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GRAINS, CANE, AND AUTOMOBILES: TAX INCENTIVES FOR ALTERNATIVE FUELS AND VEHICLES

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GRAINS, CANE, AND AUTOMOBILES: TAX INCENTIVES FOR ALTERNATIVE FUELS AND VEHICLES

THURSDAY, APRIL 19, 2007

U.S. SENATE,
COMMITTEE ON FINANCE,
Washington, DC.

The hearing was convened, pursuant to notice, at 10:07 a.m., in room SD–215, Dirksen Senate Office Building, Hon. Max Baucus (chairman of the committee) presiding.

Present: Senators Bingaman, Kerry, Lincoln, Stabenow, Cantwell, Salazar, Snowe, Thomas, and Smith.

OPENING STATEMENT OF HON. MAX BAUCUS, A U.S. SENATOR FROM MONTANA, CHAIRMAN, COMMITTEE ON FINANCE

The CHAIRMAN. The committee will come to order.

George Bissell had a hunch. He thought that what they called "rock oil" seeping from the western Pennsylvania earth could light lamps. He also thought it could make him rich. George Bissell was right.

The price of whale oil, then the major source of interior lighting for homes, was at an all-time high. Bissell was looking for an alternative means of lighting American homes and businesses. Coal-based kerosene was expensive and camphene made from turpentine tended to explode.

So Bissell commissioned chemist Benjamin Sillman to determine whether rock oil might work as a mass-produced illuminant. Bissell learned that his alternative energy source would work, and today we call it petroleum. When, in 1859, his Pennsylvania rock oil company struck oil near Titusville, PA, the modern oil industry was born.

America dominated the oil industry early on with the likes of John D. Rockefeller and Standard Oil leading the way. Production rose from a few thousand barrels a year in 1860 to 60 million barrels a year by 1900. America was the world's leading rock oil producer.

Times have changed. The world now uses 1,000 barrels of oil a second. America is the world's largest oil consumer. Where we once led the world in production, America now imports two out of three barrels of oil, often from unstable places.

From the perspectives of climate, cost, and security, our dependence on foreign oil is costing us dearly. We need a new rock oil and we need it now.

The United States Energy Information Administration said this week that drivers paid, on average, $2.88 for a gallon of regular gasoline last week. Over the last 11 weeks, the national average price of gas has surged more than 71 cents, or 33 percent. This rise in prices hits especially hard in rural America, where distances are longer and public transport is scarce or non-existent.

On the environment, we hear a consistent drum beat of bad news. In Montana, I have already experienced anecdotal evidence of climate change. We are losing glaciers that draw people to the crown jewel of our national park system, and we are experiencing forest fires that are more numerous and more severe. Yesterday, we learned from an inter-governmental panel on climate change the analysis on warming's impact on North America. That warning is that things stand to get far worse.

Climate change spells trouble for our way of life. The report says that there is a 90-percent chance that current trends will cause decreased soil pack, more winter flooding, and reduced summer flows, exacerbating competition for over-allocated water resources. Everything from timber, to skiing, to fishing will be affected.

We also learned this week that climate change stands to have a major and negative effect on national security. According to a report from a group of distinguished retired generals, climate change stands to spur massive migration, increased border tensions, and conflicts over essential resources like food and water. The report from the Center for Naval Analysis says that projected climate change "poses a serious threat to America's national security."

So we have our work cut out for us. The stakes are high, and this committee will play a key role in tackling the problems that we read about and see with our own eyes every day, and that includes finding a cleaner, greener means of powering our vehicles.

Fifteen years ago, this committee passed incentives for clean energy as part of the Energy Policy Act of 1992. That bill included a goal that alternative fuels replace at least 10 percent of petroleum-based fuel by the year 2000, and 30 percent of petroleum-based fuel by 2010. Today, biofuels account for only about 3 percent of transport fuel costs, and there is no way that we will get to 30 percent in the next 3 years.

The 1992 law also included sections to promote the use of alternative vehicles, including a tax credit for the purchase of qualified electric vehicles. But the use of alternative vehicles, while growing, has not caught on in a significant way.

Americans bought about a quarter of a million hybrid cars last year. That is a little more than 1 percent of the 17 million vehicles sold in America in 2006. We can do better on both fronts, and we have some distinguished individuals here to help us show the way.

The 2005 energy bill included some important steps in the right direction. We passed billions of tax incentives to develop and prompt the widespread use of technologies aimed at reducing our dependence on foreign oil. We passed tax credits for the purchase of hybrid and other alternatively powered vehicles. We passed incentives for the installation of alternative fuel stations, and we passed a mandate to nearly double the use of ethanol by 2012. This is progress. Every little bit helps.

But we need to do more than little bits. I realize we cannot fix this problem overnight, but part of the solution must include finding new ways to power our cars and trucks. It may be a new rock oil, maybe finding ways to make better use of the rock oil we have, and it may be a bit of both. What is clear is that we need rock-solid action, and I thank our witnesses for joining us today to provide that guidance to that end.

I would now like to turn to the witnesses. Our witnesses today are, first, James Woolsey. Mr. Woolsey is a member of the National Commission on Energy Policy. Mr. Woolsey's distinguished public service career includes stints in both Democratic and Republican administrations, including CIA Director from 1993 to 1995. He also happens to be a former classmate of mine, which I am very proud of. Mr. Woolsey will provide perspective on energy as an issue of national security.

Then we will hear from Vinod Khosla, a veteran in the venture capital world and a co-founder of Sun Microsystems. Mr. Khosla is a leading alternative energy advocate and, since 2004, has headed up Khosla Ventures, based in Menlo Park, CA. He also went to college with Mr. Woolsey and I, although just several years later.

Next, we have Dr. Farrington. Dr. Robert Farrington is the manager and principal researcher at the National Renewable Energy Lab in Colorado. He will provide perspective on alternative vehicles, including battery technology.

After Dr. Farrington, I am also pleased to welcome Jay Debertin, executive vice president and chief operating officer for processing and renewables at CHS, a producer-owned cooperative with a major stake in biofuels. Mr. Debertin, thank you for coming. Thank you for being here.

Senator STABENOW. Mr. Chairman, if I could beg your indulgence, I would love to introduce Dr. Dale.

The CHAIRMAN. Absolutely. I am sorry I missed that. Thank you.

Senator STABENOW. That is all right. And brag about somebody who did not go to school with you, but is, in fact, someone from Michigan State University where I went to school. Mr. Chairman, I am so pleased that you invited Dr. Bruce Dale, who is professor of chemical engineering at Michigan State, and associate director for the Bio-Based Technologies Office at the university.

I think, most importantly, he has been involved in cellulosic biofuel production for more than 30 years, and is one of a handful of acknowledged leaders in the area, one of five people who was asked to come and brief the President on this subject.

He has invented a number of breakthrough treatments and pretreatments. I will not explain them; I do not understand them. But I know Dr. Dale will explain them to us. But I think what is most important is that he is at the cutting edge of this technology and has important work that he is doing, and we are very, very pleased that you are with us today to share that.

The CHAIRMAN. Thank you, Dr. Dale.

Senator THOMAS. Mr. Chairman, do you have anybody from the University of Wyoming, where I went to school? [Laughter.]

The CHAIRMAN. We can sure look for one. That would be fine.

Senator THOMAS. That is another hearing.

The CHAIRMAN. That is right. That is right. That is the next hearing.

All right. Mr. Woolsey, you are first.

STATEMENT OF R. JAMES WOOLSEY, MEMBER, NATIONAL COMMISSION ON ENERGY POLICY, WASHINGTON, DC

Mr. WOOLSEY. Thank you, Mr. Chairman, members of the committee. It is an honor to be asked to be here today. I have been asked to represent the views of the National Energy Policy Commission, of which I am a member. Of course, I am also representing my own views, and one would have to parse those, but they are quite similar.

Because we depend on oil for 97 percent of our transportation needs and oil provides over 40 percent of the world's global-warming gas emissions, we have a set of problems associated with oil use.

The problem is not that we use oil at all. The problem is that it is a strategic commodity, somewhat the way salt actually was until a century or so ago. It may be hard to realize now, but wars were fought over salt. National strategies were designed around salt because it was the only way, effectively, of preserving meat, which is a huge share of the human food supply.

The invention of refrigeration changed that. We use salt today, but it is just a commodity. Sometimes we use it to preserve meat. We use it for its historic use, as well as other uses, but no country dominates world politics any more because they have salt mines.

We should hope for, and work toward, as soon as possible, a similar demise of the strategic role of oil. Not the demise of oil itself, but oil as something we depend on, very much the way the Chairman's remarks related to whale oil in the past.

There are a number of reasons, and they are on pages 2 to 4 of my prepared testimony, why oil dependence—because two-thirds of the world's proven reserves are from the Persian Gulf area—is a serious national security problem for us.

They have to do with the potential disruption by terrorist attacks; with succession crises, potentially, in Saudi Arabia; with the fanaticism of the Iranian government leaders today; with six Sunni Arab states now starting their own nuclear programs in order to match that of Iran's; and our borrowing over $300 billion a year, nearly a billion dollars every calendar day, in order to import oil.

The economy of the United States has been weakened by the dollar's being so dependent on countries holding the debt that we generate, to the tune of a billion dollars, nearly, a day. If we are weakened, think what a developing country that is heavily in debt because of its oil imports has to face.

Finally, we are funding, indirectly, the teaching of the Wahhabi School of Islam around the world. It is, if you read the fatwas of its imams, absolutely murderous with respect to Shiite Muslims, Jews, homosexuals and apostates, and horribly repressive of everyone else, including, particularly, women.

So, since that ideology is for all practical purposes the same as the ideology of al Qaeda—al Qaeda and the Wahhabi just disagree about who should be in charge, sort of the way the Stalinists and Trotskyites did, not about their underlying values—because we are

funding the dissemination over the entire world of that ideology, this is the only war the U.S. has ever really fought in which we pay for both sides. This is not a good strategy.

As Tom Friedman of the *New York Times* has put it, "The price of oil and the path of freedom run in opposite directions." This has some demonstrable reasons we could get into if the committee wants, but I think it is easy to look at what Mr. Ahmadinejad, Mr. Chavez, and Mr. Putin are doing right now and understand what leverage oil and energy can provide.

The Russians are planning, by the way, a pipeline underneath the Bering Straits, we just learned, so that they may help do to the United States what they are doing to western Europe with respect to energy dependence.

Oil provides only 2 percent of the electricity that we generate, and only about 6 or 7 percent worldwide. So, steps to replace different ways of producing electricity have very little to do with the oil transportation debate.

Whether you are a fan of wind farms or nuclear power plants, you could have one on virtually every hillside and today it would not matter with respect to oil dependence. Oil only provides, as I said, about 2 percent of our electricity.

There are a number of approaches toward replacing oil and oil-based fuels for transportation that can reduce our carbon emissions substantially. The cellulosic—and all renewable, really—feed stocks for renewable diesel, for cellulosic ethanol, butanol, and so on are one of those.

Another way, interestingly enough, is to move toward plug-in hybrid gasoline electric vehicles. Because, in the studies that are cited in my testimony, as we move a vehicle, let us say, from having an internal combustion engine to having a plug-in hybrid with, say, 20 to 30 miles all-electric range, on even today's grid, which is 51 percent coal, on a national average we improve our global-warming gas emissions, reduce global-warming gas emissions, by several tens of percents; the exact numbers are still somewhat in doubt. In a clean grid area such as California and the West Coast, we reduce global-warming gas emissions by 80 to 90 percent.

You do not need new power plants to power plug-in hybrids. Since they use off-peak overnight power, according to Pacific Northwest Laboratory's studies, you could have 85 percent of the cars in the country be plug-in hybrids before you would need to build a single new power plant for that purpose.

If one looks at moving toward renewable liquid fuels and toward electricity as a portfolio approach, some of these things may work out better than we hoped, some worse than we hoped, but, if we stop the idea of single solutions, I think we will make a big step in the right direction.

The first time we tried a single solution was with the Synfuels Corporation. That was extremely expensive. After the Saudis dropped the bottom out of the oil market in 1985, it went bankrupt in 1986, like night follows day.

The next time was a few years ago when the Federal Government and State governments such as California and others got very enthusiastic about hydrogen fuel cells for family vehicles.

The reasons are in my testimony, having to do with the cost—the huge cost—of infrastructure, as well as other failings, but I think I would have to say that the Federal Government's record in picking a single winner, whether it was the Synfuels Corporation or hydrogen fuel cells for the family car, has been absolutely dismal. What we really need to do, I believe, is focus on a portfolio of approaches.

Finally, Mr. Chairman, let me just say that you have not asked me to address domestic politics, and it is far from my expertise. I seem to have a much better understanding of dictators in other countries than I do the workings of our own political system.

But I find it interesting that since, in the area of oil, there are many additional benefits to moving away from oil as a way of moving away from a substance that produces 41 percent of the world's global-warming gas emissions, we have a different situation than we do with coal and moving away from coal for electricity generation.

Moving away from coal for electricity generation is important, and Vinod Khosla and others have some very good ideas about how to do that. But that move essentially, except for improving our global-warming gas emissions, is all cost. The question is, how much are we willing to pay for, say, being able to sequester carbon effectively or to move to a different type of generation system?

But oil has a number of reasons why one would want to move away from it, in addition to reducing global-warming gas emissions.

So one can be, as I put it, in favor of moving away from oil because of national security reasons, because of wanting to improve the health of our rural economy, because of wanting to improve the stability of developing countries, and on and on. Any one of these reasons, as far as I am concerned, suffices. One does not need to get into, in a sense, the vigorous back-and-forth about global-warming gas emissions in order to want to move away from oil.

I call the coalition that is beginning to build on moving away from oil—and I mean no disrespect since I personally see merit in all of these arguments—a coalition of the tree huggers, the do-gooders, the sod-busters, the mom-and-pop car owners, the cheap hawks, the venture capitalists, the utility shareholders, the evangelicals, and Willie Nelson. [Laughter.]

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you. Thank you, Mr. Woolsey. That was very entertaining, helpful, and constructive testimony.

[The prepared statement of Mr. Woolsey appears in the appendix.]

The CHAIRMAN. Mr. Khosla?

STATEMENT OF VINOD KHOSLA, FOUNDER, KHOSLA VENTURES, MENLO PARK, CA

Mr. KHOSLA. Thank you, Mr. Chairman and honorable members of the committee. There is a climate crisis, there is a security crisis, and an impending oil crisis. A crisis is a terrible thing to waste, because it is a unique opportunity.

The country that first finds the solution to these crises will be one of the leading economic powers of the 21st century. This is an

unprecedented economic opportunity with many beneficial side effects. However, there are many forces opposing this change. Each $4 change in the price of oil is worth $1 trillion to Saudi Arabia, a fraction of the population of California.

Our own Renewable Fuels Association, in my opinion, is not sufficiently supportive of E85 and cellulosic ethanol because of its closeness to the oil industry. In my *Wall Street Journal* editorial in January of this year, I called on President Bush to declare a war on oil. I believe this is a winnable war and a politically feasible war.

For those of you who do not believe this kind of unprecedented change is possible, I have personally seen it happen in the computer business, with people like Control Data and Burroughs disappearing; in the media business, where in 10 years Google is worth more than the 10 major media companies combined; and in the pharmaceutical business which ignored biotechnology.

And in the telecommunications business, 10 years ago major experts at AT&T laughed at me. Today, AT&T is being sold for a song. In each area, yesterday's "unthinkable facts" are today's conventional wisdom. Voice calls are free, long-distance.

This is leadership we must show the world. More importantly, many Googles and Yahoos will be created and, with the right policies, they can be all American companies. This is the unprecedented opportunity before us.

Biofuels are the most important new economic phenomenon in rural America and the most important new energy development in decades. It could shift much of the oil portion of our GDP to rural GDP and create millions of new jobs.

Entrepreneurs made these changes possible. At Khosla Ventures, we are investing in these entrepreneurs and scientists and in many different technologies. Tens of companies are popping up. We must empower these entrepreneurs and signal to them that we are serious about winning the war on oil.

Some of the optimists in the start-up world will surely be wrong, but when dozens of efforts all fail, could so many companies and investors, each with difference sources of technology, all be wrong?

My own analysis shows that 39 billion gallons of biofuels production is possible within 10 years on 19 million acres of land, and 139 billion gallons by 2027 is possible on as little as 49 million acres. The details are in the appendix to my testimony.

One of the benefits of the switch to biomass-based liquid fuels is the positive effect this will have on world poverty. I cannot imagine anything as beneficial to Africa, rural India, or Latin America as a switch to biomass-based fuels and, in fact, it will result in a more distributed and diverse geopolitical balance on energy.

So what must we do? Very specifically, we should set a very high Renewable Fuels Standard (RFS) with an automatic relief valve, as the President has proposed, so all new technology developers have an incentive to invest in R&D, knowing that, if they can produce the products, a large market exists.

If we do not achieve our RFS goals, the relief valve mechanism automatically protects consumers against too high an RFS and increases funding for advanced biofuels. So, it will be self-funding.

With the high RFS, consumers will be protected through this relief valve, as will be livestock producers who have been in contention with some of the corn ethanol producers.

My proposals will also allow us to pay as we go in today's constrained budget environment if the proceeds of the identification number purchases that the President has proposed—and I have included in the appendix—are put into a pool to allow for incentives for cellulosic and advanced biofuels.

What else? We must create a producer's credit only for cellulosic and for all advanced biofuels, independent of the Volumetric Ethanol Excise Tax Credit (VEETC) which expires, today, in 2010. There is much resistance among certain circles to this touchy topic of tariffs.

I understand where we stand politically, but for the record I must say, removing tariffs in the right way is good for America's farmers. Today we buy the cheapest Saudi Arabian oil in the world and we have tariffs on greener, cheaper ethanol that must compete with it.

But, if we set a separate RFS for E85 and protect American corn ethanol producers by having a 15 billion gallon RFS for the blend market, we will protect producers and accelerate the adoption of a market for E85 that is 1,000-percent larger than the blend market. Today we have the tail of the blend market wagging the dog of the E85 market. This is not good for America's producers.

To get long-term energy security and diversity, we need to create a fleet of cars. We should mandate that 50 percent of all cars be Flexible Fuel Vehicles (FFVs) by 2012, and 70 percent by 2015. Even as a fully funded mandate, it is only a few hundred million dollars in its peak year.

We should mandate that all pumps dispensing more than 2 million gallons of fuel a year have at least one E85 pump by 2009. Even fully funding this mandate is a fraction of a billion dollars.

We must encourage research in biomass feedstocks, tomorrow's energy crops. We must encourage E85 in other ways. One idea is to tax-exempt it from a Federal tariff of higher fuel taxes.

Moving on to the touchy topic of coal to liquids, I personally prefer not to have coal to liquids. But if we must, we must have a carbon sequestration fee of about 50 cents per gallon. Let me make it clear. If coal to liquids is treated equally to cellulosic biomass, it will permanently and forever kill cellulosic biomass.

We will be converting our biomass-based projects to coal feedstocks, which we have already tested in our current processes, because coal will be a cheaper feedstock. There will be no reason for biomass and coal to liquids will hurt America's farmers.

A few other ideas to limit the cost of the current programs in this pay-as-you-go environment. VEETC should be capped at the total capital cost invested in a plant. That can only happen if VEETC is a producer's credit. Today, VEETC is a very inefficient use of funds.

Legislation should also make accounting rules uniform between the oil industry and the fuel industry. A change in one clause, the excess of percentage over cost accorded to the oil industry, could completely fund the cellulosic incentives I am proposing, just a change in that clause.

Subsidies can also be reduced by making them variable. I have talked about this much. It reduces subsidies while providing additional insurance for farmers and corn ethanol producers because it reduces their risk in case prices are low, which is when they need the most help.

So, finally, in conclusion, I must humbly submit a mark-up of Senator Bingaman's bill which he recently introduced as an appendix to this testimony. With it, we move towards energy security and greenhouse gas mitigation and faster rural economic development while being revenue-positive, while protecting America's corn ethanol producers and protecting consumers from higher ethanol prices, and protecting livestock producers from high corn prices. We can achieve all this without any more Federal spending.

Thank you, sir.

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

[The prepared statement of Mr. Khosla appears in the appendix.]

The CHAIRMAN. Dr. Farrington?

STATEMENT OF ROBERT FARRINGTON, Ph.D., PRINCIPAL ENGINEER AND MANAGER, ADVANCED VEHICLE SYSTEMS GROUP, NATIONAL RENEWABLE ENERGY LABORATORY, GOLDEN, CO

Dr. FARRINGTON. Mr. Chairman, thank you for this opportunity to discuss the next generation of alternative fuels and vehicles.

I am Rob Farrington, the manager and principal researcher of the Advanced Vehicle Systems Group at the National Renewable Energy Laboratory in Golden, CO, the United States Department of Energy's primary laboratory for research and development of renewable energy and energy efficiency technologies. I am honored to be here and to speak with you today.

The committee is to be commended for its interest in finding alternatives to, and reducing our Nation's dependence on, imported oil. NREL is dedicated to helping our Nation develop a full portfolio of renewable energy technologies that can meet our energy needs.

As we have experts here on ethanol, I will limit my comments to vehicle issues, of which more detail is provided in my written testimony. My testimony today will focus on opportunities for reducing imported oil used for ground transportation.

The range of viable options falls into several broad categories: first of all, lowering miles traveled in personal vehicles, such as through mass transit, carpooling, biking and walking; second, using alternative fuels such as biofuels, as well as clean diesel, and increasing the fuel economy of vehicles through improvements in conventional vehicles, such as cylinder deactivation, 6-speed transmissions, advanced combustion techniques, reducing auxiliary loads, such as air conditioning, reducing vehicle mass, aerodynamic drag, and tire resistance; and finally through advanced power trains, such as hybrid electric vehicles, plug-in hybrid electric vehicles, fuel cell vehicles, and electric vehicles.

It would take more than 15 years to replace all the vehicles in our light-duty fleet of 225 million vehicles with new technology if all new vehicles sold today had that technology. The impact of any new technology will take significant time to evolve. Therefore, our

first priority should be to institute desired changes quickly and deliberately so that benefits can begin to accrue.

There is much discussion today on hybrid electric vehicles that can be plugged into an electric outlet and driven on electricity alone—sometimes called plug-in hybrids, or PHEVs. The fact that we are discussing PHEVs means several things.

First, that HEVs are an accepted technology, thanks in great measure to the sustained Congressional funding of the Hybrid Electric Vehicle Program starting in the early 1990s. About 1.5 percent of vehicles sold last year were hybrid electric vehicles.

The approximately 750,000 HEVs on the road have saved a total of 5 million gallons of gasoline, and that continues to grow every year. While putting HEVs on the road sounds simple, this in itself is a series of amazing engineering accomplishments, in that we have blended together two different power trains, including solving the complex problem of packaging them in a vehicle.

We have developed techniques for capturing their tremendous amount of energy in a moving vehicle that is lost to braking. We have learned how to operate the air conditioning system without using the engine, and we have learned to use the electric motor and the batteries to assist in accelerating the vehicle so that we can down-size the engine, saving both fuel and weight.

HEV technology can apply to nearly all personal vehicles and many types of commercial vehicles. A challenge with HEVs is that consumers generally look more at purchase price than life-cycle costs.

Beyond HEVs are plug-in hybrid electric vehicles. These are HEVs with the ability to drive on electricity alone, and then afterwards operate as a traditional hybrid electric vehicle after the electric range is reached.

PHEVs offer not only substantial oil use reduction, but also improved air quality. PHEVs can have lower fuel costs than HEVs, with projected electric fuel costs at one-third to one-half of that of gasoline per mile.

Most of the technology required for PHEVs has been developed and, in fact, could use regular 110-volt outlets to charge them. However, there are research issues that remain for plug-in hybrid electric vehicles.

The most significant requirement is technology breakthroughs required to reduce costs, coming primarily from the battery storage system, and to a lesser degree from the larger electric motor, power electronics, and the associated cooling systems.

Research must resolve issues such as high rates of charging and discharging of the batteries causing them to reach high temperatures, which reduce battery life. The impact of combining deep cycles during the all-electric mode and shallow cycles during the hybrid electric mode is unknown.

We also lack a U.S. supply chain to provide batteries and power electronics to plug-in hybrids, as we do for hybrid electric vehicles. About one-third of people put their vehicles in a garage overnight, which means that other types of charging arrangements will need to be developed.

Electric utilities see plug-in hybrids as a means of providing electric grid voltage stabilization and load leveling, high-value propo-

sitions to them. Additionally, plug-in hybrids can provide emergency power to homes, businesses, et cetera.

In conclusion, hybrid electric vehicles and plug-in hybrid electric vehicles each have distinct benefits. While all people could use hybrid electric vehicles immediately, plug-in hybrid electric vehicles might appeal primarily to those with existing 110-volt outlets. If all light-duty vehicles were hybrid electric vehicles, we might save 30 percent of our gasoline use.

If all light-duty vehicles were plug-in hybrid electric vehicles, we might save 60 percent. Additionally, plug-in hybrid electric vehicles would use domestically produced fuel for electricity, producing a further benefit to our economy, but plug-in hybrid electric vehicles will cost more than hybrids to purchase.

Hybrid electric vehicle technology is a success today. Plug-in hybrid electric vehicle technology still has some unknowns, particularly with respect to battery cost, performance, and life. I believe that we all have a sense of urgency given our current situation.

The U.S. Department of Energy is actively engaged with the automotive and trucking industry through its FreedomCAR and Fuel Partnership and the 21st Century Truck Partnership to develop fuel-saving technologies. While there is no silver bullet, we must act quickly on a variety of fronts to make the greatest reduction in imported oil as quickly as we can.

In closing, I would like to thank Chairman Baucus and the members of the Senate for your attention and interest in addressing our transportation situation.

The CHAIRMAN. Thank you, Dr. Farrington.

[The prepared statement of Dr. Farrington appears in the appendix.]

The CHAIRMAN. Dr. Dale?

STATEMENT OF BRUCE DALE, Ph.D., PROFESSOR OF CHEMICAL ENGINEERING, MICHIGAN STATE UNIVERSITY, EAST LANSING, MI

Dr. DALE. Thank you, Chairman Baucus, for the invitation to testify here today.

The age of petroleum is ending. Even if we could afford to pay a billion dollars a day indefinitely to import oil, we cannot afford the danger our petroleum addiction poses to our economic, environmental, and national security.

We have very few petroleum alternatives that can simultaneously provide geopolitical, environmental, and economic benefits. Biofuels are one of this very small handful.

I have spent over 30 years thinking about and working to develop biofuels, particularly cellulosic ethanol. From that background, I will briefly summarize the status of biofuels, where we are today, what we can expect in the next 5 years or so, and the long-term contribution biofuels can make to our liquid fuel needs. I am going to include also some comments on the role that farmers can, and should, play in our biofuels future.

Biofuels today means ethanol and biodiesel. Ethanol comes from sugar, whether that sugar is derived from cane sugar, as in Brazil, or starch from corn grain, as in the United States. We produce our

biodiesel from soil oil. Because of price and volume considerations, biodiesel from soil oil will never be more than a niche fuel.

Corn ethanol will grow rapidly until it reaches a limit of perhaps 18 billion gallons per year, roughly 10 percent of our gasoline consumption. This is important, but it does not fundamentally change our dependence on petroleum.

To end our petroleum addiction, we must reduce ethanol and other biofuels from cellulosic materials. Cellulosic materials are inexpensive, abundant residues, including crop, forest, and urban waste, as well as crops and woody plants grown specifically for their energy content.

We could produce cellulosic ethanol today using well-established technology for about $2.50 per gallon. Unfortunately, that is just not good enough yet to compete with petroleum.

But I have some good news. Over the past 30 years, I saw a relatively small, but determined—you might actually call us stubborn—group of people who worked to develop improved technologies for cellulosic ethanol. I am proud to be one of that group.

Recently, the Department of Energy announced financial incentives for a truly historic project, establishing six large demonstration plants for cellulosic ethanol using some of these advanced or new technologies.

One of Mr. Khosla's companies is testing a seventh approach, with financial assistance from the State of New York, so we are doing seven experiments in parallel on large-scale cellulosic ethanol production. I know many of these technologies in detail. In fact, one of my inventions will be tested at a cellulosic ethanol plant in Iowa.

In 5 years or less, we will have good evidence that some of these technologies can produce cellulosic ethanol for around $1.20 a gallon. When that happens, the next step will be to establish full-scale commercial plants based on the most successful new technologies. Because these technologies are new, there will inevitably be bugs in the system that can only be worked out in the context of large-scale plants.

Also, some cost improvements will only occur when suppliers have big markets, for example, for the enzymes that convert cellulose to sugars. So, there will still be large business risks. Congress should consider providing tax credits or other incentives for the first full-scale large commercial plants. That approach could be limited to perhaps the first billion gallons of cellulosic ethanol to reward the early adopters.

Cellulosic ethanol will happen, but such incentives can reduce our dependence on foreign oil much more quickly. When these large commercial plants become fully functional and the risks are sufficiently reduced, cellulosic ethanol will take off. The industry will grow very rapidly, limited mostly by our ability to gather enough of the cellulosic raw material in one spot.

So what can we expect in the longer term? I testified before Senator Lugar's Committee on Agriculture in 2001. I will repeat now what I said then. In the longer term, we can replace all of our petroleum imports, every bit of it, with cellulosic ethanol produced domestically at much less than $1 a gallon.

Then let us talk about biofuels and farmers. As ethanol production technology improves, the cost of processing will become less and less important, while the delivered cost of the cellulosic biomass will become more important. In other words, the farm sector grows in relative importance. Herein lies both danger and a great opportunity.

The danger is that if our farmers simply supply raw materials to others who process those raw materials, they will probably not do very well. We need research, policy, technology, supply chains, and business models that help farmers do two things: one, establish low-cost cellulosic biomass; and two, participate financially in the processing, thereby capturing some of the added value. Our research, energy, agricultural, environmental, and tax policies need to be properly coordinated to achieve this. That is a tall order.

But regarding tax policy, which falls under your jurisdiction, I believe we need incentives to encourage the collection of cellulosic materials, for planting and development of relevant crops, and the development of the first commercial-scale cellulosic plants. These steps will maximize our country's ability to produce cellulosic fuels.

If we do so, we can realistically expect a new era for our country, an era in which our petroleum addiction is beaten, in which we are much more secure geopolitically and environmentally, and where prosperity is returned to our rural communities. That is a future worth thinking about and worth achieving.

Thank you, Mr. Chairman. I look forward to questions.

The CHAIRMAN. You bet, Dr. Dale. Thank you very much.

[The prepared statement of Dr. Dale appears in the appendix.]

The CHAIRMAN. Mr. Debertin?

STATEMENT OF JAY DEBERTIN, EXECUTIVE VICE PRESIDENT AND CHIEF OPERATING OFFICER FOR PROCESSING AND RENEWABLES, CHS INC., INVER GROVE HEIGHTS, MN

Mr. DEBERTIN. Thank you, Mr. Chairman. I would echo your opening comments around the transformation from whale oil to fossil fuels that occurred earlier in the century. In fact, the last time the words "alternative fuels" were used, it applied to gasoline and diesel fuel because they were the alternative fuels for whale oil.

My name is Jay Debertin. I am with CHS. We are kind of a unique animal here. We are actually owned by farmers. We are an agricultural company, yet we are a petroleum refiner. We have investments in two refineries, one in Montana, one in Kansas, and we have invested in the biofuels industry as well.

We have platforms inside the company on energy, on grains, where we buy, sell, and handle grains across the world. We process soybeans into soybean oil. Those oils are sold into the vegetable oil markets, and we sell some of those oils into the biofuels market.

Our third platform is in our renewable fuels area, where we have been blending ethanol and biodiesel into the fuels we sell for the last 30 years. In these past few years we have actually invested in the production of ethanol as well, in a company called U.S. Bioenergy.

While my primary purpose here today is to present our positions on specific policy matters related to biofuels, I would also share just a couple of comments around our overall energy debate be-

cause, to echo the comments made earlier, for those who think there is a single solution and a single answer to the country's energy needs, I think that is a dangerous spot to be in.

But let me begin with the issues related to three specific biofuels: ethanol, biodiesel, and biomass. First, on ethanol, the tax incentives for ethanol and the renewable fuel standards mandate are what really launched the renewable fuels market, particularly in ethanol production. We believe that the current tax incentives for ethanol blending and production in E85 pumps are adequate.

However, we have concerns about the distribution and the infrastructure systems for ethanol and the relative positioning of ethanol supply. Unless incentives are provided to encourage distribution from Midwest ethanol producers out to the coastal States and to more States in the United States which have the demand base and the population, we would not be surprised to see a Midwest glut of domestic ethanol, with negative consequences for the fledgling industry.

In our view, the most important steps that can be taken are measures that would expand overall national demand. A requirement that all gasoline sold nationwide contain, say, a 10-percent blend would extend the demand from its current Midwestern base to the Nation's population centers on both coasts.

In addition to a 10-percent national requirement, we would also support giving States the opportunity to use up to, say, 20 percent ethanol blend if they chose to.

Second, on biodiesel, CHS would urge caution in passing a specific biodiesel mandate. We believe the supply issues arising from shifting vegetable oil production from food to energy must be better understood. With these issues in mind, we believe the current biodiesel tax incentives are also adequate.

We are also exploring renewable diesel, a topic that has been in the press of recent weeks. Our petroleum refineries are studying adding bio-based feedstocks, specifically soybean oil, into our diesel manufacturing processes.

That would mean adding soy oil before diesel is produced rather than blending in soy oil after diesel fuel is made. The Energy Policy Act of 2005 extended the $1 per gallon agriculture biodiesel tax credit to this new diesel, and the Treasury Department just issued guidance permitting its use by all petroleum refiners.

But I would also say that this new technology could be very costly to implement. We do not, at this time, think the refiner industry would adopt it en masse.

Finally, on biomass, although the viability of biomass as a feedstock in motor fuels remains uncertain, there is lots of work going on on that front, as has been explained by others here at this table.

We have looked at other biomass applications as well. For example, we are looking at co-generation opportunities at our oilseed crushing facilities in Minnesota using corn stover and other bio sources.

We would like to pursue this further, but we have found that there is really little incentive to do so and that current biomass supply is a bit unrealiable for our manufacturing facilities. But we do think that time and investment are needed to achieve marketable technologies for biomass.

I have shared with you our positions on the specific tax-related issues this committee has under consideration. I would be remiss, though, if I failed to share some of our thoughts on the bigger picture.

The real question, it seems to us, is what is the best total approach for addressing the Nation's long-term energy needs, as well as critical questions around global warming and the economic health of America. And, maybe closer to home, how can Congress advance renewable fuels as part of this solution to the country's energy needs?

On the first issue, we think at CHS that we need to advocate a broad and realistic approach to our Nation's energy future. Unlike single-minded approaches for fossil fuels or just renewable fuels, we do not see a single pathway, more of a four-lane approach, each lane representing one component of the solution, but all headed in the same direction.

A real solution will take investment in existing fossil fuels energy supply. It will also take adoption of renewable fuels. It will take investment in emerging energy technologies and conservation, sometimes overlooked but vitally important to the energy solutions for the country.

In the long term, we think that this multifaceted approach will be the solution that really solves the country's energy problems going forward.

On a second question of how Congress can advance the renewable fuels component of this total energy solution, we suggest the following.

First, support and extend the current ethanol and biodiesel tax incentives which appear to be working well and revisit those for other biofuels.

Second, as I said earlier, if there is a desire to increase the use of biofuels, we would increase our chances of success with a minimal national standard for gasoline, such as E10, where almost every gallon has a renewable element rather than establishing just another multi-billion gallon mandate. This will lead to a stronger renewable fuels industry that supports the goal of a diversification away from fossil fuels.

Third is to increase promotion of a national renewables infrastructure, which makes certain that renewable fuels are used where the highest demand exists, and finally to focus on incentives that try new means of advancing the cause of biofuels and biomass.

Thank you, Mr. Chairman. I will look forward to your questions.

[The prepared statement of Mr. Debertin appears in the appendix.]

The CHAIRMAN. You bet. Thank you all very much. Very helpful.

I guess I will first start with you, Mr. Khosla. I am trying to get an overall bigger picture view of all this so we do not have all of these discrete parts which just do not add up to a good total. Sometimes the whole is greater than the sum of the parts, but sometimes you want the parts to all fit together here.

So with respect to the renewable fuels standard that the President has suggested—what was it, 35 billion by the year 2017—in your judgment, is that a good overall goal for us to work toward?

And part of that then, I want you, Mr. Khosla, to explain your thoughts about the effect of crude prices rising and falling during the interim. I think you have suggested maybe a variable of some kind.

Then after that, Mr. Woolsey made a very good case for plug-ins, and others have too, and should there be some kind of a subsidy for plug-ins? I guess, sort of another basic question is, are we creating artificial constraints on entrepreneurial ways to develop new energy? There are certain subsidies, credits in some cases and not in others.

That is a lot of questions. I am just trying to get an overall sense of the President's renewable fuels standard. Would you modify that in any way? Also, the effect of the variable price of crude and how to handle that.

I am guessing that some entrepreneurs are a little nervous and worry that crude might fall to a lower level, and it makes their investment a little shaky. I will ask Mr. Woolsey later about plug-ins, perhaps what kind of subsidy, if any, should there be to encourage more plug-ins.

Mr. KHOSLA. So let me try to address some of those questions. The 35 billion gallon standard the President has proposed, I believe, is achievable by 2017. The danger of setting too high a standard goes away if a relief valve is put in place.

The relief valve the President has proposed is an automatic dollar-a-gallon penalty for not meeting your quota through the use of a mechanism called identification numbers, which are defined in Appendix A. That is a very good mechanism because it protects consumers against price spikes, which is the only danger of too high an RFS. There is no other danger.

It protects producers who might over-produce or produce more fuel than we think is possible today. I clearly believe that we can produce far more cellulosic ethanol within the next 5 years than anybody is planning. To give you a sense, one of our companies—

The CHAIRMAN. Driven by that high standard?

Mr. KHOSLA. Driven by that high standard. My view is, one of our companies is planning to get close to 5 billion gallons by themselves in the 2015 time frame, if there is feedstock availability. That is the only constraint. So the President's goal is achievable. I believe in the short run it would help to have imported ethanol.

In the long-term, I do not believe that will happen. To prevent price manipulation by the Saudis, as happened, I believe, as documented by the Cambridge Energy Research Associates, in the early 1980s, I have suggested that the right mechanism for VEETC is to make it a variable credit.

It goes up when producers need it most, which is when oil prices are low and, hence, ethanol prices are low, and it goes down when they do not need it, when oil prices are high like they are.

My estimates are that that will substantially reduce the amount of the VEETC subsidy's cost to the Federal Government while providing much more insurance to corn ethanol producers.

The CHAIRMAN. Now, which credit are you talking about?

Mr. KHOSLA. This is the VEETC credit that is currently part of the Energy Act of 2005. So the variable credit provides free insurance to farmers in times of low prices, and corn ethanol producers,

and it reduces the amount of Federal subsidies. I believe both of those are very good things, and it sends a signal to the Saudis that price manipulation is futile.

So the 35 billion gallon goal is achievable. A variable subsidy would provide an insurance program for this industry and reduce the cost of subsidies, increasing economics.

Finally, to your question of subsidies for plug-ins. I am a huge fan of plug-ins, but a plug-in in the next 10 years is likely to cost at least $10,000 more per plug-in. That would be an under-estimate, I would guess. That times, say, 50 percent of our vehicles, 8 million vehicles a year—we sell about 17 million vehicles a year—is a humongous amount of money.

So, I personally am a huge fan of the Federal Government supporting strategies that, within a few years—and I have publicly said within 5 years—need no subsidies.

The CHAIRMAN. All right. My time is about expired. It has expired, but I will ask Mr. Woolsey. Plug-ins. Should there be some kind of incentive for plugs-ins, do you think?

Mr. WOOLSEY. The Commission recommends, Mr. Chairman—and it is on page 15 of my formal testimony—a 5- to 10-year tax incentive program for manufacturers and consumers to encourage plug-ins, hybrids, and advanced diesels.

I think that the point is that, for plug-ins today, battery costs are in the range of $500 to $600 per kilowatt hour, and a relatively few kilowatt hour battery, say 5, 6 kilowatt hours, can give one double digits in driving capacity on an overnight charge.

What that would mean is, let us say the early plug-ins are 15 miles on an overnight charge. That is, in much of the country, 25, 30, 35 cents that one would be driving on for that distance. So I think there is a substantial incentive. You are down in the ballpark of 1, 2, 3 cents a mile compared to gasoline costs now, which are several times that.

Now, I think there is a substantial consumer incentive to having a plug-in, even if it only gets you, say, 10 or 15 miles. If one wants a plug-in that goes 40 miles on a charge, it will be several more kilowatt hours and several more thousand dollars' worth of battery.

But these things will come down with volume production of batteries. I think there is an important feature here, which is that plug-ins can affect the flexibility of the Saudis and the willingness of the Saudis to drive down the price of oil, as Vinod was talking about.

I do not think the Saudis or OPEC are likely to take a look at cellulosic fuels that are being produced, let us say in a few years, for the equivalent of $30, $40 a barrel oil and say, all right, we are going to drive the price down by turning on our reserve capacity to $20 a barrel so we can bankrupt cellulosic ethanol.

I do not think they are going to do that because they cannot drive oil prices down enough to compete successfully against 4-, 5-, 6-cent a kilowatt hour off-peak overnight electricity. Unless they can succeed, I do not think they are going to get started.

So although I like Vinod's notion of a variable subsidy for the liquid fuels, I think plug-in hybrids help protect liquid fuels, alternative fuels, as well as being quite attractive to consumers.

The CHAIRMAN. Thank you. My time has expired.

Senator Bingaman?

Senator BINGAMAN. Thank you very much for having the hearing, Mr. Chairman. I think this is very useful testimony.

One sort of big picture concern that I wanted to get people's thoughts on, and maybe start with you, Mr. Khosla, we currently have a renewable fuel standard and we are talking about substantially dramatically increasing it.

We have credits in place for production of various of these fuels. We have credits for end use of some of these fuels. We have credits and loan guarantees for companies that want to establish operations to produce the fuels.

At some point it seems there ought to be some reality check on how many pairs of suspenders and belts we want to put into this. Which of these things are the most important and which can we phase out or do without at some stage and still achieve the potential that is in here in biofuels?

Mr. KHOSLA. In my testimony I focused a lot on pay as you go. I do not believe, in the end, very many subsidies at all are required. Incentives always help, but if a high enough RFS is established, we will not need any other incentives in the long term.

Certain technologies, new technologies, will need to get started, as I said before, I believe only for 5 to 7 years, maximum. I do not believe any technology should be subsidized for more than 7 years after the start, because otherwise you have these belts and suspenders everywhere.

So a high RFS is the single thing we need because that—and I believe the administration believes that too—will keep the prices high so all fuels, all competitive fuels, can compete in the marketplace.

Having said that, certain things like cellulosic ethanol plants—and it is only the first five; it is not forever—need to establish that the technology works before Wall Street funds them.

The bulk of the dollars for any scalable solution has to come not from government, but from Wall Street. So, government can reduce that risk by building demonstration plants. Other than that, I do not believe subsidies are required.

Will incentives on hybrids help? Yes. But is that going to be a big enough scale in the next 10, 15 years? Very unlikely. I say that, having made investments in batteries for hybrids, which we are a big fan of. So minimum subsidies, I am a big fan of that. High standards of what we have to achieve, we will achieve through the price mechanism.

Senator BINGAMAN. Let me ask about this credit, feedstock. I think you are advocating a feedstock-neutral fuel credit, also an end-use neutral credit. I mean, your suggestion is that we should not be making different credits for different types of fuel or different types of feedstocks going into the fuel. What would we base the credit on, a Btu basis, or a gallon basis? What is your thought there?

Mr. KHOSLA. I am suggesting that, on a Btu basis, all renewable feedstock-based fuels should be treated equally on a Btu basis.

Senator BINGAMAN. So whatever credit we provide, it should be made available on the basis of the number of Btus per gallon for whatever feedstock is being used?

Mr. KHOSLA. Yes. Right. As long as it is a renewable feedstock.

Senator BINGAMAN. Right. Right.

Let me ask, Dr. Farrington, I notice in your comments you talk about hybrid electric vehicles and plug-in hybrid electric vehicles, but you do not talk about electric-powered vehicles.

We have a company that has announced plans to build a plant in our State to produce electric vehicles, and they believe that the technology is there to allow that to happen, to allow vehicles to travel at least 250 miles on one charge.

What is your thought about the potential for electric vehicles? I saw this movie about, "Who Killed the Electric Car?" It seemed to make a fairly persuasive case that there is something to be pursued there which we, unfortunately, have chosen not to pursue.

Dr. FARRINGTON. I think there is a great potential for electric vehicles. I think in the long run, that is probably the solution. As we are looking at plug-in hybrid electric vehicles, it really is an electric vehicle with an additional engine. As batteries drop in cost and gain in reliability, people begin saying, you know, I have not used this engine for 3 or 4 months or so. Why am I paying the additional cost for the weight of this engine? Perhaps I will get larger batteries.

Some of the current limitations really are recharging time. There are techniques available. Some of the lithium ion batteries are very similar to a pad of paper. We can actually pull them out and replace them very easily with charged batteries.

Once that type of infrastructure is available, I think some of the recharge issues will go away. Some of the recharge times that you hear about, 5 to 10 minutes to get substantial recharge, are very high-current rates. They create a lot of heat. That is a temperature problem, which reduces battery life. But I think electric vehicles have a potential. I am just not sure we are there today for that.

Senator BINGAMAN. My time is up, Mr. Chairman. Thank you very much.

The CHAIRMAN. Thank you.

Senator Stabenow?

Senator STABENOW. Thank you, Mr. Chairman, very much. An excellent panel. Thank you to each of you, and thank you, Mr. Chairman, for your leadership on this.

To Dr. Dale, you have spent a lot of time in the last 30 years focusing on various issues relating to cellulosic ethanol. Is biomass going to really become a reality? Tell us, in your view, how that is going to happen.

Dr. DALE. Yes, it is going to become a reality. The underlying fundamental reason is, the plant material is less expensive—a lot less expensive—than oil on an equal energy basis. So now that the feedstock in terms of—it costs less per Btu for a ton of straw, or grass, or woody material than it does for a Btu of oil. A lot less.

So what we have to do is figure out ways of converting that Btu, that energy content of the plant material into something that substitutes for petroleum. That is the kind of thing that we are talking about here around the table.

I worked for 30 years when oil costs were such that it was hopeless to do that. The oil costs were low enough so that you could not even afford to pay for the plant material. Now you can. Now you

have three or four times the leverage that you did before. I am fully convinced that we will do this. We are exploring a variety of approaches, and I think at least some of them are going to work.

Senator STABENOW. In your testimony you talk a lot about tax credits. We have certainly focused on that in the Energy Act of 2005, and so on. You talk about commercial plants.

But for this committee that focuses on tax policy, what do you think should be the tax priorities overall for us in being able to move a biomass agenda? I mean, are we talking about fuel producers, retailers, auto purchasers? Where do you see the major focus in order to move this?

Dr. DALE. Initially, to help overcome the risk of the first few of these very large plants, some type of an incentive ought to be put in, perhaps up to the first billion gallons of cellulosic ethanol produced, then they should go away. Because either we reduce the risk far enough so, as Mr. Khosla says, Wall Street takes over, or we do not and we should get out of that particular area.

I think also—and this is something that perhaps needs more attention than people have given it—again, as I said in my testimony, I believe that we are going to get the processing costs down for these fuels in such a way that the cost of processing will become low. So what happens is, the cost of the raw material, the agricultural or the woody material, becomes the dominant cost.

We have to position ourselves to think, for that time when that happens, about how we help incentivize the farmers, the collectors, the processors, the initial stage of this. In the initial part, I do not think the collection of it is going to be a big deal, but later on it is going to become a very big deal, very important, so we need to be thinking about that.

Senator STABENOW. Thank you.

Dr. Farrington, you talked in your discussion about plug-ins and batteries, and I could not agree more—in fact, with the whole panel—that we need to have a wide variety of alternatives and put good American ingenuity to work in a variety of different ways.

But right now we are creating the science, the chemistry, then we see other countries that are taking that and putting major investments into development, for instance, of advanced battery technology, the lithium ion battery, which I know is so critical for a number of the vehicles that the auto industry is looking at right now.

In your testimony you talked about the lack of a U.S. supply chain. Now, one of my concerns is that we have the science and that it is being taken by somebody else, and the battery technology ends up not being manufactured here, which is critically important for us in terms of jobs, as well as really developing this industry.

Japan has made a major commitment, China has made a major 5-year commitment. South Korea has made a 5-year commitment to focus on development. Who gets there first will have a major effect on what happens to jobs and the industry here. So I wondered if you might just speak a little bit more about that.

Dr. FARRINGTON. Gladly. That is a critical issue. In my perspective, we would be foolish to be trading our situation of imported oil for imported batteries and power electrics. That is the current situation we are in. Ford Motor Company has already said that they

were limited in production of hybrid electric vehicles because of batteries from Japan. That is a bad situation to be in.

Senator Bingaman and Senator Domenici have already submitted, I guess, a proposal, an act to fund substantially development of advanced manufacturing and research centers, working with industry. There must be a collaboration.

If you look at Japan, Toyota has partnered with Panasonic batteries to develop lithium ion batteries. Nissan has partnered with NEC batteries to develop batteries. The auto companies are working hand-in-hand with battery companies.

If we look at motivations here, we do not want to have programs where we develop batteries in isolation from the vehicles or vehicles in isolation from the batteries. They must be done in partnership with the intent of manufacturing here.

Senator STABENOW. Thank you very much.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you very much.

Senator Thomas?

Senator THOMAS. Thank you.

Thank you, gentlemen, for your testimony. Mr. Woolsey, could you expand on your views on the stability of clean coal-fired electric generation and the electric plug-in for hybrids?

Mr. WOOLSEY. Yes, Senator. I think that we are capable now of producing, with integrated gassification combined cycle coal plants, a system whereby carbon dioxide can readily be captured.

The problem is the cost of sequestering it. One can perhaps use it. It is being used now in abandoned or old oil and gas wells where one wants tertiary recovery, but there is only a limited amount of capability to do that.

To store it for the long term, one is probably going to have to put the carbon dioxide down a mile or two underground in deep saline, deep salt water aquifers, which are around much of the world.

At those depths, carbon dioxide is liquid and it dissolves in the salt water. And although most people who have looked at it believe that would be a very secure long-term way to sequester carbon, it is still not certain. There are still experiments being done on it. The cost is unclear.

If we can sequester carbon from coal-fired generation in that sort of fashion, and it will be a few years before we know for sure, then I think coal could have a very substantial long-term role in this country and other countries for electricity generation.

I would not suggest gassified coal via the Fischer-Tropsch process for producing diesel fuel, because, even if one sequesters the carbon in that process as much as one can, one ends up with coal only being about as bad as oil in terms of generating global-warming gas emissions.

So I think with sequestration from electricity generation and using electricity generation in part from coal, which is cheap, for plug-in hybrids, as well as our other electricity needs, there is real promise, but the jury is still out.

Senator THOMAS. All right. Thank you.

Mr. Khosla, I represent a State that is often referred to as the Saudi Arabia of coal. If coal-to-liquids is more efficient and in de-

mand in the market, why should we ignore the abundance of fossil fuels in favor of biofuels?

Mr. KHOSLA. Sir, in the testimony I submitted I suggested that coal-to-liquids would be a possibility if a 50-cent-a-gallon cost was added to coal to account for the carbon emission damage and potential sequestration costs of that carbon dioxide.

So what I would submit is that this is not only just an energy crisis, but a climate crisis, and we should be doing everything to meet our energy security needs, but not make the climate situation worse.

Senator THOMAS. I understand. The fact that we are faced with, of course, is the demand. Some of these things we are talking about are quite a ways down the road, and we are going to have a demand that we need to fulfill in the meantime.

Dr. Farrington, what is the period of time that is going to be necessary before the type that you talk about can be produced to meet demands?

Dr. FARRINGTON. In terms of plug-in hybrids?

Senator Thomas. Yes.

Dr. FARRINGTON. We currently have plug-in hybrid demonstration vehicles available. We take a hybrid, we add a battery pack and it acts as a plug-in hybrid. The technology is there. The hard part was going from conventional to hybrid.

Technically speaking, going from a hybrid to plug-in is very simple. It really will depend upon the cost of the energy storage system, and that really is the only barrier. There are a number of initiatives to try to bring down that cost and improve manufacturing, improve lifetime. So, it is difficult to predict at this point, but I would imagine at least another 2 years or so before those costs come down substantially.

Senator THOMAS. Yes. Well, some of these things are going to take much longer than that. I think that is really the issue we have to talk about, that some of these things are going to be fine 15 years from now, but in the meantime we need to use those things that we have.

I guess I am pretty prejudiced to where we can make clean coal available, whether it is electricity or fluids, particularly electricity. So I think we need to make sure that we understand what the demands are and that some of these things are a little ways away.

Very quickly, Dr. Dale, you mentioned the production of cellulose was eventually at $1 a gallon. That sounds great when we are faced with $3. However, the efficiency versus how many miles per gallon is an issue. How many miles per gallon do you expect out of cellulosic ethanol?

Dr. DALE. My friends at GM and Ford tell me that when we have enough ethanol in the fuel mixture—and they estimate about 15 to 20 billion gallons total—they will start designing vehicles to take advantage of ethanol's higher octane. Ethanol has a much, much higher octane than gas. It is about 110 octane. That means that you can burn the ethanol at a higher pressure, therefore you can get more efficiency.

It is not just how much energy the fuel has, but how efficiently you can get the energy out. They expect equal mileage. A gallon of

ethanol will give you the same mileage as we are getting for gasoline.

Senator THOMAS. That is a ways down the road. You say you supply more than half of the fuel for farmers in the Nation in two small plants in Montana and Kansas? I do not understand that.

Dr. DALE. I am sorry. I did not—

Senator THOMAS. Your statement says—

Mr. DEBERTIN. No. Excuse me, Senator. That was in my statement.

Senator THOMAS. Oh, your statement. Yes.

Mr. DEBERTIN. Yes. Not just out of our two plants, but in all the diesel fuel and all the gasoline we sell, we will touch half the farmers in the Nation.

Senator THOMAS. Oh. Just by co-ops, other people producing.

Mr. DEBERTIN. Right.

Senator THOMAS. You do not produce it.

Mr. DEBERTIN. Yes.

Senator THOMAS. All right. I misunderstood that a little. Thank you.

The CHAIRMAN. Thank you.

Senator Snowe, you are next.

Senator SNOWE. Thank you, Mr. Chairman.

Mr. Woolsey, in testimony before the committee in the House of Representatives, the Government Reform Subcommittee on Energy, in discussing our National security interests with respect to our energy policy, in describing the National Commission on Energy Policy's recommendations, you mentioned that tax incentives needed to be in place to avoid the political stalemate in achieving improved fuel efficiency.

Can you give us an assessment in this committee of the extent to which the tax incentives that we provided, for example, for hybrids, were successful in encouraging Americans to purchase hybrids? And more importantly, how encouraging of an incentive was it for the domestic manufacturers to develop hybrids?

Mr. WOOLSEY. I believe it helped substantially, Senator Snowe. This is not a field I am an expert on, the effectiveness of tax incentives. But as a broad matter, a few thousand dollars, when hybrids first came in, $2,000 or $3,000 or so dealt with substantially the difference in price between a hybrid gasoline-electric, and just a straight, let us say, Prius-sized car.

Probably something in the range of another $3,000 or so of credits for a consumer would deal with the added cost for a plug-in hybrid if it is, as I said, just a few kilowatt hours battery, say, 5, 6, 7 kilowatt hours.

The credits are, I think, important at the beginning, because although it is impressive to a driver to come in and realize that he can drive on 25 to 50 cents for a 25-mile drive with electricity and gasoline is going to cost him several times that, people tend to not do the long-run calculations of payback periods and the like.

I think a consumer incentive along the lines of making up for the bulk of the difference in cost for a plug-in would be most important, as it was for moving from regular vehicles to hybrids. If I could just add one point. The amount of added cost depends entirely on the size of the battery.

The difference between a plug-in hybrid and an all-electric vehicle is principally in the battery, particularly if one has a series hybrid of the sort General Motors has announced with the Volt. So the Tessla Corporation in California has 55 kilowatt hours in its batteries. That is $30,000, $40,000 worth of battery. It can go 250 miles on an overnight charge.

If one has 10 percent of that, a 5- to 6-kilowatt hour battery and one can go with that 10, 15 miles on an overnight charge, the added cost in the car will be a few thousand dollars.

So you are in the same range with moving from hybrids to plug-in hybrids that you are in moving from regular internal combustion engines to hybrids. I think the incentives that Congress has generated so far have been definitely helpful.

Senator SNOWE. Well, how would you describe the success of the domestic manufacturer with respect to hybrids? I mean, the foreign manufacturers have obviously reached their cap with respect to the tax credits.

Mr. WOOLSEY. They led the way. But domestic production is getting going and increasing, and generally with larger vehicles in this country than the Japanese producers who have gone with the smaller vehicles. But I think a very major decision was made by General Motors in January when they announced the Chevrolet Volt.

If this vehicle comes into dealers' showrooms within, say, a couple, 3 years, it will be one of the most important developments in automobile transportation in decades because they are discussing a 40-mile charge for a battery, and it is a relatively simple and relatively small vehicle and it is a series hybrid, which means that it is essentially an electric vehicle with just a little one-liter gasoline engine, or ethanol engine on the back that charges the battery when the battery gets down to a certain percentage. So, it is essentially an electric car, plus a bit of an insurance policy.

That, in turn, means they may be able to manufacture it without a lot of the cost of building a whole separate drive train the way we have with parallel hybrids such as the Prius. So, it is too early to tell for sure.

The rest of Detroit may follow and may come along in similar directions; we just do not know yet. But that announcement of General Motors in January was a big step for the domestic automobile industry and for the move to plug-in hybrids in general.

Senator SNOWE. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Cantwell?

Senator CANTWELL. Thank you, Mr. Chairman.

Mr. Debertin, you mentioned that your petroleum refineries are studying adding bio-based feedstock into your process, and that obviously there is cost, technology costs in that. Could you walk me through that? I mean, what is the difference between adding—if we are talking about adding renewable diesel, blending in soy before versus after, what is the significant cost differential there?

Mr. DEBERTIN. An issue is that most refiners have just begun to look at this after this recent ruling. The issue is that every petroleum refinery takes in raw material feedstocks to process in the plant. Today it is petroleum crude oil.

All of these crude oils have certain characteristics about them, and the metallurgy inside the plant and the processes inside the plant have been manufactured and designed to handle those properties, as incoming crude oil has.

The issue here is that vegetable oil will also have its own properties and its own characteristics coming into the plant. What has to be studied is, what are those characteristics, how does any petroleum refinery handle them? And each refinery will not be the same. Some will be able to treat it easier than others, but each plant will have to look at it and understand what effect it will have on things such as catalysts inside of the refinery, metallurgy inside the refinery, and be able to process it.

From there they will decide how much cost goes to adapting the refinery to handle it. In some cases it may be higher, in some cases it may be lower, but that is, I think, the process most plants are just beginning.

Senator CANTWELL. And are those huge costs?

Mr. DEBERTIN. Senator, I could not speak for every refinery and what impact that would be. What is big to someone might not be big to someone else. To a refiner our size——

Senator CANTWELL. Mr. Khosla, you are shaking your head. So you do not think those are huge costs?

Mr. KHOSLA. It is a minor cost, as I understand it. In fact, many people have not paid attention to the fact that cellulosic materials can be converted into a bio-crude that can go into an existing refinery structure. It may, in fact, be a very, very competitive use of biomass, and we should allow all these options to co-exist.

Senator Bingaman's bill defines advanced biofuels in a particular way. My mark-up of it generalized it beyond ethanol into advanced biofuels based on cellulosic feedstocks, because bio-crude could be a very important product for U.S. oil companies to get on board this bandwagon.

Senator CANTWELL. Yes. I am not disputing that it is not interesting.

Mr. KHOSLA. And the costs may not be that significant.

Senator CANTWELL. But I do not know that chicken fat is going to produce the energy supply of the future. I think the tax credit that we apply to renewable biodiesel was intended to incent people to get into refinery production. Obviously we were saying, if you could easily produce this, we were not going to give you a tax incentive and credit for it.

What we wanted to do was get large-scale refineries online. So now what we are seeing is large-scale refineries investing $40 or $50 million into facilities with stock that they are basically squeezing oil out of.

And I am not saying that you cannot have fuel from another process besides squeezing oil out of a bean, but it is frustrating to incent these companies basically who are making a $40- or $50-million investment and then have some people go around the back door to the White House, to Treasury to interpret the language—if that is in fact what has happened, and we will see if that is in fact what happened—to give petroleum companies a dollar credit.

I think we are going to have the adverse effect of discouraging the true refineries that are being built, so I think we need to understand how to best do this.

Mr. KHOSLA. So, Senator, I want to make a very important point. You bring up a very important issue. Waste, animal fat, is not the right product. It will not solve our problem. You can produce fuel with it, but it will not solve our problem at any scale that is material here.

Frankly, neither will vegetable oil. But cellulosic biomass can be converted into a bio-crude, and there are companies—not ours, but others—doing it that could feed into existing refineries.

So I have proposed in my written testimony that the Federal Government not fund or incentivize any product that is not scalable feedstock. If it yields less than 15,000 gallons per acre of land, the Federal Government should not be supporting it with any money because that is money wasted into small niches that will not amount to much.

Professor Dale is exactly right. Biomass is one of the few large enough feedstocks, as well as some renewable waste materials, like municipal sewage, that are large enough in scale to make a material dent in our oil needs. If we have a plug-in hybrid subsidy, it should be based on gallons of petroleum avoided or the reduction in petroleum miles, which I have also proposed previously, because, frankly, as much as we invest in plug-in hybrid batteries, I hope a year from now to walk in here with a 100-mile-per-gallon diesel car that is substantially an unmodified standard four-passenger sedan, because there are companies working on it. Why? Because you can get diesel engines at 100 miles per gallon efficiency for a Volkswagen Jetta by just changing fuel injectors.

Mr. WOOLSEY. Senator Cantwell? Excuse me.

Senator CANTWELL. Yes?

Mr. WOOLSEY. There is a very important point directly related to what you just said, if I might. I have advised for years a company that is involved in the waste-to-renewable diesel technology. What has recently happened that you described is, as I understand it, Treasury has effectively given the same credit for the utilization of substances like fat and soy that have food uses or other legitimate uses and are not really waste. The process works with respect to animal manure, used tires, municipal sewage, turkey carcasses in Carthage, MO at a large facility, and so on. Because the same credit is being given now to substances that would go into a regular refinery that are just, let us say, soy or animal fat, the companies that are involved in using waste are likely to migrate to Europe, where the tipping fees are huge.

Since Europeans do not feed ground-up animals back to animals the way we do, you get $100 a ton, roughly, tax credit, or tipping fee, in Europe for disposing of things like animal carcasses.

Well, the companies that can now make a good deal more money in Europe because they process waste will migrate there, I think, as a result of this recent Treasury ruling that essentially treats them the same way as using other substances that are not really waste are treated.

Senator CANTWELL. Well, I guarantee you, in Washington State we are doing all sorts of different, innovative things. But I think,

Mr. Chairman, it does deserve some reexamination of this issue, because I think that we are trying to get to the scalable level.

I think when we were thinking about that language, we were really thinking about, how do we incent large-scale refining capacity? And that is not to say that we should not be productive all across the board, but I think we have to look at this and look at the interpretation.

I know my time has expired, Mr. Chairman. I have gone over. I thank the witnesses for their fervor in answering.

The CHAIRMAN. Senator Salazar?

Senator SALAZAR. Thank you very much, Chairman Baucus, for your leadership on this issue. I also want to commend Senator Bingaman for his leadership on the Energy Committee.

I am very hopeful that, with the combined attention from the Finance Committee, the Energy Committee, and the Agriculture Committee, we are going to have a very robust energy package that will help make some of the visions possible that you have here.

I want to just thank Dr. Farrington for your great work at the National Renewable Energy Lab. It remains a crown jewel within our system. I actually hope to invite both Chairman Baucus and Senator Bingaman back there again to take a look at what you are doing there at NREL.

Mr. Khosla, congratulations on range fields and what you are doing on cellulosic ethanol. We are proud of the company's efforts.

Mr. Woolsey, I appreciate the leadership that you have brought to the Set America Free Coalition and the bipartisan group that has really put together many of the ideas that we have implemented since the 2005 act. Hopefully, this year we are going to see a lot more activity with respect to implementation of those bills.

I want to just say a couple of things. There is a group of us in the Set America Free Coalition, some 25 Senators, conservatives, Republicans and Democrats together, that moved forward with the introduction of the DRIVE Act. It includes many of the issues: hydrogen vehicle prices; the advanced technology motor vehicles manufacturing credit; the consumer incentive to purchase plug-in hybrid electric vehicles; tax incentives for private fleets; reducing the incentives for the gas guzzlers; biofuels; tax credits; and production incentives for cellulosic biofuels. We obviously will be hopefully moving forward with a package that includes much of that as we move forward.

I have a couple of questions. I know we do not have a lot of time, so let me just ask these questions. I would appreciate, like, a 30-second response.

Mr. Woolsey, in terms of the costs of the plug-in hybrids, it is an enormous problem. What is the best way that we can get around that? Think about the answer. You have about 10, 15 seconds to respond.

To you, Mr. Khosla, my question is in terms of cellulosic ethanol. There is lots of debate here about how fast and how far we can go. The 35 billion gallons by the year 2017, that would only displace 10 percent of the oil that we currently consume. Can we go further? Is that too timid a vision? Do we need more of a Manhattan-type of project here?

Dr. Farrington, you said 60 percent of our oil could be replaced with hybrid plug-ins if we moved forward with that technology. How can we get there, and how soon can we get there? What is it this committee can do to help us get there more quickly?

Dr. Dale, the same question to you in terms of the RFSs. Are we being too timid today? Should we be bolder?

And to Mr. Debertin, the same question with respect to the RFS of where we are going here, is it high enough? So if we can quickly come through. I know I have about a minute and 40 seconds left, so we will just walk this way through the table.

Mr. WOOLSEY. Senator, I think a 5- to 10-year program of credits continuing a few thousand dollars for a hybrid, a few thousand dollars for the plug-in feature, I do not think it needs to be close to $10,000 total, but something in that range, that gets manufacturers up on the step with their battery suppliers and moving along decisively.

I think some type of incentive to promote rapid turnover. If you go to Japan, all the cars look new. The reason is, the cars are new. The reason is, they have various incentives to turn over their fleet more quickly than we do. We should look into doing that.

Senator SALAZAR. So a $10,000 tax credit for hybrid plug-ins is your answer.

Mr. WOOLSEY. I do not think it has to be that much. I think a few thousand for each. I think it could be several thousand dollars short of $10,000 total.

Senator SALAZAR. All right.

Mr. Khosla?

Mr. KHOSLA. In answer to your question on cellulosic ethanol, we can do—as I have said in Appendix C, I provide details of both the number of cars on the roads and the amount of cellulosic ethanol we can produce based on the number of acres and biomass yields per acre. That detail is in Appendix C. But we can reach not only 39 billion gallons by 2017, we can reach 139 billion gallons by 2027, and by 2017 have dollar-a-gallon cellulosic ethanol.

Senator SALAZAR. So, Mr. Khosla, should our renewable fuel standard this year be 199 billion gallons by the year 2027, and could we do that?

Mr. KHOSLA. I do not think that will be needed. I am sort of a free market kind of person and would like the least amount of subsidies and mandates. Some are absolutely essential and I have proposed those. But I do believe, once we reach some number like 50 billion gallons, it will take off on its own because it will be cheaper than petroleum.

Senator SALAZAR. As a goal, though, whether we get there with an RFS or some other way, you believe that by 2027 we can get to 139 billion gallons of production?

Mr. KHOSLA. Yes.

Senator SALAZAR. All right.

Dr. Farrington?

Mr. KHOSLA. Senator, can I make one comment on hybrid vehicles? If we have an incentive, it should be based on petroleum mileage. Whether it is a plug-in electric or some other form of fuel, we should reduce petroleum mileage, because that is a key goal.

Senator SALAZAR. So we have to have a formula that ties it back down to petroleum consumption reduction.

Dr. Farrington?

Dr. FARRINGTON. Yes. In terms of, how can we accelerate the adoption of plug-in hybrids and when they might be available, number one, of course, is reducing battery cost. Number two is, establishing a U.S. manufacturing base for those suppliers is essential.

We will need to have convenient charging, because not everyone has access to 110 volts for charging. The technology is available today, except for battery replacement costs. Because they are expensive, we need a 15-year life, and we are working on that.

One thing to remember with respect to fuel consumption is, if we have a 15-mile-per-gallon vehicle, it consumes 800 gallons per year. Converting that to a plug-in hybrid could save two-thirds of that, 60 percent of that cost.

If we have a 50-mile-per-gallon vehicle, we are only consuming 240 gallons a year, and so the opportunity to save costs reduces. So the big opportunities are really with the larger vehicles that we have today.

Senator SALAZAR. Thank you very much.

Mr. Chairman, my time is up. Could I have 1 more minute to give each of the witnesses remaining 30 seconds to respond to the questions I asked?

The CHAIRMAN. Yes. Absolutely.

Senator SALAZAR. Thank you, Mr. Chairman.

Dr. DALE. Yes, we are being too timid. Yes, we could have a higher standard. Yes, we will get there to cheap cellulosic ethanol much more quickly than people believe. I think the limit will be, and probably not for long now, how much of this material can we get together?

We are focusing on the processing technology right now, but there is the whole supply chain, how you get enough biomass together. I believe that could become more of a limiting factor in the future. You just start thinking about how to incent that.

Senator SALAZAR. Thank you, Dr. Dale.

Mr. Debertin?

Mr. DEBERTIN. We are an investor in ethanol. We are making it every day right now. When this new technology that these gentlemen are speaking to can come to our offices and show us how this is a better solution right now in the market, we will be all for it. Then I think our standard is too timid. But up until that point, right now we have only essentially one horse to run with right now, and it is corn, and there is a limit on that.

Senator SALAZAR. All right. Thank you very much.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

I would just like to ask a general question of all five of you, if you could. That is, if the goal is energy security, reaching toward inexpensive energy, and with a nod to climate change, what current subsidies, credits, mandates, whatever that occur today do you think are good? Which ones would you change? Which ones would you add? The goal being, let 1,000 flowers bloom, but all these new

technologies are pretty much on a competitive basis. But some need help to scale, some need help to commercialize, and so forth.

I am going to ask each of you, given the whole panoply of credits and deductions and all the incentives in law today that favor one energy supply over another—say corn ethanol—which would you continue, which would you modify, which would you delete, and what new ones might we consider? I will start with you, Mr. Woolsey.

Mr. WOOLSEY. Mr. Chairman, I think that the key one is the incentive that the Commission has proposed for plug-in hybrids and hybrids to get production up on step. In addition, the government itself could order such vehicles to increase the volume when it is adding to its vehicle fleet.

I believe Vinod has a very good idea about the restructuring of the incentives for renewable fuels, neutral with respect to the type, as long as it is on a Btu basis. And as I have said, I think moving toward plug-ins would be a big assist to these other liquid fuels because I think it would help block the Saudis from dropping the bottom out of the market.

I guess I would say the most important thing overall is removing the barriers to competition from other fuels. We need to have flexible fueled vehicles, multiflex, methanol as well as ethanol, butanol. We need to have vehicles that can use any of these fuels, and we need to have the pumps for them at stations.

I think these relatively minor infrastructure changes will open up the market to competition from these alternative liquid fuels, as well as to electricity. That is the key thing. Today we are locked into oil because of rigidities in the infrastructure that have been put there over time.

I guess the last thing I would say, Mr. Chairman, is to call the committee's attention to a fascinating article a year ago in the Texas Review of Law and Politics by Boyden Gray, currently our ambassador to the EU, about subsidies to oil under the current tax law and how it works. It is a very substantial figure, indeed. It might be something worth looking at.

The CHAIRMAN. Thank you very much.

Mr. Khosla?

Mr. KHOSLA. As I have said, a high RFS with the idea of identification numbers to protect consumers and other producers of food products is the single most important issue. Number two most important is a flex fuel car mandate. And by the way, my definition of flex fuel cars includes plug-in electrics, as I detail in the testimony.

A flex fuel mandate and a pump mandate are absolutely essential because a car fleet takes 15 years to change over. The VEETC today is very, very inefficient. Half of it is wasted because it is a blender's credit, not a producer's credit. That would double the utility of every dollar we spent for America's corn ethanol producers, and making it variable will provide them insurance against low oil prices and low ethanol prices. So, that is third.

Fourth is this focus on advanced biofuels that are made from cellulosic or renewable waste materials. That is the only additional producer's credit, I believe, that is needed, and only for the short

run. This should, as I propose, pay off completely by 2020. Starting in 2015, it should start to decline.

The last thing I would suggest is that we use our valuable dollars to fund anything that cannot achieve the scale of 20, 30, 40 billion gallons of oil replacement. If it is not scalable, it is not material. There are lots of proposals from the environmental community that are not scalable because they are too expensive or they are very nichy, like animal fat and others. So, we fund scalable products to solve the real problem.

The CHAIRMAN. Thank you.

Dr. Farrington?

Dr. FARRINGTON. Yes. I am not a tax incentive expert, I am a researcher. But for what that is worth, our goal, I think, is to encourage less fuel consumption. There are multiple solutions to that, as I have mentioned.

Mass transit, having our fleet average move from 20 miles per gallon, which is what it is today, which is 600 gallons a year, to 40 miles per gallon, which is 300 gallons, would cut our fuel consumption for light-duty vehicles in half. We have the technology today to do that.

Then certainly with every vehicle type we have, hybrids, plug-in hybrids, and conventional vehicles should be flex fuel vehicles.

The CHAIRMAN. Thank you.

Dr. Dale?

Dr. DALE. Most of what I would like to say has already been said. I would just add that incentives are needed, or policies for the first generation of the cellulosic ethanol plants to reward the early adopters, perhaps up to a billion gallons, and then cut off the subsidies. Let them be rewarded for that. Let the risks be taken out, and away we go.

I would also add, though, as I said several times here, I think we need to figure out maybe some incentives to establish the supply chains for cellulosic biomass. The input for one full-scale cellulosic plant will require output from about 3,000 farms. It is going to take some work to figure out how to put those supply chains together. I think that is a valuable area for some incentives.

The CHAIRMAN. All right. Thank you. Very interesting.

Mr. Debertin?

Mr. DEBERTIN. Mr. Chairman, one comment I would absolutely agree with is not investing, not providing tax incentives to those opportunities that are not scalable. I think that is not a road that we should go down.

Right now, as we sit here today with alternative fuels that are being produced, it is on ethanol and it is on the biodiesel side. For you to attract capital into those industries, and we are investing in those industries, it is a knowledge of how that future looks that will attract that capital. So I would say that the tax breaks are sufficient.

I would just look for kind of knowledge. Are they going to stay in place? If you say they are not going to stay in place, that is fine. I can choose to invest my capital where I think it has a better home. But I look more for stability in the future as far out as I can see, and I am fine with whatever you agree to. It is just that it is

going to drive capital, and I will invest the capital where it needs to go.

The CHAIRMAN. What are some of the nichy ideas that are not scalable? What are some, do you think?

Mr. DEBERTIN. Personally, sir, I think one of the points of why I do not agree with the NCHS, which is in favor of a biodiesel mandate today, is because we just do not see, with soybean oil right now being essentially the only significant property for biodiesel, we think it is going to run into some food versus fuel issues very quickly.

The CHAIRMAN. Thank you. I am going to have to run. Senator Bingaman is going to take over.

Senator BINGAMAN. Senator Kerry has not had a chance to ask questions. Why don't you go ahead?

Senator KERRY. Well, I apologize for being tardy. I was chairing a Commerce Committee hearing on competitiveness, and we actually were talking about some of the same issues with the folks from NIST and NSF. It was very interesting. So to just sort of pick up, I do apologize for that. I am very grateful to all of you for being here today. This is obviously an enormously important topic.

Let me begin. A number of us had different bills that we have introduced. I have a bill on global climate change, which seeks a trading system and, among other things, a serious group of incentives for activity that you have just described.

My bill actually doubles the credit amount for fuel cell vehicles, and I wonder what your reactions are to going from, currently, it is $4,000 up to $40,000 on fuel cells, and we go from $8,000 to $80,000. We double the credit amount for new advanced lean burn technology vehicles.

Currently, the range is $400 to $2,400. We go from $800 to $4,800. We also extend the credit for hybrids, et cetera, through 2014 and make it longer and provide a special plug-in credit, et cetera. What is your reaction to those levels? Do those meet the standards that you have been articulating here or not? Anyone. Yes, Mr. Woolsey?

Mr. WOOLSEY. Senator, I think all of them sound to me to be reasonable, with the exception of the hydrogen vehicles. Hydrogen has two problems. One is, I think to get it in the family car one is going to have to increase the efficiency of the fuel cells by something like a factor of 40 or 50. That may be the easiest step.

The other is, even though central station refueling by hydrogen for vehicles like buses may have some advantages, to have the neighborhood filling station have a hydrogen reformer, pump, and storage in it, one former Secretary of Energy estimated to me the other day was going to cost something on the order of $1 trillion for infrastructure change.

If you reform natural gas into hydrogen and then turn the hydrogen into electricity, you lose about one-third of the energy. It seems interesting—more interesting—to put the natural gas in the vehicle in the first place because that is entirely plausible.

If you change electricity into hydrogen and then back into electricity, you would lose about three-quarters of the energy, and with battery improvements and technology, it would seem to me to be more wise to put the electricity in the car in the first place.

So I think we have spent a good deal more on hydrogen than really is justified, given its limited use for transportation. It has a lot of uses, fuel cells for space, for fixed fuel cells and the like. But I think, with that exception, it sounds to me like that is a very reasonable pattern of incentives for a reasonable set of possibilities.

Senator KERRY. Mr. Khosla?

Mr. KHOSLA. Senator, let me give you an example before I answer your question. I hope, a year from now, to drive here in a diesel, substantially unmodified four-passenger car that delivers 100 miles per gallon—no hybrids, no batteries, just engine efficiency.

Now, I could be wrong, but if I am right, should it have the same incentive as a car that runs on hybrids or plug-ins? I will tell you, as I mentioned earlier, we are also investing in hybrid batteries, so I do not have one particular axe or another.

I am suggesting, if we do have an incentive, it be based on petroleum mileage, because our goal is reduction in petroleum mileage, whether it happens through a plug-in electric or higher efficiency or some other mechanism. I personally am a big fan of plug-in electrics too, but I do believe it will be many, many years before they reach the average person in Mississippi. That is my standard global warming test.

Senator KERRY. Why do you believe that? The other day I saw, right out here—and I am going to do something with this—we have a company in Massachusetts, A–123 in Watertown, and they have developed a lithium battery.

It is in the back of a Prius, which a friend of mine is driving around this city now. He plays this game with himself every week to see if he can beat his record of getting 150 miles to the gallon. He is doing it now.

Mr. KHOSLA. Absolutely, the custom batteries can be done. The question is, at what cost? How many consumers will buy that car?

Senator KERRY. Well, it is a $3,500 cost additional for the complete installation. Now, I want to to give a $4,000 credit to somebody to go out and buy that car. So in effect, that is an incentive that covers the cost, is it not?

Mr. KHOSLA. I am very familiar with the A–123 battery. I am very, very excited about it. It is a significant breakthrough. We have seen lots of other technologies that are even bigger breakthroughs, some of which we are trying to invest in. So, I am a fan of making all that progress happen.

But if our goal is petroleum reduction, then that is what we should incentivize, because there are five different ways to get there. As I said, we should be able to get there by just changing the fuel injector in a traditional car, millions of which have been produced, get to 100 miles per gallon, that is a very cost-effective strategy.

There are other people in various labs around the world, or this country, trying other techniques. We have seen at least a dozen new engine design start-ups in the last 3 months, none of which we have funded, but we have seen them.

Some of them are likely going to be successful. If they reduce petroleum consumption they should be incented equally, so I suggest we have some standard, like petroleum mileage, whether it is a plug-in or some other mechanism to get there.

For example, we found very attractive plans for air hybrids, which, instead of using a battery for storing energy, use compressed air to store energy. In high-compression engines, that comes for free because the engine is already compressing air.

International Harvester has a completely different mechanism for trucks that might also be useful. So, there are many different ways to achieve petroleum mileage reduction, and any incentive should be dollars per MPG improvement on petroleum use.

Senator KERRY. I like that standard. I think that is an interesting thing for us to think about here.

Also, as people are rushing to these alternatives, you were talking about losing energy a moment ago and how much we lose in the process. There seems to be a rush here by some people to embrace liquified coal as an alternative, and that just seems to me to be absolutely crazy in terms of this lost energy versus, also, use of energy, because it uses a lot more energy and also uses dirty energy in the production. Am I wrong?

Mr. KHOSLA. You are absolutely right. As I said earlier, if we allow coal to liquids on the same basis as cellulosic, we will forever kill biomass-based fuels. Senator Salazar is not here. We have a company in Denver that uses biomass to produce ethanol and, hopefully a year from now, it will be in commercial production, contrary to everything else you have.

I will tell you, we have tested that process, both on biomass and coal as feedstock, because it is a gassification process, and producing that ethanol with coal will be cheaper.

So unless there is a disincentive, the economic decision I will have to make is to stop producing it based on biomass and produce it based on coal. That is why I proposed a 50-cent-a-gallon penalty for coal to liquids because it serves our National energy security purpose, but not our environmental purpose.

I propose that that penalty of 50 cents a gallon exist as long as its carbon emissions—life cycle carbon emissions—per mile driven are any worse than petroleum. It should be at least as good as petroleum, or better, for it not to have a penalty, which creates an incentive for the coal to liquids community to clean up their act and invest in things like sequestration and others. Then they are as good as Saudi oil, as far as I am concerned.

Senator KERRY. Well, I have gone over my time here. I will wait for the next round. But I will just say very quickly, I am glad to hear you say that. I think it is really important that a lot of people start sounding the alarm bells on that because it seems to be gaining an inappropriate foothold. I think it is completely contrary to both the security interests and the environmental interests that we have, so we need to sound that. I will come back afterwards.

Thanks, Mr. Chairman.

Senator BINGAMAN. Thank you.

Let me just ask a couple of questions, and then I will have to go. But in your statement, Mr. Khosla, where you talk about what we need to do, in the first bullet there you talk about how we need this relief valve mechanism installed, and then you indicate that you are going to explain that more.

Could you give us a brief description of how that would work as a way to protect consumers if we did increase substantially the RFS?

Mr. KHOSLA. Yes. This is the mechanism the President proposed in his legislation, and I believe it is a very good mechanism. The idea is, you set an RFS that is extremely high. The problem with that is, if you cannot reach that, then prices start spiking. Last year we saw ethanol prices reach over $4 a gallon. That is a problem for consumers. It is also a problem for livestock farmers who are worried about corn prices going up with it.

So what the President has proposed is, you can get out of your obligation to meet the RFS obligation by buying an identification number for a dollar a gallon. It effectively says, for any blender, any time the price of ethanol spikes $1 above the price of gasoline, they will buy these identification numbers and get out of their obligation.

Ethanol will stabilize at no more than $1 above the price of gasoline. That is a good thing because it protects consumers while creating an attractive market for both corn ethanol producers and cellulosic producers. But, more importantly, if we are not meeting our RFS target, it generates additional funds that can be used to incentivize ethanol in the future in subsequent years.

Senator BINGAMAN. Mr. Debertin says in his testimony here, as I read it, over on page 2 that he is concerned that unless we have incentives to encourage distribution of ethanol from Midwest ethanol producers to coastal States where the demand is, we could wind up with a Midwest glut in domestic ethanol with very negative consequences on the industry.

I would ask any of the rest of you, Mr. Khosla, did you agree that that is a possibility? I mean, on the one hand we are trying to guard against the price of ethanol going too high because there is a shortage. On the other hand, we are trying to guard against the price of ethanol going too low because there is a glut.

Mr. KHOSLA. I would have to disagree, for the following reason. First, the companies that we have invested in are building about 10 corn ethanol plants, so please take me sincerely when I say I am not a fan of big subsidies. We have an interest in more subsidies; we would benefit from them. But we are building our plants as destination plants in California, in Dallas, in New York, in the northeast, and it can be done cost-effectively.

Two, we have seen Midwestern producers and market-based efforts take care of it. I met recently with Fagan, which is one of the key voices in the Midwest for corn ethanol. They are building, or considering building, a terminal in Stockton, CA. So, the market will take care of that issue. I do not believe the Federal Government has to spend its valuable money doing it.

Senator BINGAMAN. So you think there is no real threat of a glut?

Mr. KHOSLA. Look, temporary dislocations happen in most markets, but I believe they will be very temporary. If there is a high enough RFS and the blenders are obligated to sell that much ethanol, the markets will take care of it.

Senator BINGAMAN. Mr. Woolsey?

Mr. WOOLSEY. Senator Bingaman, I think as we move to cellulosic ethanol this problem will take care of itself because

switchgrass or most of the other potential feedstocks of biomass grow in lots of places, not just in the Midwest.

So, over the short run, one does have dislocations. One has a problem that ethanol does not work well in pipelines and it picks up water and so forth. But in time, I think one would look to seeing cellulosic ethanol, perhaps butanol plants, perhaps renewable diesel plants, near where the population is.

The increase in yield of things like switchgrass by genetic engineering should make it possible to have relatively small fuel plants located where there is relatively dense growth of biomass, and then one does not have to either cut the biomass and ship it long distances or produce the ethanol and ship it long distances. You could have distributed generation, in a sense, of ethanol in the same way we are moving in some circumstances toward distributed generation of electricity.

Senator BINGAMAN. All right. I need to leave. Thank you again for your excellent testimony. Maria, I know, is next, then Senator Kerry. You folks can go back and forth as long as you would like.

Senator KERRY. Great.

Senator CANTWELL. Thank you.

I want to just go to one other question area. Thank you, Mr. Khosla, and others, for being so specific. I know that, Mr. Khosla, in your business you drill down on a lot of numbers and you have obviously put money investment behind those numbers, so thank you for sharing some of those experiences with us.

But part of our challenge as a committee, and I am glad that the Finance Committee has taken on a focus with the Energy Subcommittee, is to look at these tax incentives.

Obviously we want them to be technology-neutral to the greatest degree possible and not pick the winners and losers, but I also think that we have to look at this issue and be very open and have a discussion about it, and that is the length of the tax credits.

Now, Vinod, you mentioned you thought nothing beyond 7 years. When you start really penciling this out, 7 years is even very expensive if we are talking about the credits to ethanol. There are big impacts on our budget.

Now, that does not mean that we should immediately turn away from them, but I guess my question is, what should we be thinking about in comparing 5 years to 7 years, per se, in the focus of the generation of job creation and U.S. technology?

That is not only obviously weaning the U.S. off of foreign oil, but is there a demarcation here, is there a line here in helping the U.S. economy be an energy leader?

Now, I will just add to this that I have sent a letter to the President, signed by several members of this committee, including Senator Kerry, a bipartisan letter asking for a U.S.-China bilateral energy agreement.

If they are spending $50 to $70 billion a year on energy consumption, the United States ought to have a goal of trying to supply that. We already sell them airplanes and software and coffee in the northwest, so we would like to sell them some energy technology.

But in looking at that particular issue as well, both our domestic production and an opportunity for us to be exporters, how should

we look at this 5-year, 7-year tax credit, knowing that the numbers are very big for us and we obviously have very huge fiscal constraints?

Mr. KHOSLA. Yes. I am extremely sensitive to the fiscal constraint, and I proposed probably five or six different mechanisms to fully fund all this. Let me be clear. If a high enough RFS is set, I do not believe we need corn ethanol subsidies. The VEETC is expected to expire, today, for law, in 2010.

I would suggest we let it expire. This is from somebody who is investing in two companies that are building 10 corn ethanol plants. If the RFS exists, then I think the markets will take care of the rest. I know many of my brethren hate to hear me say that. That is important.

If we do not have it expire, we can make it variable, countercyclical with the price of oil, which will substantially reduce the cost of subsidies because oil prices are expected to stay high for the EI forecast, which would say the subsidies would go down substantially. That is mechanism number two.

The third thing. Cellulosic ethanol incentives only need to exist when volumes are low. I have suggested that they discontinue within the sort of 7-year time frame—I ramped them down—or when we reach 5 billion gallons of cellulosic production. So there is an absolute cap on the cost of these programs.

I am suggesting that once we are at 5 billion gallons, we do not need more cellulosic subsidies because we will have honed the technologies and the ecosystem enough to be cost competitive.

Let me suggest a couple of other ways. This one clause in oil accounting legislation, excess of percentage over cost method, has accounted for $80 billion in subsidies to the oil business, that one clause. Revoking that one clause could pay for 100 percent of the ethanol subsidy and cellulosic incentives I have talked about, that one clause.

The use of identification numbers, together with this high RFS, would pay for not only cellulosic, but fully fund the pumps mandate, the flex-fuel car mandate, and have lots of money left over, in my view. So there are lots of mechanisms. Most of these are detailed in my testimony. I am extremely sensitive to fiscal discipline.

Senator CANTWELL. But less than 5 years you would be concerned about?

Mr. KHOSLA. I think it takes 5 to 7 years for a new technology to get its footing. The most important issue in cellulosic today is not the cellulosic technology. That, I believe, will be mature within 3 years. I expect to be cost-competitive a year from now.

The question is, is there enough feedstock available? So for the next 5 to 7 years, we will be forced to build very small plants or ship biomass more than 30 or 50 miles, which makes biomass shipments uneconomic. So, we have to build it up.

I have proposed in my written testimony that we incent biomass production and we dedicate 2 million acres in 20 States, 100,000 acres in each of 20 States, to assessing our biomass capability, seeing what yields we get, how we handle logistics, studying biomass.

Because if we are going to solve this problem in a scalable way, biomass will be the most significant constraint, and I believe it will take 5 to 7 years to get to an economic point.

Senator CANTWELL. Thank you.

Mr. Woolsey? I know I am over my time, but if Senator Kerry will allow Mr. Woolsey to answer, then I will turn it back to you for the rest of the hearing.

Mr. WOOLSEY. Thank you. Senator Cantwell, just two points. First of all, I know that the accounting up here has to be precise and one cannot spend the public's money excessively. But one of the problems we have had in the renewables area is relatively brief periods for tax credits. That is what happened in wind. People just get into the business of producing the turbines and then the credit goes away. So you see wind turbine production look like the Grand Tetons. It is continually a problem.

If we look at the other side of this, since we borrow over $300 billion a year to import oil, nearly a billion dollars a day, every day's worth of oil imports is somewhere in the neighborhood of 10,000 or more American jobs if we substitute domestic production of fuel for the imported oil.

If we replace about a quarter of our imports, just our imports, with domestic production, we are in the range of $80 billion, which was net farm income last year in the United States.

So by replacing a quarter of our imports, not all of that money would go to rural America. Chunks of it would go to the rest. But we are talking about doubling, in effect, the amount of net farm income.

Finally, the one thing to explore by way of incentives for vehicle purchases that reduce oil use or petroleum product use is the concept of the "feebate," which is revenue neutral as far as the government is concerned, but essentially adds to the cost within a given, say, size of vehicle, adds to the cost to the consumer of the inefficient vehicles and reduces the cost of the efficient ones. That would presumably, if done right, not add dollars to public expenditures.

Senator CANTWELL. Thank you.

Senator KERRY. Thank you, Senator Cantwell.

I just might comment that I think one has to be a little bit flexible in thinking about the length of time and not certainly be arbitrary, because the experience in the 1970s when we committed to alternatives and renewables we began to become the world's leaders in photovoltaics, et cetera.

Then when Reagan came in and they pulled the guts out from under those subsidies, all of a sudden our technology that we developed went to Germany and Japan, and they have developed it and we probably lost 200,000 jobs in the doing of that, and they are still the leaders.

Likewise, if you look at the price of solar today, about 35, 40 cents per kilowatt hour, versus wind at 8 cents, 6 cents, and then fuels, less, you need to create the market. I mean, you have to create some certainty, it seems to me, in the marketplace that this is really there and it is going to be there.

You also have to think about, if you put a cap in place, if you get carbon priced, that is going to alter a lot of your thinking, I would assume, about how long and how much. Is that not right that that will affect the marketplace in such a significant way that that will affect the length of time, et cetera? Anybody want to comment?

Mr. WOOLSEY. It will, Senator Kerry, for electricity generation. But dollars of carbon dioxide price translate to pennies of cost for, say, gasoline. So if one wants to reduce, as I definitely think we should, the use of petroleum and its products for transportation, one needs to go beyond these types of incentives that have been discussed here by all of the panelists today. One needs to go beyond the carbon tax or carbon capture and sequestration because that will mainly have an influence over power plants and coal.

Senator KERRY. Absolutely. Understood. I understand that completely.

Which brings me, Dr. Farrington, to your comment about, we have the technology, and this whole issue. Senator McCain and I brought the CAFE standards issue to the floor a number of years ago, and we got 35 votes. I would suspect we would have a better vote today, but still contentious.

When you say we have the technology, let me ask you this first question. You said in your testimony that—no, I guess that was Dr. Dale's testimony on the $2.50 per gallon. But what do you know that Detroit does not know, or why is Detroit unwilling to accept what you are saying?

Dr. FARRINGTON. Well, we work very closely with Detroit on a variety of projects, including vehicle projects and the like. The big step is going from conventional vehicles to hybrid electric vehicles. We are building those. That is a known technology. The next step in technology, going from hybrids to plug-in hybrids, is a very simple step compared with the earlier step.

Senator KERRY. But when you say we have the technology, is that the technology you were referring to?

Dr. FARRINGTON. It is.

Senator KERRY. But that technology is leased from Toyota.

Dr. FARRINGTON. A great deal of it is. But GM has a two-mode technology, for example. They have introduced the Chevrolet Volt as a series plug-in hybrid, which I think has some exciting possibilities as well.

Senator KERRY. Let me understand that. But you are saying that we have the ability to go, obviously, to a plug-in. We all understand that we get much better mileage there. Is there anything else? I mean, Mr. Khosla was talking a little earlier about diesel and the ability, through a more efficient diesel, to be able to do that. Plus, through clean diesel fuel, et cetera, I would assume we have options.

Do you want to speak to that, Mr. Khosla? Are there technologies beyond just the plug-in hybrid, which in effect is using an alternative to the fuel?

Mr. KHOSLA. Yes, there are. There are plug-in hybrids. There are various types of plug-in hybrids, serial and parallel. There are air hybrids that I talked about a bit earlier where you store the energy in compressed air that are promising for certain classes of engines, high compression ratio engines, which also happen to have the highest mileage.

I have talked about engine efficiency ideas. We have one investment in an area in a car that would, by changing just the fuel injection, achieve 100 miles per gallon on a standard four-passenger

car. And, more importantly, it would be run on diesel, ethanol, or gasoline, or any mix of those without changing.

Senator KERRY. And how far away do you believe we are from that?

Mr. KHOSLA. I am hoping I can drive here next year, about a year from now, in this car.

Senator KERRY. And how long would it take—

Mr. KHOSLA. Because they are standard, pretty much unmodified production cars.

Senator KERRY. How long would it take major auto manufacturers to retool and produce?

Mr. KHOSLA. A high CAFE standard would incent them to move very quickly, a low CAFE standard would sort of be business as usual. I think CAFE standards and carbon prices make a big difference. In a $20 ton of carbon, I believe a gallon of gasoline incurs about a 20-cent-a-gallon penalty for carbon.

Senator KERRY. Dr. Dale, you talked about the $2.50-per-gallon cellulosic ethanol. Why do you think that is not good enough yet to compete with petroleum?

Dr. DALE. That is cost to produce. That is what you make it for from the plant gate.

Senator KERRY. Oh, I see.

Dr. DALE. Yes. It is cost to produce.

Senator KERRY. All right. Got you.

Dr. DALE. I would like to add just one other thing, if I may, Senator.

Senator KERRY. Sure.

Dr. DALE. Let us keep our eye on the petroleum ball. In the 1970s—I was around then—people thought we had an energy problem. We did not have an energy problem then, we do not have an energy problem now. What we have is a petroleum problem. That is why it is so important to make sure that whatever we do reduces the use of petroleum. That is the key issue.

Senator KERRY. Understood.

Well, I regret, I would like to continue this conversation, but I, unfortunately, have another meeting. I am sure all of you have pressing engagements. So, we are very grateful to you, from the committee. Thank you very, very much for being here today. We look forward to following up on this. Take care. Thank you.

We stand adjourned.

[Whereupon, at 12:20 p.m., the hearing was concluded.]

APPENDIX

ADDITIONAL MATERIAL SUBMITTED FOR THE RECORD

TESTIMONY BEFORE THE UNITED STATES SENATE

COMMITTEE ON FINANCE

APRIL 19, 2007

By Professor Bruce E. Dale, Ph. D.

Thank you, Chairman Baucus for the invitation to testify before this committee.

The age of petroleum is ending. Even if we could afford to pay a billion dollars a day indefinitely to import oil, we cannot afford the danger our petroleum addiction poses to our economic and national security. We do not have an "energy" problem as we mistakenly thought in the 1970s. Our problem is that modern society is almost completely dependent on petroleum for the liquid transportation fuels we need to move people and products around. Our dependence on petroleum for mobility puts us at great risk geopolitically, environmentally and economically. We have very few petroleum alternatives that can simultaneously provide geopolitical, environmental and economic benefits. Biofuels are one of this handful of alternatives.

I have spent over thirty years thinking about and working to develop biofuels, particularly cellulosic ethanol. From that background, I will briefly summarize the status of biofuels: where we are today, what we can expect in the next 5 years or so, and the long term contribution biofuels can make to our liquid fuel needs. I will also comment briefly on the role farmers could play in the biofuels future.

Biofuels today Biofuels today means ethanol and biodiesel. Ethanol comes from sugar, whether that sugar is derived from cane sugar, as in Brazil, or from starch in corn grain, as in the United States. We produce our biodiesel from soy oil. Because of price and volume considerations, biodiesel from soy oil will never be more than a niche fuel. Corn ethanol will grow rapidly until it reaches a limit of perhaps 18 billion gallons of ethanol per year, roughly 10% of our gasoline consumption. This is an important contribution, but it does not fundamentally change our dependence on petroleum. To end our petroleum addiction, we must produce ethanol from cellulosic materials. These are inexpensive, abundant residues including crop, forest and urban wastes as well as crops and woody plants grown specifically for their energy content. We could produce cellulosic ethanol today using well-established technology

for about $2.50 per gallon. Unfortunately, that's just not good enough yet to compete with petroleum.

Biofuels in five years But I have good news. Over the past thirty years or so a relatively small, but determined group of people have worked to develop improved technologies for cellulosic ethanol. I am proud to be among that group. Recently the Department of Energy announced financial incentives for a truly historic project...establishing six large demonstration plants for cellulosic ethanol using these improved technologies. One of Mr. Khosla's companies is testing a seventh approach with financial assistance from the State of New York. So we are testing seven approaches simultaneously. I know many of these technologies in considerable detail. In fact, one of my inventions will be tested at a cellulosic ethanol plant in Iowa. In five years or less I believe we will have good evidence that some of these technologies can produce cellulosic ethanol for around $1.20 per gallon.

When that happens, the next step will be to establish full scale commercial plants based on the most successful new technologies. Because these technologies are new there will inevitably be bugs in the system that can only be worked out in large commercial scale plants. Also, some cost improvements will only be achieved when suppliers have big markets, for example, for their enzymes which convert cellulose to sugars.

So there will still be very large business risks. Congress should consider providing tax credits or other incentives for the first full commercial scale plants in order to reduce these risks, and so investors will not fear that their investments will be stranded. Such an approach could be limited to the first billion gallons of cellulosic ethanol. Cellulosic ethanol will happen—but such incentives can help reduce our dependence on foreign oil much more quickly.

When those large scale commercial plants become fully functional, the economics become well understood and the risks are sufficiently reduced, I believe cellulosic ethanol will take off. The industry will grow very rapidly, limited mostly by our ability to gather enough cellulosic raw material together in one spot.

Biofuels in the longer term What can we expect in the longer term? I testified before Senator Lugar's Committee on Agriculture in 2001. I will repeat now what I said then. I believe that in the longer term we can replace all of our petroleum imports, every bit of it, with cellulosic ethanol produced domestically at much less than $1.00 per gallon. This is not a pipe dream, but a sober, hardheaded assessment of our ability to produce the required raw materials and process them to biofuels.

Biofuels and farmers As ethanol production technology improves, the cost of processing will become less and less important, while the delivered cost of

the cellulosic biomass will become more and more important. In other words, the farm sector will only grow in its relative importance. Herein lies both danger and a great opportunity.

How can we be sure that our nation's farmers and farm communities benefit from cellulosic ethanol? If they are simply suppliers of raw materials to others who process the raw materials to fuels, farmers probably will not do very well. We need research, policies, technologies, supply chains and business models that help farmers: 1) supply low cost cellulosic biomass and 2) participate financially in the processing, thereby capturing some of the added value. Our research, energy, agricultural, environmental and tax policies will need to be properly coordinated to accomplish this…a tall order. Regarding tax policy, which falls under your jurisdiction, we need incentives to encourage the collection of cellulosic materials, the planting of relevant crops and the development of the first commercial scale cellulosic ethanol plants. These steps will maximize our country's ability to produce this alternative fuel.

But if we do that, we can realistically expect a new era for our country and for rural America, an era in which our petroleum addiction is beaten, in which we are much more secure geopolitically and environmentally, and where prosperity has returned to our rural communities. That is a future worth not only contemplating, but achieving.

Thank you, Mr. Chairman, I look forward to your questions.

Committee on Finance
Grains, Cane, and Automobiles:
Tax Incentives for Alternative Fuels and Vehicles
April 19, 2007

Questions for the Record From Dr. Bruce Dale

1) Dr. Dale, you say that we'll eventually make cellulosic ethanol for less than $1.00 a gallon, replacing all of our imported oil. You also suggest that incentives are needed to encourage the collection of cellulosic feedstocks. Doesn't that put the cart before the horse? Rather than focusing on feedstocks, shouldn't we instead try to get large-scale facilities up and running? (Chairman Baucus)

The whole system has to come along together, feedstocks and refineries. So it is not either or, it is both. We are now constructing 7 large scale facilities for cellulosic ethanol, so I think that part is moving pretty well. When I talk to leaders in this industry, they tell me that what they are now worried about is feedstock collection and supply chain issues. So relatively speaking, I think we now need to bring the feedstock collection system forward more rapidly.

2) Which tax incentives do you think are most likely to facilitate the widespread production of cellulosic ethanol? Does a VEETC-like, per-gallon credit make most sense? Or should Congress instead provide investment tax credits, along the lines of Sections 48A and 48B for clean coal? (Chairman Baucus)

Tax policy is not an area I know much about. Whatever incentives are provided should be of limited scope and duration. Cellulosic ethanol will eventually be really cheap, and we just need to "prime the pump" to get the industry going.

3) A few of you on this panel have stated that you do not feel that biodiesel produced by soy or vegetable oil is viable long term. Most this nation's heavy duty vehicles run on diesel fuel making it imperative that green diesel fuel be a part of any discussion of biofuels going forward. As many of you know, even within the last week we have seen developments in the area of new diesel technology.

   What do you believe will be the future for green diesel fuel and what do we as a Congress need to achieve that? (Senator Lincoln)

Green diesel can be made from syngas processing of cellulosic feedstocks. I am not sure that that synthetic diesel can ever compete economically with diesel from coal or natural gas. The existing technology doesn't favor biomass feedstocks in such a competition. I think much more promising approaches are to produce diesel like molecules directly in the leaves and stems of green plants through genetic engineering, or to have microbes

making diesel like molecules from cellulose-derived sugars. A few million $ in research would tell us if either of these approaches will work, and if they do, then we can have all the green diesel we want at very competitive prices.

4) If we could achieve what you believe is possible, which is to replace all of our petroleum imports with cellulosic ethanol produced at less than $1 per gallon, what would be the effects on the economy, on national security, on the environment, and so forth? (Senator Hatch)

The DOE estimates that every $1 billion of oil imports costs us 10,000 jobs. If we replace all of our oil imports with cellulosic ethanol in 30 years, which I believe is entirely reasonable, we would be generating millions of new jobs and hundreds of billions in new economic activity. On national security, we would no longer be held hostage by countries like Iran or Venezuela, nor would the rest of the world. If we do cellulosic ethanol properly, and we know what we need to do, we should be able to greatly slow or even reverse the buildup of carbon dioxide in the air and avoid many of the other problems associate with petroleum consumption.

5) I'd like to ask you a bit more about the biomass technology being pioneered by companies such as the Iogen Corp. that would allow cellulose to be broken down and converted into ethanol.

   Many experts refer to this process as the "holy grail" of the ethanol industry, because it would make virtually every part of every kind of plant available for production.

   You mention in your testimony that in five years we will have good evidence that Cellulosic ethanol can be produced for about $1.20/ gallon and less than a $1/gallon in the longer term.

   With gas hovering around $3/ gallon, that sounds pretty good right now.

   a. On what evidence that you've seen thus far do you base your enthusiasm? (Senator Crapo)

For large scale fuels, only two things matter: the cost of the raw material, and the cost of processing. Plant raw material is already very cheap. On an energy basis, the energy content of cellulosic materials is equivalent to oil at about $15 per barrel. What we need is cheap processing to convert that energy in biomass to fuels like ethanol. Iogen and six other companies are pioneering cellulosic ethanol, and more are waiting in the wings to get started, so we are going to be exploring lots of processing pathways simultaneously. Independent analysis by different groups has shown that at least some of these pathways can potentially make ethanol very cheaply. Since we are now exploring a number of processing options simultaneously and we will learn how to get processing costs down—make the industry "mature". We have done so for many industries from semiconductors, to penicillin to petroleum, and we will do it for cellulosic ethanol also. Based on mature processing technologies, several very thorough studies have shown that we can produce ethanol for much less than $1 per gallon.

6) I would also like to ask you the same question I posed to Mr. Khosla:
    a. What do you see as the single biggest obstacle for development of cellulosic ethanol right now? (Senator Crapo)

Demonstration of cost effective conversion technologies at large scale...we are pursuing this as a country right now. Then shortly after that, learning how to gather the raw materials efficiently and at low cost.

Testimony of Jay D. Debertin,
Executive Vice President and Chief Operating Officer, Processing,
CHS Inc.
Before the Senate Committee on Finance Hearing on
"Grains, Cane, and Automobiles: Tax Incentives for
Alternative Fuels and Vehicles"

April 19, 2007

My name is Jay Debertin, executive vice president and chief operating officer for Processing for CHS, the nation's leading cooperative business. CHS is headquartered in Minnesota and is owned by more than 350,000 farmers and ranchers, through local cooperatives, in 30 states.

Today, CHS has evolved into a diverse company with several major business platforms linked to biofuels.

The first of these is Energy. We produce and distribute petroleum products for the rural marketplace from our small refineries in Montana and Kansas. Today we supply fuel to more than half of the farmers in the nation.

Our second platform is Grains. We buy, handle, and ship worldwide, grains including corn and wheat, and oilseeds such as soybeans, canola and sunflowers. We operate processing facilities that convert oilseeds into oils used in the production of cooking oils and biodiesel.

Our third platform is Renewable Fuels. For nearly 30 years, we have been blending ethanol into gasoline and soy esters into biodiesel. Today, 200 of our nation's 1,000 E85 stations, or 20 percent, carry our Cenex® brand. Last year we invested in ethanol production, as well, by becoming a 22 percent owner in US BioEnergy. Today, US BioEnergy is this nation's second-largest ethanol producer.

While my primary purpose here today is to present our positions on specific policy matters related to biofuels, I will also share our views on the overall energy debate.

Let's begin with issues related to three specific biofuels -- ethanol, biodiesel and biomass.

First, ethanol. The tax incentives for ethanol and the Renewable Fuels Standard mandate are what launched the renewables market, particularly in ethanol production. We believe the current tax incentives for ethanol blending and production and E85 pumps are adequate. However, we have concerns about the distribution and infrastructure systems for ethanol and the relative positioning of ethanol supply. Unless incentives are provided to encourage distribution from Midwest ethanol producers to the coastal states, which have the demand base and population, we would not be surprised to see a Midwest glut of domestic ethanol, with negative consequences for this fledgling industry.

In our view, the most important steps that can be taken are measures that would expand overall national demand. A requirement that all gasoline sold nationwide contain a 10 percent blend would extend the demand from its current Midwestern base to our nation's

population centers on both coasts. In addition to a 10 percent national requirement, we'd also support giving states the opportunity to use a 20 percent ethanol blend if they chose. Second, biodiesel. CHS would urge caution in passing a specific biodiesel mandate. We believe the supply issues arising from shifting vegetable oil production from food to energy must be better understood. With these issues in mind, we believe the current biodiesel tax incentives are adequate.

We are also exploring "renewable diesel." Our petroleum refineries are studying adding bio-based feedstocks, specifically soybean oil, into our diesel manufacturing processes. That would mean adding soy oil before diesel is produced rather than blending in soy ester after diesel is made. The Energy Policy Act of 2005 extended the $1.00 per gallon agri-biodiesel tax credit to this new diesel form and the Treasury Department just issued guidance permitting its use by all petroleum refiners, refineries and others. But the new technology could be costly to implement and we do not think the refining industry will adopt it en masse.

Finally, biomass. Although the viability of biomass as a feedstock in motor fuels remains uncertain, we have looked at other biomass applications. For example, we are considering co-generation at the oilseed-crushing facilities in Minnesota using corn stover and other bio sources. We would like to pursue this further, but have found that there is little incentive to do so and that the current biomass supply is unreliable. We believe both time and investment are needed to achieve marketable technologies for biomass.

I have shared with you our positions on the specific tax-related issues this committee has under consideration. I would be remiss, however, if I failed to share our view of the big picture.

The real questions are: "What is the best total approach to addressing our nation's long-term energy needs, as well as critical questions like global warming and the economic health of America." And, "How can the Congress advance renewable fuels as part of the solution to the country's energy needs?"

On the first issue, we at CHS advocate a broad and realistic approach to our nation's energy future. Unlike single-minded approaches for fossil fuels or renewable fuels, we see not a single pathway, but a four-lane approach, each lane representing one component of the solution, but all headed in the same direction. A real solution will take (1) investment in our existing fossil fuels energy supply, (2) adoption of renewable fuels, (3) investment in emerging energy technologies and, of course, (4) conservation, sometimes overlooked, but vitally important. In the long-term, we need this multi-faceted approach and we must also remember that any approach ultimately must be economically viable for the individuals and businesses involved.

On the second question of how Congress can advance the renewable fuels component of this total energy solution, we suggest the following:

First, support and extend the current ethanol and biodiesel tax incentives which appear to be working well and revisit those for the other biofuels.

Second, as I said earlier, if there is a desire to increase the use of biofuels, we would increase our chances of success with a minimum national standard for gasoline such as E10, where almost every gallon has a renewable element, rather than establishing another multi-billion gallon mandate. This will help lead to a stronger renewable fuels industry that supports the goal of diversification away from fossil fuels.

Third, increase promotion of a national renewables infrastructure which makes certain renewable fuels are used where the highest demand exists.

Finally, focus future incentives to those willing to try new means of advancing the cause of biofuels and biomass.

Embracing this leadership platform will help this nation better transition to a multi-fuel based country using the best of petroleum, renewable and alternative fuel sources.

Thank you for allowing me to speak today. I would be happy to respond to your questions.

Committee on Finance
Grains, Cane, and Automobiles: Tax Incentives for Alternative Fuels and Vehicles
April 19, 2007

Responses to Questions for the Record From Jay Debertin

Questions for Mr. Debertin

(1) I am concerned about the potential impact of fuel production that is overly concentrated in one area. A terrorist attack to a refinery can have a devastating effect on our country's economy. CHS is a cooperative-owned company, returning profits to the "farmer-owner." What benefit is there to building small biofuel plants that can be financed locally for local consumption? (Chairman Baucus)

(1) What benefit is there to building small biofuel plants that can be financed locally for local consumption?

- *Benefits may be in the 'eye of the beholder.' Locals may be able to finance, use, and sustain the viability of a small biofuels plant.*
- *However, small facilities are more vulnerable to an industry shakeout.*
- *The market place is best suited to determining where, when and how large a facility should be built.*
- *Sustainability of that facility is critical.*
- ***Deciding whether to build small vs. large is impacted by many variables. In some cases going small could have some value.***
- *Financing them in part locally should have some benefits.*
- *The scale of energy consumption is so huge in this nation that small biofuel plants should have very little impact in helping our energy security. They therefore serve other purposes.*

(2) There are an estimated 6 million flex-fuel vehicles on U.S. roads. But only about 150,000 of these vehicles actually use E85, partly because the filling stations that dispense the fuel are concentrated in the corn belt. What is CHS doing to make more E85 fueling stations broadly available in the U.S.? (Chairman Baucus)

(2) What is CHS doing to make more E85 fueling stations broadly available in the U.S.?

- *CHS is a leader in helping promote E85.*
- *Currently CHS provides approximately 200 of the 1,000 E85 stations with ethanol under its Cenex brand.*
- *CHS provides training to station personnel.*
- *CHS provides them marketing and promotion services.*

- *Although E85 may serve a role,* ***providing for a national ethanol standard of something like E10 or E20 provides far more efficiency*** *to a supply and distribution system that could piggyback off the existing petroleum system as opposed to recreating a parallel system.*
- *The 'chicken or the egg argument,' E85 pumps or E85 vehicles, is real.*
- *The promotion of E85 should start with encouraging state and federal fleets before commercial entities.*

(3) A few of you on this panel have stated that you do not feel that biodiesel produced by soy or vegetable oil is viable long-term. Most this nation's heavy duty vehicles run on diesel fuel making it imperative that green diesel fuel be a part of any discussion of biofuels going forward. As many of you know, even within the last week we have seen developments in the area of new diesel technology.

What do you believe will be the future for green diesel fuel and what do we as a Congress need to achieve that? (Senator Lincoln)

(3) What do you believe will be the future for green diesel fuel and what do we as a Congress need to achieve that?

- *Green diesel is often the name given to 'renewable diesel' which is diesel made with biomass (most likely vegetable oil) and petroleum processing call thermal depolymerization.*
- *It has important fuel characteristics that have far better qualities and cause fewer distribution problems than biodiesel.*
- *It is not yet commercially made in the US although it is to a small degree in Europe.*
- *Renewable diesel has a place, albeit relatively small in overall energy portfolio.*
- *If one of the goals is to reduce dependence on fossil fuels then renewable diesel must be considered a fuel that helps accomplish this.*
- *If another goal/benefit is to find a renewable fuel that is more environmentally friendly than petroleum diesel then this accomplishes that.*
- *If another goal is to promote new and better fuel production technology, this accomplishes that, too.*
- ***The current $1.00/gal tax incentives for renewable diesel authorized by Congress in the 2005 Energy Bill and recently validated by the IRS should be maintained at least for small refiners/refiner cooperatives.***
- *This area of renewables needs to be researched and this tax break to small or cooperative refiners serves at least in part as a Research and Development tool. It lets at least small refiners develop this renewable leg.*

(4) I found your 4-lane highway analogy as a suggested solution to our nation's energy challenges to be very interesting. I would imagine that the development of plug-in hybrids would fit into your third lane, that of investment in emerging energy technologies. However, do you share the view that many have that plug-in hybrids have the potential to transform our nation's energy situation? (Senator Hatch)

(4) Do you share the view that many have that plug-in hybrids have the potential to transform our nation's energy situation?

- *Unlike for the other questions we are answering here, we have no expertise in this area to comment.*
- *However, if a goal is to promote new and better fuel production technology, this accomplishes that.*

(5) In your testimony, you mentioned that because of supply issues, you don't feel that a specific biodiesel mandate is appropriate at this point.

a. What do you feel is an appropriate way to spur biodiesel production and when do you see the supply becoming reliable enough for your industry? (Senator Crapo)

b. What's holding it back right now? (Senator Crapo)

(5) What do you feel is an appropriate way to spur biodiesel production and when do you see the supply becoming reliable enough for your industry? What's holding it back right now?

- *A mandate and tax incentives are what invigorated the general renewable industry.*
- ***Establishing a targeted mandate and extending current biodiesel tax incentives should do the same.***
- *We agree with the 'World Perspective' analysis: It is difficult to justify any national biodiesel usage mandate for 2012 greater than about 500 million gallons based on the available supply of vegoils and the potential to profitably get rid of the additional protein meals that will be produced. That could change if there are major breakthroughs in producing vegoils from algae or other non-oilseed crops. There has been very little economic justification for most of the nation's biodiesel plants being built in the first place.*
- *Biodiesel quality issues continue to need to be addressed.*
- ***Biodiesel fuel properties are not as good as renewable diesel** and the biodiesel industry is dealing with far more extensive and expansive fixes than may be necessary given the alternative, which is renewable diesel, is better.*
- *The infrastructure to deal with the unique fuel properties of biodiesel especially in colder climates is costly.*
- *To support this industry, federal policy must facilitate a business model that accommodates the food vs. fuel dynamics that will probably be more acute for biodiesel than ethanol.*

Invited Testimony for the U.S. Senate Committee on Finance
Prepared Statement of
Dr. Robert Farrington
Manager & Principal Researcher, Advanced Vehicle Systems Group
National Renewable Energy Laboratory
Golden, CO
April 19, 2007

Mr. Chairman, thank you for this opportunity to discuss the next generation of alternative fuels and vehicles. I am Rob Farrington, the Principal Researcher and Manager of the Advanced Vehicle Systems Group at the National Renewable Energy Laboratory, in Golden, Colorado. NREL is the U.S. Department of Energy's primary laboratory for research and development of renewable energy and energy efficiency technologies. I am honored to be here, and to speak with you today.

The committee is to be commended for its interest in finding alternatives to, and reducing our nation's dependence on, imported petroleum. NREL is dedicated to helping our nation develop a full portfolio of renewable energy technologies that can meet our energy needs.

My testimony today will focus on opportunities for reducing fuel use for ground transportation. The range of viable options fall into several broad categories – lowering miles traveled in personal vehicles, using alternative fuels and increasing the fuel economy of vehicles. Each option provides benefits, but might incur increased initial costs and some degree of risk.

Consumers in the United States purchase about 16 million cars, light trucks, and SUVs annually, and we have a total fleet size of about 225 million vehicles today. Currently, it takes about 15 years to turn over the entire fleet. To put that in perspective, if we were to somehow provide all of the new vehicles built from today going forward with some dramatically new technology, a decade from now fully 40 percent of our nation's vehicles still would not have benefited from those improvements. The lesson is that the impact of any new technology will take significant time to evolve. Therefore, our first priority should be to institute desired changes quickly and deliberately, so their benefits can begin to have an impact.

Any discussion of reducing our use of imported petroleum should begin with consideration of ways we can reduce overall use of fuels. This would encompass reducing the miles traveled in personal vehicles, as well as more efficient transportation systems within the commercial sector. So, when we weigh the overall effect, the many disparate policies that deal with mass transit, carpooling, high occupancy vehicle lanes and other highway usage measures, and even biking and walking, should be seriously considered, for these efforts can and should make very significant contributions to overall energy efficiency.

Looking at technology-based solutions, the development of alternative fuels has great potential. The U.S. currently produces about 5 billion gallons of ethanol annually, and that figure is growing rapidly given the number of new plants under construction or planned. Most of the ethanol produced today is blended with gasoline to produce a 10% ethanol blend. There are some 6 million vehicles on the road that can use up to E85, the 85 percent ethanol blend, or about 2.5 percent of our total passenger vehicle fleet. So there is considerable opportunity to expand use of ethanol within the existing fleet, and we have recently seen a new emphasis among automakers to expand the number of new vehicles sold with E85, or flex-fuel, capabilities. Only about 1,100 U.S. service stations, or about one-half of one percent of the total 170,000 service stations, currently offer E85, though the rate of growth for new ethanol pumps has been expanding rapidly in recent months. It should be remembered that the miles per gallon for ethanol is approximately 26 percent less than that of gasoline. That fact suggests that ethanol costs would have to be roughly a fourth less than those of gasoline to be equal on a cost-per-mile basis. Considerable opportunities exist for biodiesel as well; most biodiesel blends are designed to be used with conventional diesel engines.

The incremental cost of making a conventional gasoline vehicle into a flex-fuel vehicle is estimated to be about $50 to $200 for each vehicle. Automakers have announced plans to double the number of flex fuel vehicles produced each year by 2010, and make half of all new vehicles flex-fuel capable by 2012. This suggests that – at least in these early stages – we are on track toward transitioning our vehicle fleet to take advantage of the projected growth of ethanol production, as we move beyond the corn feedstock, and move in a major way to produce cellulosic ethanol, as federal policies envision for the future.

Perhaps the biggest opportunity before us is to increase overall fuel efficiency for passenger vehicles and light trucks. There are a number of ways to go about this. One way is to increase miles per gallon is to reduce the mass of the vehicle. Lighter-weight materials can go a long way in that direction. What is needed are lightweight materials inexpensive enough to replace more typical steel components, so the final product does not increase substantially in cost. Reducing aerodynamic drag, through advanced vehicle design, and reducing rolling resistance, also offer some possibilities.

One area that deserves more attention is the potential to reduce fuel use by cutting the consumption of auxiliary loads. Air conditioning can account for 10 percent or more of a vehicle's fuel consumption – more in some climates – and there are a number of promising technologies that may have the potential to drastically reduce air conditioning fuel use, while maintaining a comfortable cabin for a driver and passengers. Auxiliary load reduction is particularly important as we move toward electric drive propulsion, since those loads further drain the battery and reduce the range of the vehicle. The U.S. Department of Energy created analytical and experimental capability at NREL to develop and evaluate technologies to reduce climate control loads in collaboration with automotive companies and their suppliers.

There are powertrain technologies as well that can boost the miles per gallon achieved. Some involve more efficient designs of engine and transmission systems, others turn off

selected cylinders when their power is not needed. Clean diesel is an option that is employed in Europe and gaining interest in the United States, not only for commercial vehicles, but also for personal vehicles.

Hybrid-electric vehicles (HEVs) have in recent years gained public attention and momentum in the marketplace, spurred on, at least in part, by favorable tax treatment from federal and state government. Hybrid-electric vehicles can save 20 percent to 50 percent of fuel consumption of comparable conventional vehicles, particularly in city driving. Hybrid systems turn off the gasoline-fueled engine when idling, such as when coasting or at a stop, use batteries and electric motors for short accelerations, recharge their batteries by recovering the energy used in braking and use batteries for auxiliary loads.

Sales of HEVs continue to grow and accounted for about 1.5 percent of the 16 million light duty vehicles sold in 2006, and about .3 percent of our overall fleet. Although this currently represents a small fraction, to date, we estimate hybrid vehicles have saved 230 million gallons of fuel.

The growing acceptance of hybrid-electric vehicles has helped spawn interest in utilizing electricity for our transportation needs, through plug-in hybrid electric vehicle (PHEV) technology. By relying on grid-produced electricity, plug-in hybrids have the potential to eliminate gasoline use and thereby reduce reliance on imported petroleum, for a large portion of the daily trips undertaken by a large segment of the driving population. Since the average trip length is 4.5 miles, and half of all daily driving is under 30 miles, a plug-in hybrid vehicle that could run 30 miles or more on electricity alone could displace significant amounts of imported oil.

Longer term, if PHEVs were to grow to a substantial portion of the U.S. vehicle fleet, there could be additional benefits associated with this technology. While the grid would of course provide needed electricity to the plug-in fleet, it is possible that collectively, plug-in hybrids could in turn create a new energy storage system, putting power back onto the grid, providing grid-charging, grid voltage stabilization and emergency power generation for the broader population of utility customers when needed.

Overall greenhouse gas emissions could be reduced if renewable electricity sources are used to charge the PHEV batteries, offsetting the large carbon dioxide footprint of our predominantly coal-based electricity generation system. Further advantages could be gained if plug-in hybrids were designed to use ethanol or a substantial ethanol-gasoline blend, rather than conventional gasoline, as fuel for those trips that extend beyond that which could be driven using stored electricity alone.

Hybrid-electric cars and plug-in hybrid cars each have advantages and disadvantages. The electric motors in HEVs can be used in tandem with the gasoline engine, and thus can be sized appropriately smaller than that for plug-in hybrids. The electric motor in PHEVs is larger than that in HEVs because it must be able to handle accelerations without turning on the engine.

Once the electric range is reached in a PHEV, it then operates as an HEV. It is possible that PHEVs could be designed with smaller electric motors, where the engine would assist with acceleration and hill climbing. The cost for energy storage, motors and electronics thus could be lowered. One of the benefits of both HEVs and PHEVs is that consumers can purchase vehicles with comparable characteristics of conventional vehicles that they prefer (e.g., the Ford Escape and the Ford Escape Hybrid) with no sacrifice of capability, often with improved performance and a reduction in fuel use.

Tailpipe emissions may constitute one potential issue surrounding plug-in hybrids. That is because plug-in hybrids might run long periods on electricity alone, and correspondingly long periods between use of the internal combustion engine. That could lead to multiple "cold starts" and increased tailpipe emissions given current catalytic converter design. Research into methods for managing the temperature of emission control systems could mitigate these concerns.

Energy storage remains the most critical barrier in the commercialization of plug-in hybrids, as it has been historically in the evolution of electric-powered vehicles. It is important to note that the battery requirements for HEVs and PHEVs are fundamentally different. HEVs might be likened to sprinters – they need high power for short distances, primarily in acceleration. PHEVs are more like cross-country runners – they need extra power to summit the hills but also need sustained energy over the longer haul.

These differing needs conflict with the limitations of current battery technology. HEVs are able to maintain battery life by only using about 10 percent to 20 percent of the available battery capacity, never coming close to depleting the energy in the battery. Because they rely on electricity alone for substantial travel, PHEVs require a lot more energy storage. To minimize cost, weight and volume, about 80 percent of the battery's capacity would be cycled daily in a PHEV. Beyond these concerns about "deep discharges," PHEVs will have numerous shallow discharges as well. The resulting impact on battery behavior and lifespan is not yet known, and should be the subject of continued research and testing.

Lithium ion batteries constitute the most promising battery technology for plug-in hybrids today, though lithium ion technology still must surmount several potential issues before it can be broadly commercialized for vehicle use. These issues include the potential for heat buildup during and following charging, the demands posed by extreme hot and cold climates and long-term reliability.

While lithium ion batteries are the focus for PHEVs, any development to reduce cost and improve lifetime will also benefit HEVs. The early application of lithium ion batteries may actually be in HEVs. This constitutes both a learning opportunity and a pathway to broader deployment in PHEVs. Toyota has indicated that they will use lithium ion batteries in the next generation Prius due in 2008 or 2009.

Further research is required to understand how consumers will use these vehicles in order to size battery systems correctly. Each additional kilowatt of energy storage costs the same. But if batteries are infrequently used, then they will have minimal benefits, and a higher cost per mile. On the other hand, PHEVs offer flexibility – batteries could be added to increase range after purchase, to suit individual needs.

From a U.S. economic and technology-competitiveness standpoint, it is important to note that nearly all batteries for HEVs, currently of nickel-metal hydride technology, and much of the power electronics, are manufactured in Japan with growing capacity in China and South Korea. In order for U.S. manufacturing to be competitive, we need to develop a domestic supplier base for HEV and PHEV components.

There are two significant government-industry partnerships engaged in research and development of HEVs and PHEVs, as well as other important advanced automotive technologies: the FreedomCAR and Fuel Partnership for light vehicles and the 21st Century Truck Partnership for heavy vehicles. Researchers at NREL, other national laboratories and within industry have identified energy storage, power electronics and electric motors – the subsystem needed to control and distribute electrical energy around the vehicle -- as areas where additional research related to HEVs and PHEVs would provide significant benefits to the nation.

Hybrid electric powertrains also provide opportunities for the nation's approximately 18 million commercial vehicles. Urban commercial vehicles, such as postal vehicles, refuse haulers, utility vehicles and delivery vehicles experience significant stop-and-go driving. The rigors of these short-haul commercial vehicles are well-suited to systems that capture braking energy, assist the engine during frequent accelerations and turn off the engine during coasting and stops. Such systems could reduce fuel consumption by 30 percent or more.

However, each of these unique commercial vehicles present a differing set of demands, which in turn determine vehicle size, configuration and duty cycles. As a result, each type of vehicle is likely to have a different hybrid powertrain solution. For example, the duty cycle of a refuge hauler most often consists of a long drive to a neighborhood, followed by repeated short starts and stops, ending with a long drive to a municipal waste site. Rather than using batteries, this application might be ideal for ultracapacitors – devices with very high power to move such a heavy load over short distances – while the engine is used only to and from the municipal waste site.

Hybrid transit buses are being used today and have demonstrated an average 27 percent reduction in fuel use. Depending on climate, about 25 percent of the fuel for transit buses is used for heating and cooling passengers. School buses can double the fuel economy with hybridization, but at twice the $70,000 price of a conventional bus. Postal delivery vehicles could benefit significantly from plug-in operation where they might use the engine to reach a neighborhood and then an all-electric mode while making mailbox-to-mailbox stops.

On the other end of the heavy vehicle spectrum, long-haul trucks, which operate at fairly constant speeds, consume nearly 16 billion gallons of diesel fuel annually. The opportunities here reside in more efficient engines, reduced aerodynamic drag, low rolling resistance tires and the opportunity to use biofuels. One promising method of cutting fuel consumption and tailpipe emissions is to use batteries to provide heating and cooling, and electricity for lighting, entertainment and ancillary equipment, during mandatory driver rest periods. Most of those needs today are met through idling of the truck's main engine.

Many other commercial vehicles also idle for extended periods during the delivery of packages or collection of refuse, or simply to operate necessary equipment like fans, extension buckets, backhoes, etc. Altogether, idling of commercial vehicles is estimated to consume more than 2 billion gallons of fuel annually, with commensurate production of unwanted emissions. Some of these loads during idle could be provided by battery packs, such as from a plug-in hybrid.

There are some promising developments in the commercial vehicle arena. FedEx currently is creating a fleet of 100 hybrid delivery vans with an estimated 57 percent improvement in fuel economy and significantly reduced emissions. The Sprinter delivery vans produced by DaimlerChrysler can travel 20 miles on electricity alone.

It may be helpful to look at relative fuel savings as a way to sort out the technology opportunities for achieving greater fuel efficiency in the U.S. A vehicle driven 12,000 miles, getting 25 miles a gallon, consumes 480 gallons of gasoline annually. A similarly-sized HEV might cost about $3,000 more, and at 40 to 50 miles per gallon, save as much as 180 to 240 gallons a year, respectively. A PHEV, meanwhile, at 80-100 miles per gallon, might save 330 to 360 gallons a year and could cost about an additional $9,000 beyond that of a conventional vehicle, if it were mass produced. If we look at the resulting fuel savings versus cost equation, a hybrid-electric vehicle would save about twice as much fuel per dollar of incremental cost – at today's projected costs.

Most automotive consumers focus on vehicle purchase price and not on lifetime costs which would include operating and maintenance costs. Cost reductions are needed to increase the market acceptance of HEVs and eventually PHEVs. Fundamental research is required to significantly reduce costs for energy storage devices and power electronics that will not come solely from mass production.

There are, however, other benefits that can be attributed to plug-in hybrids. PHEVs would mostly rely on domestically-produced electricity. The cost of this electricity would be about half as much as gasoline, calculated on a per-mile basis. And while that electricity today would be produced by significant amounts of coal and natural gas, plug-in hybrids could, over the longer term, be powered by renewable and other environmentally beneficial resources as our grid generation systems are diversified. It is assumed that most plug-in hybrids would be charged at off-peak periods to take advantage of favorable rates. PHEVs also have the potential for zero emissions for most trips in a typical urban environment, and could transfer day-time urban emissions to more

remote nighttime emissions when off-peak charging is used. PHEVs also require minimal change in existing infrastructure, because a PHEV with a 30-mile range could use 110 volts, commonly available in garages, to charge a vehicle overnight.

In summary, the opportunities we have before us to increase energy efficiency and use of alternative fuels, including domestically produced electricity, that will reduce our reliance on imported oil have tremendous potential. About 60 percent of the crude oil we use is imported, and crude oil costs equal 56 percent of the price of a gallon of gasoline. Given that, a 20 mile-per-gallon vehicle will use about 8400 gallons of gasoline over its 14-year life, and consume about $8,500 worth of imported crude oil. Thus, efforts to reduce imported fuel consumption clearly can provide significant benefits for the U.S. economy, as well as the environment.

My testimony today shows, I believe, that a single solution to our transportation fuel challenges does not exist. Differing options offer various benefits and tradeoffs, and therefore national policies should be structured accordingly.

Current biofuels like biodiesel and corn ethanol – and longer-term, cellulosic ethanol – can displace significant amounts of imported petroleum while providing attendant environmental and economic benefits. Deployment of existing fuel-saving technologies, coupled with development of even more fuel-efficient methods, can still go a long way toward making today's conventional internal combustion engines more efficient.

At the same time, hybrid-electric vehicles could provide one of the quickest technological paths toward reducing imported oil – particularly if developed to use biofuels. However, HEVs are limited to reducing our fuel consumption by 20 percent to 50 percent. Longer term, plug-in hybrid vehicles offer the promise of eliminating our dependence on foreign-produced petroleum, and provide a transition to an all-electric personal transportation system which could include hydrogen fuel cell vehicles (FCVs) and perhaps also plug-in FCVs.

As we take the necessary steps toward a future where advanced vehicle technologies play a larger role, we should do so understanding the corresponding need to create a U.S. manufacturing base for HEVs and PHEVs and their components. It would be less than productive to trade our dependence on imported petroleum for a dependence on imported batteries. The lack of domestic industries to produce advanced battery and power electronics could, longer term, pose a serious issue for U.S. competitiveness. The U.S. currently relies almost exclusively on Japanese-produced components in these fields with growing capacity in China and South Korea.

The overarching goal should be to achieve the greatest impact in displacing foreign oil imports, long-term, collectively and nationwide. Any such portfolio should be directed at advancing multiple new technologies and fuels, as there is no single solution to our nation's energy and transportation challenges.

Thank you.

Committee on Finance
Grains, Cane, and Automobiles: Tax Incentives for Alternative Fuels and Vehicles
April 19, 2007

Responses to Questions for the Record From Dr. Robert Farrington

1) You say in your testimony that, "It would be less than productive to trade our dependence on imported petroleum for a dependence on imported batteries. The lack of domestic industries to produce advanced battery and power electronics could, longer term, pose a serious issue for U.S. competitiveness." What can we do to make sure the U.S. doesn't fall further behind in the battery race? (Chairman Baucus)

U.S. battery manufacturing capability is required for hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and eventually totally electric vehicles (EVs), each of which will most likely use different battery cell designs. First, we must support U.S. R&D on energy storage systems to establish our technical innovation and leadership in this area (including design of cells, electrodes, electrolytes, separators, assemblies, and thermal management systems). Second, we must minimize technical and investment risk to battery manufacturers for such large investments in new technologies without an existing market. Third, we should encourage collaborations among battery manufacturers, energy storage system integrators, and vehicle manufacturers such as has been done in Japan and was done in the U.S. Department of Energy's (DOE) Hybrid Electric Vehicle Program during the 1990s. Our national laboratory system, which houses cutting-edge modeling and experimental tools, should be actively employed to assist industry in all of these areas.

2) Your testimony focused principally on fuel consumption and emissions reduction by cars, light trucks and heavy-duty trucks. One area not addressed in your remarks is the potential for fuel savings and reduced emissions in rail transport. What is the potential for improvement in rail carrier efficiency, in terms of both fuels and vehicle technologies? Is the fuel cell or hybrid approach feasible with locomotives? What might Congress do to facilitate gains in these areas? (Chairman Baucus)

Our focus at DOE and National Renewable Energy Laboratory (NREL) is on cars and trucks, primarily because that is where most of the gains could potentially be made (on-road diesel use in the U.S. is approximately 7 times that of rail use).

Diesel electric locomotives, which are hybrids, are common and provide significant benefits over purely diesel engines. An extension to conventional rail travel may be to use an external electric line for all electric transport in urban areas as these locomotives already have electric motors. The costs and benefits of these systems need to be assessed.

3) You note in your testimony that, "Since the average trip length is 4.5 miles, and half of all daily driving is under 30 miles, a plug-in hybrid vehicle that could run 30 miles or more on electricity alone could displace significant amounts of imported oil." Many people in urban areas park along the street, not in garages, where outlets are available. If plug-in hybrids are to catch on in areas like these, what sort of infrastructure will be needed to advance their use? (Chairman Baucus)

Whereas, HEVs can provide benefits to nearly all users, plug-in hybrid electric vehicles will initially appeal to those with existing access to 110-volt charging. Eventually, the greatest opportunity may in fact be in urban areas where public on-street parking is common. We have the technology required to install electric outlets on public streets, and private and public parking structures, etc. The key issue is one of commitment in order to overcome the traditional chicken-and-egg syndrome. Buyers are unlikely to purchase PHEVs if they can't charge them, and companies are unlikely to install electric outlets unless there is a demand. Some interim opportunities may be to encourage companies, shopping centers, restaurants, military and federal facilities, etc., to install charging for employees and customers. A mechanism to bill customers for the electricity can be similar to parking meter keys already used in urban areas or radio transmitters used for high-occupancy vehicle lanes. It is conceivable that existing parking meters could be modified with electric outlets.

4) You say in your testimony that reducing rolling resistance offers a possibility for increasing overall fuel efficiency for passenger vehicles and light trucks. Last year, the National Research Council issued a report suggesting that it was possible to significantly reduce rolling resistance, without sacrificing safety and performance characteristics, by a change in tire composition. Do you agree with the report's findings? What is a realistic timeline for implementation of this technology? (Chairman Baucus)

The NRC report referenced by Chairman Baucus states that "The committee could not find safety studies or vehicle crash data that provide insight into the safety impacts associated with large changes in traction capability, much less the smaller changes that may occur from modifying the tread to reduce rolling resistance." The report also states that "tires with higher wet traction grades tend to have higher rolling resistance." In The Japan Automotive Digest (April 23, 2007) Sumitomo claims that new low-rolling resistance truck tires may

improve highway fuel economy by 17% by adding silica to rubber. A significant challenge facing the tire industry is the large amount of oil used to produce tires. The alternative, natural rubber, is a limited commodity, often located in politically unstable areas. Reduced petroleum use can be obtained not only by changing tire composition to reduce rolling resistance but also from automatic tire inflation and other means, which keep the tires operating at optimal conditions. One of the research areas identified to NREL by the tire industry is to develop accelerated life-testing techniques to evaluate wearability and lifetime of new tire materials and designs. With adequate R&D funding, these advanced tire technologies could be ready for commercialization in the next 5 to 10 years.

5) A few of you on this panel have stated that you do not feel that biodiesel produced by soy or vegetable oil is viable long term. Most this nation's heavy duty vehicles run on diesel fuel making it imperative that green diesel fuel be a part of any discussion of biofuels going forward. As many of you know, even within the last week we have seen developments in the area of new diesel technology.

   What do you believe will be the future for green diesel fuel and what do we as a Congress need to achieve that? (Senator Lincoln)

   Because diesel fuel is critical for commerce—essentially all goods and commodities are transported using diesel vehicles—the continued development of renewable replacement fuels should be a priority. And because of their high efficiency, diesel engines may become more prevalent in U.S. light-duty automobiles as well. In the U.S., approximately 40 billion gallons per year of diesel is used by our on-road vehicles.

   Biodiesel can be produced from a broad range of vegetable oil, animal fat, and waste feedstocks, not just from soybean oil, by a chemical process known as tranesterification. Green (or renewable) diesel is the term used for a fuel which also comes from plant or animal oil feedstocks, but is produced via a hydrotreating process similar to that used in petroleum refineries to produce distillate liquids. (This process can also provide a renewable replacement for petroleum-based jet fuel.) In 2004 NREL estimated that the current resource for biodiesel production was 1.7 billion annual gallons. Optimistically, there is potential to add to this resource over the next decades to provide over 10 billion annual gallons, still only 25% of current on-highway diesel fuel use, by 2030. With today's technology, the limitations are clearly on the feedstock side— the U.S. simply does not have the plant, animal, or waste oil base to support large-scale biodiesel or green/renewable diesel production. To achieve a higher potential will likely require government investment in both technology development and incentives.

   On the feedstock side, longer-term R&D on high oil-yield sources, such as algae, should be pursued. Although soybean fields can produce only 50 gallons of oil per acre, algae has the potential to provide <u>100 times</u> that yield— and on otherwise

non-arable land utilizing brackish, saline, or even wastewater. Beyond that, the major potential source of a renewable diesel fuel could come from thermochemical conversion of biomass followed by synthesis of hydrocarbons in a process that has been termed biomass-to-liquids or BTL. To ensure adequate supplies of non-petroleum diesel fuel, long-term R&D on BTL process development should be accelerated.

The biodiesel tax credit initiated in January of 2005 is driving market growth and innovation in the private sector to increase oil production and yield from existing feedstocks, and to develop new energy crops and processes for recovery of oils from waste streams. Additional incentives for development of oilseed processing infrastructure may be required to expand the size of the oil resource.

Beyond that, we need to address the attributes and quality of these new fuels themselves. R&D that ensures that they are compatible with diesel engines and do not cause increases in tail-pipe emissions must be performed in concert with feedstock and process development.

6) Dr. Farrington, comment on which side—the consumer-demand side, or the manufacturer-supply side—do you believe tax incentives make the most difference in advancing plug-in electric vehicles? (Senator Cantwell)

Our overall goal should be to reduce our dependence on imported oil and reduce carbon dioxide emissions, to which PHEVs are one of many promising solutions (along with mass transit, carpooling/HOV lanes, more efficient conventional vehicles, HEVs, EVs, bicycles, etc.). While I am not an economist, I believe this question requires detailed analysis including an assessment of unintended consequences. Manufacturing incentives could encourage production by reducing risk to the manufacturer in case such vehicles are not purchased. Consumer incentives can be positive; however, they may unintentionally push many potential buyers into the alternative minimum tax where they cannot claim consumer tax credit, without modification to the current tax law. Combinations of incentives are also possible, with Federal manufacturer incentives and state consumer tax incentives, such as exists in Colorado.

7) Dr. Farrington, what steps can we take to also create a domestic supplier base for hybrid electric and plug-in electric vehicle components so that we are not importing our power electronics from China or South Korea? (Senator Cantwell)

First, we need qualified scientists and engineers to develop the technology. I believe that the solution begins with our education system. With fewer and fewer Americans pursuing engineering and science degrees, including doctoral degrees in these areas, we are losing our technical competitive edge. Furthermore, we have a difficult time retaining qualified foreign-born students who come to earn their doctoral degrees in top U.S. universities and wish to stay to work in our R&D establishment. Second, we need to actively support collaborative research

in cost-effective, efficient components that engages industry (suppliers and vehicle manufacturers), academia, and national laboratories. Third, we need to minimize risk to companies that commit significant investments into long-term R&D while they exist in an investor environment of short-term quarterly profits and losses. Fourth, we need to invest in manufacturing R&D also, ensuring that the U.S. has the best production capabilities such that the technologies developed here actually remain in the U.S. for the manufacturing phase. All of these points also apply to battery R&D and manufacturing, not just to power electronics.

8) Dr. Farrington, I know many of my colleagues here share my enthusiasm for biofuels and we are exploring ways to solve the "chicken and egg" problem that has been a significant barrier to the widespread adoption of biofuels.

One of those problems is that there are about 6 million flex-fuel vehicles on the road, but very few E85 pumps. Only about 150 thousand of those vehicles actually fill up with E85.

a. What is the primary impediment to getting more fueling stations in place?

The main impediments to more E85 fueling stations involve (1) securing adequate financial resources for upgrading existing or building new stations and (2) establishing a sufficient business case for E85 sales via adequate flex-fuel vehicles (FFV) populations and motivated fuel consumers. While 6 million FFVs sounds like a significant number, it represents less than 3% of the light-duty vehicles, and even those may not be present in sufficient concentrations locally to sustain a station. In addition, the lower energy content of E85 compared to gasoline means that E85 must be priced below gasoline to be economically competitive for consumers on a per mile basis.

b. What can the government do to move this along? (Senator Cantwell)

Section 1342 of the Energy Policy Act of 2005 provided a tax credit equal to 30% of the of cost alternative refueling property, up to $30,000 for a business property. This credit could be expanded or extended past its current expiration date of December 31, 2009. Incentives could be increased for automakers to increase their production of FFVs, especially in geographic regions with the highest ethanol production. In addition, the supply of ethanol to the E85 market could be made more dependable through tax incentives that improve the economics for using ethanol as E85 instead of E10. Alternatively, a gasoline tax could be used to encourage use of ethanol and other alternatives (as well as reduction in vehicle miles traveled), much as European countries have used gasoline taxes to encourage diesel infrastructure and use of mass transit. Finally, Federal programs that support local and regional partnerships, such as the Clean Cities program, that bring station owners, fuel providers, vehicle dealers, and fuel consumers together are also critical.

An additional pathway would be to investigate the benefits and barriers to increasing the ethanol percentage (beyond the 10% in E10 offered in some states) in all gasoline for all conventional vehicles. The impacts on drivability, reliability, and tailpipe emissions from increasing the ethanol concentration in conventional gasoline are not currently known. NREL is participating in an effort led by DOE to develop the required data to determine the feasibility of implementing E15 or E20.

9) In your testimony you identify the battery storage system as the key cost driver for plug-in hybrid vehicles. Can you share with us what the U.S. is doing to address this technical challenge? (Senator Salazar)

DOE is working closely with industry, including the U.S. Advanced Battery Consortium (USABC), on overcoming technical obstacles for lithium ion batteries including thermal issues, lifetime, and the effects of daily deep cycles combined with numerous shallow cycles. DOE announced on April 5th that it will provide up to $14 million of a $28 million cost-shared solicitation for PHEV battery development. USABC has issued the call for proposals. DOE and USABC aim to improve battery performance, so vehicles can drive up to 40 miles on electricity before recharging, or the range of most daily round-trip commutes. The research will seek to identify battery technologies that have the potential to be commercialized and quickly brought to market, in addition to meeting USABC's criteria for performance, weight, life-cycle, and cost.

10) In your testimony you raise the concern that the lack of domestic industries to produce advance battery storage systems results in the U.S. currently importing batteries from Japan, and China and South Korea in the future. Do you have suggestions for what the U.S. could do to speed the development of a domestically produced advanced battery storage systems? (Senator Salazar)

This is a critical issue that is also addressed in my responses to questions 1 and 7.

11) Let's say that our nation makes a dramatic shift toward using the electric grid to power our vehicles. Would you say by that time, that hydrogen fuel cells will be at a point where average consumers will then be able to take their Plug-in hybrid vehicles off the grid and run as fuel cell vehicles? How long would it take to get to that point? (Senator Hatch)

Fuel cell vehicles (FCVs) could also be plug-in hybrids where the fuel cell replaces the engine found in a PHEV. In that case, hydrogen does not replace the electric power to daily charge the batteries, but replaces the internal combustion engine and eliminates the requirement for petroleum. An FCV is essentially an EV with onboard electric generation. A plug-in fuel cell would then have two sources of electricity—the utility grid and the fuel cell.

In terms of pure FCVs, the DOE goal is to have technologies ready for a hydrogen infrastructure and fuel cell systems by 2015 such that reasonably priced FCVs could begin appearing in automaker showrooms by 2020. Of course, it would take some time after that for the penetration of these vehicles to be a significant portion of our U.S. vehicle fleet.

12) As you mentioned in your testimony, automakers have announced plans to make ½ of all new vehicles E85, or flex fuel capable by 2012.

As you know there are tax incentives in place to encourage infrastructure development for E85, but do you feel like Congress is doing enough to encourage development that will keep pace with the goals of the automakers? (Senator Crapo)

The current incentives are a great start; however, if the government desired to significantly increase the number of flex-fuel vehicles, it could provide a tax incentive to manufacturers for the additional cost or other policy considerations such that all new vehicles would be flex-fuel vehicles at some near point in time.

13) Additionally, you mention that the incremental cost of making an automobile into a flex-fuel vehicle ranges from $50 -$200.

What sort of economies of scale are you talking about that would achieve that cost? (Senator Crapo)

At today's production rate, the current incremental cost for manufacturing flex-fuel vehicles is between $50 and $200 per vehicle.

14) Can you expound on the new air conditioning technologies that have the potential to reduce fuel use in vehicles? (Senator Crapo)

There are various technologies to reduce the fuel used for air-conditioning vehicle occupants. The first is to reduce the solar load to the vehicle including solar-reflective glass (which reflects about 50% of the heat while maintaining high visibility), solar shades, infrared reflective paint, and ventilating the vehicle while it is parked in the sun. The second would provide efficient distribution of the cooled air such as through climate-control seats (which cool the occupants instead of the entire vehicle), occupant controls (which cool only the occupants and not empty seats), and advanced air diffusers. The third would be to use efficient equipment including variable displacement compressors, electric compressors, and optimized components.

15) As we all know, plug-in electric cars have been around for a long time. Even with tax incentives for their purchase passed by Congress (which have since expired and not reauthorized for lack of use), they have never achieved the popularity of modern hybrids.

What steps, in your opinion, are necessary to the success of future generation plug-in hybrids? (Senator Crapo)

I think that there is a natural progression from HEVs to PHEVs and eventually to EVs as consumers re-evaluate their driving requirements and as battery capability increases and costs decrease. In order for PHEVs to have a large market penetration, there will need to be an infrastructure in place that makes it convenient to recharge the vehicle—not just at home, but also at work and other remote locations.

EVs still have limitations in range and recharge time as well as high battery cost and charger installation cost. One challenge with EVs is that they carry batteries sufficient for a range of 300 miles or so, even though 50% of daily driving is less than 30 miles. Therefore, a significant portion of their expensive battery pack is not highly utilized. The benefit of PHEVs is that the owner only pays for and transports the battery set that is frequently used. In addition, recharge time is not an issue because PHEVs will operate as HEVs if the battery pack is depleted, whereas an EV needs to be plugged in at a fixed location for the entire recharge cycle.

16) Is there any potential for PHVs for agricultural equipment?

What are the associated challenges associated with load- carrying vehicles and this technology? (Senator Crapo)

In principle, there is potential for PHEVs in most vehicle applications. The energy storage for commercial and industrial vehicles can be used for ancillary loads (lifts, drills, electric power, etc.) as well as for moving the vehicle. It would be worthwhile investigating the types of power and energy requirements for agricultural equipment; however this is not currently in the DOE portfolio of technologies being addressed because the potential fuel savings is much less than that of light vehicles and on-road heavy vehicles.

United States Senate
Committee on Finance

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Opening Statement of Senator Chuck Grassley
Committee on Finance Hearing, "Grains, Cane and Automobiles"
Thursday, April 19, 2007

First of all, I would like to thank Chairman Baucus for calling this hearing today, titled "Grains, Cane and Automobiles." Although the title may be somewhat tongue in cheek, the topic is very important. Today we will hear from a diverse panel of experts, all of which have come to the same conclusion. Our panel members today are national security experts, technology investors, scientists, inventors and pillars of the rural economy. Even though they have all approached this problem from totally different backgrounds, they are offering similar conclusions. They have concluded we need to invest in the science, technology and infrastructure to empower the American people with their own choice to free themselves from the grip of foreign petroleum.

Everyone wants to talk about shaking our growing dependence on foreign fossil fuels, but we will never have that opportunity in our lifetimes and maybe not in our children's lifetimes if we do not aggressively identify domestic energy options. The Finance Committee has jurisdiction over all of the potential tax and trade provisions that can help create a consistent sustainable energy policy for this nation.

As a long-term member of this committee and the previous chairman of this committee, I have aggressively proposed utilizing the tax code to help level the playing field between traditional fossil fuel-powered automobiles and the petroleum-based fuel refineries. In fact, for years, I have worked to decrease our reliance on foreign sources of energy and accelerate and diversify domestic energy production. I believe public policy ought to promote renewable domestic production that uses renewable energy and fosters economic development.

Specifically, the development of alternative energy sources should alleviate domestic energy shortages and insulate the United States from the hostile governments that dominate oil supply. In addition, the development of renewable energy resources that supplement and expand our existing fuel inventory conserves existing natural resources and protects the environment. Finally, alternative energy development provides economic benefits to farmers, ranchers and forest land owners, such as those in Iowa who have launched efforts to diversify the state's economy and to find creative ways to extract a greater return from abundant natural resources.

Diversification of fuel and automobiles is important to our future energy policy. Studies show that biomass crops could produce between $2 billion and $5 billion in additional farm income for American farmers. If you consider the recent success of ethanol since the Energy Policy Act of 2005 was signed into law, this number may be low.

In addition, marginal farmland incapable of sustaining traditional yearly production is often capable of generating native grasses and organic materials that are ideal for biomass energy production. Turning tree trimmings and native grasses into energy provides an economic gain and serves an important public interest. I hope our continued review of energy policy will promote our research and success in utilizing biomass not only for electricity production but for the alternative fuel market.

And finally, I have continued concerns that our U.S. trade deficit has been substantially impacted by our continued reliance on foreign fossil fuel and U.S. reliance on foreign technology. I will be very wary of proposals that would only substitute our dependence on foreign oil for just another dependence on foreign fuel alternatives and technology. Our continued economic security depends on the ability to have energy choices not tied to a particular government or technology. I am pleased the Finance Committee energy hearing schedule has chosen to review the state of fuel and automobile technology.

Statement of Vinod Khosla to Committee on Finance hearing on "Grains, Cane, and Automobiles: Tax Incentives for Alternative Fuels and Vehicles."

Mr. Chairman and honorable members of the Committee, there is a climate crisis, a security crisis and an impending oil crisis - and as Stanford economist Paul Romer has said, **a crisis is a terrible thing to waste. The country that first finds solutions to these crises will be the leading economic power in the 21st century.** America's scientists and technologists, powered by new ideas and the energy of America's entrepreneurs, are best equipped to solve this problem. **It is an unprecedented economic opportunity with many beneficial side effects**, which has attracted wide-spread attention and support across the political spectrum. It even includes business leaders like the CEOs, from companies like DuPont, GE and Duke Energy, who have called for tough federal limits on carbon dioxide emissions. Recently, that call was echoed by institutional investors managing $4 trillion in assets.

However, there are many forces that will oppose this change. Each $4 change in the price of a barrel of oil costs Saudi Arabia (a country with a smaller population than California) a trillion dollars. Our own Renewable Fuels Association, in my opinion, is not sufficiently supportive of E85 and cellulosic ethanol because of its closeness to the oil industry and it's reluctance to support any agenda that the oil industry opposes. Hundreds of billions of dollars are at stake for the oil producing companies. My impression is that the American Petroleum Institute is on a massive PR campaign to prevent or slow this transition. **In my Wall Street Journal editorial on January 23, 2007, I called on President Bush to declare a war on oil. This war is winnable, politically feasible with small compromises, and a great boon to all Americans - rural or urban. It will direct three hundred billion dollars of oil money from the terrorism financing mid-east countries to rural America each and every year, and will lead to $1 a gallon wholesale cellulosic ethanol within a decade.**

For those of you who don't believe this is possible, there are many precedents for massive change. In 1982 when I started Sun Microsystems, I was told that one could not compete against IBM, Digital Equipment Corporation, Data General, Burroughs, Control Data and other stalwarts of the computer business. Most of them are now gone and a few have adjusted, humbled by the seemingly "toyish" microprocessor. In 1996 I got in a room with the CEO's of nine major US media companies, including the Washington Post, New York Times, Knight-Ridder, Tribune, Cox, Times-Mirror and others and tried to explain how the internet would disrupt their business models, and little companies like Yahoo, Ebay, Google and others would be a threat. Today Google is worth as much as all of them combined. The pharmaceutical companies went through a similar experience, ignoring biotechnology in the early days. Ten years ago every major telecommunications company told me that they would never adopt the internet IP protocol as their core network just as we were starting a telecommunications equipment company called Juniper to produce IP equipment. Major "experts" like AT&T laughed at the idea that all long distance calls would be virtually free to consumers. Today, for failing to heed that trend, major players like AT&T are mere brands, their company sold for a song. Less than ten years later, yesterday's "unthinkable fact" is today's "conventional wisdom".

Wind power now costs about five percent of what it did 25 years ago. Solar energy costs are down more than 90 percent since 1970. With the right policies, the unthinkable transition from oil to renewable fuels can happen in the oil industry too - in fact it is likely to happen because it makes sense for consumers, for the climate, for national security, and it makes economic development sense for America as a whole. And it won't stop there. We will go on to not only replace gasoline but diesel, then jet fuel, then many plastics and polymers and home insulation and much more, all from renewable resources grown by America's and the world's farmers. This is leadership we must show the world.

America's farmers and corn ethanol producers have done this country a great service and I have written often in defense of the much maligned corn ethanol. **It is the most important new economic phenomenon in rural America and the most important new energy development in decades. Biomass and agricultural based energy could permanently correct the rural/urban economic development imbalance. It could shift much of the oil portion of our GDP to rural GDP and create millions of new jobs.** The farmer must make as much money with cellulosic crops for us to achieve substantial availability. Appendix C (C.1 and C.2) shows estimated farmer economics. Farmers can make more money growing biomass crops than corn (Ideally, they would grow them in corn/soy/biomass crop rotations). Biomass's lower input costs both improve farmer economics and environmental sustainability requiring less water and fertilizer. Energy crops will make it possible to replace all of America's gasoline in twenty five years on about 60 million acres of land (Appendix E.1 shows production and E.2 consumption capability). The Khosla Ventures investments in cellulosic and corn ethanol are shown in Appendix B. **Our best estimate of current cellulosic ethanol development shows cost effective production in 2009, subject only to feedstock availability at economic cost.**

We are investing in entrepreneurs and scientists in all these areas. It is heartening that leading scientists from MIT, Harvard, Caltech, Berkley, Stanford, and many other such institutions, that previously had no work going on in energy, are now the founders of these innovative startups. Such focus on the part of our best scientists and innovation is key to the technological breakthroughs and surely will not come form the American Petroleum Institute and its "cannot do" attitude. We have found scientists working on energy breakthroughs at Dartmouth (Mascoma), in pipe-fitting shops in Denver (Range), using platforms developed for malaria drugs in Berkeley (Amyris), in other university labs at Harvard, Stanford and Caltech (Gevo and LS9), in India (Praj), in New Zealand (Lanza) and in other parts of the world. The DOE went looking for 3 biomass fuel projects to fund, and instead found twice as many worthwhile projects (see Appendix F).The conventional wisdom says that we will have to stay dependent on oil. I ask all the experts who pontificate about this to look at the facts, and at the latest developments in our labs, and imagine the future instead of extrapolating from the old energy world using conventional platitudes. We must empower these entrepreneurs, and signal to them that we are serious about winning the war on oil. Some of the optimists in the startup world will surely be wrong, but will dozens of efforts all fail? Could so many companies and investors (Appendix D –a selection of companies we know of), each with a different source of technology, all be wrong? My analysis (refer back to Appendix E.1) shows **39**

billion gallons of biofuels production is possible in the U.S., at reasonable cost, by 2017 on 19 million acres; and 139 billion gallons by 2027 on 49 million acres. Details of potential production and consumption of E85 ethanol if an FFV mandate is instituted is shown in Appendix E.2

One of the benefits of the switch to biomass based liquid fuels (to replace oil) is the positive effects with regard to world poverty. A focus on biomass will generate new income for Africa, India and Latin America's rural poor in addition to America's rural population. Almost certainly, America will produce all its own fuel given its agricultural advantages; Latin America might supply Europe and China; Africa might supply Europe and India and result in a new, more distributed and diverse geopolitical balance on energy and incomes.

What do we need to do?

1. **Set a very high RFS with an appropriate "automatic" relief valve** as the President has proposed, so all new technology developers have an incentive to invest in R&D knowing if they can produce and sell a product within a $1.00 per gallon of the cost of gasoline initially, a market will exist for their product. This incentive of a large market is critical to encourage the risk capital investment and to encourage America's scientists, technologists, and entrepreneurs. I suggest the President's goal of 35 billion gallons by 2017 is reasonable. **If we don't achieve it the relief valve mechanism automatically protects consumers and increases funding for advanced biofuels** as I shall explain below.
2. **Offer consumers price protection** against high ethanol prices by allowing the notion of identification numbers that the President has proposed. I would suggest that these numbers can be purchased at $1.00 per gallon limiting the price of ethanol and hence the price of corn, **protecting livestock producers too** and blunting fuel versus food arguments. I have written about why (in my opinion) most such arguments are specious anyway. Otherwise, why would developing countries be clamoring for lower farm subsidies? Incidentally the roughly $3 billion in ethanol subsidies last year I was told decreased farm subsidies by about $6 billion in 2006. A net gain to the treasury!
3. My proposal will allow us to **pay as we go** in today's constrained budget environment. The purchase of identification numbers combined with a high RFS will allow us to set an ambitious target; if this target is not **reached**, it will raise funds **if the proceeds of the identification number purchases are put into a pool to allow incentives for cellulosic biofuels (under my proposal).** The President has proposed such funds go into treasury instead. The more we miss our target the larger the funds we will have to incentivize their development under my proposal. Incentives will be self funding.
4. **Create a "producers credit" for cellulosic ethanol and all advanced biofuels** independent of the VEETC credit which expires in 2010. A credit of $0.76 per gallon to any producer of advanced biofuels (as defined in the Appendix to this testimony) as long as it achieves atleast a 50% reduction in carbon emission per mile driven and uses **scalable feedstocks like cellulosic biomass or renewable**

large scale waste will encourage such production. I propose such a credit start declining by $0.15 per year starting in 2015 and expire completely by 2020. I am specifically proposing that vegetable oils that are used for biodiesel are not a scalable feedstock and should not be included because it will not be land efficient. **To solve our long term problems, any agricultural feedstock must generate at least 1500 gallons per acre by 2030.** My calculations show that land use is the most critical variable and cellulosic biofuels can produce between 2500-3000 gallons per acre by 2030. Certain food kernel based fuels are unlikely to even approach 1000 gallons per acre. We should be **encouraging technologies with long term potential to scale** but not be funding technologies that won't eventually produce atleast 25% of our gasoline replacement.

5. There is much resistance among certain circles to removing tariffs. I submit that **removing tariffs in the right way is good for America's farmers** and will result in much larger markets eventually for E85 and result in cheaper fuels for consumers. Today we buy the cheapest Saudi Arabian oil in the world and add a tariff to the much greener and cheaper Brazilian ethanol which it competes with. We should protect corn ethanol producers who have done so much for our country by keeping the tariffs for ethanol blending up to 20% blends by **setting a separate RFS of 15 billion gallons per year for the blend market – this will protect corn ethanol producers. By removing tariffs for E85 use only, we will dramatically expand the market for E85 ethanol while still making room for cellulosic ethanol from America's farms by having a 20 billion gallon "primary fuels market" RFS for advanced biofuels like cellulosic E85.** We should encourage Europe to do the same. The gasoline equivalent price can be reached with imported ethanol and cellulosic incentives, getting the E85 markets, including cars, pumps and fuel production going. Today we have the blend market "tail" wagging the development of the E85 market "dog". This anomaly in the long term is not good for America's producers who would benefit from a 1000% bigger E85 market than a small "blend market" for ethanol, or for American consumers who will keep paying a higher price for gasoline.
6. The oil interests would like to distract us with just the blend market and not encourage the creation of fleets of vehicles capable of taking a fuel alternative to gasoline like E85 ethanol. I believe the Renewable Fuels Association has not been sufficiently supportive of E85 and cellulosic ethanol because of its closeness to the oil industry - I don't believe they are acting in the best interest of America's farmers, corn growers or it's national security interests. To get long term energy security and diversity we need to create a fleet of cars capable of multiple fuels. We should **mandate that 50% of the cars be FFV's by 2012 and 70% by 2015**, capable of E85 ethanol and other advanced biofuels like butanol and mixed alcohols. I estimate this costs less than $50 per car, and probably around $35. To be more technology neutral we could potentially require all cars to offer at least one renewable fuel by these dates, - plug-in hybrids, E85, butanol, biogas based CNG are among the alternatives offered to automakers. Renewable fuels should be defined as broadly as possible including all mixtures of alcohols, and renewable diesel and gasoline form scalable feedstocks.

7. **Mandate that all pumps dispensing more than 2m gallons of fuel have atleast one E85 pump by 2009** and all pumps dispensing more than 1.5m gallons have one E85 pump by 2011. Only gas stations with millions of dollars of annual revenue will be subject to this mandate.
8. We must encourage research on biomass feedstocks, tomorrow's "energy crops." Switch grass or miscanthus grass are economic for farmers at the yields of 6-10 tons per acre today, but we need even higher yields and "grass cocktails" to avoid the problems of monoculture agriculture and lower biomass prices. We need significantly more research in agronomy practices focused on energy crops and crop rotation schemes. I have proposed a "7 year by 7 year crop" rotation between food crops and biomass "cocktail crops" that improve yields and sustainability while reducing crop inputs like water and fertilizer. Miscanthus already yields 15 tons per acre in a wide variety of regions, including the U.K., and in Illinois test plantings. **My analysis shows that 24 tons per acre is possible by 2030 and about 50 million acres will replace most gasoline consumption in the US. I have proposed twenty universities in geographically disparate areas each manage five plots of biomass crops for a total of two million acres of biomass energy crop plantings.** This will create a realistic map of our biomass capabilities, of optimal crops, logistics and sustainable crop practices. Feedstock availability of one million tons within a thirty mile radius of a 100 million gallon per year cellulosic plant is likely to be the single biggest impediment to scaling cellulosic ethanol availability.
9. Create incentives for E85 sales. This is key to scaling usage and create demand pull, but will not happen unless E85 is at 70% of the cost of gasoline. A limited period (ten years or the first 5 billion gallons per year dispensed) **E85 tax exemption from federal taxes** would help together with the cellulosic credit mentioned above.
10. **I prefer to see no coal to liquids included in the alternate or renewable fuels standards. Coal to liquids could be included in the RFS (as the administration prefers) if there is a $0.50 per gallon penalty** unless the technology is at least carbon emission neutral (relative to gasoline on a per mile driven basis). Without this provision, if coal to liquids is allowed as part of a general alternative fuels standard (as the administration has proposed) **coal as feedstock will permanently kill biomass to fuels since coal will always be cheaper** as a feedstock and the scale of the plants will be larger for coal based fuels, making cellulosic biofuels uneconomic relative to coal to liquid fuels. We can convert our Georgia forest based ethanol plant to coal to liquids and achieve lower production costs. **Coal to liquids will hurt America's farmers,** making cellulosic crops uneconomic and be a real disincentive against distributed rural economic growth.
11. **Ideally, in this "pay as you go" environment VEETC should be capped at the maximum amount invested in the capital of the plant but this can only be done if VEETC is made a producers credit.** No producer should get more of a VEETC subsidy from the government than the total cost of the physical plant which typically happens within the first three years. This will materially limit the cost of the program to the federal government and would allow more funding of

cellulosic incentives. It is unconscionable that the federal government is paying many times the cost of plant construction for old plants. Further by making VEETC a blenders credit it becomes a highly inefficient funding mechanism providing little support to producers when they need it most in times of excess supply and low prices as blenders have pricing power at such times. This hurts small producers the most as the more sophisticated producers engage in sophisticated financial transactions and avoid these dynamics. **I suspect that the principal reason for this distortion is ADM's desire not to be perceived as receiving $750 million annually** (which they do receive) **in direct subsidies** (as a pure profit measure, that would have ranked 184th on Fortune 500 in 2005 from subsidies alone) from the government every year as they expand capacity to 1.5 billion gallons annually - they prefer to make it look like blenders are getting this subsidy. Maybe half the funds provided as credits probably end up with the small corn ethanol producers **making the current credit format a very inefficient use of government funds.** As a result we have a very inefficient funding mechanism under the excuse that small producers cannot use tax breaks. The latter problem can be solved through the mechanism of tradable identification numbers as the administration has proposed.

12. **All advanced biofuels** that use large volume feedstocks capable of tens of billions of gallons of production without disrupting markets, and replacing petroleum based products **should be treated equally**. Beyond cellulosic ethanol and waste based ethanol, entrepreneurial and larger companies are working on butanol, diesel like fuels from cellulosic materials, jet fuels from cellulosic materials, and even gasoline directly from cellulosic and waste materials.
13. Legislation should make accounting rules uniform between the oil industry and the biofuels industry; many tax advantages and subsidies are embedded in the arcane accounting rules (for e.g. "excess of percentage over cost" rule which has been a $80b subsidy for the oil industry). **A revocation of the "excess of percentage over cost" accounting rule that allows oil companies to take more than 100% depreciation would probably fully fund the cellulosic incentives** proposed here.
14. In today's "pay as you go" environment" **subsidies can be reduced while providing increased benefits in the form of insurance to ethanol producers – variable subsidies will provide insurance to producers by linking any ethanol VEETC subsidies to the price of oil.** Just as tax breaks for oil should be phased out as the price rises, subsidies for clean energy should be decreased if oil price rises and increased as the price of oil falls. This would signal to oil suppliers – and OPEC in particular – that predatory pricing would be futile. Such oil price manipulation by the OPEC cartel happened in the early 1980's. Alternatively, we can mandate a "price floor" tax for oil, to prevent market manipulation. Implement a $40 floor on oil (as suggested in the past) such that any time the price goes below $40, funds can be placed in a "price stabilization fund", which can be used to reduce the price of oil when the price inevitably rises or to fund alternatives to oil. The benefit of a price floor mechanism is that it would encourage all alternative technologies, not just ethanol
15. Most renewable technologies get an "Investment Tax Credit". We should consider

making advanced biofuels facilities eligible for this. However this would encourage higher capital cost technologies that trade off upfront capital costs for lower operations costs. This may not be the optimal tradeoff.

16. A "carbon emission fee" per gallon of gasoline or diesel sold could alternatively provide the funds necessary to fund the cellulosic ethanol and advanced biofuels producers' credit. This can help with "pay as you go" and get us started on accounting fro carbon costs till such time that a "cap and trade system" for carbon emissions is instituted.

I humbly submit a markup of Senator Bingaman's bill (Appendix A) with additional mechanisms that move us faster towards energy security and green house gas mitigation and faster rural economic development, that is revenue positive, that protects corn ethanol producers, that protects consumers form high ethanol prices and livestock producers from high corn prices, that allows for corn ethanol, cellulosic ethanol, E85 and even coal to liquids in a way even many environmentalists can support.

- Why is this good for farmers & rural America?
  - Long term agricultural alternative to gasoline
  - Long term value to "land products" & land
  - Rural % of GDP will increase changing the traditional rural/urban balance
  - Increased plant financing & ethanol (substitute biofuel) IPO's → demand for "land products"
  - More upside for farmer owned Biofuels plants
  - Cellulosic ethanol (same for butanol, biogasoline, fermentation diesel with cellulose as a feedstock) will increase land value without hurting livestock farmers
  - No "blend wall" that is captive to oil company blending of biofuels – means more R&D money for cellulosic
  - Increase in total farm GDP and the creation of new jobs for the economy

- Why is it good for America?
  - Reduce Carbon Dioxide emissions and take steps towards combating the climate risks associated with global warming

- Increase fuel diversity in the US and internationally, offering choices to the consumer (and perhaps even energy independence)
- Support domestic fuel production and reduce dependence on foreign oil. It reduces security costs and costs to the US economy by hundreds of billions of dollars annually (Senator Lugar estimated our import costs at approximately $320 billion per year, as well as an additional $50 billion a year in oil-related military spending in the Middle East)
- Improve the rural economy and reduce the trade deficit. Offer the nation multiple fuel options in the future by facilitating a flex-fuel fleet
- Geopolitically, the world will be less dependent on oil and thus countries like Iran, Iraq, Venezuela, Nigeria, and Russia

- Why is it good for Consumers?
  - Biofuels will create an alternative to oil, hence competition; advanced biofuels are fully compatible with hybrids
  - Biofuels will decrease demand for oil, decreasing the price of gasoline
  - Biofuels will start a trajectory of oil alternatives, opening energy to new innovative fuels like bio-butanol, bio-gasoline, fermentation diesel and more that are cheaper and cleaner
- Why is it good for the world?
  - Reduces the developing world's exposure to risky, expensive gasoline that is often heavily subsidized (to make it affordable)
  - Biomass is plentiful worldwide, and offers the possibility of energy independence for developing countries
  - Takes steps towards alleviating world poverty and reduces there exposure to climate risk (i.e. – what happens to Bangladesh, Mauritius, etc if the ocean level rises?)
  - Enables China, India, and other fast-growing economies to continue to do so while limiting their greenhouse gas emissions

Appendix A – Proposed Markup to Senator Bingham's Bill

1. Title: To enhance the energy security of the United States by promoting biofuels, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) Short Title.—This Act may be cited as the "Biofuels for Energy Security and Transportation Act of 2007".

(b) Table of Contents.—The table of contents of this Act is as follows:

Sec.1.Short title; table of contents.

Sec.2.Definitions.

TITLE I—RENEWABLE FUEL STANDARD

Sec.101.Renewable fuel standard.

TITLE II—RENEWABLE FUELS INFRASTRUCTURE

Sec.201.Infrastructure pilot program for renewable fuels.

Sec.202.Bioenergy research and development.

Sec.203.Bioresearch centers for systems biology program.

Sec.204.Loan guarantees for renewable fuel facilities.

Sec.205.Grants for renewable fuel production research and development in certain States.

Sec.206.Grants for infrastructure for transportation of biomass to local biorefineries.

Sec.207.Biorefinery information center.

Sec.208.Conversion assistance for cellulosic biomass, waste-derived ethanol, approved renewable fuels.

Sec.209.Alternative fuel database and materials.

Sec.210.Fuel tank cap labeling requirement.

TITLE III—STUDIES

Sec.301.Study of advanced biofuels technologies.

Sec.302.Study of increased consumption of ethanol-blended gasoline with higher levels of ethanol.

Sec.303.Pipeline feasibility study.

Sec.304.Study of optimization of alternative fueled vehicles to use E-85 fuel.

Sec.305.Study of credits for use of renewable electricity in electric vehicles.

SEC. 2. DEFINITIONS.

In this Act:

(1) ADVANCED BIOFUEL.—

(A) IN GENERAL.—The term "advanced biofuel" means fuel derived from renewable biomass other than corn kernels.

(B) INCLUSIONS.—The term "advanced biofuel" includes—

Comment [vk1]: It would be nice to state a minimum carbon emission reduction relative to petroleum of atleast 50% per mile driven as a "requirement"

(i) ethanol derived from cellulose, hemicellulose, or lignin;

(ii) ethanol derived from sugar or starch, other than ethanol derived from corn ***or wheat kernels or sugarcane sugars;***

Comment [vk2]: Could generalize to "food kernels"

(iii) ethanol derived from ***renewable*** waste material, including crop residue, other vegetative waste material, animal waste, and municipal solid waste;

(iv) diesel, ***gasoline or aviation fuel*** -equivalent fuel derived from renewable biomass, including oil ***or algae or renewable waste material;***

Comment [vk3]: Fuels produced from oils may never be land efficient; biodiesel and gasoline can also be produced from corn kernels which will then move to cellulosic materials; such direct production of diesel, jetfuel and gasoline equivalents should be encouraged if they transition to cellulosic materials.
"Vegetable oil" should be excluded from the definition of advanced biofuels.

(v) biogas produced by the anaerobic digestion or fermentation of organic matter from renewable biomass; and

(vi) butanol ***or higher alcohols*** produced by the fermentation of renewable biomass.

(v) "hydrocarbon fuel equivalent" products produced from renewable feedstocks or renewable waste materials

(2) CELLULOSIC BIOMASS ETHANOL.—The term "cellulosic biomass ethanol," means ethanol, ***butanol, mixed alcohols or hydrocarbon fuel equivalent products*** derived from any cellulose, hemicellulose, or lignin that is derived from renewable biomass ***or from renewable waste materials. "Gallon equivalent" of cellulosic biomass ethanol will be computed base don the energy content of the fuel product or fuel mix relative to ethanol.***

(3) CONVENTIONAL BIOFUEL.—The term "conventional biofuel" means ethanol derived from corn ***or wheat kernels.***

Comment [vk4]: Other grains like sweet sorghum may be more desirable as they grow on less fertile lands

(4) RENEWABLE BIOMASS.—

(A) IN GENERAL.—The term "renewable biomass" means any organic matter that is available on a renewable or recurring basis.

(B) INCLUSIONS.—The term "renewable biomass" includes—

(i) renewable plant material, including—

(I) feed grains;

(II) other agricultural commodities;

(III) other plants and trees grown for energy production; and

(IV) algae; and

(ii) renewable waste material, including—

(I) crop residue;

(II) other vegetative waste material (including wood waste and wood residues);

(III) animal waste and byproducts (including fats, oils, greases, and manure); and

(IV) municipal solid waste.

(C) EXCLUSIONS.—The term "renewable biomass" does not include old-growth timber of a forest from the late successional stage of forest development

Comment [vk5]: Might be worth also excluding biomass produced on lands that were ecologically sensitive lands in the last twenty years such as rain forests, peat forests etc.

(5) RENEWABLE FUEL.—

(A) IN GENERAL.—The term "renewable fuel" means motor vehicle fuel, ***aviation fuel,*** boiler fuel, or home heating fuel that is—

(i) produced from renewable biomass; and

(ii) used to replace or reduce the quantity of fossil fuel present in a fuel mixture used to operate a motor vehicle, ***aeroplane,*** boiler, or furnace that would otherwise operate using fossil fuel.

(B) INCLUSION.—The term "renewable fuel" includes—

(i) conventional biofuel; and

(ii) advanced biofuel.

(6) SECRETARY.—The term "Secretary" means the Secretary of Energy.

(7) SMALL REFINERY.—The term "small refinery" means a refinery for which the average aggregate daily crude oil throughput for a calendar year (as determined by dividing the aggregate throughput for the calendar year by the number of days in the calendar year) does not exceed 75,000 barrels.

TITLE I—RENEWABLE FUEL STANDARD

SEC. 101. RENEWABLE FUEL STANDARD.

(a) Renewable Fuel Program.—

(1) REGULATIONS.—

(A) IN GENERAL.—Not later than 1 year after the date of enactment of this Act, the President shall promulgate regulations to ensure that motor vehicle fuel, ***aviation fuel,*** home heating oil, and boiler fuel sold or introduced into commerce in the United States (except in noncontiguous States or territories), on an annual average basis, contains the applicable volume of renewable fuel determined in accordance with paragraph (2).

(B) PROVISIONS OF REGULATIONS.—Regardless of the date of promulgation, the regulations promulgated under subparagraph (A)—

(i) shall contain compliance provisions applicable to refineries, blenders, distributors, and importers, as appropriate, to ensure that the requirements of this subsection are met; but

(ii) shall not—

(I) restrict geographic areas in the contiguous United States in which renewable fuel may be used; or

(II) impose any per-gallon obligation for the use of renewable fuel.

(C) RELATIONSHIP TO OTHER REGULATIONS.—Regulations promulgated under this paragraph shall, to the maximum extent practicable, incorporate the program structure, compliance, and reporting requirements established under the final regulations promulgated to implement the renewable fuel program established by the amendment made by section 1501(a)(2) of the Energy Policy Act of 2005 (Public Law 109–58; 119 Stat. 1067).

(2) APPLICABLE VOLUME.—

(A) CALENDAR YEARS 2008 THROUGH 2022.—

(i) RENEWABLE FUEL.—For the purpose of paragraph (1), subject to clause (ii), the applicable volume for any of calendar years 2008 through 2022 shall be determined in accordance with the following table:

Applicable volume of renewable fuel	
Calendar year:	(in billions of gallons):
2008	8.5
2009	10.5
2010	12.0
2011	12.6
2012	13.2
2013	13.8
2014	14.4
2015	15.0
2016	18.0
2017	21.0
2018	24.0
2019	27.0
2020	30.0
2021	33.0
2022	36.0

(ii) ADVANCED BIOFUELS.—For the purpose of paragraph (1), of the volume of renewable fuel required under clause (i), the applicable volume for any of calendar years 2016 through 2022 for advanced biofuels shall be determined in accordance with the following table:

Applicable volume of advanced biofuels	
Calendar year:	(in billions of gallons):
2016	3.0
2017	6.0

Comment [vk6]: Personally the administrations approach of having a higher standard but having a "relief valve" with a $1 "ID" purchase is a very good idea. Already we might find that these numbers are too low, causing instability in ethanol markets. The administrations proposal will put an upper limit of ethanol at $1 above the price of gasoline but will ensure the maximum possible renewable fuel use that can be produced at this "$1 above gasoline price"

Comment [vk7]: Personally the Presidents goal of 35b gallons by 2017 is more desirable as long as obliged parties can get out of it by paying $1 per gallon as the administration has proposed. That generates funds to incentivize the sale of advanced biofuels and E85 fuel cheaper. The $1 per gallon extra will also encourage the sale of E85 which is key to increasing demand among consumers. It would also allow for imports and still provide a price umbrella for US producers. It would also allow the coal to liquids as long as they achieved atleast a 10% reduction in carbon emission per mile driven.

Comment [vk8]: Personally I would set standards starting at 100m gallons in 2009 so as not to discourage all the technologies currently being commercialized. A "relief valve" like the one the administration has proposed would also work here and allow for more aggressive RFS standards. Three billion gallons in 2016 feels very low. I would recommend 100m in 2009, growing 100% per year till 3b gallons is achieved and then growing 50% per year through 2016. We could put easy outs for advanced biofuels in 2009-2016 if they are not available giving DOE Secretary to make the determination.

2018	9.0
2019	12.0
2020	15.0
2021	18.0
2022	21.0

(B) CALENDAR YEAR 2023 AND THEREAFTER.—Subject to subparagraph (C), for the purposes of paragraph (1), the applicable volume for calendar year 2023 and each calendar year thereafter shall be determined by the President, in coordination with the Secretary of Energy, the Secretary of Agriculture, and the Administrator of the Environmental Protection Agency, based on a review of the implementation of the program during calendar years 2007 through 2022, including a review of—

(i) the impact of renewable fuels on the energy security of the United States;

(ii) the expected annual rate of future production of renewable fuels, including advanced biofuels; and

(iii) the impact of the use of renewable fuels on other factors, including job creation, the price and supply of agricultural commodities, rural economic development, and the environment.

(C) MINIMUM APPLICABLE VOLUME.—Subject to subparagraph (D), for the purpose of paragraph (1), the applicable volume for calendar year 2023 and each calendar year thereafter shall be equal to the product obtained by multiplying—

(i) the number of gallons of gasoline that the President estimates will be sold or introduced into commerce in the calendar year; and

(ii) the ratio that—

(I) 36,000,000,000 gallons of renewable fuel; bears to

(II) the number of gallons of gasoline sold or introduced into commerce in calendar year 2022.

Comment [vk9]: Should the ratio increase by 2-3% per year? This would add less that 3b gallons per year but offer continuity. It could be subject to an assessment of the factors above on impacts

(D) MAXIMUM QUANTITY DERIVED FROM CONVENTIONAL BIOFUEL FEEDSTOCKS.—For the purpose of paragraph (1), the applicable volume for calendar year 2023 and each calendar year thereafter shall not exceed 15,000,000,000 gallons of conventional biofuel.

Comment [vk10]: A similar limitation can be placed on imports and coal to liquids if a higher RFS is picked. If a 35b by 2017 standard is picked then coal to liquids (subject to being better than gasoline in carbon emission) and imports should constitute no more than 10b of the standard. Further we can specify that the blend market is not subject to tariff free imports

(b) Applicable Percentages.—

(1) PROVISION OF ESTIMATE OF VOLUMES OF GASOLINE SALES.—Not later than October 31 of each of calendar years 2008 through 2021, the Administrator of the Energy Information Administration shall provide to the President an estimate, with respect to the following calendar year, of the volumes of gasoline projected to be sold or introduced into commerce in the United States.

(2) DETERMINATION OF APPLICABLE PERCENTAGES.—

(A) IN GENERAL.—Not later than November 30 of each of calendar years 2008 through 2022, based on the estimate provided under paragraph (1), the President shall determine and publish in the Federal Register, with respect to the following calendar year, the renewable fuel obligation that ensures that the requirements of subsection (a) are met.

(B) REQUIRED ELEMENTS.—The renewable fuel obligation determined for a calendar year under subparagraph (A) shall—

(i) be applicable to refineries, blenders, and importers, as appropriate;

(ii) be expressed in terms of a volume percentage of gasoline sold or introduced into commerce in the United States; and

(iii) subject to paragraph (3)(A), consist of a single applicable percentage that applies to all categories of persons specified in clause (i).

(3) ADJUSTMENTS.—In determining the applicable percentage for a calendar year, the President shall make adjustments—

(A) to prevent the imposition of redundant obligations on any person specified in paragraph (2)(B)(i); and

(B) to account for the use of renewable fuel during the previous calendar year by small refineries that are exempt under subsection (g).

(c) Volume Conversion Factors for Renewable Fuels Based on Energy Content or Requirements.—

(1) IN GENERAL.—For the purpose of subsection (a), the President shall assign values to specific types of advanced biofuels for the purpose of satisfying the fuel volume requirements of subsection (a)(2) in accordance with this subsection.

(2) ENERGY CONTENT RELATIVE TO ETHANOL.—For advanced biofuel, 1 gallon of the advanced biofuel shall be considered to be the equivalent of 1 gallon of renewable fuel multiplied by the ratio that—

(A) the number of British thermal units of energy produced by the combustion of 1 gallon of the advanced biofuel (as measured under conditions determined by the Secretary); bears to

(B) the number of British thermal units of energy produced by the combustion of 1 gallon of pure ethanol (as measured under conditions determined by the Secretary to be comparable to conditions described in subparagraph (A)).

(3) TRANSITIONAL ENERGY-RELATED CONVERSION FACTORS FOR CELLULOSIC BIOMASS ETHANOL.—For any of calendar years 2008 through 2015, 1 gallon of cellulosic biomass ethanol shall be considered to be the equivalent of 2.5 gallons of renewable fuel. ***The 2.5 gallons of renewable fuel factor will also be used for purposes of calculating the VEETC credit as per the Energy Policy Act of 2005 with the additional 1.5 times VEETC credit being issued as additional***

"identification numbers" to producers of advanced biofuels at the rate of 0.76 gallons per gallon of advanced biofuels produced. Only US producers of advanced biofuels will be eligible for this additional credit.

(d) Credit Program.—

(1) IN GENERAL.—The President, in consultation with the Secretary and the Administrator of the Environmental Protection Agency, shall implement a credit program to manage the renewable fuel requirement of this section in a manner consistent with the credit program established by the amendment made by section 1501(a)(2) of the Energy Policy Act of 2005 (Public Law 109–58; 119 Stat. 1067).

(2) MARKET TRANSPARENCY.—In carrying out the credit program under this subsection, the President shall facilitate price transparency in markets for the sale and trade of credits, with due regard for the public interest, the integrity of those markets, fair competition, and the protection of consumers and agricultural producers.

(3) The regulations promulgated under sections A and B shall provide that

(i)Unique identification numbers be generated and assigned to each batch of or other quantity of production of renewable fuel by the producer for facilities located in the United States and by the importer for renewable fuels imported into the United States.

(ii) Identification numbers are based on the volume of alternative fuel, adjusted for volume conversion factors under section (c) above.

(iii) Identification numbers may be used to demonstrate compliance with the renewable fuel volume obligation.

(iv) Identification numbers may be held by any party or transferred to any party.

(v) Identification numbers are valid for the compliance purposes for the year in which they are generated.

(vi) The President shall make additional identification numbers available for sale to all parties at a price of $1.00 per gallon of ethanol equivalent. Any obliged party that is unable to acquire sufficient identification numbers to meet its obligations under this Act may purchase such identification numbers. Funds received in payment for identification numbers shall be used by the President to encourage advanced biofuels production as per programs recommended by the Department of Energy. Such funds will primarily be used to encourage advanced biofuels production facilities.

(e) Seasonal Variations in Renewable Fuel Use.—

(1) STUDY.—For each of calendar years 2007 through 2020, the Administrator of the Energy Information Administration shall conduct a study of renewable fuel blending to determine whether there are excessive seasonal variations in the use of renewable fuel.

(2) REGULATION OF EXCESSIVE SEASONAL VARIATIONS.—If, for any calendar year,

the Administrator of the Energy Information Administration, based on the study under paragraph (1), makes the determinations specified in paragraph (3), the President shall promulgate regulations to ensure that 25 percent or more of the quantity of renewable fuel necessary to meet the requirements of subsection (a) is used during each of the 2 periods specified in paragraph (4) of each subsequent calendar year.

(3) DETERMINATIONS.—The determinations referred to in paragraph (2) are that—

(A) less than 25 percent of the quantity of renewable fuel necessary to meet the requirements of subsection (a) has been used during 1 of the 2 periods specified in paragraph (4) of the calendar year;

(B) a pattern of excessive seasonal variation described in subparagraph (A) will continue in subsequent calendar years; and

(C) promulgating regulations or other requirements to impose a 25 percent or more seasonal use of renewable fuels will not significantly—

(i) increase the price of motor fuels to the consumer; or

(ii) prevent or interfere with the attainment of national ambient air quality standards.

(4) PERIODS.—The 2 periods referred to in this subsection are—

(A) April through September; and

(B) January through March and October through December.

(f) Waivers.—

(1) IN GENERAL.—The President, in consultation with the Secretary of Energy, the Secretary of Agriculture, and the Administrator of the Environmental Protection Agency, may waive the requirements of subsection (a) in whole or in part on petition by one or more States by reducing the national quantity of renewable fuel required under subsection (a), based on a determination by the President (after public notice and opportunity for comment), that—

(A) implementation of the requirement would severely harm the economy or environment of a State, a region, or the United States; or

(B) extreme and unusual circumstances exist that prevent distribution of an adequate supply of domestically-produced renewable fuel to consumers in the United States.

(2) PETITIONS FOR WAIVERS.—The President, in consultation with the Secretary of Energy, the Secretary of Agriculture, and the Administrator of the Environmental Protection Agency, shall approve or disapprove a State petition for a waiver of the requirements of subsection (a) within 90 days after the date on which the petition is received by the President.

(3) TERMINATION OF WAIVERS.—A waiver granted under paragraph (1) shall terminate after 1 year, but may be renewed by the President after consultation with the Secretary of Energy, the Secretary of Agriculture, and the Administrator of the

Environmental Protection Agency.

(g) Small Refineries.—

(1) TEMPORARY EXEMPTION.—

(A) IN GENERAL.—The requirements of subsection (a) shall not apply to small refineries until calendar year 2013.

(B) EXTENSION OF EXEMPTION.—

(i) STUDY BY SECRETARY.—Not later than December 31, 2008, the Secretary shall submit to the President and Congress a report describing the results of a study to determine whether compliance with the requirements of subsection (a) would impose a disproportionate economic hardship on small refineries.

(ii) EXTENSION OF EXEMPTION.—In the case of a small refinery that the Secretary determines under clause (i) would be subject to a disproportionate economic hardship if required to comply with subsection (a), the President shall extend the exemption under subparagraph (A) for the small refinery for a period of not less than 2 additional years.

(2) PETITIONS BASED ON DISPROPORTIONATE ECONOMIC HARDSHIP.—

(A) EXTENSION OF EXEMPTION.—A small refinery may at any time petition the President for an extension of the exemption under paragraph (1) for the reason of disproportionate economic hardship.

(B) EVALUATION OF PETITIONS.—In evaluating a petition under subparagraph (A), the President, in consultation with the Secretary, shall consider the findings of the study under paragraph (1)(B) and other economic factors.

(C) DEADLINE FOR ACTION ON PETITIONS.—The President shall act on any petition submitted by a small refinery for a hardship exemption not later than 90 days after the date of receipt of the petition.

(3) OPT-IN FOR SMALL REFINERIES.—A small refinery shall be subject to the requirements of subsection (a) if the small refinery notifies the President that the small refinery waives the exemption under paragraph (1).

(h) Penalties and Enforcement.—

(1) CIVIL PENALTIES.—

(A) IN GENERAL.—Any person that violates a regulation promulgated under subsection (a), or that fails to furnish any information required under such a regulation, shall be liable to the United States for a civil penalty of not more than the total of—

(i) $25,000 for each day of the violation; and

(ii) the amount of economic benefit or savings received by the person resulting from the violation, as determined by the President.

(B) COLLECTION.—Civil penalties under subparagraph (A) shall be assessed

by, and collected in a civil action brought by, the Secretary or such other officer of the United States as is designated by the President.

(2) INJUNCTIVE AUTHORITY.—

(A) IN GENERAL.—The district courts of the United States shall have jurisdiction to—

(i) restrain a violation of a regulation promulgated under subsection (a);

(ii) award other appropriate relief; and

(iii) compel the furnishing of information required under the regulation.

(B) ACTIONS.—An action to restrain such violations and compel such actions shall be brought by and in the name of the United States.

(C) SUBPOENAS.—In the action, a subpoena for a witness who is required to attend a district court in any district may apply in any other district.

(i) Effective Date.—Except as otherwise specifically provided in this section, this section takes effect on January 1, 2008.

TITLE II—RENEWABLE FUELS INFRASTRUCTURE

SEC. 201. INFRASTRUCTURE PILOT PROGRAM FOR RENEWABLE FUELS.

(a) In General.—The Secretary, in consultation with the Secretary of Transportation and the Administrator of the Environmental Protection Agency, shall establish a competitive grant pilot program (referred to in this section as the "pilot program"), to be administered through the Vehicle Technology Deployment Program of the Department of Energy, to provide not more than 10 geographically-dispersed project grants to State governments, local governments, metropolitan transportation authorities, or partnerships of those entities to carry out 1 or more projects for the purposes described in subsection (b).

(b) Grant Purposes.—A grant under this section shall be used for the establishment of refueling infrastructure corridors, as designated by the Secretary, for gasoline blends that contain at least 85 percent renewable fuel, including—

Comment [vk11]: *Too much room to manipulate this as biodiesel and diesel don't require different infrastructure. There is no need for this.*

(1) installation of infrastructure and equipment necessary to ensure adequate distribution of renewable fuels within the corridor;

(2) installation of infrastructure and equipment necessary to directly support vehicles powered by renewable fuels; and

(3) operation and maintenance of infrastructure and equipment installed as part of a project funded by the grant.

(c) Applications.—

(1) REQUIREMENTS.—

(A) IN GENERAL.—Subject to subparagraph (B), not later than 90 days after

the date of enactment of this Act, the Secretary shall issue requirements for use in applying for grants under the pilot program.

(B) MINIMUM REQUIREMENTS.—At a minimum, the Secretary shall require that an application for a grant under this section—

(i) be submitted by—

(I) the head of a State or local government or a metropolitan transportation authority, or any combination of those entities; and

(II) a registered participant in the Vehicle Technology Deployment Program of the Department of Energy; and

(ii) include—

(I) a description of the project proposed in the application, including the ways in which the project meets the requirements of this section;

(II) an estimate of the degree of use of the project, including the estimated size of fleet of vehicles operated with renewable fuel available within the geographic region of the corridor;

(III) an estimate of the potential petroleum displaced as a result of the project, and a plan to collect and disseminate petroleum displacement and other relevant data relating to the project to be funded under the grant, over the expected life of the project;

(IV) a description of the means by which the project will be sustainable without Federal assistance after the completion of the term of the grant;

(V) a complete description of the costs of the project, including acquisition, construction, operation, and maintenance costs over the expected life of the project; and

(VI) a description of which costs of the project will be supported by Federal assistance under this subsection.

(2) PARTNERS.—An applicant under paragraph (1) may carry out a project under the pilot program in partnership with public and private entities.

(d) Selection Criteria.—In evaluating applications under the pilot program, the Secretary shall—

(1) consider the experience of each applicant with previous, similar projects; and

(2) give priority consideration to applications that—

(A) are most likely to maximize displacement of petroleum consumption ***at the lowest cost per gallon of petroleum displaced***;

(B) demonstrate the greatest commitment on the part of the applicant to ensure funding for the proposed project and the greatest likelihood that the project will be maintained or expanded after Federal assistance under this

subsection is completed;

(C) represent a partnership of public and private entities; and

(D) exceed the minimum requirements of subsection (c)(1)(B).

(e) Pilot Project Requirements.—

(1) MAXIMUM AMOUNT.—The Secretary shall provide not more than $20,000,000 in Federal assistance under the pilot program to any applicant.

(2) COST SHARING.—The non-Federal share of the cost of any activity relating to renewable fuel infrastructure development carried out using funds from a grant under this section shall be not less than 20 percent.

(3) MAXIMUM PERIOD OF GRANTS.—The Secretary shall not provide funds to any applicant under the pilot program for more than 2 years.

(4) DEPLOYMENT AND DISTRIBUTION.—The Secretary shall seek, to the maximum extent practicable, to ensure a broad geographic distribution of project sites funded by grants under this section.

(5) TRANSFER OF INFORMATION AND KNOWLEDGE.—The Secretary shall establish mechanisms to ensure that the information and knowledge gained by participants in the pilot program are transferred among the pilot program participants and to other interested parties, including other applicants that submitted applications.

(f) Schedule.—

(1) INITIAL GRANTS.—

(A) IN GENERAL.—Not later than 90 days after the date of enactment of this Act, the Secretary shall publish in the Federal Register, Commerce Business Daily, and such other publications as the Secretary considers to be appropriate, a notice and request for applications to carry out projects under the pilot program.

(B) DEADLINE.—An application described in subparagraph (A) shall be submitted to the Secretary by not later than 180 days after the date of publication of the notice under that subparagraph.

(C) INITIAL SELECTION.—Not later than 90 days after the date by which applications for grants are due under subparagraph (B), the Secretary shall select by competitive, peer-reviewed proposal up to 5 applications for projects to be awarded a grant under the pilot program.

(2) ADDITIONAL GRANTS.—

(A) IN GENERAL.—Not later than 2 years after the date of enactment of this Act, the Secretary shall publish in the Federal Register, Commerce Business Daily, and such other publications as the Secretary considers to be appropriate, a notice and request for additional applications to carry out projects under the pilot program that incorporate the information and knowledge obtained through the implementation of the first round of projects authorized under the pilot program.

(B) DEADLINE.—An application described in subparagraph (A) shall be submitted to the Secretary by not later than 180 days after the date of publication of the notice under that subparagraph.

(C) INITIAL SELECTION.—Not later than 90 days after the date by which applications for grants are due under subparagraph (B), the Secretary shall select by competitive, peer-reviewed proposal such additional applications for projects to be awarded a grant under the pilot program as the Secretary determines to be appropriate.

(g) Reports to Congress.—

(1) INITIAL REPORT.—Not later than 60 days after the date on which grants are awarded under this section, the Secretary shall submit to Congress a report containing—

(A) an identification of the grant recipients and a description of the projects to be funded under the pilot program;

(B) an identification of other applicants that submitted applications for the pilot program but to which funding was not provided; and

(C) a description of the mechanisms used by the Secretary to ensure that the information and knowledge gained by participants in the pilot program are transferred among the pilot program participants and to other interested parties, including other applicants that submitted applications.

(2) EVALUATION.—Not later than 2 years after the date of enactment of this Act, and annually thereafter until the termination of the pilot program, the Secretary shall submit to Congress a report containing an evaluation of the effectiveness of the pilot program, including an assessment of the petroleum displacement and benefits to the environment derived from the projects included in the pilot program.

(h) Authorization of Appropriations.—There is authorized to be appropriated to the Secretary to carry out this section $200,000,000, to remain available until expended.

SECTION. XXX, BIOMASS CROP RESEARCH AND DEVELOPMENT

(a) In general – The Secretary, in consultation with the USDA, shall establish a competitive grant program to provide 20 geographically disbursed universities to conduct pilot biomass energy crop research, including yield maximization, input minimization, storage, and handling of biomass at five sites managed by each of the twenty universities.

(b) Grant Purposes – A grant under this section shall be used for the establishment of biomass energy crops over two million acres including-

a. Maximizing the yield potential of various potential biomass crops in various parts of the country with a view to establishing long term goals for the biomass potential in the country and selecting optimal crops for each region of the country.

b. Providing low cost biomass feedstocks to early producers of advanced biofuels.

c. Optimizing crop management, including sustainable ways to produce biomass crops, optimal crop rotation schemes

d. Establishing best practices for harvesting and storage and handling of biomass crops.

SEC. 202. BIOENERGY RESEARCH AND DEVELOPMENT.

Section 931(c) of the Energy Policy Act of 2005 (42 U.S.C. 16231(c)) is amended—

(1) in paragraph (1), by striking "$213,000,000" and inserting "$326,000,000";

(2) in paragraph (2), by striking "$251,000,000" and inserting "$377,000,000"; and

(3) in paragraph (3), by striking "$274,000,000" and inserting "$398,000,000".

SEC. 203. BIORESEARCH CENTERS FOR SYSTEMS BIOLOGY PROGRAM.

Section 977(a)(1) of the Energy Policy Act of 2005 (42 U.S.C. 16317(a)(1)) is amended by inserting before the period at the end the following: ", including the establishment of at least 7 bioresearch centers that focus on biofuels, of which at least 1 center shall be located in each of the 4 Petroleum Administration for Defense Districts with no subdistricts and 1 center shall be located in each of the subdistricts of the Petroleum Administration for Defense District with subdistricts".

SEC. 204. LOAN GUARANTEES FOR RENEWABLE FUEL FACILITIES.

(a) In General.—Section 1703 of the Energy Policy Act of 2005 (42 U.S.C. 16513) is amended by adding at the end the following:

"(f) Renewable Fuel Facilities.—

"(1) IN GENERAL.—The Secretary may make guarantees under this title for projects that produce advanced biofuel (as defined in section 2 of the Biofuels for Energy Security and Transportation Act of 2007).

"(2) REQUIREMENTS.—A project under this subsection shall employ new or significantly improved technologies for the production of renewable fuels as compared to commercial technologies in service in the United States at the time that the guarantee is issued. ***Such new technologies must have the potential to achieve scalability and competitive cost with traditional biofuels within five years.***

Comment [vk12]: I would suggest a limit of the first five plants of any substantially similar technology. Eligibility for low cost loans is key to getting these going.

"(3) ISSUANCE OF FIRST LOAN GUARANTEES.—The requirement of section 20320(b) of division B of the Continuing Appropriations Resolution, 2007 (Public Law 109–289, Public Law 110–5), relating to the issuance of final regulations, shall

not apply to the first 6 guarantees issued under this subsection.

"(4) PROJECT DESIGN.—A project for which a guarantee is made under this subsection shall have a project design that has been validated through the operation of a continuous process pilot facility with an annual output of at least 50,000 gallons of ethanol.

Comment [vk13]: I would suggest the use of a minimum amount of investor equity that should be first at risk (for e.g. 20% of project cost) instead of the 50,000 gallon number. If investors are subordinated to the Federal loan guarantee the program will achieve its purpose. No investor will want to lose their equity and they will be prudent about the projects where they request loan guarantees.

"(5) MAXIMUM GUARANTEED PRINCIPAL.—The total principal amount of a loan guaranteed under this subsection may not exceed $250,000,000 for a single facility.

"(6) AMOUNT OF GUARANTEE.—The Secretary shall guarantee 100 percent of the principal and interest due on 1 or more loans made for a facility that is the subject of the guarantee under paragraph (3).

"(7) DEADLINE.—The Secretary shall approve or disapprove an application for a guarantee under this subsection not later than 90 days after the date of receipt of the application.

"(8) REPORT.—Not later than 30 days after approving or disapproving an application under paragraph (7), the Secretary shall submit to Congress a report on the approval or disapproval (including the reasons for the action).".

(b) Improvements to Underlying Loan Guarantee Authority.—

(1) DEFINITION OF COMMERCIAL TECHNOLOGY.—Section 1701(1) of the Energy Policy Act of 2005 (42 U.S.C. 16511(1)) is amended by striking subparagraph (B) and inserting the following:

"(B) EXCLUSION.—The term 'commercial technology' does not include a technology if the sole use of the technology is in connection with—

"(i) a demonstration plant; or

"(ii) a project for which the Secretary approved a loan guarantee.".

"(iii) fewer than five commercial plants built with substantially similar technology

(2) SPECIFIC APPROPRIATION OR CONTRIBUTION.—Section 1702 of the Energy Policy Act of 2005 (42 U.S.C. 16512) is amended by striking subsection (b) and inserting the following:

"(b) Specific Appropriation or Contribution.—

"(1) IN GENERAL.—No guarantee shall be made unless—

"(A) an appropriation for the cost has been made; or

"(B) the Secretary has received from the borrower a payment in full for the cost of the obligation and deposited the payment into the Treasury.

"(2) LIMITATION.—The source of payments received from a borrower under paragraph (1)(B) shall not be a loan or other debt obligation that is made or guaranteed by the Federal Government.

"(3) RELATION TO OTHER LAWS.—Section 504(b) of the Federal Credit Reform Act of 1990 (2 U.S.C. 661c(b)) shall not apply to a loan or loan guarantee made in

accordance with paragraph (1)(B).".

(3) AMOUNT.—Section 1702 of the Energy Policy Act of 2005 (42 U.S.C. 16512) is amended by striking subsection (c) and inserting the following:

"(c) Amount.—

"(1) IN GENERAL.—Subject to paragraph (2), the Secretary shall guarantee up to 100 percent of the principal and interest due on 1 or more loans for a facility that are the subject of the guarantee.

"(2) LIMITATION.—The total amount of loans guaranteed for a facility by the Secretary shall not exceed 80 percent of the total cost of the facility, as estimated at the time at which the guarantee is issued.".

(4) SUBROGATION.—Section 1702(g)(2) of the Energy Policy Act of 2005 (42 U.S.C. 16512(g)(2)) is amended—

(A) by striking subparagraph (B); and

(B) by redesignating subparagraph (C) as subparagraph (B).

SEC. 205. GRANTS FOR RENEWABLE FUEL PRODUCTION RESEARCH AND DEVELOPMENT IN CERTAIN STATES.

(a) In General.—The Secretary shall provide grants to eligible entities to conduct research into, and develop and implement, renewable fuel production technologies in States with low rates of ethanol production, including low rates of production of cellulosic biomass ethanol.

(b) Eligibility.—To be eligible to receive a grant under the section, an entity shall—

(1)(A) be an institution of higher education (as defined in section 2 of the Energy Policy Act of 2005 (42 U.S.C. 15801)) located in a State described in subsection (a); or

(B) be a consortium of such institutions of higher education, industry, State agencies, or local government agencies located in the State; and

(2) have proven experience and capabilities with relevant technologies.

(c) Authorization of Appropriations.—There is authorized to be appropriated to carry out this section $25,000,000 for each of fiscal years 2008 through 2010.

SEC. 206. GRANTS FOR INFRASTRUCTURE FOR TRANSPORTATION OF BIOMASS TO LOCAL BIOREFINERIES.

(a) In General.—The Secretary shall conduct a program under which the Secretary shall provide grants to local governments and other eligible entities (as determined by the Secretary) (referred to in this section as "eligible entities") to promote the development of infrastructure to support the transportation of biomass to local biorefineries, including by

portable processing equipment.

(b) Phases.—The Secretary shall conduct the program in the following phases:

(1) DEVELOPMENT.—In the first phase of the program, the Secretary shall make grants to eligible entities to assist the eligible entities in the development of local projects to promote the development of infrastructure to support the transportation of biomass to local biorefineries, including by portable processing equipment.

(2) IMPLEMENTATION.—In the second phase of the program, the Secretary shall make competitive grants to eligible entities to implement projects developed under paragraph (1).

(c) Authorization of Appropriations.—There are authorized to be appropriated such sums as are necessary to carry out this section.

SEC. 207. BIOREFINERY INFORMATION CENTER.

(a) In General.—The Secretary, in cooperation with the Secretary of Agriculture, shall establish a biorefinery information center to make available to interested parties information on—

(1) renewable fuel resources, including information on programs and incentives for renewable fuels;

(2) renewable fuel producers;

(3) renewable fuel users; and

(4) potential renewable fuel users.

(b) Administration.—In administering the biorefinery information center, the Secretary shall—

(1) continually update information provided by the center;

(2) make information available to interested parties on the process for establishing a biorefinery; and

(3) make information and assistance provided by the center available through a toll-free telephone number and website.

(c) Authorization of Appropriations.—There are authorized to be appropriated such sums as are necessary to carry out this section.

SEC. 208. CONVERSION ASSISTANCE FOR CELLULOSIC BIOMASS, WASTE-DERIVED ETHANOL, APPROVED RENEWABLE FUELS.

(a) Definitions.—In this section:

(1) APPROVED RENEWABLE FUEL.—The term "approved renewable fuels" means an alternative or replacement fuel that—

(A) has been approved under title III of the Energy Policy Act of 1992 (42

U.S.C. 13211 et seq.); and

(B) is made from renewable biomass.

(2) PRODUCER.—The term "producer" means—

(A) a merchant producer;

(B) a farm or dairy cooperative; or

(C) an association of agricultural producers.

(3) WASTE-DERIVED ETHANOL.—The term "waste-derived ethanol" means ethanol derived from—

(A) animal waste (including poultry fat and poultry waste) and other waste material; or

(B) municipal solid waste.

(b) Conversion Assistance.—The Secretary may provide grants to producers of cellulosic biomass ethanol, waste-derived ethanol, and approved renewable fuels in the United States to assist the producers in building eligible production facilities described in subsection (c) for the production of ethanol or approved renewable fuels ***provided that such new technologies have the potential to achieve scalability and competitive cost with traditional biofuels within five years and their potential production by 2030 exceeds 25% of US biofuels requirements.***

(c) Eligible Production Facilities.—A production facility shall be eligible to receive a grant under this section if the production facility—

(1) is located in the United States; and

(2) uses renewable biomass.

(d) Authorization of Appropriations.—There are authorized to be appropriated to carry out this section—

(1) $400,000,000 for fiscal year 2008;

(2) $500,000,000 for fiscal year 2009; and

(3) $600,000,000 for fiscal year 2010.

SEC. 209. ALTERNATIVE FUEL DATABASE AND MATERIALS.

The Secretary and the Director of the National Institute of Standards and Technology shall jointly establish and make available to the public—

(1) a database that describes the physical properties of different types of alternative fuel; and

(2) standard reference materials for different types of alternative fuel ***or fuel mixtures.***

(3) define the fuel specifications as broadly as possibel to encourage innovation,

lower costs of each unit of energy in fuels and fuel mixtures, and related specifications.

SEC. 210. FUEL TANK CAP LABELING REQUIREMENT.

Section 406(a) of the Energy Policy Act of 1992 (42 U.S.C. 13232(a)) is amended—

(1) by striking "The Federal Trade Commission" and inserting the following:

"(1) IN GENERAL.—The Federal Trade Commission"; and

(2) by adding at the end the following:

"(2) FUEL TANK CAP LABELING REQUIREMENT.—Beginning with model year 2010, the fuel tank cap of each alternative fueled vehicle manufactured for sale in the United States shall be clearly labeled to inform consumers that such vehicle can operate on alternative fuel ***and the fuel tank cap will be of a designated color.***"

TITLE III—STUDIES

SEC. 301. STUDY OF ADVANCED BIOFUELS TECHNOLOGIES.

(a) In General.—Not later than October 1, 2012, the Secretary shall offer to enter into a contract with the National Academy of Sciences under which the Academy shall conduct a study of technologies relating to the production, transportation, and distribution of advanced biofuels ***and feedstocks for such biofuels.***

(b) Scope.—In conducting the study, the Academy shall—

(1) include an assessment of the maturity of advanced biofuels technologies;

(2) consider whether the rate of development of those technologies will be sufficient to meet the advanced biofuel standards required under section 101;

(3) consider the effectiveness of the research and development programs and activities of the Department of Energy relating to advanced biofuel technologies; and

(4) make policy recommendations to accelerate the development of those technologies to commercial viability, as appropriate.

(c) Report.—Not later than November 30, 2014, the Secretary shall submit to the Committee on Energy and Natural Resources of the Senate and the Committee on Energy and Commerce of the House of Representatives a report describing the results of the study conducted under this section.

SEC. 302. STUDY OF INCREASED CONSUMPTION OF ETHANOL-BLENDED GASOLINE WITH HIGHER LEVELS OF ETHANOL.

(a) In General.—The Secretary (in cooperation with the Secretary of Agriculture, the Administrator of the Environmental Protection Agency, and the Secretary of Transportation) shall conduct a study of the feasibility of increasing consumption in the United States of ethanol-blended gasoline with levels of ethanol that are not less than 10 percent and not more than 25 percent, including a study of production and infrastructure constraints on increasing the consumption.

(b) Report.—Not later than 1 year after the date of enactment of this Act, the Secretary shall submit to Congress a report describing the results of the study conducted under this section.

SEC. 303. PIPELINE FEASIBILITY STUDY.

(a) In General.—The Secretary, in coordination with the Secretary of Agriculture and the Secretary of Transportation, shall conduct a study of the feasibility of the construction of dedicated ethanol pipelines.

(b) Factors.—In conducting the study, the Secretary shall consider—

(1) the quantity of ethanol production that would make dedicated pipelines economically viable;

(2) existing or potential barriers to dedicated ethanol pipelines, including technical, siting, financing, and regulatory barriers;

(3) market risk (including throughput risk) and means of mitigating the risk;

(4) regulatory, financing, and siting options that would mitigate risk in those areas and help ensure the construction of 1 or more dedicated ethanol pipelines;

(5) financial incentives that may be necessary for the construction of dedicated ethanol pipelines, including the return on equity that sponsors of the initial dedicated ethanol pipelines will require to invest in the pipelines;

(6) technical factors that may compromise the safe transportation of ethanol in pipelines, identifying remedial and preventative measures to ensure pipeline integrity; and

(7) such other factors as the Secretary considers appropriate.

(c) Report.—Not later than 15 months after the date of enactment of this Act, the Secretary shall submit to Congress a report describing the results of the study conducted under this section.

SEC. 304. STUDY OF OPTIMIZATION OF ALTERNATIVE FUELED VEHICLES TO USE E-85 FUEL.

(a) In General.—The Secretary shall conduct a study of methods of increasing the fuel efficiency of alternative fueled vehicles by optimizing alternative fueled vehicles to operate using E-85 fuel.

(b) Report.—Not later than 180 days after the date of enactment of this Act, the

Secretary shall submit to the Committee on Energy and Natural Resources of the Senate and the Committee on Natural Resources of the House of Representatives a report that describes the results of the study, including any recommendations of the Secretary.

SEC. 305. STUDY OF CREDITS FOR USE OF RENEWABLE ELECTRICITY IN ELECTRIC VEHICLES.

(a) Definition of Electric Vehicle.—In this section, the term "electric vehicle" means an electric motor vehicle (as defined in section 601 of the Energy Policy Act of 1992 (42 U.S.C. 13271)) for which the rechargeable storage battery—

(1) receives a charge directly from a source of electric current that is external to the vehicle; and

(2) provides a minimum of 80 percent of the motive power of the vehicle.

(b) Study.—The Secretary shall conduct a study on the feasibility of issuing credits under the program established under section 101(d) to electric vehicles powered by electricity produced from renewable energy sources.

(c) Report.—Not later than 18 months after the date of enactment of this Act, the Secretary shall submit to the Committee on Energy and Natural Resources of the Senate and the Committee on Energy and Commerce of the House of Representatives a report that describes the results of the study, including a description of—

(1) existing programs and studies on the use of renewable electricity as a means of powering electric vehicles; and

(2) alternatives for—

(A) designing a pilot program to determine the feasibility of using renewable electricity to power electric vehicles as an adjunct to a renewable fuels mandate;

(B) allowing the use, under the pilot program designed under subparagraph (A), of electricity generated from nuclear energy as an additional source of supply;

(C) identifying the source of electricity used to power electric vehicles; and

(D) equating specific quantities of electricity to quantities of renewable fuel under section 101(d).

Appendix B – Khosla Ventures Portfolio

Cellulosic:

Mascoma - Mascoma Corporation is leading the development of bioprocess technologies for cost-effective conversion of cellulosic biomass to ethanol.

Celunol - Celunol is a leader in the effort to commercialize the production of cellulosic ethanol from an engineered bacterium.

Range – Will build the first commercial cellulosic ethanol plant in the US using a proprietary anaerobic conversion and heterogeneous catalyst technology.

Coskata – Coskata is commercializing a fermentation technology for the production of fuel-grade ethanol from syngas.

Corn/Sugar Fuels:

Altra – Altra intends to become the leading integrated biofuels company in the U.S., producing ethanol and biodiesel from a variety of feedstocks

Cilion - Cilion is building destination ethanol plants, promising to be the cheapest and greenest ethanol from initially corn and incorporating cellulosic technologies as they come online.

Hawaii Bio – HBE is actively researching sugarcane and other potential fuel crops, processing techniques, and distribution channels for the production of renewable bio-fuels within Hawaii.

Brenco – Brenco uses Brazilian sugar-cane to produce ethanol in various mills across Brazil.

Future Fuels

LS 9 - LS9, Inc., the Renewable Petroleum Company™, is combining synthetic biology and cellulosic feedstocks to make petroleum replacements from bacteria

Gevo – Gevo is a leader in the bacterial production of biobutanol from sugars and cellulose.

Amyris - Amyris Biotechnologies is translating the promise of synthetic biology into industrial production of fermentation diesel and higher alcohols from sugars and cellulose.

LanzaTech – LanzaTech is developing a proprietary fermentation technology to convert industrial flue gas from steel mills as a resource for bio-ethanol production.

Efficiency:

Transonic – Transonic is using proprietary fuel injection technology to increase the efficiency of gasoline engines by 3X

Appendix C.1 – Income to Farmers from Biomass and Corn

This chart looks at the potential benefit to a farmer from planting biomass vs. corn under two price scenarios – in both cases, Biomass appears to be the attractive option.

	Biomass	Corn
Grain yield (bushel)	N/A	150
Grain price ($/bushel)	N/A	$3.50 / $3.00
Biomass yield (tons)	15	2
Biomass price ($/ton)	$40 / $30	$40 / $30
Total revenue	**$600 / $450**	**$605 /$ 510**
Variable costs	$84	$168
Amortized fixed costs	$36	$66
Net return	**$480 / $330**	**$371 / $276**

Source: Ceres Company, Khosla Ventures

Appendix C.2 – Economies of Miscanthus Farming vs. Corn/Soy Rotation

This study, down by the University of Illinois, compares the relative profitability of planting a hectare of a corn/soy rotation to growing Miscanthus over a 10 year period. The net results are staggering – the corn/soybean rotation provides a loss of $903 (hence farmers need farm subsidies to stay in business) over the period, while the miscanthus rotation provides a profit of $2,900. This makes biomass an attractive crop fro farmers to grow.

Annual and extended projected costs and profits for two cropping systems in Central Illinois over a 10 year period.

Costs ($ ha^{-1})	Corn/Soybean[1] rotation			*Miscanthus*[2] energy crop			
	Corn	*Soy*	**10 years**[3]	*1st year*	*2nd year*	*3rd–10th*	**10 years**
Fertilizer	131	47	**621**	62	60	23	**242**
Pesticides	77	79	**520**	15	0	0	**15**
Seed	84	47	**445**	316	0	0	**316**
Crop Drying	17	5	**77**	0	0	0	**0**
Machinery repair, fuel, hire	67	59	**423**	45	101	95	**635**
Labor	89	84	**580**	84	82	77	**562**
TOTAL VARIABLE COSTS	464	321	**2657**	521	242	195	**1770**
Machinery overhead, housing, depreciation, non-land interest	257	198	**1533**	22	58	54	**360**
Land	373	373	**2496**	373	362	341	**2496**
TOTAL OTHER COSTS	630	571	**4029**	395	420	396	**2856**
TOTAL ALL COSTS	1094	892	**6686**	916	662	591	**4626**
Yield (tons ha^{-1})	*10.5*	*3.5*					
Yield, (dry tons ha^{-1})				*0*	*17*	*35*	
Value ($ ton^{-1})	*98*	*195*		*40*	*39*	*38*	
GROSS REVENUE ($ ha^{-1})	1020	681	**5783**	0	663	1330	**7527**
NET PROFIT[4] ($ ha^{-1})	–74	–210	**–903**	–916	1	739	**2900**

[1] Corn and soybean costs and average yields for Central Illinois after (Hoeft et al. 2000) and prices based on Chicago Board of Trade Dec. 2002 futures.
[2] Miscanthus seed costs based on (Lewandowski et al. 2000) and harvest costs assuming cutting and baling as for corn silage. Machinery costs from University of Minnesota Extension and Illinois Farm Business Farm Management Association. A predicted yield of 35 t/ha for Central IL is assumed (Figure 1), and a price of $40/t. This compares to $44 /t proposed by (McLaughlin et al. 2002) for US biomass crops and an EU suggested price of $49 /t (Bullard 2001).
[3] Total values over 10 years, discounted annually at 3%.
[4] Farm gate price, excluding subsidies.

Source: http://www.aces.uiuc.edu/DSI/MASGC.pdf

Appendix D – Sampling of Biofuels Companies

The focus n biofuels has re-vitalized interest in the last year. Many new companies have been formed and old ones revitalized.

Terrabon – Terrabon is developing and commercializing the Mixalco Process, which involved the conversion of piles of biomass to organics acids using mixed microbial cultures, folloed by the chemical conversion of the acids to a liquid fuel.

BIOeCON – The biomass-waste will be directly converted with the use of a selective catalyst into a useful bio-oil. This will be an ethically and ecologically justified raw material: Green oil, ready for further processing in existing petrochemical refineries instead of fossil based crude oil.

Cobalt – Cobalt Biofuels is a renewable fuels company based in Mountain View, California, specializing in technology and processes for the transportation fuel industry.

Advanced Biofuels – Advanced BioFuels is at the forefront of research and development of combustible fuels, with a focus on butanol, derived from biological, renewable sources.

Environmental Energy – Environmental Energy is concentrated on the production of butanol using ABE fermentation.

Virent – Virent Energy Systems, Inc., headquartered in Madison, Wis., is dedicated to enabling the hydrogen economy by dramatically increasing energy densities and eliminating hydrogen storage issues through widespread use of its Aqueous Phase Reforming (APR) process. Virent's APR system offers a cost-effective method for producing hydrogen and natural gas using a renewable biomass. Virent is also developing routes to hydrocarbons.

BioFine – BioFine has designed a process that converts cellulosic biomass such as paper mill sludge, municipal solid waste, unrecyclable waste paper, waste wood and agricultural residues into chemicals for fuel, pesticides and other useful material.

LiveFuels – LiveFuels is partnering with Sandia National Labs to devise a version of car fuel out of algae. The algae would be grown in ponds and then sold to refiners for conversion to petroleum.

Iogen – Iogen is a world leading biotechnology firm specializing in cellulose ethanol - a fully renewable, advanced biofuel that can be used in today's cars.

BRI – BRI Energy is a company that ferments gasified waste, biomass or hydrocarbons such as coal into ethanol.

Choren - CHOREN is one of the world's leading gasification technology companies for solid biomass and oil based residue feedstock. The center-piece of the technology is the patented Carbo-V® process that made the production of tar-free synthetic combustion gas possible and provided the breakthrough for the conversion of biomass to energy.

Imperium - Imperium Renewables Inc. (IRI) is a national leader in next generation biodiesel refining and manufacturing technology. IRI is a technology driven full service system provider, manufacturer, and engineering corporation that specializes in renewable fuels, especially the petroleum diesel replacement, biodiesel.

Aurora Biofuels – Aurora Biofuels is a California based renewables company that converts algae to biodiesel.

ClearFuels – ClearFuels uses the gasification of biomass to syngas and then chemical catalysis to ethanol

Green Biologics- Green Biologics has isolated thermophiles from a range of compost environments and has built a library of these micro-organisms capable of converting waste plant material into valuable chemicals, such as butanol and ethanol.

Agrivida – Agrivida engineers plants with dormant cellulytic enzymes which can be activated with an external stimulus.

Edenspace – Similar to Agrivida, Edenspace is developing enhanced crop plants.

Sun Ethanol - Consolidated bioprocessing (CBP) using clostridia for low cost cellulosic ethanol production

Dow Chemical – Dow Chemical Co. is exploring how it could use crops and other plant materials to replace oil and gas as a chemical feedstoc

Dupont - DuPont and the U.S. Department of Energy [DOE] are jointly funding a research program to develop technology to convert non-food agricultural feedstocks into ethanol. This program is focused on corn stover - the leaves, stalks and cobs that are left in the field after harvest.

Convertech – Convertech has developed a process using a continuous steam auto-hydrolysis technique to convert plant materials from various sources (like straw or forestry waste or new annual plant crops) into a range of biochemical co-products with a minimum expenditure in energy.

Metabolix - Metabolix applies the cutting edge tools of biotechnology to create a new generation of highly versatile, sustainable, biobased, biodegradable, natural plastics and chemicals.

Changing Waste Technologies – Changing Waste Technologies, in Arkansas, is using animal waste (amongst others) to generate energy sources

Genotypes, Inc – Genotypes Inc is a biochemistry firm based in Pacifica, CA that is engineering yeast towards the production of biofuels

C3 BioEnergy - C3 BioEnergy will manufacture renewable propane and a hydrogen by-product from biomass feedstocks.

Advanced Catalyst Systems – Advanced Catalyst Systems is working on producing gasoline, diesel, and aromatics from ethanol using catalysts

Appendix E.1 – How Much Ethanol Can We Produce?

These are Khosla Ventures projections of the expected yields of cellulosic ethanol from 2005 to 2030, accounting for improvements in yield efficiency and increases in land usage. Over the period, crop yields are likely to increase four-fold! Additionally, it's worth noting that the gasoline demand does not take into account increased engine efficiencies (such as that proposed by Transonic, one of our investments) or increased CAFÉ (Demand is projected to grow 1% per year along historical lines.).

Year	Yield (tons/ac)	Yield (Gals/ton)	Million Acres Biomass Ac.	Production Cellu.Eth. Gals (Billions)	Production Corn Eth. Gals (Billions)	Production Total Eth (gals) (Billions)	Ethaol Prod. Gas. Eq Gals (Billions)	Gasoline Demand(1%) (Billions Gal)
2005	6	80	0	0	4.0	4.0	3.2	140
2006	6.3	83.2	0	0	4.8	4.8	3.8	141.4
2007	6.6	86.5	0	0	5.8	5.8	4.6	142.8
2008	6.9	90.0	0	0.0	6.9	6.9	5.5	144.2
2009	7.3	93.6	0.1	0.1	8.3	8.4	6.7	145.7
2010	7.8	97.3	1	0.8	10.0	10.7	8.6	147.1
2011	8.3	98.3	3	2.5	10.9	13.4	10.7	148.6
2012	8.9	99.3	5	4.4	12.0	16.5	13.2	150.1
2013	9.6	100.3	7.5	7.2	13.2	20.4	16.4	151.6
2014	10.2	101.3	10	10.4	14.6	24.9	19.9	153.1
2015	10.9	102.3	13	14.6	14.6	29.1	23.3	154.6
2016	11.7	103.3	16	19.4	14.6	33.9	27.1	156.2
2017	12.5	104.4	19	24.8	14.6	39.4	31.5	157.8
2018	13.4	105.4	22	31.1	14.6	45.7	36.5	159.3
2019	14.3	106.5	25	38.2	14.6	52.8	42.2	160.9
2020	15.4	107.5	28	46.2	14.6	60.8	48.6	162.5
2021	16.3	108.6	31	54.8	14.6	69.3	55.5	164.2
2022	17.2	109.7	34	64.3	14.6	78.9	63.1	165.8
2023	18.3	110.0	37	74.4	14.6	89.0	71.2	167.5
2024	19.4	110.0	40	85.3	14.6	99.8	79.9	169.1
2025	20.5	110.0	43	97.2	14.6	111.7	89.4	170.8
2026	21.8	110.0	46	110.2	14.6	124.8	99.8	172.5
2027	23.1	110.0	49	124.4	14.6	139.0	111.2	174.3
2028	24.5	110.0	52	140.0	14.6	154.5	123.6	176.0
2029	24.5	110.0	56	150.9	14.6	165.5	132.4	177.8
2030	24.5	110.0	60	161.7	14.6	176.3	141.0	179.5

Appendix E.2 – How Much Ethanol Can We Use (based on FFV's on the road)?

The table below contains projections of the expected trajectory of FFV vehicles and E85 demand in the US, assuming the implementation of an RPS standard and the FFV mandates discussed earlier.

		New cars/yr	New FFV's	Cum FFV Cars	% E85 (per car fuel %)	E85 Demand
		(000's)	(000's)	(000's)		(Billion Gallons)
2005		16,177	1,000	1,000		
2006		15,944	1,000	2,000		
2007		16,328	2,000	4,000		
2008		16,442	2,000	6,000		
2009		16,637	3,327	9,327	0.1	1
2010		16,799	5,040	14,367	0.15	2
2011		16,977	6,791	21,158	0.2	3
2012		17,085	8,543	29,700	0.25	6
2013		17,099	10,259	39,960	0.3	9
2014		17,139	11,997	51,957	0.35	14
2015		17,164	12,015	63,972	0.4	19
2016		17,281	12,097	76,069	0.45	26
2017		17,450	12,215	88,284	0.5	33
2018		17,664	12,365	100,648	0.55	42
2019		17,833	12,483	113,132	0.6	51
2020		18,011	12,608	125,739	0.65	61
2021		18,246	12,772	137,511	0.7	72
2022		18,508	12,956	149,467	0.75	84
2023		18,788	13,152	160,619	0.75	90
2024		19,077	13,354	171,973	0.75	97
2025		19,356	13,549	182,194	0.75	102
2026		19,664	13,765	190,919	0.75	107
2027		19,953	13,967	198,096	0.75	111
2028		20,192	14,134	203,688	0.75	115
2029		20,467	14,327	207,755	0.75	117
2030		20,735	14,515	210,272	0.75	118

Estimate assumes adoption of policy recommendations for flex-fuel mandates
Does not include "other" gasoline use (lawnmowers, boats,…), hybrid or plug-in hybrid FFV's, lighter vehicles, higher CAFÉ standards etc.

Appendix F – DOE Grant Press Release

United States Department of Energy
Office of Public Affairs
Washington, D.C. 20585

News Media Contact(s):
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For Immediate Release
February 28, 2007

DOE Selects Six Cellulosic Ethanol Plants for Up to $385 Million in Federal Funding
Funding to help bring cellulosic ethanol to market and help revolutionize the industry

WASHINGTON, DC – U.S. Department of Energy (DOE) Secretary Samuel W. Bodman today announced that DOE will invest up to $385 million for six biorefinery projects over the next four years. When fully operational, the biorefineries are expected to produce more than 130 million gallons of cellulosic ethanol per year. This production will help further President Bush's goal of making cellulosic ethanol cost-competitive with gasoline by 2012 and, along with increased automobile fuel efficiency, reduce America's gasoline consumption by 20 percent in ten years.

"These biorefineries will play a critical role in helping to bring cellulosic ethanol to market, and teaching us how we can produce it in a more cost effective manner," Secretary Bodman said. "Ultimately, success in producing inexpensive cellulosic ethanol could be a key to eliminating our nation's addiction to oil. By relying on American ingenuity and on American farmers for fuel, we will enhance our nation's energy and economic security."

Today's announcement is one part of the Bush Administration's comprehensive plan to support commercialization of scientific breakthroughs on biofuels. Specifically, these projects directly support the goals of President Bush's Twenty in Ten Initiative, which aims to increase the use of renewable and alternative fuels in the transportation sector to the equivalent of 35 billion gallons of ethanol a year by 2017. Funding for these projects is an integral part of the President's Biofuels Initiative that will lead to the wide-scale use of non-food based biomass, such as agricultural waste, trees, forest residues, and perennial grasses in the production of transportation fuels, electricity, and other products. The solicitation, announced a year ago, was initially for three biorefineries and $160 million. However, in an effort to expedite the goals of President Bush's Advanced Energy Initiative and help achieve the goals of his Twenty in Ten Initiative, within authority of the Energy Policy Act of 2005 (EPAct 2005), Section 932, Secretary Bodman raised the funding ceiling.

"We had a number of very good proposals, but these six were considered 'meritorious'

by a merit review panel made up of bioenergy experts. So I thought it would be best to front-end some more funding now, so that we could all reap the benefits of the President's vision sooner," Secretary Bodman said.

Combined with the industry cost share, more than $1.2 billion will be invested in these six biorefineries. Negotiations between the selected companies and DOE will begin immediately to determine final project plans and funding levels. Funding will begin this fiscal year and run through FY 2010. EPAct authorized DOE to solicit and fund proposals for the commercial demonstration of advanced biorefineries that use cellulosic feedstocks to produce ethanol and co-produce bioproducts and electricity.

The following six projects were selected:

- **Abengoa Bioenergy Biomass of Kansas, LLC of Chesterfield, Missouri, up to $76 million.**
  The proposed plant will be located in the state of Kansas. The plant will produce 11.4 million gallons of ethanol annually and enough energy to power the facility, with any excess energy being used to power the adjacent corn dry grind mill. The plant will use 700 tons per day of corn stover, wheat straw, milo stubble, switchgrass, and other feedstocks.
  Abengoa Bioenergy Biomass investors/participants include: Abengoa Bioenergy R&D, Inc.; Abengoa Engineering and Construction, LLC; Antares Corp.; and Taylor Engineering.
- **ALICO, Inc. of LaBelle, Florida, up to $33 million.**
  The proposed plant will be in LaBelle (Hendry County), Florida. The plant will produce 13.9 million gallons of ethanol a year and 6,255 kilowatts of electric power, as well as 8.8 tons of hydrogen and 50 tons of ammonia per day. For feedstock, the plant will use 770 tons per day of yard, wood, and vegetative wastes and eventually energycane.
  ALICO, Inc. investors/participants include: Bioengineering Resources, Inc. of Fayetteville, Arkansas; Washington Group International of Boise, Idaho; GeoSyntec Consultants of Boca Raton, Florida; BG Katz Companies/JAKS, LLC of Parkland, Florida; and Emmaus Foundation, Inc.
- **BlueFire Ethanol, Inc. of Irvine, California, up to $40 million.**
  The proposed plant will be in Southern California. The plant will be sited on an existing landfill and produce about 19 million gallons of ethanol a year. As feedstock, the plant would use 700 tons per day of sorted green waste and wood waste from landfills.
  BlueFire Ethanol, Inc. investors/participants include: Waste Management, Inc.; JGC Corporation; MECS Inc.; NAES; and PetroDiamond.
- **Broin Companies of Sioux Falls, South Dakota, up to $80 million.**
  The plant is in Emmetsburg (Palo Alto County), Iowa, and after expansion, it will produce 125 million gallons of ethanol per year, of which roughly 25percent will be cellulosic ethanol. For feedstock in the production of cellulosic ethanol, the plant expects to use 842 tons per day of corn fiber, cobs, and stalks.
  Broin Companies participants include: E. I. du Pont de Nemours and Company;

Novozymes North America, Inc.; and DOE's National Renewable Energy Laboratory.

- **Iogen Biorefinery Partners, LLC, of Arlington, Virginia, up to $80 million.**
  The proposed plant will be built in Shelley, Idaho, near Idaho Falls, and will produce 18 million gallons of ethanol annually. The plant will use 700 tons per day of agricultural residues including wheat straw, barley straw, corn stover, switchgrass, and rice straw as feedstocks.
  Iogen Biorefinery Partners, LLC investors/partners include: Iogen Energy Corporation; Iogen Corporation; Goldman Sachs; and The Royal Dutch/Shell Group.
- **Range Fuels (formerly Kergy Inc.) of Broomfield, Colorado, up to $76 million.**
  The proposed plant will be constructed in Soperton (Treutlen County), Georgia. The plant will produce about 40 million gallons of ethanol per year and 9 million gallons per year of methanol. As feedstock, the plant will use 1,200 tons per day of wood residues and wood based energy crops.
  Range Fuels investors/participants include: Merrick and Company; PRAJ Industries Ltd.; Western Research Institute; Georgia Forestry Commission; Yeomans Wood and Timber; Truetlen County Development Authority; BioConversion Technology; Khosla Ventures; CH2MHill; Gillis Ag and Timber.

Cellulosic ethanol is an alternative fuel made from a wide variety of non-food plant materials (or feedstocks), including agricultural wastes such as corn stover and cereal straws, industrial plant waste like saw dust and paper pulp, and energy crops grown specifically for fuel production like switchgrass. By using a variety of regional feedstocks for refining cellulosic ethanol, the fuel can be produced in nearly every region of the country. Though it requires a more complex refining process, cellulosic ethanol contains more net energy and results in lower greenhouse emissions than traditional corn-based ethanol. E-85, an ethanol-fuel blend that is 85-percent ethanol, is already available in more than 1,000 fueling stations nationwide and can power millions of flexible fuel vehicles already on the roads.

For more information on President's Bush's Twenty in Ten Initiative, visit: http://www.whitehouse.gov/stateoftheunion/2007/initiatives/energy.html.

Abengoa One pager
Alico One pager
Blue Fire One pager
Broin One pager
Iogen One pager
Range Fuels one pager

U.S. Department of Energy, Office of Public Affairs, Washington, D.C.

Opening Statement of U.S. Senator Ken Salazar
Committee on Finance
Grains, Cane, and Automobiles: Tax Incentives for Alternative Fuels and Vehicles
Thursday, April 19, 2007

Thank you Mr. Chairman and Ranking Member Grassley. I want to thank you for holding today's hearing on this important topic of how our country can reduce our dependence on foreign oil in the transportation sector through the greater use of alternative fuels and improvements in vehicle technology.

We must champion a new ethic and goal of setting America free from its overdependence on foreign oil. Our transportation sector is extremely dependent on oil, much of it imported from abroad. It is imperative that we reduce our dependence on foreign oil for national security and economic security reasons.

Our country must also transition to clean transportation fuels in order to deal with carbon emissions and the very real threat of global warming. Almost 40 percent of the CO2 emissions in America come from the use of oil in the transportation sector. If we are to effectively deal with global warming, we must find cleaner ways to fuel our transportation sector.

A national commitment that includes effective policy measures is necessary if we are to make fundamental changes in the use of foreign oil in our transportation sector. The Finance Committee has before it a number of bills that will help reduce America's dependence on foreign oil and move us more rapidly to the use of cleaner transportation fuels. For example, the DRIVE Act (Dependence Reduction through Innovation in Vehicles and Energy) (S. 339) that was introduced by Senator Bayh, and that I am cosponsoring along with 23 of my fellow Senators, has been referred to the Finance Committee. The DRIVE Act has a number of tax-related provisions including:

1. Idling Reduction Tax Credit: Tax credit up to $3,500 for the purchase of idling reduction technology for heavy duty trucks. Argonne National Laboratory has estimated that long-haul truck idling consumes 54,000 barrels per day or 20 million barrels of diesel fuel each year.

2. Plug-in Electric Hybrid and Hydrogen Vehicle Prizes: The Energy Policy Act of 2005 (EPAct of 2005) authorizes that "Freedom Prizes" be established to encourage and recognize development and deployment of technologies that overcome scientific and technical barriers in order to reduce oil use and oil imports. The DRIVE Act would increase the authorization level for these prizes to $450 million, and would make plug-in hybrid electric and hydrogen vehicles technologies eligible for the prizes.

3. Advanced Technology Motor Vehicles Manufacturing Credit: The DRIVE Act would establish a tax credit for automobile and parts manufacturers to invest in advanced automotive technologies, including hybrid, advanced diesel, and fuel cell vehicles. The credit would be worth up to 35% of eligible investments in research, manufacturing, and engineering. The credit for each year would not exceed $75 million.

4. Consumer Incentives to Purchase Plug-in Hybrid Electric Vehicles: The DRIVE Act would expand the existing tax credit for the purchase of a hybrid vehicle that was set in EPAct of 2005. The potential tax credit would be increased depending on how far the vehicle could travel on the car's battery.

5. Tax Incentives for Private Fleets: Under the DRIVE Act private businesses would receive tax credits for the purchase of more efficient vehicles. Eligible taxpayers who own a fleet of at least 100 vehicles, and purchases at least ten vehicles eligible for the credit, would qualify for a tax credit of 15% of those purchases. To be eligible for the tax credit, the vehicle must have a rated fuel economy at least 25% higher than the CAFÉ standard for that vehicle class.

6. Reducing Incentives to Guzzle Gas: Under our current tax policy, the U.S. government grants a $25,000 tax deduction for the business purchase of sports utility vehicles over 6,000 pounds, and this creates a strong incentive for business owners to purchase large vehicles. The DRIVE Act will save the government money by reducing the tax advantage that accrues from the purchase of the larger vehicles. Farm vehicles would be exempt from this section.

7. Biofuels Tax Credits: The DRIVE Act would extent the existing tax credits for biodiesal fuel, and would extend the existing small ethanol producer tax credit for facilities that produce ethanol from sugar cane, sugar beets, and cellulose.

8. Production Incentives for Cellulosic Biofuels: The Drive Act would increase the authorization to provide incentives for the production of biofuels from cellulosic materials to $200 million annually over five years.

The Senate Committee on Finance has a key role to play in providing incentives to reduce our country's reliance on foreign oil, and that is why today's hearing is so timely. Changes in how we fuel our transportation sector are imperative to reducing this reliance. I look forward to hearing from our witnesses today on their ideas on the most promising changes that can be made in the transportation sector to improve our country's national and economic security, and to reduce greenhouse gas emissions. I also look forward to working with the Chairman and the committee on development of an energy tax package.

Mr. Chairman, I thank you again for holding this important hearing.

U.S. Senate Committee on Finance

Hearings on Grains, Cane and Automobiles: Tax Incentives for Alternative Fuels and Vehicles

April 19, 2007

Testimony of R. James Woolsey,
Member National Commission on Energy Policy

Mr. Chairman and Members of the Committee it is an honor to be asked to testify before you today on this important subject. I have been asked to represent the National Energy Policy Commission of which I am a member and I happily do so, but other than on those points where the Commission has made a recommendation I of course represent only my own views.

Before moving to policies and incentives I thought it might be useful to the Committee if I gave some underlying rationale for why we, and others, are recommending moving toward alternatives to oil.

There are many aspects of our dependence on oil for 97 per cent of our transportation needs that affect both our national security in a traditional sense and, via oil's contribution to global warming, our security in a broad sense as well – oil contributes over 40 per cent of the global warming gas emissions caused by fossil fuels.

I do not believe that we will reach a sound energy policy if we ignore any of three key needs: to have a long-term supply of transportation fuel that is as secure as possible, as clean as possible (in terms of global warming gas emissions as well as other pollutants), and as inexpensive as possible. Today oil meets none of these three criteria. The reason this is important to us is that oil is a strategic commodity today insofar as we are in near-total dependence on it for transportation – not merely a commodity. Until a little over a century ago salt was such a strategic commodity as well (I am indebted to Anne Korin of IAGS for pointing out this analogy). Wars were fought and national strategies driven in part by salt, because it was the only generally-available way of preserving meat, a major portion of our food supply.

Today we haven't stopped using salt, but no part of our national behavior is driven by the need for it - it has a market and is shipped in commerce. But because it has affordable and effective competitors for meat preservation -- refrigeration, among other technologies - its dominant role is over. No nation sways world events because it has salt mines.

For a number of reasons we must strive for a similar path of decline in influence for oil - away from being a strategic commodity and toward being just a commodity. Oil will still be useful and valued for its high energy content and its relative ease of shipment for a long time. It will be used in heating and in the production of some chemicals as well - in those uses it is already, in a sense, no longer a strategic commodity because it has competitors. Doubtless it will be used for many years to produce transportation fuel as well. But in the interests of our national security, our climate, and our pocketbooks we should now move together as a nation - indeed as a community of oil importer nations - to destroy, not oil of course, but oil's strategic role in transportation as quickly and as thoroughly as possible.

National Security

The national security reasons to destroy oil's strategic role are substantial.

Over two-thirds of the world's proven reserves of conventional oil lie in the turbulent states of the Persian Gulf, as does much of oil's international infrastructure. Increasing dependence on this part of the world for our transportation needs is subject to a wide range of perils.

Just over a year ago, in response to bin Laden's many calls for attack on such infrastructure, al Qaeda attacked Abcaiq, the world's largest oil production facility, in northeastern Saudi Arabia. Had it succeeded in destroying, e.g., the sulfur-clearing towers there through which about two-thirds of Saudi crude passes -- say with a simple mortar attack -- it would have succeeded in driving the price of oil over a hundred dollars a barrel for many months, perhaps close to bin Laden's goal of $200 a barrel.

Royal succession in Saudi Arabia could also bring major problems. King Abdullah is a sponsor of some reforms in the Saudi system and sometimes works toward cordial relations with us and other oil importers, but he is in his eighties, as is Crown Prince Sultan. If Prince Nayef, the Interior Minister, succeeds to the throne his views are famously close to those of the extremely reactionary Wahhabi religious movement in the Kingdom. It was he, for example, who decided not to inform the US a few months before the Khobar Towers bombing

when "... a few months earlier Saudi authorities had intercepted a car from Lebanon that was stuffed with explosives and headed for Khobar." (Wright, The Looming Tower, 2006, pp. 238-39). Cordial relations with the US may not be at the top of his agenda.

Iran's President is part of a circle, the Hojateih, around Ayatollah Mesbah-Yazdi that is radical even by Iranian post-1979 standards. Indeed Mesbah-Yazdi was exiled to a school in the city of Qum by Ayatollah Khomeini because the latter thought Mesbah-Yazdi too radical. The Hojatiehs' views center on the importance of encouraging the return of the Twelfth Imam from the 10th century (the Mahdi) so that he may begin the battles between good and evil that they believe will end the world. The efficacy of deterrence and containment in dealing with Iran's nuclear weapons development program is not clear when Iran's leaders talk of the desirability of Iran's becoming "a martyr nation" and shrug at the possibility of millions of deaths by saying "Allah will know his own."

In response to Iran's nuclear program, this past winter six Sunni Arab states, including Egypt and Saudi Arabia, announced that they too would have "peaceful" nuclear programs. But since a number of these states have very plentiful supplies of oil and gas it seems unlikely that all these programs will be limited to electricity generation. We may be seeing the beginning stages of a nuclear arms race in the Gulf region between Sunni and Shia.

The US now borrows from its creditors such as China and Saudi Arabia over $300 billion per year, approaching a billion dollars a day of national IOU-writing, to import oil. This contributes heavily to a weakening dollar and upward pressure on interest rates (our annual oil debt is well above our trade deficit with China). For each of these daily billions of dollars that we can avoid borrowing and can figure out how to spend productively producing domestically for our transportation needs we create 10,000 or more jobs in the US. Another interesting perspective is that net farm income in the US is in the range of $80 billion annually. So by replacing about a fourth of our imports with domestically-produced alternatives, we create value in this country about equal to a doubling of net farm income.

If these IOUs we send abroad put a strain on the world's wealthiest economy, think what they do to the economies of developing countries in, say, Africa that have no oil themselves. Debt is the central inhibitor of economic development - importing expensive oil is helping bind hundreds of millions of the world's poor more firmly into poverty.

A share of our payments for oil, along with others', find their way to Saudi Arabia. The Saudis provide billions of dollars annually to their Wahhabi sect, which establishes religious schools and institutions throughout the world. Lawrence Wright in his fine work, The Looming Tower, states that with about one per cent of the world's Muslim population the Saudis support via the Wahhabis "... 90 per cent of the expenses of the entire faith, overriding other traditions of Islam." (p.149)

These Wahhabi teachings, if one reads the fatwas of their imams (see Shmuel Bar, Warrant for Terror: Fatwas of Radical Islam and the Duty of Jihad, 2006), are murderous with respect to the Shia, Jews, homosexuals, and apostates and horribly repressive with respect to everyone else, especially women. They are essentially the same basic beliefs as those expressed by al Qaeda. The Wahhabis and al Qaeda do not disagree about underlying beliefs but rather, a bit like the Stalinists and Trotskyites of the 20's and 30's, about which of them should be in charge. The hate-filled underlying views of both, however, point in the same overall direction. Many Wahhabi-funded madrassahs, world-wide, echo and perpetrate this hatred and thus promote its consequences. Thus, as has often been said, when we pay for Middle Eastern oil today, this Long War in which we are engaged becomes the only war the US has ever fought in which we pay for both sides.

Finally, as Tom Friedman of the New York Times puts it, "the price of oil and the path of freedom run in opposite directions". Work by Collier at Oxford and other scholars has pointed out the link between commodities commanding huge amounts of economic rent, such as oil (or the gold and silver brought from the New World by Spain in the sixteenth century) and political autocracy. Such a commodity, unless it is acquired by a mature democracy such as Norway or Canada, tends to concentrate and enhance the power in the hands of a ruler. "There should be no taxation without representation" says Bernard Lewis, "but it should also be noted that there is no representation without taxation." If a country is so oil-rich that it doesn't need taxes it does not need, and often does not have, any real legislative body – and thus no alternate source of power in the State – to levy them. And as for enhanced power from oil wealth, note the behavior recently of Messrs. Ahmadinejad, Chavez and Putin.

So the national security reasons to move against oil's role as a strategic commodity are substantial.

Carbon Emissions

Most of the attention regarding climate change has centered on reducing CO2 emissions from coal because of its central role in many parts of the world,

including the US, in electricity generation. This testimony will not deal with these particular emissions except to note that oil use in transportation is only lightly affected by the steps that may be taken, such as carbon taxes or carbon cap-and-trade systems, to limit CO2 emissions from coal. An increase in price of many dollars per ton of CO2 will have only pennies' worth of effect in the price of gasoline. So while such methods of limiting emissions from coal combustion have much to commend them, they have little to do with reducing the over-40 per cent of CO2 emissions that come from oil, especially in its transportation uses. Other tools must be found.

Replacing gasoline with corn-derived ethanol provides a start, but only a start. As a general proposition, fuels made from renewable resources merely recycle differently the CO2 that is already in the atmosphere and that will stay there in any case, e.g. by unharvested grasses (which have fixed CO2 in the photosynthesis process) dying and decaying in the field. Thus compared to fossil fuels, which introduce into the atmosphere CO2 that could otherwise remain sequestered below-ground, renewable fuels typically exhibit much lower net CO2 emissions on a well-to-wheels basis. When ethanol is made from corn, however, the process may use enough natural gas in producing fertilizer and, depending on the fuel used to fire the ethanol plant, on ethanol production that its use reduces global warming gas emissions perceptibly but only modestly compared to those from gasoline (although even corn ethanol of course reduces oil use). Also, beyond the range of replacing approximately 10 per cent of gasoline, use of corn-derived ethanol for transportation fuel begins to create problems with land use. Other fuels (see below) need to be utilized

In my judgment it is important to limit the CO2 emissions from oil used for transportation (somewhere around a quarter of our fossil-fuel CO2 emissions), but I find much of the current debate, couched in terms of belief, to be less than enlightening. Belief in a scientific theory, even one that has been accepted by many reputable scientists for many years, should always be held tentatively and, Karl Popper taught us well I believe, a theory should always be regarded as a candidate for refutation. Such refutation may be total – the late senior Saudi imam Ben Baz to the contrary notwithstanding, the sun doesn't rotate around the earth. Or it may be partial: Newton wasn't so much proven wrong by Einstein but rather his theories were shown to have limitations.

Today the clear weight of scientific opinion – e.g. the views of the US National Academy of Sciences – is on the side of the proposition that global climate change is in part anthropogenic and that it is related to the release of CO2 and other gases such as methane. And although critics are right to point out that earlier predictions by others have not borne out – global cooling, massive famine

from population increase - this should not affect our judgment about CO2 and global climate change (except to give all of us a reasonable reminder about the importance of scientific theories always needing to be held tentatively).

I find most congenial the approach to these issues adopted by the Nobel-Prize-winning economist, Thomas Schelling, who points out that we insure against many phenomena which we are not certain will occur, but which we nonetheless take seriously. It is a question of the insurance premium's appropriate size. With respect to coal-fired electricity there is a major debate because most steps to abate CO2 emissions have cost - e.g. moving toward carbon capture and sequestration - but no major benefits other than limiting CO2 emissions, at least none (e.g. pollution abatement) that can't be dealt with more cheaply.

But breaking oil's strategic role in transportation, I would maintain, is different. As discussed below, such an objective has modest costs (some of them indeed are negative) and substantial other benefits. Oil should thus be an early candidate for public policy decisions to speed its strategic demise.

Affordability

We have made some substantial mistakes with regard to affordability in the past. Ignoring cost in attempting to destroy oil's strategic role in transportation is not only expensive, it is self-defeating. For example, in the aftermath of war, revolution, and oil crises in the Middle East in the 1970's the US initiated the very expensive Synfuels Corporation. It promptly went bankrupt in 1986 after the Saudis increased their production from their reserves and drove oil down to near $5/barrel. Something similar happened to various expensive petroleum alternatives in the late 90's when, for a number of reasons, oil prices sank to around $10/barrel.

Our most recent mistake has been investing so heavily in hydrogen fuel cell technology for passenger vehicles. Hydrogen fuel cells have real utility in many fixed applications, in the space program, and perhaps, once their cost has been adequately reduced, for some types of fleet vehicles. Hydrogen production for chemical use may also be one reasonable way to utilize stranded electricity (electricity produced at a site for which no, or inadequate, transmission is available). But to have an adequate number of hydrogen fueling stations in our neighborhoods to support family cars driving on hydrogen would require a huge investment in infrastructure, by some estimates nearly a trillion dollars.

And then one needs to answer two questions about creating hydrogen from either natural gas or electricity. Why reform natural gas into hydrogen for fuel cells and not just put the natural gas into internal combustion engines in the

first place, especially since the conversion wastes about a third of the original energy? Many cities have natural-gas-powered buses and Iran is even modifying its existing automobile fleet to be dual fuel vehicles of a sort that can use either gasoline or natural gas. Or rather than convert electricity (via electrolysis of water) into hydrogen and then via a fuel cell into electricity again, losing about three-quarters of the energy in the process? Why not put the electricity into the vehicle's battery, as with a plug-in hybrid, in the first place?

If we insist on expensive single solutions such as hydrogen – a platinum (not just silver) bullet – and ignore cost and the utility of building on existing infrastructure, we will fail. This is in part because in addition to oil's being a strategic commodity for transportation from the point of view of us, the importers, it is also a strategically manipulable commodity from the point of view of those who control it. Chinese and Indian demand, and the possibility that the peak oil theory will prove out and the major Middle Eastern fields will soon peak in their production capability, may keep oil prices high. But many investors will still be worried about a repeat of the sharp oil price drops of the mid-eighties and the late nineties. The world changed in important ways in the early 1970's when the Railroad Commission of Texas was in effect replaced by OPEC as the arbiter of the world's oil prices.

We need to convince our investors and ourselves that our economy is not subject to being manipulated by others based on whether we are being too aggressive in developing alternatives to oil, or supporting Israel's existence too determinedly. Instead we should develop a portfolio of approaches toward breaking oil's strategic hold on us, building on existing transportation capabilities wherever possible and keeping in mind cost, carbon emissions, and national security.

Toward a Portfolio

Electricity

As modern battery technology has developed in response to the markets for modern electronics, communications, power tools, and a host of other uses, it has brought with it opportunities to substitute electricity for oil products in transportation. Hybrid gasoline-electric cars have now been provided with these advanced batteries -- such as lithium-ion – with improved energy and power densities. Dozens of vehicle prototypes are now demonstrating that these "plug-in hybrids" can more than double hybrids' overall (gasoline) mileage. With a plug-in, charging your car overnight from an ordinary 110-volt socket in your garage can let you drive 20 miles or more on the electricity stored in the topped-

up battery before the car lapses into its normal hybrid mode. If you forget to charge or exceed 20 miles, no problem, you then just have a regular hybrid with the insurance of liquid fuel in the tank. And during those 20 all-electric miles you will be driving at a cost of between a penny and three cents a mile instead of the current 10-cent-a-mile-plus cost of gasoline.

Utilities are rapidly becoming quite interested in plug-ins because of the substantial benefit to them of being able to sell off-peak power at night. Because off-peak nighttime charging uses unutilized capacity, DOE's Pacific Northwest National Laboratory estimates that adopting plug-ins will not create a need for new base load electricity generation plants until plug-ins constitute over 84% of the country's 220 million passenger vehicles. Further, those plug-ins that are left connected to an electrical socket after being fully charged (most U.S. cars are parked more than 20 hours a day) can substitute for expensive natural gas by providing electricity from their batteries back to the grid: stabilization of the grid's frequency and voltage, and "spinning" reserves to help deal with power outages.

The economic savings that can result from these vehicle-to-grid (V2G) connections are very substantial.

First of all, V2G takes advantage of the fact, surprising to most people, that today's light vehicle fleet has twenty times the power capacity of our electric power system and less than one-tenth its utilization. A relatively few vehicle batteries can thus store much larger amounts of energy relative to the grid's needs than most people realize. Vehicles that are fully charged can be left plugged into electric outlets and serve useful, and profitable, purposes. I would refer the Committee to experts on this matter - particularly Professor Willett Kempton of the College of Marine and Earth Studies at the University of Delaware who, together with his colleagues there, has published widely on this subject. But one example is that if only 3 per cent of the nation's light vehicle fleet were plug-in hybrids, plugged into the grid, they would alone be able to handle the grid stabilization market, on which utilities today spend about $10 billion.

Second, major infrastructure changes are not needed in order to use V2G. Forty out of fifty states today have net metering laws which let homeowners sell power they generate, such as from rooftop photovoltaics, back to the grid - those who have solar systems on their roofs can literally watch their electricity meters run backwards. V2G's flexibility will improve as the grid gets "smarter" but it can be done today. Professor Kempton's work thus suggests that utilities can save a great deal of what is now spent on fossil fuels by substituting V2G connections and that this in turn can benefit consumers quite substantially. In

his models the credits the consumer obtains from connecting his plug-in hybrid to the grid, after it has been fully charged, for several hours a day cover a substantial share of the consumer's monthly car payments. It seems too good to be true that both consumers and utilities could make money while together they reduce fossil fuel emissions, but such seems to be the clear logic of the economics of plug-in hybrids and V2G.

Once plug-ins start appearing in showrooms, (company announcements now make it seem likely that we will see the first production models within 2-3 years), it is not only consumers and utility shareholders who will be smiling. If cheap off-peak electricity supplies a portion of our transportation needs, this will help insulate alternative liquid fuels from OPEC market manipulation designed to cripple oil's competitors. Indian and Chinese demand and peaking oil production may make it much harder for OPEC today to use any excess production capacity to drive prices down and destroy competitive technology. But as plug-ins come into the fleet low electricity costs will stand as a substantial further barrier to such market manipulation. Since OPEC cannot drive oil prices low enough to undermine our use of off-peak electricity, it is unlikely to embark on a course of radical price cuts at all because such cuts are painful for its oil-exporter members. Plug-ins thus may well give investors enough confidence to back alternative liquid fuels without any need for new taxes on oil or subsidies to protect them.

Environmentalists should join this march, and over time with increasing enthusiasm. The Environmental and Energy Study Institute has reported that, with today's electricity grid, there would be a national average reduction in carbon emissions by about 60% per vehicle when a plug-in hybrid with 20-mile all-electric range replaces a conventional car. Further studies are underway on this important subject, but it seems clear that replacing a conventional vehicle with a plug-in hybrid will show substantial reductions in carbon emissions today in clean-grid areas such as the West Coast and some reductions on an average basis nation-wide (coal fuels about 51 per cent of our overall electricity generation). In states where coal-fired generation dominates the electricity market there may still be some reductions in carbon emissions on a net basis by moving toward plug-in hybrids. In any case, if other public policies such as cap-and-trade lead to electricity's increasingly being generated from less carbon-emitting sources -- such as renewables, nuclear power, or coal with carbon capture and sequestration – this process will further reduce net vehicle emissions as well.

And as far as infrastructure investment is concerned, some is indeed needed for plug-in hybrids: each family with such a vehicle would need an extension cord. Period.

Renewable Liquid Fuels

Because, as discussed above, renewable liquid fuels hold the promise of very substantial CO2 reductions on a well-to-wheels basis I will limit this testimony to them. It is of course possible that technological innovation will make possible a sufficient degree of carbon sequestration from other alternative fuels - from oil sands, oil shale, coal-to-liquid - that they will meet relevant CO2 emissions requirements.

In my view, even if the nation moves toward plug-in hybrid gasoline electric vehicles, and even with expected battery improvements, there will be a substantial market for liquid fuels. This is because in order for a driver not to be concerned at running out of electricity I believe there will be substantial motive to have liquid fuel in the tank. Liquid fuel will be necessary for road trips in a plug-in hybrid beyond the battery-charge range. And although over time we can probably expect battery performance to improve and the need for liquid fuel decline, battery cost today (perhaps $500-600/kilowatt hour) substantially limits battery size for moderate-cost vehicles to the plug-in hybrid ranges rather than all-electric. In addition to battery cost reductions, wide availability of quick-charging could reduce the demand for liquid fuels over time, but those renewable fuels with a substantial cost advantage may prove particularly durable in the public market.

Cost advantages can accrue from a number of sources.

For example, the ability to grow feedstocks such as switch grass on many types of land effectively removes the land limitations frequently associated with corn-derived ethanol. We found on the National Energy Policy Commission in our 2004 report that, with reasonable assumptions about improvements in vehicle mileage and yield per acre of feedstocks, enough switch grass could be grown on the amount of farm land equivalent to the soil bank (about 30 million acres, or around 7 per cent of US farm land) to replace over the next twenty years about half of US gasoline.

Further, over time cellulosic ethanol and cellulosic methanol may exhibit cost advantages over corn-derived ethanol; for example, cellulosic ethanols' production is likely to be simplified by the perfection of consolidated bioprocessing (so that hemi-cellulose and cellulose may be processed together). Its production costs may be lowered by rapid yield improvements using new genetic techniques, possibly but not necessarily including the genetic engineering of the feedstocks themselves - e.g. to simplify the breaking down of the grasses' or other feedstocks' lignin. And its shipping costs may be lowered by locating small facilities near markets - switchgrass will grow in more parts of the country than corn.

Bio-butanol may exhibit the above advantages and also profit from the fact that it is both more energy-intensive and more pipeline-friendly than ethanol.

Renewable diesel, made by thermal processes from many types of carbon-based waste -- from turkey offal to hog manure to used tires - and P-Series fuels, made from waste and biomass, may both exhibit cost advantages from environmental cleanup. Conversion of only a portion of industrial, municipal and animal wastes—using thermal processes now coming into commercial operation—appears to be able to yield several million barrels a day of diesel, or with modest further processing, methanol.

In Europe the negative costs ("tipping fees") that a fuel producer can obtain while making fuel from such clean-up processes are substantial - approximately $100/ton in some cases. We may be about to see some of these processes that simultaneously clean up the environment and produce fuel leave the United States and migrate to Europe, particularly since the executive branch has recently decided to extend to oil refineries the $1/gallon "renewable diesel" credit previously focused on cleanup renewable fuel-producing technologies. (See IRS Notice 2007-37)

And one or more of the above processes may also find cost advantages in the production of high-margin niche products in biorefineries that do not produce only fuel. For example, today polylactic acid, a major ingredient in many plastics that is ordinarily made from hydrocarbons, is being produced from carbohydrates (corn) in Nebraska. In relative short order we may see other such products moving us in a transition from hydrocarbon to carbohydrate feedstocks for a range of chemicals.

In short there is a good deal of promise that we may be able to shift our liquid fuel consumption toward renewable fuels that radically reduce our reliance on oil products. A key policy step to enabling liquid fuel choice is to ensure that most new cars are flexible fuel vehicles, cars that can run on any combination of gasoline and alcohols such as ethanol and methanol. Every car sold in the U.S. is required to have seatbelts and airbags; similarly, every car should enable fuel flexibility, a feature which adds less than $100 to the manufacturing cost of a vehicle and provides a platform on which fuels can compete.

Materials and Other Fuel Efficiency Steps

There are a range of fuel efficiency steps that can be undertaken. I will mention here only one: constructing vehicles with inexpensive versions of the carbon fiber composites that have been used for years for aircraft construction.

This can substantially reduce vehicle weight and increase fuel efficiency while at the same time making the vehicle considerably safer than with current construction materials. This is set forth thoroughly in the 2004 report of the Rocky Mountain Institute's *Winning the Oil Endgame* ("WTOE"). Aerodynamic design can have major importance as well. Using such composites in construction breaks the traditional tie between size and safety. Much lighter vehicles, large or small, can be substantially more fuel-efficient and also safer. Such composites have already been used for automotive construction in Formula 1 race cars and are now being adopted in part by BMW and other automobile companies. The goal is mass-produced vehicles with 80% of the performance of hand-layup aerospace composites at 20% of the cost. RMI's investigations suggest that such construction is expected approximately to increase the efficiency of a normal hybrid vehicle by something in the range of 70 per cent without increasing manufacturing cost. (WTOE 64-66).

A Portfolio of Programs and Criticisms

None of us is wise enough to be able to tell today how quickly and affordably, say, battery improvements will occur compared with progress in the production of bio-butanol, or when it will be more economic to produce family cars from carbon composites than to spend the marginal dollar on improving consolidated bioprocessing for cellulosic ethanol. This sort of decision is best made by the market, once access to it has been made possible. Indeed, as with the family's investments, the nation is better off putting stock in a portfolio of approaches rather than looking for any single solution. The search should not be for a platinum bullet such as hydrogen fuel cells but rather for a number of pieces of silver-plated buckshot.

Indeed I believe that the principal effort of the federal government on these issues should be to remove market barriers to entry for transportation programs such that oil, as a strategic commodity, sees vigorous competition. These steps will, if undertaken wisely, help introduce Americans and others sooner rather than later to practical alternatives in their daily lives - the ability to choose rather than the requirement to take what OPEC decides to give us.

Critics of Moving Away From Dependence

Broadly speaking there seem to be four main types of critics of developing a portfolio to move away from oil dependence.

The first, more or less characterized by a recent report by the Council on Foreign Relations, seems to be driven by a concern that in seeking to move away from oil dependence we will do foolish nationalistic things. For example, the

report states that "[t]he voices that espouse 'energy independence' are doing the nation a disservice by focusing on a goal that is unachievable over the foreseeable future...." But virtually no one who is working to reduce dependence on oil has as his objective a simple switching of buying patterns (e.g., we buy more from Canada and Mexico, Europe buys more from the Middle East); this, of course, would have no major effect on the essentially world-wide oil market. Nor are those who wish to reduce dependence fixated on achieving at any cost total energy autarchy - the straw man the report creates, then argues against. The American people have met difficult challenges before - there is no reason not to use our capacity for technological innovation to reduce our oil dependence decisively while at the same time avoiding fantasies of finding single perfect solutions. The Council Report amounts to telling someone afflicted with alcoholism that he needs to remember that a glass or two of red wine a day would be good for his health. There is truth in the point, but it's not the main thing he needs to fix right now.

The second type is a few car buffs who have not kept up with battery technology and are somehow infuriated at the suggestion that electricity could be a useful and effective method of fueling transportation in place of gasoline. It is indeed difficult to rev loudly a car using electric drive - it just persistently stays quiet. If performance is the objective, however, the acceleration of which an electric motor is capable can be quite remarkable. The new Tesla all-electric roadster advertises zero to sixty in 3.95 seconds. I've driven it. It's true.

The third type of critic apparently prefers paying oil producing states in the hope that they will not generate terrorists rather than giving tax credits for producing alternative fuels in the US. For example, recently in the Milken Institute Review Messrs. Jerry Taylor and Peter Van Doren wrote that they didn't want to see greater use of alternative fuels lead to "smaller producer-state subsidies" to the "young" and "underemployed" of oil-exporting states since "reduc[ing] revenues flowing to Islamic terrorists might perversely increase the recruitment pool for Islamic terrorists...." This might be called the "Billions for tribute, not one cent for oil alternatives" approach.

Finally, there is the new Satanism school. Writing in the Wall Street Journal columnist Holman Jenkins recently accused me personally of "surrendering [my] soul upfront" and "rushing into a devil's bargain" by praising the use of ethanol rather than oil products, and then again that "Satan will insist on his due" even if though I urge moving from corn to cellulosic biomass as a feedstock. I was really shocked at this allegation - not about me, since I would honestly have to plead guilty to at least second-degree ethanol support, but I was surprised to see Mr. Jenkins link the Devil to ethanol, even outside the context of excessive recreational ethanol consumption. So I

communicated to Mr. Jenkins that I had given him a call and the Devil had assured me that it wasn't true: "I'm totally," he said, "invested in geothermal."

Legislative Programs

There are two that I wish to mention.

The first is that of the National Commission on Energy Policy.

The Commission is a bipartisan group of energy experts that first came together in 2002 and issued a comprehensive set of consensus recommendations for U.S. energy policy in December 2004. (full report at www.energycommission.org) The Commission is supported primarily by the Hewlett Foundation with support from several other private, philanthropic foundations. The Commission's ideologically and professionally diverse 21-member board includes recognized energy experts from business, government, academia, and the non-profit sector.

Our final recommendations, which are described in our 2004 report, *Ending the Energy Stalemate*, were informed by intense discussions over several years, by dozens of analyses, and by extensive outreach to over 200 other groups. Those recommendations, I should stress, deal with a comprehensive set of energy policy issues including climate change, our nation's dependence on oil and the need for increased investment in new energy technologies and critical energy infrastructure. Two years later, although Congress passed major energy legislation in the summer of 2005, concerns about oil security and climate change continue to grow more urgent. The Commission has continued to explore options for meeting these central energy challenges. Just yesterday, the Commission issued an updated suite of recommendations focused on addressing the demand as well as supply side of the oil security equation as well as advancing a timely response to the problem of global climate change.

Focusing on the Commission's views of the achievements necessary in the transportation sector to enhance oil security, the Commission originally called on Congress to "significantly strengthen" and "simultaneously reform" the existing Corporate Average Fuel Economy (CAFE) program. It also proposed providing targeted manufacturer and consumer incentives to accelerate the deployment of advanced vehicle technologies and to address the competitiveness concerns of the U.S. auto industry. I am glad that we made these recommendations, but I was always disappointed that we couldn't pick a number in 2004.

A little over two years later, I am very pleased to announce that Commission is now calling for establishing a 4% per year fuel-economy improvement target. Despite promising advances on the technology front—

including substantial progress in developing vehicles, such as hybrid electric and plug-in hybrids, that could radically reduce gasoline consumption per mile traveled—I believe that improving the efficiency of the nation's light-duty vehicle fleet remains an important and as-yet-untapped area of policy opportunity for reducing oil dependence and making the nation more energy secure. Further, it is an enabler for other positive steps such as a rapid transition to plug-in hybrids and flexible fuel vehicles (FFV's).

In addition to strengthening CAFE, I would urge on the Commission's behalf that Congress establish a five to ten year tax incentive program for manufacturers and consumers to encourage the domestic production and purchase of plug-in hybrid, hybrid-electric, and advanced diesel vehicles that achieve superior fuel economy. Cost is always an issue, of course, in the Committee's deliberations. I would only note that, in view the over-300-billion-dollar debt that we are incurring annually for oil imports, each billion dollars marks about a day of borrowing. Each day that we replace oil imports with domestic production of an alternative thus roughly equates to 10,000 or more potential new American jobs. Thus a $ 3 billion tax incentive program would be a major step, and the funds would of course have to be found for it. But in the overall context, it is only the equivalent of three days of oil imports as we attempt to satisfy our nation's 250-barrel-per-second appetite for oil.

The effect of encouraging a portfolio of approaches to destroying oil's role as a strategic commodity is that the programs can work together, and together they can give us a much better chance of succeeding than banking on one. For example, a 50 mpg hybrid, once it becomes a plug-in, will likely get solidly over 100 mpg of gasoline (call it "mpgg"); if it is also a flexible fuel vehicle using 85% ethanol, E-85, its mpgg rises to around 500; if it is made from light, crash-resistant carbon composites its mileage may approach doubling again – edging toward 1000 mpgg. Any one, or all, of these technologies may not work out as well as we hope, but a portfolio approach gives us a chance for substantial progress even if this is not the case. Suppose we achieve only 200 mpgg? Still not bad.

With a portfolio approach the market will likely operate to expand sharply the use of these technologies that heavily reduce oil use in the foreseeable future and are already in pilot operation. However, in order to speed their introduction into the marketplace, the government would need to provide targeted consumer and manufacturer incentives to promote their domestic development, production, and deployment. In conclusion, I believe that we need a combination of improved fuel economy standards coupled with the greatly accelerated the adoption of transformative vehicle technologies. Incentives alone will not do the job: absent a change in standards, average fuel economy

will continue to stagnate so long as gains from more efficient vehicles can be offset by a larger market share for less efficient models. As the Commission and I have argued in the climate and national security contexts, a combination of regulation and incentives is likely to be more effective than either approach in isolation because it generates a simultaneous market pull and market push for new technologies.

I have also appended to this testimony a point sheet setting out the provisions of the DRIVE Act, titled the Vehicle and Fuel Choices for American Security Act in the 109th Congress and re-introduced in the 110th Congress by Senators Bayh, Brownback, Coleman, and Lieberman and 21 other Senators, including six members of this Committee, Senators Bingaman, Kerry, Schumer, Lincoln, Cantwell, and Salazar. Among the important steps this legislation, based on the Set America Free Coalition's Energy Security Blueprint, advances are: a national oil savings target of 2.5 million barrels per day by 2015, increasing over time; programs that increase fuel choice in transportation; and federal manufacturing retooling incentives for producing efficient vehicles and the authority to set efficiency standards for tires and heavy duty trucks.

A Surprising Coalition

You have not asked me to assess the domestic political dimensions of this issue, and such is far from my expertise. I would only conclude by noting that I continually find it interesting that there seems to be much more consensus on what needs to be done in moving decisively to reduce oil dependence than on the reasons for doing so. In broad terms the approach suggested above – using a combination of regulatory and market mechanisms to remove barriers to the use of oil alternatives, including electricity, and to promote the development and commercialization of a portfolio of such renewable technologies – can obtain, I believe, substantial support from a potentially rather wide coalition.

There are a number of reasons individuals come to be interested in moving the US (indeed the world) away from oil dependence. Some are interested in protecting the environment, including of course from climate change. Some are struck by the impoverishment of developing countries, a condition substantially enhanced by oil debt. Some are particularly interested in improved prosperity for rural America, and indeed moving increasingly toward a carbohydrate-based, rather than hydrocarbon-based, economy for transportation and chemicals. Some are focused on the order-of-magnitude reduction in driving costs that can come from electricity. Some are especially worried about our increasing dependence on the Middle East for oil and

resentful at the use to which an important share of the Middle East's oil earnings are put. Some are excited at the prospect of innovation in this field creating economic opportunities. Some in the business of providing electricity see the opportunity for reduced costs and increased earnings. Some believe that the Bible's injunction that we should both care for the planet and see that it is used for human benefit points us generally in this direction. And some are simply struck by a sense of commitment.

With no disrespect intended, especially since I personally see merit in all of the above arguments, I have called this in the past a coalition of the tree huggers, the do-gooders, the sod-busters, the Mom and Pop car owners, the cheap hawks, the venture capitalists, the utility shareholders, the evangelicals, and Willie Nelson.

But what is interesting is that, as long as the basic criteria that our transportation be secure, have low emissions, and be affordable are kept in mind any one of these arguments suffices. So it is not necessary that people agree about the reasons for moving sensibly but decisively to reduce oil dependence, merely that each, for his or her own reason, is willing to work toward the same end.

Post-Script: A Further Evolution in Security and Low Emissions

Today electricity production and transportation fuel demands have little to do with one another. Unlike the 1970's, when around 20 per cent of our electricity was produced by oil, today only 2 per cent is so produced. So substantial changes in the way we produce electricity – with renewables or nuclear energy, for example – don't really affect our oil use.

We have seen above how the coming of plug-in hybrids can to a substantial extent replace gasoline with electricity as a fuel and that, for some time, this will put little added demand on electricity production because of the use of off-peak power for these purposes and the use of V2G.

There is a further development on the horizon, however, of which we should be aware. The security of the electricity grid requires attention. In addition to its heavy use of coal (without carbon capture and sequestration), a condition that contributes heavily to global climate change emissions, the grid has substantial security problems.

Three and a half years ago, for example, a tree branch fell in a storm in Ohio and the cascading grid failures quickly took about 80 gigawatts, the equivalent of eighty nuclear power plants, off line. New York, New England, and Eastern Canada were without power for over a day. As we require more and more from the grid, and do not build enough transmission lines we contribute substantially to the grid's vulnerability. Whether it is resistance to electricity generation, say from wind farms' being located relatively near consumers, or resistance to power line construction we have almost gone past "Not In My Back Yard" (NIMBY) to "Build Absolutely Nothing Anywhere Near Anything" (BANANA). Also, our fragmented regulatory system hinders security measures. A National Research Council study in 2002 on which I served, and a number of other reviews as well, have pointed out the grid vulnerabilities of, especially, the grid's unprotected transformers and the easily hackable SCADA (Supervisory Control and Data Acquisition) control systems.

The point is that tree branches, with the current grid, are bad enough, but terrorists are much smarter than tree branches. They would know not only what parts of the grid to attack (much of this is, sadly, on the internet – this is a subject about which the US is, perhaps to our peril, quite open), but could produce outages lasting months not just days.

So, in addition to taking steps to improve grid security such as requiring the stockpiling of adequate numbers and types of transformers and other key components and better protecting the SCADA systems, we need to build resilience into the grid by generating our own electricity when we can. Fortunately the technology of both distributed solar generation – thin film, then nano-solar at the site where the electricity is used – and distributed, roof-top, wind generation is coming along nicely, and costs are going down. Wind tends to blow at a different time of day than the sun shines, so distributed wind (some new generators can operate with only a very few mph of wind blowing, much less than required for the very large turbines used in wind farms) and solar operating together, with new technologies that can lower costs, show real promise. For example just last week I saw a solar electricity-generating blanket being assessed now by the US Army. It is about the size of a pool table top and, once spread on the ground in the sun, generates within five minutes about a kilowatt of electricity. Several of these would power the needs for light, refrigeration, and communications within a home that was using electricity frugally (e.g. the right kind of light bulbs, and not too many turned on).

Especially when distributed wind and solar are combined with battery storage, say in the basement of a home, we are not that far from many residences and other buildings being able to generate a portion of their electricity needs themselves. Today if a tree branch or a terrorist takes out a major segment of the

grid, once we have used up any available diesel fuel for diesel generators we are back in the 19th century. But before too many years we may be in a position to have such an outage, for many of us, affect only, say, our homes' air conditioning. Losing air conditioning can be bad, but being shoved unceremoniously back into the nineteenth century would be considerably more bracing.

Finally, the advent of plug-in hybrids will affect these distributed-generation possibilities as well. Today investing in roof-top solar collectors is, roughly, a matter of spending tens of thousands of dollars for a system, including batteries, to produce and store several kilowatts. But as costs come down for both distributed solar and wind, and as federal and state tax incentives mature, those costs are headed toward being in the thousands of dollars rather than the tens of thousands. And if part of what I am replacing with the electricity generated on my roof is gasoline (by charging my plug-in hybrid), the overall security, efficiency, and lowered emissions of my evolving home electricity system could be quite promising.

There are some interesting opportunities coming if we will but grasp them.

Committee on Finance
Grains, Cane, and Automobiles: Tax Incentives for Alternative Fuels and Vehicles
April 19, 2007

Answers of R. James Woolsey to Questions for the Record

Questions for Mr. Woolsey:

A few of you on this panel have stated that you do not feel that biodiesel produced by soy or vegetable oil is viable long-term. Most of this nation's heavy duty vehicles run on diesel fuel, making it imperative that green diesel fuel be a part of any discussion of biofuels going forward. As many of you know, even within the last week we have seen developments in the area of new diesel technology.

What do you believe will be the future for green diesel fuel and what do we as a Congress need to achieve that? (Senator Lincoln)

Answer: I believe that biodiesel (e.g. from soy or restaurant grease) has some utility but that, in order for it to be used in volume, the comparatively limited yields of fuel per acre of crops is an inhibiting factor. Another inhibiting factor is the presence of methyl esters which, as I understand it, prevent biodiesel's being refined into other fuels.

As I noted, however, in my answer during the hearing to Senator Cantwell, I believe that the technological advantage in the diesel world lies more with renewable diesel.

Renewable diesel can be made—via thermal processes—from all sorts of waste: slaughterhouse offal, hog manure, chicken litter, municipal solid waste, used tires, car bodies (with metal extracted) etc. (As I mentioned in the hearing I have advised for some years one of the companies in the renewable diesel field.) This means that its production can be used to clean up wastes that no one wants, as distinct from utilizing only feedstocks that have alternative uses such as soy, animal fats, etc. I mentioned to Senator Cantwell that a recent Treasury ruling that gives the same tax advantage to oil refineries that process feedstocks that have such alternative uses (e.g. animal fats) as is given to those operators who clean up noxious wastes will have the effect of driving waste clean-up technologies to Europe. The EU gives substantial tipping fees (negative costs) to those who clean up noxious wastes. To use only one example, the last time I looked, in Europe, where there is great sensitivity to BSE (mad cow disease), a company is paid about $100/ton to destroy slaughterhouse waste in the process of producing renewable diesel. In the US, on the other hand, where our slaughterhouse waste is still sold to renderers, ground up, and used in certain feeds there is a cost of several tens of dollars a ton which renewable diesel facilities must pay for such feedstocks. If, at the same time, oil refineries are given the same tax

advantage as renewable diesel facilities even though they are not cleaning up such noxious wastes it is hard to imagine any business plan for renewable diesel processors that keeps them in the US rather than Europe.

We lose something important with respect to reducing our oil dependence if these processors don't set up in the US—by most calculations the amount of waste in the US, including municipal solid waste, that could be processed cleanly into renewable diesel (and refined, if desired, into gasoline, aviation fuel, etc.) would make possible the replacement of several million barrels a day of petroleum. One final point: many of the wastes from which renewable diesel can be made would otherwise turn into methane, more than twenty times worse than carbon dioxide as a global warming gas. So producing renewable diesel is a potent instrument in reducing global warming gas emissions as well as reducing reliance on petroleum for reasons of national security.

1) **Mr. Woolsey, in your testimony you referenced a report by the DOE's Pacific Northwest National Laboratory (PNNL) on the potential of plug-in hybrids. According to that study, the U.S. electricity grid is underutilized most of the time, and, with the proper plan in place, could deliver enough power to fuel most of the country's cars and light trucks, thereby reducing greenhouse gas emissions and curbing our reliance on foreign oil.**

   We know we have the infrastructure to handle these new vehicles and we know that a shift of this kind has significant promise in terms of weaning us off of foreign fuel sources.

   I have been working with Senators Hatch and Obama to craft a package of appropriate tax incentives that will help accelerate the production and adoption of plug-in hybrid vehicles. We are looking at incentives both for consumers to purchase these vehicles and for manufacturers to retool their facilities.

   Can you, or Dr. Farrington, comment on which side—the consumer-demand side, or the manufacturer-supply side—do you believe tax incentives make the most difference in advancing plug-in electric vehicles? (Senator Cantwell)

Answer: I believe that consumer tax credits would be more effective, in part because—although I am no specialist on tax matters—it seems to me that the financial condition of American automobile manufacturers makes many tax incentives difficult for them to utilize. I would suggest that clear, early, and substantial federal government orders for plug-in electric vehicles (plug-in hybrids and EVs) would be of substantial benefit in encouraging manufacturers to turn to producing them because such would encourage long-term contracts with suppliers, especially battery developers.

2) **What do you think about doubling the tax incentive for plug-in hybrids as compared to regular hybrids? (Senator Salazar)**

Answer: I believe that is approximately right. The most recent cost I have heard for lithium-ion batteries (certainly not the only possible plug-in battery technology, but one leading one) is $500-600/kilowatt-hour. This is expected to halve over the next several years. For the time being, however, if we assume that a plug-in hybrid (PHEV) that is capable of 20-25 miles of all-electric driving (before moving into hybrid mode) might need a 6-8 kwh battery and that one capable of around 40 miles all-electric would need a 10-12 kwh battery, then this would suggest a range from a bit under $4,000 to a bit over $6,000 in added cost. It is reasonable to assume, however, in my view that car purchasers would be able to see that there is some advantage to them in being able to do much of their driving at a cost of 1-3 cents/mile (the approximate cost of off-peak electricity for the all-electric ranges of these PHEVs) rather than the 10-15 cents/mile of today's average internal combustion engine vehicles in the US. That would suggest that the entire added cost of the battery might not need to be fully covered by the credit. We would want to make sure that any credit also encourages the adoption of PHEV technology by large vehicles and fleet vehicles. It thus might be useful to peg the tax credit to the kwh of the PHEV battery rather than offering a single figure—it takes more kwh in the battery (and more cost) for a delivery van PHEV to have a 20-mile all-electric range than a small sedan.

3) **Will you please explain why incentives for flexible-fuel vehicles are so important? (Senator Salazar)**

Answer: I believe that flexible fuel capability (including the ability of the vehicle to use not only gasoline, ethanol, and butanol but also methanol) is the key to having an infrastructure into which renewable fuels can move as soon as they are produced. It is a bad idea, in my view, to wait for the fuels before having the FFVs since the FFV capability is generally so easy and inexpensive to install in vehicles as they are being produced and the existence of the FFVs in the overall vehicle fleet will remove a barrier to renewable fuel use and help give an incentive to their production. Brazil took only 2-3 years to go from 5% of their new vehicles' being FFVs to 75% being such. The cost to the manufacturer is modest—by most accounts in the range of $50-150. Accordingly I would favor in this case—since our national security is involved—a mandate rather than an incentive. The mandate should extend to vehicles imported into the US as well as those manufactured here. Over a few years we should be able to transition to a situation wherein all new vehicles will be FFVs. Reasonably-priced conversions of existing vehicles to be FFVs may be possible (such is done in Brazil) and some incentive could perhaps be useful to encourage such conversions.

4) **I believe that hybrid-electric vehicles are great in their own right, but that their greatest potential will be realized when they are transformed into plug-in hybrids. I share your vision of a day when electrons, not liquids are a major source of transportation fuel. I understand that even**

when electrons are generated from a coal power plant, they are still cheaper and cleaner than standard petroleum.

For that reason, Senators Cantwell, Obama, and I are developing a follow up to the CLEAR Act, which will provide tax incentives to U.S. consumers of and U.S. manufacturers of plug-in electric and plug-in hybrid vehicles. What role do you see for the Congress in promoting Plug-in Hybrid Vehicles? (Senator Hatch)

Answer: I believe that approximately doubling for plug-in hybrids (PHEVs) the tax incentive that has been applied to hybrids is in general a reasonable way to provide an incentive for PHEV purchases, but there are some important considerations that may lead Congress to a more tailored approach. The most recent cost I have heard for lithium-ion batteries (certainly not the only possible plug-in battery technology, but one leading one) is $500-600/kilowatt-hour. This is expected to halve over the next several years. For the time being, however, if we assume that a plug-in hybrid (PHEV) that is capable of 20-25 miles of all-electric driving (before moving into hybrid mode) might need a 6-8 kwh battery and that one capable of around 40 miles all-electric would need a 10-12 kwh battery, then this would suggest a range from a bit under $4,000 to a bit over $6,000 in added cost. It is reasonable to assume, however, in my view that car purchasers would be able to see that there is some advantage to them in being able to do much of their driving at a cost of 1-3 cents/mile (the approximate cost of off-peak electricity for the all-electric ranges of these PHEVs) rather than the 10-15 cents/mile of today's average internal combustion engine vehicles in the US. That would suggest that the entire added cost of the battery might not need to be fully covered by the credit. We would want to make sure that any credit also encourages the adoption of PHEV technology by large vehicles and fleet vehicles. It thus might be useful to peg the tax credit to the kwh of the PHEV battery rather than offering a single figure—it takes more kwh in the battery (and more cost) for a delivery van PHEV to have a 20-mile all-electric range than a small sedan.

5) **In 1992, the Energy Policy Act included a goal that alternative fuels replace at least 10 percent of petroleum-based fuel in the U.S. by 2000. We have obviously fallen far short of this goal, but we have similar far-reaching goals now for alternative fuel utilization.**

I have read several prognostications that even dedicating all US corn and soybean production to biofuels would meet only 12% of gasoline demand and 6% of diesel demand.

What can Congress do to reach alternative energy utilization goals and avoid the same fate as the aggressive goals set 15 years ago? Is Congress taking the appropriate measures to adequately meet these goals? (Senator Crapo)

Answer: I believe that since 1992 there has been far too much government focus (federal and some states) on and funding for hydrogen fuel cell technology—although fuel cells have a number of other uses—for ordinary passenger vehicles (see pp. 6-7 of my written statement). At the same time there has been too little government focus on advancing the technology of renewable fuels using cellulosic and waste feedstocks as distinct from feedstocks such as corn and soybeans that have food and feed uses (see pp. 10-11). And the battery improvements that make feasible the plug-in hybrid and much more capable all-electric vehicles than just a few years ago have come from the consumer electronics industry, not government. In short, I think most of the advances that make it possible for us to turn now from oil to electricity and renewable fuels to power transportation have had little to do with any useful federal government policy—progress has been through the creativity of our private sector.

I believe Congress should enact the DRIVE Act, discussed in the Hearings, as originally introduced to mandate flexible-fuel vehicles that can utilize the full range of renewable fuels and to provide a consumer tax incentive for the purchase of plug-in hybrids. Congress should also encourage firm US Government orders for plug-in hybrids for the USG vehicle fleets in order to give the automobile industry assurance that it will have an early market in sufficient volume to warrant long-term contracts with suppliers, especially battery companies.

6) **Your testimony referencing the emission-reducing benefits of hybrid gasoline-electric cars was intriguing. You mentioned that use of these hybrid cars could reduce emissions by 60% per vehicle and that plug-in hybrids would show even more substantial emission reductions in clean-grid areas.**

   As we all know, plug-in electric cars have been around for a long time. Even with tax incentives for their purchase passed by Congress (which have since expired and not reauthorized for lack of use), they have never achieved the popularity of modern hybrids.

   What steps, in your opinion, are necessary to the success of future generation plug-in hybrids? (Senator Crapo)

Answer: I noted in my testimony the one study (from EESI) that had indicated an average 60% reduction in GWG nation-wide but added that others were underway, so we should not yet adopt that specific number. What does seem clear is that shifting to PHEVs, I noted, would provide "substantial" reductions in GWG emissions in clean grid areas such as the West Coast and "some" reductions nation-wide on an average basis. It is also the case that as the grid is made cleaner the vehicles are as well—not the case with internal combustion engines burning only fossil fuels.

I think it is important to distinguish between two types of vehicles that are plugged in to charge their batteries: all-electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs). The former were common early in the century and there was an effort in California to promote them with a mandate in the late 90s and the

early years of this century. The fate of EVs under the California mandate is perhaps most entertainingly told in the film "Who Killed the Electric Car" and is a complex story, but although there is good reason to believe that the demand for EVs even with the battery technology of the time was substantial, it was still the case that a number of people were concerned that even if they had been able to charge their battery fully overnight and could drive 100 miles or so on that charge that they still might be stranded if they had to take an unexpectedly long trip. PHEVs deal with that uncertainty by having liquid fuel in a tank that can be replenished at any filling station, so that when the (smaller-then-EV) PHEV battery reaches the end of its overnight charge after the car has been driven 25-40 miles the car merely becomes an ordinary hybrid, using both liquid fuel and the battery, now charged by regenerative braking. I call it "an EV with an insurance policy." Also, battery improvements in the last few years have been substantial and some new EVs (such as the Tesla) are getting 200 miles or more on an overnight charge—approaching the range of what one could drive on a tank of liquid fuel. Finally, some batteries can be rapidly charged more easily than others and there are developments on this front as well.

COMMUNICATIONS

TESTIMONY PRESENTED
BY
EV RENTAL CARS

BEFORE THE

SENATE COMMITTEE ON FINANCE

THE HONORABLE MAX BAUCUS, CHAIRMAN

APRIL 19, 2007

BY

JEFF PINK
CHIEF EXECUTIVE AND FOUNDER
EV RENTAL CARS
LOS ANGELES, CA

Mr. Chairman, distinguished Members of the Committee, I would like to sincerely thank you for the opportunity to testify before you today on the issue of providing tax incentives for alternative fuel vehicles.

My name is Jeff Pink, and I am the Chief Executive Officer and Founder of EV Rental Cars, the only rental company in the United States renting exclusively environmental vehicles to America's driving public. EV Rental Cars, based in Los Angeles, has offered a fleet of all-environmental hybrid vehicles to the public since its inception in 1998, and currently has more than 350 cars in eight locations primarily throughout the Southwest United States. EV Rental Cars' mission is to provide the most technologically advanced vehicles to America's consuming public as soon as the manufacturer releases them to the industry's marketplace. EV Rental Cars has the statistics and surveys in its possession that demonstrably show that most Americans' first exposure to hybrid and alternative fuel vehicles often occurs behind the wheel of a rented vehicle. EV Rental Cars, as the leading and largest environmental rental company in the nation, believes very strongly in its stated goal of educating the driving public to the real and obvious advantages of driving clean fuel cars; not just to an individual family's budget when it comes to gasoline-related transportation expenses, but also to the perceivable benefit of cleaner air quality in the home, on the road and in the workplace. EV Rental Cars is proud of its record of preventing over 100 tons of air pollution materials over the years from being released into the elements, saving the American public over $1 million in non-recoverable pollution abatement-related costs.

While we applaud the work that this Committee has helped to facilitate in providing individuals with an alternative motor vehicle income tax credit, and the yeoman's work that you have done in leading and educating the American public as to the real benefits of driving clean vehicles, I stand here today to ask you to consider an expansion of the highly successful individual tax credit provisions to include companies such as mine that are involved in the purchase of clean, alternatively-fueled fleet vehicles.

EV Rental Cars is in the front ranks of America's responsible clean energy companies. However, that leadership has come at a terrific price. EV Rental Cars alone has purchased almost 400 vehicles in the 2006 calendar year and, lacking access to the tax incentives enjoyed by responsible Americans looking to have an impact on America's energy future, has lost over $832,000 in hoped-for applicable tax credits. At the time of these vehicle purchases, EV Rental Cars believed in and relied upon the alternative motor income tax credits provision to enable it to receive tax credits for these purchases. As the law is written today, that is not the case. I stand here today, hoping that the Committee will consider an expansion of the existing tax code coverage of hybrid and clean car technology tax credits for owners of hybrid fleets, such as EV Rental Cars, and the retroactive credit for those 2006 purchases in the 2007 alternative energy tax legislation under consideration by the Finance Committee. Specifically, EV Rental Cars requests immediate relief and asks that EV stakeholders be allowed to reduce their regular tax through the use of these tax credits for the 2006 tax year without impact from the federal AMT and not limited by the tentative minimum tax, and further that tax credits not used during this 2006 tax year be allowed to be carried over for use in all years subsequent to

2006. The tax credits that were carried over from 2006 into 2007 will get the same tax treatment in 2007 that they received in 2006; i.e., in 2007, these credits will be allowed fully against the regular tax and not limited by the tentative minimum tax. By granting this relief, this legislation will provide Americans with the opportunity to experience new technology and be educated in the financial incentives involved in driving responsibly. Additionally, as we believe that funds for these tax credits were already allocated for providing relief to the American taxpayers in 2006, the change in the law that we are advocating would not necessitate new funds to be allocated for this purpose.

Tom Friedman, one of America's paramount economic thinkers, was quoted in the New York Times just this past week as saying, "Today, we are paying the accumulated economic, geopolitical and climate prices for the car culture in America. I am not proposing that we radically alter our lifestyles. We are who we are - but if we want to continue to be who we are, enjoy the benefits and be able to pass them on to our children, we need to fuel our future in a cleaner, greener way."

EV Rental Cars has played a pivotal role in this discussion. We are asking that, as the debate over America's energy future goes forward in this Subcommittee and on the Floor of the United States Senate that you might consider our emerging industry as one deserving of a helping hand from the Congress. If we are to continue to be a part of this national debate, we are hopeful that you might consider assisting an industry that literally has its hands tied behind its back. We stand ready to work with you as you address any alteration of the U.S. Code that impacts our rental car industry and future clean transportation options for Americans.

Statement for the Record

Senate Finance Committee Hearing on
Grains, Cane, and Automobiles: Tax Incentives for Alternative Fuels and Vehicles

April 19, 2007

Submitted by H2Diesel
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The Problem

- Current tax incentives for alternative fuels are very narrowly tailored and do not allow true American innovation to develop new technologies and production techniques that can enhance U.S. energy security, support America's rural economy, produce cleaner burning fuel, and support 100 percent domestic renewable energy resources.
- Innovative American small businesses are already producing the next generation of bio fuels from a wide array of agricultural products and animal fats that have many advantages over traditional biodiesel.
- However, these companies cannot compete on a level playing field because traditional biodiesel is the only product that currently qualifies for the $1.00 per gallon producers' tax credit.
- In addition, a recent IRS ruling broadens the applicability of the tax credit, but only to include a production technique (adding animal fat or vegetable oil to the production of traditional petroleum diesel) that will allow major multi-national oil production companies to benefit from the tax credit.
- Even with this expanded applicability, effective domestic bio fuel production techniques are denied the credit.
- As a result of the narrowly tailored definition (Section 40(A) of the tax code), and the recent IRS ruling, small domestic companies cannot compete on a level playing field, the marketplace for alternative fuels is significantly distorted, and benefits of the tax credit are in many cases accruing to those who least need it.

Proposed Solution

- Congress should recognize that the current tax code definitions of biodiesel and renewable diesel are of limited use and do not encourage new, innovative technology that can truly address U.S. energy needs and do so in an environmentally advantageous and cost effective manner.
- Congress should enact a new, broader definition of "bio fuel" to encourage U.S. technologies and production techniques for the next generation of bio fuels that will reduce U.S. dependence on foreign oil, support America's rural economy, significantly reduce harmful engine emissions, and encourage domestic, fully renewable energy resources.

- For example, a new definition could include, "a liquid fuel derived from agricultural products, animal fats, or wastes from agricultural products or animal fats."
- Such a definition should be carefully considered, however, to ensure that it benefits only those innovative companies that truly can make a difference.

H2Diesel

H2Diesel is a small U.S. company (Boca Raton, Florida and Houston, Texas) that holds an exclusive license for North America, Central America and the Caribbean to proprietary technology for the manufacture of an alternative "bio-fuel" from produced vegetable oils and animal fats that can be used for power generation, heavy equipment, marine use and as a heating fuel. H2Diesel plans to eventually expand the market for this bio fuel to motor vehicles. H2Diesel's product is manufactured using a blending -- or emulsion -- process that yields a proprietary bio-fuel that provides a cheaper, 100 percent renewable alternative energy source with significantly lower emissions than traditional fuels and a cleaner and more efficient alternative to heating oil.

Major aspects of current bio diesel and renewable diesel production technology

- Requires a complex and energy-intensive production method that is very expensive
- Produces chemical by-products that must be handled and disposed of, which adds cost to production and creates potential environmental problems.
- In the case of biodiesel, has limited use and is not suitable for all climates, especially in colder climates.
- In the case of biodiesel, can only be used in fuel blends up to 20%
- In the case of biodiesel, when blended, results in a product that is still 80% foreign oil and still emits some harmful pollution.
- In the case of renewable diesel, is unlikely to result I the construction of new, domestic fuel refining capacity.

H2Diesel has significant advantages over traditional bio diesel

- Proprietary manufacturing process results in dramatically lower production costs and no harmful by-products
- Produced from any number of vegetable feedstocks, animal fat, and renewable oilseed crops, including soybeans, canola, plamatic, sunflower, GMO, cotton seed, mustard seed, and restaurant waste oil
- Is a domestic fuel that reduces our nation's dependence on foreign oil, improving energy security
- Improves the rural economy by creating farming jobs
- Can be used as heating oil, power generation fuel, and as a motor fuel
- Produces approximately 80% less carbon dioxide emissions and almost 100% less sulfur dioxide than traditional petroleum diesel
- Is a renewable "carbon neutral" fuel, which results in no net emissions of harmful CO2
- Contains virtually no sulfur; reduces emissions that can cause acid rain; eliminates formation of sulfates which cause particulate pollution

- Emits significantly less nitrogen oxides than either traditional bio diesel or petroleum diesel. Nitrogen oxides are a significant component of urban smog and have been linked to asthma
- Small production plant footprint allows for less environmental impact while at the same time increasing US refining capacity.
- Can be used by any conventional diesel engine at 100% strength and extends the life of diesel engines because it is more lubricating than petroleum diesel fuel
- Facilitates process automation that results in reduced labor and energy costs

However, H2Diesel and other innovative U.S. companies face significant barriers to competing on a level playing field because current law and tax policy designed to encourage companies to explore renewable energy technologies is too narrowly focused to allow true innovation. Current tax policy does not fully encourage new technologies that can break the United States' continuing dependence on foreign energy suppliers.

For example, the current tax code definition of "biodiesel" (Internal Revenue Code Section 40A(d)(1)(A)) is limited to products that are methyl esters that meet the requirements of ASTM specification 6751. Similarly, renewable diesel is defined as diesel fuel derived from biomass using a thermal depolymerization process which meets the registration requirements under section 211 of the Clean Air Act and the requirements of ASTM D975 or D396. This limited definition will exclude any other domestically produced, renewable, vegetable oil-based products that have equivalent or superior properties to the narrowly defined "Biodiesel."

Current tax policy focuses heavily on encouraging the production of "biodiesel," principally a $1.00 per gallon blenders' income tax credit. Without this credit, the cost of producing biodiesel would be prohibitive. The blenders' tax credit should be extended to include other innovative technologies.

U.S. companies have and are continuing to develop new technologies to create new bio fuels that hold great promise to more fully address U.S. energy needs, which go well beyond just motor vehicle fuel consumption (home heating oil, power generation), today and in the future.

These bio fuels are potentially far superior to traditional biodiesel or renewable diesel, with greater applications, lower production cost, greater environmental benefits (cleaner burning product) and can be produced from a wide range of agricultural products.

U.S. law and tax policy must acknowledge this reality and encourage greater innovation in U.S. technology by creating a new definition of "bio fuels" that will help speed new technologies and production techniques into the market place while supporting America's rural economy.

The current tax code definitions of biodiesel and renewable diesel has are of limited use, and do not encourage new, innovative technologies that can truly address U.S. energy needs. Congress must enact a new definition of "bio fuel" to encourage U.S. technologies and production techniques for the next generation of bio fuels that will reduce U.S. dependence on foreign energy supplies. Such a definition should be carefully crafted to ensure that it benefits only those innovative companies that can make a real difference.

Methanol Institute

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April 19, 2007

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Dear Senate Finance Committee Leaders:

As your Committee met today to discuss tax incentives for alternative fuels and vehicles, we would like to bring to your attention two technical corrections needed for equitable tax treatment of the alternative fuel methanol:

- First, while the Energy Policy Act of 2005 (PL 109-58) did include methanol fueled vehicles under the definition of qualifying alternative motor vehicles for the vehicle tax credits (Section 1341), the final legislation mistakenly did not include methanol alternative fueling stations as qualifying for the infrastructure installation tax credit (Section 1342).

- Second, the Volumetric Ethanol Excise Tax Credit established under the American Jobs Creation Act (PL 108-357) includes methanol produced from renewable resources as a qualifying alcohol fuel for VEETC treatment. However, the alternative fuel tax incentives adopted under the SAFETEA bill (PL 109-59) mistakenly failed to include methanol as a qualifying alternative fuel along with CNG, LNG, LPG, hydrogen, Fischer-Tropsch fuels, and P-Series fuels. This means that methanol produced from natural gas or coal gasification does not qualify for any federal tax incentives even though these fuels have been defined as qualifying alternative fuels under previous federal legislation (Alternative Motor Fuels Act of 1988 and Energy Policy Act of 1992).

During the 1990s methanol was considered a serious contender to gasoline, with thousands of methanol flexible fuel vehicles introduced and nearly 200 fueling stations. While support for methanol gave way to compressed natural gas, battery electric and later ethanol vehicles, there is a resurgence of interest in the use of methanol today. Much of this interest is generated by simple economics; the current contract price for methanol is about $1.00 per gallon, and we have recently seen spot sales of less than 70¢ per gallon. Even adjusting for methanol's lower energy content than gasoline, the full delivered cost to the consumer would be just $2.00 per gallon.

Methanol also offers the broadest range of potential production feedstocks. In the U.S. and on a global basis, natural gas is the typical feedstock for methanol production. Today, much of the 2.4 billion gallons of methanol consumed each year is imported from countries with access to inexpensive natural gas such as Trinidad and Chile. In Kingsport, Tennessee, Eastman Chemical operates a coal-based methanol

plant that was the U.S. DOE's first successful integrated gasification combined cycle commercial demonstration project. Also known as "wood alcohol," mature gasification technologies – like that employed in Kingsport – can be utilized for the gasification of biomass (forest thinnings, waste wood, municipal waste) for the production of cellulosic methanol. With energy efficiencies in the 60-70% range, one ton of biomass can be converted into 165-185 gallons of methanol. By comparison, the potential yields from cellulosic ethanol may only reach 60 gallons of fuel per ton of biomass after extensive research efforts.

There is an increasing call for truly flexible fuel vehicles that can run on any combination of gasoline ethanol or methanol. An "A-85" or alcohol compatible FFV would offer significant benefits in fuel diversity, price competition and consumer agility. The late Roberta Nichols, who founded the Ford Motor Company's industry leading FFV technology development wrote, *"The good news is, the FFV can use either methanol or ethanol and, in fact, some of the early experimental cars ran well on a combination of all three fuels (methanol, ethanol, and/or gasoline), which made them really flexible!"*

As the trade association for the global methanol industry, the Methanol Institute is *seeking a level playing field* with respect to federal tax incentives for the use of methanol as an alternative fuel. We believe that technical corrections to current tax credits for alternative fuels and alternative fueling station equipment installation can greatly help put the methanol option back on the table.

Sincerely,

John Lynn
President & CEO

Grains, Cane, and Automobiles:
Tax Incentives for Alternative Fuels and Vehicles
April 19, 2007

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In response to the committee's request for individuals to present their views....

King Solomon: "Where there is no vision, the people perish." (Pro 29:18) about 1000 BC

Here is a summary of one of my ideas for revitalizing rural Montana which focuses on the community production of bio-diesel and could carry over to most of rural America. I have mentioned this idea to you and some of your staff in the past and am very sorry not to be in Washington on Thursday to present these ideas in person. Thank you for your invitation which I consider a great honor. Unfortunately, I am in Europe for a food show in London, business meetings in Belgium and a lecture which I have been invited to give in Italy so I am begging your pardon for not being in Washington.

We have all seen decline of small rural towns in our state as well as the upward spiral of the cost of fuel. Farmers can not longer pay for the high cost of inputs such as farm chemicals and fuel. I believe it is time to support the conversion to locally grown fuel and fertilizer. For the purpose of this discussion I will limit my comments to fuel, particularly bio-diesel and leave other discussions including ethanol production to another time.

First, let me say that I agree with some critics who say that there is not enough farmland in America to grow our entire diesel needs. But, having said that, let us not wring our hands and disparage the concept of bio fuels and lubricants. Because one approach does not hold the entire solution, should it dismissed out of hand or would it not be better allowed to become part of the solution? After all, many of those shouting down the concept of home grown fuel have their own agenda and kingdoms to protect which has brought us not only high costs of procuring and protecting our fuel supply but also continues add to the problem of green house gas emission by the burning of fossil fuels. These serious problems could be mitigated by turning a focus to locally produced and consumed renewable bio-fuels.

I emphasize locally produced and consumed and mean that this production should be done by a collection of small locally owned businesses or co-ops in each major community of each county of the state. It is time to reverse the trend of centralization and concentration of our most basic needs which not only puts the money, control and power into a few hands, almost always out of state, but opens up questions of national security when the vulnerability of centralized energy production is considered. It does not take a terrorist bomb to cause a big effect. We have already seen the effect of one very strong hurricane on our fuel production system.

The extremely high cost of giant plants is also a problem often solved by the money of out of state investors. Small community sized plants, which would be only big enough to produce enough for local consumption, could be financed by members of the community and therefore returns on those investments would help the local community.

Besides the ownership, control and security issue, small community owned and operated bio-diesel plants would have would also minimize the transportation of seed from the farms to the plants and fuel from the plants back to the farm. This would not only reduce the cost of the fuel but would save on wear and tear of roads which can hardly be maintained the way it is with the decrease in availability of the railroad. The idea would be that seed would be hauled to the nearest crusher which would be no further, and these days sometimes much closer than current markets, and fuel would be hauled back the farm no further than it is being hauled by the local distributor now. In most cases this existing local distributor would be the one to make the deliveries as they already have all the equipment needed to do so. I have talked to my local distributor in Big Sandy and he is very interested in this idea.

Another problem created by large centralized production systems and that is the concentration of byproducts like mash. If amount produced is so large that it cannot be used by the local livestock growers and must be shipped out to producers further away, this will add additional cost as well as road wear and use of fuel. If there ended up being some glycerin by product, perhaps this could be added to locally grown biomass and pelleted for local use to heat homes.

Also consider the ripple effect of 2 or 3 good additional jobs in 2 or 3 communities of each county in eastern Montana. Unlike the large financial returns anticipated by a few large companies, the goal for the small community plans would be to make a modest income, which would stay in the community because of local ownership, and provide a great service to each community where they were located.

I have been growing camelina on my farm for 2 years now and estimate from my experience only 5% of the farm land in Montana is required to provide enough diesel to run the farms in our state. According to state estimates of diesel use,

only another 6% of the state farm land would be required to fill the diesel needs of the state. Eleven % is not much diversity in farm cropping systems to yield great dividends for the state's agricultural situation. Of course this solution is not possible for more populous states. I believe the long term answer for them for a self sustaining fuel supply and reduction of green house gasses for all of us lie in hydrogen produced with wind generated electricity. That solution will be a little longer coming but in the mean time, we could help stabilize the cost of fuel to the farms and rural communities who need the most help and at the same time help revitalized the economies of rural America. Why not create a model for bio-diesel development on a locally owned and operated system. No new refineries would have to be built and diesel now produced could be sold out of state to bring more money back into the state.

If community based fuel production became a national goal, it could be encouraged finically but a tax rebate equaling the fuel tax now currently being paid as well as a tax credit connected to the % of fuel actually produced by locally grown seed and sold locally. This would aid those in actual production and not those groups speculating on huge profits from large plants which outstrip their local market needs. Again these large plants require large markets, high transpiration and distribution costs of feed stocks coming in and products and byproducts going out.

Another way to encourage local small industry would be to help with the QC testing of the finished product which is quite expensive. Research money to develop a cheaper test would also be a great help. I hope some of these ideas are helpful to you and thank your for your interest.

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