S. HRG. 112–107

SMALL NUCLEAR REACTORS AND ALTERNATIVE FUELS

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED TWELFTH CONGRESS

FIRST SESSION

ON

S. 512
S. 937
S. 1067

JUNE 7, 2011

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SMALL NUCLEAR REACTORS AND ALTERNATIVE FUELS

TUESDAY, JUNE 7, 2011

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 10:05 a.m. in room SD–366, Dirksen Senate Office Building, Hon. Jeff Bingaman, chairman, presiding.

OPENING STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

The CHAIRMAN. OK. Why don't we get started?

The purpose of today's hearing is to get testimony on 3 bills.

S. 512, which is the Nuclear Power 2021 Act. That's a bill that I introduced along with Senator Murkowski.

S. 1067, the Nuclear Energy Research Initiative Improvement Act that Senator Mark Udall introduced. Senator Murkowski and I have co-sponsored that bill.

S. 937, which is the American Alternative Fuels Act of 2011 introduced by Senator Barrasso.

Let me thank all the witnesses for testifying today. I want to particularly mention that 2 of our witnesses are New Mexicans.

Deputy Assistant Secretary, John Kelly, from the Department of Energy's Office of Nuclear Energy, spent many years at Sandia National Laboratory.

Mr. Joe Colvin, who is on our second panel, is the President of the American Nuclear Power Society and now resides in Santa Fe and well known here in Washington as the former President and CEO of the Nuclear Energy Institute.

So I welcome those 2, but all witnesses today.

Small nuclear reactors, those that are less than 300 megawatts hold a promise of reducing the cost of nuclear plant construction. Proponents claim these reactors can utilize modular construction techniques such that plant sub assemblies can be built and assembled onsite thus reducing the construction costs. Large nuclear plant cost is a major issue where 2,000 megawatt plants exceed $14 billion. In addition, advocates believe that the small size makes it applicable to the chemical industry for process heat thus minimizing carbon dioxide emissions.

The 2 nuclear bills before us today establish research programs to reduce the cost of construction using small reactors as well as authorizing 2 cost share demonstrations to license before the Nuclear Regulatory Commission. There are many opinions on the mer-

its of these reactors. We look forward to the witnesses' comments on the legislation before us.

We'll also hear testimony on S. 937, the American Alternative Fuels Act which Senator Barrasso, along with Senator Murkowski, Senator Manchin and Senator Coats on the committee, co-sponsored. This includes a number of provisions that would seek to increase our use of transportation fuels that do not come from petroleum. I'm glad that my colleagues are thinking about ways that we can continue our current trajectory of relying less on petroleum to fuel the transportation sector. Diversifying our transportation fuels is a clear benefit to our national and economic security.

I am, however, concerned that some of the provisions of S. 937 might have high environmental costs. So I hope we can focus on ways to enhance national, economic and environmental security simultaneously. Avoid polices that might sacrifice any one kind of security in pursuit of another.

I have an additional concern that some of the provisions in S. 937 are clearly beyond the jurisdiction of our committee. Some of the topics covered in the bill are squarely within the committee's expertise and jurisdiction. Others, such as long term contracting authority for the Department of Defense and reassessing "best available control technology" under the Clean Air Act are clearly not in our jurisdiction.

It's my view that it would not be appropriate for us to circumvent the committees that do have jurisdiction on those issues for which those committees expertise would be valuable.

So let me stop with that and defer to Senator Murkowski for her comments.

STATEMENT OF HON. LISA MURKOWSKI, U.S. SENATOR FROM ALASKA

Senator MURKOWSKI. Thank you, Mr. Chairman. Good morning. Thank you for the hearing.

It's nice to see a packed house in the Energy Committee. We've got a line outside. So I think that that demonstrates the interest in nuclear and more specifically, the small modular reactors that we're discussing today.

Let me start with small modular reactors. Clearly having drawn great support over the past few years. This technology has lower upfront costs, increased safety, the siting flexibility, potential for domestic manufacture and ability to incrementally add capacity as demand and grid capacity warrant, all arguments for giving real consideration to small modular reactors. I hope that they'll play a larger role in our policy conversations as we look at the role that nuclear power can play in meeting our energy needs and reducing our greenhouse gas emissions.

The ongoing problems in Japan have certainly focused the world's attention on nuclear safety issues. SMRs have some significant benefits in this area. Because they are small reactors with a lower power level, SMRs present less of a potential radioactive source than conventional reactors. Small reactors can also be designed with the entire primary coolant system in a single integrated vessel eliminating some of the more severe accident scenarios.

Additionally while economies of scale have continued to make larger reactors an attractive option, not every utility or operating site needs or even can handle 1,000 plus megawatts of new power. The ability to incrementally ramp up the amount of electricity generated to meet demand growth while staying within a grid's capacity is again, another positive for SMRs.

Two of the bills we're considering today seek to further the research and development of SMRs. I believe that they're both good bills. I look forward to hearing our witnesses' perspectives on each of them.

I'm also glad, Mr. Chairman, that we've got an opportunity to consider the third bill before us today, the American Alternative Fuels Act. I do appreciate the good work that Senator Barrasso has put into this bill as well as his emphasis on removing the government imposed barriers that are making it harder to develop alternative fuels. This bill as a whole has already drawn some bipartisan support from members of our committee. Two provisions from within it were unanimously accepted during a recent markup.

I'm optimistic that our committee will continue to find common ground as we look at the remaining provisions of the bill. Foremost among those is its repeal of section 526 of the 2007 energy bill which unnecessarily restricts the types of alternative fuels that the Federal Government, and particularly, our military, can pursue. Especially given the events of the past several months while our economy is still very, very weak, oil hovering near $100 a barrel and the stability of a foreign energy supply threatened by international unrest.

It's clearly appropriate to prioritize our energy security and make greater use of our own abundant resources. A true energy policy should include everything that America has from biomass and natural gas to coal and unconventional oils. This will all advance our goal of greater energy security through reduced reliance on foreign energy.

I'm glad that we have an opportunity to discuss these issues this morning, Mr. Chairman. I look forward to the comments from the witnesses. Thank you.

The CHAIRMAN. Thank you very much. Let me just introduce our first panel.

Dr. John Kelly is Deputy Assistant Secretary for Nuclear Reactor Technologies in the Office of Nuclear Energy in the Department of Energy.

Mr. Steven Chalk is the Deputy Assistant Secretary in the Office of Energy Efficiency and Renewable Energy in the Department of Energy.

So Dr. Kelly, why don't you start and then Mr. Chalk, we'll hear from you. Then we'll have some questions.

STATEMENT OF JOHN E. KELLY, DEPUTY ASSISTANT SECRETARY FOR NUCLEAR REACTOR TECHNOLOGIES, OFFICE OF NUCLEAR ENERGY, DEPARTMENT OF ENERGY

Mr. KELLY. Great.

Thank you, Chairman Bingaman, Ranking Member Murkowski and members of the committee. This is my first testimony before Congress. It's a particular pleasure for me to be discussing small

modular reactors because these have been an area of great interest to me for some time.

Before joining the Department I co-chaired an American Nuclear Society Special Committee that was looking into the generic licensing issues associated with small modular reactors. Over the course of the last 18 months this special committee, together with the Nuclear Energy Institute, the Nuclear Regulatory Commission and the nuclear industry has made great progress in forging the blueprint for the regulatory framework for small modular reactors.

The Administration continues to view nuclear power as an important clean energy option. Small modular reactors are a promising and innovative technology that could give our utilities additional clean energy options and allow nuclear to penetrate the energy market more broadly. Secretary Chu has written, "If we can develop this technology in the U.S. and build these reactors with American workers, we will have a key competitive advantage."

Small modular reactors are already inspiring American innovation Have the potential to significantly enhance U.S. competitiveness. There are several small modular reactor vendors pursuing both light water reactor and advanced concepts, and many utilities are interested in this technology to replace aging fossil plants.

Earlier this year the Department released its fiscal year 2012 budget request which included an expanded small modular reactor program that we originally proposed in FY 2011. The request for 2012 is $29 million for R and D and $67 million for design certification and licensing activities. The DOE request outlines a multiyear, $452 million program that would use cost share agreements with industry partners to complete design certification activities for up to 2 small modular reactor designs.

The events at Fukushima Nuclear Power Plant have led the Nuclear Regulatory Commission to launch a 90-day review to see what lessons could be learned from the Japanese experience and applied to U.S. nuclear plants. I want to note that the designers of light water, small modular reactors have already placed great emphasis on inherent safety of these reactors. Because of their lower power level, SMRs require less cooling after shut down.

Most designs incorporate passive safety features that use natural circulation to supply back up cooling in unusual circumstances. Some concepts even use natural circulation for normal operations requiring no pumps and providing an even more robust safety case. Last, SMRs can be sited underground which should improve their security profile and may enhance seismic safety.

Turning to the 2 bills under consideration by the Committee, the Department has a few comments.

S. 1067 gives broad authority to conduct research into small modular reactors as well as other connected issues.

S. 512, the Nuclear Power 2021 Act would require the Department of Energy to carry out a program to develop and demonstrate 2 small modular reactor designs. If passed several features would be important to consider.

The requirement that at least one of the designs be less than 50 megawatts is too restrictive in our opinion. Simply having an upper bound of 300 megawatt electric would be more appropriate. Any cost share design, development and licensing activity that uses a

competitive procurement should let the marketplace establish the appropriate design parameters.

The second point is the licensing effort should include 2 different designs to promote competition.

Finally the program should initially be focused on light water reactor technology because of the larger experience with design and licensing with such reactors.

That concludes my formal remarks. Thank you for the opportunity to testify. I look forward to answering your questions and working with the committee to achieve the Administration goals of securing energy security while reducing the Nation's carbon emissions. Thank you.

[The prepared statement of Mr. Kelly follows:]

PREPARED STATEMENT OF JOHN E. KELLY, DEPUTY ASSISTANT SECRETARY FOR REACTOR TECHNOLOGIES, OFFICE OF NUCLEAR ENERGY, DEPARTMENT OF ENERGY

INTRODUCTION

Thank you, Chairman Bingaman, Ranking Member Murkowski, and Members of the committee. This is my first testimony before Congress and it is a particular pleasure to be discussing small modular reactors (SMRs) with you, as they have been an area of great interest to me for some time.

Before joining the Department of Energy, I co-chaired an American Nuclear Society special committee that was developing solutions to generic licensing issues for small modular reactors. Over the course of the last 18 months, this special committee, together with the Nuclear Energy Institute, the Nuclear Regulatory Commission and the nuclear industry, has made great progress in forging the blueprint for the regulatory framework for small modular reactors. This progress demonstrates an increased interest in the licensing and commercialization of SMRs.

The Administration continues to view nuclear power as an important clean energy option. Small modular reactors, specifically reactors that have an electrical output of less than 300 megawatts, are a promising and innovative technology. We see these smaller reactors as giving our utilities additional clean energy options and allowing nuclear power to penetrate the energy market more broadly. Secretary Chu has written that, "if we can develop this technology in the US and build these reactors with American workers, we will have a key competitive edge". SMRs are already inspiring American innovation and have the potential to significantly enhance U.S. competiveness.

Since former Assistant Secretary Dr. Pete Miller testified to this committee in 2009 on the two bills we are discussing today, several developments have taken place. A little 2 over a year ago, we released our fiscal year 2011 budget request, which proposed a small modular reactor program with $40 million of funding. The proposal was to spend half of that funding on R&D efforts and half to initiate a competitive selection process to establish public-private partnerships to cost-share design certification and licensing efforts with the selected winners.

Earlier this year, the Department released its fiscal year 2012 budget request, which included an expanded version of the small modular reactor program. The request for FY 2102 is $29 million for R&D and $67 million for design certification and licensing activities. The DOE request outlines a multi-year, $452 million program that would use cost-shared arrangements with industry partners to complete design certification activities for up to two light water small modular reactor designs. There are several potential SMR vendors pursuing both LWR designs and more advanced concepts. Many utilities are interested in this technology to replace aging fossil plants.

The events at the Fukushima nuclear power plants have led the Nuclear Regulatory Commission to launch a 90-day review to see what lessons can be learned from the Japanese experience and applied to U.S. nuclear plants. I want to note that designers of light water SMRs have already placed major emphasis on the inherent safety of these reactors. Because of their lower power level, SMRs have a much lower level of decay heat and therefore may require less cooling after reactor shutdown. Several designs incorporate passive safety features that utilize gravity-driven systems rather than engineered, pump-driven systems to supply backup cooling in unusual circumstances. Some concepts use natural circulation for normal operations, requiring no primary system pumps and providing an even more robust

safety case. In addition, many SMR designs utilize integral designs for which all major primary components are located in a single pressure vessel. That feature results in a much lower susceptibility to certain potential events, such as a loss of coolant accident, because there is no large external primary piping. Lastly, most SMRs can be sited underground, which should improve their security profile and may enhance seismic safety.

Comments on S. 512 and S. 1067

Turning to the two bills under consideration by the committee, the Department has a few comments.

S. 1067 gives broad authority to conduct research into small modular reactors, as well as other connected issues.

S. 512, the Nuclear Power 2021 Act, would require the Department of Energy to carry out a program to develop and demonstrate two small modular reactor designs. If passed, several factors would be important to consider:

- The requirement that at least one of the designs be less than 50 MW is too restrictive; simply having an upper bound of approximately 300 MWe would be more appropriate. Cost-shared design development and licensing should be based on competitive procurements and the market place should establish the appropriate design parameters.
- The licensing effort should include two different designs.
- The program should initially be focused on light water reactor technology based on the large amount of experience—both design and licensing—with such reactors.

Conclusion

That concludes my formal remarks. Thank you for the opportunity to testify and I look forward to answering your questions and working with the committee to achieve the administration's goals of energy security and reducing the nation's carbon emissions.

The CHAIRMAN. Thank you very much.

Mr. Chalk.

STATEMENT OF STEVEN G. CHALK, DEPUTY ASSISTANT SECRETARY FOR RENEWABLE ENERGY, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, DEPARTMENT OF ENERGY

Mr. CHALK. Good morning, Chairman Bingaman, Ranking Member Murkowski and members of the committee. Thanks for the opportunity to appear before you today to discuss the Department of Energy's work on alternative fuels.

The American Alternative Fuels Act of 2011, sponsored by Senator Barrasso, is still being reviewed by the Department and other Federal agencies including the Department of Defense and the Environmental Protection Agency. So we do not yet have a formal position on the bill. I will, therefore focus my comments today on the Department of Energy's efforts to research, develop and demonstrate the next generation of alternative fuels and electric vehicles.

The transportation sector accounts for two-thirds of U.S. oil consumption and represents one-third of our greenhouse gas emissions. After housing, transportation is the second biggest monthly expense for most American families. The President recently outlined a portfolio of actions, which taken together could cut U.S. oil imports by a third by 2025. These include programs that would expand biofuels, put a million electric vehicles on the road by 2015 and increase the fuel economy of our cars and trucks. DOE's past, present and future investments are critical to lowering costs for American families while reducing our dependence on oil and enhancing our national, economic and environmental security.

Making our cars and trucks more efficient is one of the easiest and most direct ways to reduce our petroleum consumption and save consumers money. We continue to work on improving existing engine technology that will help our cars and trucks travel farther using less energy.

Domestically produced biofuels are also a key component to reach the President's goals. Domestic biofuels can provide a cost effective alternative to oil imports while creating business opportunities and jobs in the U.S., especially in rural areas. DOE develops programs that both increase the use of today's biomass technologies and support innovative research next generation biomass technology.

An example of this is algae based biofuels, which are a very promising next generation technology that DOE is pursuing. Our current research on algae includes developing suitable strains and cultivation parameters, harvesting and extracting oils from algae biomass and including techno-economic analysis of different algae processes. We're confident that continued R and D in collaboration with relevant government stakeholders, including academia and industry will pave the way for significant commercial scale-up of algae-based fuels. DOE is also making investment in next generation biofuel technologies from a variety of other feed stocks including corn stover, wood waste and other materials. We're exploring ways of converting cellulose not just to ethanol, but to cost competitive, drop in substitutes for gasoline, diesel and jet fuel.

Targeted investments under the American Recovery and Reinvestment Act have enabled us to invest in 29 different integrated bio-refineries to validate first of a kind technologies at pilot, demonstration and commercial scales to reduce risk to further investment. These projects are expected to generate at least 170 million gallons of advanced biofuels. Bringing more commercial bio-refineries online would help meet our ambitious RFS goals.

The Administration also has a goal to put a million electric vehicles on the road by 2015. Meeting this goal will help establish the United States as a leader in clean energy technology through capitalizing on the ingenuity of American industry. In 2009 there were only 2, relatively small battery factories in the U.S. Over the next few years, through the Recovery Act investments, the U.S. will be able to produce enough batteries and components to support 500,000 plug in and electric vehicles per year. At the same time, DOE projects a drop in battery costs of about 50 percent by 2013 compared to 2009.

In sum, DOE's transportation portfolio will save consumers money, reduce our dependence on foreign oil, lower our environmental impact and keep America on the cutting edge of clean energy technologies enabling us to build and lead a 21st century clean energy economy. Thank you again for your opportunity to discuss these issues. I welcome any questions that you may have.

[The prepared statement of Mr. Chalk follows:]

PREPARED STATEMENT OF STEVEN G. CHALK DEPUTY ASSISTANT SECRETARY FOR RENEWABLE ENERGY, OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY, DEPARTMENT OF ENERGY

Chairman Bingaman, Ranking Member Murkowski and Members of the committee, thank you for the opportunity to discuss the Department of Energy's (DOE's) efforts to research, develop and deploy the next generation of alternative fuels and

electric vehicles. I will also briefly discuss some areas of S. 937, the American Alternative Fuels Act of 2011, sponsored by Senator Barrasso. However, the Administration is still reviewing the bill and we do not have a position on the bill at this time.

Alternative Fuels

The transportation sector accounts for approximately two-thirds of the United States' oil consumption and contributes to one-third of the Nation's greenhouse gas emissions[1]. After housing, transportation is the second biggest monthly expense for most American families[2]. As the President said on March 30, "In an economy that relies so heavily on oil, rising prices at the pump affect everybody." Emphasizing that "there are no quick fixes," the President outlined a portfolio of actions which, taken together, could cut U.S. oil imports by a third by 2025. These include programs that would increase the fuel economy of our cars and trucks and increase the use of nonpetroleum fuels. Both biofuels—including algae-based fuel—and electric vehicles are critical components of the President's strategy to lessen our dependence on foreign oil.

Home-grown biomass can provide a cost-effective alternative to oil imports while creating business opportunities and jobs in the U.S. Increased use of biofuels also contributes to national and economic security by insulating our economy from damaging fluctuations in international petroleum prices. And biomass use contributes to national environmental goals, helping reduce both smog and greenhouse gas emissions.

Within DOE, programs in the Office of Energy Efficiency and Renewable Energy (EERE), the Office of Science, the Advanced Research Projects Agency-Energy (ARPA-E) and the Loan Guarantee Program have all made investments in next-generation biofuels science and technology. DOE also works closely with the US Department of Agriculture (USDA), the Environmental Protection Agency (EPA), the Department of Defense (DOD), the Department of Transportation's Federal Aviation Administration (DOT/FAA) and other Departments and agencies to accelerate U.S. use of biomass resources.

The Nation has ambitious goals for biomass energy through the Renewable Fuels Standards (RFS) established through the Energy Independence and Security Act of 2007 (Pub. L. No. 110-140). The RFS required the annual use of 9 billion gallons of biofuels in 2008 and expands the mandate to 36 billion gallons annually in 2022 (of which no more than 15 billion gallons can be conventional biofuels, and no less than 21 billion must be from advanced biofuels).

The Navy has set a goal for renewable fuels to comprise 50 percent of its transportation fuel consumption by 2020. We are working closely with DOD to accelerate the deployment of pioneer plants that can support this ambitious goal.

As we take steps to break down barriers to greater use of today's biofuels, DOE is also making investments in next-generation biofuels technologies. The American Reinvestment and Recovery Act of 2009 (the Recovery Act) accelerated investment in innovative biorefineries, providing funding for an additional 18 RD&D projects, in addition to the 11 projects previously funded in 2007 and 2008. Through these projects, DOE is helping scientists and entrepreneurs explore technologies for converting biomass products such as algae into fuel. To help accelerate the development of these technologies, President Obama announced a goal of breaking ground on four commercial-scale cellulosic or advanced biofuels plants over the next two years. To help meet this goal, the FY 2012 budget includes funding for a reverse auction in which cellulosic and advanced biofuels project sponsors would compete for additional support.

With support for such plants, advanced conversion technologies could play a significant role in a commercial biofuels market within a few years. DOE is supporting two main pathways to convert biomass into biofuels in a cost-effective manner: (1) thermo-chemical conversion, based on pyrolysis or gasification, and (2) biochemical conversion using enzymes, fermentation, and other mechanisms, including algae. Over the longer term, research advances showing promise in the laboratory could greatly increase the productivity and reduce the cost of biochemical processes using engineered yeast, bacteria, and other organisms.

ARPA-E is also undertaking a novel alternative storage approach in its Electrofuels program. ARPA-E is seeking ways to make liquid transportation fuels—without using petroleum or biomass—by using novel microorganisms to harness chemical or electrical energy to convert carbon dioxide into liquid fuels. This fuel can serve as a form of energy storage, ready to be used in vehicles, machines, or other pieces of equipment. The objective of this program is to develop a new para-

[1] http://www1.eere.energy.gov/vehiclesandfuels/pdfs/vehicles__fs.pdf
[2] http://www.bls.gov/news.release/cesan.nr0.htm

digm for the production of liquid fuels that could overcome the challenges associated with current technologies.

Electric Vehicles

Few technologies hold greater promise for reducing our dependence on oil than electric vehicles (EVs). In his 2011 State of the Union address, the President set a goal to have the United States become the first country with a million EVs on the road by 2015. Meeting this goal will help the United States become a leader in the clean energy economy, while capitalizing on the ingenuity of American industry. Manufacturing products needed for the clean energy economy will generate long term economic strength in the U.S., creating jobs across the country while reducing air pollution and greenhouse gas emissions.

Department of Energy investments past, present, and future are critical to achieving this goal. In 2009, the U.S. had only two, relatively small, factories manufacturing advanced vehicle batteries, and produced less than two percent of the world's hybrid vehicle batteries.[3] But over the next few years, thanks to investments from the Recovery Act in battery and electric drive component manufacturing, and electric drive demonstration and infrastructure, the U.S. will be able to produce enough batteries and components to support 500,000 plug-in and electric vehicles per year. High volume manufacturing, coupled with battery technology advances, design optimization, and material cost reductions, could lead to a drop in battery costs of 50 percent by 2013 compared to 2009, which will lower the cost of electric vehicles, making them accessible to more consumers. Further policies and research are needed to build on the work under the Recovery Act. That is why the Administration supports new efforts to help develop electric vehicle manufacturing and adoption in the United States through improved consumer incentives, investments in R&D to advance innovative technologies, and a competitive program to encourage communities that invest in electric vehicle infrastructure and regulatory streamlining.

ARPA-E's Batteries for Electrical Energy Storage in Transportation (BEEST) program seeks to develop a new generation of ultra-high energy density, low-cost battery technologies for long electric range plug-in hybrid vehicles and EVs. Improving the energy density of batteries will increase the range of electric vehicles, which the Department understands is of critical concern to consumers. If successful, new battery technologies developed under this program will help move electrified light-duty vehicles toward the ranges, performance, lifetime, and cost that will help shift transportation energy sources from oil to electricity drawn from the domestically powered U.S. grid. ARPA-E's objective is to fund high-risk, high reward research efforts that will promote U.S. leadership in this emerging EV battery market.

Loan and Loan Guarantee Program

The Department of Energy's loan and loan guarantee programs are another key component to winning the clean energy future. As a representative of the Office of Energy Efficiency and Renewable Energy, I can only speak generally to the activities of the Loan Programs Office, which is a separate office within DOE.

In the two years since this Administration took office, the Loan Programs Office has helped drive significant investment in our energy economy. Since March 2009, the Department has issued conditional commitments for loans or loan guarantees to 29 projects, 16 of which have reached financial close—with more to follow soon.

DOE has provided (or conditionally committed to provide) over $30 billion in financing to these 29 projects, which have total project costs of nearly $48 billion. The projects are spread across the country, and reflect an array of clean energy and automotive technologies, such as wind, solar, geothermal, transmission, battery storage, and nuclear. These projects include the world's largest wind-farm; two of the world's largest concentrated solar power facilities; the first nuclear power plant to begin construction in the United States in the last three decades; and the world's first flywheel energy storage plant.

Project sponsors estimate these 29 projects will create or save over 61,000 jobs, including construction and operating jobs.[4] Cumulatively, they will generate over 25 million MWh of clean energy each year—enough to power over two million households, or nearly all the households in Maryland.[5] And they will avoid nearly 17 mil-

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[3] http://www.whitehouse.gov/sites/default/files/blueprint__secure__energy__future.pdf

[4] Breakdown by program is as follows (based on Sponsor estimates): 1703: 5,210 construction, 1,340 permanent; 1705: 12,900 construction, 3,470 permanent; ATVM: 5,700 created, 33,000 saved.

[5] Sources: EIA 2005 Residential Energy Consumption Survey, Table US8; U.S. Census Bureau, American FactFinder, 2010.

lion tons of CO_2 annually—more than is produced by all of the approximately three million registered vehicles in Oregon.[6]

Under the Section 1703 program, DOE has offered conditional commitments for four projects so far, including one nuclear power, one front end nuclear, and two energy efficiency projects, which amount to just over $10.6 billion in total government supported financing, including capitalized interest. Under 1705, DOE has issued conditional commitments to 21 projects representing approximately just under $11.8 billion in financing, including capitalized interest. In addition, a significant number of projects are sufficiently far along in the due diligence process that we have issued a working draft term sheet and are in active negotiations with the applicants. LPO estimates that these projects, if they ultimately reach financial close, will utilize all of our remaining credit subsidy appropriations.

To date, DOE has committed and closed five ATVM loans, totaling over $8.3 billion, which will support advanced vehicle projects in eight states. We anticipate making a number of significant additional ATVM loan commitments in the coming months.

It is important to remember that the loan programs are not grant programs; loans provided or guaranteed by the Department must be repaid. We review projects on a competitive basis, and we do not fund every eligible project. We ensure that the loans we support meet our statutory requirement of having a "reasonable prospect of repayment." Every project that receives financing first goes through a rigorous financial, legal and technical review process—similar to, and in some ways more comprehensive than, what a private sector lender would conduct—before a single dollar of taxpayer money is put to work. This due diligence and underwriting process takes thousands of man-hours to complete for each transaction, particularly as the projects in questions are large, complex, and require the coordination of multiple parties. The Department is committed to processing transaction as expeditiously and transparently as possible, while ensuring that taxpayer resources are prudently deployed and properly safeguarded.

GENERAL COMMENTS ON S. 937 THE AMERICAN ALTERNATIVE FUELS ACT OF 2011

The American Alternative Fuels Act of 2011 seeks to promote and understand the use of alternatives to conventional petroleum fuels. The bill seeks to provide additional incentives for algae-based fuels, examine the emissions impacts of electric vehicles, expand contract authority for the Department of Defense to purchase alternative fuels, and implement reforms to Department of Energy's Loan Programs. As I mentioned previously, these provisions fall under the jurisdiction of multiple federal agencies, including the Department of Energy, Department of Defense, and the Environmental Protection Agency.

As the Department of Energy continues to review sections of the legislation impacting the Department, various DOE programs are continuing to advance the primary goal of the legislation—to reduce our oil dependence.

For instance, DOE believes that algae based fuels may be an attractive piece of a long term strategy for biomass production. Algal biofuels have the potential to meet a portion of the renewable fuels mandate. Some advantages algal biofuels may have over other biomass feedstocks include higher per-acre oil productivity, use of non-arable land, water input flexibility, mitigation of greenhouse gas emissions and the production of high grade fuels and valuable coproducts.

As such, DOE is pursuing the development of algae-based biofuels through funding from the Office of Biomass Programs. DOE continues to support the technical development of algal fuels through focused R&D. Through the efforts of several consortia, drawing upon private sector, academia, and industry stakeholders, scientists and engineers are making advances in mitigating the remaining economic and technical barriers to achieving the full potential of algal biofuels. Currently, research on algae includes developing suitable algal strains and cultivation parameters, harvesting and extracting oils from algal biomass and techno-economic analysis of different algal biofuels processes. However, because the Renewable Fuel Standard program is administered by the Environmental Protection Agency, DOE cannot speak to any possible implementation challenges associated with using the Renewable Fuel Standard to create incentives for algal biofuel production.

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[6] Sources: U.S. Environmental Protection Agency, Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle; U.S. Department of Transportation, Federal Highway Administration, Highway Statistics 2008, Table MV-1 (December 2009).

Summary

The President recently set a goal of reducing petroleum imports by one third by 2025. Together with increased fuel economy in vehicles, acceleration of electric vehicle deployments, and expanded production and use of biofuels this goal is well within reach. The Department of Energy welcomes the opportunity to continue working with the committee to advance our energy goals. I would be happy to answer any questions the committee may have.

The CHAIRMAN. Thank you both very much.

Let me start with some questions of you, Dr. Kelly. We have a document here in the briefing materials that I got from the World Nuclear Association. They list what they describe as medium and small reactors with development well advanced. They list 16 of them around the world that they claim have development well advanced.

What is the timing for the work that the Department of Energy is pursuing here? I'm concerned, I guess, that we may just be studying this issue and one of these days wake up and find that there's a version of a modular nuclear reactor available for sale produced in China and somewhere else that, sort of, steals the march on any U.S. company that might be interested in this. What is the timeframe and then where do you see us as far as being up with these other 16 advanced developments?

Mr. KELLY. Great. Thank you.

Over the course of the last year we've been conducting market research into what is the viability of vendors, utilities, of all stakeholders in this market. What we conclude at this point is that we believe that within the decade we could have small modular reactors of the light water version up and operating in the U.S., designed and built by U.S. companies. We see multiple vendors available. Utilities are interested. So we see that as the front runner in terms of getting the technology from design to actual production of electricity.

Longer term we have a program, as outlined in our budget request, to investigate advanced concepts which would have greater benefit. We see that timeframe for deployment of those systems out a little bit longer in time, maybe 15, 20 years.

The CHAIRMAN. But you don't believe that the development of these modular nuclear reactors and the sub assemblies and all of that is likely to occur more rapidly elsewhere, outside the country?

Mr. KELLY. In my opinion, no at this point. We believe that any design would need to go through an extensive licensing review which would take several years. Some of these have begun in Korea, for instance. But we're awaiting the outcome of their work. But we intend, with the program that we propose, to begin that effort as soon as possible.

The CHAIRMAN. Now the cost sharing that we have contemplate in this legislation, the way I understood it, this would be a useful thing because it would not only provide resources and give some advantage to the 2 models that were chosen, it would also give the Nuclear Regulatory Commission some direction as to where they could go as far as approving licenses for modular nuclear reactors. Is that a correct understanding or why do you think we should include cost sharing and have the government pay part of the cost of this thing?

Mr. KELLY. In our market survey, what industry told us is that the regulatory risk of actually taking these new and innovative designs through the process is something that they thought as a significant risk. Felt it appropriate for the government to help reduce the risk of market entry for these new designs. At the same time they are very interested in cost share.

So we already understand that they are investing their own resources to further design work. So they're willing and able to enter into a public/private partnership with no cost share agreements.

The CHAIRMAN. OK.

Mr. Chalk, let me ask you just with regard to this S. 937. There's a suggestion that algae based fuels should receive triple credits under this renewable fuel standard that we already have on the books. If that feed stock is using carbon that has already been used in an energy production process, that's an interesting concept.

Could you give us a sense of how likely it is that commercial scale, algae based, biofuel facilities will be located with power plants. I guess that would be a precondition to this happening, right?

Mr. CHALK. Yes, sir. Algae provides a great opportunity to use CO_2 from power plants before we emit it into the atmosphere. Basically to recycle that CO_2.

Algae feeds off CO_2 and sunlight, and you can make diesel fuels from algae that are very similar to petroleum based diesel fuel you see today. Algae requires lots of CO_2 in order to fatten up and produce these lipids or these oils.

Location of a nearby power plant would be critical to affordability of an algae facility. If the CO_2 has to be shipped very long distances obviously it's going to increase the costs of these fuels. So co-location or somehow liquefying or solidifying the CO_2 would be very important.

The CHAIRMAN. OK. My time is up.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Mr. Kelly, you mentioned the licensing issue. I think you used the word that it would be an extensive process perhaps taking several years. Can you just outline some of the challenges or the hurdles that we're facing with the licensing of these SMRs?

Mr. KELLY. If we're talking about light water technology we, in our discussions with the Nuclear Regulatory Commission, believe that they have a lot of knowledge already about that technology. So that barrier is fairly low. There are some unique features.

Senator MURKOWSKI. So when you say that's fairly low does that mean that we could move through the licensing process in a relatively expedited timeframe?

Mr. KELLY. NRC has their processes, as we've discussed it with them. So they would lay out all the sections of the design to be evaluated. They would come up with a time table.

What I think we would achieve is high confidence in the schedule for the licensing process because of the maturity of the technology. That, in principle, should lead to an expedited licensing process. So we're going in, I think, with significant knowledge as opposed to more advanced technologies which might have some technical un-

certainties that would need additional research to satisfy the regulator.

Senator MURKOWSKI. But what you're saying then is that it is only as to the light water reactors that we might anticipate a more expedited process?

Mr. KELLY. Exactly. So we view our R and D program, the component that we've outlined, as developing the information that would eventually get other types of SMRs on par with light water reactor technology. But we see that a little bit further out in time.

Senator MURKOWSKI. Alright. I think what we continue to looking for is some level of certainty as to this process and the timelines and appreciate all that goes with it. But the hope is that there can be some element of standardization, if you will, through the design certification.

Let me ask you, Mr. Chalk, you know, one of the big component pieces in Senator Barrasso's bill is the repeal of section 526 under the Energy Independence and Security Act of 2007. You omitted either in your testimony to reference that at all. I do understand that you say that the Administration has taken no formal position.

Can you give me a little bit more about where you guys might be on section 526?

Mr. CHALK. Yes. I can give you some insight from the Department of Energy. First of all, section 526 of EISA is on the procurement and acquisition of alternative fuels, and basically says that no Federal agency shall contract or buy an alternative or synthetic fuel unless its greenhouse gas profile is better than conventional fuels.

We view this as very important if we're going to address climate change. We feel that the Federal Government needs to take leadership on this issue, and repealing section 526 would reverse that leadership.

In fact, a couple weeks ago, the President directed all the Federal agencies to purchase 100 percent alternative fuel vehicles, hybrids or EVs by 2015, and going forward to work with private companies to upgrade their large fleets to alternative fuels vehicles. So we feel——

Senator MURKOWSKI. What might this mean to further energy sources from Canada? I met with a group of Canadian producers, no more than a couple weeks ago, and this is absolutely their No. 1 agenda item. I think we all recognize that in certain parts of Canada the product that we get whether it's from Alberta or what might be coming from the Keystone pipeline. This is pretty significant to us in terms of supply.

Mr. CHALK. Yes, I agree. When we look at the attributes we want, in our fuel supply, one thing we want is diversification. We don't like petroleum. We don't want to be 95 percent dependent on one feed stock. So diversification is really important.

The more we rely on domestic and North American fuels, the less we have to rely on fuels from sensitive countries like some in the Middle East. But the environmental profile of fuels in terms of their criteria emissions, greenhouse gas, emissions and overall sustainability criteria like water use are just as important. A part of the attributes that we seek and we're agnostic on feed stock or the technologies that are used, but we want alternative fuels to meet

those environmental attributes, and lower greenhouse gases is one of the criteria that we feel is important when we look at an alternative fuel in terms of diversification, if it's domestically produced, it's environmental impact and energy security.

Senator MURKOWSKI. From what you've said I don't argue with diversification. But I do think that we recognize that when it comes to meeting our energy needs it is important that we focus on North America. Canada is a good, strong neighbor. They've been helping us out and providing us with the resource that we desperately need. The concern that with section 526 staying in there we severely limit our options, I believe.

Mr. Chairman, I've got other questions, but I will defer to later.

The CHAIRMAN. Very good.

Senator Franken.

Senator FRANKEN. Just to follow up on Senator Murkowski's question about Canadian oil which is from the Tar Sands, has a higher greenhouse gas and the concern that she heard from Canadian producers regarding this bill and this exception. Doesn't that oil just sort of become part of the entire world oil supply? Isn't it hard to distinguish that oil?

I mean, doesn't that become sort of a mute point?

Mr. CHALK. Yes, it's a commodity, so it becomes part of the world's supply.

But this particular law is on which alternative fuels Federal agencies can purchase. .

Senator FRANKEN. OK.

Do we have a commercial scale algae based fuel plant anywhere?

Mr. CHALK. Yes and no. We have different types of algae.

Senator FRANKEN. First yes and then no.

Mr. CHALK. We have what we call dark and light algae. The Solazyme process is a dark process. You actually feed the algae sugar. The algae is not really a feed stock, but it is somewhat at a production level.

The sugar then makes the oil with the algae, and you get the oil out of the algae. Solazyme is working with the Department of Defense. So that process yields hundreds of thousands of gallons per year and is somewhat commercial.

The light processes are those you typically think about, where algae actually is a feed stock, where it's collecting the sunlight and you're feeding it CO_2 typically in a water system. It's really aquaculture. We don't have that at acommercial scale yet.

We have a couple companies under contract at DOE. One is Sapphire, in New Mexico, and the other is Algenol. They're scheduled to have pilot facilities completed next summer. So hopefully after next summer we'll be able to assess where to go in terms of commercial scale.

Senator FRANKEN. We're getting like the first commercial cellulosic in Emmetsburg, Iowa, right?

Mr. CHALK. Yes.

Senator FRANKEN. That that would—so I have just some concern about the algae being, you know, getting 3 times the credit in a sense of other feed stocks.

Mr. CHALK. Yes. In the bill I don't understand the rationale for the 3 times.

Senator FRANKEN. Yes, I don't.

Mr. CHALK. We would say that algae is a great pathway because it doesn't compete with cellulosic ethanol. Cellulosic ethanol is probably, in terms of traditional algae at least 5 years ahead of traditional algae in terms of technical maturity. We're not quite there on the light algae that's produced from light and CO_2.

Senator FRANKEN. Can I ask you about coal to liquids technology which would be a beneficiary to the repeal of section 526? What are your thoughts either from a personal standpoint or on behalf of the Administration on CTL as a technology? Is it viable any time here soon? What are the pros and cons of it?

Mr. CHALK. Unfortunately that's not under my purview. It's in the Office of Fossil Energy.

Senator FRANKEN. OK.

Mr. CHALK. So I would like to get back to you on the record.

Senator FRANKEN. Sure.

Mr. CHALK. On the greenhouse gas profile and so forth on that.

[The information referred to follows:]

Coal to liquids (CTL) is a commercial process which converts coal into liquid transportation fuels, such as diesel, gasoline, and jet fuel. These coal-derived liquid transportation fuels are compatible with our current petroleum-based fuel distribution infrastructure.

According to the Energy Information Administration's (EIA) Annual energy Outlook 2011 (AEO2011) Reference case, world oil price is projected to be just under $125/barrel by 2035 and West Texas Intermediate (WTI) spot price as of July 14, 2011, was approximately $95/barrel. Although studies indicate CTL using today's technologies would be profitable at this oil price, industry is best positioned to evaluate commercial-scale market opportunities for CTI.

Technology currently in the demonstration/deployment stage such as carbon capture and storage (CCS) technology, if applied to the CTL project, would reduce lifecycle emissions of the fuel to roughly equivalent to conventional petroleum. A co-feeding coal and biomass to liquids (CBTL) concept is another strategy to reduce greenhouse gas (GHG) emissions that is currently being explored. Implementing CCS technology and increasing the percentage of biomass in the feed can reduce the life cycle GHG emissions of the fuel to below the petroleum baseline.

Senator FRANKEN. Dr. Kelly, how does a modular nuclear reactor compare to like that in a submarine? A submarine is how many megawatts, like 150 or something?

Mr. KELLY. You know, I actually don't know the design details of the naval submarines. But they are small. I believe on the same order of magnitude as the SMRs that we're talking about now.

Senator FRANKEN. OK, so these modular reactors, how do they compare in terms of cost effectiveness per megawatt compared to the standard, large nuclear reactors? I understand there's more flexibility here.

Mr. KELLY. Right. So what the designers have taken on is the question of how to reduce the initial capital costs for these reactors by through design.

Senator FRANKEN. Sure.

Mr. KELLY. So they've designed them smaller. At the same time, they've paid particular attention to the safety case. So they've made them very safe with lots of cooling, natural processes and secure. So they've been thinking about the underground siting. So they've tried to put together the main attributes we're interested in: cost, safety, security, together in the design.

But to get the competitive advantage they really are going to have to rely on factory fabrication, mass production. So what comes

into play here then is this economy of scale verses economy of mass production. The naval experience though, points us in the direction that by going to factory fabrication you can actually lower the cost as you begin to build more units. You learn through that process how to reduce labor, how to use more automation, etcetera.

Our initial studies and again, these are very preliminary, indicate that the economy of mass production is very feasible with these designs. We believe we can achieve a parity with the large plants on a per megawatt basis.

Senator FRANKEN. Thank you. My time is up. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Portman.

Senator PORTMAN. Thank you, Mr. Chairman and thank you, gentlemen, for being here this morning.

I have some follow up questions regarding the small modular reactors. To me this is really exciting technology. It also happens to be a place where Ohio plays a role because of our current role in the research development and also the supply chain should this become something that utilities take up.

I would say from what I've heard, Dr. Kelly, it is different in kind also because with the current plants, typically they're built onsite as compared to have been built in a factory and then shipped to the plant in parts which is part of your comments to scale, I guess. That you can create efficiencies through the way in which it's produced. Is that accurate?

Mr. KELLY. That's correct, sir. Having a controlled environment for fabricating critical modules or subcomponents and then doing just the final assembly at the site, we believe will significantly reduce the construction costs. That's part of it.

The other attribute is the quality level. That having welding done in a controlled environment and doing the inspections while it's being done can actually then improve the quality of the product and eliminate the need for rework that is sometimes found in onsite construction.

Senator PORTMAN. Yes, almost an assembly line type example, technique.

Mr. KELLY. Exactly.

Senator PORTMAN. Going back to our manufacturing roots in Ohio and elsewhere.

The second thing that I've heard is that in terms of the cost, that by having a serial design, in other words, being able to line up plants over time, reactors over time, utilities would be able to offset some of the costs by having a revenue stream including the costs of some of the loan guarantees that are being discussed. Is that accurate?

Mr. KELLY. That's accurate, so that a revenue can be generated while you're still building out the multi-modules and in that type of scenario. The other attribute is that the licensing, once you have the design certified, it lasts for a long time. Then so as long as you're building replicas of an initial model the licensing process is significantly simplified.

Senator PORTMAN. In terms of the licensing process light water seems to be the way to go because it would be easier to get it through the NRC. Is it the right way to go technologically?

Mr. KELLY. I think for electricity production given what we have today that is a true statement that it is the best way to go. We understand the fuel and licensing the fuel are a big part of the licensing effort. But if we think longer term we may want these small reactors in more remote locations, have waste management missions, long live core, export markets, these types of things. That's where we see the R and D program coming into play to help develop the technology to enable those additional missions for SMRs.

Senator PORTMAN. Let's talk about the export potential for a second. It seems to me this is one area where the United States is a little bit ahead of some of our competitors in terms of the technology. I would say that in the same it's not true since we haven't moved forward with nuclear power for such a long period of time with regard to other aspects with our nuclear technology.

Do you think that's accurate and do you think there's a potential to export this technology and this expertise abroad?

Mr. KELLY. Again, this is based on information that we've collected over the last year. But in our opinion, there have been a number of designs that have been put forward over the last 10 to 15 years for small modular reactors. Many of those have not gotten traction.

But we now see, at least for these light water reactors, significant investment by private companies in those designs. So we believe the time is ripe to pursue forward with the technologies.

Senator PORTMAN. Do you see export markets?

Mr. KELLY. There are certainly significant interest internationally. The IAEA has a committee that has polled countries and there's significant interest. It's primarily because the electricity demand may be smaller. Their infrastructure for the plants may be more limited. So there may be a much better match between the smaller output of these plants and the indigenous infrastructure in those countries.

Senator PORTMAN. This just seems to be a great opportunity for us. I think there are members of this committee who are interested in nuclear power are really interested in having this move forward. I notice in your testimony you talked about the $96 million in FY 2012 for the program. You also said that there's a DOE request for a multiyear, $452 million program that would be a cost share arrangement with private industry partners to complete some of these design certifications and so on.

In your opinion, Dr. Kelly, is this adequate? Is this funding outline adequate to be able to do what you think is necessary to have these SMR demos up and deployed and going forward?

Mr. KELLY. We based our cost estimates on input from industry. You know, assuming that there's a significant cost share contribution from industry for this effort we think that we could get through the design certification up to 2 reactors with that funding level.

Senator PORTMAN. What date do expect these SMRs to be operational with that funding level?

Mr. KELLY. We're targeting operation within a decade perhaps as early as 2018, 2019. We're looking at a 4 to 6 year process for the design and licensing and then construction could begin after that.

Senator PORTMAN. My time is up. Thank you, Mr. Chairman. I have additional questions for the record. Thank you, Dr. Kelly.

The CHAIRMAN. Thank you.

Senator Landrieu.

Senator LANDRIEU. Thank you and following up on Senator Portman's line of questioning which was excellent and Dr. Kelly thank you for being here.

The industry of course, based on the packed house today and the line outdoors and the meetings that have been requested of the members of this committee, seem to be extremely interested in accelerating the timeframe of this effort. There seems to be a tremendous amount of promise for these small nuclear reactors. I know we've been pressing you for dates and you keep saying some time in the next 10 years.

Can you be a little bit more specific? My second question is, is there any barrier that exists that you can identify that Congress could eliminate for you or is it something that you and staff need more of or less of to accelerate this process? Because we would like the United States to be the leader and we see a real opportunity here.

Mr. KELLY. Right. In terms of the timeframe so at this point we do not have any contracts with any industrial firms because our program has not yet been initiated. So, but we have gotten information from them in terms of what they think.

Senator LANDRIEU. Why hasn't the program been initiated yet?

Mr. KELLY. It was requested in 2011 and the continuing resolution was passed but as a new start it still needs Congress to approve that as a new start program in FY 2011.

Senator LANDRIEU. So have we not approved it, Mr. Chairman?

The CHAIRMAN. So as I understand what you're saying is that there's no money in the continuing resolution to begin the program. Therefore you're going to have to wait until we do our appropriation for the next fiscal year and hope that——

Mr. KELLY. No, it's been requested that this program be allowed to be initiated this year. But it's within discussion with all other type of new start activities.

Senator LANDRIEU. That's what I'm confused about. I mean, I think we believe, at least I believe, let me just speak for myself, that we've given you the green light. We want to provide the money. We want you to go, green light, fast.

I just keep hearing this, sort of, well, we don't know when we'll get to it. We've had competing. So try to be a little bit more clear about your intentions and the Secretary's intentions to accelerate what we think is a very promising program.

Mr. KELLY. Right. So we think the program that we've outlined will accelerate the deployment of SMRs relative to what industry would do on its own. So the cost share component should be able to bring in by a couple of years what we think industry would be able to do with private investments.

But nevertheless, going through the regulatory process which we think is a 4 to 6 year type of effort, allows us then to have confidence in the safety and security of these units. At the same time gives these designs a comparative advantage worldwide. It is recognized around the world.

Senator LANDRIEU. We appreciate that. I'm all for not picking one design and moving forward. But I'm also for giving industry some signals as to what designs could potentially be, you know, be accelerated more quickly because it's almost like a chicken or the egg.

I mean, there's a lot of money out there willing to be invested in a promising technology. But for industries to be designing 50 different types when the government may be looking at only 1, 2 or 3, I don't know. I'm going to learn more about the details of this.

But I understand there are 2 potentially promising maybe even more designs. But again, it's sort of a partnership that has to work. You're waiting for industry. They're waiting for you. Then our taxpayers are, you know, paying more for electricity than they need to be.

Mr. KELLY. Right.

Senator LANDRIEU. So I'm going to be pressing for some more specifics on that.

Let me move to algae really quickly. I've been having some great visits down to Louisiana. People bring this subject up to me whether I ask for it or not which indicates to me that there's a lot of excitement.

We've got one company, Aquatic Energy. They haven't been able to get a grant for years from the Department. I'm not sure why because we have a lot of water. We have a lot of sugar. We have a lot of power plants in Louisiana.

So I'm going to be sending you all another letter about this. But nonetheless, there are many companies that are looking to do the research. But in Louisiana we have what all the byproducts, or the initial products you've discussed here at the table.

We have the power plants.

We have sugar.

We have sunlight.

We have adequate water.

From what I can understand algae doubles the cells every 12 hours. It produces approximately 6,000 gallons of oil per hector compared to 200 gallons for soybeans, 1,000 for palm. They sequester carbon dioxide which you've mentioned. They don't have to compete with drinking water, the production, because they can grow in any fresh water source including waste water which is very interesting.

Algae is very similar to petroleum according to my producers and pipeline folks. Because you don't have to retrofit the equipment. It can move through the pipelines, you know, as designed which is a significant advantage.

I'm sympathetic to the Senators. I represent a lot of corn interest and sugar cane interest myself. But I think for the long term future of the country to find a product like this that doesn't compete as a food source, that can be produced almost anywhere and have the added benefit of sequestering carbon is something that we really should be very excited and enthusiastic about. We are in Louisiana.

So my final question, Mr. Chalk. What do you when you look out in 5 years, what do you see in terms of algae production actually in the United States?

Mr. CHALK. I would say in 5 years we should be in a very good position to be at what we would call demonstration scale. Right now we're at pilot scale. I mentioned Algenol and Sapphire and they are really at a pilot scale producing about a million gallons a year. Hopefully we can scale up at least by a factor of 10 in 5 years.

I would agree with everything you said. In addition, algae needs nutrients which the chemical industries near Louisiana could provide as well. We have requested $10 million in the FY 2012 budget for algae. So hopefully if that money is appropriated there will be new opportunities for companies to give us proposals.

Senator LANDRIEU. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Barrasso.

Senator BARRASSO. Thank you very much, Mr. Chairman for holding this hearing. I want to thank Senators Manchin as well as Senators Murkowski and Coats for co-sponsoring the American Alternative Fuels Act.

High gas prices are causing American families pain at the pump. With gasoline at nearly $4 a gallon, American families are spending an additional $800 this year to fill up their tanks. The high prices are hurting families. It affects the quality of life for families living with children and with bills and with a mortgage.

It also threatens to undercut our economic recovery. So this is an issue of economic security as well as national security. That's why I introduced this bill along with our co-sponsors.

The American Alternative Fuels Act breaks down the barriers to alternative fuels. The bill repeals section 526 of the 2007 Energy bill which discourages development of alternative fuels and limits access to available resources. The bill also promotes algae based fuels by giving it credit under the renewable fuel standard. The bill also would give the Department of Defense authority to enter into long term contracts for purchasing alternative fuels. This provision will help spur the development of America's alternative fuel capacity.

Promoting alternative fuels for the Defense Department will safeguard the military from price spikes and make us less dependent on foreign sources of oil. The Department of Defense sent a letter to Congress in 2010 supporting long term alternative fuel contracting authority. The letter says, "The Department of Defense agrees that alternative fuels can play a role in ensuring our Nation's energy security." It says, "We believe long term contracting could help encourage infrastructure investments to develop a domestic alternative fuels market."

This bill would provide the long term contracting authority that I believe is needed. The American Alternative Fuels Act is an important step to increasing alternative fuels in the country. It will foster greater production of American fuels and help address our reliance on foreign oil.

Mr. Chalk, I believe one of the major challenges for alternative fuels and alternative vehicles is fuel distribution infrastructure. Coal based fuels, I believe, don't face the same challenges, which makes it a much more viable alternative in the short term. Could you tell me does the Department of Energy support the use of

America's coal resources as a transportation fuel that can help replace some of the oil that's imported from overseas?

Mr. CHALK. Yes, as I said earlier we strongly believe diversification is really critical here. Diversification including through some of the feed stocks we've been talking about world enable us to not be overly reliant on petroleum like we are now. But we also think domestic fuels are important to keep the money flowing in our economy and in the North American economy as well when we look at Canada. But environmental attributes are also very important.

When we look at the attributes of alternative fuels, greenhouse gas intensity is an important criteria. We are trying to go in a trend to reduce greenhouse gases. So we are agnostic in terms of feed stock, but we should be in a downward trajectory as far as greenhouse gas intensity compared to the fuels we use today, specifically the benchmark conventional fuels.

Senator BARRASSO. What alternative fuel sources are really the easiest and the least expensive to deploy widely in the short term?

Mr. CHALK. Ethanol, as you know, is displacing about 5 percent of our petroleum today. The RFS has called for billions of additional gallons of bio. Today around 10 or 11 billion gallons of ethanol will be delivered and the greenhouse gas benefit is about 20 percent.

Cellulosic ethanol is being delivered today, but in very small quantities. As we mentioned we're hoping to scale that up in the next 5 years providing a greenhouse gas benefit of about 60 percent. So the renewable fuel standard is our guidepost. In the renewable fuel standard there are checks and balances with greenhouse gases being reduced and sustainability criteria.

Senator BARRASSO. Alright. You mentioned Canada. You had a previous question from Senator Franken about Canada and what's going on. I don't know if you saw the article in today's New York Times*. Canada prepares plans B and C in case oil sands pipeline hits a roadblock.

Mr. Chairman, I'd like to, if I could, introduce this as part of the record.

[The information referred to follows:]

The transportation sector accounts for approximately two-thirds of the United States' oil consumption and contributes to one-third of the Nation's greenhouse gas (GHG) emissions. After housing, transportation is the second biggest monthly expense for most American families. Earlier this year, the President outlined a portfolio of actions which, taken together, could cut U.S. oil imports by a third by 2025. These include programs that would put one million electric vehicles on the road by 2015; increase the fuel economy of our cars and trucks; as well as expand the biofuels market and commercialize new biofuels technologies, including cellulosic and other advanced biofuels.

Senator BARRASSO. I just want to highlight a couple of paragraphs from this.

"Oil producers in Canada have several alternatives for reaching the United States market. Recent investments by Chinese companies in the oil sands suggest that a growing alternative market lies across the Pacific. Ronald Liepert, the Energy Minister in Alberta said that while Canada would prefer to sell its oil to the United States, this commodity, he said, will go someplace."

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* http://www.nytimes.com/2011/06/07/business/energy-environment/07pipeline.html

Do you agree with that?

Mr. CHALK. I do. As Senator Franken alluded to, this commodity is going to enter the world market and it's going to be sold. It's going to be mixed in with whole gasoline or diesel pool.

Senator BARRASSO. So the final paragraph says, "In particular China is already a major consumer of other Canadian natural resources and a small investor in the oil sands." Its Minister of Energy in Alberta quotes, "I can predict confidently that at some point China will take every drop of oil Canada can produce." So if the United States is blocked, it seems to me, that if we're blocked from obtaining this oil, then it's going to go to China.

Mr. CHALK. We have a goal of reducing our oil imports by a third by 2025, I believe. Let me check on that record.

Mr. CHALK. The critical part of this is less reliance. So biofuels is one pathway increasing corporate average fuel economy which we've done over the last few years. CAFE standards are increasing from 2010 to 2016 by about 35 percent in light duty cars and about 25 percent in light trucks.

Finally, electrification through plug in hybrid vehicles and battery electric vehicles can also reduce our reliance on foreign oil.

Senator BARRASSO. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Manchin.

Senator MANCHIN. Thank you, Mr. Chairman. I want to thank also Senator Barrasso and Senator Murkowski that were on this bill. We believe very strongly in it.

West Virginians believe that basically we are too dependent on foreign oil. It's cost us a tremendous toll as far as in our human suffering that goes on around the world trying to secure the energy that we need for this country. We believe that there is a better alternative. This is why we introduced and why I'm happy to sponsor or co-sponsor this bill. All we're saying is we should be using everything humanly possible.

Mr. Chalk, do you believe that we can be energy independent in the United States?

Mr. CHALK. I believe we can be self reliant. I believe that we can——

Senator MANCHIN. At a competitive price, sir?

Mr. CHALK. Yes, sir.

Senator MANCHIN. At a competitive price?

Mr. CHALK. I believe that. For instance, if you look at our electric vehicle program right now we have all the tools in the tool kit. I've been at the Department of Energy for 20 years and never in a program have we covered all the bases over basic research, the research and development, demonstration, the manufacturing to deployment that we have that in the electric vehicles area.

We've also proposed a hub which gets the best scientists in the world together for basic energy science related to energy storage.

Senator MANCHIN. Do you believe that can be done without coal?

Mr. CHALK. Pardon me?

Senator MANCHIN. Do you believe we can have energy independence without coal?

Mr. CHALK. I believe we can.

Senator MANCHIN. How?

Mr. CHALK. We wouldn't shut it out through the diversification——

Senator MANCHIN. You're 50 percent. You're 50 percent in this Nation right now, dependent on fossil base. The rest of the world has more demand. I can tell you in my little state that there's more demand for the coal being exported, kept the prices higher for with every industry of our time.

Now if the rest of the world is going to be using the coal that we're producing in West Virginia. They want to buy up our coal fields in West Virginia. Here we are not even using it to our best abilities.

Why would—does that make any sense to you at all?

Mr. CHALK. We are looking at coal. We've got clean coal programs in the Department.

Senator MANCHIN. Why isn't the rest of the world looking at it that way? Why do they just need—they're taking our jobs. They're taking our economy from us.

We're raising the price. New Jersey just lost a large plant, 250 jobs. Twelve cents a kilowatt hour was their average price per kilowatt hour on fuel because of all the regulations we put on. They came down into the Pennsylvania/West Virginia area and relocated that plant because of 6 cents.

Don't you think you're going to displace the jobs and the markets that go with it?

Mr. CHALK. The best opportunity we have for economic growth are these new technologies that I'm talking about, electrification, biofuels——

Senator MANCHIN. Where do you think the electric is going to come from?

Mr. CHALK. Pardon me?

Senator MANCHIN. Where do you think this electric is going to come from at a competitive price?

Mr. CHALK. It will come from the same sources that we have now. We're hoping to double renewable energy by 2035 with the President's proposed clean energy standard.

Senator MANCHIN. So you're saying the Department of Defense they've already run B–52 bombers on coal to liquids and they were very pleased with it. But the provisions we have in the law here don't allow us to develop it.

Mr. CHALK. It doesn't allow the Federal Government to buy that fuel because it's going backward in terms of greenhouse gas emissions.

Senator MANCHIN. It's best for them to buy foreign oil?

Mr. CHALK. Our strategies to develop biofuels and biofuels can yield great jet fuel and great diesel fuel and we're doing that through 2 pathways. One is cellulosic and one is through the algae work that we talked about. Both of these pathways are what we call drop-in fuels which are totally compatible with today's jet engines.

Senator MANCHIN. I just think—do you find it appalling that we don't have an energy policy in 2011 in the United States of America?

Mr. CHALK. I believe we do. We have a blueprint for the energy——

Senator MANCHIN. Who's this? The bureaucracy or the lawmakers? I mean, do you find us to be an impediment to you all moving forward with what you want to do?

Mr. CHALK. I think we have pieces of very good energy legislation.

Senator MANCHIN. Don't you think we should be——

Mr. CHALK. We also have an agenda in our blueprint for how we're going to relieve our dependence——

Senator MANCHIN. Don't you think the elected representatives should be leading that and representing the people that they do serve?

Mr. CHALK. I think that they are. Yes.

Senator MANCHIN. You think they are?

Mr. CHALK. I think leadership in the Senate Energy and Natural Resources Committee has been great over the last few years.

Senator MANCHIN. Do you support the repealing of section 526?

Mr. CHALK. As I said, we don't have a formal position. It does not allow the Federal Government to contract or buy fuel that emits more greenhouse gases than conventional technologies. So——

Senator MANCHIN. You're talking about oil base.

Mr. CHALK. So that's the first trend that we want. We want to address climate change. We want to reduce greenhouse gases.

Senator MANCHIN. We want jobs. We want an economy. We want to be able to compete. We don't want wars around the world. We don't want to continue to be relying on foreign oil.

Don't you think that plays a part also?

Mr. CHALK. I think that all of these goals are mutual. I think we can get reduced greenhouse gases along with new jobs.

Senator MANCHIN. Is China worried about reducing greenhouse gases? Is India worried about reduced greenhouse gases? Is Indonesia?

Mr. CHALK. China is going to be formidable and they are already very formidable competitor in all of these areas I'm talking about: electric vehicles, solar technology, wind technology.

Senator MANCHIN. One final question, sir.

Mr. CHALK. They see that as economic growth.

Senator MANCHIN. Do you believe that we should be developing these new technologies overseas verses developing here in the United States?

Mr. CHALK. We want to develop them here in the United States.

Senator MANCHIN. Thank you.

The CHAIRMAN. I thank you all.

Senator Murkowski, do you have additional questions?

Senator MURKOWSKI. I recognize we have a second panel, Mr. Chairman. So I don't want to take too much more time. But I certainly appreciate what my colleague, Senator Manchin, has been drilling at and what Senator Barrasso said.

You know, as we talk about our dependence on foreign sources of oil I think we have to recognize that some of our dependency is making us more vulnerable as a Nation than others. I appreciate Senator Franken's question and your response about oil being a global commodity. We all understand that.

But I certainly am not losing sleep thinking that we are gaining a substantial source of our oil revenue from our neighbors in Canada. I do lose a lot of sleep over the reliance that we have on Middle Eastern sources of oil and how we reconcile that. But I think that the position that you have just stated here, Mr. Chalk, on behalf of the Administration allows for a vulnerability. It enhances our insecurity. I don't think that's the direction that we should go in.

Yes, we need to be working to reduce our emissions. But as Senator Manchin has said, there are technologies that we can be advancing in this country that allow us to use our most affordable resource. Let's use it smartly. Let's use the technologies to have the jobs, to have the energy and to reduce our reliance.

Mr. Kelly, I wanted to ask you one very quick question. I had asked you about some of the hurdles with the SMRs. A question came up about the control rooms that would be required for the reactors.

In existing reactors there's one control room for each reactor. But in a small modular reactor set up would you still require one control room for each reactor or would there be one control room for the entire plant? Have we worked that through yet?

Mr. KELLY. That particular question is still being worked by the Nuclear Regulatory Commission. They are studying that. They're pointing toward the need to collect data on how human and machines work together in order to quantify how many operators, how many shift supervisors, etcetera.

We——

Senator MURKOWSKI. Is that information coming as quickly as you would like?

Mr. KELLY. I believe so. It's certainly going to be in time for the design activity that we're talking about. They have a very public process. They have the issues. They will publish their findings and then seek public comment.

At this point it seems to be heading in a direction that's favorable.

Senator MURKOWSKI. OK.

Thank you, Mr. Chairman.

The CHAIRMAN. Do others have additional questions or can we go to the second panel?

Thank you both very much for your testimony. We appreciate it. We will move now to the second panel.

Dr. Edwin Lyman, who is the Senior Scientist with the Global Security Program at the Union of Concerned Scientists.

Mr. Joe Colvin, who is the President of the American Nuclear Society.

Dr. James T. Bartis, who is Senior Policy Researcher with RAND Corporation.

Mr. Brian Siu, who is Policy Analyst with the Natural Resources Defense Council.

We thank all of you for being here. We'll have the same ground rules for you as we do with all witnesses. That is we will include your entire statement in the record as if read. We would appreciate it if you would each take about 5 minutes and give us the main points that you think we need to understand from your testimony.

Dr. Lyman, why don't you begin, please?

STATEMENT OF EDWIN LYMAN, SENIOR SCIENTIST, GLOBAL SECURITY PROGRAM, UNION OF CONCERNED SCIENTISTS

Mr. LYMAN. Good morning. On behalf of the Union of Concerned Scientists, I would like to thank Chairman Bingaman, Ranking Member Murkowski and the other members of the committee for the opportunity to provide our views on the—some of the important legislation that's being considered today.

The Union of Concerned Scientists is neither pro nor antinuclear power. But we have served as a nuclear safety and security watchdog for over 40 years. UCS is also deeply concerned about global climate change. We have never ruled out an expansion of nuclear power as an option to help reduce greenhouse gas emissions provided that it is affordable relative to other low carbon options and that it meets very high standards of safety and security.

However, the Fukushima Daiichi crisis has revealed significant vulnerabilities in nuclear safety around the world. If we want to reduce the risk of another Fukushima in the future, new nuclear plants will have to be substantially safer than the current generation. To this end we appreciate the initiative of Members of Congress who seek to bolster the development of innovative nuclear technologies through legislation such as S. 512. But to help ensure the Energy Department will spend taxpayer money only on technologies that will actually increase nuclear safety in the end, we believe that S. 512 should provide more stringent and specific safety criteria than it currently does.

In our view small modular reactors may pose some benefits but they're likely to be modest at best. But on the other hand unless they're carefully designed, licensed, deployed and inspected, small modular reactors could actually pose greater safety, security and proliferation risks than large reactors. This has to be avoided.

Small modular reactors start out with a very big cost disadvantage because of the economies of scale. By standard formula the overnight capital cost per kilowatt of a 125 megawatt reactor would be nearly two and a half times greater than that of a 1,250 megawatt unit for all other factors being equal. Now advocates of small reactors argue there are a whole host of other factors that could help reduce those costs. But one estimate I'm aware of in a 2007 paper by Westinghouse actually found when they quantified these factors they could not overcome the big burden or the big cost disadvantage from economies of scale. At best you might achieve parity with large reactors per kilowatt which is what Dr. Kelly said in the first panel.

Given there is no apparent capital cost advantage for SMRs the advocates of SMRs have been pushing to reduce the operating maintenance costs. Dr. Kelly testified or told the Nuclear Regulatory Commission in March that the Nuclear Regulatory Commission's framework, regulatory framework for small modular reactors will be a very large determinant into the economic feasibility of these plants. As a result the industry has been pressing the NRC to reduce regulatory requirements based on the idea that small modular reactors will be inherently safer than large reactors.

Now even a 50 megawatt reactor will still contain an enormous quantity of fission products. There has to be significant protection against accidents or sabotage. So cutting regulatory requirements is not really the thing to do especially in light of the Fukushima accident.

What we found from Fukushima is that we need significant margins of safety to protect against extreme events. We believe the NRC should be increasing nuclear safety requirements across the board today rather than considering reducing them for SMRs. Because even if an SMR has inherent safety advantages you don't want to erode those advantages by reducing the safety margins and you may end up with something which is no safer than what we have today.

Consider the reduction of emergency planning zones which some have advocated. We've seen in Fukushima that significant radioactive contamination has occurred well beyond the ten mile zone which is the current regulatory standard in the United States for emergency planning. In fact the levels would trigger resettlement if they occurred here in the United States. So I don't think we should be talking about reducing emergency planning zones today for any type of reactor.

Also we've seen how the impact of multiple reactors at one site can greatly complicate dealing with crises as we've seen in Fukushima. You have to consider the interactions between the reactors. For small modular reactors we might have up to 12 modules at a site. You have to have additional safeguards to ensure that you can deal with multiple events and you do not want to do things like reduce the number of qualified operators that can deal with a significant confusing crisis like we saw at Fukushima.

We've also seen that multiple safety systems disabled a reactor can lead to a rapid degradation of the core and meltdown. Sabotage can actually simulate that and even cause a faster meltdown than we saw in Fukushima. So you do not want to actually reduce security requirements which is another aspect which has been considered.

So we believe that the legislation should really encourage the Department of Energy to pursue designs that only have greatly increased safety and security standards relative to current reactors. Should also not accelerate or put undue pressure on the Nuclear Regulatory Commission to accelerate licensing of novel designs because you're going to pay in the end later if you take short cuts now.

I will stop my remarks. Be happy to take your questions. Thank you.

[The prepared statement of Mr. Lyman follows:]

PREPARED STATEMENT OF EDWIN LYMAN, SENIOR SCIENTIST, GLOBAL SECURITY PROGRAM, UNION OF CONCERNED SCIENTISTS

Good morning. On behalf of the Union of Concerned Scientists, I would like to thank Chairman Bingaman, Ranking Member Murkowski, and the other distinguished members of the committee on Energy and Natural Resources for the opportunity to provide our views on S. 512, the Nuclear Power 2021 Act, and S. 1067, the Nuclear Energy Research Initiative Improvement Act of 2011.

The Union of Concerned Scientists is neither pro nor anti-nuclear power, but has served as a nuclear power safety and security watchdog for over 40 years. UCS is

also deeply concerned about global climate change and has not ruled out an expansion of nuclear power as an option to help reduce greenhouse gas emissions-provided that it is affordable relative to other low-carbon options and that it meets very high standards of safety and security. However, the Fukushima Daiichi crisis has revealed significant vulnerabilities in nuclear safety. If we want to reduce the risk of another Fukushima in the future, new nuclear plants will have to be substantially safer than the current generation. To this end, we appreciate the initiative of members of Congress who seek to bolster the development of innovative nuclear technologies through legislation such as S. 512. But to help ensure that the Energy Department will spend taxpayer money only on technologies that will actually increase nuclear safety, we believe that S. 512 should provide more stringent and specific safety criteria than it currently does.

S. 512 supports the development and licensing of two small modular reactor (SMR) designs, which are defined by the bill to be less than 300 electric megawatts. In our view, any advantages that SMRs may offer over larger reactors would be modest at best. On the other hand, unless they are carefully designed, licensed, deployed and inspected, SMRs could pose greater safety, security and proliferation risks than large reactors.

Because nuclear reactor costs follow the principle of economies of scale, smaller reactors will begin with a large economic disadvantage. For example, a standard formula indicates that the overnight capital cost per kilowatt of a 125 megawatt reactor would be roughly 2.5 times greater than that of a 1250 megawatt unit, all other factors being equal. Advocates argue that SMRs offer advantages that can offset this economic penalty, such as a better match of supply and demand, reduced up-front financing costs, reduced construction times, and an accelerated benefit from learning from the construction of multiple units. However, a 2007 paper by Westinghouse scientists and their collaborators that quantified the cost savings associated with some of these factors did not find that they could overcome the size penalty: the paper found that at best, the capital cost of four 335 megawatt reactors was slightly greater than that of one 1340 megawatt reactor.[1]

Given that there is no apparent capital cost benefit for SMRs, it is not surprising that the SMR industry is seeking to reduce operating and maintenance (O&M) costs by pressuring the Nuclear Regulatory Commission to weaken certain regulatory requirements for SMRs. Deputy Assistant Energy Secretary John Kelly told the Nuclear Regulatory Commission in March that the NRC's regulatory requirements for SMRs will "directly influence the operating cost, which will be a large determinant into the economic feasibility of these plants."

For example, the industry argues that regulatory requirements for SMRs in areas such as emergency planning, control room staffing and security staffing can be weakened because SMRs contain smaller quantities of radioactive substances than large reactors and therefore pose lower risks to the public. The NRC is currently considering the technical merits of these arguments. But even a single 50-megawatt SMR will contain an enormous quantity of radioactive fission products and could pose a severe public health threat if the core is damaged by an accident or sabotage.

Moreover, small reactors will not necessarily be safer than large reactors on a per-megawatt basis. Simply put, the risk to the public posed by one 1200-megawatt reactor will be comparable to that posed by six 200-megawatt reactors (assuming that all units are independent), unless the likelihood of a serious accident is significantly lower for each small reactor. But such an outcome will not be assured under the current regulatory regime. The Nuclear Regulatory Commission has a long-standing policy that new nuclear reactors, large or small, are not required to be safer than operating reactors. One consequence of this policy is that new reactor designs that have inherent safety features not present in current reactors may not actually end up being safer in the final analysis if designers compensate by narrowing safety margins in other areas, such as by reducing containment strength or the diversity and redundancy of safety systems. Any safety advantages will be eroded further if the NRC allows SMR owners to reduce emergency planning zones and the numbers of operators and security officers per reactor.

One of the early lessons from Fukushima is that prevention of serious nuclear accidents requires significant margins of safety to protect against extreme events. After Fukushima the NRC should be strengthening nuclear safety requirements across the board, rather than weakening them for SMRs. Consider the following examples:

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[1] M.D. Carelli et al., "Economic Comparison of Different Size Nuclear Reactors," 2007 LAS/ANS Symposium, Cancun, Mexico, 1-5 July 2007. Available at http://www.las-ans.org.br/Papers%202007/pdfs/Paper062.pdf

- Emergency planning zones around U.S. nuclear plants extend to a radius of ten miles. Yet significant radiological contamination from the Fukushima accident has been detected well beyond a distance of ten miles from the plant. In fact, radiation levels high enough to trigger resettlement if they occurred in the United States have been detected over 30 miles away from the Fukushima site. The discussion we should be having today is whether current emergency planning zones need to be increased, not whether we can shrink them for SMRs.
- As we have seen in Fukushima, nuclear plants with multiple reactors that experience severe conditions present extreme challenges. At Fukushima, the need to manage multiple simultaneous crises resulted in what sometimes appeared to be a game of "whack-a-mole" as the plant operator was forced to shift limited resources from one unit to another as new problems cropped up. These considerations make multiple-reactor sites less attractive from a safety perspective. Yet many plans entail multiple SMRs at one site-in some proposals, up to twelve SMRs would be co-located. The need to maintain adequate physical separation between individual SMRs and sufficient equipment and resources to ensure all the reactors could be safely shutdown and managed in an emergency would likely drive up costs.
- Fukushima also demonstrated how rapidly a nuclear reactor accident can progress to a core meltdown if multiple safety systems are disabled. A well-planned and executed 6 terrorist attack could cause damage comparable to or worse than the earthquake and tsunami that initiated the Fukushima crisis, potentially in even less time. And although Osama bin Laden is gone, the terrorist threat to domestic infrastructure may actually increase over time as al Qaeda seeks to retaliate. This is the wrong time to consider reducing security requirements for nuclear power plants, regardless of their size.

UCS is also concerned that reducing safety and security requirements for SMRs could facilitate their sale to utilities or other entities in the United States and abroad that do not have prior experience with nuclear power. Some SMR vendors argue that their technology is well-suited for deployment to remote areas, military bases, and countries in the developing world that have relatively low electric demand and no nuclear experience or emergency planning infrastructure. In the United States, for example, a rural electric cooperative might be interested in replacing an old coal-fired plant with a small nuclear plant. As another example, high-temperature gas-cooled SMR vendors are marketing reactors to the chemical industry worldwide for the production of process heat. However, SMRs deployed in this manner would raise additional safety, security and proliferation concerns compared to their deployment by experienced nuclear utilities.

The distributed deployment of small reactors would put great strains on licensing and inspection resources. Nuclear reactors are qualitatively different from other types of generating facilities, not least because they require a much more intensive safety and security inspection regime. Similarly, deployment of individual small reactors at widely distributed and remote sites around the world would strain the resources of the International Atomic Energy Agency (IAEA) and its ability to adequately safeguard reactors to guard against proliferation, since IAEA inspectors would need to visit many more locations per installed megawatt around the world. Maintaining robust oversight over vast networks of SMRs around the world would be difficult, if even feasible.

UCS does not support the deployment of SMRs to any entity that does not have a demonstrated or plausible capability to manage and operate nuclear facilities safely. UCS believes that the United States needs to carefully control the deployment of SMRs, especially those that it supports through proposed cost-sharing programs.

How can legislation address these problems? S. 512 has a provision that requires DOE to take into account "the efficiency, cost, safety and proliferation resistance of competing reactor designs." We would suggest that even more stringent factors be applied. Congress should direct DOE to consider only designs that have the potential to provide significantly greater levels of safety and security than currently operating reactors (and hence exceed NRC requirements). As a corollary, Congress should prohibit DOE from selecting designs with a business case that depends on a weakening of NRC safety and security regulations or marketing reactors to countries with inadequate safety rules.

S. 512 requires DOE to establish a program to develop designs for two SMRs and then to obtain design certifications from the NRC by January 1, 2018 and combined operating licenses by January 1, 2021. We are concerned about the establishment of statutory requirements of dates certain for the completion of licensing actions on these new reactor designs. This requirement could put undue political pressure on the NRC to accelerate its reviews of these novel technologies (if, for instance, DOE

blames the NRC for schedule delays), and potentially force it to cut short its examination of complex technical issues. It would be counterproductive to undermine the thoroughness of the review of new reactor designs, because it would be much more costly to fix problems discovered after construction has already begun. Therefore, we respectfully suggest that while the bill could instead impose a deadline on DOE to submit its licensing applications to the NRC, it should not impose a deadline on the final approval of those applications, but rather let the NRC reviews proceed at a pace determined by the technical complexity of the reviews.

We would also like to comment on S. 1067, which requires the Secretary of Energy to conduct a research program to "lower the cost of nuclear reactor systems." We suggest that the bill direct the Secretary to "conduct research to lower the cost of nuclear reactor systems while increasing their levels of safety and security." After all, one can always reduce costs by cutting corners: the real research challenge is how to reduce cost without compromising safety. Given that the Fukushima accident review may well indicate the need for additional-and potentially costly-safety requirements for both operating and new reactors, there is an acute need for research on how to enhance safety as cost-effectively as possible.

Thank you for your attention.

The CHAIRMAN. Thank you very much.

Mr. Colvin, go right ahead.

STATEMENT OF JOE COLVIN, PRESIDENT, AMERICAN NUCLEAR SOCIETY

Mr. COLVIN. Good morning. Thank you, Mr. Chairman and Ranking Member Murkowski and members of the committee.

As indicated I am here as my capacity as President of the American Nuclear Society or ANS. ANS represents the more than 11,000 men and women of the American nuclear community including utilities, national laboratories, government, State agencies, industrial vendors, suppliers, universities and the whole area of medicine. Our members have been involved with small reactors for almost the entire 55 year history of their organization including the Experimental Breeder Reactor, EBR–1, the first reactor to produce electricity in the U.S. in 1951 and with the 10 megawatt USS Nautilus reactor, the original SMR which paved the way for the nuclear navy and today's commercial water cooled reactor fleet.

The ANS and its membership believe that the development of new generation of SMRs has the potential to make a significant contribution to our long term energy, economic and national security. They offer a unique flexibility. Has been discussed earlier by Dr. Kelly, they can produce large quantities of fresh water through desalination, can be used to produce hydrogen and biofuels, deployed in remote areas to produce energy for towns and military installations, heat for mining operations and unconventional oil recovery. SMRs could also be an attractive alternative for smaller U.S. utilities, especially in the Midwest, who seek to replace old coal fired generating stations because of environmental considerations.

Today's SMR designs also employ the latest generation suite of safety features. Obviously we're all saddened by the events at Fukushima, the earthquake and tsunami, and the impact on the Japanese population as well as the world as a result of Fukushima Daiichi nuclear power plant events. In the wake of those events we must reiterate our commitment to maintaining the highest levels of safety.

Frankly, in my view the best way to improve long term nuclear safety is to hasten deployment of a new generation of reactors that

have advanced safety systems. New SMR designs employ features such as underground containment structures that can be filled with water to provide indefinite decay heat removal without external power or diesel generators, "Integral designs" that place steam generators and pressurizers within the reactor pressure vessel thereby eliminating the threat of primary coolant loop ruptures and extensive use of natural phenomena such as convection and conduction in place of pumps, valves and pipes.

There's also a national security aspect to the development of U.S. SMR technology that must be considered. Beyond the United States, over 60 countries have expressed interest in new nuclear power plants. Some of those countries already have nuclear power plants, others are developing Nations who do not have the electrical grid that can support a 1,000 megawatt nuclear plant.

While U.S. nuclear technology is still considered to be the gold standard in safety and reliability, the nuclear supply market has been increasingly international in the last 30 years. If the U.S. is unwilling or unable to develop exportable SMR technology there are several other Nations who are prepared to meet the growing demand. I believe it's clearly preferable to have the active U.S. engagement in global nuclear marketplace rather than seeding that territory to non U.S. suppliers that may always not share our approach to our safety and non-proliferation.

ANS fully supports the legislation. Although we're a 501(c)(3) organization so normally that's not—we do not normally support legislation as a process. But I can confidently say that S. 512 represents a strong foundational effort to augment the Federal Government's role in U.S. SMR development.

The 2 bills including S. 512 and S. 1067 would give DOE the additional tools to address the technical aspects of nuclear energy which have the greatest impact on installed costs. The 2 bills focus on advanced light water SMR technology which I think clearly is the next target for commercialization. I urge the committee and the Administration to keep the pedal down on Gen Four reactor technology. Both high temperature gas and liquid metal cool fast reactor systems offer true game changing potential to address long term carbon emissions and to turn nuclear waste into a clean energy fuel.

In closing I would like to offer the following observations.

It's critically important that the U.S. transition to a stable, long term energy policy emphasizes reliability, affordability, predictability in pricing, diversity of supply and well paying, domestic, job growth. Under any conceivable scenario nuclear energy will be an indispensible component of our nuclear energy future. SMR technology will likely play an increasing important role.

Thank you for the opportunity to be with you today. Thank you.

[The prepared statement of Mr. Colvin follows:]

PREPARED STATEMENT OF JOE COLVIN, PRESIDENT, AMERICAN NUCLEAR SOCIETY

Thank you, Chairman Bingaman and members of the committee for the opportunity to testify before the committee today. I am here in my capacity as President of the American Nuclear Society (ANS), the premier U.S. professional society dedicated to promoting the beneficial uses of nuclear science and technology. The ANS has roughly 11,000 national members and another 10,000 plus members of 51 local sections spread across 38 states. We also have 38 student sections at major U.S.

universities and 11 international sections in other countries. Our members span the nuclear enterprise, including: utilities, national laboratories, government and state agencies, industrial vendors and suppliers, universities, and medicine.

ANS members have been involved with small reactors for almost the entire 55 year history of the organization, including the Experimental Breeder Reactor (EBR-1), the first reactor to produce electricity in 1951, and the 10 MW USS Nautilus reactor—the original SMR—which paved the way for the nuclear navy and today's commercial water cooled reactor fleet.

More recently, through its Special Committee on SMR Generic Licensing Issues, ANS has worked with experts in the U.S. nuclear industry, universities, national laboratories, and government agencies to identify key regulatory impediments in the areas of licensing, risk informed regulation, physical security, staffing requirements, which could hinder timely deployment of a new generation of SMRs, and offered consensus solutions to address them.

My testimony today will focus on 3 main points:

1. SMRs have great potential to contribute to U.S. energy, economic and national security.
2. S. 512, the Nuclear Power 2021 Act is an important step toward the near-term deployment of U.S. SMR technology.
3. There are other SMR related technical and regulatory challenges that need to be addressed by the federal government.

1. The Potential of Small Modular Reactors

The ANS and its membership believe that the development of a new generation of small modular reactors has the potential to make a significant contribution to our long-term energy, economic, and national security. SMRs offer several unique advantages over their larger brethren.

First, they provide great operational flexibility. SMRs can be deployed in arid regions to produce large quantities of fresh water through desalination. They can be used as a heat source for industrial processes, including hydrogen production, fertilizers, production of synthetic fuels and biofuels. They can be deployed in remote areas to produce energy for towns and military installations as well as heat for mining operations and unconventional oil recovery. SMRs could be an attractive alternative for smaller U.S utilities, especially in the Midwest, who seek to replace their old, coal-fired generating stations because of environmental considerations. These facilities would already have the necessary water, rail and transmission facilities and the necessary infrastructure, thereby simplifying the installation process.

Second, new SMR designs employ the latest generation suite of safety features. Obviously we are all saddened by the Japanese earthquake and tsunami and its impact on the Fukushima Daiichi nuclear power plant. In the wake of these events, we must reiterate our commitment to maintaining the highest levels of safety.

Frankly, in my view, the best way to improve long-term nuclear safety is to hasten deployment of a new generation of reactors that have advanced safety systems. New SMR designs employ features such as underground containment structures that can be filled with water to provide indefinite decay heat removal without external power or diesel generators; "integral" designs" that place steam generators and pressurizers within the reactor pressure vessel, thereby eliminating the threat of primary coolant loop ruptures; and extensive use of natural phenomena such as convection and conduction in place of pumps, valves and pipes.

Third, there is a national security aspect to the development of U.S. SMR technology that must be considered. Beyond the U.S., over 60 countries have expressed interest in developing new nuclear energy generation capacity. While some of these countries already have existing nuclear plants, others would be new entrants, many of whom are from the developing world which do not have electrical grids that can absorb a 1 GW nuclear plant in their current configuration.

While U.S. nuclear technology is still considered to be the gold standard in safety and reliability throughout the world, the nuclear supply infrastructure has become thoroughly internationalized in the last three decades. If the U.S. is unable or unwilling to develop SMR technology which can be exported internationally as well as used domestically, there are several nations who are prepared to meet the growing global demand. I believe it is clearly preferable to have active U.S. involvement in the global nuclear marketplace, rather than ceding the territory to non-US suppliers that may not always share our approach toward safety and nonproliferation.

2. S. 512 the Nuclear Power 2021 Act

As a 501(c)(3) not-for-profit organization, the American Nuclear Society does not normally endorse congressional legislation. However, I can say confidently that S. 512, The Nuclear Power 2021 Act, represents a strong foundational effort to aug-

ment the federal government's role in U.S. SMR development. It would provide the US Department of Energy (DOE) with the authority to enter into public-private partnerships to develop and license small modular reactors. We believe this would significantly accelerate U.S. SMR reactor development in a manner that furthers U.S. environmental, foreign-policy, and economic objectives. This legislation builds on the proven success of the Nuclear Power 2010 (NP 2010) program, which expedited the design and licensing activities of the Westinghouse AP 1000 and GEH ESBWR reactors, enabled the submission of over 15 combine construction permit and operating license (COL) applications for NRC review, while attracting billions in private investment in creating tens of thousands of jobs.

3. Other challenges to SMR development/deployment

ANS encourages Congress to consider other aspects of SMR development. These include accelerating the development of SMR-related codes and standards; updates to U.S. laws and regulations that would facilitate accelerated maturation and transfer of SMR-relevant technology from the national laboratories to U.S. industry and regulators; streamlining export control laws to minimize the incentives to "off-shore" SMR component manufacturing; and integration of university-based U.S. nuclear science and engineering education programs with SMR development efforts to ensure we have technically skilled workforce to design, deploy, and operate these reactors in the future. Furthermore, I strongly encourage the U.S. Nuclear Regulatory Commission (NRC) to move forward with alacrity in addressing the outstanding generic licensing and regulatory issues, including instrumentation and control, required staffing levels, unique design features, enabling construction activities during operations, and security requirements.

In closing, I would like to offer the following observation: it is critically important that the U.S. transition to a stable long-term energy policy emphasizes reliability, affordability, predictability-in-pricing, diversity of supply and well-paying domestic job growth. Under any conceivable scenario, nuclear energy will be an indispensable component of our energy future, and SMR technology will likely play an increasingly important role.

The CHAIRMAN. Thank you for that testimony.

Dr. Bartis, go right ahead.

STATEMENT OF JAMES T. BARTIS, SENIOR POLICY RESEARCHER, RAND CORPORATION

Mr. BARTIS. Mr. Chairman and distinguished members, thank you for inviting me to testify on S. 937, the American Alternative Fuels Act of 2011. My remarks today are based on RAND studies that cover a spectrum of alternative fuels including oil shale, coal to live liquids, oil sands and biofuels. As is RAND's policy my testimony neither endorses nor opposes specific legislation.

An important finding from this body of research centers on the vastness of the resource base for alternative fuels in the United States. The largest deposits of oil shale in the world are located in Western Colorado and Eastern Utah. The potential yield is about triple the oil reserves of Saudi Arabia.

Our coal resource base is also the world's largest dedicating only 15 percent of recoverable coal reserves to coal to liquid production would yield roughly 100 billion barrels of liquid transportation fuels, enough to sustain 3 million barrels per day for more than 90 years.

Our biomass resource is also appreciable offering to yield over 2 million barrels per day of liquid fuels. Over the longer term, as we have heard earlier today, advanced research in photosynthetic approaches for alternative fuels production offers the prospect of even greater levels of sustainable production.

Our research at RAND also examined the benefits that a commercial alternative fuels industry would yield to our Nation's eco-

nomic well being and national security. In particular a national energy policy directed at:

One, promoting increased energy efficiency.

Two, the development of a commercial, alternative fuels industry would weaken the ability of the OPEC cartel to raise world oil prices by limiting production.

This benefit alone is substantial. Every $10 increase in the price of crude oil costs the average American household over $550 per year. That's because they use more than just gasoline.

Another important benefit of some alternative fuels is the reduction in life cycle, greenhouse gas emissions as compared to their petroleum counterparts. Alternative fuels have offered significant reductions include some, but not all, renewable fuels and some, but not all, fuels manufactured from a blend of coal and biomass.

Presently the legislation governing the energy policies of the United States strongly promotes the production of alternative fuels that can be derived from renewable resources. These policies have successfully promoted the extensive use of corn derived ethanol in gasoline powered vehicles. This has yielded energy security benefits but economic and environmental impacts have been mixed.

Moving beyond food derived fuel will be difficult. Production of cellulosic biofuels is well below the target set by Congress. Our examination of near term renewable oils such as seed oils and waste oils and fats indicates that the national production potential is extremely limited.

Meanwhile U.S. Federal energy policies give very little support to any alternative fuel produced from coal or for that matter, any other fossil energy source. In doing so, we forgo the opportunity to develop a domestic industry that has the potential of producing millions of barrels per day of alternative fuels that can reduce dependence on imported oil while not increasing greenhouse gas emissions. Moreover over the long term liquid fuels derived from the combination of coal and biomass could provide a new market for coal that could counter the adverse local and regionally economic impacts of reduced demand for coal in power generation due to potential future measures to reduce greenhouse gas emissions.

Our analysis indicates that there are serious misperceptions regarding the use of coal as opposed to biomass for alternative fuels production. Coal facilities do have higher capital costs, but their through put is also higher. Our research also shows that alternative fuels derived from coal or a mixture of coal and biomass have production costs that are generally more favorable when compared to those of fuels produced from most biomass resources.

While there is no doubt that additional coal mining raises safety, health and environmental issues, inappropriate production of biomass could also lead to serious, adverse environmental impacts including loss of biodiversity, diversion of water resources and water pollution. With regard to worker health and safety, agriculture ranks among the most hazardous industries. For these reasons we suggest that when framing new energy legislation Congress refrain from establishing resource specific goals and instead focus on desired outcomes such as conventional petroleum, displaced and life cycle greenhouse gas emissions. More to the point, I would suggest

consideration of revising the renewable fuels standards so that they become "the clean and secure fuels standards."

With regard to the provisions contained in S. 937, my written testimony addresses sec. 3 and sec. 5–7. My overall assessment of these sections is that enactment of any or all will not appreciably influence future alternative fuels production in the United States. To do so requires legislation that is a bit more comprehensive and that focuses on goals, as I mentioned, including environmental goals and establishes broad based mechanisms that are free of technology, resource, regional or sector bias.

This concludes my remarks. Thank you.

[The prepared statement of Mr. Bartis follows:]

PREPARED STATEMENT OF JAMES T. BARTIS[1] THE RAND CORPORATION

TESTIMONY ON S. 937 THE AMERICAN ALTERNATIVE FUELS ACT OF 2011[2]

Chairman and distinguished Members: Thank you for inviting me to testify on S. 937, the American Alternative Fuels Act of 2011. I am a Senior Policy Researcher at the RAND Corporation with over 30 years of experience in analyzing and assessing energy technology and policy issues. At RAND, I have been actively involved in research directed at understanding the costs and benefits associated with the use of domestically abundant resources, such as coal, oil shale and biomass, to lessen our nation's dependence on imported petroleum. The findings that I will discuss today are drawn from studies sponsored and funded by the National Energy Technology Laboratory (NETL) of the U.S. Department of Energy, the United States Air Force, the Federal Aviation Administration, the National Commission on Energy Policy, the U.S. Chamber of Commerce, and the Defense Logistics Agency.

Today, I will discuss the strategic importance of alternative fuels and our assessment of the most promising candidates for near-term production. I will also specifically address sections 3 and 5 through 7 of S. 937. These are the sections of the proposed legislation where I hope to provide useful insights to the committee based on our recent research on alternative fuels and energy security.

The Importance and Value of Alternative Fuels

The United States' consumption of liquid fuels is about 19 million barrels per day (bpd). Meeting this demand requires importing about 10 million bpd of petroleum, mostly in the form of crude oil. In a world that consumes about 85 million bpd of petroleum products, the United States holds first place in total consumption and in the magnitude of its imports.

Currently the average price of crude oil imports is over $105 per barrel. At these prices, oil imports will cost U.S. oil consumers nearly $400 billion per year. Considering both direct and indirect expenditures for energy, each $10 per barrel increase in the price of world oil costs the average U.S. household over $550 per year.

The national security consequences of the dependence of the United States, and its allies and trading partners, on imported oil are well-documented.[3] All oil consumers are vulnerable to increased prices for oil when oil exporters are able to reduce supplies on the world oil market. Most serious would be the economic impact of a large and extended disruption in global oil supplies as a result of conflict or natural disaster. There is also the problem of wealth transfers to the governing regimes of some oil exporting nations, such as Libya, Venezuela and Iran, that pursue policies that run counter to the national security interests of the United States and its allies. When oil prices are high, these nations have more funds to invest in pur-

[1] The opinions and conclusions expressed in this testimony are the author's alone and should not be interpreted as representing those of RAND or any of the sponsors of its research. This product is part of the RAND Corporation testimony series. RAND testimonies record testimony presented by RAND associates to federal, state, or local legislative committees; government-appointed commissions and panels; and private review and oversight bodies. The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors.

[2] This testimony is available for free download at http://www.rand.org/pubs/testimonies/CT364/.

[3] Imported Oil and U.S. National Security, Crane et al., Santa Monica, Calif.: RAND Corporation, MG-838-USCC, 2009.

chasing armaments and building their own industrial bases for manufacturing munitions. High oil prices also provide more funds that may eventually find their way to large terrorist organizations such as Hamas and Hizballah.

Alternative fuels are already being produced in many countries. Examples include corn-derived ethanol in the United States and sugar-derived ethanol in Brazil, synthetic crude from oil sands in Canada, coal-to-liquids production in South Africa, natural gas-to-liquids production in Qatar and Malaysia, and small amounts of biodiesel production in the United States and Europe. Expanding alternative fuels production beyond these initial efforts would offer economic and national security benefits to the United States. Because it provides a substitute for products refined from crude oil, increased production of alternative fuels will reduce demand for crude oil, resulting in lower world oil prices to the direct benefit of all oil consumers. Lower world oil prices and greater supply diversity also mitigate the adverse national security impacts of imported oil.

About 45 percent of the operating refinery capacity of the United States is located in the hurricane-prone states of Texas, Louisiana, and Mississippi. Because alternative fuels production would likely occur in diverse locations throughout the United States, a domestic alternative fuels industry would improve the resiliency of the petroleum supply chain, especially against natural disasters. Increasing the geographical diversity of fuels production implies that a smaller fraction of supplies would be affected by any natural disaster. As such, we anticipate less economic disruption as the remaining supplies are allocated to users.

For certain alternative fuels, another important benefit could be a reduction in lifecycle greenhouse gas emissions, as compared to their counterparts produced from conventional petroleum. Alternative fuels that offer significant reductions include some, but not all, types of renewable fuels and fuels manufactured from a blend of coal and biomass.

But if alternative fuels are to achieve these economic, security, and environmental benefits, combined global and domestic production of alternative fuels must be an appreciable fraction of global and domestic demand for liquid fuels. Specifically, the need is for an alternative fuel portfolio that can competitively produce millions of barrels per day in the United States. Alternative fuel advocates often use gallons per year when describing production potential. For perspective, one million barrels per day is 15.3 billion gallons per year.

An important finding from our research in alternative fuels is that the United States has resources that could be used to produce alternative fuels at a rate of millions of barrels per day. The largest deposits of oil shale resources in the world are located primarily in western Colorado and eastern Utah. The potential yield is about triple the oil reserves of Saudi Arabia. Our coal resource base is also the world's largest. Dedicating only 15 percent of recoverable coal reserves to coal-to-liquid production would yield roughly 100 billion barrels of liquid transportation fuels, enough to sustain production of three million barrels per day for more than 90 years. Our biomass resource base is also appreciable, offering to yield over two million barrels per day of liquid fuels. And over the longer term, advanced research in photosynthetic approaches for alternative fuels production offers the prospect of even greater levels of sustainable production.

Presently, mining in the United States produces about 1.1 billion tons of coal per year. Nearly all of this production is directed at the generation of electric power. Coal's future in power generation will depend on whether the United States adopts measures to control greenhouse gas emissions. If such measures are implemented, it is very likely that the level of coal mining will decrease, with potential adverse economic impacts in traditional coal mining areas. Using coal to make liquid fuels, especially when combined with biomass so that greenhouse gas emissions are favorable, provides not only the economic and national security benefits associated with reducing dependence on imported oil, but also a new market for coal that could counter the adverse local and regional economic impacts of reduced demand for coal in power generation.

Assessment of Alternative Fuels

The Duncan Hunter National Defense Authorization Act for Fiscal Year 2009 contained a provision calling for the Secretary of Defense to select a federally funded research and development center (FFRDC) to conduct a study of the use of alternative fuels in military vehicles and aircraft. Responding to Congress, the Department of Defense asked the RAND National Defense Research Institute, an FFRDC, to conduct an examination of alternative fuels for military applications. Our report on this study was published and delivered to the Secretary of Defense and Congress

in January 2011.[4] As part of that study, RAND researchers examined the opportunities to produce alternative fuels in a way that reduces lifecycle greenhouse gas emissions relative to emissions from the production and use of the petroleum products that they would replace.

Because this Congressionally-mandated study was directed at military applications, we focused our attention on alternative fuels that could substitute for jet fuel, diesel fuel, and marine distillate fuel, since these are the major liquid fuels consumed by military aircraft, ships, ground vehicles, and associated combat support systems. These fuels are often referred to as distillate fuels to distinguish them from the more volatile and more easily ignited gasoline used in spark-ignition automobiles.

As a group, distillate fuels account for over 95 percent of military fuel purchases, which are currently averaging about 340,000 barrels per day. Distillate fuels are also important in the civilian sector, fueling the trucking industry and commercial aviation and serving as an important home heating fuel in some parts of the United States. Current consumption of distillate fuels in the United States is about 5 million bpd. For comparison, recent gasoline demand is running at slightly below 9 million bpd.

While the emphasis of our assessment of alternative fuels was on military applications, our results also apply to alternative fuels that could displace petroleum-derived distillate fuels that are used in civilian application. Note, however, that as part of this Congressionally-mandated study, we did not examine options for producing alternative fuels that can substitute for gasoline, such as alcohol fuels. For safety and operational reasons, these more volatile fuels are not appropriate for military applications. Since RAND has not conducted an in-depth examination of alcohol fuels, my remarks today will not cover this family of fuels.

Also included here is a brief statement regarding the oil shale resources located in the Green River Formation of Colorado, Utah, and Wyoming. Here our findings derive from the RAND 2005 examination of oil shale and our continuing monitoring of progress in this area.[5]

Fischer-Tropsch fuels are the most promising near-term options for producing middle distillate fuels cleanly and affordably.—The Fischer-Tropsch (FT) method was invented in Germany in the 1920s. It can produce alternative liquid fuels that can substitute for petroleum derived civilian and military fuels, including civilian and military jet fuels, marine fuels, and automotive diesel fuel, and home heating oil. Generally, gasoline is produced as a co-product in FT facilities, and one commercially proven variant can be configured to produce only gasoline. The method accepts a variety of feedstocks. For example, a commercial facility operating in South Africa uses coal, one operating in Qatar uses natural gas, and forest product firms in the United States are examining the viability of small facilities that would use biomass. Blends of up to 50 percent FT-derived jet fuel and petroleum-derived jet fuel have been certified for use in commercial aircraft. Ongoing work by the services strongly suggests that appropriately formulated FT fuel blends can be safely used in tactical military systems as well.

Both coal and biomass are abundant in the United States. Together, they are sufficient to support a multimillion-barrel-per-day alternative fuel industry based on FT fuels. But if FT fuel production is to occur without compromising future national goals to control greenhouse gas emissions, the following must hold:

- For biomass-derived FT fuels, the biomass feedstock must be produced in a sustainable manner; specifically, its production should not be based on practices that lead to sizable emissions due to direct or indirect changes in land use. If this is achieved, lifecycle greenhouse gas emissions can be near zero.
- For coal-derived FT fuels, carbon dioxide emissions at the FT fuel production facility must be captured and sequestered. If this is achieved, lifecycle emissions can be in line with those of petroleum-derived fuels.
- For FT fuels derived from a mixture of coal and biomass, carbon dioxide capture and sequestration must be implemented. The biomass must also be produced in a sustainable manner. If this is achieved, lifecycle emissions can be less than half those of petroleumderived fuels. For example, a feedstock consisting of a 60/40 coal/biomass blend (by energy) should yield alternative fuels with lifecycle greenhouse gas emissions that are close to zero.

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[4] Alternative Fuels for Military Applications, Bartis and Van Bibber, Santa Monica, Calif.: RAND Corporation, MG969-OSD, 2011.

[5] Oil Shale Development in the United States: Prospects and Policy Issues, Bartis et al., Santa Monica, Calif.: RAND Corporation, MG 414-NETL, 2005.

The preceding approaches can result in FT fuels with lifecycle greenhouse gas emissions that are less than or equal to those of their petroleum-derived counterparts and thereby fuels that are eligible for government purchase per the provisions of section 526 of the Energy Independence and Security Act of 2007.

Considering economics, technical readiness, greenhouse gas emissions, and general environmental concerns, FT fuels derived from a mixture of coal and biomass represent the most promising approach to producing amounts of alternative fuels that can meet military, as well as appreciable levels of civilian, needs by 2030. But whether this technology will reach its potential depends crucially on gaining early production experience-including production with carbon capture and sequestration-in the United States. To our knowledge, no agency of the U.S. government has announced plans to promote early commercial use of FT fuels derived from a mixture of coal and biomass.

It is highly uncertain whether appreciable amounts of hydrotreated renewable oils can be affordably and cleanly produced within the United States or abroad.—Hydrotreated renewable oils are produced by processing animal fats or vegetable oils (from seed-bearing plants such as soybeans, jatropha, or camelina) with hydrogen. Various types of algae have high oil content and are another possible source of oil for hydrotreatment. Fifty-fifty blends of hydrotreated oils have already been successfully demonstrated in flight tests sponsored by the commercial aviation industry. Laboratory analyses and testing strongly suggest that hydrotreated renewable oils can also be formulated for use in the Department of Defense's tactical weapon systems. Technical viability is not an issue.

The problem lies in uncertainties regarding production potential and commercial viability, especially affordability and lifecycle greenhouse gas emissions. Animal fats and other waste oils may offer an affordable low-greenhouse-gas route to hydrotreated renewable oils. But these fats and waste oils are also traditionally used in other nonfuel applications, including animal feed additives and the manufacture of soaps, household cleaners, resins, and plastics. Because the supply of these feedstocks is limited, substitutes would need to be found for use in these other applications. These substitutes may cause additional greenhouse gas emissions. Production potential is also a significant issue with animal fats and waste oils: The available supply of these feedstocks will likely limit production to no more than 30,000 barrels per day.

With regard to feedstock vegetable oils, to keep lifecycle greenhouse gas emissions at levels lower than those of petroleum-derived fuels, these oils must be derived from crops that do not compete with food production and that minimize nonbeneficial direct and indirect changes in land use. Jatropha and camelina are often mentioned as ideal plants to meet these requirements, but there exists little evidence to back these claims. Even if low-greenhouse-gas approaches can be established and verified, total fuel production is likely to be limited. Producing just 200,000 barrels per day (about 1 percent of daily U.S. petroleum consumption) would require an area equal to about 10 percent of the croplands currently under cultivation in the United States.

Advanced approaches, such as photosynthetic approaches using algae or other microbes as a feedstock, may yield renewable oils without the limitations and adverse land-use changes associated with seed oils. But all of these advanced approaches are in the early stages of the research and development (R&D) cycle. Large investments in R&D will be required before confident estimates can be made regarding production costs and environmental impacts. Considering (1) the very limited production potential for fuels derived from animal fats and waste oils, (2) the highly uncertain prospects for affordable, low greenhouse-gas fuels derived from seed crops, and (3) the early development status of algae/microbe-based concepts, renewable oils do not constitute a credible, climate-friendly option for meeting an appreciable fraction of civilian or military fuel needs over the next decade. Because of limited production potential, fuels derived from animal fats, waste oils, and seed oils will never have a significant role in the larger domestic commercial marketplace. Algae/microbe-derived fuels might, but technology development challenges suggest that algae/microbe-derived fuels will not constitute an important fraction of the commercial fuel market until well beyond the next decade. This assessment holds for algae-derived fuels based on photosynthetic energy conversion or based on the conversion of cellulosic biomass. Algae-derived fuels based on the conversion of sugars compete with food production and are not a sustainable source of liquid fuels.

The prospects for oil shale development in the United States remain uncertain.—With regard to oil shale, most of the high-grade shale is on federal lands. Six years ago, when we published our examination of oil shale, we concluded that the prospects for development were uncertain. They remain so today. The Bureau of Land Management has made available small amounts of acreage so that private firms can

perform research and development and demonstrate technology performance before committing to the construction of full-scale commercial plants. It is our understanding that privately-funded research activities are ongoing but that no private firm is prepared to commit to commercial production. Meanwhile, the Department of the Interior has announced a review of the commercial rules for the development of oil shale resources on public lands. In part, this review will examine approaches for assuring a fair return for providing access to oil shale lands. This part of the review is consistent with recommendations provided by RAND to the Congress in 2007.[6] The key to progress lies in formulating a land access and incentive policy that rewards those private firms willing to take on the substantial risks associated with investing in pioneer production facilities. It would not be advisable to develop detailed regulations that would pertain to full-blown commercial development until more information is available on process performance and impacts.

Comments on S. 937

The remainder of my testimony is focused on specific sections of S. 937.

Section 3. Repeal of Unnecessary Barriers to Domestic Fuel Production

Section 3 would repeal section 526 of the Energy Independence and Security Act of 2007 as well as section 1112 of the National Aeronautics and Space Administration Authorization Act of 2008.

Section 526 prohibits federal agencies from entering into a contract for procurement of an alternative fuel or a fuel from an unconventional petroleum source unless the contract specifies that the lifecycle greenhouse gas emissions of that fuel are less than the equivalent product produced from conventional petroleum. The only exception would be for alternative fuels purchased for the purposes of research and fuel testing.

As enacted, section 526 places severe restraints on the government's ability to purchase fuels. It would prohibit the government from purchasing any mobility fuel that might be derived in part or whole from coal, oil shale, oil sands, or biofuels without a certification from the fuel supplier regarding lifecycle greenhouse gas emissions. To my knowledge, section 526 has not been applied to biofuels, even though biofuels can have lifecycle greenhouse gas emissions that are higher than the equivalent product produced from conventional petroleum.

Since passage of section 526, the main concern has been whether the law prohibits government purchases of fuels that might be derived in part from Canadian oil sands. If this were the case, the government would be unable to purchase fuels from a growing number of commercial fuel vendors. With less competition, it is reasonable to expect that the government would incur increased costs. Additionally, the Defense Department may find it difficult or very costly to purchase aviation fuel in South Africa or Qatar, where alternative fuels from coal and natural gas are likely to be blended with conventional fuels.

To remedy this problem, Congress in 2010 passed legislation (Public Law 111-314, Sec 30210) that provides an exception to the fuel purchase prohibitions of section 526. That exemption apparently allows government purchases of commercially available fuels that might in part be derived from alternative fuels so long as three conditions hold. The language of section 30210 is unclear, so my interpretation of Public Law 111-314 as providing a remedy to the more onerous provisions of section 526 may be incorrect.

Repeal of section 526 would remove any confusion regarding the exemptions to constraints on government purchases of mobility fuels. It would also allow agencies to continue their current practice of purchasing biofuels, such as corn-derived alcohol fuels and biodiesel, without regard to lifecycle greenhouse gas emissions. Finally, it would allow federal procurement of alternative fuels such as coal-derived liquids, natural gas-derived liquids, and fuels produced from oil shale without regard to lifecycle greenhouse gas emissions.

The primary policy issue raised by repeal of section 526 is whether it is in the national interest to allow government agencies to promote the production of alternative fuels that have lifecycle greenhouse gas emissions that are significantly higher than their petroleum counterparts. For example, repeal of section 526 would open the door to a government procurement of coalderived liquids produced without managing greenhouse gas emissions.

If Congress is concerned with the limitations and continued uncertainties associated with the implementation of section 526, I suggest consideration of legislation

[6] "Policy Issues for Oil shale Development," Testimony by James T. Bartis presented before the House Natural Resources Committee, Subcommittee on Energy and Mineral Resources, April 17, 2007. Available for download at http://www.rand.org/pubs/testimonies/CT279.

that would clarify the meaning of Section 30210 of Public Law 111-314 so that the government is not prohibited from purchasing commercial fuels derived in part from alternative fuels or oil sands. Congress should also clarify whether section 526 prohibitions apply to biofuels.

If the intent of Congress is to promote the early production of alternative fuels with greenhouse gas emissions that are comparable or better than those of their petroleum counterparts, I suggest consideration of an amendment to section 526 that would allow the government to target purchases of alternative fuels derived from fossil fuel resources (such as coal, natural gas, or oil shale) if 90 percent of greenhouse gases produced during the alternative fuel production process are captured and sequestered or if lifecycle greenhouse gas emissions are no more than five percent above the lifecycle greenhouse gas emissions of their petroleum counterparts. This suggested amendment would still require management of greenhouse gas emissions, but it would significantly reduce the costs of building and operating pioneer alternative fuels facilities that are based on coal, stranded natural gas resources in Alaska, and possibly oil shale.

Section 5. Algae-Based Fuel Incentives

Section 5 would modify a portion of the Clean Air Act that governs the implementation of the Renewable Fuel Standard program managed by the Environmental Protection Agency (EPA). This program forces the use of government-selected fuels in the transportation sector. It provides unknown, but potentially very high, levels of subsidies to certain renewable fuel producers, but works in a way that the total costs borne by the public are hidden. These hidden costs include not only increased prices at the pump but also at the supermarket. Finally, this program puts government in the position of picking technology winners irrespective of whether these technologies offer environmental or energy security benefits.

Under section 5, each gallon of algae-based fuel would basically receive a triple subsidy if it were produced using carbon dioxide from an energy production process that would otherwise release that carbon dioxide into the atmosphere. section 5 does not define an "energy production process." Possible candidates include electric generating plants that use fossil or biofuels, oil refineries, alternative fuel production facilities, and natural gas processing plants.

Section 5 applies to algae that use sunlight to convert carbon dioxide to oils that are similar to vegetable oils. These oils can be converted to a biodiesel or can be treated with hydrogen so that they are interchangeable with conventional diesel or jet fuel. The technical viability of producing useful fuels from algae has been established for some time. The big unknown is whether these fuels can be produced at costs that are competitive, or even in the ballpark, with conventional fuels. Over the past two years, we have closely examined this issue. Our finding is that photosynthetic approaches to algae appear very promising, but that at this time algae-derived fuel is a research topic, not an emerging fuel option.

EPA has published its renewable fuel standards for 2011. From their Notice of Final Rulemaking, it is clear that the rule requires the use of fuels from small experimental facilities. This could lead to fuel refiners and importers paying very high premiums i.e., over $10 per gallon for certain renewable fuels. These additional costs will likely be passed to consumers. If EPA continues to apply this logic, any small pilot or demonstration plant built for the purpose of understanding scale-up and operational issues would be transformed into a commercial production facility. The same would apply to pre-commercial algae-derived fuel production facilities, including those being built with federal funds.

If this were a direct government expenditure, many would doubt that subsidies in the range of $10 to $30 per gallon are appropriate. Considering that commercially viable photosynthetic algae production is many years in the future, a more productive approach in accelerating this technology is direct investment in research and development.

Overall, the net effect of section 5 will be a transfer of wealth from fuel consumers to firms trying to develop algae-derived fuel. It is difficult to see how these subsidies and this approach will have any impact over the next decade on the rate of development of a commercially viable industry.

Section 6. Loan Guarantees

This section would amend the Energy Policy Act of 2005 so that eligibility for DOE loan guarantees would include facilities that produce a fuel that can substitute for natural gas using a solid feedstock, provided that at least 90 percent of the carbon produced through the gasification process is captured. Since any renewable energy projects already qualify for loan guarantees, the net effect of this amendment

would be to extend the coverage of the loan guarantee program to projects that use coal, or possibly oil shale, to make a substitute natural gas.

Considering the resource estimates and recovery costs for shale gas, it is highly unlikely that any firm will consider using any solid, non-renewable feedstock to produce natural gas as a primary product. Oil shale production facilities might produce natural gas as a by-product, although it is not clear whether such production would cause them to qualify for a loan guarantee. Overall, it is highly unlikely that enactment of this section will have any impact, positive or negative, on energy production in the United States.

Section 7. Multi-year Contract Authority for Department of Defense For Procurement of Alternative Fuels.

The main benefit would be to allow the use of the purchasing power of the Defense Department for the promotion of early commercial experience in the production of alternative fuels. The "Required Provisions" within section 7 make it fully consistent with the findings of our research on alternative fuels for military applications. Specifically, our analysis suggests that a cost-effective approach, considering both government and industry perspectives, would be one in which:

- the Defense Department would commit to purchase alternative fuels that meet military specifications at a specified floor price;
- the alternative fuels producer would commit to sell alternative fuels that meet military specifications to the Department according to a specified formula that would basically set a ceiling price; and
- the Department's purchase price would be set using a market-based formula when prices for the corresponding petroleum-derived fuels are between the floor and the ceiling.

This arrangement places a collar on the prices of some fraction of the fuels that would be produced by an alternative fuels production facility. In return for guaranteeing a minimum sale price to the benefit of the producer in the event that world oil prices are low, the Department would be guaranteed a maximum purchase price that would be lower than world oil prices in the event that world oil prices pass a specified threshold. Such arrangements appear to be allowed and meet the provisions of section 7 that call for "pricing mechanisms to minimize risk to the Federal Government from significant changes in market prices for energy."

This arrangement would have the added benefit of promoting the use of coal-derived liquids in applications where they have the greatest value. In particular, most military applications involve the use of high sulfur jet fuel in turbine engines. These applications place no value on the high cetane number and near-zero sulfur levels of hydrotreated renewable fuels and Fischer-Tropsch fuels.

In closing, I thank the committee for inviting me to testify. I hope the foregoing analysis of policy issues is useful to your deliberations.

The CHAIRMAN. Thank you very much.

Mr. Siu, go right ahead.

STATEMENT OF BRIAN SIU, POLICY ANALYST, NATURAL RESOURCES DEFENSE COUNCIL

Mr. SIU. Chairman Bingaman, Ranking Member Murkowski and members of the committee, thank you very much for today's opportunity to testify on the subject of S. 937. My name is Brian Siu and I'm a policy analyst for the Natural Resources Defense Council. NRDC is a national, non-profit organization dedicated to the protection of public health and the environment.

There is no doubt that our sources of conventional liquid fuel have become increasingly problematic. We are reminded of this every time events beyond our control drive price volatility. Thus it is with good reason that the Nation is in search of energy efficiency in alternative fuels. It is vitally important not to let the urgency that we all feel distorts sound, long term judgment driving investments that are ultimately more harmful than the ones we have today.

Today I'll focus my comments on 3 provisions of the American Alternative Fuels Act that increase the likelihood of such mistakes.

The first of these provisions would repeal section 526 of the Energy Independence and Security Act of 2007. NRDC strongly opposes efforts to repeal this reasonable protection that ensures that the Department of Defense and other Federal agencies do not exacerbate climate change by buying fuels with higher greenhouse gas emissions than conventional fuels. It is noteworthy that section 526 does not categorically prohibit any fuel source nor does it require emissions to even decline, it simply ensures that the Federal Government does not commercialize environmentally flawed technologies that make no effort to reign in their carbon pollution to at least parity with conventional petroleum. Such restrictions are necessary given scientific concern that rising temperatures will induce higher sea levels, migration of invasive species, disease factors and severe weather incidents.

The link between climate change and national security is another strong reason to preserve section 526. I do not profess to be a military expert, but take them at their word when they cite the climate change's numerous liabilities. Highly credentialed organizations such as the National Intelligence Council, the Center for Naval Analysis and the Pentagon have all noted that climate change can act as an accelerant of instability drive humanitarian crises, tax military resources and less readiness and threaten coastal installations.

Placed in this context section 526 is largely about accountability. Removing it would allow fuel producers to access public funds without making any effort to mitigate these well acknowledged, public concerns. By contrast, preserving section 526 sends a signal that new fuel technologies must balance energy, environment and climate security.

Next Section 7 of 937 empowers DOD to enter 20 year contracts for alternative fuels. For emerging fuel technologies long term contracts are viewed as a way to mitigate risk by establishing a known and stable revenue stream. NRDC agrees that some form of genuinely low carbon fuel is desirable for environment and supply. However this provision does not encourage such fuels and would have the opposite effect.

First, it acts in conjunction with repealing section 526 to wipe long term financial support for fuels that are vastly more destructive than today's.

Second, the language fails to ensure that potentially beneficial fuels do not also accrue unacceptably high ecological costs.

While emerging biofuels may provide sustainable options for aviation and ground transport careless development can also lead to a range of consequences such as water quality deterioration, greenhouse gas emissions and habitat loss. Given that possibility, eligibility guidelines must help minimize unintended consequences. Unfortunately no such guidelines are set here.

Finally, section 8 of 937 would amend the determination of best available control technology or BACT, under the Clean Air Act by allowing emissions reductions from electric vehicles to be taken into account. The BACT requirement is designed to ensure that newer, modified major facilities minimize their emissions of regu-

lated air pollutants like sulfur dioxide, particulates, oxides of nitrogen and mercury as well as carbon pollution.

NRDC has serious concerns with introducing offsets into the BACT determination process since it would allow power plants to forgo available technology to control emissions that are dangerous to human health. In doing so, it risks failing to protect those whose health would be adversely affected by increasing power plant emissions since there's really no guarantee that offsite emission reductions would geographically match increased power plant pollution. In those cases air quality from some local businesses and residents would be allowed to deteriorate simply because it improved elsewhere.

In conclusion fuel policy must include protections to hedge against significant environmental harms. Unfortunately no such protections appear in S. 937. Once again, NRDC thanks you for the opportunity to present its views. I'm happy to answer questions. Thank you.

[The prepared statement of Mr. Siu follows:]

PREPARED STATEMENT OF BRIAN SIU, POLICY ANALYST, NATURAL RESOURCES DEFENSE COUNCIL

Chairman Bingaman, Ranking Member Murkowski and members of the committee, thank you for today's opportunity to testify on the subject of Senate bill 937. My name is Brian Siu. I am a policy analyst for of the Natural Resources Defense Council (NRDC). NRDC is a national, nonprofit organization of scientists, lawyers and environmental specialists dedicated to protecting public health and the environment. Founded in 1970, NRDC has more than 1.2 million members and online activists nationwide, served from offices in New York, Chicago, Washington, Los Angeles and San Francisco.

S. 937 would amend several existing laws in an effort to promote alternative transportation fuels. While the bill may be well intentioned, NRDC maintains that many of its provisions will have unintended consequences that outweigh any expected benefits. Today, I will focus my comments on three key provisions. The first of these provisions is the proposed repeal of section 526 of the Energy Independence and Security Act of 2007 (EISA). The second allows the Defense Department (DoD) to enter 20 year procurement contracts for alternative fuels. Finally, the third provision requires state and federal agencies that issue construction permits for major new or modified power plants under the Clean Air Act to consider on-road pollution reductions due to electric vehicle deployment when determining best available control technology.

Section 526 of the Energy Independence and Security Act of 2007 Should Remain in Place

There is no doubt that our sources of conventional liquid fuel have become increasingly problematic. We are reminded of this every time geopolitical unrest, natural events or developments beyond our control drive price volatility. Thus, it is with good reason that the nation is in search of energy efficiency and alternative fuels. But it is vitally important not to let urgency distort sound long term judgment, leading to investments that cause more harm than good. Section 3 of the American Alternative Fuels Act increases the likelihood of such mistakes by repealing section 526 of EISA. NRDC strongly opposes efforts to weaken or remove this reasonable, common sense protection.

Put simply, section 526 disallows federal agencies from procuring alternative fuels that have higher lifecycle greenhouse gas emissions than conventional petroleum products. It is noteworthy that section 526 does not categorically prohibit any type of fuel nor does it require emissions to actually decline. It simply ensures that federal government does not exacerbate climate change by expanding or commercializing high carbon technologies before measures are taken to capture and dispose the carbon pollution. While section 526 applies to all federal agencies, the Department of Defense is the largest federal purchaser of fuel. In the past, the United States Air Force was eager to develop liquid coal fuels. section 526 prevented DoD

from leveraging its significant procurement power to commercialize those fuels unless the emissions were managed responsibly.

There are strong environmental reasons to avoid expanding or commercializing high carbon fuels. The increased carbon loadings associated with these fuels would accelerate global warming and its catastrophic consequences. There is broad scientific concern that rising temperatures will induce higher sea levels, shifting disease vectors, migration of invasive species, and severe weather incidents.

To help avoid these consequences, the United States and other nations will need to deploy energy resources that release lower amounts of carbon pollution than today's use of oil and gas. To keep global temperatures increases from causing widespread environmental and economic harm, we need to get on a pathway now to allow us to cut global warming emissions significantly from today's levels over the decades ahead. The technologies we choose to meet our energy needs in the transportation sector and in other areas must have the potential to perform at greatly improved emission levels. Unfortunately, high carbon fuels such as liquid coal, tar sands, and oil shale do not have a role in that scenario. Liquid coal without carbon capture and storage, for instance, produces approximately double the carbon pollution as conventional petroleum fuel over the full product lifecycle.

The good news is that others in the transportation sector plan to reduce their emissions of greenhouse gases. Pursuant to the Administration's vehicle efficiency and carbon pollution standards, for instance, auto companies will achieve an equivalent of 35.5 miles per gallon by 2016. According to the Environmental Protection Agency, the 2012-2016 standards will avoid 960 million metric tons of greenhouse gas emissions that would have otherwise been emitted into the atmosphere.[1] As the auto and other economic sectors endeavor to reduce carbon emissions, unchecked high carbon fuel facilities could offset their achievements. In the interests of consistency and fairness, federal government should not assist these fuels to mass market, especially when no measures are taken to bring emissions into alignment with even conventional fuels.

There are other substantial environmental reasons to avoid these technologies. Fuels such as liquid coal and tar sands tend to impose significant upstream impacts as a result of feedstock extraction. These are difficult to avoid, especially as the industry scales up. For instance, it requires nearly half a ton of coal to produce one barrel of liquid coal. Thus, establishing a mature liquid coal industry, perhaps at 3 million barrels per day, would greatly increase coal mining. Meeting those levels would require roughly 550 million additional tons of annual coal production.[2] By comparison, the Energy Information Administration estimates that the United States mined just over one billion tons of coal in 2009.[3] Thus, a significant liquid coal industry might increase mining activity by roughly 50% over today's levels.

The environmental consequences would be tremendous. Today, coal mining is already responsible for a range of environmental harms including biodiversity loss, mountaintop removal, groundwater contamination and loss of natural heritage. To be certain, coal plays a major role in America's power production and will for some time. But few believe this energy source is benign. As we evaluate our liquid fuel options, we must remember that the decisions we make today will have growing implications for decades to come. We must therefore prioritize resources that achieve balance between energy supply and environmental sustainability while avoiding fundamentally flawed technologies that are not already in use today.

The recognized link between climate change and national security is yet another reason to preserve section 526. In recent years, many military and security experts have noted that increased temperatures, droughts, and extreme weather events could exacerbate political tension and resource competition in some of the world's volatile regions. Moreover, military experts have expressed concern that elevated seal levels threaten coastal installations as well as the supporting industries. Here are direct quotations from national security voices with impeccable credentials:

- In 2008, the National Intelligence Council noted that "As climate changes spur more humanitarian emergencies, the international community's capacity to respond will be increasingly strained. The United States, in particular will be called upon to respond. The demands of these potential humanitarian responses may significantly tax US military transportation and support force structures,

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[1] Environmental Protection Agency, "EPA and NHTSA Finalize Historic National Program to Reduce Greenhouse Gases and Improve Fuel Economy for Cars and Trucks", April 2010.

[2] James Bartis et al, Producing Liquid Fuels from Coal, RAND Corporation, 2008.

[3] Energy Information Administration, Annual Energy Review 2009, August 2010.

resulting in a strained readiness posture and decreased strategic depth for combat operations."[4]

- In 2008, the National Intelligence Council also found that "A number of active coastal military installations in the continental United States are at a significant and increasing risk of damage, as a function of flooding from worsened storm surges in the near-term. In addition, two dozen nuclear facilities and numerous refineries along US coastlines are at risk and may be severely impacted by storms."[5]
- In 2009, the Center on Naval Analysis found that "Destabilization driven by ongoing climate change has the potential to add significantly to the mission burden of the U.S. military in fragile regions of the world" and that "the U.S. should not pursue energy options inconsistent with the national response to climate change."[6]
- In 2010, the Pentagon Quadrennial Defense Review stated that although "climate change alone does not cause conflict, it may act as an accelerant of instability or conflict, placing a burden to respond on civilian institutions and militaries around the world. In addition, extreme weather events may lead to increased demands for defense support to civil authorities for humanitarian assistance or disaster response both within the United States and overseas."[7]

Placed in this context, section 526 is largely about accountability. It simply ensures that alternative fuel providers do not benefit from federal procurement initiatives if their products make addressing these risks even more difficult than they already are. Stated another way, removing section 526 would allow fuel producers to access public coffers without at least making efforts to mitigate these well acknowledged national concerns.

Finally, repealing section 526 sends the wrong signal to the broader economy. Even if the DoD chooses not to pursue high carbon fuels due to previously noted concerns, repealing the provision would increase tolerance for these types of fuels. A signal that increasingly harmful fuels are now endorsed by the federal government could help encourage investments that are wholly incompatible with the need to reduce carbon pollution and harmful extractive practices while drastically reducing opportunities in cleaner, sustainable fuels that that provide a wider array of benefits.

Long Term Contracting Provisions must Include Environmental Protections

Section 7 of the American Alternative Fuels Act empowers the Department of Defense to enter 20-year contracts for alternative fuels. As written, NRDC opposes this provision since it fosters alternative fuels without the necessary safeguards to avoid unacceptable environmental costs.

Current regulations limit the Department of Defense from entering into fuel procurement contracts that exceed a five year period. But there has been growing interest in extending the contracting window. This is because many emerging technologies pose high risk due to initial technology costs and lack of commercial experience. In the past, long term fixed price contracts have been viewed as a way to mitigate those risks by establishing a known and stable revenue stream. It is believed that this certainty will help attract private capital for the project.

NRDC agrees that some form of genuinely low carbon alternative fuel is desirable for both environmental and energy security reasons. However, this provision falls short of encouraging such fuels and could easily function to the opposite effect. First, the provision acts in conjunction with repealing section 526 to provide long term financial support for fuels that are more destructive than today's. Secondly, the language fails to set any environmental parameters that ensure alternative fuels do not create unacceptably high ecological costs. NRDC does not categorically oppose these forms of support, so long as the resulting fuels are consistent with public health, climate science and environmental protection. But the long term contracting provision in this bill appears to create a pathway for unchecked high carbon, high impact fuels.

As an example, I will once again use liquid coal to describe the risk. Liquid coal facilities are large, centralized and capital intensive. By some estimates, the invest-

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[4] June 25, 2008: House Permanent Select Committee on Intelligence & House Select Committee on Energy Independence and Global Warming: Statement for the Record by Dr. Thomas Fingar, Deputy Director of National Intelligence for Analysis—National Intelligence Assessment on the National Security Implications of Global Climate Change to 2030

[5] ibid.

[6] Center for Naval Analysis, Powering America's Defense: Energy and the Risks to National Security, May 2009.

[7] U.S. Department of Defense, Quadrennial Defense Review, February, 2010.

ment costs might approach $125,000 per barrel of daily production capacity.[8] Indeed, recent cost estimates for proposed commercial scale projects exceed billions of dollars per facility. Given these costs, a long term contract, or even the possibility of such an arrangement could go a long way towards assuring investors that the project can generate profitable returns over a significant portion of the operating life.

Yet for reasons we have already discussed, federal agencies should not help deploy technologies that undermine climate and environmental priorities. Instead, these types of supports should be reserved for fuels that strike balance between security, environmental and climate concerns. These parameters will foster new fuel technologies that respond to, rather than ignore the growing impacts of increased fuel demand.

Even for advanced biofuels, the proposed language is environmentally insufficient. NRDC believes that emerging forms of drop in biofuel can provide sustainable options for aviation and ground transport if caution is observed throughout the chain of production. But vegetative feedstocks are intertwined with land and water health. Thus, careless development can lead to a range of consequences such as water quality deterioration, soil impaction, habitat loss and greenhouse gas emissions. As a nascent advanced biofuels fuels industry scales up, it is critically important to observe these risks so that the supporting resources can sustain the industry.

Unfortunately, S. 937 is silent on these critical issues. To manage these concerns, NRDC recommends an approach taken by Senator Murray, Senator Cantwell and Representative Inslee. Their proposal, the Domestic Fuel for Enhancing National Security Act (D-FENS), would provide 15-year contracting authority for DoD but limit eligibility to "advanced biofuel" as defined under section 211(o) of the Clean Air Act. That definition includes critical land and wildlife protections as well as greenhouse gas targets. To that extent, the D-FENS Act addresses separate but linked challenges. Rather than favoring mountaintop removal and global warming, it helps diversify fuel supply with sustainable alternatives to oil. At the same time, it helps identify environmentally realistic pathways amid public concern over unintended environmental consequences of careless fuel development. And by encouraging genuinely low carbon fuel, it helps manage the recognized national security threats of global warming. This approach demonstrates how a core emphasis on performance can address multiple but linked challenges.

In sum, NRDC does not support the long term contracting provisions in American Alternative Fuels Act. While we believe that there may be some role for these instruments, the potential effects of significant alternative fuel production require careful attention to environmental protection and public health. At this time, parameters to encourage that balance have not been included.

The Clean Air Act's "Best Available Control Technology"

Requirements Should Not Be Changed in an Alternative Fuels Bill

Section 8 of the bill would amend the determination of best available control technology (BACT) under the Clean Air Act. The requirement for major new and modified sources to meet emission limitations reflecting BACT was originally adopted as part of the 1977 Clean Air Act amendments. The Act requires a preconstruction review and the issuance of a permit for the construction of any new or modified "major emitting facility".[9] The BACT requirement is designed to require new or modified major facilities to minimize their emissions of any regulated air pollutant, including greenhouse gas emissions.

The American Alternative Fuels Act introduces, for the first time, an off-site consideration in determining BACT. It is not at all clear how off-site emission reductions would be incorporated into a determination of BACT. Perhaps most importantly, there is significant risk that this provision would fail to protect those whose health will be adversely affected by increased emissions of power plant pollutants that are directly dangerous to human health such as sulfur dioxide, particulates, oxides of nitrogen, and mercury, as well as carbon pollution that contributes to risks of death, illness, and injury through climate change impacts. There is no guarantee that off-site emission reductions will affect the same locations that are affected by unmitigated power plant pollution. There is certainly no guarantee that electric vehicles will be deployed in the immediate vicinity of large power plants where some pollutant concentrations are highest. In those cases, it would be highly inequitable to allow air quality for some local businesses and residents to deteriorate simply because it improved elsewhere.

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[8] James Bartis et al, Producing Liquid Fuels from Coal, RAND Corporation, 2008.

[9] See 42 U.S.C. §§7475, 7501-7503.

Moreover, it would base the long term BACT determination upon factors that are hard to discern and may fluctuate over time. While a plant must undergo a BACT determination only before major construction, the vehicle mix and vehicle usage patterns may shift on an ongoing basis, rendering the original determination inaccurate. For instance, the determination would not respond to subsequent vehicle retirements, migrations or other shifts to the fleet mix. It is also unclear what the assumed pollutant reductions would be in reference to as an increasing number of clean and efficient vehicle choices enter the market. While generating emissions can be predicted with relative accuracy, it will be hard to determine what the vehicle purchaser would have chosen if not an electric vehicle. Comparison to an average vehicle, a cleaner vehicle or something less efficient will yield different pollution reductions that could applied in the BACT determination.

Finally, introducing offsets into the BACT determination essentially allows power plants to forego available technology that could improve health and save lives. The determination process includes an analysis on technical and economic feasibility, ensuring that the environmental measures are achievable. Indeed, it is worth noting that vehicle electrification is a key opportunity for power producers to enter the lucrative transportation fuel market. As more electric and plug-in electric vehicles hit the road, power producers will meet the new electricity demand and therefore capture new revenue. NRDC believes that allowing them to minimize their responsibility over emissions that are a direct result of significant new business opportunities provides a windfall at the expense of those who may be affected by air quality impacts.

Conclusions

NRDC appreciates and shares the desire to identify alternative fuel sources. The nation's dependence on petroleum is a known economic and national security burden. However, we also maintain that each alternative fuel pathway provides unique tradeoffs, some greater than others. These effects are destined to grow as fuels achieve self sufficiency and expand in scale. Policymakers must be highly cognizant of the potential impacts in order to avoid the significant unintended consequences that wide scale fuel production can create. The best way to manage these risks is to establish parameters that guide investment decisions. With regards to S.937 those should be:

- Avoid actions that move us backward on climate change. Given the national security, environmental and economic implications, it is best to forego commercializing high carbon, high risk technology. To that extent, section 526 must remain in place because it sends the right signal to private markets and government alike.
- Only extend long term financial support to technologies with demonstrable environmental benefits. Federal procurement awards represent an exciting opportunity to develop fuels with climate, supply, and environmental advantages. Capturing these benefits once again requires embedding the right parameters to optimize results.
- Maintain strong protections for public health and air quality. While vehicle electrification may reduce pollution in some regions, these reductions may not geographically match where pollution from the power facility would increase. It is inequitable to relax pollution controls in these regions simply because pollution has declined elsewhere.

Once again, NRDC thanks you for the opportunity to present its views. As the nation continues to strive towards alternatives to petroleum, we look forward to working with the committee to develop policies that foster a balanced and sustainable outcome.

The CHAIRMAN. Thank you all very much for your testimony. Let me start with a few questions.

Mr. Colvin, I think it was Senator Franken who raised the question of how the small nuclear reactor models that are now coming forward are—how they relate to the naval reactors that you referred to in your testimony. Could you just give us a general perspective on that? Is there a close connection or is it very different?

Mr. COLVIN. Thank you, Mr. Chairman.

You know, the question that we talked about in SMRs from the reality was that the U.S. light water reactor program really developed from the Navy program in concert with the government pro-

grams. I operated SMRs on 6 different nuclear submarines for nearly 20 years. There are some very good similarities and some differences.

The biggest issue has to do with the power density, the fact that the submarine has to operate in an environment with rapidly changing power level requirements for propulsion mainly. So that's probably the largest difference. The basic philosophy and the basic design of these plants is the same.

The second nuclear submarine built was actually the USS Seawolf which was a liquid cool fast reactor that operated for a number of years before it was converted to light water. So back in—this was in 1975 through 1978. So we have a tremendous history of development of these technologies that we can bring to bear on these new designs.

It is being brought to bear on these new designs. So there are very, very good similarities, but at the same time, we're looking at the advanced technologies, advanced design characteristics and ways to improve the safety and reliability of these plants in much different ways than we looked at back in the early 1950s.

The CHAIRMAN. Alright. Let me switch and talk about this section 526.

Mr. Siu and Dr. Bartis, either one or both of you might comment on how you see, section 526 affecting the Department of Defense's ability to contract for coal to liquid fuel if greenhouse gas emissions were sequestered or otherwise reduced?

Dr. Bartis, why don't you go ahead first and then Mr. Siu, if you have a comment.

Mr. BARTIS. With extensive capture of greenhouse gas emissions we think current technology abounds. Coal to liquid plants would put out emissions, life cycle emissions, that are comparable to those from conventional petroleum products. In some cases it is going to be very technology specific. We don't have that much experience here in the United States.

In some cases they may be slightly over. When I say slightly, we're talking about a few percent. Or they could be slightly under. As you all are aware, you know, the greenhouse gas problem we have it's not about a couple of percent.

So given the—one of the things that we suggested for your consideration was would be to allow coal to liquid plants that do capture, say 90 percent of their greenhouse gas emissions and sequester them, to allow them to be included within the DOD purchasing. But——

The CHAIRMAN. Do you——

Mr. BARTIS. It's at the margin. It's just at the margin. That's the problem. It's right at the edge.

The CHAIRMAN. If the coal to liquids plant was producing or was capturing 90 percent it would be eligible to enter into or to be selling to the Department of Defense.

Mr. BARTIS. Not under—not necessarily under current law. It may miss the mark by a couple of percent points, by a very small amount.

The CHAIRMAN. I see. OK.

Mr. BARTIS. That's why when we suggested that there could be a slight modification to the act that would allow coal to liquid

plants with sequestration to conform, to be allowed to be purchased.

The CHAIRMAN. OK.

Mr. Siu, did you have a point of view on this?

Mr. SIU. Yes, I do. In terms of the impacts on section 526 I agree with Jim to a large extent. If you sequestered enough carbon dioxide at the CTL plant you could achieve emissions on parity with conventional petroleum.

There is a degree of error in there, a couple percent above, a couple percent below. But assuming that you achieve parity with conventional petroleum there is no legal contradiction with section 526. I think that it's a misperception that section 526 is a technological ban. It's a performance standard.

The CHAIRMAN. You're both recommending that we try to legislate performance standards rather than technology specific provisions. That's my understanding. Is that right?

Mr. BARTIS. I mean I don't want to get—there's a much broader way to approach this. But within the current context it would try, you know—to me the most important goal is to get some early production experience here in the United States on coal to liquids production. Because then we'll see how this technology performs and we'll start learning.

This slight modification, to me, a very slight modification that does not compromise on the major goal of section 526 will go a long way in opening that door up. But there are other—there's a bigger problem with section 526 which I mentioned in my written testimony. That's this issue of incidental blending of, I'll say, oil sands or if we want to buy fuel from Cutter, we're going to find gas derived alternative fuels that have excessive greenhouse gas emissions compared to section 526, blended in it's going to preclude us from buying those fuels.

Now there appears to be some legislation that have corrected that problem. I've read it. I don't understand it fully. So we suggest in our remarks that we might want to clarify that.

Mr. SIU. May I respond to that?

The CHAIRMAN. Sure.

Mr. SIU. Just to depart from what Mr. Bartis is saying a little bit. NRDC supports section 526 in its current form. In terms of buying jet fuel and other DOD fuel from South Africa, Cutter, if you look at the DLA, then DESC 2009, section 526 implementation plan, they cut themselves out an exception to buying overseas where readiness might be a problem there.

NRDC does not take an issue with this position.

The CHAIRMAN. Alright.

Senator Murkowski.

Senator MURKOWSKI. Thank you, Mr. Chairman. Gentlemen, appreciate your testimony.

Mr. Siu, you mentioned that within NRDC you can look at the picture. You've got energy. You've got the intersect with environment and you've got climate security. I would suggest that we also need to be looking at economic security.

What that means to this Nation in terms of our jobs, in terms of the strength of our economy, in terms of how we, again, move away from this vulnerability that we have. There's vulnerability on

oil and other sources of energy, most certainly. But clearly there is economic vulnerability that comes to us when we basically say well, ok, China can have everything that they're going to produce out of Alberta.

Mr. Bartis, you mention the economic benefits of coal to liquids. Cite a whole series of statistics, which I think are helpful to us. You mention as we're talking about Department of Defense, long term contracting and the ability really to help advance in perhaps a more robust manner the development of some of these alternative fuels, technologies, if in fact, DOD has that long term contracting authority to go forward.

But it's not just the benefits to our military I would suggest. Would you not also agree that we could then see those benefits translate to commercial aviation, to the Maritime industry in terms of how they power the vessels? I mean, what are we talking about specifically, if you were able to get this long term contracting within DOD?

Mr. BARTIS. In fact we just completed a congressionally mandated study at RAND where we looked at the military benefits and the civilian benefits of alternative fuels. Because alternative fuels are no worse and they're no better than regular fuels for the military. So there's limited military benefits, if any, to these fuels.

So our view is that if the military is going to be involved in alternative fuels the reason they should be involved is as an agent of the broader government to encourage early production. We don't see a tactical military benefit with these fuels.

Senator MURKOWSKI. Let me ask you, Mr. Colvin, about the SMR bills. If we could get things moving forward, as I think, you and I would agree is a good thing for this country and our energy policy, if you had a small nuclear reactor design of about 300 megawatts that's licensed by the NRC, how long would the build out of something like this take?

How long to construct? How long to bring a reactor online? Then how would that compare, for instance, with a smaller SMR in say the 50 megawatt range?

Mr. COLVIN. I think the biggest challenge we have moving forward is the design certification, licensing process that we have to face going forward by the Nuclear Regulatory Commission. I think there's a perception as illustration by Dr. Lyman's comments that the industry and the designers are trying to cut regulatory requirements. But the reality is, I think, we need to look at the regulatory requirements going forward that are necessary to provide the adequate levels of protection of the public health and safety.

They may not be the same as we're operating today because the technology is different. It's a different design or a different criteria. I think that's going to be the biggest transition.

So if you look at the timeframe right now, as Dr. Kelly talked about, we're looking out at about between 4 and 6 years to achieve the design certification. That's fairly similar to the timeframe for the large advanced reactors that we're seeing. So right now, that process hasn't changed.

I think what we were trying to encourage is between the Department of Energy and the Nuclear Regulatory Commission. To lay out the plan to in fact accelerate the licensing activities as well as

the research and development activities for the SMR technology to be able to move forward and make that transition. Once we get to the design certification phase with the first of a kind engineering nearly completed for that design, then we get the construction build out process for the SMRs will be considerably shortened from the light water reactor technology we have today. I mean——

Senator MURKOWSKI. That's not saying much. Because we know how long it takes.

Mr. COLVIN. Today you're seeing U.S. reactor technology, advanced reactor technology, that will be built and into operation in less than 4 years for a 1,100 plus megawatt plant. We haven't done that in the United States yet. We have 2 utilities that are in the process of building and looking for the license, combined operating license for 2 AP1000 reactors, both at southern companies, Vogtle plant near Augusta, Georgia and then South Carolina Electric and Gas summer plant up on the South Carolina coast.

Those plants are going to gain a tremendous amount of experience from the construction and build out that's being conducted in China by the U.S. companies, by Westinghouse and Shell Engineering. So I think we're going to see the economy of scale and the experience feedback that's going to give us an accelerated timeframe. I think we'll see the same thing in the SMR technology moving forward.

Senator MURKOWSKI. Thank you. Thank you, Mr. Chairman.

The CHAIRMAN. Senator Manchin.

Senator MANCHIN. Dr. Bartis, is there—do you know of any commercial coal to liquid plants in the United States and has any been permitted recently?

Mr. BARTIS. Quite a few have been announced. There's—I think the one that's farthest along is in Wyoming. It's a plant that would produce gasoline using the process developed by Exxon Mobil and commercially proven on natural gas in New Zealand. Now that plant has started, I believe, some site preparation work. But that's the only plant that's moved forward that far, so far.

Senator MANCHIN. What country is developing more in CTL than most or what's the most developing Nation that you know of?

Mr. BARTIS. China was. China had a very aggressive program but they've run into problems with their coal supply. So I think they've pulled back a lot of builds because of that.

Senator MANCHIN. Because of the stock feed.

Mr. BARTIS. Yes, they're having problems delivering coal to——

Senator MANCHIN. South Africa. How's their CTL program?

Mr. BARTIS. South Africa's CTL plant is moving along. Most interestingly, of course, is that, you know, the big technical advances have taken place with natural gas to liquids. It's the same technology. Quite frankly, I thought it would never apply to the United States except now that we have stranded gas in Alaska this may be a technology that's applicable there.

We've had great progress in Cutter. They will be producing, this year, about 170,000 barrels per day. That's not gallons per year. That's a huge amount of fuel.

So the technology is really up to date.

Senator MANCHIN. You believe that basically we, as a country, could be energy independent if we use the resources we have available?

Mr. BARTIS. We have so much oil shale, coal and biomass that together it is easy to see that we could be using, well, making well over 5 to 6 million barrels a day from these resources alone. Combine that with efficiency measures and I think we could easily make that. But we have to have—we have to unleash these other fuels.

Senator MANCHIN. Not the course we're on now.

Mr. BARTIS. The situation we have now it's not going to get us there.

Senator MANCHIN. Mr. Siu, do you believe that we're too dependent on foreign oil?

Mr. SIU. Yes. That's NRDC's position. But we also believe that there are other tradeoffs that we have to consider when planning out our energy technologies.

Senator MANCHIN. Do you look at the economy at all when you're stating your policies or taking you all's position? Do you look at the economy, I mean, the American economy, if you will, the jobs that go with it, the balance between environment and the economy?

Mr. SIU. Yes, we, of course, consider the economy. We believe energy efficiency provides benefits to consumers. We believe that reducing the oil imports provides economic benefits to the United States. So yes, we are in agreement there.

However, I think where we depart is where we also believe that we should put emphasis on avoiding unintended consequences when we deploy some of these fuels to, you know, broad scale.

Senator MANCHIN. Do you believe any of that can be done without the use of fossil but we have gas and coal and the abundance of resources we have in this Nation?

Mr. SIU. To argue the other side of that I think that if we deploy coal technologies that we're not already using here in a very irresponsible way, I think it completely destroys our chances of achieving these other important public priorities.

Senator MANCHIN. Mr. Colvin, as far as on the nuclear. What is our reliance on nuclear power in America? Is it 19? I heard 19, 20 percent?

Mr. COLVIN. We generate about 20 percent of our electricity, about 1 out of 5 households is served by nuclear generated electricity in the United States currently, Senator.

Senator MANCHIN. Coal is how much, Mr. Bartis?

Oh, I'm sorry, Mr. Colvin. That would be OK if you have the answers, sir, go ahead. Go ahead.

Mr. COLVIN. Coal generates, we generate about 50 percent of our electricity from coal in the U.S.

Senator MANCHIN. So 70 percent between nuclear and coal right now. The 30 percent, is a derivative of so many other different things, correct?

Mr. COLVIN. Correct.

Senator MANCHIN. There's nothing in sight that's going to take that, in any short period of time, take up that amount of dependency that we have?

Mr. COLVIN. No, not that we see, Senator. I think one of the things that I might just mention, you know, the big question that faces a lot of the utilities is what's the best, long term source of electricity going forward when you take in all the parameters. The biggest risk that's seen by most of the utilities is the volatility of natural gas.

Senator MANCHIN. Do you see the citizens of this country paying a much higher price because of our indecision in not having an energy policy?

Mr. COLVIN. Yes, absolutely, Senator.

Senator MANCHIN. What has that increased? I mean, I know I see my mother's bill and some different of our bills coming across what they were before, a year or 2 or 5 years ago.

Mr. COLVIN. You know, it really depends on the area of the country. I think in parts of the country we have very low and economical electricity prices given where we are today. But in some parts of the country, especially the Northeast we see very, very high electricity prices. Those are typically caused by the difference in generation sources that we apply to the electricity sector.

Senator MANCHIN. Thank you.

The CHAIRMAN. Senator Barrasso.

Senator BARRASSO. Thank you very much, Mr. Chairman.

Mr. Bartis, I enjoyed your presentation. I had an opportunity to read everything you've submitted. I admire the work that you've been doing because I believe that coal is America's most affordable, available, reliable and secure source of energy and using America's coal resources as a transportation fuel will decrease our dependence on foreign sources of oil and really strengthen our national security.

Getting to section 526 of the 2007 energy bill, that places restrictions, as we know, in the Federal Government's ability to purchase alternative fuels. In your testimony you highlighted potential problems for the Defense Department purchasing fuels in areas. I think you said, in South Africa as well as in Qater.

Would repealing section 526 decrease the Department of Defense fuel costs in the long term? What's your assessment of that?

Mr. BARTIS. To the extent that if section 526 prohibits the incidental inclusion of alternative fuels then there's going to be fewer vendors that are willing to sell to our Defense Department. So that's going to make costs go up. As I mentioned so repeal, outright repeal, would certainly eliminate that problem.

I've also suggested that the bill could be amended slightly and take care of that problem.

Senator BARRASSO. From a practical perspective does section 526 in its current form discourage investment in coal to liquids, even including coal to liquids with a major carbon capture potential?

Mr. BARTIS. I think it gives the investment community a signal and that the government is opposed to—doesn't favor coal to liquids. But it's a signal. It's hard for me to quantify that.

Senator BARRASSO. Thank you.

Mr. Siu, following up on the section 526 discussion with the previous panel I want to ask you a question related to Canadian oil verses Middle Eastern oil. The Administration said, as I heard it, it said that it doesn't believe that buying Canadian oil is better

than buying oil from the Middle East. That so if Canada can provide oil from oil sands that's say, higher in greenhouse gas emissions and Saudi Arabia can provide oil that's lower in greenhouse gas emissions.

Does your organization believe that oil from Saudi Arabia is better for the United States to purchase?

Mr. SIU. I think what the Administration might have been referring to is the effect on the world oil market and how the world oil market affects us. As far as I know last—economically speaking in last year's, this year's price run ups the Canadians weren't cutting us any good neighbor to the south deals.

Senator BARRASSO. Let me ask about the position of your organization, the position of your organization for imports. Is a greenhouse gas potential impact the greater issue?

Mr. SIU. I think the greenhouse—I think they're both important issues. I think given the national security liabilities of climate change, I think we seriously need to consider that as well when turning to more and more greenhouse gas intensive forms of fuel.

Senator BARRASSO. So I'll get back to the question. Yes or no? If Canada can provide oil from oil sands that's higher in greenhouse gas emissions, Saudi Arabia can provide oil that's lower in greenhouse gas emissions. Does your organization, the NRDC, believe that oil from Saudi Arabia is then better for the United States than oil from Canada?

Mr. SIU. NRDC hasn't had that internal discussion yet and put a formal opinion out on that. I will give you my personal opinion on it, is I don't think that there this a benefit to buying from Canada as opposed to Saudi Arabia if we're talking about how much money each of these countries is deriving from the world oil market.

Senator BARRASSO. Mr. Bartis, do you want to comment?

Mr. BARTIS. If we impose a barrier to a logistically preferred purchase then we're going to—there's going to be a premium attached to that. The net greenhouse gas effect will be zero because that Canadian tar sands is just going to go somewhere else and we're just playing with the logistics of the oil, the international world oil market.

Senator BARRASSO. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Shaheen has not yet asked any questions so maybe we should give her a chance to ask questions first and then Senator Franken.

Senator SHAHEEN. Mr. Chairman, Senator Franken, can go ahead.

The CHAIRMAN. Alright.

Senator Franken.

Senator FRANKEN. OK, if you want to be that way.

[Laughter.]

Senator FRANKEN. Mr. Bartis, last week in your testimony in the House you said that, "Without management of greenhouse gas emissions liquid fuels produced from coal will have life cycle greenhouse gas emissions that are about twice that of their conventional petroleum counterparts." Even if you had carbon capture and storage—that's the end of your quote. OK. Even if you had carbon cap-

ture and storage for these liquid coal production facilities the greenhouse gas emissions would be higher than conventional petroleum based fuels depending, I guess, on how much carbon you could sequester.

Now the National Academies of Science warned just last month that, "The risk of dangerous climate change impacts is growing with every ton of greenhouse gas is emitted into the atmosphere." Given this warning from America's scientists does it make sense to use Federal dollars to produce fuels that have greater greenhouse gas emissions than the ones that are employed today? Shouldn't we instead be focused on technologies like advanced biofuels which don't have—which have a lower carbon footprint and which are renewable and have—and are being brought to commercial scale, have already been brought to commercial scale. Now cellulosic is being brought to commercial scale.

Mr. BARTIS. It is true that without any management of greenhouse gas emissions coal to liquids is a technology with double the life cycle emissions of conventional petroleum. That's why we at RAND and others, for example, those at the National Academy, one of the study committees, Princeton University and others have examined another alternative, have examined the alternative sequestration. With carbon sequestration we believe they're basically even, a couple percent either way, with conventional petroleum.

It depends on what fuel you're talking about. There is a way that oil is a lot dirtier than the average oil in terms of greenhouse gases, for example.

Senator FRANKEN. OK.

Mr. BARTIS. But——

Senator FRANKEN. Like cellulosic ethanol.

Mr. BARTIS. Cellulosic ethanol isn't here today, right?

Senator FRANKEN. It's being, actually, it is—there is a commercial scale plant being built in Emmetsburg.

Mr. BARTIS. It's a first of a kind demonstration plant. It's——

Senator FRANKEN. It's a commercial plant. There have been demonstrations.

Mr. BARTIS. But if you look at the production. I don't know if it's 100 barrels a day or 200 barrels a day because it's a small facility. What I was trying to say in my written testimony is, is that there are ways to make coal a very clean fuel by combining coal with biomass and including sequestration.

When you do that we can get greenhouse gas emissions that are very favorable. We can significantly lower the cost of some of these processes that just depend on biomass. Many of the cellulosic processes on biomass begin with gasification.

Senator FRANKEN. OK. Let me ask you this.

Mr. BARTIS. Right. OK. I'm sorry.

Senator FRANKEN. Is there commercial scale sequestration?

Mr. BARTIS. Yes. It's done commonly in the United States. We use about 40——

Senator FRANKEN. Where?

Mr. BARTIS [continuing]. Million tons of CO_2 are taken out of the ground and put into oil fields in the United States. It's common. It's been done. It was discussed by the IPCC. It's in Colorado and the regional oil fields.

Senator FRANKEN. OK. Let me put it this way.

Mr. BARTIS. It stays in the ground.

Senator FRANKEN. I understand that. Has there been sequestration in a way—I'll ask Mr. Siu. Has there been commercial sequestration in a way that has made coal, clean coal?

Mr. SIU. Not to my knowledge outside of enhanced oil recovery.

Senator FRANKEN. In a commercial, you know, scale?

Mr. SIU. Not to my knowledge, no.

Senator FRANKEN. Mr. Bartis.

Mr. BARTIS. We have a coal to liquid—a coal to natural gas plant in North Dakota that sends its product to an oil field in Canada. It sends its CO_2.

Senator FRANKEN. Is that plant now——

Mr. BARTIS. It's a commercial plant. It was built——

Senator FRANKEN. All right. I mean, where is the plant? Is it carbon neutral?

Mr. BARTIS. I don't know if it's carbon neutral.

Senator FRANKEN. You don't know. So you have no answer to my question in this sense.

Mr. BARTIS. I don't know whether it's carbon or not. I can find out.

Senator FRANKEN. OK. Because when you burn biomass it's carbon neutral, right? I mean——

Mr. BARTIS. Biomass it is, no, it is not carbon neutral when you use biomass. Not at all. There is significant issues with regard to the life cycle greenhouse gas emissions when using certain forms of biomass.

Senator FRANKEN. OK.

Mr. BARTIS. When you start using food there's a major problem.

Senator FRANKEN. OK. OK. I guess my time is up then go to Senator Shaheen. Unless you don't want to ask any?

[Laughter.]

Senator FRANKEN. Oh, wait. It's actually I go to the chairman. The chairman is the Chairman.

The CHAIRMAN. Let me call on Senator Shaheen for her questions and then we'll have an opportunity for you to continue with more questions, Senator Franken.

Senator SHAHEEN. Thank you, Mr. Chairman.

I apologize for having missed the testimony, but I would actually like to go back and address some of the nuclear issues in the other 2 pieces of legislation that are pending before the committee this morning. I find it very interesting that there is technology that could develop smaller, more cost effective nuclear plants. I'm interested in how the current regulations around nuclear plants would affect those potential nuclear reactor designs.

So are there requirements in the legislation or should there be requirements in the legislation that address safety concerns with these nuclear designs that might be different than current nuclear plants. I don't know, Dr. Lyman or Mr. Colvin, if either of you would like to address that.

Mr. LYMAN. Thank you for your question. As I said in my testimony, on paper certain designs have features that look like they might present safety advantages. But unless—those safety advan-

tages could be lost if there's an erosion of the safety standards that govern their licensing.

So we believe that—the Nuclear Regulatory Commission has a policy that new nuclear reactors don't have to be any safer than existing reactors. We think that's a bad policy because we're missing an opportunity. I mean if we build reactors that may be around for 60, 80 years why not use the best available technology. Make sure they're safer than what they have today.

We feel that the consequence of that policy is that the designs and the licensing aren't as good as they should be. So we think, you know, Congress has the opportunity and Department of Energy is already interested in financing of these cost sharing programs but what the value added of this legislation could be to lock in additional safety and security levels that even the Nuclear Regulatory Commission doesn't require because of their own bureaucratic issues.

Senator SHAHEEN. Could you talk about what some of those safety and security requirements ought to be?

Mr. LYMAN. Yes. I mean, for example, as I said in my testimony, the emergency planning zones around U.S. nuclear reactors are only required to be 10 miles. Yet we've seen after Fukushima that there are significant contamination that goes much further.

So we've always thought that 10 miles is not adequate to address all the populations that may be at risk. So we'd like to make sure that if we site new nuclear reactors in the future we make sure that there's emergency planning, very rigorous emergency planning in place to make sure that potassium iodide, for example, will be able to get to the children who might need it. That people will be evacuated out of zones where they might receive high radiation exposure.

Now the small modular reactor community has been arguing that because these reactors are smaller they'll have less radioactivity we can shrink these zones even to the boundary of the plant so that the people living right outside the gate may not even have to receive any special instructions. We think that that is shortsighted, especially in what we've seen in Fukushima.

Senator SHAHEEN. Do we know, and maybe Mr. Colvin you could also address this. Do we know if the technology for these modular reactors is more advanced and what that would mean in terms of any emissions?

Mr. COLVIN. I think that the real point in this and I made the comment earlier, Senator, was that we really need to have the NRC set the safety standards for the reactors in a way to protect the public health and safety. That's been the NRC's mandate from day one. On the industry side I reckon, an experience we've had in the advanced light water reactor program.

The industry has actually set a standard for itself to design all the new advanced reactors to a level at least 10 times safer. Problematically and deterministically then we did with the earlier light water reactors. In fact, the advanced reactors that we're building, planning to build in Georgia, South Carolina, that are being built in China, meet that criteria.

We think there's a lot of that same logic and philosophy in practice that would go into the advanced—to the SMR design. We're

asking the Electric Power Research Institute is undertaking a project to develop what we call a utility requirements document which was the basis for the design of those plants that would lead you to those levels of safety and ultimately be decided by NRC.

If you really look at S. 512, what S. 512 is trying to do, in my view, is to in fact launch those discussions between DOE, NRC and the industry and to help define those criteria. We need to move that discussion forward because there may be safety criteria that are different than the criteria we use today that could lead us even to higher levels of safety even though we don't follow the procedures we've used in the past. I think that's the real benefit of moving forward in this public/private partnership working with the government and with the Nuclear Regulatory Commission to define that.

Senator SHAHEEN. Thank you. My time is actually expired. But one issue that we saw in Japan was that the reactor design was not—didn't consider the worst case scenario which was not just the earthquake but the tsunami. I think, as you point out, if we're going to be looking at a new design we should make sure that they address the worst case scenario.

Coming from a state where we licensed the last nuclear power plant in the country I think we do need to re-evaluate the ten mile emergency zone around nuclear plants.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you. Let me just see if Senator Murkowski had any additional questions. Alright.

Senator Franken.

Senator FRANKEN. I just want to say one thing and then ask a question. I would love to see carbon sequestration in coal fired utility plants work magnificently. I mean, that would be—solve a lot of problems.

If we could find all the places to sequester it whether it be the bottom of the ocean, whatever it is, if it works, that would be—I think we'd all agree, everyone would be just jumping for joy because then we'd have a use for all this coal in a clean way. So that's my one—I want to say that. But I wonder about making liquid fuel out of coal before we establish that we can actually do that.

Dr. Lyman, you mentioned the need for safety in the siting and operation of modular reactors. Are there any issues that you think we should worry about regarding the design of modular reactors?

Mr. LYMAN. Yes. For one example, Fukushima has also shown that a defective containment design can lead to unacceptable radiological consequences and a large radiological release. Now many of the modular reactor designs depend on having containment buildings that are smaller, that have less capacity, to withstand something like a hydrogen explosion.

In some cases it would be hard to see how you can design a small modular reactor economically without shrinking the containment like that. But you have to examine the consequences of whether those containment buildings are really going to be robust enough to protect the public and beyond design based accident.

Senator FRANKEN. Thank you. As far as the worst case scenario, in Minnesota, in Monticello we have the exact as—plant as

Fukushima and although Minnesota the chances of having—Senator Shaheen was talking about worst case scenario, the chances of an earthquake of that level in Minnesota are very low. But if we had a tsunami in Minnesota we'd have bigger problems that even the reactors.

[Laughter.]

The CHAIRMAN. You're opposed to tsunamis, is that the——

[Laughter.]

Senator FRANKEN. No, I'm just saying that if there was a tsunami in Minnesota we'd be——

The CHAIRMAN. Really in trouble.

Senator SHAHEEN. So the Great Lakes are not a potential.

Senator FRANKEN. Actually I don't know maybe the Great Lakes. I don't know.

[Laughter.]

The CHAIRMAN. Thank you all very much. We've learned a great deal. We appreciate your hard work and testimony.

That will conclude our hearing.

[Whereupon, at 12:03 p.m. the hearing was adjourned.]

APPENDIXES

APPENDIX I

Responses to Additional Questions

RESPONSES OF JAMES T. BARTIS[1] TO QUESTIONS FROM SENATOR MURKOWSKI, ON S. 937[2]

Question 1. Coal-to-liquid (CTL) Fuel in Alaska (S. 937)—The military bases in my home state of Alaska have shown significant interest in CTL fuels over the years. When you look at Alaska's resource base and geographic location, what do you think the most viable alternative fuels are, both now and over the near term?

Answer. My RAND colleagues and I have not conducted research on the prospects of producing alternative fuels in Alaska; however, I can make a few general comments. Alaska has three resources that potentially can be used to produce alternative liquid fuels: natural gas, coal, and biomass. Abundant natural gas resources are located in the Alaska North Slope. Because of projected production of shale gas in the lower-forty eight, it is possible that North Slope gas will not be marketable. This stranded North Slope gas could serve as the feedstock for a gas-toliquids (GTL) production facility. The technology for such a plant is fully commercial, as shown by the recent construction of two modern GTL plants in Qatar. The liquid products of the facility could be transported using the Trans-Alaska Pipeline System. With stranded natural gas, a large GTL plant might be an economically viable project. However, we have not examined the extra costs or environmental damage that would be incurred in constructing and operating a plant in the harsh environment of the North Slope. An alternative is to transport North Slope gas to a location on the Gulf of Alaska, from whence it could be brought to market as LNG or converted to an alternative liquid fuel.

In the absence of a Trans-Alaska Gas Pipeline, a potentially attractive location for alternative fuels production is the Cook Inlet area. A few small (e.g., 5,000 barrels per day) production facilities using a combination of biomass and natural gas (BGTL) could yield favorable greenhouse gas emissions without the need to capture and sequester greenhouse gas emissions. Such a facility could possibly qualify for federal loan guarantees. Further analysis would be required to determine whether, and under what conditions, the fuel produced from such a facility would qualify under the renewable fuel standard provisions of the Clean Air Act.

Another option for Alaska would be to construct an alternative fuels plant that would use a combination of coal and natural gas to produce liquid fuels (CGTL). This feed combination has process advantages that could reduce overall production costs, but whether this combination makes economic sense depends on the delivered costs of coal and natural gas. A moderate size facility (e.g., 20,000 barrels per day) would require a major increase in Alaskan coal production and may require the development of new natural gas production in the Cook Inlet area. Lifecycle greenhouse gas emissions associated with the production of fuels from a CGTL plant are

[1] The opinions and conclusions expressed in this testimony are the author's alone and should not be interpreted as representing those of RAND or any of the sponsors of its research. This product is part of the RAND Corporation testimony series. RAND testimonies record testimony presented by RAND associates to federal, state, or local legislative committees; government-appointed commissions and panels; and private review and oversight bodies. The RAND Corporation is a nonprofit research organization providing objective analysis and effective solutions that address the challenges facing the public and private sectors around the world. RAND's publications do not necessarily reflect the opinions of its research clients and sponsors.

[2] This testimony is available for free download at http://www.rand.org/pubs/testimonies/CT364z1.html.

likely to be much lower than a coal-only alternative fuels plant, but still higher than those from the corresponding petroleum fuels. To reach parity with conventional petroleum would require capturing and sequestering greenhouse gases that would otherwise be emitted at the production facility. Oil producers in the Cook Inlet basin might be interested in purchasing captured carbon dioxide for use in enhanced oil recovery.

In the preceding, I have emphasized alternative fuel concepts that involve natural gas, since such concepts might give Alaska a competitive advantage as compared to other U.S. locations. Other concepts such as using coal, biomass, or a combination of both as a feedstock are possible. Whether Alaska affords a competitive locale for such production facilities depends on local construction costs and the costs of delivering suitable feedstocks to the facility.

Transport of finished fuels, such as diesel, jet, and home heating oil, to Alaskan ports represents a small fraction of the total costs of delivering fuel to these ports. Consequently, local demand in Alaska, whether civilian or military, is not a significant factor in determining whether Alaska is a favorable location, as opposed to other U.S. locations, for alternative fuel production facilities.

Question 2. Economic Benefits of Coal-to-liquid and Coal/Biomass-to-liquid Fuels (S. 937): You've researched the economic benefits of coal-to-liquid and coal/biomass-to-liquid fuels. In one scenario, you project that the United States could develop an industry capable of producing 3 million barrels a day by 2030. Can you describe the economic value of that production to the United States, especially in terms of how much less we would spend to acquire foreign oil, the government revenues that would be generated, and any potential impact on global oil prices?

Answer. In our 2008 report on liquid fuels from coal, we examined the economic benefits of domestic production of alternative fuels. The most substantive benefits are those associated with the economic profits of domestic production and reductions in the world oil price. Three million barrels per day of alternative fuels production would reduce imports of petroleum by about $120 billion dollars per year. This estimate is based on a world oil price of $100 per barrel. If production costs, including a reasonable rate of return on capital investments, are below the prevailing market price for oil, a domestic alternative fuels industry would generate economic profits. For example, once an alternative fuel technology, such as CBTL becomes mature, we expect that production costs could be much lower than those of first-of-a-kind facilities. In 2011 dollars, $75 per barrel might be possible. At world oil prices of $100 per barrel, this production cost would yield an economic profit of $25 per barrel, or equivalently, $27 billion per year if annual production is 3 million barrels per day. Through income taxes, about a third of these economic profits would go to the federal government, and thereby broadly benefit the public. Smaller amounts would go to state and local governments.

Fundamental economic considerations indicate that lower world oil prices will result from any increase in liquid-fuel production anywhere in the world, whether it be conventional petroleum extraction or from unconventional resources such as tar sands or from alternative fuels from coal, biomass or natural gas. Our research indicates that an alternative fuel production level of 3 million barrels per day could cause world oil prices to drop by between 2 and 5 percent, as compared to what they would otherwise be. Assuming that a 3 million barrel per day industry is operating in 2030 and that the world oil price is $100 per barrel at that time, the analysis that we published in 2008 indicated that the value of the world oil price reduction to the U.S. economy is a savings of between $10 and $25 billion per year. These benefits are in addition to the economic profits discussed above.

Since publication of our 2008 report on coal-derived liquids, very little progress has been made toward obtaining early production experience. For that reason, a very aggressive national program in coal and coal/biomass fuel production would be required to achieve a production level of 3 million barrels per year by 2030.

Question 3. CTL Abroad (S. 937)—We often hear about the investments that other countries, particularly China, are making in alternative and renewable technologies. Can you discuss any investments that China—and perhaps India and other nations—are making into CTL fuels?

Answer. Our main source of global CTL fuel developments is the National Energy Technology Laboratory. We have also discussed CTL development with senior Chinese government officials. Within China, two CTL plants are operational. One is a small facility 2,500 barrels per day) that produces gasoline using the ExxonMobil coal-to-methanol-to-gasoline process. The other is a facility designed to produce 24,000 barrels per day of fuels using a method generally referred to as direct liquefaction of coal. This facility is the first direct liquefaction facility built at a significant scale since the end of the Second World War. We do not know whether it will be able to reach and sustain operations at or near its design capacity.

A number of additional CTL plants in China had been announced, but all of these appear to have been placed on hold. In addition to CTL plants, China also has about 35 facilities that gasify coal to produce various chemicals. As such, these plants provide China with extensive experience in technology that is directly applicable to alternative fuels production.

Press reports indicate that two large CTL plants have been approved by the Indian government. Within India, the major investors are reported to be Tata Steel and Jindal Steel and Power, Ltd. We do not have information regarding the level of design work that has been completed on either of these two projects.

Question 4. Oil Shale (S. 937)—Your organization has estimated that the U.S. has about 800 billion barrels of technically recoverable oil shale. Can you provide the committee with an assessment of the federal government's current approach to oil shale? Do you believe federal policies are helping, hindering, or hurting efforts to commercialize this resource?

Answer. I have examined the commercial leasing rules published in 2008 and find them to be seriously deficient. Basically the oil shale leasing rules were modeled on existing rules for coal and oil leasing. The rules do not take into account the geographic concentration of the oil shale resource base, the fundamental uncertainties regarding the economic, environmental, and technical performance of oil shale production technologies, and the national energy security benefits of being able to produce eventually a few million barrels per day of fuel (gasoline, diesel, and jet) derived from oil shale. My June 3, 2011 testimony before the Energy and Power Subcommittee of the House Energy and Commerce Committee further amplifies on this matter and suggests areas where Congress might offer direction.

It is my understanding that the Department of the Interior is conducting a review of the commercial leasing rules for oil shale. At this time RAND does not have sufficient information to make an informed assessment of the impact of current or prospective federal policies on the commercialization of oil shale.

Question 5. Energy Security as a Priority—One of the greatest benefits of coal-derived fuels is their ability to provide our military with a more stable, domestic source of the energy. section 526 of the 2007 energy bill effectively sets us on a course to rely even more upon the unstable regions where many of our military men and women are now deployed. Which do you believe is the greater national security imperative: the potential to source military fuel from domestic resources, or the ability to reduce greenhouse gas emissions by maintaining the status quo established by section 526?

Answer. RAND research on alternative fuels shows that viable approaches to produce alternative fuels are available that would allow coal and other fossil fuel resources to be used to produce alternative fuels without increasing greenhouse gas emissions. Specifically, research by RAND and others shows that using a combination of fossil fuel resources and biomass can result in lifecycle greenhouse gas emissions that are significantly lower than those associated with conventional petroleum products or with certain biofuels that receive favorable treatment under Renewable Fuels Standard provisions of the Clean Air Act.

Full repeal of section 526 is unlikely to have a significant impact on the development of a domestic alternative fuels industry. First, government purchases account for less than 2 percent of national fuel consumption. Second, potential investors in alternative fuel production projects will likely remain wary of the possibility of future legislation that will place a cost on emitting greenhouse gases. Considering the growing evidence of the deleterious impacts of increasing atmospheric concentrations of greenhouse gases, such legislation is likely over the financial lifetime of an alternative fuel facility. Consequently, alternative fuel production projects that are based on fossil energy resources are likely to include management of greenhouse gas emissions so that net emissions are in line with those of conventional petroleum products.

In my written testimony submitted to the committee on June 27, 2011, I provided options for minor revisions to section 526 that would serve to reduce fuel procurement costs, and reduce barriers to the procurement of fossil-derived alternative fuels that can be produced with greenhouse gas emissions that are comparable to those of conventional petroleum-based fuels.

Question 6. Long-term Contracting Authority: What role do you believe long-term contracting authority for the Department of Defense could play in the development of a robust alternative fuels industry? Do you believe that the military's efforts to bring alternatives into the marketplace would have any positive effects for other industries, including the commercial aviation and maritime industries?

Answer. Long-term contracting authority will not have any appreciable role unless it is coupled with other measures that would provide incentives for investments in alternative fuel projects. Otherwise, the military will be purchasing at competitive

prices, and therefore offering no incentive beyond the civilian marketplace. Measures to provide incentives for investment include investment subsidies (such as direct grants and tax credits), loan guarantees, production subsidies, and price floors. The cost effectiveness and risks of these various measures differ considerably. By examining incentives from the perspective of the federal government as well as private investors, our analysis revealed that a balanced and cost-effective approach would include a price floor on purchases of fuel from pioneer production facilities, an investment incentive (such as an investment tax credit, a loan guarantee, or both), and an income sharing agreement, in the event that world market oil prices significantly increase during the term of the incentive agreement.

While properly prepared alternative fuels are no less able than conventional fuels for meeting the needs of the Defense Department, they offer no particular tactical or operational benefit. Therefore, the only significant benefit of Defense Department purchases would be to promote early production of fuels that have application in the broader civilian market. This raises the issue of whether incentives for early production should be placed within the Defense budget, as opposed to within the budget of the Department of Energy.

RESPONSES OF JAMES T. BARTIS TO QUESTIONS FROM SENATOR UDALL

Question 7. Your report Alternative Fuels for Military Applications recommends that "Fischer-Tropsch fuels are the most promising near-term options for meeting the Department of Defense's needs cleanly and affordably." (p. xi)

Your report did not evaluate the amount of water required to produce this level of alternative fuels, or the amount of wastewater that would be created. It did not assess the discharge of this contaminated water, or protection of surface or ground waters. Your report did not compare the impact on water use of F-T coal to liquid fuels compared to advanced biofuels. Given that your report did not assess the impact on water quantity or quality of producing military fuels, how can you credibly claim that using this process can meet the Department of Defense's fuel needs both "cleanly and affordably"?

BACKGROUND

In the 1990s, Bechtel performed a series of studies for DOE in which they evaluated a variety of coal liquefaction schemes for indirect liquefaction (Bechtel 1998) and determined the following water needs:

"For eastern coal 7.3 gal of water/gal F-T liquid

"For western coal 5.0 gal of water/gal F-T liquid"

Emerging Issues for Fossil Energy and Water, NETL, June 2006

"Before coal liquefaction can make a significant contribution to meeting the demand for liquid fuels, it will be necessary to ensure that sufficient water resources are available at proposed plant sites."—ibid

Answer. The report on Alternative Fuels for Military Applications drew on our 2008 report: Producing Liquid Fuels from Coal: Prospects and Policy Issues. That report did examine water requirements to produce liquid fuels from coal as well as other environmental issues, including greenhouse gas emissions, air quality, land use, ecological impacts, and water quality. With regard to water consumption, our analysis suggests that the practical lower limit is about 1.5 gallons of water per gallon of F-T liquid. The amount of water that will be consumed in a CTL plant will depend on the availability of suitable water supplies, including groundwater. Where water supplies are abundant and inexpensive, as they are in certain locations in the central and eastern United States, CTL plant designs may involve consumption of over 10 gallons of water per gal of F-T liquid. These estimates do not include water used during coal mining or during the production of biomass.

In contrast, plants built in arid regions will likely employ methods to minimize the consumption of water. How much will depend on cost-benefit and regulatory analyses that will be done as part of the front-end engineering design of such facilities. It is possible that water consumption may be a limiting factor in locating CTL plants in arid areas. At present, this remains an unresolved issue. If and when industrial interest in CTL development grows to the point at which several large plants are planned in arid regions, local, state, tribal and federal governments should assess how longterm water supplies and projected demand will be affected. Otherwise, heavy water usage in early CTL plants will compete with other priority uses and possibly foreclose further CTL development.

We did not do a comparative analysis of water requirements for various alternative fuel production concepts. Available information suggests that water requirements for F-T fuels are comparable or lower than other near-term biofuel production

concepts for middle distillate fuels, including hydrotreated renewable oils and algae-derived fuels.

Consistent with current regulations and modern engineering practices, Fischer-Tropsch facilities will be built with zero discharge of water. With regard to both coal-derived fuels and biofuels, the primary water quality concerns are associated with feedstock production. In the case of coal mining, these issues include mine drainage, hydrological impacts, and the management of coalslurry impoundments. For biofuels, the water quality issues depend very much on how the feedstock is produced, including whether irrigation is used for feedstock production.

Question 8. In your testimony (page 3) you state that, "advanced research in photosynthetic approaches for alternative fuels production offers the prospect of even greater levels of sustainable production." In this case, how do you define, "sustainable production"? And would you consider liquid fuel production from coal to be sustainable on the same timescales as that of these photosynthetic approaches?

Answer. In my testimony, "sustainable" implies production that can be carried out over an extended timeframe with acceptable environmental impacts. For coal, our analysis show a sustainable timeframe could be on the order of 100 years. If and when industry interest indicates that large-scale development of a coal-derived alternative fuel industry is likely, a review of the legislation and regulations governing mine safety, environmental protection, and reclamation may be appropriate to assure that production will be sustainable.

Advanced photosynthetic approaches, such as algae and certain biochemical approaches for liquid and gaseous fuels production, are at the research stage. If and when they will be commercially viable approaches for alternative fuel production remains highly uncertain. Whether these approaches will offer sustainable production of millions of barrels per day is also highly uncertain, depending on process details, such as water requirements, that are not well understood at the present state of knowledge. If development efforts are successful, these photosynthetic approaches offer sustainable production over a multi-century timeframe, and possibly with environmental impacts that are more favorable than those associated with coal/biomass approaches. The prospect of successfully achieving a sustainable, environmentally superior process for alternative fuels development warrants federal investment in long-term research and development directed at photosynthetic approaches.

Question 9. The February 2010 Quadrennial Defense Review notes that climate change will play a significant role in the future security environment for the United States. Additionally, in the Congressionally-mandated report by the National Research Council, National Security Implications of Climate Change for U.S. Naval Force, the authors list a number of adverse impacts that climate change will have on U.S. Naval operations, and U.S. national security, in general. For example:

> climate change can act as an accelerant of instability or conflict" (page 20)

and,

> Viewed from a national security standpoint, these [climate-induced] changes would likely amplify stresses on weaker nations and generate geopolitical instability in already vulnerable regions." (page 21)

And a number of reports, including the recent America's Climate Choices suite of reports from the National Research Council, affirmatively attribute climate change to increasing levels of greenhouse gases in the atmosphere.

In your testimony you state (page 9) that Congress ought to consider an amendment to section 526 of the Energy Independence and Security Act of 2007:

> suggest consideration of an amendment to section 526 that would allow the government to target purchases of alternative fuels derived from fossil fuel resources (such as coal, natural gas, or oil shale) if . . . lifecycle greenhouse gas emissions are no more than five percent above the lifecycle greenhouse gas emissions of their petroleum counterparts."

Given this context, isn't such a proposal in direct conflict with the aforementioned national security interests of the United States since greenhouse gas emissions would increase under your proposal?

Answer. My testimony does not recommend or advocate specific legislation. As an energy policy researcher working at the RAND Corporation, my testimony is provided for the purpose of informing the committee and its staff of alternative options. For that reason, the quotation from the testimony regarding consideration of an amendment to section 526 was preceded by the phrase: "If the intent of Congress is to promote the early production of alternative fuels with greenhouse gas emis-

sions that are comparable or better than those of their petroleum counterparts, . . . ”

Information on the adverse impacts of increasing atmospheric concentrations of greenhouse gases suggest that national security consequences represent but a single dimension of a growing global environmental problem. If Congress is interested in reducing U.S. greenhouse gas emissions, I strongly suggest consideration of broad-based approaches, such as placing a fee on carbon dioxide emissions. Liquid fuel use by the U.S. military generates less than 1 percent of national greenhouse gas emissions. Targeting military fuel consumption, which is basically the impact of section 526, while ignoring the much larger civilian sources of greenhouse gas 10 emissions is not an effective approach to addressing the national security or other adverse impacts of rising atmospheric greenhouse gas concentrations.

With regard to the suggestion of “no more than five percent,” a number of “conventional” petroleum products that government is allowed to purchase are characterized by lifecycle greenhouse gas emissions that are above 5 percent of the U.S. average. For example, fuels produced from heavy oils produced in California or imported from Venezuela exceed the 5 percent threshold.

Question 10. With respect to your testimony on section 7 of S.937 (Multi-year contract authority for DOD procurement of alternative fuels), do you have any comments on the manner in which the Congressional Budget Office currently scores such long-term contracting authority? Do you feel their accounting methodology is a true and accurate representation of the actual cost to the federal government? Does it account for the cost savings accrued over the lifetime of the contract or for the fact that the federal government would be purchasing some form of fuel, electricity, etc. anyways?

Answer. These specific questions deal with issues that we have not examined and, therefore, respectfully defer comment.

Question 11. In 2007 you testified in front of Congress that the BLM should “rescind the requirement to prepare a programmatic EIS for a commercial leasing program [for oil shale],” and instead you recommended that the federal government phase in a process based upon research results. Last month, you testified in front of the House Energy and Commerce committee that “It would not be advisable to develop detailed regulations . . . until more information is available on process performance and impacts.” Just last week, in front of the same committee you stated in written testimony that the 2008 commercial leasing regulations are “seriously deficient.” Can you say more? Does the rush to lease jeopardize the development of oil shale?

Answer. The research that we conducted on oil shale in 2004 and 2005 indicated that not enough information was available to assess the environmental impacts of large scale oil shale development. Major information shortfalls included:

1) Options for mitigating damage to plants and wildlife;

2) Reducing uncertainties associated with ecological restoration after oil shale production activities;

3) Understanding the subsurface environment, including hydrological, geochemical, and geophysical phenomena that could result from oil shale development; and

4) The air and water emissions associated with advanced processes for oil shale development.

It was and continues to be our judgment that these information shortfalls preclude moving forward with a programmatic EIS for a full-scale commercial leasing program.

The written testimony provided to the Energy and Power Subcommittee of the House Energy and Commerce Committee on May 5 and June 3 and to the Senate Energy and Natural Resources Committee on June 7 represents our current perspective on the challenges of moving forward with oil shale development. The emphasis should be on obtaining information from a limited number of pioneer facilities. The leasing program should be designed to motivate investment in such pioneer plants. A rush to a commercial leasing program could seriously jeopardize the development of oil shale and could result in adverse socioeconomic and environmental impacts that could have a profound effect on northwestern Colorado and northeastern Utah.

Question 12. Last month you testified in front of a house committee that in regard to oil shale development, “It would not be advisable” to proceed with “full-blown commercial development” until we know more. How much do we know about the research that is going on, whether it will bring us to a point where we can even contemplate commercial development of America’s oil shale resources? In the past,

you've also raised concerns about water quantity and quality. Has research addressed these concerns?

Answer. Formal research by RAND on oil shale terminated with publication of our 2005 report. Since then, I and other staff have tried to maintain an awareness of what progress is occurring. With regard to the four information shortfalls discussed in the answer to Question 11, we are not aware of significant progress, although certain firms interested in oil shale development may have information that is not publicly available. Government support of research that would address these information shortfalls is very small.

Question 13. What can you tell us about other attempts to develop oil shale around the world; Estonia being the nation that is mentioned the most often? What can you tell us about these other experiences with oil shale? What have been the results? Is it the case that Estonian is struggling to manage the tremendous volumes of toxic waste from their years of oil shale development?

Answer. In Estonia, oil shale is primarily used as a solid fuel for the generation of electric power. A small amount is converted to a liquid fuel, all of which is used in power generation or 12 cogeneration plants. To our knowledge, oil shale in Estonia is not used to produce transportation fuels. A recent environmental assessment of oil shale produced and consumed in Estonia indicates severe impacts have occurred. These include subsidence over underground mining areas, overexploitation of underground waters, pollution of surface and underground waters, and the emission of hazardous air pollutants (Gavrilovaa, Olga, et al, "A life cycle environmental impact assessment of oil shale produced and consumed in Estonia," Resources, Conservation and Recycling, Volume 55, Issue 2, December 2010, Pages 232-245).

China also produces a small amount of liquid fuels from oil shale. We have not been able to locate information on the environmental impacts of oil shale production in China.

RESPONSES OF JAMES T. BARTIS TO QUESTIONS FROM SENATOR PORTMAN

Question 14. Would you see it as a positive step for development of domestic energy resources if government agencies—the Department of Defense specifically—were given authority to enter into long term purchasing agreements for alternative fuels?

Answer. This question is similar to Question 6 posed by Senator Murkowski. Please see Answer 6.

Question 15. Would those long term purchasing agreements assist alternative fuels developers in obtaining the private financing they need to move forward with projects?

Answer. They could if such purchasing agreements protected investors against the risk that world oil prices might drop for an extended period during the financial lifetime (about 20 years after operations commence) of an alternative fuel project. In particular, if DoD were given authority to grant long-term contracts, it could offer price floors to investors to protect them against low world oil prices. To balance this benefit to investors, DoD could require price discounts during periods of high oil prices. To be more cost-effective, however, fuel contracts designed to promote early commercial production should be part of a broader package of incentives, such as investment tax credits, accelerated depreciation, and loan guarantees. The RAND analysis also argues against long-term contracts that establish a guaranteed or fixed price without recourse to adjusting prices. Such agreements are rarely observed in contracts between private parties and are far less likely to serve the federal government's interests. More of this is discussed in Camm, Bartis, and Bushman, Federal Financial Incentives to Induce Early Experience Producing Unconventional Liquid Fuels, Rand Corporation, TR-586-AF/NETL, 2008.

Question 16. How effective would you say the Department of Energy has been in utilizing its Loan Guarantee Program?

Answer. Loan guarantees can strongly encourage private investment. However, they encourage investors to pursue early alternative fuels production experience only by shifting real default risk from private lenders to the government. By their very nature, the more powerful their effect on private participation, the higher the expected cost of these loan guarantees to the government. In addition, loan guarantees encourage private investors to seek higher debt shares that increase the risk of default and thus increase the government's expected cost for providing the guarantee. Consequently, it is appropriate that the government should take great care in employing loan guarantees to promote early experience in producing alternative fuels.

RAND has not conducted an analysis of the effectiveness of the Department of Energy in utilizing its Loan Guarantee Program, and therefore the preceding obser-

vations should not be interpreted as justifying the pace or portfolio of the Department of Energy's loan guarantee program. It is my understanding that the Department of Energy has not yet made a commitment, either conditional or final, to provide a loan guarantee to any project that would produce an alternative liquid fuel.

Question 17. Are you familiar with section 526 of the 2007 Energy bill and the restrictions it places on the federal government's ability to purchase alternative fuels? Does that policy make any sense in a world where energy prices are spinning out of control and we are increasingly dependent on foreign energy sources?

Answer. I am familiar with section 526 and the restrictions it places on the federal government. Please see my responses to Question 5 from Senator Murkowski and Question 9 from Senator Udall.

RESPONSES OF JOE COLVIN TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Your testimony mentions other countries pursing small modular reactors, can you describe these efforts?

Answer. There is significant international interest in the field of small modular reactors (SMR) given the potential benefits and uses of this technology for mankind. The major countries pursuing SMRs, in addition to the US, are Russia, China, Argentina, South Africa and Japan. There are currently 16 specific SMR designs from these countries that are well-advanced and that are believed to be at the forefront of the initial designs being pursued.

Question 2. What do you think will be the hardest element to licensing small modular reactors?

Answer. From the licensing perspective, the hardest element will likely be the safety criteria and design requirements set by the Nuclear Regulatory Commission (NRC) from two important perspectives:

I. First, the NRC needs to determine the necessary safety case for SMRs from a thorough evaluation of the steps necessary to protect the public health and safety. This must recognize the unique design considerations of the technologies, rather than just to apply the regulatory requirements currently used for larger reactor technologies. The unique designs of SMRs will result in safer plants, rely on natural phenomena such as natural circulation, not on power-driven pumps, likely be located below ground, rely on inherently safe considerations that do not require the typical containment structures, etc. Applying the current regulatory requirements, as is, will likely lead to SMRs not being viewed as viable by customers in the future.

II. Second, many of the new technologies are in areas outside the typical light-water reactor technology currently licensed in the US. The NRC does not currently have the expertise necessary to evaluate the designs, safety cases and technology of the advanced SMRs, such as high-temperature gas reactors and fast reactor technology. It's important that the NRC, working with the DOE and industry, develop this expertise to allow efficient and effective licensing of these advanced concepts.

Question 3. Given your experience with the nuclear industry and their utilities trending over the last 40 years towards large 1000 MW reactors with economies of scale, do you think small modular reactors will be adopted by this same market?

Answer. Clearly the economies of scale and the economics of the SMR technology will determine if SMRs are adopted by utilities in the US and around the world. Many of the US companies interested in building new reactors are interested in larger reactors in the range of 1000MWe to 1500MWe; however, there are many other smaller utilities in the US that would likely be interested if the SMR technology is proven—utilities whose systems could not support the addition of a large reactor or those utilities that desire to shut down older coal-based units and replace them with non-emitting generation sources. Outside the US, there will be many applications for SMR technologies, once proven, since most of the developing world could take full advantage of the smaller capacity of SMRs and then add additional plants as needed.

Question 4. Your testimony mentions the early relationship of these reactors with Navy prototypes, my understanding is Naval power reactors are substantially different in design and operation than small modular reactors—is that true?

Answer. The US Naval Submarine reactor programs were clearly the first SMRs and were the foundation of many of the technologies that are being used and/or developed today. For example, the 10MW light-water reactor for the first nuclear submarine, USS Nautilus (SSN-571) formed the basis for the initial commercial designs. The second submarine reactor on the USS Sea Wolf (SSN-575) was a liquid

metal sodium-cooled intermediate reactor using thorium fuel. A number of the currently proposed SMRs intend to use liquid metal cooling with a fast reactor fuel, including thorium-based technologies.

At the same time, submarine reactors have many differences in the designs due to their intended purpose. For example, the majority of the reactor output of a submarine reactor is used for propulsion and the reactor needs to be able to change power very rapidly to meet tactical conditions. Additionally, reactor design criteria such as power density, length of time between refueling, etc. result in design considerations different than for SMRs used in power generation, steam production or desalinization applications.

RESPONSES OF JOE COLVIN TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1. (S. 512 and S. 1067)—What is the biggest hurdle that needs to be overcome for all components of a small modular reactor to be manufactured in the United States?

Answer. The loss of US manufacturing capability for large reactor components and equipment is a serious concern. The current global marketplace for nuclear components and equipment is likely to continue until there are sufficient markets to warrant the investment in new plants and equipment in the US. There has been some recent investment in new facilities in the US for reactor construction in Virginia and in Louisiana; however, these facilities will provide only part of the equipment and components for new reactors. New facilities will be built when the growth in new reactor construction in the US expands significantly.

Question 2. (S. 512 and S. 1067): In order for any SMR to move forward, there must be interest from a user. What are you hearing from utilities about their interest in SMRs?

Answer. There is significant interest and support from US utilities in new SMR technology. For example, the Tennessee Valley Authority recently announced a partnership with B&W for the m-reactor project and desires to pursue the development of a prototype to prove the technology for future applications and sales. In the end, the utilities are interested in keeping all their options open for SMR technology. Once SMRs are proven to be safe, licensable and competitive, there will be increasing interest and use of this promising technology.

RESPONSES OF EDWIN LYMAN TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Fukushima Daiichi involved an accident with several reactors all adjacent to each to other, do you see a similar safety concern with multiple small modular reactors sited adjacent to each other as proposed by many vendors?

Answer. In light of the Fukushima Daiichi accident, I do see a safety concern with co-located multiple small modular reactors (SMRs) in close proximity that should be addressed by the Nuclear Regulatory Commission (NRC) in SMR licensing. In its June 2011 report to the International Atomic Energy Agency, the Nuclear and Industrial Safety Agency of Japan (NISA) stated that

> The accident occurred at more than one reactor at the same time, and the resources needed for accident response had to be dispersed. Moreover, as two reactors shared the facilities, the physical distance between the reactors was small and so on. The development of an accident occurring at one reactor affected the emergency responses at nearby reactors.
>
> Reflecting on the above issues, Japan will take measures to ensure that emergency operations at a reactor where an accident occurs can be conducted independently from operation at other reactors if one power station has more than one reactor. Also, Japan will assure the engineering independence of each reactor to prevent an accident at one reactor from affecting nearby reactors. In addition, Japan will promote the development of a structure that enables each unit to carry out accident responses independently, by choosing a responsible person for ensuring the nuclear safety of each unit."

These lessons need to be studied by the NRC, which has acknowledged that some of its current regulations and procedures do not account for events affecting multiple units on a site. For instance, according to the NRC, emergency planning regulations focus on single-unit events with regard to requirements for emergency operations staffing, facilities and dose projection capability. Also, the NRC's guidance for probabilistic risk assessment, an analysis tool which is used in many regulatory applications, does not require the consideration of multiple-unit events.

It is also clear that NRC will need to consider these issues in developing its licensing approach for small modular reactor sites, which may host two to four times the number of units present at the largest U.S. nuclear plant site today. As I pointed out in testimony, prior to Fukushima SMR vendors called for relaxing NRC staffing requirements for multiple modules, which would tend to decrease, rather than increase, the independence of modules at a site. In the aftermath of Fukushima, such requests need to receive very careful scrutiny.

Question 2. What concerns you, technically, in the licensing process at the NRC for these small reactors?

Answer. At present the NRC has almost no regulations specific to small modular power reactors. Small reactor vendors are lobbying the NRC to weaken certain requirements for small reactors based on a perception that they will be safer. My chief concern is that there is inadequate justification at this point for licensing small reactors to a lesser standard than large reactors. The Fukushima disaster has shown that nuclear safety standards need to be raised for all plants. To the extent that small reactors have inherent safety features relative to large reactors, they can be part of this solution, but not if standards for small reactors are weakened.

One aspect of NRC's licensing approach for small modular reactors that I find particularly troublesome is a recent proposal to "risk-inform" the reviews of small modular reactor applications.[1] This proposal would use probabilistic risk assessment (PRA) information to assess which systems, structures and components (SSCs) of small modular reactors are the most important with regard to severe accident risk, and would downgrade the review of SSCs that are determined not to be "risk-significant." But the Fukushima accident has called into question the nuclear community's understanding of risk for reactor types that have been operating around the world for decades. In particular, equipment that could have mitigated the outcome of the Fukushima accident was not available for use because it was not sufficiently well-protected. Similar equipment at U.S. plants is not considered "risk-significant" and therefore is not required to have high reliability or survivability. This misperception of risk is likely to be even greater for new plant designs, since their PRAs are only paper studies that have not been validated with plant operating data. I am concerned that the NRC's proposal would put too much weight on these theoretical studies in small modular reactor licensing reviews and as a result could fail to thoroughly evaluate important contributors to plant risk in the real world.

Question 3. Do you believe some of these reactors as proposed are truly passive in their safety features, that is they can shut down and cool themselves without intervention?

Answer. I am not aware of any credible reactor design that is truly passive and can shut itself down and cool itself in every circumstance without any potential need for intervention. Some reactor designs, large or small, have certain passive safety features that allow the reactor to depend less on operator action for a limited period of time following designbasis accidents. Small reactors may have an advantage here because the lower the power of a reactor, the easier it is to cool through passive means such as natural convection cooling. But generally all passively safe reactors require some features, such as valves, that are designed to operate automatically but are not one hundred percent reliable. And operators will always be needed to monitor systems to ensure they are functioning as designed, and to intervene if they fail to do so. Both passive systems and operator actions would require functioning instrumentation and control systems, which have been shown to be unreliable during severe accidents both at Three Mile Island and Fukushima. It is unrealistic to expect any reactor design to be completely passive in every contingency, and as result passive designs should also be equipped with highly reliable active backup systems and associated instrumentation and control systems.

Question 4. Many people believe that small modular reactors can be used in geographically remote locations or with smaller utilities than would be for large reactors—this seems simplistic to me—can you comment on this?

Answer. In my view, small modular reactors are not suitable for deployment in remote locations unless there is an established infrastructure to cope with emergencies, and if sufficient numbers of trained operator and security staff can be provided. In light of the answer to the previous question, it is unrealistic to assume the availability of small reactors that are so safe they can be shipped around the world without the need to ensure the highest levels of competence and integrity of local regulatory authorities, plant operators, emergency planning organizations and security forces. Fukushima has demonstrated the importance of timely off-site response in the event of a severe accident, so the accessibility of reactors in remote

[1] R.W. Borchardt, "Use of Risk Insights to Enhance the Safety Focus of Small Modular Reactor Reviews," SECY-11-0024, U.S. Nuclear Regulatory Commission, February 18, 2011.

locations also must be a prime consideration. Even within the U.S., small utilities with little or no experience in operating nuclear plants need to fully appreciate the unique challenges and responsibilities associated with nuclear power and should not expect that small modular reactors will provide any relief in this regard.

RESPONSE OF EDWIN LYMAN TO QUESTION FROM SENATOR MURKOWSKI

Question 1. (S. 512 and S. 1067)—Could you describe how a light-water small modular reactor (SMR) would have fared if faced with similar conditions at the Fukushima Daiichi power plant? (S. 512 and S. 1067)—Much of your testimony is directed at the concern that the Nuclear Regulatory Commission will weaken regulatory requirements for SMRs. In your view, do all of the requirements need to be the same for small and larger reactors? Capital costs aside, if a site is only being used for a 300 megawatt reactor—to replace an existing coal power plant—or a single 50 megawatt reactor for off-grid applications, should the emergency planning zone requirements be the same as a 1200 megawatt reactor?

Answer. It is difficult to say in general how any light-water small modular reactor would have fared under the conditions experienced at Fukushima Daiichi. That would depend on many factors, including the plant design basis, siting characteristics, the size, number and separation of modules on site, the level of operator staffing, and the adequacy of the emergency procedures. While heat removal requirements would be less challenging for a single small reactor than a single large one, on a per-megawatt basis (that is, if one 1250 MW plant is replaced with ten 125 MW modules, for example) the difficulty of coping with multi-unit accidents could well outweigh this advantage. And for any plant, large or small, the key factor is the most severe event that the plant is designed to withstand. No reactor, large or small, can be expected to survive an event significantly beyond its design basis, and that is why post-Fukushima nuclear safety standards for new reactors need to be strengthened across the board. If the NRC weakens standards for SMRs based on an erroneous perception of their safety relative to large reactors, SMRs may well end up less able to cope with a severe event.

RESPONSES OF BRIAN SIU TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. I do not understand how increased demand for electricity to power electric cars is relevant to EPA's assessment of "best available control technology." Could you explain how these are related to each other, and what policy change might result from tying the two together, as they are in Sec. 8 of S. 937?

Answer. NRDC finds the implementation pathway for section 8 of S. 937 to be unclear. The provision appears to allow on-road emissions reductions due to electric vehicle deployment to be taken into account when determining best available control technology for power plant pollution. Yet the bill's language is extremely vague, lacking rules or parameters to guide how these offsets would be determined, measured, monitored or otherwise applied. For instance, it does not explain which pollutants could be considered or how they would be measured. Nor does it explain how baseline emissions would be evaluated. In order to determine an offset for BACT, one must know what the consumer would have bought if an electric vehicle were not chosen. Without that information, it would be impossible to determine the pollution reduction that actually took place. Yet, no such guidance is provided under section 8 of the bill. For these reasons it is difficult to predict if and how this provisions could be implemented.

Assuming that section 8 could be implemented, the provision poses serious risks to public health and welfare. As mentioned, it appears to use on-road pollution reductions from electric vehicle deployment to justify laxer pollution controls for power plants. For instance, if electric vehicles were able to reduce on-road NOx emissions, those reductions could apparently be taken into account when determining BACT for the generating source. This poses serious risks to local air quality and public health because increased power plant pollution might not geographically match on-road emissions reductions. Thus, the provision would allow air quality in some regions to deteriorate based on improvements elsewhere. This would be extremely unfair to local businesses and residents who would ultimately suffer the health impacts.

Moreover, on-road emissions reductions could conceivably be applied to carbon dioxide and other greenhouse gases since BACT determinations now include global warming pollution. If so, section 8 is once again at fundamental odds with sound public policy. Allowing power plants to increase their carbon pollution would significantly undermine efforts to lower transportation sector emissions. Automakers will achieve the Administration's vehicle efficiency and tailpipe standards through range

of clean technologies, including vehicle electrification. Section 8 introduces an element of emissions leakage that allows power plants to directly negate those automaker achievements. To that extent, it would provide a windfall to the power sector at the expense of auto manufacturers that are working to provide a cleaner vehicle fleet. NRDC maintains that this is inequitable and short sighted policy that will make necessary transportation emissions reductions much more difficult.

Question 2. What would be the likely outcome if algae-based fuels that were co-located with power plants were given triple RFE credits? Would suggest favoring some algae technologies and pathways over others?

Answer. It is difficult to predict whether a credit multiplier would effectively promote algal fuels. If successful, however, it could come at the expense of other emerging biofuels since the signal could potentially divert investment from other nascent fuel technologies. This view is not intended to show disapproval or opposition to sustainably grown algal fuels in general. It simply speculates on one possible outcome of S. 937s proposal.

Environmentally, it is important to note that there is no carbon benefit to co-locating algal fuel production near power plants or other large industrial sources of carbon dioxide. Algae requires the same volume of carbon dioxide to grow irrespective of location. From a carbon accounting standpoint, it is irrelevant whether the algae takes carbon directly from the atmosphere or from a carbon dioxide stream that is imminently headed to the atmosphere. Thus, the proposal applies a triple credit multiplier where there are no significant carbon benefits relative to algae grown elsewhere.

RESPONSES OF JOHN E. KELLY TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. S. 512, the Nuclear Power 2021 Act requires cooperative agreements with cost-sharing. Can you comment on the non-federal cost sharing outlined in this bill?

Answer. Under the provisions of S.512, industry would be required to support design certification activities at a 50% cost-share level and construction and operating license activities at a 75% cost-share level. i

In balancing, the acceleration of work and the offset in risk afforded by the Government cost-share. DOE determined that at least 50% cost-share From industry for both the design certification and licensing activities was a starting point. The Department believes that a higher cost share from industry be incentivized and will include greater than 50% industry contribution as a priority rating criterion for selection.

Question 2. S. 1067, the Nuclear Energy Research Initiative Improvement Act authorizes $50 million per year for 5 years—is this adequate?

Answer. The S. 1067 Bill authorizes $50 million a year for the research element of the Small Modular Reactor (SMR) program. The Department's budget request for FY 2012 outlined a $452M, five-year program to help accelerate the commercialization of light water reactor based SMRs through a cost-shared public-private commercial application project. In addition, a research component ($28.7 million in FY 2012) was proposed to accelerate the development of more advanced SM R concepts. The Department believes that this level of funding is appropriate.

Question 3. S. 512, authorizes the selection under merit review of two candidate small reactors to begin a demonstration program lor licensing. Are these the appropriate reactor sizes to consider for licensing?

Answer. A wide range of design parameters and power levels have emerged during the recent surge in the domestic SMR market. These designs have largely been driven by what the vendors perceive to be their customers needs and requirements, including cost, incremental load growth, and aging fossil plant replacement. As such, the Department does not see the need for this bill to dictate reactor size constraints to the industry. The Department has defined the upper limit on the SMR power output as 300 MWe, and will only be considering those designs that meet this criterion in our solicitation. Beyond this constraint, we should be soliciting and selecting, projects based on the value they can provide in improving the U.S. environment, economy, and energy security and let market forces determine the precise size range.

Question 4. S. 1067, the Nuclear Energy Research Initiative Improvement Act authorizes research and development, should it also include demonstrations as well?

Answer. The Department does not plan to support demonstrations of either the near-term light water-based or advanced SMR designs.

Question 5. S. 1067 requires cost sharing—is that appropriate?

Answer. Yes. The Department expects that any RD&D activity that supports the development of technologies will be cost-shared. Any RD&D activity that supports specific designs will be appropriately cost-shared by the industry partners that receive direct benefit from that activity.

RESPONSE OF JOHN E. KELLY TO QUESTION FROM SENATOR MURKOWSKI

Question 1. Given your background with DOE and the American Nuclear Society, and your interaction with Nuclear Energy Institute and the Nuclear Regulator Commission, could you discuss some of the lessons learned from implementing the Nuclear Power 2010 program in terms of industry participation, cost sharing, and design certification that would be applicable to the Nuclear Power 2021 Act?

Answer. Nuclear Power 2010 (NP 2010) was a government-industry, 50-50 cost-shared initiative with two main goals: demonstrating the then newly revised. Nuclear Regulatory Commission's design-centered licensing approach and providing industry with information needed to make decisions to construct and operate those plants. The program concluded at the end of FY 2010.

A NP2010 lessons learned report is under development and will ultimately be available on the DOE Office of Nuclear Energy website. Key lessons learned from the NP2010 program that should be applied to SMR activities supported under the Nuclear Power 2021 Act include:

- Developing the business case and, most importantly, a Roadmap in the early phases of the program
- Encouraging the formation of utility-led industry consortia based on a specific reactor technology
- Including appropriate industry cost share (50-50 minimum)
- Including utility members of consortia in a leadership role, especially with respect to reactor technology selection
- Including utility participation in reactor design development
- Avoiding and/or tightly controlling 'in-kind' contributions on industry cost-share
- Phasing project activities and including appropriate project decision points (off-ramps) and oversight

NE is incorporating these lessons into the SMR program methodology at each stage of the program.

RESPONSES OF JOHN E. KELLY TO QUESTIONS FROM SENATOR PORTMAN

Question 1. In your opinion, with the funding outline suggested by DOE ($452 million), what is the earliest that you think the first SMR demo could be deployed and operational?

Answer. The Department believes industry is planning deployment decisions in a timerrame that could result in the first SMR plants being operational in the 2020 timeframe.

Question 2. The Administration requested $67 million for design, certification and licensing. In which of those three areas will the majority of the funding, be spent?

Answer. In FY 2012, the vast majority of the $67 million request would be for engineering work-to support design related activities. Total expenditures for Nuclear Regulatory Commission design certification and licensing are modest by comparison. Perhaps two-thirds to three-quarters of the cost will be associated with design activities, recouizing that there arc some grey areas or overlaps between these activities and that there would be some discretion on how costs are allocated between the activities.

Question 3. Small Modular Reactors have received increased attention since the disaster in Japan. SMR designs are considered "highly passive," meaning if there is a situation where the reactor is disconnected from the grid, the safety functions of the unit can still engage and ensure that the reactor is shut down without an external incident. Dr. Pete Lyons, Assistant Secretary of the Office of Nuclear Energy at the Department of Energy, highlighted this fact in March at the Senate Energy of Natural Resource Committee's briefing on Japan. Can you speak in more detail about these particular safety functions?

Answer. All of the currently proposed light water-based SMR technologies have been designed to provide long-term cooling via natural circulation after accidents that may result in a loss of powered systems. This means that the circulation ofwater over the fuel is driven by thermal gradients and gravity, so there is no need for powered pumps. This passive cooling capability does not require emergency generators or additional operator actions to continue cooling a reactor core. Some designs utilize natural circulation cooling for normal operation as well. Most of these designs also integrate the primary system components within the reactor pressure

vessels, which could significantly reduce the possibility for large-break loss-of-coolant accidents. SMRs also employ smaller cores requiring less water to cool.

Question 4. The economics of natural gas have changed significantly in the past couple of years. Prices have dropped significantly since 2008 and many are saying that prices will remain low and stable for the significant future. In your opinion, at what price level must natural gas be for S'AVIRs to be competitive?

Answer. At the current market price for natural gas, existing options for electricity generation are not competitive based solely on a cost per kilowatt basis. however, significant long-term investments in electrical generation capacity must consider more than current fuel prices. Utilities adding future capacity will consider price volatility, diversity of supply, the amount of capital cost and financing, project risks, and policy considerations. For example, natural gas price volatility over time and policies to curb greenhouse gases could affect electricity' generation choices.

While it is premature to provide a specific price range for SMRs to compete favorably with natural gas at present, the Department thinks that tinder certain circumstances, future (nth of a kind) SMRs can be competitive with both large baseload nuclear plants and the historical mean price for natural gas. In addition. SMRs offer potential buyers a lower (or incremental) capital investment. lower interest costs and a shorter construction schedule than the large nuclear plants.

RESPONSES OF STEVEN G. CHALK TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. Could you please explain to us what changes in Administration policy would result from the repeal of Sec. 526 of the Energy Independence and Security Act of 2007, as called for in S.937? Is it likely that government purchasing decisions would be altered in any way?

Answer. The Department has not analyzed what changes in Administration policy would result from the repeal of Sec. 526 of the Energy Independence and Security Act of 2007, as called for in S. 937. Sec. 526 of EISA 2007 is consistent with the goals contained in Executive Order 13514 and is an effective provision in helping meet the Administration's greenhouse gas reduction goals.

Question 2. Could you explain to us how the changes to the DOE loan guarantee program proposed by S. 937 would affect DOE's decisions about what projects are awarded loan guarantees?

Answer. The Administration is still reviewing S. 937 which proposes an expansion of section 1703 eligible projects to include substitute natural gas production facilities. DOE is concerned that the reporting requirement proposed in S. 937 could have detrimental effects on the Department's ability to review loan guarantees effectively.

RESPONSES OF STEVEN G. CHALK TO QUESTIONS FROM SENATOR MURKOWSKI

Loan Guarantees for Fossil Projects (S. 937)

Question 1. The 2005 Energy Bill names "coal gasification" as eligible for support under the loan guarantee program that the law created. As you are aware, coal is abundant in the United States and a very affordable option for consumers. Not only does gasification make coal use cleaner, but it can also diversify the products we make with it, including electricity, fuels, plastics, fertilizer, and other commodities.

Please describe the level of interest the coal sector has shown in the loan guarantee program, and the status of the Department's support for coal-utilizirw, projects that have sought guarantees. How does that compare to guarantees considered in other sectors?

Answer. The Loan Guarantee Program has received several fossil applications in the section 1703 program.

Oil Shale (S. 937)

Question 2. DOE has estimated that our technically recoverable oil shale resource base is potentially greater than one trillion barrels. Please describe what DOE is doin4 to help commercialize this potentially massive resource. Is your Department coordinating its efforts with the Department of Interior?

Answer. DOE worked closely with the Department of the Interior and other representatives of the Unconventional Fuels Task Force (established under subsection 369(h) of the Energy Policy Act of 2005) in developinv, the Task Force's initial report and program plan to expedite commercialization of unconventional fuels, including oil shale. The initial report and the program plan are available on the Task Force's website at www. unconventionalluels.org.

RESPONSES OF STEVEN G. CHALK TO QUESTIONS FROM SENATOR MANCHIN

Question 1. During my tenure as Governor of West Virginia, I chaired the Southern States Energy Board for one year we released a study, the American Energy Security Study, which evaluated opportunities to use coal and biomass as transportation fuel feedstocks. Are there legislative actions we could take to enhance the American Alternative Fuels Act of 2011 to provide more market opportunities for coal-derived fuels?

Answer. Conversion of.coal to transportation fuels is a mature technology. The Energy Information Administration's (ER) Annual Energy Outlook 2011 projects that world oil prices will he just under $125/barrel in 2035 (2008 $/barrel). Given ETA's long-term projection and current world oil prices, which are near $100/barrel as of June 13, 2011, industry is best positioned to evaluate market opportunities to proceed with commercial production of transportation fuels derived from coal.

Question 2. Over the past several years, RAND has studied various mechanisms to stimulate the creation of a broader alternative fuels industry in the United State using domestic resources. Are you in a position to identify the mechanisms that would be most effective in encouraging the necessary investment in projects to produce alternative fuels from domestic energy resources?

Answer. DOE is familiar with RAND's work on this issue, and representatives from DOE's Biomass Program have met with an author of RAND's recent study, "Alternative Fuels for Military Applications." Alternative fuels are a critical component of DOE's strategy to lessen our dependence on oil while creating business opportunities and jobs in the United States. Biofuels derived from domestic biomass can potentially provide a cost-effective alternative to oil and, depending on the choice of feedstock, can contribute to national environmental goals, by helping reduce greenhouse gas emissions.

Private sector investment is necessary for creating meaningful growth in the U.S. alternative fuels industry, and DOE and other agencies can play an effective role in stimulating this investment through a variety of mechanisms. In our discussions with investors and prospective binfuel producers, we have identified four main sources of risk that discourage private investment: (I) feedstock supply risk; (2) fuel-production technology risk; (3) product offtake risk; and (4) regulatory stability risk.

For (1) and (2), both USDA and DOE have been supporting projects ranging from R&D to small-scale trials and up to "pioneer" commercial scale plants in order to improve and demonstrate the necessary technologies at scale. Continuing these research, development, and demonstration efforts for emerging, new crops and conversion technologies should encourage private investors in these areas.

For (3), there are two factors. First, long-term fuel-purchase contracts are virtually unknown in private industry, and limited by law to 5 years for Department of Defense purchases. Second, crude oil prices (and therefore fuel prices) are exceedingly volatile. Even though the long-term trend of increasing oil prices justifies investment in alternative fuels, the volatility of crude oil prices can deter investors clue to the significant downside risk when crude oil prices are low.

For (4), the issue is that advanced biofuels will entail huge investments both for farmers (new, perennial crops and the equipment to plant and harvest them) and fuel producers (costly new biorefineries).

APPENDIX II

Additional Material Submitted for the Record

NUSCALE POWER,
Portland, OR, June 7, 2011.

Hon. JEFF BINGAMAN,
Chair, Committee on Energy and Natural Resources U.S. Senate, Washington, DC.

RE: S. 215, a bill to promote small, modular scalable nuclear power reactors, public witness testimony for the record.

DEAR MR. CHAIRMAN AND RANKING MEMBER,

On behalf of NuScale Power, Inc. of Corvallis, Oregon we are writing in support of your efforts to enact S.215, as currently drafted and introduced in the Senate and which was passed in identical form by your committee last session. We believe that the creation of a U.S. based, nuclear manufacturing industry will significantly contribute to our nation's long-term economic goals and help the U.S. sustain and grow the existing 20 percent contribution to our electricity needs from clean, non-emitting nuclear power.

There is a great deal of urgency in these efforts as the U.S. already faces stiff competition from overseas vendors. With quick and proper action, I believe we can preserve much of the U.S. market share and compete successfully in overseas markets because of our superior design features and the commitment to safety in the U.S. that is unsurpassed around the world.

Small, modular reactor technologies build on a rich history of American innovation and world class nuclear design, manufacturing and operations. The President has recognized the need for nuclear power as part of a comprehensive energy, environment and employment strategy for this country, including new financial incentives. NuScale is ready to deliver:

- NuScale Power owns and operates a one-third scale test facility on the campus of Oregon State University. It is in use to document critical tests required to comply with NRC design certification and licensing. The next phases of regulatory approval are costly in the U.S. and require federal support.
- Since last year, NuScale Power has conducted extensive discussions with various government operations centers managed by both DOE and DOD. We are in the process of scoping both research and deployment opportunities that have the potential to benefit the federal government directly by lowering the facilities' long term costs and reducing their greenhouse gas impacts as an electric power consumer.
- NuScale Power has committed to construct a full-scale control room simulator to specifically address digital instrumentation, control and human factors analysis that will be integrated in all of the next generation nuclear plants, regardless of size. NRC staff has visited Corvallis to review these plans and provide their input.
- As confirmed by a panel of independent experts whose work was presented to the NRC in September 2009, NuScale Power has achieved safety margins that are 10 times safer than the previous generation of nuclear plants. This translates into improved public safety and better financial risk management.
- NuScale Power's inherently safe technology has received considerable attention since the natural disaster and ensuing nuclear accident in Japan. We have developed a nine-page safety illustration that can be viewed on our website, www.nuscalepower.com. It shows how our reactor and spent fuel pool might have responded to similar events. From what we know now, the results are very positive.
- Finally, in addition to the President's leadership in requesting funding for research, development and demonstration of small, modular reactors, the Nuclear Regulatory Commission and its staff have also continued to provide on-going li-

censing support efforts in their own separate budget request. In a Commission briefing held in March 2011, NRC staff outlined for the Commission the planned approach to licensing SMRs. Staff concluded by saying, in essence, "It's not a matter of whether we can license these plants but how we best proceed." This was encouraging to us, and is a positive sign that Congress can move forward with taxpayer dollars to support the licensing efforts.

Our company experienced a temporary financial setback earlier this year but we are receiving considerable interest in new funding from investors that include American manufacturers, fabricators, suppliers, constructors and investment firms. We have advised DOE that we expect to be in a position to compete for Federal cost-sharing dollars as early as FY2011 if the program is approved by Congress.

NuScale Power wants to thank you, the other cosponsors of this legislation and other members of the committee for the support you are providing to SMRs. We look forward to continued work with you and your staff.

Sincerely,

PAUL G. LORENZINI,
Chief Executive Officer.

STATEMENT OF STEVEN STERIN, PRESIDENT, ADVANCED FUEL TECHNOLOGIES, CELANESE CORPORATION, ON S. 937

Mr. Chairman and members of the committee—On behalf of Celanese Corporation (Celanese), I am pleased to offer the following statement to be entered into the hearing record.

Mr. Chairman, we believe that our federal fuels policy should be feedstock and technology neutral, should promote domestic fuel sources and should be subsidy free.

Celanese Corporation will deliver a fuel that adheres to each of these concepts, provided federal regulations do not discriminate against our process for producing ethanol from basic hydrocarbons such as natural gas and coal.

Celanese is a leading global technology and specialty materials company that makes a broad range of products essential to everyday living. Headquartered in Dallas, Texas, Celanese employs approximately 7,250 people worldwide, including 2,350 in the U.S. Our products, manufactured in the Americas, Europe and Asia, are found in many consumer and industrial applications and deliver value to customers around the globe with innovative solutions using best-in-class production technologies. It is from this expertise that I derive my comments for today's hearing.

Celanese commends the Senate Energy & Natural Resources Committee for considering S. 937, the American Alternative Fuels Act of 2011. This legislation would expand the opportunities for domestic fuel production using traditional hydrocarbon feedstocks. Celanese believes that new, ground-breaking technologies within the energy and fuels industries can help alleviate the high cost of gasoline consumers are facing at the pump, be part of a solution to broader energy security concerns about our dependence on foreign petroleum and minimize some of the unintended consequences of the current federal policy on transportation fuels.

Celanese has developed and is in the process of commercializing a game-changing process to produce ethanol from basic hydrocarbons, and we can do so in a much more water-and energy-efficient manner than the traditional fermentation process. In addition, under today's market conditions, we will be able to produce ethanol for approximately $1.50 per gallon—a fraction of the current per gallon cost of corn-based ethanol or gasoline. Because of this, Celanese could compete with traditional ethanol even without a subsidy from the federal government.

Celanese is concurrently intends to commercialize its technology both domestically at our Clear Lake, Texas facility and at our wholly owned operation in Nanjing, China. In China, the growing demand for additives that promote cleaner burning gasoline faces concerns about the diversion of food sources such as corn to produce fuel. This country faces a similar dilemma. Public policy in the United States, however, would preclude our product from competing in the current fuel ethanol marketplace.

Current transportation fuels policy is dictated largely by the Renewable Fuels Standard (RFS), which was established by the Energy Policy Act of 2005 and amended by the Energy Independence and Security Act of 2007. The RFS created a federally mandated marketplace designed to promote the development of domestic renewable fuel technology and production capacity. This new capacity would replace the use of traditional fuels based on petroleum, much of which is imported from foreign countries. The RFS establishes specific feedstock and fuel definitions that cre-

ate fuel categories, which are then required to be produced and used at volumes prescribed on an annual basis. While well-intentioned, the structure of the RFS is overly rigid and does not lend itself to ongoing advances in technology and processes that can fall outside the original definitions outlined in statute, even those that may address the underlying purposes of the RFS.

Celanese's groundbreaking technology is a perfect example of these limitations. Our technology is not only capable of producing ethanol at a fraction of the cost of traditional fermentation, but it also can more quickly ramp up production of advanced biomass-based fuels. Under the current RFS regime, however, we could not sell our fuel into the mandated U.S. marketplace, forcing the company to look to other markets around the world to deploy this technology.

In addition to the statutory prohibition, the RFS creates an over-reliance on the agricultural community to grow the feedstocks necessary to produce the bulk of the 36 billion gallons of fuel required by 2022. This over-reliance has resulted in a number of unintended consequences. For instance, the RFS's diversion of traditional food and animal feed crops to the fuel sector has negatively impacted a number of industries that depend on these products. Corn prices today are near historic highs, leaving little margin should natural disasters or other events disrupt the normal growing season. Celanese believes diversifying the use of feedstocks to produce renewable and alternative fuels would greatly enhance our overall ability to meet the growing energy and fuel demands facing the nation and mitigates these unintended consequences.

Celanese commends the committee's consideration of S. 937 because our company believes that public policy surrounding transportation fuels should be technology and feedstock neutral. Such neutrality would unlock the full potential of American ingenuity and make better use of our abundant natural resources. We encourage the committee to continue exploring the potential of all new and emerging technologies. Celanese stands ready to add its expertise to this issue and would be pleased to provide additional information to the committee, its Members and staff.

Thank you for this opportunity to offer our thoughts on the committee's important work.

STATEMENT OF MARVIN S. FERTEL, PRESIDENT AND CHIEF EXECUTIVE OFFICER, NUCLEAR ENERGY INSTITUTE

The Nuclear Energy Institute[1] (NEI) appreciates the committee's continuing recognition of nuclear energy's essential role in achieving three strategic U.S. goals: energy security, environmental protection and economic development. Your vision and leadership will help America achieve the clean energy future we want while creating the high quality jobs we need.

Specific to today's hearing, NEI's comments are focused on S. 512, the Nuclear Power 2021 Act, and S. 1067, the Nuclear Energy Research Initiative Improvement Act of 2011, which we broadly support. The Nuclear Power 2021 Act will help accelerate the development and deployment of small modular reactors (SMRs) in much the same way that the highly successful Nuclear Power 2010 program helped to commercialize the large, advanced nuclear plants now being built in the United States and overseas, including those expected to be licensed in the United States later this year. The Nuclear Energy Research Initiative Improvement Act of 2011 will direct research to drive down the cost of manufacturing and constructing nuclear power systems, including small reactors.

Small Reactor Development Advances Energy, Environmental Benefits in New Markets

Small-scale reactors can complement large nuclear plant projects by expanding potential markets in the United States and abroad for carbon-free energy production. Smaller reactors provide energy companies and other users with additional options to achieve energy and environmental objectives.

Their small size-less than 300 megawatts-and innovative features like dry cooling expand the range of sites suitable for deployment to include remote and arid regions. These and other attributes make them well-suited to repower some of the

[1] The Nuclear Energy Institute is the industry's policy organization, whose broad mission is to foster the beneficial uses of nuclear technology in its many commercial forms. Its membership, more than 350 corporate members in 17 countries, includes every U.S. utility that operates a nuclear power plant as well as international utilities, plant designers, architect and engineering firms, uranium mining and milling companies, nuclear service providers, universities, manufacturers of radiopharmaceuticals, universities, labor unions and law firms.

50,000 MW of older coal plant retirements predicted in a December 2010 study by the Brattle Group[2], helping us achieve our clean energy goals.

Modular construction will allow these new small reactors to be built in a controlled factory setting, transported to the site by rail, truck or barge, and installed module by module, improving manufacturing efficiency and cost while reducing construction time and financing costs. Because they can be manufactured in North America to meet growing domestic and export demand, their deployment will create high-tech U.S. jobs and improve our global competitiveness.

Public/Private Partnerships are Essential to Achieve Small Reactor Deployment

The economic, energy security and environmental benefits of small reactor technologies make a strong case for accelerated market development. Work remains to design, develop and license small reactor designs. A variety of factors must be addressed to achieve this outcome. The cost and time required to design, develop, and license a small reactor is not necessarily reduced linearly with size. In addition, it takes time and resources for the Nuclear Regulatory Commission (NRC) to develop the institutional capacity to license new reactor designs.

All of these issues increase the risk and uncertainty for vendors facing expensive design and licensing challenges. Traditional partnerships among technology vendors, component manufacturers and end users are necessary but insufficient in themselves. Absent additional business risk mitigation through government incentives, the potential benefits of these small, modular reactor concepts may go unrealized, or may be realized later than desirable.

Leveraging these private sector resources through public partnerships with the Department of Energy and other government entities will accelerate these new reactor technologies to market, achieving their many benefits while helping regain U.S. nuclear leadership.

Legislation Before this Committee Contains Practical, Proven Provisions

The industry supports the intent of both S. 512, the Nuclear Power 2021 Act, and S. 1067, the Nuclear Energy Research Initiative Improvement Act of 2011. Together they can accelerate the deployment and improve the competitiveness of U.S.-developed small modular reactors.

S. 1067 authorizes the Secretary of Energy to carry out research, development and demonstration programs to reduce manufacturing and construction costs relating to nuclear reactors, including small-scale, modular designs. By focusing federal research support on programs to reduce the cost of licensing, construction and the manufacturing plant components, S. 1067 can accelerate the construction of small modular reactors.

Chairman Bingaman's Nuclear Power 2021 Act directs the Secretary of Energy to carry out programs to develop and demonstrate two small, modular reactor designs. It would seek to secure design certifications and combined licenses for the two designs by 2021. Proposals for this initiative will be made on the basis of scientific and technical merit, using competitive procedures, and taking into account efficiency, cost, safety, and proliferation resistance.

Since the Nuclear Power 2021 Act was first introduced in 2009, both the industry and the NRC have explored the option of using 10 CFR Part 50 to license the "first mover" plants of a specific small reactor design. Subsequent designs would be licensed under 10 CFR Part 52 using a combined operating license.

The Administration's FY 2012 budget request for a cost-shared program to develop and demonstrate two small modular reactor designs provides the flexibility to use 10 CFR Part 50 to license the lead plants of a specific small reactor design. The cost-shared provision of this proposed DOE program requires a minimum of 50 percent industry funding for both design certification and licensing support. This also differs from S. 512, which requires that not less than 75 percent of the funding for licensing demonstration come from non-federal sources.

Conclusions and Recommendations

NEI appreciates the committee's ongoing, comprehensive support of public-private partnerships to share the costs and risks associated with developing and licensing small modular reactors. S. 512 demonstrates the committee's vision and leadership role in deploying small reactors within the next 10 years.

Beyond legislation the committee is considering now, the industry recognizes that the committee's support has also extended to the Department of Energy's FY 2012 budget request for the LWR SMR Licensing Technical Support Program, and SMR

[2] Potential Coal Plant Retirements Under Emerging Environmental Regulations, The Brattle Group, December 8, 2010.

Research and Development. NEI thanks the committee for its bipartisan support of this funding, which is critical to help ensure our industry can meet the deployment timelines laid out in S. 512.

The intent and vision of The Nuclear Power 2021 Act and the Department of Energy's SMR activities are united, and together promise to create the partnerships that will reestablish our nation's leadership in advanced nuclear energy innovation.

NEI nonetheless encourages the committee to consider two minor modifications to S. 512 that would ensure its implementation is aligned with DOE's FY 2012 SMR cost-share program. These recommendations are:

1. Provide the Department of Energy, Nuclear Regulatory Commission, eligible vendors and utilities the flexibility to use either the 10 CFR Part 52 or 10 CFR Part 50 licensing framework, as appropriate; and
2. Apply a consistent, minimum 50 percent industry contribution to all activities included in the program.

Current regulations allow the use of either 10 CFR Part 52 or 10 CFR Part 50 for the deployment of first-of-a-kind nuclear power plants. "First mover" utilities may choose to use the 10 CFR Part 50 framework to provide necessary flexibility in the deployment of the first SMRs.

NEI believes that the use of this framework, where appropriate, would be advantageous to the committee's goal to achieve near-term deployment of small reactors. Therefore, S. 512 should be modified slightly to align with current regulatory options. In addition, the Department of Energy's Fiscal Year 2012 budget request for the SMR program includes financial cost-share assistance with a minimum of 50 percent industry contribution to support both design and licensing of selected reactor systems. NEI believes this cost-share arrangement is appropriate to the risks of both vendors and utilities, and therefore recommends that S. 512 be modified to align with the Department's request.

We urge the sponsors to combine the small reactor provisions into a single bill, and adopt the two changes recommended above.

The potential benefits of small, modular, nuclear energy plants are substantial and the technologies should be pursued and supported. These designs expand the strategic role of nuclear energy in meeting national environmental, energy security and economic development goals.

NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION,
Arlington, VA, June 9, 2011.

Hon. JEFF BINGAMAN,
Chairman, Senate Energy Committee, U.S. Senate, Washington, DC.

Hon. LISA MURKOWSKI,
Ranking Member, Senate Energy Committee, U.S. Senate, Washington, DC.

DEAR SENATORS: On behalf of over 900 not-for-profit electric cooperatives serving consumers in 47 states, I am writing to respond to a false and, frankly, demeaning statement made by the Union of Concerned Scientists (UCS) at your June 7, 2011 hearing regarding S. 512, the Nuclear Power Act of 2012. The UCS, without any foundation or apparently any facts in hand, asserted that electric cooperatives would be inexperienced or unsafe operators of Small Modular Reactors (SMRs). In fact, cooperatives successfully and solely operated two of the first small reactor demonstrations in the nation—the Elk River reactor in Elk River, Minnesota, and the Lacrosse Boiling Water Reactor in Genoa, Wisconsin. Moreover, electric cooperatives own shares of nine nuclear plants in eight states, totaling 2,710 MW of generation. In many cases, cooperatives have experienced staff on site at those plants and are members of the management teams that operate the facilities.

In Edwin Lyman's testimony on behalf of the UCS, he states:

> UCS is also concerned that reducing safety and security requirements for SMRs could facilitate their sale to utilities or other entities in the United States and abroad that do not have prior experience with nuclear power. Some SMR vendors argue that their technology is well-suited for deployment to remote areas, military bases, and countries in the developing world that have relatively low electric demand and no nuclear experience or emergency planning infrastructure. In the United States, for example, a rural electric cooperative might be interested in replacing an old coal-fired plant with a small nuclear plant. As another example, high-temperature gas-cooled SMR vendors are marketing reactors to the chemical industry worldwide for the production of process heat. However, SMRs << File: GE letter re coops and smrs.docx >> deployed in this manner would raise additional

safety, security and proliferation concerns compared to their deployment by experienced nuclear utilities. (emphasis added) 4301 Wilson Blvd.

Mr. Lyman has no grounds to imply that electric cooperative deployment of SMRs raises safety, security or proliferation concerns beyond those raised by deployment by investor-owned utilities with whom electric cooperatives frequently partner. The regulations, safety and licensing requirements set forth by the Nuclear Regulatory Commission (NRC) apply equally to all nuclear operators. And, electric cooperatives have experience operating nuclear generation successfully—as well as natural gas, coal, hydropower, wind, solar, and biomass generation. I can only speculate, therefore, that the UCS does not believe that people in "rural" areas are as effective in engineering and business as people in urban areas, or that they do not believe that not-for-profit, consumer-owned businesses are legitimate. I am disappointed that the UCS used their invitation to your hearing on this important topic to distort the committee's understanding of electric cooperatives.

To update you on current activities among electric cooperatives—Oglethorpe Power Corporation has 30% ownership of the Vogtle 3 and 4 reactors in Georgia. They are the first new nuclear plants that will be built in the nation in several decades, with help from a loan guarantee from the Department of Energy. And, thirteen generating and transmitting cooperatives from across the country are members of the Babcock and Wilcox mPower consortium that is seeking to deploy its first SMR by 2020. Cooperatives will continue to seek safe, affordable and reliable generation options for their consumers. As such, electric cooperatives support your efforts through S. 512, the Nuclear Power Act, to make licenses for SMRs a reality.

Thank you for your consideration of these facts and do not hesitate to call on me or my staff with any questions or concerns.

Sincerely,

GLENN ENGLISH.

NUSCALE POWER,
Portland, OR, June 29, 2011.

Hon. JEFF BINGAMAN,
Chairman, Committee on Energy and Natural Resources U.S. Senate, Washington, DC.

Hon. LISA MURKOWSKI,
Ranking Member, Committee on Energy and Natural Resources, U.S. Senate, Washington, DC.

RE: Union of Concerned Scientists Testimony on Small Modular Reactors (SMR's)

DEAR CHAIRMAN BINGAMAN AND RANKING MEMBER OF THE COMMITTEE,

On June 7, a representative of the Union of Concerned Scientists (UCS) testified before your committee regarding S. 512 and S. 1067, and the safety of small, modular reactors. As the President and Chief Executive Officer of NuScale Power, Inc., a company that is developing a 45MWe light water Small Modular Reactor (SMR), I am writing to challenge claims in this testimony regarding both the safety and economics of SMRs.

Enhanced Safety—A number of the new SMR designs offer an approach to commercial nuclear power that greatly enhances safety. Since I am most familiar with the NuScale design, let me speak to some of these unique features. NuScale's SMR design includes:

- An innovative approach that places each small reactor in its own steel containment vessel then submerges both in a pool of water below ground. The pool of water is so large it can absorb all the heat from every reactor module for more than 30 days until it is safely cooled after shutdown.
- A containment vessel that can withhold ten times the pressure of a conventional containment building. Because it is entirely submerged in a large pool of water, the containment vessel is highly effective at transferring heat from the nuclear fuel, if needed.
- A plant that does not require any back-up emergency electrical generators to operate the systems that remove the decay heat produced after shutdown. Instead, water continues to cool the fuel using natural circulation.
- A simple design that eliminates almost all of the pumps, pipes and valves required in a large nuclear power plant, and thus numerous traditional failure modes—no pumps to fail, no pipes to break. For these and other reasons, an independent analysis of the NuScale design estimated that it was safer by at least a factor of 10 and as much as a factor of 100 when compared to current nuclear power plants.

- Because the nuclear reactor and its containment are submerged in a pool of water inside a building designed to withstand large earthquakes, tornadoes and aircraft impact, there are added barriers between the nuclear reactor and the external environment, greatly minimizing the potential for an environmental release in the event a severe accident should ever occur.
- Because the plant and the pool of water are below ground, it is seismically more resilient and can withstand larger seismic forces.

It is clear from its testimony that the UCS had no knowledge of, or appreciation for, any of these features. The testimony rests on the dubious significance of the observation that many units may be located at a single site. While a single NuScale installation may indeed house up to 12 individual units, each would have its own individual containment, and all would be submerged in a large pool of water with a sufficient capacity to remove all the decay heat from all the units inside the facility. In the event of a situation like Fukushima, the operators can put the plant into safe long-term shutdown simply by opening valves that allow water to circulate and continue to cool the fuel. The simplicity and lack of complexity associated with the design do not compromise safety; quite the contrary, they collectively reduce risks and improve safety.

Improved Economics—For decades, the economics of nuclear power have been informed by what insiders refer to as the "economies of scale." If a plant of a particular design can be increased in size, typically the per unit costs go down. With no more thought or insight than this, UCS confidently asserts that SMRs will be uneconomic because they are small. A closer look says otherwise.

NuScale challenged this historic notion by asking a different question. If one starts with a clean sheet of paper, are there economies that are unique to a smaller plant that can be captured to improve economic performance? We discovered there are and have tried to capture that idea in what we refer to as the "Economies of Small." Those economies come first from the simplicity that allows major systems to be eliminated, and second, from the efficiencies that can be captured by moving from the construction yard to a factory floor. The experience of manufacturers in the nuclear navy bears this out. They even have a well established "rule of thumb" gained from their real world experience with submarines and aircraft carriers. According to that principle, as manufacturing moves to the factory floor, productivity improves by as much as a factor of eight. This combination of simplicity and manufacturing efficiency have allowed NuScale to produce a plant design that fully captures the advantage of reduced capital costs and thus reduced financial risk while at the same time maintaining competitive unit costs. This has been confirmed both by comprehensive engineering design and estimating efforts, and the independent reviews of industry experts.

Taken together, the prospect of an approach to nuclear power that increases safety and strengthens economics explains why SMRs have attracted the attention they have over the past three years. When one adds to this the opportunity to strengthen the domestic manufacturing base and create new export markets, one can see why S. 512 and S. 1067 serve the national interest.

There were other contentions in the UCS testimony, most of which rely on the presumption that existing regulations and regulatory agencies will somehow choose to ignore their rules for SMRs. The notion that untrained operators will be running nuclear plants is but one example. On its face, these are claims without merit.

The many professionals at NuScale Power and at our strategic partners across the U.S. appreciate the support proposed in S. 512 and S. 1067. We are committed to delivering a clean, inherently safe and economic technology that can make a profound difference in efforts to address climate change and improve the quality of life around the world. Interestingly, and contrary to the innuendo in the testimony of the UCS, NuScale is relying on the international strength of U.S regulatory oversight to build its global markets. U.S. regulatory approval has become the "gold standard" throughout the world. That is why we have chosen to gain regulatory approval in the U.S. first and use it as a platform to reach out to global markets. In short, we believe the cost-shared licensing process envisioned by this legislation assures that the U.S. regulatory oversight process will apply these high standards to the evolution of new SMR designs as they mature into the marketplace. It is a process we embrace and one which is assured by this legislation.

Sincerely,

PAUL G. LORENZINI,
President and Chief Executive Officer.

World Nuclear Association
Report: http://www.world-nuclear.org/info/inf33.html

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