom line.

One thing I would point out, MTBE, a blue ribbon panel looked at the health impact studies of ethanol.

The CHAIRMAN. Mr. Greene, do you want to add a word here?

Mr. GREENE. I am sorry, I was listening to the——

The CHAIRMAN. The gentleman's time was——

Mr. SHADEGG. I appreciate the indulgence.

The CHAIRMAN. The Chair recognizes the gentlelady from South Dakota.

Ms. HERSETH SANDLIN. Thank you, Mr. Chairman.

I first want to thank Dr. Leschine for her comments about corn ethanol playing a central role in the future development of biofuels in the country, and I want to state for the record my strong disagreement with the statement of the ranking member, Mr. Sensenbrenner, that the tariff and the blender's credit together constitute corporate welfare. I think it is unfortunate that when we are trying to promote protection for taxpayers, leveling a playing field and achieving important policy objectives related to energy independence, that such a statement would be made from such a distinguished and long serving Member of Congress, particularly as it relates to leveling a playing field and driving a market that is good for a number of policy objectives and taxpayers.

Let me build on that and ask Mr. Endres, in your testimony you stated that ethanol is selling at $1.55 per gallon and conventional gasoline is selling at over $2, but that not all refiners are capitalizing on the economic advantages of ethanol blending. So if ethanol is so much cheaper than gasoline right now, why are some refiners still not maximizing their use of ethanol in your opinion?

Mr. ENDRES. Well, the challenge is the refiners have a lot on their plate. Quite honestly, we work closely with our customers and in fact have a number of issues, reducing sulfur, trying to expand their facilities. They just have a lot of priorities on their plate, and so that is why it is important, I believe, that we continue to drive them to innovate the product in the field stream.

We are working diligently to help that happen as well, but this will clearly set the stage. In fact many times we have heard them say, just tell us what it is that is a priority and we will focus on it, and so I think that is it.

Ms. HERSETH SANDLIN. And so a measure to drive them that way. Given that we have had tax incentives, the blender's credit for a number of years before we had the Renewable Fuel Standard of the Energy Policy Act of 2005, would you agree that not only do we need earlier targets for cellulosic ethanol, as Chairman Markey was questioning earlier, but that we have more aggressive targets within the Renewable Fuel Standard, particularly for the years 2008 to 2010?

Mr. ENDRES. Yes.

Ms. HERSETH SANDLIN. And Mr. Gatto, you would agree with that?

Mr. GATTO. Absolutely. I think the most important thing for the committee to realize is that ethanol right now is at a transition point, and without a very aggressive campaign to expand the RFS in 2008 and through 2010, what you are going to see is the investment community absolutely run from this space. We have already seen it, we have had a record pace with which we were building plants. We have now seen that over 50 percent of the new plants that were to be built have been put aside. We have seen certain banks in this space have now started to take their teams that were

focused on biofuels and move those teams into other areas of business. So it is an absolute imperative.

Ms. HERSETH SANDLIN. Thank you.

Also for Mr. Endres and Mr. Gatto, before I have a question for Mr. Greene. The EPA has a current chart based on the percentage change of greenhouse gas emissions of a number of different fuels, and right now corn ethanol averages 21.8 percent reduction compared to conventional gasoline. Now, just as you responded to Mr. Shadegg's question, Mr. Endres, as to how technological advances have increased the energy balance, the energy output of ethanol compared to earlier plants, do you agree with the statement that technological advancements will also increase beyond 21.8 percent reduction as it relates to reducing greenhouse gas emissions?

Mr. ENDRES. Absolutely. There has been work within the industry that shows in fact we could move that much closer, in fact corn-based ethanol to cellulosic levels, potentially 50 percent reduction in fossil fuel use. So by integrating new fuel systems, energy fuel systems, actually potentially burning biomass could help us get there.

Ms. HERSETH SANDLIN. Thank you. Mr. Gatto, I am going to cut you off just so I can move to Mr. Greene and visit with you afterward, and you can take that as a written question for the record.

Mr. Greene, you state in your written testimony that "on farms and on forests across the country and abroad imprudent biomass harvesting would cause soil erosion, water pollution, habitat destruction while also substantially reducing the carbon sequestered on land."

Now, much of the excitement about biomass that I hear of from where I am and other parts of the country centers around dense perennial grasses that use very little water or fertilizer and can be harvested year after year without cultivation. So if we can achieve this, it doesn't sound like the scenario that you are painting in your testimony. So I would like to know exactly what about the model of those types of perennial grasses would concern you.

Mr. GREENE. I think the critical part of the sentence that you read is the imprudent part. The challenge I see is that even though there are models out there that are very exciting with the mixed perennial grasses and crops, just because we have those models doesn't mean that we will use them. It is easy to envision switchgrass becoming a monoculture being bred to have a lot of above ground biomass, much lower root structure. These are the pressures that the marketplace will put on farmers and breeders unless we put a reward out there for good management.

Ms. HERSETH SANDLIN. Thank you. Thank you, Mr. Chairman.

The CHAIRMAN. Gentlelady's time has expired.

The Chair recognizes the gentleman from Missouri, Mr. Cleaver.

Mr. CLEAVER. Thank you, Mr. Chairman. I live in a city that suffers from the Nation's failure in geography. And people will ask me how are Dorothy and Toto despite the fact that I live in Missouri, or are you the mayor of Kansas. The truth is Kansas City is the largest city in our State, most people would probably say St. Louis, but Kansas City is significantly larger, 322 square miles, it is a huge city, one of the largest cities geographically in the country.

We have one E85 service station. It is in south Kansas City. So if you land at the airport you are somewhere in the neighborhood of about 45 minutes away from an E85 service station. Even if you have the desire to purchase a flex fuel vehicle and you want to get it, you know, there are not many people who are going to drive 45 minutes to get gasoline.

What can we do to help move, create more of these stations in our country? The chances are the only places you can find an E85 service station is near a GSA facility because they have been mandated to use biofuels. And so that is why you would only have two in New York, because it is based primarily on GSA. What can we do?

Mr. ENDRES. First, we have been pretty vocal on this. VeraSun has worked for a long time with E85, we continue to see the expansion of it, but it is still way too small. We believe that the blender's credit worked for E10, it clearly worked, and we think there should be a blender's credit that is focused on E85 to give the blenders a clear signal that in fact the product will be available. And our challenge today with E85 is that it gets less mileage because the vehicles don't optimize for the octane in the vehicle. So we need to discount that fuel in order to make it available and compelling for consumers.

And so one of the things that again we advocated is within the VEETC system providing for E85 blender's credit so that it becomes affordable. We think blenders would roll it out quite quickly.

Mr. CLEAVER. Anyone else?

Mr. GREENE. I would just point to the importance of setting a long-term trajectory and a clear commitment from our country to shifting away from using oil as a primary transportation energy to using alternatives. That is the signal to the market, to oil companies, to the gasoline stations it can play a critical role in their decisions to invest what will eventually be hundreds of billions of dollars over time to a new infrastructure.

Mr. CLEAVER. But if Brazil is deriving about 30 percent of their fuel from ethanol and someone said, I am not sure whether it was a correct figure, that most of that or half of that is eaten up during the production season, and we don't have the capacity here geographically in terms of the acreage to produce the corn to do 30 percent, I don't think; isn't it going to be too difficult to push someone to invest in an E85 service station, realizing at the optimum, at the maximum level they wouldn't be able to sell but 10 percent?

Mr. ENDRES. Well, I would just say that it is working to a certain extent because companies like ours and other ethanol producers have provided the fuel at a value to make it work and that in fact we now see a number of new models coming out that are flex fuel. So it is kind of a chicken and egg problem, but we do believe that autos will come out and produce more efficient flex fuel vehicles once they see the market is there for them and that in fact the economics will significantly improve, and therefore the blender's credit could be a short-term kick start to making this work.

Mr. GATTO. This is not a supply issue, nor is it a price issue. I think it is an issue of access and one where, you know, to the extent that the consumer had the opportunity to truly understand that if they went and bought that car, that Chevy Impala for exam-

ple, and had a place to go and fill up that they would do so more often. It is quite interesting if you travel through Brazil and look at the service stations down there, they have two signs. They have a sign talking about ethanol and the ethanol price and they have the petroleum price. And down there in fact the amount of ethanol that is being consumed is well over 60 percent of the total consumption and expanding to 90 percent.

Mr. CLEAVER. Thank you, Mr. Chairman.

The CHAIRMAN. Gentleman's time has expired.

The Chair recognizes the gentleman from Washington State, Mr. Inslee.

Mr. INSLEE. Thank you. I very much appreciate all of your testimony, because I just got done writing a book talking about the great potential benefit of biofuels and I am glad I wasn't totally wrong. So you sort of comforted me, particularly Mr. Gatto's reference to President Kennedy, because we named the book Apollo's Fire after basically that whole concept.

I want to ask you in that vein, aren't we just pathetically short of the real challenge here as to what we really need to do to get this going? I mean, last night I was talking to a group about this issue and I was sort of bragging about all the great stuff we are doing, and this lady stood up and said, you guys are pathetic, you are doing one-tenth of what you really need to do to get this job done. Looking at what is going on in the ecosystem right now, I sort of agree with her.

Do you have any comments about what we really ought to be doing here? We went from 3,000 planes in 1939 in America to 30,000 in 1943. Couldn't we accelerate these numbers much more rapidly than we have? Anybody want to just comment on that?

Mr. ENDRES. Absolutely, and the market is gearing up for it, but there is a clear question now on whether or not there will be a market for the product. So absolutely. Look, the Renewal Fuel Standard required about 4.7 billion gallons be incorporated this year. At the time that was being debated there was a lot of discussion about how it just could not be done, there was no way it could be done. The industry produced 6.5 billion gallons this year. So the capital is ready to flow in and willing to be put to work, but there is a clear question today because of concern over a lack of demand for the product.

Mr. INSLEE. Is there any reason we wouldn't statutorily codify this commitment to make 50 percent of cars at least flex fuel in short order? Does that make sense?

Mr. ENDRES. In effect, the autos have made a commitment to produce more than 50 percent of vehicles as flex fuel vehicles.

Mr. INSLEE. Let me ask you about requirements for pumps. When I talked to folks in Brazil, they told me, look, you will never get this done unless you really have some requirement for people to put in pumps, because as long as one entity has control of a fossil fuel base and that is almost all they sell, they are not going to willingly work with you to get ethanol pumps in and biodiesel pumps in. Shouldn't we have some legal requirement for a percentage under certain circumstances that biofuel pumps be put in for distributors of certain sizes? Anyone want to take that?

Mr. GATTO. I think you have really hit the nail on the head. Here again you look at the ethanol industry, it has risen to the occasion. During the blue ribbon panel talking about phasing out MTBE, the community at large was saying can we create enough ethanol to satisfy the need? We did that in 2 years.

So the problem is not supply, the problem is not investment. The problem is that the investment community is unsure whether or not this truly is going to be something sustainable. And so you can make the product, you can make it available to the consumer at a price that is certainly far more competitive than gasoline in many instances. The problem is if you don't control the pump, you don't control what comes out.

So I would say absolutely it is an imperative that if we are talking about an expansive RFS, we also have to include the ability to put the cars on the road and create the opportunities for customers to be able to use the product.

Mr. INSLEE. I have been fighting for this to let you know we will continue that effort.

Mr. Gardner.

Mr. GARDNER. I would just like to add that the demand is so clearly there. And I want to echo the sentiments that we have heard today, because a large part of our work is helping bands fuel up because they can't find it at pumps. I would love for you all to put us out of business, because I don't want to be spending time doing that. I would love every band to find it at a Flying J or any truck stop and fuel up. We can spend our time doing other things in other areas. So absolutely the demand is there and we can hardly keep up with it just within our little community.

Mr. ENDRES. I would say that I agree that we need the infrastructure in place, but I am much more a fan of the incentive-based approach to make this happen. If you mandate it, it is very difficult if you mandate it in areas where there is no ethanol in the market. So I would just absolutely agree we need the infrastructure, but the incentive-based approach is a better way to do it because those markets that have ethanol will definitely put the infrastructure in place.

Mr. INSLEE. Mr. Greene.

Mr. GREENE. I will just add I think it is critical when we think about biofuels and their role and potential that we think about it in a broader context of solving the big picture problem that I think you are talking about here, solving global warming.

I think the issues that are being debated right now on the energy bill, improving vehicle fuel economy performance, making our electric sector cleaner through use of renewable electricity, when you put a package together like that with biofuels, suddenly the potential for biofuels becomes much greater, because for using less fuel and our economy is getting cleaner, then again a round of biofuels are going to go a longer way to clean up the atmosphere, doing their share. So I think the package approach that is being discussed is absolutely critical.

Mr. INSLEE. Thank you.

The CHAIRMAN. Yes.

Ms. LESCHINE. I would like to add, actually completing, looking at the whole package and concluding that there still is room for

new technologies and actually the development of new technologies will be essential. And so I think an important component will be support for basic research and development of these technologies which will really be a driver for the next stage of biofuels.

Mr. INSLEE. Thanks very much.

The CHAIRMAN. The gentleman's time has expired.

I just want to point out here that in Massachusetts we have 150,000 flex fuel vehicles right now driving around and one pump, which makes an awful long line at the gas station, so we definitely have to solve this problem. People are buying the vehicles and then have no place to go to buy fuel for it.

Gentleman from New York, Mr. Hall.

Mr. HALL. Thank you, Mr. Chairman.

I would just follow up on what you are saying by remarking that some might consider this a hoax perpetrated on the American people by the automobile industry, which advertises that you are doing something green by buying a flex fuel vehicle when in fact you can't get the fuel in most parts of the country.

So with that in mind I am curious, starting with Mr. Greene, what you think of some way to incentivize the availability and an infrastructure being put in by linking incentives for flex vehicles to the number of pumps available in the State where the buyer lives, for instance?

Mr. GREENE. I think it is critical to think about that. Solving this problem takes three parts. You need the fuel, the pumping station, and you need the vehicles, and they need to come together simultaneously in time and space, because having a fueling station over there and a vehicle over here is not going to do you any good. So linking them together like that makes a lot of sense.

Mr. HALL. And perhaps combining that with incentive for the oil companies, and I say oil because, as mentioned before, if that is their primary product, they don't really have that much incentive, unless they are heavily invested in biofuels, to blend ethanol or other biofuels in. Once the profit of a given company exceeds a certain percentage in addition to the price of the raw barrel of oil that it will then be considered to be excess profit and they have a choice of paying it as an excess profit tax or investing it in pumps that provide blended fuels. There must be some way of going at this from both ways to motivate the oil companies and also motivate the auto industry in their promotion and advertising.

Thoughts from anybody else briefly on that?

Mr. ENDRES. Yes, I think that is kind of a stick approach versus a carrot and a stick, and we think that again there is a lot of ethanol now across the country, all these new reformulated fuel markets. Ethanol is in place, so we now need to take that fuel and put it out into E85 pumps, not just E10. Where you have E10 you can potentially have E85 pumps as well. We just need an incentive, a way for us to in the short run bridge this fuel economy difference, and I think you would see a pretty dramatic roll out of E85.

And realize too not all stations are owned by oil companies, they are owned by a lot of independent people and they are very willing to put these pumps in. But again when we do the math with them it becomes difficult. I believe the incentive approach may get you

there and do it in a more smooth fashion than trying to use some sort of a severe mandate.

Mr. HALL. Thank you. I would just comment—I only have a short bit of time, so I will make a comment and another question and then I will be out of time. In Westchester County, which I represent, the county buses have been for the last couple of years hybrid buses, and our county executive just decided to switched them all over to biodiesel hybrid buses. When you start pyramiding one technology on top of the other, then when he turns them into plug-in hybrid biodiesel buses you start to get the multiplication of these different new technologies to increase—I should say decrease the amount of petrochemicals that we are burning.

This would go, I guess, to Dr. Leschine. If you could tell us how—for instance, in my district and others around the country farmland is constantly battling development pressure and we are hoping biofuel growth can play a role keeping that land open. We don't have a lot of corn, we have a variety of other crops that are grown. At the same time if we are going to be growing more fuel crops we need a plan to make sure our soil and water resources can support that. What kind of strategies should we be devising should Congress, USDA, and EPA and others take to make that happen?

Ms. LESCHINE. Well, what we are talking about is diversifying biomass, sources of biomass which can be utilized for cellulosic ethanol production. And there certainly is a great deal going on to do that in order to make, to develop technologies that will be able to make use of plants which can be grown in all regions. So what this is going to require is working with the agricultural community as well as the research community to develop the appropriate cultivation techniques and the proper crops that can grow in particular areas working together.

I think we really do need to have more cross-talk on this to understand more about what crops are the most appropriate for a particular area. We look at crops in terms of the production per acre, but the highest production per acre in some ideal place might not be the ideal crop for a particular area. I think we need to have more integration between the agricultural community and the agricultural workers and the research community that is developing these technologies for using in particular biomass crops.

Mr. HALL. Thank you, Doctor. Thank you, Mr. Chairman.

The CHAIRMAN. The gentleman's time has expired.

The Chair recognizes Mr. McNerney.

Mr. MCNERNEY. Thank you, Mr. Chairman.

Mr. Gatto, one of the things that really excites me about biofuels is the potential for job creation, especially in rural America. Could you go into that a little bit in terms of what kind of jobs you think would be created and how will it impact the rural economy?

Mr. GATTO. I think I have some numbers that I had asked for because this is one of the things that I think is often missed. National picture, current ethanol, 234,000 jobs, household income increased by over $40 billion, domestic spending $70 billion, and reduced cap outflow to oil producing countries by $64 billion.

Mr. MCNERNEY. On a yearly basis.

Mr. GATTO. On an annual basis. This is the impact of ethanol. Cellulosic ethanol has the opportunity to quadruple that, because

of the number of plants and, more importantly, we are talking about taking these facilities and moving them into communities very similar to your colleague in New York where rather than focusing necessarily on switchgrass we might be talking the paper sludge from the area mills, we might be talking about taking the mixed wastepaper that is coming from the municipal streams. So all of these become opportunistic and we start looking at what the origins of these feedstocks and how they can complete the cycle.

Mr. MCNERNEY. Thank you.

I understand that total biodiesel production is rather limited due to acreage and crop limitations and so on. How do the limitations, and I am not sure who would be the best one to answer this question, how do the limitations between biodiesel and bioethanol compare in terms of potential for growth?

Mr. GATTO. I am not sure that there is a differentiation necessarily. One of the interesting things, and maybe Don can speak to this, that is emerging is the opportunity to take one of the byproducts that comes from an ethanol plant and actually convert that to extract biodiesel. So again the context here is when you look at an ethanol plant today it is truly a biorefinery of the future. It is taking everything that comes in that front door and creating products that are renewable and sustainable in nature. So what comes out of an ethanol plant is something called DDGs, which is a high protein cattle feed. That product also has the possibilities of being turned into biodiesel and taking an even higher protein value product to put back into the marketplace.

Mr. MCNERNEY. Mr. Endres.

Mr. ENDRES. We have tested that process, we have actually converted our oil from the germ in corn into biodiesel and we are building our first extraction facility and will be rolling that out of the facility. So the two go hand in hand. Ethanol only uses the starch in corn, the rest of the product, the protein, the oil, the fiber is a byproduct. And so we think that these facilities over time will significantly step into the utilization of that corn kernel, and so we think they will go hand in hand and we can actually provide feedstock to the biodiesel industry as well.

Mr. MCNERNEY. Mr. Greene.

Mr. GREENE. I would say, however, that the total amount of available vegetable oil and the crops that we know that produce vegetable oil around the world is substantially less than the amount of cellulose that we know is in the world. And the important thing to understand though is biodiesel is a process, it is a way of changing vegetable oil into diesel like alternative. Ethanol is a molecule. Both of these things are technologies and what we need to do is step back. There are other ways to make diesel alternatives from plant matter and there are other molecules other than ethanol. A lot of people talk about butanol, but butanol is just one other molecule. There are a lot of molecules out there. We need to be careful as we encourage this factory and try to bring along quickly that we don't lock ourselves into one technology, one conversion pathway such as biodiesel, one molecule such as ethanol. We need to focus on the benefits that we want and let the marketplace figure out what the best technology mix will be.

Mr. MCNERNEY. Could you segue from that into what sort of environmental considerations we need to take in terms of using large-scale agriculture for fuel?

Mr. GREENE. Well, I think biodiesel is a prime example of how it can be both done in a wonderful way and in a very destructive way. We have heard earlier about family farmers, small farmers or students using waste oil, producing vegetable oil. These are great examples of community-based agriculture, reusing waste materials to make transportation fuel.

On the other extreme you have palm oil being grown on rain forest land, lands where they burned off the rain forest, burned the peat soil. The greenhouse emissions from that conversion process outweigh any benefits you get from avoiding oil for hundreds of years. So the extremes here are pretty stark and we need to again focus on the benefits that we want and make sure that we are picking those and not trying to tell farmers how to grow their crops, but say you have to produce a fuel with real greenhouse benefits, with real soil quality benefits, and then let them figure out how to do that. Our farmers are incredibly resourceful, and if we let them they will do great things for us.

Mr. MCNERNEY. Thank you. I yield back to the Chair.

The CHAIRMAN. I thank the gentleman very much. We have a roll call which is about to be called out on the House floor, but we have a few more minutes before that would occur. Why don't we have a lightning round of 2 minutes apiece for each one of the members who would like to ask another round of questions. We will first recognize the gentlelady from South Dakota.

Ms. HERSETH SANDLIN. Thank you, Mr. Chairman.

Mr. Gatto, perhaps you could take 30 seconds to respond to my earlier question. And then Mr. Greene, if you could comment on your testimony where bioenergy feedstocks must not be grown or extracted from public forest lands. We have a lot of slash piles in the Black Hills National Forest and I just want you to clarify if those slash piles from projects by the Forest Service or from a timber contract sale wouldn't be used under that policy.

And then finally, Mr. Gardner, thank you. Governor Brian Schweitzer from Montana has commented in the past about the importance of making conservation cool and I think that is true for concerns about climate as well. Your efforts, particularly among younger generations, will help us in our policy objective propel the consumer demand in particular for more environmentally friendly transportation fuels and electricity sector, and I just wanted to thank you for that. But Mr. Gatto, if you could.

Mr. GATTO. Yes. The question was relative to corn ethanol emissions at 21.8 percent over gasoline and the question was can it segue closer, I believe, to what we are looking at in cellulose. Cellulose, interestingly EPA numbers as well target greenhouse gas emission reduction by over 99.9 percent. But if you look at traditional corn plants today, they are in fact already reducing greenhouse gases by as much as 40 percent.

The CHAIRMAN. Mr.——

Ms. HERSETH SANDLIN. Mr. Greene has maybe 5 seconds on that slash pile question.

Mr. GREENE. I think the potential for forest material from public lands to support a robust cellulosic industry is very limited. I think it is critical that we fend around homes to save lives, but I don't think the forest, our public forests are a major source of material for the cellulosic industry.

The CHAIRMAN. The gentlelady's time has expired.

The gentleman from Missouri.

Mr. CLEAVER. Thank you, Mr. Chairman. Biofuels are already heavily subsidized by the Federal Government in an attempt to encourage their use. Producers of biodiesel or diesel blends are able to claim $1 tax credit—I am sorry, $1 per gallon tax credit—that would seem to me to be a reasonably subsidized method of encouraging use.

Is there anything else that can be done to encourage use? I guess, maybe more importantly, is that $1 per gallon subsidy adequate?

Mr. ENDRES. I believe the dollar/gallon subsidy is very adequate, it is working. What is happening in the marketplace now is vegetable oil values have improved. So it is now incenting companies like ours to invest in technology to extract oil. Also new gasification technologies and catalyst to produce various oil blends to be converted to green diesel and other types of fuel. So I think it has been very impactful, it is working, and in fact you see technology developing as a result.

Mr. CLEAVER. Thank you, my time is up.

The CHAIRMAN. The gentleman from Washington State.

Mr. INSLEE. Thank you. Let me ask Mr. Greene and Mr. Gatto to address this issue of how a low carbon fuel standard would work. Mr. Greene cautioned us not to choose a particular technology, but do it based on performance. Perhaps both of you could tell us how that should or should not work.

Mr. GREENE. Sure. As you know, the idea of the low carbon fuel standard is to get a goal for the transportation fuel industry and say we want you to reduce the average greenhouse gas emissions from all the gallons of fuel you sell. California is targeting a 10 percent reduction by 2020. A gallon of fuel, renewable fuel, that comes into the marketplace then is evaluated by the industry for its ability to reduce that average. A gallon of old-fashioned, ancient corn ethanol that produced a very small benefit would be valued less than a modern corn ethanol industry plant and versus a cellulosic industry would be valued even higher just because of the amount of greenhouse gas reductions each of those different gallons would provide.

So it drives the market forward, also allows competition among technologies, the different diesel alternative technologies we heard about, ethanol, butanol, electricity, all the different technologies to get to compete on the benefit they provide the marketplace.

Mr. GATTO. I think, from an industry perspective I think the question is going to be what does this transition period look like, what is the percentage or what is the right number. I think in general what it does do is it differentiates certain bad products and really moves us towards a better understanding of how we can take these programs, whether it is ethanol going to butanol or higher al-

cohols and actually making them more sustainable and certainly more environmentally beneficial.

The key that I would like to stress here is, we are looking at corn today, which is a very, very good example of what we could do. It is a great improvement over where we are today with oil. Cellulosic ethanol is an extraordinary improvement over that and we have an opportunity to do more.

The CHAIRMAN. The gentleman's time has expired. The gentleman from New York, Mr. Hall.

Mr. HALL. Thank you, Mr. Chairman. I just wanted to thank Mr. Gardener for his work and say, as somebody who spent many a night at a truck stop with my band and crew and drivers, getting some food in the middle of a trip, there are opportunities for conversations with truckers. And I wouldn't be surprised if they and the teamsters and trucking companies might be interested in these possibilities. There might be another way of getting at it.

Getting the word out is a big part of the problem. And when I found out that I could buy biodiesel for my own home, it was just me finally going, hey, I think I will call my fuel oil company. I picked up the phone in Dover Plains, New York, and I asked, and they said, sure. We have got 20 percent soy blend we could send you. Most people don't know to ask. So the more we spread the word, as you are doing, the more people will know to ask.

The CHAIRMAN. The gentleman's time has expired.

Mr. Gardner, maybe you will be a Member of Congress some day, too. We have a veteran from Orleans who is up here and who knows. Just not in my district, please, even though you were educated there.

The gentleman from California, Mr. McNerney.

Mr. MCNERNEY. Thank you. I have a fairly straightforward question.

Ethanol degradation of oil pipelines, is there a way to mitigate that? What is the solution to that issue?

Mr. ENDRES. We have worked a great amount with our customers. In fact, we believe you will see now ethanol blended in pipelines. Remember, the issue of that pipeline is more so on water; there is water that lays in those pipes, and it picks up the water. That has been the principal challenge, not corrosion of the pipe. We pipe ethanol around it a great deal. We pipe it throughout our plants. It is a product we drink. It is just that, that is an overused issue. And in fact, we believe we will see some companies now starting to pipe ethanol in a regional method in the near future.

Mr. MCNERNEY. Thank you.

The CHAIRMAN. The gentleman's time has expired. We thank our witnesses very much. We are committed to passing a bill with a strong renewable fuel standard in it. You have given us some of the other issues that we have to deal with as well, obviously the collateral environmental effects, that we will have to build in protections, and also the incentives to make sure that the pumps are out there so that people who are buying these flex-fuel vehicles have a place that they can then take advantage of this new fuel.

So your testimony has been extremely helpful to us in helping to propel us forward towards producing this legislation before the Congress adjourns this year.

We thank you. And with that, this hearing is adjourned.
[Whereupon, at 11:42 a.m., the committee was adjourned.]

THE SELECT COMMITTEE ON
ENERGY INDEPENDENCE AND GLOBAL WARMING

December 10, 2007

Dear Mr. Gardner ,
Following your appearance in front of the Select Committee on Energy Independence and Global Warming, members of the committee submitted additional questions for your attention. I have attached the document with those questions to this email. Please respond at your earliest convenience, or within 2 weeks. Responses may be submitted in electronic form, back to me at aliya.brodsky@mail.house.gov. Please call with any questions or concerns.

Thank you,
Ali Brodsky
Chief Clerk
Select Committee on Energy Independence and Global Warming

1) At all times, we should be mindful of the nations more vulnerable citizens who struggle with any fundamental resource that escalates in price. As exemplified by recent riots in Mexico over the rising cost of flour tortillas, are you at all concerned about rising food costs as more crops and farmland is dedicated to feedstock for fuels rather than food?

Yes, this is a real issue. Also, growing virgin crops for biofuels isn't the most environmentally sustainable approach. There are extreme examples of rainforest being torn down in South America to grow crops for biofuels—this clearly negates the environmental benefits.

This is why it is crucial to use a diversity of feedstocks such as algae, waste vegetable oil, cellulosic, etc. Again I must stress that not all biofuels are created equal. There needs to be environmental and social standards for **sustainable** biofuels. I outlined some guidelines in my testimony laid out by the Sustainable Biodiesel Alliance that takes into consideration feedstock, production, and distribution form both an environmental and socio-economic perspective.

2) One of the key roles of the federal government is to assist with research and development. What R&D programs have you found particularly helpful in developing and improving biofuels?

I get excited about the programs that are exploring truly renewable resources for feedstocks such as algae.

3) With forest fires raging in California and releasing enormous amounts of carbon into the atmosphere, would you support a policy that allows us to better manage forests by harvesting wood waste that could be used for biofuel production?

Absolutely.

4) Have you found the cost of biodiesel to be higher or lower than regular diesel?

It ranges from state to state, day to day, supplier to supplier. Generally it can cost anywhere from $0.05 less than standard diesel to $0.40 more. We hope that as petroleum diesel prices continue to rise, the biodiesel industry bases it's prices on actual production costs and not the petroleum diesel market. There is a real opportunity for biofuels to become the "new normal" if prices are significantly less!

5) Has the cost of touring risen as a result of the environmental changes that you have made? And if so, who is financing the additional cost?

It depends on what changes are made. For venues, being more efficient with power and water use has and will continue to save them money. For eco-friendly catering products, it's the same cost. My band has saved money by switching out rechargeable batteries for disposables in our stage equipment. But of course, things like organic cotton T-shirts cost more to purchase, but we've found our fans are willing to pay a little more for this.

6) Why do auto manufacturers void warranties for vehicles that use bio-fuels? For example, does biodiesel wear out the rings and fuel injectors faster than conventional diesel? Further, do you think it is the federal government's role to dictate to private companies what should or should not be covered under warranties?

I think automakers are just nervous about "new" fuels (Rudolph Diesel invented the engine in the 1800's to run on peanut oil). Biodiesel's lubricity actually makes it better for engines and even cleans the residue left from petroleum diesel. As far as the federal government's role, I think in general it is necessary at this point for the government to dictate environmental practices and products to private

companies. History has proven that companies as a whole are not particularly concerned about the environment. Corporations have been playing a major role getting us into this mess and they are in a unique position to help get us out. Reverb and other non-profits like it are working hard to spread awareness and consumer demand from the "bottom-up" approach, but time is tight and we need some serious legislation to approach this from the "top-down" simultaneously.

7) The American Jobs Creation Act provides a tax credit of up to $1.00 per gallon for the sale and use of "agri-biodiesel" -- biodiesel from virgin agricultural products. The credit is $0.50 per gallon for biodiesel from recycled grease. In addition, the law provides an excise tax credit for biodiesel blends (i.e., biodiesel and conventional diesel). Producers are eligible for one credit or the other, but not both. The Energy Policy Act of 2005 extends these credits through 2008. Do your support making these credits permanent?

In general, I support the government helping the biofuels industry at least as much as it has helped the petroleum industry (which is quite a lot even before considering the military operations and wars the government has spent in the billions for petroleum) to get us on the right track. Specifically, I believe the credits should favor the most sustainable biofuels, unlike what is outlined above. Why a dollar for virgin agricultural products and only $0.50 for waste vegetable oil that otherwise would be thrown out? Biofuels made from virgin agricultural products, while a semi-acceptable stepping-stone, is not the best option from an environmental or social perspective and should not be the end-all-be-all. The industry needs to be moving toward most sustainable feedstocks, production, and distribution as fast as possible. Proper tax incentives can help make that shift happen.

Responses to Questions from United States House of Representatives Select Committee on Energy Independence and Global Warming
Hearing Entitled, "The Gas is Greener: The Future of Biofuels"

Donald L. Endres
CEO, VeraSun Energy Corporation

1) At all times, we should be mindful of the nations more vulnerable citizens who struggle with any fundamental resource that escalates in price. As exemplified by recent riots in Mexico over the rising cost of flour tortillas, are you at all concerned about rising food costs as more crops and farmland is dedicated to feedstock for fuels rather than food?

It is ironic that efforts to reduce our dependence on oil through expansion of ethanol is blamed for increasing food costs, when, in fact, the price of energy is a leading factor in higher food prices.

An Informa Economics Inc. study released in December 2007 concluded that rising energy and transportation costs are the key drivers to increases in the consumer price index for food. The study found that increasing petroleum prices have about twice the impact on consumer food prices as corn prices do. Only four percent of the change in food prices could be attributed to changes in the price of corn.

Additionally, it is important to note that ethanol is produced from field corn. Almost all U.S. field corn, including exports, feeds livestock not humans. The most critical component of the corn kernel for livestock is protein. Ethanol plants do not consume the protein in ethanol production. Ethanol is produced from the starch of the corn kernel. The remaining protein, vitamins, minerals and fiber make up distillers grains which are sold as livestock feed.

Finally, it is of note that we actually have a corn surplus in the United States today and corn yields per acre continue to rise. American farmers produced 10% more corn than was consumed for all uses in 2007. Historically corn yields have doubled with every generation of farmer. With new planting practices and corn varieties, both benefiting from technological advances, the trend line on corn yields is increasing and an accelerated pace. It is projected that corn yields will double again by 2030.

2) One of the key roles of the federal government is to assist with research and development. What R&D programs have you found particularly helpful in developing and improving biofuels?

It is likely that the DOE grant funding for cellulosic ethanol will be viewed as key funding events when we look back from the future. They stimulated several potential cellulosic technologies at a key point and will probably illuminate which of the paths are most successful. In addition, research at NREL and Argonne resulted in development of foundational intellectual property and valuable tools used in the industry. The SunGrant Initiative, a partnership between the land grant universities and the DOE, recently began funding key research in all aspects in the

cellulosic supply chain. Future research should continue to focus on means to reduce capital costs, improve operating efficiencies, reduce carbon footprints, and improve sustainability of operations.

3) With forest fires raging in California and releasing enormous amounts of carbon into the atmosphere, would you support a policy that allows us to better manage forests by harvesting wood waste that could be used for biofuel production?

I know there are several companies working to commercialize technologies to convert wood chips into ethanol. I see no reason why responsible thinning techniques and removing wood waste from properly managed federal forests should be excluded from being an eligible feedstock in ethanol production.

4) The increasingly higher price of gasoline should serve as a market incentive for increased ethanol use. Why do you think the market is not working in that way?

While it took time for the market to respond, today we see significant growth in ethanol blending throughout much of the nation. This is the direct result of both the Renewable Fuels Standard (RFS) legislation as well as very attractive ethanol blend economics.

The high price of oil and gasoline has created a significant incentive for the market to blend ethanol. For example, in 2008 ethanol will be used for the first time throughout the Southeast United States. In the past six months, Florida, Georgia, North Carolina, South Carolina and virtually all other Southeastern states updated their fuel specifications to enable refiners to more easily blend ethanol. The Colonial pipeline, which services most of these markets, published a new specification this week requiring that all gasoline shipped through the pipeline be compatible for ethanol blending. Most importantly, ethanol is flowing into these markets, through existing distribution systems and to consumers… today.

Public policy is helping to pave the way for the market to function. Before passage of the expanded RFS in December, the ethanol industry was outpacing the existing schedule which mandated 5.4 billion gallons in 2008. Because of this, the RFS was not acting as a market driver and there was more uncertainty in the market. As a result, many refiners chose not to proactively expand ethanol use.

The recently enacted RFS mandates renewable fuel use of 9 billion gallons in 2008, 11.1 billion gallons in 2009, and 12.95 billion gallons in 2010. These early year increases provide certainty to the market and are already working with market forces to foster expanded ethanol blending. Additionally, the new RFS calls for use of 36 billion gallons of renewable fuels by 2022. This will require significant expansion in use beyond the current ten-percent blend market into E85 and other higher blends, increasing demand which is key to cellulosic ethanol's success.

5) On the issue of transporting biofuels, how is ethanol primarily shipped – via tanker or pipeline? And E85 requires dedicated tanks and pumps at the station, correct? Is a substantial investment in infrastructure necessary in order to make biofuels more viable throughout the country?

Ethanol Shipping
The majority of ethanol today is shipped by rail. VeraSun ships ethanol throughout the country by unit train which is essentially a "virtual pipeline" of 80 to 96 rail cars delivering the same product non-stop from origination to destination and back again. Unit trains allow us to decrease our delivery time to customers and are up to two times faster and more cost-effective than traditional rail shipping. Work is underway to expand and add terminal locations across the country that can receive unit train shipments.

E85
Gas stations do need to install E85-certified pumps and, depending upon the pump technology, allocate a dedicated E85 tank. However, infrastructure costs are not the most significant obstacle to increasing E85 availability. Based on our experience, the most critical thing needed to quickly build a robust E85 market in the United States is to improve the E85 economic incentive. Fuel retail owners must know that E85 will be priced appropriately and that there will be sufficient consumer demand to install E85 infrastructure. Today, Flexible Fuel Vehicles (FFVs) are not designed to take advantage of E85's high octane. Therefore, FFV drivers receive fewer miles per gallon running on E85 than on conventional gasoline. This directly affects consumers and requires that E85 be sold at a discount to gasoline for it to be competitive in the marketplace.

To address this economic disincentive to install E85 pumps, Congress should create a blenders credit for ethanol blended above 10% within the existing VEETC system. This credit would compensate for the discount resulting from the loss in miles per gallon efficiency. We believe that establishing this incentive will lead to higher blends like E85 and will help ensure that higher blends are priced properly at the pump for consumers and spur increased demand. This will help make a fuel retailers decision to offer higher blends of ethanol much easier and lead to much quicker expansion of ethanol use across the United States.

6) I applaud your investment in types of ethanol production other than corn. Can you tell us the most important differences or challenges in producing ethanol between corn and switchgrass, soybeans, wood chips and the like?

Corn is a very consistent feedstock and a very dense energy source (starch content) that is relatively easy to handle. The capital costs of building a corn ethanol plant are around $2 to $2.25 per gallon produced, the operating costs are relatively low and the co-product is an excellent high protein feed. All the valuable protein in the kernels is concentrated in the distiller's grains. With the projection by the corn seed companies that corn yields will increase to 300 bushels per acre we believe that corn based ethanol has the potential to produce more than 50 billion gallons of ethanol without increasing acres or taking away demand from feed, food and exports. Corn based ethanol will continue to make a great contribution to the U.S. fuel stream for many years.

Conversion of cellulosic material to ethanol has been proven in the laboratory. The challenge is to refine the process so that it can be done on a large-scale, commercial basis. The most significant challenge for commercialization of cellulosic technologies is the physical time necessary to convert cellulosic feedstocks into ethanol. Native grasses, wood chips and other

cellulosic feedstocks tend to be much less uniform in nature, require much more aggressive and expensive pretreatment steps, and result in lower yields per ton of biomass handled. They also require much higher capital costs; between $4 to $7 per nameplate gallon produced. No cellulosic technology today that we have investigated has matured to the point where capital and operating costs combined can compete with corn-based ethanol. Continued research and investments can bring these costs down.

7) Have you looked into how you might convert corn ethanol production plants to other biofuel plants if those biofuels become more promising as a future technology?

We believe that cellulosic ethanol technologies will be incorporated into existing corn ethanol facilities as the technology develops. For example, current ethanol facilities use the starch of the corn kernel to make ethanol. The remaining corn fiber, stover and cobs are largely waste materials now but show promise as a cellulosic feedstock. As cellulosic technology improves and provides comparable financial results to corn starch, we believe corn ethanol facilities will evolve to process agricultural wastes to expand ethanol production. Installing cellulosic ethanol technology along side of starch based production leverages existing infrastructure investments already in place such as experienced plant staff, rail loading, energy center, etc. This will reduce total capital cost to build new cellulosic production.

8) Why do you think that some refiners are hesitant to blend ethanol into their product even though there is a cost savings?

I do not want to speculate on this point, but it now appears they are moving forward with blending in most major markets. We are committed to working with our customers (refiners) to expand the amount of ethanol blended into conventional gasoline as well as develop higher blends like E85. Passage of the expanded RFS has helped us in this regard. Enactment of an E85 incentive within the VEETC system will also help refiners make the decision to move forward on blending sooner rather than later.

9) Ethanol is no longer a fledgling industry. Now that it is more established, what kinds of efficiency in production are coming on line that make ethanol cheaper and less resource intensive to produce?

First, we believe the corn ethanol production process is very efficient today, especially when compared to traditional refining of crude oil to gasoline on almost every metric.

Like oil refineries or many other manufacturing facilities, our biorefineries are becoming complex and efficient as they mature. VeraSun is in the process of adding oil extraction technology into our facilities which will allow us to produce both ethanol and crude oil for biodiesel production from the same corn kernel. Extracting the oil from distillers grain for biodiesel produces more energy for transportation fuels.

Another technology involves fractionating the kernel into its three components (germ, endosperm, bran). This enables an ethanol plant to produce food-grade oil while increasing the throughput of the current fixed assets.

Increasing corn yields will also result in greater efficiency of the industry. It is estimated that corn producers will double yields to 300 bushels per acre by 2030. Doubling yields will also reduce inputs on a per bushel basis. Maintaining the current trends in reducing the nitrogen applications per bushel produced is important. Seed companies are also working on varieties that use less nitrogen and are more drought tolerant, and therefore, more water efficient. Some strains being commercialized already contain the enzymes required to break down the sugars in the process.

Precision agriculture and minimum tillage techniques are allowing producers to apply the absolute minimum inputs required to grow the crops.

10) To be clear, do you support consumer tax credits for the purchase of E85 vehicle purchases? What other incentives do you think are needed for the auto industry to produce advanced Flexible Fuel Vehicles? Would you advocate incentives for auto-makers to produce flex-fuel cars or for consumers to purchase those vehicles?

Consumer tax credits could help drive purchase of Flexible Fuels Vehicles (FFVs), depending upon the amount of the credit. The question will be whether any incentive is significant enough to really move the needle.

To date, the most effective incentive for automakers to produce FFVs has been the CAFE credit program. We appreciate that Congress extended this credit in its current form through 2014 in the recent Energy Independence and Secuirty Act of 2007. We believe that it will continue to be an important tool for driving FFV production into the future. Given this, we think that Congress should revisit the decision to scale back the credit beginning in 2015 with a total phase-out in 2019. As more E85 enters the market, the utilization rate of E85 in FFVs will increase. When this occurs, there is no reason to limit the amount of the FFV credit if automakers calculate it using the actual utilization rate. The law should be amended to allow automakers to calculate their credit in this, uncapped manner if they choose.

11) Do you think that increasing the CAFÉ standard will help or hurt E85's potential development since current Flex Fuel vehicles get lower gas mileage when using E85?

We believe that the increase in CAFE standards including in the Energy Independence and Security Act of 2007 will not hurt E85's potential development given that the bill also extends the FFV Cafe Credit program in its current form until 2014. Automakers have said that this has been the most effective incentive in spurring the production of FFVs.

12) You support a modified Volumetric Ethanol Excise Tax Credit (VEETC). Can you explain that further?

VEETC fosters demand for ethanol. The 51-cent Blenders Tax Credit is an incentive to the petroleum industry to blend ethanol into their gasoline and has been an effective policy tool to

ensure that this occurs. There have been proposals in this Congress to reduce VEETC by five cents and use the savings to incent production of additional renewable fuels. If Congress eventually decides to reduce VEETC, we believe that some of these savings should be invested in programs that will ***spur ethanol demand beyond ten-percent blends***.

Retailers interested in promoting high blends of ethanol must provide a price differential to gasoline to help offset the fuel economy reduction for consumers. Currently, there is little incentive to purchase ethanol for E85 and sell it for 20% less than gasoline when it can be blend it into E10 and receive full gasoline pricing. This creates a system with little incentive to develop higher blends including E85.

The existing VEETC system can be improved to help promote demand for higher ethanol blends. An additional credit could be given to blenders who blend ethanol for use in blends higher than E10. The credit could be based on ethanol content of the fuel. For example, a blender who blends ethanol into E85 would receive an additional forty cents above the VEETC credit to offset the reduction in fuel economy from E85. Gasoline sold with ethanol content above E10 would receive a proportionate amount of additional BTU incentive.

Expanding the use of higher blends of ethanol will:

- Enhance America's energy security goals,
- Establish the framework needed to dramatically increase the amount of renewable fuels used in transportation fuel beyond the ten percent blends,
- Provide consumers with a fuel alternative, dampening dependence on gasoline and pricing volatility, and
- Support the economic development from biofuel production in American by growing demand.

BioEnergy
International, LLC

Answers to the Select Committee on Energy Independence and Global Warming

Stephen J. Gatto
BioEnergy International LLC

January 30, 2008

1) At all times, we should be mindful of the nations more vulnerable citizens who struggle with any fundamental resource that escalates in price. As exemplified by recent riots in Mexico over the rising cost of flour tortillas, are you at all concerned about rising food costs as more crops and farmland is dedicated to feedstock for fuels rather than food?

BioEnergy is sensitive to unintended consequences during the transitional period from first generation corn ethanol facilities to next generation advanced cellulosic biorefineries. As I testified, it is clear we need a pragmatic, phased program that pulls the industry toward next generation technologies based on non-food renewable feed stocks. There is growing industry consensus that 15 billion gallons per year of ethanol from corn is a sustainable target as we work toward accelerating commercialization of advanced biofuels to meet the newly enacted Renewable Fuels Standard (RFS).

With this in mind, the ethanol industry must take extra strides to minimize any impacts of food verses fuel, and we must all keep in mind that there is an even greater impact to the costs of food -- and to our economy, environment and overall quality of life -- from the costs of our reliance on petroleum for energy, transportation fuel and packaging. For every dollar spent on food, 81 cents goes to non-food related expenses—processing, packaging, transport, etc; all of which depend much more heavily on petroleum prices than grain prices.

In addition, the increased price of food is directly related to the increased price of energy, particularly oil. A 33% increase in oil prices (about $1.00 per gallon—the current situation), increases the consumer price index of food by up to .9%. Increased corn prices have a fraction of that impact. US corn exports to the top ten countries with the highest percentage of undernourished people equaled .01%, while Japan alone received 33% of US corn exports in 2005. The breakdown of US corn usage was: 50% animal feed; 19% exports; 18% ethanol; and 12% food (2006). Finally, even with increased demand from ethanol, US corn supply this year is expected to

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exceed demand by about 987 million bushels. Corn yields per acre are improving at a steady rate of about 2-3% per year. With little increase in the demand for corn from other sectors, USDA's 10-Year Baseline Outlook projects that increases in corn acreage and yield gains will outpace ethanol demand and allow corn prices to ease.

2) One of the key roles of the federal government is to assist with research and development. What R&D programs have you found particularly helpful in developing and improving biofuels?

I applaud the change in Congressional leadership last year for funding critical biofuels and technology R&D programs that have been authorized since 2005 but not funded. In addition, I recommend expanded R&D grants to private companies -- rather than public biofuels research centers or DOE labs -- to help companies traverse the "valley of death" in product development from R&D to incubation, pilot and demonstration to expedite commercialization and speed to market. I also commend expansion of the Department of Energy and US Department of Agriculture loan guarantee programs for large scale commercial projects above $100 million.

3) With forest fires raging in California and releasing enormous amounts of carbon into the atmosphere, would you support a policy that allows us to better manage forests by harvesting wood waste that could be used for biofuel production?

Absolutely. In fact, I would welcome the opportunity to help craft a sustainable program, much as I had the honor in crafting an innovative sustainable program in the Pacific Northwest and California with the Quincy Library Group. For cellulosic feed stocks, BioEnergy aspires to craft a national model in Pennsylvania working in partnership with Governor Edward Rendell as part of his PennSecured Fuels and Energy Independence initiatives.

4) The higher prices of gasoline should serve as a market incentive to use biofuels. Why do you think that is not occurring?

It is not occurring because Oil controls what goes into the pump and what goes out, regardless of price. This is why I applaud the enactment of the recently expanded Renewable Fuels Standard as critical to force the market to integrate biofuels into transportation fuels. In addition, I support incentives for infrastructure and distribution, as well as flex fuel cars.

5) On the issue of transporting biofuels, how are you primarily transporting your fuels – via tanker or pipeline? Like E85, the biofuels you make would require dedicated tanks and pumps at the station, correct? So are we going to have to

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make a substantial investment in infrastructure in order to make biofuels more viable throughout the country?

Currently, BioEnergy does not transport biofuels with our two ethanol plants still under development. Once our plants are operational, we expect to rely on partners to distribute our ethanol, and anticipate our distribution partners – such as Getty Petroleum in Pennsylvania -- to transport ethanol via rail, barge, and pipeline. We do support increased federal and state funding to help address any transitional issues and to build-out new infrastructure. I am confident the US can handle any distribution and infrastructure needs, particularly with Brazil providing a model of success for distributing and transporting ethanol.

6) In the past, waste-to-energy facilities have gotten a lot of criticism by the environmental community for emissions. What in your processes keeps emissions down and makes waste a viable feedstock for creating biofuels?

BioEnergy is building two gas-fired state of the art corn ethanol facilities that will be among the most efficient dry mill plants in the nation as the first leg of our 3 legged stool. These will be retrofitted with our IP through our program to commercialize cellulosic technologies. We are confident our novel IP will reduce greenhouse gas emissions by over 40%, will allow renewable biomass waste to be used as feedstock, and provide for improved energy efficiency with lignin to self-power future plants. This program is dubbed ***INDEPENDENCE -- Integrated National Demonstration Project to End Energy-dependence with Cellulosic Ethanol INDEPENDENCE*** – and is an integrated plan with dedicated resources and strategic partners:

- launch first-of-its-kind Research Center in Woburn, Massachusetts early 2008;
- work in partnership with the Commonwealth of Pennsylvania on a cellulosic pilot plant 2008 – 2010;
- integrate these two facilities with a Joint Venture in Brazil to advance sugar cane bagasse as a waste feedstock with an existing sugar mill owner and operator in Brazil to unleash unsurpassed advances in technology and processing for bagasse advanced systems. This cellulosic demo will have a capacity of 5-10 mgpy, will be bolted-on a Brazilian Sugar Mill, will target ethanol production, and will use technology- phase deployment (C-5 to C-6).

BioEnergy can achieve this plan by 2012 because of over ten years of unparalleled pilot plant success with bagasse and other cellulosic feed stocks, the assemblage of an industry renowned team, and innovative partnerships.

7) I think you are right that this is an evolving market, and like the Apollo program we are not going to go straight to the moon, rather we are going to make

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progress in stages. What do you think the appropriate timeframe and path are for moving from corn to switch grass to possibly solid waste?

I applaud the recent passage of an expanded RFS, and embrace the timeline of 2012 as an appropriate target for commercial-scale cellulosic ethanol biorefineries.

8) Have you looked into how you might convert corn ethanol production plants to other biofuel plants if those biofuels become more promising as a future technology?

Absolutely. In fact, BioEnergy's strategic plan is based on an integrated program to retrofit destination ethanol facilities sited near emerging markets and cellulosic feed stocks:

(1) the creation of a secure cash flow stream through conventional ethanol facilities – one in Pennsylvania and the other in Louisiana – that will not be stranded assets, but retrofit platforms very similar to the early oil refineries;

(2) the diversification of our product portfolio through the introduction of BioEnergy's novel biocatalysts for the manufacture of green chemicals and biopolymers allowing for enhanced efficiencies on the front end, and improved revenues on the back end;

(3) the optimization and commercialization of cellulose technology for retrofitting into existing and future plants to drive down costs and move away from food based raw materials.

9) Do you support tax credits as a way of supporting the market for biofuels?

Yes. Tax credits are strong incentives to support biofuels markets. I wholeheartedly support producer tax credits, as well as tax credits to build out E85 infrastructure and for consumers to purchase flex fuel cars. In 2006, the federal government spent just $2.5 billion on ethanol tax credits, and received over $9 billion in returns and savings (because of ethanol's positive effect on corn prices, federal payments to farmers are projected to fall by about $6 billion – or nearly 75% - between 2006 and 2007). Moreover, the Renewable Energy Action Project has calculated that Oil companies pay an effective corporate income tax of 11%, compared to a non-oil industry average of 18%; the oil industry will receive about 86% of the total $16.1 billion of federal tax breaks offered to the energy industry (2005 to 2009). In addition, in 2006, ethanol industry operations and construction added a total of $5 billion to state and federal tax revenues. Ethanol production also contributed $41.1 billion to US GDP.

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SunEthanol

Answers to questions from Members of the Select Committee on Energy Independence and Global Warming

Susan Leschine

Professor, University of Massachusetts, Amherst
Founder and Chief Scientist, SunEthanol

1) *At all times, we should be mindful of the nations more vulnerable citizens who struggle with any fundamental resource that escalates in price. As exemplified by recent riots in Mexico over the rising cost of flour tortillas, are you at all concerned about rising food costs as more crops and farmland is dedicated to feedstock for fuels rather than food?*

The use of food crops for fuels demands watchful oversight. Rising food costs are always a concern, especially for people with limited resources. I believe that providing sufficient food at affordable prices for all our citizens and meeting our export commitments are the primary obligations of U.S. agriculture.

I also feel that we have an obligation to view the bigger picture of food price increases. For every dollar spent on food, 81 cents goes to non-food expenses such as processing, packaging, and transport, all of which depend much more heavily on petroleum prices than grain prices. The increased price of food is directly related to the increased price of energy, primarily oil. An increase in oil prices significantly increases the consumer price index of food. Increased grain prices have had only a fraction of the impact of oil on food prices. Biofuels have not significantly impacted the price of food. Oil industry executives are reaping excessive profits, not farmers.

A false assumption, often voiced by news media, is that demand for corn for biofuels production has caused a shortfall in world food supplies. However, in 2007, when

corn ethanol production increased dramatically, corn exports increased 14% over 2006 levels to 2.45 billion bushels. In addition, the export of distillers' grains and solubles (DGS, a protein-rich animal feed and byproduct of corn ethanol production) has increased over the past ten years from 0.6 to 3 million metric tons.

For the long-term, to avoid conflicts between food and fuel, we must look to non-food sources of biomass for biofuel production, for example, through the development and deployment of cellulosic ethanol technologies.

2) *One of the key roles of the federal government is to assist with research and development. What R&D programs have you found particularly helpful in developing and improving biofuels?*

A serious commitment of the federal government to assist with the research and development of biofuels will be essential if we are to succeed in stabilizing carbon dioxide emissions. This will be an enormous task. The magnitude of the technological innovation required is only now being recognized. (For example, see *A Shift in the Debate Over Global Warming* by Andrew C. Revkin, New York Times, April 6, 2008.)

The most helpful programs I have found have been basic research programs in the Department of Energy's Office of Science. The Energy Biosciences Program provided modest support for the research of my lab for several years until recently when the Program focus changed as part of a reorganization and reemphasis to large projects such as the Bioenergy Research Centers. It is too early to judge the value of this reinvestment. However, as can be seen from the DOE map pinpointing these projects (attached), large sections of the country have been mostly excluded, including the Northeast.

Successful development and deployment of advanced energy technologies such as cellulosic biofuels in a reasonable timeframe will require significant resources reaching all parts of our country for workforce development and basic research. If we are to be serious about combating global warming, we need to get serious about funding technological development. The DOE's fiscal year 2009 budget, requesting

slightly less funding for renewable energy R&D, while seeking an increase of 34% for fossil energy, flies in the face of reason as we approach perhaps the greatest challenge to civilization ever: stabilizing our climate.

3) *With forest fires raging in California and releasing enormous amounts of carbon into the atmosphere, would you support a policy that allows us to better manage forests by harvesting wood waste that could be used for biofuel production?*

Yes, where appropriate and with proper recognition of sensitive areas. Harvesting wood waste could provide significant biomass for biofuels production. (Perlack, et. al. 2005. *Biomass as Feedstock for Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply*, prepared for the US DOE and USDA by Oak Ridge National Laboratory)

4) *Is there any environmental impact of harvesting microbes from the forest soil in which you found them? Or can they be developed in the lab on a scale that does not require much from nature?*

Originally, the Q Microbe was isolated from a very small sample of soil (less than a gram) collected from forest soil near Massachusetts' Quabbin Reservoir. Now we can grow the Q microbe in the lab in a nutrient broth or "culture medium." We use inexpensive waste products, such as paper pulp sludge, in the culture medium as sources of nutrients for the microbe. As we scale-up the cellulosic ethanol process we will construct "seed fermentors" to grow enough of the Q microbe to inoculate large fermentors where ethanol will be produced from cellulosic biomass, such as corn stover or switchgrass.

5) *Other than the ethanol produced is there any waste by-product of these microbes?*

From the point of view of the microbe, ethanol is a waste product. Besides ethanol, the microbe produces small amounts of lactic acid and acetic acid (vinegar). We are devising methods to reduce these byproducts. Once the fermentation process is complete and the ethanol has been removed, there remains a high-protein residue that could be used as animal feed or fertilizer.

6) *At this stage, do you have any idea what kind of costs you would be looking at to produce ethanol in this way?*

SunEthanol projects a cost of $1.54 per gallon ethanol produced using the Q consolidated bioprocessing system. This assumes a cost of $0.65 per gallon for the feedstock and the remainder for labor, energy, chemicals, and depreciation.

7) *How long do you believe it will be before microbes can produce a commercially viable amount of ethanol? How long will it take to make a significant contribution to our nation's transportation fuel inventory?*

The Renewable Fuels Standard amended by the Energy Independence and Security Act of 2007 calls for 100 million gallons of cellulosic biofuel by 2010, and 16 billion gallons by 2022. These are lofty goals and will require significant technology innovation to achieve. SunEthanol aims to have a pilot plant in operation by 2010, and will expand to full-scale commercial production to contribute significantly to our nation's fuel inventory by 2015.

Respectfully submitted,

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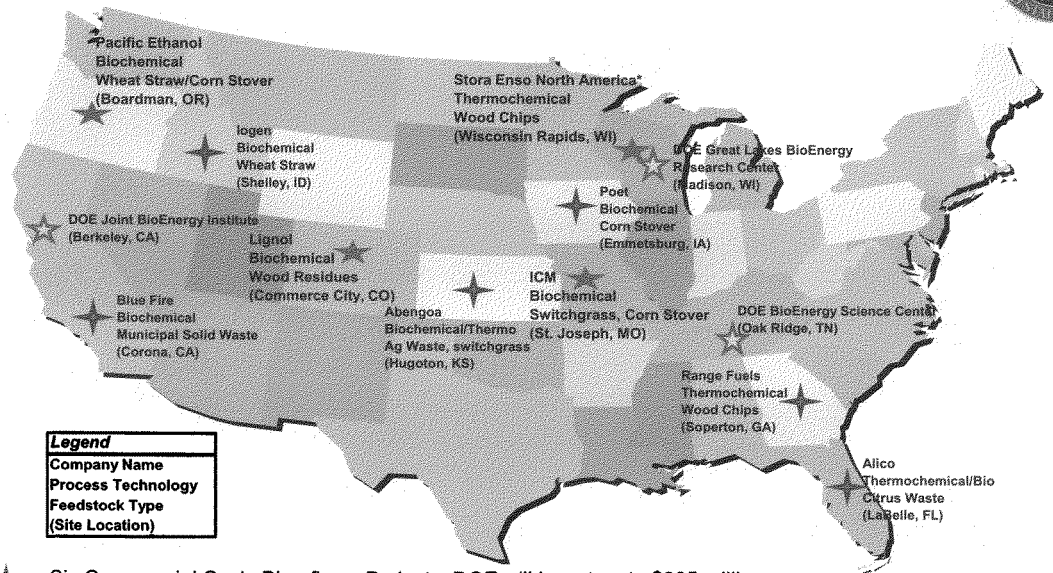
April 7, 2008

Major DOE Biofuels Project Locations

Geographic, feedstock and technology diversity



- Six Commercial-Scale Biorefinery Projects; DOE will invest up to $385 million
- Four Small-Scale Biorefinery Projects; DOE will invest up to $114 million (first round)
- Three Bio-Energy Centers; DOE will invest up to $405 million

** Acquired by NewPage Corporation*

Nathanael Greene
Senior Policy Analyst
Natural Resources Defense Council

1) At all times, we should be mindful of the nations more vulnerable citizens who struggle with any fundamental resource that escalates in price. As exemplified by recent riots in Mexico over the rising cost of flour tortillas, are you at all concerned about rising food costs as more crops and farmland is dedicated to feedstock for fuels rather than food?

I certainly believe that as one of the wealthiest societies on earth, we have a moral obligation to try to help ensure that everyone has access to a sufficient and nutritious diet. I do not believe, however, that recent increases in food prices were primarily or even significantly caused by increasing demand for food crops to produce biofuels. High energy prices combined with distortive domestic and international agricultural policies are much more likely suspects. (The often referred to "Mexican tortilla riots" are good evidence of this. Press reports suggest that it was actually a relatively peaceful protest over food prices cause by Mexico shift from monopoly protection of white corn producers to more market oriented pricing. Did US demand for corn play a role? Maybe, but it is clear that Mexican agricultural policy was the larger driver.)

Nevertheless, it is critical to closely monitor the competition for arable land between food, feed, and fuel crops both near-term and long-term for two reasons. First, it is certainly possible for this competition to combine with agricultural, biofuels, and trade policies to cause local or even regional food shortages and high food prices. This potential will grow if we do not find more and better ways to integrate biomass production into food and feed production and also increasingly move our biomass production onto degraded and fallow land.

Second, the competition for arable land is also important because shifting arable land from food and feed to fuel puts increased pressure for the conversion of natural ecosystems to active agricultural production. Natural ecosystems are generally rich in biodiversity and above and below ground carbon, and conversion will generally lead to the loss of both the biodiversity and the carbon. The carbon that would be released from many landscapes is equal to many years worth of avoided petroleum combustion. Thus if fuel feedstock production displaces food and feed and thus indirectly causes conversion of these ecosystems, the greenhouse gas benefits of the biofuels produced would be largely or entirely negated.

Both the food vs fuel concern and the global warming pollution concern point to the importance preserving the definition and standards for lifecycle greenhouse gas emissions reductions that are in the historic energy bill signed by the President this week. If rigorously implemented drawing on the best

science, these will do more than any other provision to encourage the most efficient use of land for the biofuels produced to meet the renewable fuel standard.

2) One of the key roles of the federal government is to assist with research and development. What R&D programs have you found particularly helpful in developing and improving biofuels?

I don't have firsthand experience with any government R&D programs, but believe that the Biomass Research and Development Act as amended in the 2005 Energy Policy Act provides the best overall structured approach to biofuels R&D. The Biomass R&D Act required DOE and USDA to work together and target R&D through merit based RFPs to four different areas of R&D at three different levels. The areas targeted are crops, conversion, co-products, and environmental analysis and the levels of R&D targeted are demonstrations, applied innovations, and fundamental science.

While the DOE has significantly increased its funding of biofuels R&D, the vast majority of this funding is not going through the Biomass R&D Act structure, which seems like a lost opportunity to ensure breadth and balance.

3) With forest fires raging in California and releasing enormous amounts of carbon into the atmosphere, would you support a policy that allows us to better manage forests by harvesting wood waste that could be used for biofuel production?

Forest fires are a natural part of the carbon cycle and harvesting wood from our public lands to make biofuels is not good climate policy. There is little to no empirical evidence documenting the efficacy of thinning at reducing the extent or severity of fire, thus its effectiveness at addressing community fire risk is speculative at best. In contrast, ample evidence exists on how best to protect homes and communities from forest fires--whatever the cause. These proven methods, known as "firewise", involve clearing flammable material from the immediate radius of the home and making sure important safety measures are followed, like installing fireproof roofing. For more information on "firewise" and the importance of increased federal investment in community fire protection, please see NRDC's recent report "Safe at Home: Making the Federal Fire Safety Budget Work for Communities" (http://www.nrdc.org/land/forests/safe/contents.asp), which presents findings of a pilot study documenting a CA community's fire preparedness level and provides specific recommendations. Moreover, while limited thinning in the immediate vicinity of homes and businesses can help reduce fire

risk, from a fuels production perspective forest thinnings this will never produce enough biomass to produce any significant amount of biofuels. Existing programs that use this material for heat and power schools and other public spaces presents a much more efficient use of this woody material.

4) Do you believe that ethanol reduces greenhouse gas emissions?

Whether ethanol reduces or increases greenhouse gas emissions relative to gasoline depends entirely on how it is produced. Different production pathways in use today from cropping practice through refining practice almost certainly do both—some reducing and some increasing—and future pathways have the same potential. That is why it's so important that we stop treating all gallons of biofuels as if they are the same and start targeting our incentives and mandates to those gallons that produce the most benefits.

5) It sounds to me like you think that biofuels create more problems than they are worth. In a fiscally constrained environment, do you think there are better R&D uses for investment – for example carbon capture and storage – instead of creating fuels that might otherwise put a stress on the environment?

Biofuels are quite possibly the most complicated renewable source of energy to "get right" from a broad sustainability perspective, but they are also almost certainly needed to meet the levels of greenhouse gas reductions needed to avoid catastrophic climate change. Biofuels are almost certainly needed and needed in annual quantities at least ten times greater than we're using them today. We will also almost certainly need carbon capture and storage. In the end, we simply cannot afford to not be investing in both of these technologies.

6) On page 8 of your written statement you say, "Current federal biofuels policies, from the RFS to the various tax credits, simply reward volume and are based on the assumption that more is better. Moving forward, it is critical that these policies mature to a "better is better" approach and start to reward good performance." By requiring an increased RFS in the energy bill currently under consideration, do you agree that we are still leaning toward a "more is better" approach?

The historic energy policy act signed by the President this week takes the first significant step towards "better is better" biofuels policy by requiring a level of performance from all biofuels that are used the meet the renewable fuel standard. The lifecycle greenhouse gas reduction standards in the act are the first

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GHG standards signed into law ever and for the first time require biofuels to provide clear climate benefits. This is not enough, however. The RFS is still a volume requirement and while it established minimum standards, we need a policy that encourages the best performance. Ultimately, we need a low-carbon fuel standard. This approach requires a level of performance (a reduction in the average GHG intensity of transportation fuel sold) and thus provides the greatest reward those gallons that provide the most benefits.

7) The Boston based Clean Air Task Force has asserted in a recent report that Europe's 2003 biofuels directive lead to unexpected increases in GHG emissions, tropical deforestation and biodiversity loss. What is your response to that assessment?

Increased greenhouse gas emissions and an increased rate of biodiversity loss are certainly a possible outcome of biofuels done wrong. As I mentioned in my response to the first question, if crops for biofuels compete for arable land, they contribute directly and indirectly to the economic pressure to convert natural ecosystems to managed agriculture. Tropical rainforest are among the most biologically and carbon rich lands in the world, and they are under intense pressure from agriculture. Fortunately, there are ways to integrate biomass production into food and feed production and ways to grow biomass on degraded and fallow lands that may actually increase carbon sequestration on these lands. The key is the policy drivers.

The energy act recently signed includes a definition of lifecycle greenhouse gas emissions that includes land-use changes, standards that require all biofuels to provide various levels of GHG reductions, and safeguards for various sensitive lands. If carefully implemented, these provisions should minimize the economic pressures for land-conversion caused by the RFS and create a market for feedstocks produced on degraded and fallows lands and cultivated with carbon-smart practices.

8) On page 12 of your testimony, you say "So while it's much harder to know where things stand, we know that a lot of investor dollars are being bet on near-term commercialization. The research is being driven by venture capitalists and private investors." That being said – why does the federal government really need to get involved in the market other than ensuring that environmental standards are met?

No. Much of the private sector investment has been induced by the existing and expected market for biofuels, which the state and federal government is critical in creating. There is simply too much capitol inertia in the petroleum fuel market to expect it to adopt low-carbon fuels at a rate sufficient to avoid catastrophic climate change.