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CLEAN ENERGY RESEARCH AND DEVELOPMENT

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED ELEVENTH CONGRESS

SECOND SESSION

TO

RECEIVE TESTIMONY ON THE RESEARCH, DEVELOPMENT, PRIORITIES, AND IMPERATIVES NEEDED TO MEET THE MEDIUM- AND LONG-TERM CHALLENGES ASSOCIATED WITH CLIMATE CHANGE

JANUARY 21, 2010

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CLEAN ENERGY RESEARCH AND DEVELOPMENT

THURSDAY, JANUARY 21, 2010

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

The committee met, pursuant to notice, at 10:01 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.

Today's hearing will examine the role of research and development in meeting the medium- and long-term goals associated with our energy challenges and with climate change.

The discovery of new science and the invention of new technologies is the major engine of economic growth in our time. Our investments in new energy technologies, and the science underlying those technologies, has been surprisingly deficient over the last 20 years.

We can measure this deficiency in a couple of ways. One traditional way of looking at research and development investment in a given industrial sector is to compare them to the overall sales of products in that sector. If we use this measure, our national research and development investments in medicine and biotechnology, as a percentage of sales, are about 40 times greater than our research and development investments in energy.

Another way to see the deficiency in energy related research is to look at Federal expenditures. We have a chart here. Let me have someone—Rose can hold that up. This is Federal research and development budget authority, by budget function. You can see the dotted line—or maybe you can't from where people are sitting—but the dotted line that goes down at the bottom is the one that relates to energy. This chart is part of a report just released by the National Science Foundation, shows how Federal investments in energy have compared to other areas of research and development. You can see energy technology funding and energy-related basic science are the 2 lines at the bottom of the chart.

The need for an adequate funding policy for energy science and technology is a very important topic. Secretary Chu is here to talk about this issue with us today. I want to thank him for appearing before the committee to focus our attention on this.

The disparity, between the importance of this funding and what we actually have been investing, is highlighted by the issue of climate change. Various legislative proposals before Congress require domestic greenhouse gas emission reductions of up to 20 percent below 2005 levels in 2020, and the figure of 8-percent cuts below 2005 levels in 2050.

In this fiscal year 2010 budget blueprint and during the 2008 Presidential campaign, President Obama addressed the need to stimulate new technology across a variety of sectors by proposing that we spend 15 billion annually for each of the next 10 years in the area of research and development to meet these reduction targets.

The President's belief that we need a strong technology development effort over the long haul matches up with a recent report that the National Academy of Sciences, the National Academy of Engineering issued entitled "America's Energy Future." The Academies concluded that meeting long-term goals to reduce greenhouse gas emissions will require a transformation in the way we produce and transmit and consume energy. They found that the needed transformation will only come about through sustained research and funding.

The need for a whole suite of new energy technologies is also being taken seriously by our international competitors, such as Japan. Here is a chart that I've shown before in the committee. This is one the Japanese have prepared, called Japan's Cool Earth 50 Program, which is a coordinated effort between government and industry to develop a global lead in the export of energy technologies that minimize carbon dioxide emissions. Japanese see these technologies as being essential to their future economic well-being and to job creation in their country.

With all this as background, it is troubling that some of the current legislative proposals before Congress to address climate change give relatively low emphasis to providing funding for this needed science and technology. The purpose of our hearing today is to highlight the need to deal with this issue.

Secretary Chu is ideally qualified, both technically and with his policy expertise, on these important issues. We look forward to having him discuss his vision of the research and development efforts that'll be needed over the longer term to meet the challenges associated with climate change.

I recognize that the Secretary has a great many issues that he's responsible for in the Department of Energy. In addition to his responsibilities for research and innovation, we will be having Secretary Chu back before our committee in 2 weeks, on February 4, to testify on the Department's budget request for fiscal year 2011 and to answer questions on the full range of issues under DOE's purview. We are also planning a hearing for February 9 on the status of the Department of Energy's Loan Guarantee Program.

Given these other oversight opportunities that we have here in the committee, I hope we can maintain a focus this morning on an—on the important issue of energy science and technology and its role in responding to the challenges of climate change and our energy challenges.

Let me defer to Senator Murkowski for her comments.

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

Senator MURKOWSKI. Thank you, Mr. Chairman.

I appreciate the opportunity this morning to look at the medium- and the long-term prospects for technology to address our climate change issues.

I welcome you, Secretary Chu, back to the committee. I appreciate the time that you're giving us and the focus that you have placed on so many important issues.

As we look to reduce our greenhouse gas emissions and develop cleaner energy technologies, I've been consistently saying that we need to look at all the technologies that are available, not just a select few. We recognize that a great deal of focus has been on our renewable energy sources, a great deal of attention from the government funding, and the stimulus bill certainly attests to that. But, the sources which we actually use for 85 percent of our energy should not be ignored: oil, coal, natural gas. These will continue to be primary sources of energy in our Nation for years to come.

I look forward to hearing from Mr. Secretary regarding what the Department is doing to advance the efficiency and the technology. I'm very pleased this morning to actually be reading, in the Energy Daily, an article that indicates that you are looking to support additional funding for fossil energy projects. You're quoted as stating that, "We're also asking again for additional loan authority for fossil energy projects in order to provide that critical balance." It is clear to me that there is an appreciation for all of our sources within the energy portfolio.

I'm also interested in learning more about the medium- and long-term prospects for nuclear energy, which, as we know, doesn't produce any greenhouse gas emissions. What is the status in resolving what to do with our spent nuclear fuel? What progress have we made in the past year on this issue? I think we recognize that these are very important pieces of the puzzle as we work to reduce our emissions.

I look forward to hearing from you this morning, Mr. Secretary, on these topics and other ways that we can address climate change through technology, research, and development.

The CHAIRMAN. Secretary Chu, we're glad to have you here. Please, go right ahead.

STATEMENT OF HON. STEVEN CHU, SECRETARY, DEPARTMENT OF ENERGY

Secretary CHU. Thank you, Chairman Bingaman, Ranking Member Murkowski, members of the committee. Thank you, for the opportunity to testify today.

For the past several months, Congress has considered various bills—energy bills, including comprehensive—energy bills, including comprehensive energy and climate legislation. As part of that process, industries and groups have spoken up to promote and defend their interests. I'm concerned, however, that an important part of this discussion has been missing and that we've not adequately focused on the importance of research and development of new energy technologies. Today, I'm here to speak up for clean energy R&D.

Investment in energy R&D will drive innovation across the economy and maintain America's competitiveness. It will create jobs and entire new industries. It's vital for meeting the energy and climate challenge.

We have many technologies in hand today to begin a transition to a low-carbon economy, and we're accelerating that work through the Recovery Act. We also need breakthroughs and better technologies to make the steep reductions in greenhouse gas emissions that we need.

Economics of R&D investments have been well studied, beginning with the Nobel-prizewinning work of Robert Solow. Dr. Solow showed that increases in productivity were ultimately due to technology development, and that this development occurs through the acquisition and application of knowledge.

Several years ago, I was a member of the committee that produced the National Academies' report, "Rising Above the Gathering Storm." As our report stated, "Since Solow's pioneering work, the economic value of investing in science and technology has been thoroughly investigated. Published estimates of the return on investment for publicly funded R&D range from 20 to 67 percent."

Let me stress that we are talking about an annual rate of return on investment. I personally would be delighted to get 5 and 8 percent return per year, but never mind.

What has been the return on investments in the DOE in the past? There's a 2001 study by National Academy of Sciences entitled, "Energy Research of DOE: Was It Worth It?" The study looked at the impact of 22 billion in investments on energy efficiency and fossil energy research from 1978 to 2000 by investigating in detail impacts of a few specific technologies supported by these investments. It found that most of the cases studied did not yield significant benefits within the timeframe of this study. This is what you'd expect from an R&D program, since the full benefits are often realized over decades. But, a few of the investments in energy efficiency were stunningly effective. In particular, an investment of only $12 million in a few key energy-efficiency technologies—advanced refrigerators, compact fluorescent light bulbs, heat reflecting glass—helped lead to $30 billion in benefits for the American people.

Let me give you another recent example of the benefits of DOE research. The Department was an early funder of the A123Systems battery company. In 2001 and 2003, A123 received small business innovation research grants totaling $850,000 to test and refine its cutting-edge lithium ion battery technology. Since then, A123 has raised more than $100 million in private capital, and its customers now include several automakers working on hybrid and electric vehicles.

Today, 98 percent of the batteries that power American's hybrid cars are made in Asia. But, thanks in part to the Recovery Act, A123 is now building a new plant in Michigan that will increase the company's battery manufacturing capability to a level that can supply 24,000 plug-in hybrid electric vehicles with 15-kilowatt-hour battery systems per year. This will create or save roughly 5,400 jobs nationwide while giving the United States a foothold in a key growth industry.

The administration understands the urgent need for more scientific research, and plans to double the Federal investment in key R&D agencies. With our precious research dollars, the Department of Energy is seeking breakthroughs such as the following: gasoline and diesel-like biofuels generated from lumber waste, crop waste, solid waste, and nonfood crops; automobile batteries with 3 times today's energy density, that can survive 15 years of deep discharges; photovoltaic solar power with fully installed costs, four times cheaper than today's technology; computer design tools for commercial and residential buildings that will enable dramatic reductions in energy consumption, with investments that will pay for themselves in less than 10 years; large-scale energy storage systems so that variable renewable energy sources, such as wind and solar power, can become baseload generators.

In addition to our base programs, the Department has launched a broad research strategy that begins by drawing upon the credible resources of our National Laboratories and universities. With the help of Congress and this committee, the Department is also pursuing 3 new complementary approaches to marshal the Nation's brightest minds to accelerate energy breakthroughs.

The first approach is the Energy Frontier Research Centers, which are multiyear, multi-investigator scientific collaborations focused on overcoming known hurdles in basic science.

The second approach is the Advanced Research Projects Agency-Energy, or ARPA-E. ARPA-E uses highly entrepreneurial funding model to explore potentially transformative technologies that are too risky for industry to fund. We've already funded several extremely exciting projects, including a liquid metal battery that could offer grid-scale energy storage; a new wind turbine that can achieve higher efficiencies with smaller size; and a new approach to carbon capture, inspired by an enzyme used in the human body.

The third novel funding approach, Energy Innovation Hubs, will establish larger, highly integrated teams working to solve priority technology challenges. This work spans from basic research to engineering development so that the ideas can be quickly commercialized. With this approach, we are taking a page from America's great industrial laboratories in their heyday. Their achievements, from the transistor to information theory that makes modern telecommunications possible, are evidence that we can build creative, highly integrative research teams that accomplish more faster than researchers working separately. The Hubs are expected to begin work in 2010, and will be fully operational by 2011.

Today, the Department of Energy has assembled, and continues to recruit, a team of extraordinary talented individuals with technical depth and breadth. The shared camaraderie of this team is also beginning to break down decades of stovepipe thinking.

We're changing the way we do business at the DOE. As an example, in order to identify the best possible reviewers for the first round of ARPA-E proposals, I wrote a letter to many of the presidents of our research universities, asking for the names of their best scientists and engineers. We then called upon those people to help review the proposals, arguing that they should help us as part of their patriotic duty. We were able to review 3,700 applications, conducting over 4.2 person-years of work in a few short weeks.

That fact, the fact that we could only fund 1 percent of the applications, speaks volumes that additional research support would be money well spent.

To achieve our energy and climate goals, we need strong and sustained commitment to research and development. I can assure you that I will do everything in my power to ensure that the Department of Energy will use these resources wisely.

I urge this committee and the Senate to look closely at this issue in the coming months, and I look forward to working with you on it. I'm pleased to take any questions at this time.

[The prepared statement of Secretary Chu follows:]

PREPARED STATEMENT OF HON. STEVEN CHU, SECRETARY, DEPARTMENT OF ENERGY

Chairman Bingaman, Ranking Member Murkowski, Members of the Committee, thank you for the opportunity to testify today.

For the past several months, Congress has considered various energy bills, including comprehensive energy and climate legislation. As part of that process, industries and groups have spoken up to promote and defend their interests. I am concerned, however, that an important part of this discussion has been missing. I am concerned that we have not adequately focused on the importance of research and development of new energy technologies. Today, I am here to speak up for clean energy R&D.

Investment in energy R&D will drive innovation across the economy and maintain American competitiveness. It will create jobs and entire new industries. And it is vital for meeting the energy and climate challenge. We have many technologies in hand today to begin a transition to a low-carbon economy, and we are accelerating that work through the Recovery Act. But, over the long-term, we will need breakthroughs and better technologies to make the steep reductions in greenhouse gas emissions we need.

The economics of R&D investments have been well-studied, beginning with the Nobel Prize-winning work of Robert Solow. Dr. Solow showed that increases in productivity were ultimately due to technology development and that this development occurs through the acquisition and application of knowledge.

Several years ago, I was a member of the committee that produced the National Academies Report "Rising Above the Gathering Storm." As our report stated: "Since Solow's pioneering work, the economic value of investing in science and technology has been thoroughly investigated. Published estimates of return on investment for publically funded R&D range from 20 to 67%." Let me stress that we were talking about an annual rate of return on investments.

What has been the return on investments in the DOE been in the past? There was a 2001 study by the National Academies of Science entitled "Energy Research at DOE: Was It Worth It?" The study looked at the impact of $22.3 billion in investments in energy efficiency and fossil energy research from 1978 to 2000 by investigating in detail the impacts of few specific technologies supported by these investments. It found that, while most of the cases studied did not yield significant benefits within the timeframe of the study, a few of the investments in energy efficiency were stunningly effective—just what you would expect from an R&D program. In particular, an investment of $12 million in a few key energy efficiency technologies—advanced refrigerator and freezer compressors, electronic ballasts for fluorescent lamps, and low-emissivity glass—helped lead to $30 billion in benefits for the American people.

Let me give you another recent example of the benefits of DOE's research efforts. The Department was an early funder of the A123Systems battery company. In 2001 and 2003, A123 received Small Business Innovation Research grants totaling $850,000 to test and refine its cutting-edge lithium-ion battery technology. Since then, A123 has raised more than $100 million in private capital, and its customers now include several automakers working on hybrid and electric vehicles. In 2009, A123 went public in the biggest IPO of the year.

And this success story does not end there. Today, 98 percent of the batteries that power America's hybrid cars are made in Asia. But, thanks in part to a Recovery Act grant, A123 is now building a new plant in Michigan that will increase the company's battery manufacturing capacity to a level that can supply 24,000 plug-in hybrid electric vehicles with 15kwh battery systems per year. This will create or save roughly 5,400 jobs nationwide, while giving the U.S. a foothold in a key growth industry.

It is imperative that government provide R&D funding, especially at the front end when private investments would not recoup the full value of the shared social good or when a new technology would displace an embedded way of doing business. As the National Economic Council recently stated: "certain fundamental investments and regulations are necessary to promote the social good. This is particularly true in the case of investments for research and development, where knowledge spillovers and other externalities ensure that the private sector will under-invest—especially in the most basic of research." Federal R&D investment also builds the human, physical, and technological capital needed to perform breakthrough research and to transfer those innovations to the market.

The Administration understands the urgent need for more scientific research and plans to double the federal investment in key R&D agencies. Additionally, the Recovery Act gave the Department of Energy significant new research funding.

With our precious research dollars, the Department of Energy is seeking breakthroughs such as the following:

- Gasoline and diesel-like biofuels generated from lumber waste, crop wastes, solid waste, and non-food crops;
- Automobile batteries with three times today's energy density that can survive 15 years of deep discharges;
- Photovoltaic solar power with a fully installed cost four times cheaper than today's technology;
- Computer design tools for commercial and residential buildings that enable reductions in energy consumption of up to 80 percent with investments that will pay for themselves in less than 10 years; and
- Large scale energy storage systems so that variable renewable energy sources such as wind or solar power can become base-load power generators.

In addition to our base programs, the Department has launched a broad research strategy that begins by drawing upon the incredible resources of our National Laboratories. With the help of Congress and this Committee, the Department is also pursuing three new, complementary approaches to marshal the nation's brightest minds to accelerate energy breakthroughs.

The first approach is the Energy Frontier Research Centers, which are multi-year, multi-investigator scientific collaborations focused on overcoming known hurdles in basic science.

The second approach is the Advanced Research Projects Agency-Energy (ARPA-E). ARPA-E uses a highly entrepreneurial funding model to explore potentially transformative technologies that are too risky for industry to fund. We have already funded several extremely exciting projects, including a liquid metal battery that could provide grid-scale energy storage, a new wind turbine that can achieve higher efficiencies with a smaller size, and a new approach to carbon capture inspired by an enzyme used by the human body to capture and transport carbon dioxide generated in our cells during metabolism to the lungs where it is exhaled.

The third novel funding approach, Energy Innovation Hubs, will establish larger, highly integrated teams working to solve priority technology challenges. This work spans from basic research to engineering development so that the ideas can be quickly commercialized. With this more proactive approach to managing research, we are taking a page from America's great industrial laboratories in their heyday. Their achievements—from the transistor to the information theory that makes modern telecommunications possible—are evidence that we can build creative, highly-integrated research teams that can accomplish more, faster, than researchers working separately.

The Hubs will tackle three of the most important energy challenges we face: How can we derive fuels directly from sunlight in an efficient and economical way? How can we design, construct and retrofit commercial and residential buildings that are vastly more energy efficient than today's buildings? How can we use modeling and simulation technologies to make significant leaps forward in nuclear reactor design and engineering? The Hubs are expected to begin work in 2010 and will be fully operational by 2011.

I am extremely excited about these programs, as well as the Department's other research and development efforts. Today, the Department of Energy has assembled, and continues to recruit, a team of extraordinary talented individuals with technical depth and breadth. The shared camaraderie of this team is also beginning to break down decades of stove-piped thinking.

We are changing the way we do business at the DOE to improve customer responsiveness and the quality of our selection of competitive grants. As an example, in order to identify the best possible reviewers for the first round of ARPA-E proposals, I wrote a letter to many of the Presidents of our research universities to ask for

the names of their best scientists and engineers. We then called upon those people to help review the proposals, arguing that they should help us as part of their patriotic duty. The technical community responded heroically and we were able to review 3,700 applications, conducting over 4.2 person years of work, in a few short weeks. That fact that we could only fund 1 percent of the applications speaks volumes that additional research support would be money well spent.

To achieve our energy and climate goals, we need a strong and sustained commitment to research and development. These investments are needed for our country's future economic prosperity, energy security, and environmental sustainability. I can assure you that I will do everything in my power to ensure that the Department of Energy will use these resources wisely.

I urge this committee and the Senate to look closely at this issue in the coming months, and I look forward to working with you on it. I'm pleased to take any questions at this time.

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

Let me start with a few questions. One obvious issue—I think those of us who've tried to understand some of these climate change proposals—one issue that's become clear to me is that the cap-and-trade proposals that have been put out there would have much more impact on certain sectors in reducing emissions than they would on other sectors. For example, although a third of our emissions, approximately, come from the transportation sector, most experts I've heard from indicate that putting a price on carbon is not going to substantially affect action in the transportation sector to reduce those emissions. Or at least it's not going to affect it to near the extent that it will affect action in the electric power sector, for example.

It has struck me that if this is the case, then we are back to trying to find other policy initiatives to deal with the emissions from the transportation sector. That's where work through the Department of Energy, through research grants, might be particularly focused. Does that make sense, as a way to think about where the resources should be focused, where the efforts should be focused, as it relates to reduction of greenhouse gas emissions?

Secretary CHU. Yes, I agree with you. Let me just say that any price that we can conceivably think of putting on carbon in the foreseeable future, in the coming decades, would not be enough of a price signal. The transportation sector is the most difficult. So, it has to be multipronged.

No. 1, we should continue to improve the efficiency of our automobiles—not only our personal-vehicle automobiles, but heavier trucks—and, in fact, all in the transportation sector—trains, as well. For that reason, we are starting programs, very aggressive programs. We think we can, for example, in long-haul trucking, reduce the energy consumption by 30 percent. That would be a very big deal. Automobiles, we can continue to improve the mileage standards.

The other thing is the electrification of short-range personal vehicles. People who live in cities and suburbs, surveys show that quite often they don't drive more the 50 miles a day. That means that plug-in hybrids become an acceptable means—or you can carry your conventional fuel tank for longer trips. So, the key thing there is the battery, and we are investing heavily on developing the battery technology. As I said in my testimony, we think we can make batteries that are 2, 3 times higher energy density and that can last the lifetime of the car.

The other thing is, How do you transition away from traditional fuels made from oil? That's a research program. I think there are many exciting things that have just come out, in the last 5 or 10 years, both in using agricultural waste or growing energy crops and converting them into, not only ethanol, but fuels that could be direct substitutes for gasoline, diesel fuel, and jet fuel.

We are also looking at ways, in gasifying material that can even be blended with carbon resources, where you capture the excess carbon dioxide from these processes, sequester it, and there's a estimate that says if 40 percent of the feedstock would be biofuels, it becomes a net sync of carbon. You take the plants that have grabbed the carbon dioxide out of the air, you turn them into a biofuel, you loose that with coal—you can think of coal as being the energy source—take all the excess carbon dioxide in the refining process, put it underground, and now you've got a fuel that's at zero carbon.

So, there are many ways. But, you are right, the transportation sector is the most difficult one, and it requires more research and development.

The CHAIRMAN. Let me stop with that.

Senator MURKOWSKI.

Senator MURKOWSKI. Thank you, Mr. Chairman.

Secretary, I would like to focus my questions this morning on nuclear and the potential that it has as we look to reduce our emissions.

It's been reported that the White House has sought to restrict what type of research that DOE can conduct on future nuclear reactors, whether it's the fast reactor or activities associated with the smaller reactors. I'd like you to comment on this. If it is accurate, how does this impact the role of nuclear as we attempt to meet our energy needs and as we reduce our emissions?

Secretary CHU. I think the White House—I don't "think"—the White House is supportive of nuclear. We see this as part of the solution. Right now, 20 percent of our electricity is generated by nuclear. We would, as a minimum, like to maintain that, possibly grow that. For that reason, we are working aggressively to help restart the American nuclear industry with loan guarantees, with research in the out years that could lead to more advanced, safer nuclear power.

So, you know, I think there may be—well, let me just say, that is the policy of the administration. The details are still being worked out as to how one advances it.

Senator MURKOWSKI. It is possible, to have some limitation or a directive that says, "Don't go down the path of the smaller modular"and I'm just using that as an example. I'm trying to understand whether it is endorsement of all nuclear as a broader policy or whether, within the administration, we're trying to pick winners and losers within the nuclear portfolio.

Secretary CHU. What we in the Department of Energy are trying to do is make our best technical assessment—and it's a bit of crystal-ball-looking—but the best technical assessment of what could be productive. But, because it's research, you do not want to down-select. So, you're, I think, referring to a snippet in a time of discus-

sion where things have not been finalized. So, this is a work in progress.

Senator MURKOWSKI. You went into some detail about the ARPA-E projects. I understand that the initial recipients for the ARPA-E funding represented a wide variety of energy technologies, but nuclear energy was not part of that. Did the Department receive any proposals for advanced nuclear energy technologies?

Secretary CHU. You know, in all honesty, I don't know whether we did or not. I'm just, kind of, mentally thinking back on it. It was—if we did, it was a very, very small fraction.

Senator MURKOWSKI. Would you support them if they were to come in?

Secretary CHU. It depends on what they were. I think, you know, when we support only 1 percent of the proposals, it's a very deep cut. But, there is a slight difference. I could say—what we are looking for in ARPA-E is something where the funding cycle is very short—2, 3 years. Then, after 2 or 3 years, either you get funding from a different part of an agency—a different part of the DOE or some other agency, or you get private-sector support. So, many of the things that are nuclear really will take a 10-, 20-year funding-cycle stability. So, if there are things which are wild, crazy ideas that you could say, "OK, this could lead to sustained support from the Nuclear Energy Program of the DOE," we would look at it.

Senator MURKOWSKI. OK. Let me ask about how we deal with the whole issue of waste. We recognize that decades ago, the National Academy of Sciences concluded that some form of geologic repositories is going to be necessary for the ultimate disposal, whether it's the direct disposal of the used nuclear fuel or whether it's the reprocessing.

Does the administration agree that ultimately we're going to have some form of geologic repository?

Secretary CHU. Yes.

Senator MURKOWSKI. Then, more specific to this Blue Ribbon Commission, when is the administration intending to convene the panel to figure out what the path forward is going to be on disposition?

Secretary CHU. Unfortunately, I've been saying for several months, "soon," sometimes "very soon." I still go back to saying "very soon." These things are complicated issues, there are a lot of stakeholders, and—but——

Senator MURKOWSKI. At this point in time, there's no immediate plan to convene?

Secretary CHU. All I can say is, stay tuned. We, in the Department of Energy and the administration, are working hard to push this thing forward as fast as possible, to convene the committee within a reasonably short timescale. So, you know, there are vetting issues. There are all sorts of things that—but we're in the final stages of that.

Senator MURKOWSKI. I think it is one of those issues that we look at what the administration has declared as, "This is how we're going to define this path forward." I think there has been some frustration. I appreciate that it takes a while to get a panel in place. However, we would all like to see that convene sooner.

Secretary CHU. I agree with you.

Senator MURKOWSKI. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Dorgan.

Senator DORGAN. Mr. Chairman, thank you very much.

Dr. Chu, thank you for all of your work. I know that you and Matt Rogers and your entire agency are hard at work trying to evaluate how to best invest the $36 billion that came your way from the Economic Recovery Act. I want to ask you about that in just a moment.

First, let me ask you about this issue—50 percent of our electricity comes from coal, and we're not going to transition away from that 50 percent quickly, if ever. The question is, How do we fund the research now that's necessary over the longer period to find ways to decarbonize the use of coal?

There are a lot of estimates about what that will cost. I'm pretty convinced that we can do that, and actually find ways to use carbon. You can create fuel from carbon and find beneficial uses of carbon. But, there are suggestions about direct appropriations, loan guarantees, tax credits, and wires charges. What's your assessment of how we accumulate the funding and how much funding is necessary in the next 10 20, and 25 years to be able to effectively be able to use the most abundant resource and decarbonize its use?

Secretary CHU. I think all those things are necessary. They would help. As you know, the Department of Energy funds not only the research that will look into improving technologies that we have—improving the amine process, improving cold ammonia, looking to improve the gasification process—but we are also looking, further down the road, at things that really upend it and replace those.

You spoke about using coal for transportation fuel. Is there a way we can do that, that actually decreases the net carbon footprint significantly below that of using oil for gasoline? I think the answer is, "We can do that." So, if it's possible to do that, that would be great. So, we would have a significant reduction in our production and use of transportation fuel, as coal's a resource. Is this is a possibility? There are many things like that.

I've said quite often, and believe deeply, that the United States has an opportunity to show leadership in this area. If we do develop the leadership in this area, this is something that we can actually export, as well.

Now, let me say that there is one thing—we need a long-term signal. Some of these investments—we—the Federal Government can give a lot in R&D and technical research incentives and things like that, but, on the flip side, the industry has to get a long-term signal that says, "There's going to be," for example, "a limitation of carbon that will ratchet down," so that they, too, can get serious about it. So, it's not a little slipstream experiment; it's, "We're going to have to make it work, let's begin to think about our long-term investments."

Right now, from utility companies on, there's a lot of money sitting on the sidelines, wanting to know, "When is this going to happen?" It's more, "When is it going to happen?" not "if it's going to happen." But, it's money sitting on the sidelines. Since it's money

sitting on the sidelines, that's money not invested, which means jobs not created.

Senator DORGAN. If there are those in the industry that are not yet serious, they are making a very big mistake.

Secretary CHU. I agree.

Senator DORGAN. So, I think almost everybody understands where we're headed. We're headed toward a lower carbon future.

Secretary CHU. Right.

Senator DORGAN. We need to find ways to achieve that.

You described several things that you've done in ARPA-E, I think, selecting 1 percent of the proposals. Could you have someone, in plain English, send us something that's understandable about the areas of inquiry? I'm very interested in them, but I know they are complex and interesting and fascinating. Would you be willing to send us a little white paper about what you're funding and why you're funding——

Secretary CHU. Sure.

Senator DORGAN [continuing]. These specific areas, just so we get a sense of what ARPA-E is going to provide us?

[Information referred to follows:]

Building Efficiency

Project Title	Large-Scale Energy Reductions through Sensors, Feedback, & Information Technology
Organization	Stanford University, Human Sciences and Technologies Advanced Research Institute
Website	http://hstar.stanford.edu/cgi-bin/
Type of Project	Building Efficiency
Project Description	Smart meters and related technologies promise that energy information will change energy use. With ARPA-E's financial support, Stanford University will establish an interdisciplinary group of researchers and industry leaders to develop new ways to connect people with electric sensor data. This project will explore the use of interactive media (e.g., mobile devices, social networking, multiplayer games), new data visualization techniques, novel incentive systems, and community programs that encourage retrofits and the purchase and proper use of energy efficient technologies. This project will also explore the use of energy information to improve prescriptive economic and engineering models, as well as to inform the development of sensor communications networks. If successful, this project could reduce average residential energy use by up to 30 percent and lead to the creation of software interfaces that display energy data, algorithms that calculate and monitor energy use in behavioral categories, media products (e.g., games, social networking applications, curricula) that encourage reductions in energy consumption, automated recommendation engines related to demand shifting, and curricula for school and community programs.

Project Title	Low-Cost Electrochromic Film on Plastic for Net-zero Energy Building
Organization	ITN Energy Systems, Inc.
Website	www.itnes.com
Type of Project	Building Efficiency
Project Description	ITN Energy Systems is developing a novel film coating for windows that will significantly reduce heat and energy loss in all types of buildings. This film consists of a solid-state electrochromic film on plastic substrates. The primary obstacle to the deployment of so-called "smart windows" is the significant cost of energy-saving films. ARPA-E funding will be used to develop a new, cost-effective manufacturing process and intelligent, sensor-based process controls to monitor production quality. By adopting an innovative approach to manufacturing film coatings, ITN Energy Systems intends to lower their cost and enable their widespread adoption. If successful, this project could decrease energy use in buildings by up to 40 percent and significantly reduce pressure on utilities during periods of peak demand.

Project Title	Ammonothermal Bulk GaN Crystal Growth for Energy Efficient Lighting
Organization	Momentive Performance Materials
Website	www.momentive.com
Type of Project	Building Efficiency
Project Description	Lighting consumes a significant percentage of total energy production. Momentive Performance Materials (MPM) is developing gallium-nitride solid-state lighting that is more efficient at generating light and produces minimal waste heat. MPM has already demonstrated a high-pressure, high-temperature process to grow single-crystal gallium nitride material with low defects. This process is inherently scalable to mass production. ARPA-E funding will enable MPM to improve the technology and move closer to commercialization. If successful, this project will enable the deployment of low-cost, high-efficiency solid-state lighting devices.

Carbon Capture

Project Title	CO_2 Capture with Enzyme Synthetic Analogue
Organization	United Technologies Research Center
Website	www.utc.com
Type of Project	Carbon Capture
Project Description	United Technologies Research Center (UTRC) is using ARPA-E funding to develop a new process for capturing the carbon dioxide emitted by coal-fired power plants. UTRC is focusing its research on a naturally-occurring enzyme that is used by nearly every organism on earth to manage carbon dioxide levels. The naturally-occurring form would not survive within a smokestack environment, so UTRC seeks to develop a synthetic analogue of the enzyme that could be used to study aspects of its catalytic mechanism. The ultimate objective of this research is to create an enzyme analogue / polymer nano-composite thin-film structure that could act as a selective membrane to separate carbon dioxide from other gases in power plant smokestacks. The proposed technology may be easier to install and more reliable than existing technologies because it does not involve any moving parts or consumables. If successful, the proposed technology would allow coal-fired power plants to capture up to 90 percent of carbon at a significantly lower incremental cost.

Project Title	Pilot Scale Testing of Carbon Negative, Product Flexible Syngas Chemical Looping
Organization	Ohio State University
Website	www.chbmeng.ohio-state.edu/
Type of Project	Carbon Capture
Project Description	Ohio State University (OSU) developed an innovative process – the Syngas Chemical Looping (SCL) process – for efficiently converting carbonaceous fuels such as coal and biomass into electricity, hydrogen, and/or liquid fuel with zero or negative net carbon dioxide emission. OSU will use ARPA-E funding to construct a 250 kWth pilot-scale plant to demonstrate the SCL process. A blend of biomass and coal will be converted to clean energy carriers such as hydrogen and electricity with 100 percent carbon dioxide capture. OSU is working with a wide range of companies to address all industrial concerns while preparing the technology for commercialization. Once commercialized, the process could be utilized to produce low cost electricity, hydrogen, and/or synthetic liquid fuel with zero or negative net carbon dioxide emission. If successful, this project will drastically reduce greenhouse gas emissions while promoting the efficient usage of indigenous energy sources such as coal and biomass.

Project Title	Carbon Nanotube Membranes for Energy-Efficient Carbon Sequestration
Organization	Porifera Inc.
Website	www.poriferanano.com
Type of Project	Carbon Capture
Project Description	With ARPA-E's financial support, Porifera aims to develop high flux, high selectivity carbon nanotube (CNT) membranes to efficiently separate carbon dioxide from industrial smokestack emissions. Presently, companies rely on chemical absorption to separate carbon dioxide from other emissions. However, chemical absorption is expensive and energy-intensive, and has an independent, negative impact on the environment. The goal of this project is to replace current chemical-based carbon dioxide separation technology with membrane-based technology. If this project is successful, it will result in carbon-dioxide separation membranes that deliver higher efficiency, cheaper sequestration, and lower energy consumption.

Project Title	Energy Efficient Capture of CO_2 from Coal Flue Gas
Organization	Nalco Company
Website	www.nalco.com
Type of Project	Carbon Capture
Project Description	With ARPA-E's financial support, Nalco Company is developing a novel process to capture carbon in the smokestacks of coal-fired power plants. Nalco Company's electrochemical platform will rapidly capture carbon dioxide and desorb it at atmospheric pressure without heating, vacuum, or consumptive chemical usage. If successful, this technology will reduce the incremental carbon capture costs by up to 50 percent and make it more affordable for coal-fired power plants to clean their smokestack emissions.

Project Title	Electric field swing adsorption for carbon capture applications
Organization	Lehigh University
Website	www3.lehigh.edu/engineering
Type of Project	Carbon Capture
Project Description	With ARPA-E's financial support, Lehigh University is developing a novel approach to separate carbon dioxide from other gases in the smokestacks of coal-fired power plants. Lehigh University intends to use electric fields to reversibly and selectively enhance the affinity of certain high-surface-area, solid, absorbent materials for carbon dioxide. By flicking a switch, coal-fired power plants could control whether the materials adsorb carbon dioxide or release it for collection. ARPA-E funding will be used to develop appropriate materials and optimize the adsorption process. If successful, this technology would significantly reduce the time and energy required for carbon capture.

Direct Solar Fuels

Project Title	Towards Scale Solar Conversion of CO_2 and Water Vapor to Hydrocarbon
Organization	Pennsylvania State University
Website	www.psu.edu
Type of Project	Direct Solar Fuels
Project Description	With ARPA-E's financial support, Pennsylvania State University (Penn State) will develop a novel process in which sunlight, carbon dioxide, and water vapor are combined to create hydrocarbon fuels that can be used within the current energy infrastructure. Using natural outdoor sunlight, Penn State has already achieved efficient solar conversion of carbon dioxide and water vapor to methane and other more complex hydrocarbons. Penn State now seeks to convert approximately 2 percent of sunlight to a liquid chemical fuel that can be stored or transported as needed. If successful, this project could increase domestic production of renewable transportation fuels, thus reducing U.S. dependence upon foreign sources of fossil fuels.

Project Title	Affordable Energy from Water and Sunlight
Organization	Sun Catalytix Corporation
Website	www.suncatalytix.com
Type of Project	Direct Solar Fuels
Project Description	With ARPA-E's financial support, Sun Catalytix is developing a versatile, inexpensive, efficient, self-repairing, and scalable method for storage of renewable energy. Sun Catalytix will exploit a novel water oxidation catalyst discovered at MIT that employs earth-abundant elements to generate hydrogen and oxygen from tap water or clean sea water. ARPA-E funding has enabled Sun Catalytix to move the novel catalyst technology from the academic laboratory to a commercial setting for practical application. Specifically, Sun Catalytix aims to design and develop a new class of electrolyzer and photoelectrochemical cell (PEC) devices, including an inexpensive 100 Watt electrolyzer and a direct solar-to-fuel PEC module. It is anticipated that both devices will be constructed from materials that support mass production, operate efficiently using readily-available water supplies, and serve as robust test-beds for innovative new products. If successful, this project will allow economical and distributed energy storage from renewable energy supply using water as a feedstock, and enable continuous power in off-grid locations at much lower cost than incumbent technologies.

Project Title	Shewanella as an Ideal Platform for Producing Hydrocarbon Biofuels
Organization	University of Minnesota
Website	www.umn.edu
Type of Project	Direct Solar Fuels
Project Description	With ARPA-E's financial support, the University of Minnesota seeks to develop hydrocarbon biofuels from a renewable resource, namely the Shewanella bacteria. Hydrocarbon fuels have significant advantages over alternative fuels like ethanol. For example, hydrocarbon fuels, unlike ethanol, could make use of the United States' existing refining and distribution infrastructure. The University of Minnesota has already proven that naturally-occurring Shewanella bacteria produce hydrocarbons and are tolerant to the same. This project aims to engineer Shewanella bacteria to produce higher levels of hydrocarbons from carbon dioxide, thus removing carbon dioxide from the atmosphere. This proposed research will also explore innovative bio-production methodologies to allow continuous harvesting of hydrocarbons, which would generate significant cost savings compared to traditional batch fermentation. The hydrocarbon feedstock generated by this novel approach will be chemically processed using knowledge obtained from a century of petroleum refining. If successful, this project could increase domestic production of renewable transportation fuels and reduce our nation's dependence upon foreign sources of fossil fuels.

Project Title	Sustainable Cyanobacteria Designed for Solar-Powered Highly Efficient Production of Biofuels
Organization	Arizona State University
Website	www.asu.edu
Type of Project	Direct Solar Fuels
Project Description	With ARPA-E's financial support, Arizona State University (ASU) will use cyanobacteria (specifically, synechocystis) to produce carbon-neutral, sustainable biofuels. Synechocystis grows on non-arable land, and therefore does not compete with food crops. ASU intends to modify synechocystis to convert sunlight and carbon dioxide into fatty acids, which will be further transformed into liquid transportation fuels. If successful, this project could increase production of domestic renewable biofuels and reduce U.S. dependence on foreign sources of fossil fuels.

Project Title	A Genetically Tractable Microalgal Platform for Advanced Biofuel Production
Organization	Iowa State University
Website	www.iastate.edu
Type of Project	Direct Solar Fuels
Project Description	With ARPA-E's financial support, Iowa State University (ISU) is modifying an acquatic microorganism, Chlamydomonas, to generate feedstock for the production of biofuels. Chlamydomonas is a versatile microorganism that can be easily managed and modified to assimilate carbon, generate energy-bearing molecules (lipids) from sunlight, and tolerate industrial-scale production. This project will generate new bio-fuel production capability, adaptable to a wide range of conditions and end products and with the transformational capability of genetically combining (i.e., breeding) a wide variety of desirable traits. If successful, this project will provide another renewable source of bio-fuels and reduce our nation's dependence on foreign sources of fossil fuels.

Biomass Energy

Project Title	Conditionally Activated Enzymes Expressed in Cellulosic Energy Crops
Organization	Agrivida
Website	www.agrivida.com
Type of Project	Biomass Energy
Project Description	Agrivida is using ARPA-E funding to develop a new method for converting plant biomass into useful feedstock for the production of bio-fuels. To date, the use of plant biomass as feedstock for bio-fuel production has been limited by the difficulties inherent in degrading cell walls in plant cells. Agrivida aims to develop cell wall-degrading enzymes that can be produced at high concentration within plants. Once the crops are harvested, the engineered enzymes can be activated by adjusting the conditions of the bio-fuel production process. The activated enzymes would convert the plant cell walls into fermentable sugars that can be used to produce bio-fuels and other bio-products. If successful, this project could increase domestic production of renewable bio-fuels and reduce our nation's dependence upon foreign sources of fossil fuels.

Project Title	Scaling and Commercialization of Algae Harvesting Technologies
Organization	Univenture / Algaeventure Systems
Website	www.univenture.com
Type of Project	Biomass Energy
Project Description	With ARPA-E's financial support, Univenture and Algaeventure Systems are jointly developing a new and inexpensive method for harvesting algae utilizing low energy surface chemistry properties in a mechanical-electrical device. Algae have a wide range of potential applications, such as in the production of food, feed, chemicals, plastics, and pharmaceuticals. More importantly, algae could be a rich source of feedstock for bio-fuel production. The principal obstacle to the use of algae in commercial products, including bio-fuels, is the high cost of harvesting and dewatering algae. Harvesting and dewatering are necessary to extract the energy storage molecules (lipids) contained within the algae. To date, transforming algae into a dense sludge sufficient for lipid extraction has required a multistage, energy-inefficient process consuming 30 percent to 50 percent of the total cost of algae cultivation. Univenture and Algaeventure Systems have designed and fabricated an innovative algae harvesting dewatering and drying system that is far more energy-efficient than existing techniques. If successful, this technology could dramatically reduce the energy cost necessary to harvest, dewater, dry algae and potentially transform the economics of algae-based bio-fuel production, and generate new jobs.

Project Title	Quaternary Phosphonium Based Hydroxide Exchange Membranes
Organization	University of California, Riverside
Website	www.ucr.edu
Type of Project	Vehicle Technologies
Project Description	The University of California, Riverside (UC Riverside) is using ARPA-E funding to develop a new class of fuel cells. To date, the use of proton exchange membrane fuel cells (PEMFCs) has been hindered by their high cost, which is attributable to their use of costly materials – in particular platinum – as catalysts. UC Riverside will develop a new class of hydroxide exchange membranes (HEMs) that can eliminate the use of platinum in fuel cells and replace it with inexpensive metals such as nickel and silver, thus providing the breakthrough needed to make fuel cell technology economically viable. These fuel cells will have further benefits, such as high hydroxide conductivity, alkaline stability, and dimensional stability. Such fuel cells will also have immediate application in zero emission vehicles and solar and wind energy storage. If successful, this project could facilitate the use of fuel cells in automobiles and reduce U.S. demand for fossil fuels from foreign sources.

Project Title	Gallium Nitride Advanced Power Semiconductor & Packaging
Organization	Delphi Automotive Systems LLC
Website	www.delphi.com
Type of Project	Vehicle Technologies
Project Description	Delphi Automotive Systems is developing a novel electrical energy conversion device that will be 50 percent more efficient than existing silicon-based technologies. This device will consist of a 600 Volt gallium nitride device combined with sintered interconnects and double-sided cooling. This unique design will reduce the device size, cost, and energy losses. The power conversion device has already proven successful in a laboratory setting, so Delphi Automotive Systems will use the ARPA-E funding to move the device closer to low-cost, high-volume commercial production. If successful, this project will improve the energy efficiency and cost-effectiveness of hybrid/electric vehicles and renewable energy systems (e.g., solar, wind).

Project Title	High Energy Permanent Magnets for Hybrid Vehicles and Alternative Energy
Organization	University of Delaware
Website	www.Udel.edu
Type of Project	Vehicle Technologies
Project Description	High-energy permanent magnets are indispensable for many applications in the electric, electronic, automobile, communications, and information technologies industries. Currently the demand for these magnets is even higher in the emerging markets of hybrid/electric vehicles, windmill power systems, power generation systems, and energy storage systems. The United States has lost its lead in this critical field of technology as producers have migrated to Asia. The University of Delaware's research and development will provide the fundamental innovations and breakthroughs that will help re-establish the United States as a leader in the science, technology, and commercialization of this essential class of materials. The goal of this project is to develop materials that will allow the United States to fabricate the next generation of permanent magnets with magnetic energy density (maximum energy product) 2x higher than the current value of the strongest Nd-Fe-B magnets. If successful, this project will lead to lower-cost and more energy-efficient and power-dense magnets for deployment in a wide range of clean energy technologies.

Waste Heat Capture

Project Title	Advanced Semiconductor Materials for High Efficiency Thermoelectric Devices
Organization	Phononic Devices, Inc.
Website	www.phononicdevices.com
Type of Project	Waste Heat Capture
Project Description	To date, the United States generates most electricity by creating heat, whether it is through burning coal or splitting atoms. The heat, in turn, makes steam, which turns a turbine and makes electricity. This process is highly inefficient since approximately 60 percent of the heat is wasted. Phononic Devices intends to recapture this waste heat and convert it into usable electric power, or, depending on the source of the heat, provide refrigeration and cooling. This 'thermoelectric' concept uses advanced semiconductor materials, similar to those found in microprocessors and solar cells, to manage heat by manipulating the direction of electrons at the nanoscale. Resembling computer chips, thermoelectric devices are quiet, have no moving parts or harmful emissions. Phononic Devices' design concepts are projected to dramatically improve thermoelectric efficiency from less than 10 percent today to more than 30 percent, resulting in significant energy savings for power generation and cooling. If successful, this project would open new opportunities for domestic power generation and reduce our nation's dependence on foreign sources of fossil fuels.

Project Title	Harvesting Low Quality Heat Using Economically Printed Flexible Nanostructured Stacked Thermoelectric Junctions
Organization	University of Illinois
Website	www.Illinois.edu
Type of Project	Waste Heat Capture
Project Description	Each year, the United States loses an enormous amount of energy, equivalent to two trillion watts, to waste heat (i.e., heat generated by machines, electrical equipment, and industrial processes that is lost to the surrounding environment without being put to useful purpose). The University of Illinois is using ARPA-E funding to develop flexible, thermoelectric modules composed of silicon nanotubes and an economic and highly scalable approach to fabricate such modules. The modules' structural flexibility will enable their deployment in diverse settings with minimal customization of heat exchangers and use of real estate. For example, the modules could be put to immediate use in power plants, data centers, and automobiles. If successful, the thermoelectric modules could increase electricity production in the United States by up to 23 percent without any accompanying increases in carbon and noise emissions.

Water

Project Title	Carbon Nanotube Membrane Elements for Energy Efficient and Low Cost Reverse Osmosis
Organization	NanOasis Technologies, Inc.
Website	www.NanOasis.com
Type of Project	Water
Project Description	With ARPA-E's financial support, NanOasis will utilize carbon nanotubes to create industrially-scalable reverse osmosis (RO) membranes that could transform desalination and wastewater reuse and produce dramatic energy savings. Reverse osmosis is used to provide potable water by desalinating three main sources of input water: brackish inland waters, municipal wastewater, and seawater. NanOasis is developing RO membranes that will be ten times more permeable than existing membranes. These new membranes will not require any modifications to existing desalination plants. NanOasis' membranes will be packaged in the industry standard form-factor so they can be drop-in replacements in existing plants. With their low cost and high energy savings, customers could recover their investments in membrane technology within a matter of months. NanOasis' membrane technology could reduce reverse osmosis energy consumption by 30 to 50 percent in existing desalination plants by the drop-in replacement of legacy RO membrane elements with NanOasis' ultra low pressure elements. In new desalination plants optimized around NanOasis' membrane technology, the total cost of water could be reduced by up to 40 percent by the combination of energy savings, membrane savings and smaller, less complex, lower cost facilities that could yield the same water output. If successful, this project could revolutionize the field of desalination and wastewater reuse and yield an estimated 290 trillion watt in energy savings over 10 years, corresponding to 177 million tons of carbon dioxide.

Project Title	Catalytic Biocrude Production in a Novel Short-Contact Time Reactor
Organization	RTI International
Website	www.rti.org
Type of Project	Biomass Energy
Project Description	RTI International is using ARPA-E funding to develop a novel process for bio-crude production. Working with a range of industry partners, RTI International will focus on the development of a single-step catalytic biomass pyrolysis process with high carbon conversion efficiency to produce stable bio-crude with low oxygen content. Transformational biofuels technologies like catalytic biomass pyrolysis have the potential to substantially enhance the economic and energy security of the United States by converting abundant domestic biomass resources into a hydrocarbon-rich pyrolysis liquid that can be upgraded into liquid transportation fuel. This project is expected to yield a condensed hydrocarbon liquid (bio-crude) that can make use of the existing petroleum-refining infrastructure. If successful, this project could increase domestic production of renewable transportation fuels and reduce our nation's dependence upon foreign sources of fossil fuels and create new jobs.

Project Title	MacroAlgae Butanol
Organization	E.I. du Pont de Nemours and Company
Website	www.dupont.com
Type of Project	Biomass Energy
Project Description	With ARPA-E's financial support, E.I. du Pont de Nemours and Company (DuPont) is developing a commercially viable process for the production of an advanced bio-fuel, isobutanol, from seaweed. Using seaweed as a feedstock for the production of isobutanol has significant advantages, including reduced land use. Isobutanol has further advantages over alternative fuels like ethanol. For example, isobutanol is more comparable in performance to gasoline than ethanol, and can be blended in gasoline at higher levels than ethanol without changes to automobiles or the existing refinery and distribution infrastructure. DuPont aims to develop a microorganism to efficiently convert the sugars in seaweed into isobutanol. Isobutanol is projected to deliver a 90 percent reduction in greenhouse gas emissions compared to gasoline derived from petroleum. Seaweed-derived isobutanol has the potential to replace 6.8 billion barrels of gasoline per year in the United States alone. If successful, this project could increase domestic, renewable bio-fuel production, reduce our nation's dependence on foreign sources of fossil fuels, and decrease emissions of greenhouse gases.

Project Title	High Yielding, Low Input Energy Crops
Organization	Ceres, Inc.
Website	www.ceres.net
Type of Project	Biomass Energy
Project Description	Using advanced plant breeding and biotechnology, Ceres Inc. is developing new varieties of energy grasses (specifically, switchgrass, miscanthus, and sorghum) for use as feedstock for the production of biofuels. These varieties will have greater yields than naturally-occurring grasses and require fewer agricultural inputs (e.g., nitrogen fertilizers). The ARPA-E funding will enable Ceres Inc. to test these varieties in the field and move closer to commercialization. Full-scale deployment of this technology could conserve 1.26 billion barrels of oil, 58 million tons of coal, 1.2 million tons of nitrogen fertilizer, 682 million tons of carbon dioxide, and 82 million pounds of nitrogen oxide emissions from 2020 to 2030. Indeed, the carbon sequestered in the roots of perennial plants like switchgrass and miscanthus has the potential to make these grasses carbon negative (i.e., they can sequester more carbon dioxide from the atmosphere than is released in the lifecycle of producing and burning the fuel derived from them). If successful, this project could increase domestic, renewable biofuel production, reduce our nation's dependence on foreign sources of fossil fuels, decrease emissions of greenhouse gases, and generate new jobs.

Conventional Energy

Project Title	Upgrading Refinery Off-gas to High-Octane Alkylate
Organization	Exelus Systems
Website	www.exelusinc.com
Type of Project	Conventional Energy
Project Description	Oil refineries in the United States are highly efficient at chemical conversion. Because of the sheer scale of refining in the United States, even seemingly insignificant inefficiencies add up to massive losses of potential fuel. Among the most significant sources of wasted fuel is refinery off-gas (ROG). It is difficult and expensive to separate the useful elements in ROG, so refineries typically burn the ROG rather than putting it to productive use. With ARPA-E's financial support, Exelus Systems is developing a novel process for separating useful elements (e.g., olefin) from ROG. This process could allow 42 percent of ROG to be converted into approximately 46 million barrels of gasoline per year. Putting ROG to productive use would significantly reduce the emissions released by refineries burning ROG. If successful, this project will increase domestic production of gasoline and reduce carbon emissions.

Energy Storage

Project Title	Electroville: High Amperage Energy Storage Device-Energy for the Neighborhood
Organization	Massachusetts Institute of Technology
Website	http://web.mit.edu/dsadoway/www/
Type of Project	Energy Storage
Project Description	Large-scale storage of electrical energy is a huge problem in an array of fields ranging from load leveling of power grids to providing uninterruptible backup power for hospitals and manufacturing facilities, but it is particularly important to enable the use of renewables as a means of reliably meeting the electricity needs of our population. While there have been striking improvements in batteries in recent decades, there is no current technology that is able to meet the necessary performance requirements, such as long service lifetimes spanning thousands of cycles at deep depth of discharge (>80 percent), very high current rates, and very low cost (<$50/kWh). ARPA-E funding will be used to develop design parameters and a working prototype that can store and deliver energy on the roder of 5-kWh. The device will use cheap and domestically abundant materials and is expected to attain unprecedented current density and lifespan at an acceptably low cost. If successful, this project will facilitate the widespread deployment of renewable energy technologies in the United States.

Project Title	Low Cost, High Energy and Power Density, Nanotube-Enhanced Ultracapacitors
Organization	FastCap Systems
Website	www.fastcapsystems.com
Type of Project	Energy Storage
Project Description	FastCap Systems is using ARPA-E funding to develop a novel energy storage technology that would combine all of the advantages of ultracapacitors and batteries, without the disadvantages of either technology. Specifically, FastCap Systems intends to produce an ultracapacitor made of carbon nanotubes, extremely small high performance tubes of carbon that provides high energy density, high power, and extreme temperature reliability. In addition, the ultracapacitor will be safe from leaking and explosions. If successful, this project could greatly reduce the cost of hybrid/electric vehicles and increase their safety and reliability.

Project Title	Planar Na-beta Batteries for Renewable Integration and Grid Applications
Organization	Eagle Picher Technologies, Inc.
Website	www.eaglepicher.com
Type of Project	Energy Storage
Project Description	Large-scale, low-cost energy storage is necessary for widespread penetration of renewable energy and improved grid reliability. While high temperature sodium-beta batteries have long been a promising grid scale energy storage technology current sodium-beta battery technologies suffer from high cost and low reliability. Eagle Picher Technologies (EPT), in collaboration with the Pacific Northwest National Laboratory, will use ARPA-E funding to develop and demonstrate a completely new planar sodium-beta battery, a major departure from the current architecture based on highly expensive tubular designs. By using a novel and inexpensive stacked architecture, EPT aims to achieve dramatically improved performance at lower temperatures and lower cost. EPT's design will simplify the manufacturing process, and enable the production of scalable, modular batteries at half the cost of existing designs. The layered batteries will have increased active areas and decreased diffusion distances, which will increase energy density by 30 percent and power density by 100 percent. If successful, this project could create new jobs, allow large scale battery storage on the electric grid to become a reality, making the grid more stable and easing the integration of renewable energy technologies onto the grid.

Project Title	Silicon Coated Nanofiber Paper as a Lithium Ion Anode
Organization	Inorganic Specialists
Website	www.InorganicSpecialists.com
Type of Project	Energy Storage
Project Description	Inorganic Specialists is developing a silicon-coated carbon nanofiber paper for use in lithium-ion batteries. This novel and unique paper can store four times more energy than existing technologies. This material is unique in that it simultaneously meets the criteria of breakthrough energy storage, low irreversible capacity, stable cycling, low cost, and viable manufacturability. ARPA-E funding will be used to develop manufacturing processes and equipment and to establish the feasibility of manufacturing the silicon-coated paper on an industrial scale. If successful, this project will accelerate the deployment of hybrid/electric vehicles and wind/solar power systems.

Project Title	Sustainable, High Energy Density, Low Cost Electrochemical Energy Storage Metal Air
Organization	Arizona State University
Website	http://engineering.asu.edu/macme
Type of Project	Energy Storage
Project Description	With ARPA-E's financial support, Arizona State University's Metal-Air Ionic Liquid (MAIL) battery program seeks to create a safe, ultra-high energy density, and low-cost battery technology that incorporates earth-abundant materials. If successfully developed, the MAIL battery has the potential to increase the range of electric vehicles to distances approaching 1000 miles and to dramatically decrease the cost of electric vehicles. Advanced battery technologies have broad application. To date, the use of advanced battery technologies has been limited by their low energy density, high cost, safety problems, and reliance on earth-rare materials from unreliable foreign sources. MAIL batteries will use domestically available earth-abundant materials to achieve lower cost and a more reliable supply of raw materials. Furthermore, MAIL batteries will have unparalleled safety because the primary chemicals will not be stored in the same space; hence, in the event of a crash involving a hybrid/ electric vehicle, there would be little or no risk of catastrophic energy release and fire. If successful, this project will enable the rapid and widespread deployment of long-range, low-cost plug-in hybrid/electric vehicles and the use of the U.S. electric grid as the source of transport energy in place of imported fossil fuels.

Project Title	High Energy Density Lithium Batteries
Organization	Envia Systems
Website	www.enviasystems.com
Type of Project	Energy Storage
Project Description	Envia Systems is using ARPA-E funding to develop lithium-ion batteries with the highest energy density in the world (over 400 Wh/kg vs ~150 Wh/kg current state of the art). This project will entail the development of advanced high capacity silicon-carbon nano-composite anodes and complementary high capacity cathodes. In addition, Envia Systems will develop processes to scale the production of both anode and cathode materials to high volumes. Scaling of the materials will involve reproducibility of materials not only with high performance but also with high quality and consistency. If successful, this project will increase U.S. leadership in the field of advanced battery technologies, hasten the shift to hybrid/electric vehicles, and reduce U.S. dependence on foreign sources of fossil fuels.

Renewable Power

Project Title	Direct Wafer: Enabling Terawatt Photovoltaics
Organization	1366 Technologies
Website	www.1366tech.com
Type of Project	Renewable Power
Project Description	Crystalline silicon wafers are commonly used in photovoltaic cells to capture and convert sunlight to productive energy. To date, the use of photovoltaic cells has been limited by the high cost of manufacturing silicon wafers. With ARPA-E's financial support, 1366 Technologies is developing a novel wafer manufacturing process that plucks wafers directly from molten silicon and could cut the cost of installed photovoltaic systems in half and reduce wafer capital costs by 90 percent. By dramatically lowering the cost of photovoltaic cells, this manufacturing process could enable the United States to add 600 GW in solar energy production and save approximately 694 million metric tons of annual carbon dioxide emissions. If successful, this project could increase domestic energy production and generate many new jobs in the solar photovoltaic industry.

Project Title	Breakthrough High Efficiency Shrouded Wind Turbine
Organization	FloDesign Wind Turbine
Website	http://www.flodesignwindturbine.org/
Type of Project	Renewable Power
Project Description	With ARPA-E's financial support, FloDesign is developing a novel wind turbine that delivers significantly more energy per blade diameter than existing models. FloDesign's wind turbine is not only significantly cheaper to produce and operate than existing designs, but also has potentially wider application than existing models. The more compact design will enable the deployment of wind turbines in a wider range of locations, including urban environments. If successful, this project could facilitate the deployment of wind power in the United States and accelerate the shift to renewable energy sources.

Project Title	Adaptive Turbine Blades: Blown Wing Technology for Low-Cost Wind Power
Organization	PAX Streamline, Inc.
Website	www.paxscientific.com
Type of Project	Renewable Power
Project Description	With ARPA-E's financial support, PAX Streamline will develop and construct a prototype "blown wing" (circulation control) wind turbine at the 100 kW scale. "Blown wing" technology has the potential to introduce a radical simplification to the manufacture and operation of wind turbines. Unlike a fixed airfoil, a "blown wing" can be dynamically adjusted to maximize power under a wide range of wind conditions. And, unlike fixed airfoils which must be laboriously manufactured to high precision, an effective blown wing can be generated from a slotted extruded pipe that can be domestically manufactured at a fraction of the cost. Blown wing technology has been demonstrated on fixed and rotary wing aircraft by the U.S. military, but no demonstration of blown wing technology has been attempted for wind turbines. If successful, this project could enable the economic proliferation of distributed, medium-scale wind turbine technology in sites throughout the United States.

Project Title	Low-Contact Drilling Technology to Enable Economical EGS Wells
Organization	Foro Energy
Website	www.foroenergy.com
Type of Project	Renewable Power
Project Description	Geothermal energy is a potentially rich source of carbon-free electricity generation in the United States. To date, the use of geothermal energy has been hindered by the difficulty in penetrating ultra-hard crystalline basement rocks. Conventional drill bits penetrate these rocks slowly and wear down quickly. As a result, drilling is slow and expensive. Foro Energy will use ARPA-E funding to develop a thermal-mechanical drilling technology that will increase drilling rates up to 10-fold relative to conventional drilling technologies. This increase in drilling efficiency will result in a significant reduction in drilling costs. If successful, this project could enable the widespread use of geothermal energy and accelerate the shift to renewable energy sources.

Vehicle Technologies

Project Title	Automotive Carbon Fiber Composites by Fast Cycle RTM
Organization	General Motors
Website	www.gm.com
Type of Project	Vehicle Technologies
Project Description	Each year, the United States loses an enormous amount of energy, equivalent to two trillion watts, to waste heat (i.e., heat generated by machines, electrical equipment, and industrial processes that is lost to the surrounding environment without being put to useful purpose). General Motors (GM) is using ARPA-E funding to develop a system for recovering waste heat in automobiles. By recovering the waste heat, GM will increase fuel economy. The new system will utilize shape memory alloys (SMAs), which are deformed by heat and return to their original form at cooler temperatures. GM will combine SMAs with mechanical designs to achieve a tenfold improvement in power generation compared to existing technologies. This project has potentially unlimited application. It is applicable to heat sources in transportation, homes, buildings and the natural world – anywhere a heat differential exists could be exploited to generate useful energy. If successful, this project could increase fuel efficiency by up to 10 percent and reduce annual fuel consumption in the United States by up to 380 million barrels.

Project Title	Wave Disc Engine
Organization	Michigan State University
Website	www3.lehigh.edu/engineering
Type of Project	Vehicle Technologies
Project Description	Michigan State University is developing a novel generator for use in hybrid automobile engines. Nearly 85 percent of automobile fuel is wasted. Only 15 percent of fuel is actually used for propulsion. The new generator will make better use of automobile fuel. It is projected that the generator will use 60 percent of fuel for propulsion, thus significantly reducing the percentage of fuel that is wasted. The generator is compact in size (about the size of a cooking pot), yet it will replace nearly 1,000 lbs. of engine, transmission, cooling system, emissions, and fluids. As a result, automobile companies will be able to produce lighter, more fuel-efficient hybrid vehicles. If successful, this project will significantly increase fuel consumption efficiency, reduce automobile emissions by up to 90 percent, substantially decrease U.S. imports of fossil fuels from foreign sources, and create new jobs.

Senator DORGAN. I'm very excited about that.

Finally, regarding the $36 billion in programmatic and loan guarantee funding that you got through the recovery program. I see 2 issues in front of us with energy. One is energy security, with 70 percent of our oil coming from other countries—we have a need for greater energy security. The second is the need to address climate change in a thoughtful and appropriate way.

How are you using this $36 billion with respect to those 2 goals? How do you see those 2 goals, with respect to your opportunity to invest a great deal of money, more than any Energy Secretary in the history of America, in pursuit of those 2 goals?

Secretary CHU. In terms of energy security, we are looking, as I said, at this multipronged attack at driving the efficiency up in the automobile sector, which will also help the automobile industry take a leadership role in the most efficient, highest-technology vehicles in the world. That's a very important part; and the biofuels

aspect of it, to start to partially substitute our fuel with agricultural wastes. Electrification.

I think the other thing that we're also trying to do is—as you know, we have a large loan guarantee program; and, because of the still-frozen credits, this is a big stimulus in order to get some of the things that will help the United States take a leadership position in this new energy economy. We are aggressively standing up that program.

Part of the issue is, we started with very few people at the beginning of this year, 16 employees, now we have 50. We went from zero loans to—if you include the automobile manufacturing loans and the others, nine conditional loans; and we've got a few dozen more in the pipeline. We just hired a person, this last fall, Jonathan Silver, a very, very good person. We're looking hard at streamlining all those processes.

We constantly talk about this opportunity and this—not only opportunity, but this responsibility. If you look at what the Department of Energy has today, and what its charge is, we see ourselves as a major innovator in the United States, not only for energy, but largely, in the future, for a lot of our economic prosperity—from the loans, from the basic fundamental research that will help us solve the energy problems, to the applied research, to helping pilot and deploy, to loans. This is all within the Department of Energy, and this is, I think, a key. If we do this right—and we are very determined to do this right—this will be a key to American prosperity.

The CHAIRMAN. Senator Corker.

Senator CORKER. I know that Senator Bunning was here prior to me, so——

The CHAIRMAN. Oh——

Senator CORKER [continuing]. I'm going to——

The CHAIRMAN [continuing]. Were you here before? I was given a list.

Senator BUNNING. You were busy.

The CHAIRMAN. No, I was given a——

Senator CORKER. Yes.

The CHAIRMAN [continuing]. List that had Senator Corker first, but if you're—you were here first, go right ahead.

Senator CORKER. No, no, no. Go ahead, Senator.

Senator BUNNING. Thank you.

I would like to get back to what Senator Murkowski was pursuing on nuclear. Is it my understanding, what you said about nuclear, that we would like to maintain our 20-percent production of electricity from nuclear power, and try to expand on it?

Secretary CHU. Yes.

Senator BUNNING. Do you know how long the nuclear power industry has been on the sidelines?

Secretary CHU. I think the last powerplant that was completed and put online—was started sometime in the early/middle 1970s.

Senator BUNNING. OK. Just so I'm starting from the same point. I want to be—make sure that you and I are on the same starting line.

Isn't it time—not only that this administration and other administrations have just failed to pursue nuclear power as an alternative—when we, in fact, are—if we want a green energy produc-

tion of electricity, particularly electricity, that that is the prime source of doing it?

Secretary CHU. I would agree with you, that it is a very important part of the energy portfolio we will need in the coming century in order to decrease our carbon footprint. I agree with that.

Senator BUNNING. OK. If you agree with that, then why do we drag our feet in licensing, assisting with the moneys available, in pursuing a technology, not only that exists, but that will exist in the future, on nuclear energy?

Secretary CHU. I wouldn't characterize as dragging of feet. For example—first, the licensing is an NRC responsibility, but the Nuclear Regulatory Commission is working toward streamlining the licensing procedures. In the——

Senator BUNNING. Do you know how long——

Secretary CHU. Are——

Senator BUNNING. I've been on the Energy Committee for 12 years, and I've heard that same story from everybody who's sat in your seat.

Secretary CHU. All I can say is, what I know is that before they were—in the 1970s and before, they were licensing each reactor as a entirely new separate project.

Senator BUNNING. But, we know, since 1970, the nuclear power energy improvements have been vast and varied. If a country like France, who I don't think—consider a very progressive country, can produce 80 percent of their power from nuclear energy, and can—and we are stuck at 20, there's a gap there that we ought to be able to make up considerable time in a short period rather than delay and delay, through licensing and roadblocks to nuclear power. If we're going to have a greener America, nuclear power has got to be at the top of the list.

Secretary CHU. I don't think we have a disagreement here. I—as you well know, I'm very supportive of nuclear power. We are working very hard, in the Department of Energy, to get out these loans. They're big, complicated instruments, but that has occupied a lot of my time personally, and time of the top people.

Senator BUNNING. One other statement you made, "I just want to confirm the administration's commitment to research and development for carbon capture and storage." Was I accurate when I heard your statement?

Secretary CHU. Yes, that——

Senator BUNNING. So, the——

Secretary CHU [continuing]. That we are——

Senator BUNNING [continuing]. Administration——

Secretary CHU [continuing]. Committed——

Senator BUNNING [continuing]. Is continuing to do that.

Secretary CHU. Yes.

Senator BUNNING. Is going to continue to do it.

Secretary CHU. That is correct.

Senator BUNNING. OK. Thank you.

The CHAIRMAN. Senator Sanders.

Senator SANDERS. Mostly, I want to know why Jim Bunning doesn't like France.

[Laughter.]

Senator SANDERS. But, on another subject.

Mr. Secretary, first of all, congratulations on the work that you are doing. I agree with what the President has said, and I think you have said, that we are in a transformational moment. It is, to me, basically insane that we are importing, every single year, $350 billion worth of oil from abroad, when we are sitting on technologies that can make us energy independent and substantially cut back on greenhouse gas emissions. I think that is the goal that you are trying to achieve. Is that not right?

Secretary CHU. That's—that is correct.

Senator SANDERS. What it is so important about that is, not only from a political—geopolitical point of view, but we create, over a period of years, millions of jobs, making our country energy independent and moving to energy efficiency and sustainable energies.

I am—just a brief word on nuclear—my impression is, No. 1, that this country has put more money into nuclear than any other form of energy.

No. 2, that if you want new energy, you know what the most expensive way of getting is? Go nuclear. That's the most expensive way.

No. 3, I would love to see volunteers tell us—maybe Kentucky, maybe other States—where we're going to put all of this waste. I usually don't see hands going up and saying, "Hey. We want all that waste." Nevada apparently doesn't want it, and maybe other volunteers can go forward.

But, I think that the evidence is pretty strong—and I want the Secretary to talk about this—that if you really want to make this country energy independent, probably the most cost-effective way is—going forward, is energy efficiency.

I can tell you, Vermont is leading the country on that, and we have barely scratched the surface. If the whole country did what Vermont did—and again, I'm not here saying that we've done all that much—we could prevent the construction of over 300 new coal-burning plants, with all of the greenhouse gas emissions.

Now, I noticed in your paper, Mr. Secretary, you talk about research that would cut energy consumption of up to 80 percent in buildings. We have some of those in Vermont right now, but I see tremendous potential there. In cold-weather States like mine, that is just a huge savings of energy. Could you say a word about, in general, energy conservation?

Let me also tell you that the stimulus package is playing a really good role in Vermont, putting people to work, doing just that.

But, say a word on energy conservation, if you could.

Secretary CHU. I think energy efficiency and energy conservation is very low-hanging fruit. A lot of it—well, is more than low-hanging fruit; it will actually save money. We are working very hard. We have put out a call for proposals in part of our EECBG grants, the Energy Conservation Block Grants, to look at how one can develop self-sustaining programs—not using tax dollars, but to get a mechanism in place where homeowners, for example, can have the confidence that they can say, "If I borrow this amount of money, I will actually save more money"——

Senator SANDERS. Right.

Secretary CHU.—"on my energy bills than the interest I have to pay on the loan. I have the confidence this will occur." That if we

can start to pilot and mass produce these programs, it will have a life of its own.

Senator SANDERS. All right, we—I hope everyone understands what the Secretary is saying. Because one of the problems that we have, is people understand—for example, they're living in a home which is not energy efficient. They don't have the capital to make the investment. Can we work out a way, for example, with municipalities, with the help of the Federal Government, by which, by paying off, maybe, a little bit higher property taxes every single year, they can get an initial investment to make their homes more energy efficient? They are saving money, and, over a period of years, they're paying it back, either through their electric bill or through their property tax. Is that what you're talking about?

Secretary CHU. That's one of the mechanisms. Another mechanism—we're working very closely with HUD. Secretary Donovan and I have signed a memo of understanding, when property changes hands, we're going to make energy-efficient mortgages part of the original mortgage, so it's a low interest rate. When you sell the property, the additional payments on the mortgage, we say, will be less than the savings of your energy bill. So, the homeowner should have no out-of-pocket expense and will immediately begin to save money and energy.

The banks—what's in it for the banks? They can loan more money and have a higher rate of return.

Senator SANDERS. This is clearly a win-win situation.

Secretary CHU. Right.

Senator SANDERS. In the brief time I have, say a word on what you see the potential of solar—both solar thermal and photovoltaics. The cost of photovoltaic has gone down fairly substantially recently, hasn't it?

Secretary CHU. Yes, that's right. The photovoltaic costs, over the last 20 years, have gone down by more than a factor of 10. In the last couple of years, the module itself is now less than $2 a watt. We're expecting, by the end of 2010 it will be pushing on a dollar a watt.

Now, the fully installed costs of a module, if you put it on a big box top like a—you know, Kmart, Costco, one of those—is still about $4 a watt, installed—the full cost, the installation, and everything else.

So, the module itself is now going to be a small fraction. We've been talking to a lot of people. about what are called the balance-of-cost systems—a lot of effort now is being paid to the converters and the inverters to make them a micro-integrated part of the module themselves. Those things actually don't last as long as the module. If you do that, then there will be a dramatic quantum decrease in the cost and the reliability. So, there are things like that, which I see great promise.

So, if I had to predict, in the next 3 or 4 or 5 years, I would expect another factor-of-2 decrease.

Senator SANDERS. Wow. Very good.

Secretary CHU. Yes.

Senator SANDERS. Thank you very much, Mr. Secretary.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Corker.

Senator CORKER. Mr. Chairman, thank you.

I appreciate my friend's comments from Vermont. I do think that, you know, there's probably 35-percent energy consumption out there that could be reduced through efficiencies. I do hope that we will look heavily at programs like that. I know, in the Tennessee Valley, TVA has said those same kinds of things. I hope that we can figure out ways of leveraging efficiencies.

I also want to thank the Secretary regarding his comments about battery-powered vehicles. I know, in Tennessee, we're building a new plant there to make those batteries. Nissan just came out with a Nissan LEAF. I know, in Detroit, where Deb Stabenow's from, the Chevy Volt is getting ready to come online. To me, the whole vision of using baseload power, that's underutilized in the evenings, to charge vehicles is something that I hope all of us will engage in. I thank you for referring to that.

I guess I will say, on the other hand, I—Mr. Secretary—and I know Ranking Member Murkowski went down this line regarding the Blue Ribbon Commission—you talk about changing the way that the Energy Department is doing business, and 4.2 years' worth of person-hours was put in place in a very short amount of time. Yet, we don't have this Blue Ribbon Commission. It does seem to me that, in much of our energy debate, we go around the world to get from A to B, when, in essence, there is a clean baseload energy—nuclear energy—that a Blue Ribbon Commission to deal with some of the issues—my friend, Bernie Sanders, was referring—hasn't even been appointed. It seems—it does sort of feel, to us, that you're slow-walking the things that many of the folks in the White House may think are bad policies, and yet we've asked you to take steps to go forward with, and yet you're trying to go around the world to get to other technologies that—when, in essence, we've got a carbon-free, clean technology that we could do a lot with to—reprocessingwise and others—to reduce the waste.

I guess it makes me—I've just got to be candid—less trustful of the Department as it relates to that. I just don't understand it. I mean, it seems like, on every count, this—and whether—I'm going—I know the Chairman—and I appreciate—sort of, preempted me on loan guarantees, and I'll wait until a hearing to talk about that. But, nothing's really happening there. No Blue Ribbon Commission which is appointing people. We—I talked to you last week about some other issues relating to nuclear energy. It does feel like—that, candidly, you're slow-walking things that are proven, and wanting to spend lots of money on things that are unproven. Yet, we have an opportunity to really link up battery-powered vehicles with nuclear and do some efficiency operations that really could be tremendous for our country. But, instead, we're up here talking about $15 billion in additional research and development, which—by the way, I like research and development—and we ought to prioritize it, and maybe take it from some other area, if it's something that's high priority, and not add to.

But, I wish you'd respond to that, because, as I listened to your testimony, your answers are not clear. You say these issues are difficult, but—we talk about rocket scientists; you know, you're kind of one of those people; you're pretty smart, got a lot of gray matter

there. I find it difficult that you guys haven't figured out how to put together a Blue Ribbon Commission on nuclear waste.

Secretary CHU. Senator, I can assure you that—well, for—let me just start by saying, you know, I'm not a politician. My biggest asset, when I came here to Washington, was my credibility as a scientist. I am determined to leave Washington as someone who will always speak the truth and I can assure you that I am not slow-walking this. I am pushing as hard as I can.

Senator CORKER. When you say you're not a politician, are you saying that you're being interfered with by politicians from the White House on the——

Secretary CHU. No.

Senator CORKER [continuing]. With the commission?

Secretary CHU. No, no——

Senator CORKER. What are you——

Secretary CHU [continuing]. No——

Senator CORKER. I don't——

Secretary CHU [continuing]. No.

Senator CORKER [continuing]. Understand——

Secretary CHU. No, no.

Senator CORKER [continuing]. The point.

Secretary CHU. No, no. Look, these are complicated issues. I'm not—there are a lot of stakeholders, and there is a process that we have to go through——

Senator CORKER. What is complicated about putting together some really smart people to try to solve this problem? Are we lacking smart people in——

Secretary CHU. No, we——

Senator CORKER [continuing]. Our country?

Secretary CHU [continuing]. We are not lacking smart people. It's sort of like the loans, in the sense that—I actually read the—a very recent loan that I had to sign off on. You know, I actually looked at all the pages. Once you start to look at the details of some of these things, they become more complicated.

I don't want to go into the details of why it has taken so long. I would say, yes, I've been frustrated that it's taking as long as it has, but it's about to happen. I am not doing a doubletalk by saying "I am slow-walking this."

Senator CORKER. I know my time's up, Mr. Chairman. I thank you for the hearing.

I thank you for your service, and I'm thankful that you want to leave here with your integrity intact as a scientist. I would say that it seems to me that much of life is finding simple, elegant ways to get from A to B.

Secretary CHU. I agree.

Senator CORKER. I feel like, listening to your testimony today, that's not what's happening today. I don't know what the outside interferences may be to keep that from occurring.

But, I'll just close by saying this. I—you know, the—you and I had a great conversation the other day about climate, and I appreciate that conversation. I think, to the degree that climate enthusiasts can figure out a way of focusing on climate without it being a net-plus extraction from our citizens' pockets into your pockets or our pockets, that would be a good thing. It seems to me that there

were a number of things said today that would help us move along without that occurring. Especially when look at transportation really not being affected by a price on carbon—I think everybody kind of understands that—and knowing that nuclear could produce a—and other things—could produce a lot of carbon-free energy, there are lots of ways we can take huge steps down that road. I'm glad someone as intelligent as you are helping us do that. I hope we'll speed it up a little bit, but I thank you for your testimony.

The CHAIRMAN. Senator Stabenow.

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

Welcome, Secretary, it's wonderful to have you in front of the committee again.

I guess, I—we all view things sort of from our perspectives and our States and so on, but I have to say that, from my perspective, I have a different view than my friend from Tennessee, just in terms of how fast things are moving. We all want things to go faster, but I remember great frustration that, after we passed the energy bill in 2005, no loan guarantees were given out. So, you were handed a program, coming in, where you had to literally go and figure out how to do that, as well as the provisions that we worked on with section 136 for retooling loans, as well as the other programs that we put in place.

So, I'm sure you share the same feeling, that we would love things to—always to move more quickly. But, I want to thank you for moving things as quickly as you have, because we are seeing real results.

When you mentioned A123 batteries, this is a wonderful example of a company that was in Asia and came back. That's what we want to have happening more. It came back because of the partnership with the Federal Government.

Our companies have been competing against countries for way too long. As the Chairman's chart showed, with the investments in China and so on, every other country is out there racing to be the leaders in these technologies.

So, I want to thank you. Also, having come from the North American Auto Show, a week ago, and seeing, actually, the fruits of your labors, our labors, in terms of the new technologies and new partnerships, it's pretty exciting to see. I don't know if you're coming to the Washington Auto Show next week, but I would certainly invite you to do that, because there are very exciting things that, frankly, would not be happening if it was not for the partnerships that we now have with DOE and with the Federal Government and with the innovators, our manufacturers, our—and so on.

I wonder if you might comment—because, from my perspective, when we talk about these issues, it is about energy independence, certainly it is about global warming, but it's about jobs. I see everything through jobs, and this is about jobs. How do we create clean-energy manufacturing jobs, not just in the end product, but in the processes? I mean, you spoke about that. I mean, the way, in a maturing solar panel industry, or as we—on wind, the way we continue to, not only bring prices down, but create jobs, is through investing in processes—manufacturing processes that do that. I know that the Industrial Technology Program has been a huge success that you have put into place for improving manufacturing tech-

nologies to reduce energy, improve competitiveness. Many, many more companies coming forward wanting to partner.

I know that, in section 48C, our Manufacturing Tax Credit we put in the Recovery Act that the Chairman and I both pushed very, very hard for, we have seen 3 times as many requests come forward.

So, I wondered—and I appreciate that you have said, the President has said, the Vice President has said, that you want to expand this credit to be able to take advantage of that. But, could you speak about the potential out there of these things, and a little bit more about what this means in terms of jobs right now, and the fact that we do have folks ready to go, as I understand it, if we were putting the dollars into these areas, to be able to get things moving more quickly?

Secretary CHU. The potential's enormous. I think this whole business of transitioning to a clean-energy economy is something that will generate, now and next week and in the coming decades, meaningful jobs. It will generate and give real life to recapturing, and making sure we never lose, the high-technology manufacturing. This is something we should not say, "Oh, manufacturing's not important." It is vitally important to the United States, high-technology manufacturing especially.

So, all of the programs you've talked about are ways of keeping the manufacturing here in our borders. We have companies that set up plants overseas, in part because there's a market overseas. A lot of the programs we're doing, a strong clean energy—or renewable energy portfolio standard will mean there will be a demand here in the United States. Then, when there is a demand in the United States, then all of the sudden you see manufacturing of wind turbines in the United States. When there were ways to supporting wind and solar in Europe, you saw the manufacturing migrate to Europe.

So, there are many policy instruments. We have to look at all of them, both to get it so that when a company says, "Well, can I manufacture here? Can I manufacture in China? Should I manufacture in Mexico?"—"No, you want to manufacture here."

The manufacturing of windows, the manufacturing of wind turbines, the manufacturing of all of these things should be done here in the United States. You need a market demand for it. You need long-term signals that tell people we're serious about this. You need all these things. You need the tax credits, the 48C tax credits for manufacturing, the 1603 tax credits for installing these things, that they can turn right around and—many of those companies have taken that tax-credit money, which normally would have been parsed out over 10 years—they take the money and invest in a new renewable energy project. We need a loan guarantee for the nuclear.

Now, after six, eight nuclear power plants, do I think the Federal Government says, "OK. Look, this is good enough. The—you know, it's got to stand on its 2 feet, but in order to start something that had stopped for 30 years, you need a little help."

All—quite frankly, I want to see—we have a lot of hydro in the United States. If you replace an old turbine, with a new turbine that's more efficient—and it's actually better for the fish, OK, and

there's no environmental impact except on the positive side—should people get credit for that renewable source? Yes. OK, it's improving. You go from, let's say, 60 percent to 80 percent efficiency, and you save more fish. This is a good thing. OK? If it makes economic sense, it's a good thing.

So all of these avenues, we should be looking at to——

Senator STABENOW. Thank you. I know my time is up, but I would just want to add that the—I've introduced legislation, along with Congressman Peters in the House, for Advanced Technology Vehicle Program, to expand upon that, and particularly to focus on light-duty trucks, commercial vehicles, and so on, where, I agree with you, there's tremendous potential for energy savings and real opportunities for us in new technologies.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

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

Mr. Secretary, thank you for being here.

I enjoyed your comments, fascinated with this new approach to carbon capture, using enzymes that are part of the respiratory process, and I want to learn a little more about that. It's—I think there are a lot of opportunities out there to use different ways of approaching things.

Wanted to follow up with Senator Dorgan, and his comments that—he had mentioned the fact that still half of the electricity in the United States comes from coal. Coal continues to be the most available, abundant, reliable, secure source of energy. We have lots of it in the United States, and a lot of it is being used worldwide. So, it seems to me the best use of some of our research dollars and technology, along the lines that you and I have spoken of in the past, are along those lines that could then help develop the technology to use here in the United States, but also to use globally to work with carbon dioxide.

In some of our work as a committee, I just wanted to ask what your recommendations would be—because you had said, over the next 8 to 10 years we really have to be deploying carbon-capture technology, the—and what we need to be doing now with, say, things like pore space ownership and long-term liability with carbon capture, to make that a reality, and any suggestions there.

Secretary CHU. Yes. First, the Department of Energy is now engaged in, I think it's, 6 or 7 experiments, in various places in the United States, to test different storage sites. This is in regard to the legal liability issue. I mean, we have to make sure that, when we pump this carbon dioxide into the ground, that it will stay there for a long time, it will not leak out, certainly not leak out suddenly, because there are real issues there.

When I was director of Lawrence Berkeley Lab, we had a very good earth science department. I was talking those people up and became convinced that—and also some of my colleagues at Stanford—became convinced that, yes, you could do this. You can store and sequester it safely, and give people the confidence, where you can underwrite that this will not leak out. So, we are doing that now. You still have to prove it.

So, we're doing that, as well as the capture part.

Senator BARRASSO. Thank you.

Just last month, Mr. Secretary, Secretary Clinton pledged to raise about $100 billion in climate aid for developing countries. You know, I was—I'm concerned that that—how—where—how that money's going to be spent—deployed, and if we'd not be better off trying to use that money to develop technology to share globally or sell globally if you really want to get a handle on some of the issues of carbon capture sequestration, dealing with a technology, and how that $100 billion would best be used. We have huge budget deficits in the United States. I think we need to reprioritize and reduce government spending. Should we be investing in American energy innovation instead of handing out $100 billion to climate aid to foreign governments? What's the best use of that money?

Secretary CHU. I'm not sure what you're referring to, in terms of the $100 billion, because—but, let me comment on what the Department of Energy is doing.

We are entering into bilateral agreements with countries. For example, in China we have agreed to invest equally in 3 areas. One is building efficiency. The other is using coal in a clean way, including carbon capture and storage. The other is electrification, cleaning up our vehicles, making them more efficient, and electrification. Seventy-five-million dollars over 5 years from each country in these 3 areas, so we will codevelop.

You know, we believe we still have a technological edge. China has incredible markets. If we codevelop these things, then we think we can mutually help each other. Personally, I think it speaks volumes that China is willing to invest money now in carbon capture and storage.

So, we are discussing, with other countries, like India, similar sorts of things.

Senator BARRASSO. What I was referring to is, Secretary Clinton had made a decision—or an announcement that the—and along with the President—that we'd invest 100—where we'd find and collect and give to other countries $100 billion. This is a result of the Copenhagen conference, and came—it came out of that.

Want to just move to one last question, in my final minute here, Mr. Secretary. The Department of Energy has always maintained very high standards, the highest standards of quality in the production of information given members of the public. I have concerns about what's happening now with what's been called "Climategate," emails that have been leaked. The work of those scientists really provided a substantial portion of the data that compromises—that comprises the United Nations Intergovernmental Panel on Climate Change reports. I just wonder if you believe that the Department of Energy, at this point, and other Federal agencies, should continue to rely on the U.N.'s work, if the process used to develop its reports would really violate the Department of Energy's own research standards and principles. Because there is no way, right now, that we can even get the raw data and other research material that have been used for what we now know of these leaked reports, and question about the integrity of some of this research.

Secretary CHU. The short answer to your question of, Do we believe that we should continue to rely on the IPCC, in terms of climate information? The answer is, yes.

With regard to "Climategate," there are mountains of evidence that suggest what is happening—not "suggest," but actually show, in my mind, what is happening. The "Climategate" thing that you're talking about is—there were 3 different groups using tree rings as a proxy for the amount of carbon dioxide. One of those groups found that the tree ring says that the carbon dioxide in the atmosphere wasn't increasing the way direct measurements were indicating. So, what they did is, they just said, "Well, I don't understand this," they threw the data out.

Now, that is being investigated. When scientists throw data out, you should throw the whole dataset out.

There are 2 other groups that didn't see this anomaly. If you look back in the history of that group, they actually went anomalous couple of other times.

So—but, that's a little snippet of all the things that have been showing that the climate is changing. It is changing radically. So, as you well know, there are all these little warts and bumps as science marches on. OK? But, when you have tens of thousands of things going in one direction, there's going to be 2 or 3 things that say, "Uh." So, it doesn't really impact the overall conclusions, in my mind, at all.

Now I know what—suspect that that's what you're asking about—I believe what Secretary Clinton was saying is that the world, not the United States, will—which includes the private sector would work toward building it up—if the developing and developed countries could come to an agreement, then you could see about developing a fund of up to a $100 billion a year of both private and public money—and, you know, —this is not United States—and then investing it in the poorest economies. But, that was based on if a lot of things happen.

Senator BARRASSO. Thank you.

Thank you, Mr. Chairman.

Just because you had—earlier you had said something about "money sitting on the sidelines," and I'd like to see that money used in some of the technology. Then we could share in that, internationally. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Menendez.

Senator MENENDEZ. Thank you, Mr. Chairman.

Secretary, thank you for your service. I—couple areas I want to talk to you about.

One is, you know, I believe that energy efficiency is one of our keys to reaching both our climate goals and to reducing our energy dependence and to creating millions of new green jobs.

I also believe energy efficiency, like job creation, is best done from the bottom up. A lot of that is through local efforts. That's why I, along with Senator Sanders, championed the Energy Efficiency and Conservation Block Grant Program, which is currently distributing a little over $3 billion to cities and counties around the country to help them use energy more efficiently, create new jobs, and also reduce costs for taxpayers. Could you tell the committee how much of the money in the program has been awarded thus far?

I also wanted to know if you agree that it's essential we continue to fund this program beyond the Recovery Act so we can continue

to make our communities greener, create more jobs, and reduce their energy costs?

Secretary CHU. OK. So, as of this week—I happen to have the numbers here—89 percent of the grantees have received some or all of their funding. So, in terms of dollars, it's $2.265 billion, out of a total of 2.7 billion, have been obligated. Now, significantly less has been costed—actually spent. But, the commitments—the obligations are going to the cities, the towns, the localities. Again, there are these issues. The first tranches you apply, you get money to develop a plan, you submit the plan; as soon as the plan is approved, then you get more money, and so on. So, we are working through the processes. It's uneven. Sometimes plans are good, boom, it's good to go. There are other approval processes that need—you know, in the statutes—that need to be approved, both at the State level and at the Federal level. We are working as hard as we can to streamline any way and—any way we can help, in the Department of Energy, to help the mayors, for example, who are receiving these block grants, to get it going.

Senator MENENDEZ. What do you expect to be the time between obligation and distribution?

Secretary CHU. It's a partnership between the local governments that we give the money to and how well they can get the—remember, we have another obligation, and this is taxpayer dollars. The Vice President has said, "We want the money spent quickly, but we want it to be spent wisely."

Senator MENENDEZ. Of course. My point is, if you've obligated it, it's because you've reviewed their plans and you have made a decision that their plans are worthy——

Secretary CHU. That's correct.

Senator MENENDEZ [continuing]. Of being funded. So, now we have $2.6 billion obligated. I'm just wondering how much time before you actually have the delivery and expenditure of those.

Secretary CHU. Yes. That—again, it depends on the—at the local level, because they have to satisfy certain requirements——

Senator MENENDEZ. What do you think about moving forward on this program?

Secretary CHU. We are trying to move—help the local governments move——

Senator MENENDEZ. I'm talking about——

Secretary CHU [continuing]. This forward.

Senator MENENDEZ [continuing]. Beyond——

Secretary CHU. Oh.

Senator MENENDEZ [continuing]. This tranche of money from the stimulus.

Secretary CHU. I think the idea of investing in energy efficiency is a very big idea. Now—but, the way to do it—that's why we are looking very hard at trying to look at ways in which private-sector money—or, if it's public-sector money, where it's heavily leveraged. OK?

So, if you just pay for everything, that will get some good things done, but we can't continue this. So, we're looking at programs—and that's why we're piloting these programs with the EECBG money, so that—if energy efficiency does really save money, and I believe it does, then the private sector would be able to make

money on this. But—and they say, "Well, why haven't they, so far?" There are hurdles. There's inertia, there's inconvenience, there's a lack of information, there's a lack of trust about whether the work you contract will actually be good. So, we are looking to overcome all these hurdles. So, it becomes a very commonplace thing that people come and say, "When I invest $5,000 in weatherization, I'm going to get return on my money." So, to the extent that we can leverage any Federal taxpayer dollars to make this possible, that's OK. But, it—again, we're focusing on leveraging it.

Senator MENENDEZ. I'm all for leveraging. But, clearly, when you go directly to a taxpayer, at a municipal level or a county level, and you are getting energy savings, you're creating jobs, in the first instance, putting people to work, which we desperately need to do in this economy, and at the same time achieving long-term energy savings, which means a reduction in the cost to taxpayers, that's a multiplicity that I'm not quite sure that the private sector will always generate, as it relates to counties and municipalities. They'd have to pay a private contractor to do it. So, if it's going to go—if the incentive is going to go that way—so, I just want to urge your attention to the difference, you know, more for leveraging money, and maybe even getting municipal buy-in, to some degree, if you're going to get a leverage. But, I'm simply saying that, at the end of the day, there are—there was a ripple here of savings that's important.

Let me just turn to one other issue. I very much pursue solar energy here on the committee. You know, I believe that—you know, I've authored bills, like this Grid Access Act, which would create national standards, to allow people to easily connect their solar systems to the grid and sell excess power back to their utility. My home State of New Jersey has the second highest solar power capacity in the country. It's No. 1 in solar installed per square mile. So, this is incredibly important.

You know, solar photovoltaic panels have plummeted in price recently. They're increasingly an attractive option for consumers. One, what policies do you think are most critical to continuing to lower the price of solar power? What are the major market barriers to its continued growth?

Finally, Senator Stabenow and I have written the Solar Manufacturing Jobs Creation Act that would allow equipment used to manufacture solar powers to be added to the list of property that qualifies for the 30-percent solar investment tax credit. Do you think that that is an incentive worthy to be considered of?

Secretary CHU. I think tax credits are very helpful. I think development of lighter-weight modules that don't penetrate roofs is very helpful. I think we want to be able to get it—solar—in a position where, when you install it, you don't need a city inspector and a license to put it on your roof, but add—because that adds inconvenience and cost. This is part of the balance-of-cost systems that—you know, we want to do it, so it's like buying a water heater. All right?

So, we're—well, I've talked before about the reliability of the inverters and converters. This is a very focused target now. How do we get—one of the sad things is that the brilliant electrical engineers that were building us better and better chips haven't been really paying attention to what I call "power electronics." So, we

want to get, in the pipeline, gifted people who are going to work on power electronics, because this is going to be a very important technological market in the future. It's, again, going to our—prosperity. So, we are looking at all those things and how we can do this. That's—so.

Senator MENENDEZ. We'll—I won't delay, Mr. Chairman—but, we'd love to talk to you about——

Secretary CHU. Sure.

Senator MENENDEZ [continuing]. Some of the greater aspects of this question. How do we continue to lower that price? How do we deal with major market barriers? How do we look at connections to the—we'd like to talk to you about all of that. But, I won't——

Secretary CHU. OK.

Senator MENENDEZ [continuing]. Delay before the committee.

Secretary CHU. If I can indulge the Chairman, just—regarding your other question, the EECBG, the weatherization, the CEP, those are all Recovery Act things. We are working as hard as we possibly can to get that money out to stimulate the economy, to put the people who are unemployed back to work and so that is very important. That ripple effect—I totally agree with you, that was the philosophy behind Congress and the administration getting behind the Recovery Act. It has made the recession much less worse than it could have been. I think that it has been a success story.

But, then, going forward, we can't just simply do the same ad infinitum, because you know, it's a big deficit. So, that's why, you know, when the Recovery Act funds do end, we have to look at those things that can keep the momentum going. That's what I was really talking about regarding——

Senator MENENDEZ. No, I understand that we can't continue to spend, but you're going to have a budget. You're going to ask us to spend——

Secretary CHU. Right.

Senator MENENDEZ [continuing]. On certain things.

Secretary CHU. Right.

Senator MENENDEZ. I'm just looking, in the context of your spending that you're going to ask for, you know, justify to me why—one, what you're going to spend; and 2, where is this program, in terms of its prioritization, as it relates to that spending? So——

Thank you Mr.——

Secretary CHU. OK.

Senator MENENDEZ [continuing]. Chairman.

The CHAIRMAN. Senator Wyden.

Senator CANTWELL. Thank you, Mr. Chairman.

Welcome, Mr. Secretary. Good to see you again.

In addition to my duties here, I chair the International Trade Subcommittee, as well, at the Senate Finance Committee. I want to talk to you particularly about the export market in clean technologies. This is something you've talked about in the past, and it seems to me good clean technology policy is a twofer. We come up with clean technologies in our country that are going to help us tackle climate change, and we've got a very lucrative market for our exports, which means we're right in the grill of a field that's

going to allow us to come up with more high-skill, high-wage employment.

You said—and I thought you really put your finger on it, I'm just going to quote you here, briefly, and see if we can get in a little discussion—you said, "The only question is which countries will invent, manufacture, and export clean technologies and which countries will become dependent on foreign products." That was your comment, and I think it really, frankly, captures the challenge of our time here, you know, linking, particularly, clean tech to something that we can export around the world. Now, we did an analysis of this, and we found that, in some key areas, particularly wind turbines and solar panels, we're actually falling behind foreign competitors, in terms of our competitiveness in global markets. We saw that 80 percent of clean energy investments are going to take place outside of the United States even though global trade and environmental goods has doubled just in the last few years.

So, you all aren't the lead, in terms of export policy, but you do play a very key role, particularly with the Commerce Department. Tell me, if you would, specifically what you think can be done between the Department of Energy and the Commerce Department to get us back in this position of leading in the field of export of clean technology.

Secretary CHU. Senator, you're quite right that Commerce is the lead agency, in terms of the import/export. But, the Department of Energy is lead agency, in terms of generating the innovation, generating first the inventions, and then the innovation that leads to new products.

It is true that, over the past decade or 2, the amount of solar—manufacturers for solar photovoltaics has been declining in the United States. I think that's turning around. There are a number of very innovative companies that are thin-film solar companies, for example, or even polycrystalline solar companies that have higher efficiencies. One of our first loan guarantees, Cylindra, has a very, very good product and is manufacturing here in the United States.

So, I hope that this will be turned around. It requires a number of policies that will help support the building of factories here in the United States. If we have the superior stuff, we would like to manufacture in the United States.

This goes back to my comment about high-technology manufacturing. You know, these companies—I know one company reasonably well, because it was in the Bay area, called Applied Materials; they are masters at automating things and turning manufacturing—very complex manufacturing processes into high-tech very efficient manufacturing. There was a time, over the last year, where they sold 14 turnkey factories. They sell turnkey high-tech factories. All 14 were abroad. So——

Senator WYDEN. Here's——

Secretary CHU [continuing]. This is a——

Senator WYDEN. Here——

Secretary CHU [continuing]. Combination of tax——

Senator WYDEN. Here's what——

Secretary CHU [continuing]. Policies, fiscal policies——

Senator WYDEN. Here's what I need to know, Mr. Secretary. The U.S. is now losing market share in overseas markets on environ-

mental goods. That's what we found in this report. I'll ship it over to you. We just did it. The trade deficit in these goods is growing substantially. What mechanism is there between the Department of Energy and the Commerce Department so that we can figure out how to tap the export potential of clean-tech before we lose more ground? What mechanism actually exists between your agency and the Department of Commerce to tap export potential?

Secretary CHU. I think you need, first, a local demand here, to encourage the manufacturing of these products here. Then, given that, if you're manufacturing here, then that could be part of the export. If there's no local demand here, and it's all abroad, they will build a factory abroad. I think this is part of it. This, again, to the long-term strategy that the United States must have, in terms of where the world will be. I think we will live in a carbon-constrained world. So, why not take the leadership?

Let me give you an example. I visited Cummings diesel. Cummings makes diesel engines. A very high ranking official there was telling me that because of the regulations on particulate matter, NO_X, in diesels, that were demanded of our diesel manufacturers, they had to develop cleaner diesels. They thought, initially, that it was a disaster to the industry; it wasn't adding customer value, because it would increase the cost of the diesels; and decrease the efficiency somewhat. But, in the end, they figured out how to do it, and now they're the leader in clean diesel manufacturing in the world. This person—I don't know what his exact title was, but he said, "Cummings might not be here as a standalone company had not we been required to develop clean diesels. But, now that we have clean diesels, we're the leader in the world in clean diesels for trucks."

Senator WYDEN. My time's expired. I'm going to want to ask you some more questions, specifically, Mr. Secretary, about the relationship with you all and the Commerce Department.

Secretary CHU. OK.

Senator WYDEN. Because I still am not clear on what the strategy is to tap the full potential here, and I'd like to talk to you about it some more.

Thank——

Secretary CHU. I——

Senator WYDEN [continuing]. You, Mr. Chairman.

Secretary CHU. I would be glad to talk with you about that.

The CHAIRMAN. Senator Cantwell.

Senator CANTWELL. Thank you, Mr. Chairman.

Good to see you, Secretary.

I think I'll follow on my colleague, because we know that the Pacific Northwest is looked on by several industries as an epicenter for clean energy jobs and manufacturing. If we get the manufacturing credit, and we get some of these programs moving more rapidly, we think that we could capitalize on that. I'm not sure all the reasons why the Northwest has been already a focal point but——

I saw an anecdote, last week in the New York Times, that Bill Gross, who runs eSolar, which is a solar thermal startup in California, announced that they are going to build the biggest solar thermal deal ever in China, a 2-gigawatt, $5-billion plant using their technology. But, eSolar said they applied for an Energy De-

partment loan for a 92-megawatt project in New Mexico, but in the time that it took for them to do that, they decided to go ahead with the Chinese project instead.

So, obviously we're glad they're using the technology, but how do we move faster, given that China seems to be surpassing the U.S. in the wind market? China is now building six wind farms with the capacity of 10,000 to 20,000 megawatts apiece. In the solar world, they are dominating the panel manufacturing. So, how do we make sure that we get this manufacturing credit implemented and these jobs and leadership of the United States in this key technology?

Secretary CHU. The way you do it is, you look at why it takes the delays it takes in order to get these projects going. We have different ways of doing business than in China. You know, they can—with one stroke of the pen or wave of the hand, they can go and do these. We have processes that are established to do many, many things, including protecting the environment, that one has to go through its steps. So, the loan guarantees—again, we—you know, we're mandated by Congress to try to negotiate with any applicant so that we can get the best value for the taxpayer dollars.

I think that if we're allowed to leave a little bit of change on the table, it might make things go faster, but there are statutes written into the laws that demand that we do certain things. There are statutes written into the laws which are—I think, you know, on balance, good. You know, I think it's good we have environmental protection standards. It—we just want to do those things in a timely manner. But, so China has not caught up to us on those environmental protection standards, and so they can do things at a faster pace.

Senator CANTWELL. I think we definitely need to figure out how to further streamline this process and obviously make the manufacturing credit more robust.

I wanted to ask you, because I know the Chairman asked you about the price signals, and I'm a big fan of whatever we can do in moving faster, from the government. But, I also want your thoughts on this, of whether it's really going to be the private-sector investment level that really decarbonizes our economy, and what it's going to take to get a predictable economywide price signal on carbon.

So, if you could tell me your thoughts on that, and whether you think that a predictable carbon price is the only way to ensure a significant number of nuclear power plants are built, as well.

Secretary CHU. I think it is very important to have a long-term signal that we will be living in a carbon-constrained environment, in a carbon-constrained world. If I were a utility company and thinking of investing anywhere from a billion to $10 billion in a new power—depending on what the plant was, whether it's a coal plant or a nuclear plant—that would be operational for 60, maybe 80 years, it will be very important to me as to what the long-term signal is going to be. That's why I think—and this is what I hear from industry—why the money is on the sidelines.

You can't make those investments—the financial institutions, the banks are holding back, saying, "Well, I'm not sure we can make these loans, because we don't know what the lay of the land is today." The rate commissions also need those signals.

So, things are semi on hold because of that.

Senator CANTWELL. I wasn't in the room, but I'm gathering, from your answer to Senator Bingaman, that the price signal that is happening in the marketplace right now isn't enough?

Secretary CHU. No, it's——

Senator CANTWELL. It's——

Secretary CHU [continuing]. Not. I mean, there——

Senator CANTWELL [continuing]. Not predictable. It's not——

Secretary CHU. It——

Senator CANTWELL [continuing]. Long-term.

Secretary CHU. A price signal, in many sectors, would not be enough. We just talked about transportation, a price on carbon. The price signal that would end up on the gasoline would not be enough, based on CBO estimates of what it would do—let's say, Waxman-Markey would do to the price of gasoline.

So, you'll have to get it through other things. I think some of the things have to be regulatory, as in a standard. The price of—the efficiency of your—if you have a satellite TV box or cable TV, you know, that thing draws 10, 20 watts. There's no price signal that will actually make that draw 1 watt; whereas, the engineers can make it draw 1 watt. It might increase the cost of manufacturing of that little box by just a little bit. So, there you just have to say—you've got to regulate that, just as we do refrigerators.

So, you look at all the sectors. Some of them, there will be price signals; some of them, there will be, "This is where we have to be by 2050 and 2040 and 2030." There are all of these things.

Pure price signal, alone, can't get us there. That's why we're looking at renewable portfolio centers. That's an artificial market drawn to make sure that you will have—if American manufacturers get into this business, that they will have a product to sell.

Senator CANTWELL. My time's up, but I just wanted to make—you do support a long-term price signal as a——

Secretary CHU. I——

Senator CANTWELL [continuing]. Way——

Secretary CHU. I——

Senator CANTWELL [continuing]. Not a short-term or near-term price signal. But, you're saying, if you had something that was 30 years of policy——

Secretary CHU. Right.

Senator CANTWELL [continuing]. Predictability——

Secretary CHU. Right. That's——

Senator CANTWELL [continuing]. That——

Secretary CHU [continuing]. Right.

Senator CANTWELL [continuing]. That predictability would unleash——

Secretary CHU. That——

Senator CANTWELL [continuing]. The private——

Secretary CHU. That would——

Senator CANTWELL [continuing]. Sector——

Secretary CHU [continuing]. Unleash private investment. I agree with that.

Senator CANTWELL. Thank you. Thank you, Mr. Secretary.

The CHAIRMAN. Senator Shaheen.

Senator SHAHEEN. Thank you, Mr. Chairman.

Mr. Secretary, thank you for being here. I apologize for being late and for missing so much of your testimony, because I do appreciate all of the work that you and the Department are doing to address our energy future.

I missed Senator Menendez's question, but my staff told me that I—he addressed one of the concerns that I wanted to raise with you this morning, and that is that our energy office in New Hampshire is concerned about the increasing reporting requirements for many of the programs that DOE is administering, and that they are changing, they're becoming increasingly strict. I know, that all of us are very concerned about accountability and making sure that we get the best job that we can for the money that we're spending, but their concern is that they're going to have to hire additional staff, so take funding away from the program part to put on staff to deal with reporting requirements.

Are there additional ways that we can balance the need for accountability and the effort in States to get these programs working in a way that's effective?

Secretary CHU. I hope so. I will certainly personally look into this. I've been told, that many of these requirements are—have been essentially mandated.

Again, it's, you know, spend quickly but spend wisely. When you're spending that kind of money, especially that new money, it is ripe for abuse. So, for that reason, you know, our IG offices are trying to help us design programs simply to prevent them before they occur.

Now, having said that, it is possible to go too far. So, we are always looking at ways to streamline processes. I certainly have heard that additional reporting, which was required in much of the Recovery Act, seems like a lot.

Senator SHAHEEN. Thank you. I appreciate that. If we can be helpful as you're taking a look at that, I would certainly be happy to help in any way that we can.

Secretary CHU. OK.

Senator SHAHEEN. I think this other issue may have been raised by others, as well, but we have a number of small- to medium-sized businesses in New Hampshire that are doing very innovative things when it comes to new energy technologies, companies like Warner Power. One of the things that we're hearing from too many of those businesses, I think, is that they're having trouble accessing assistance from DOE, particularly funding. Obviously these businesses are the kind that we want to grow. So, what more can we do to help businesses like Warner Power and some of the other small- and medium-sized businesses to commercialize those technologies that they're working on? What, specifically, is the Department doing to help with that?

Secretary CHU. There are, again, mechanisms. We give grants, with matching money. We also give loan guarantees. The only trouble is that the way, for example, the loan guarantees currently are set up, and what we're required to do——

Senator SHAHEEN. Right.

Secretary CHU [continuing]. Doesn't make the processing of a small loan worth it.

Senator SHAHEEN. Right.

Secretary CHU. Again, it's the hoops that we, in the Department, have to jump through. We are constantly looking at, Do—you know, what are the requirements we put on ourselves? What are the requirements that we think are necessary? What are the requirements that are statutes?

I would be glad to talk to you and work with you, because I agree with you that a lot of these—a lot of the real innovation in the United States comes out of these small entrepreneurial garages. How do you actually get them started, especially in this era of very tight credit? So, I will admit, it is not a solved problem. OK?

Senator SHAHEEN. Thank you. I'd appreciate that.

Secretary CHU. OK.

Senator SHAHEEN. Willing to do it. I remember, our first conversation, this is an issue that you raised, and something you felt the Department needed to work on.

Finally, one of the things that is a big issue in New Hampshire, because we have a higher-than-usual percentage of individual dwellings, both homes and commercial buildings—and so, our energy costs are very high, because we need to do a lot more work when it comes to energy efficiency and—with buildings. We're seeing a growing number of communities embrace the PACE concept, the Property Assessed Clean Energy financing. What is the Department of Energy doing to help encourage those PACE programs? Is there more that we ought to be doing?

Secretary CHU. It is a local issue, but we are trying to spread the word that this is a good thing. But, what we are doing is making it so that one can more efficiently and effectively assess what are the needs, where the money would be spent the wisest, to get the most return on investment for a homeowner. We are developing an energy audit tool that could be put onto a BlackBerry or iPhone and things like that.

Senator SHAHEEN. OK.

Secretary CHU. We are looking at how we can, essentially, give license or some way of approving that these contractors are trustworthy, you know, kind of a Good Housekeeping——

Senator SHAHEEN. Yes.

Secretary CHU [continuing]. Seal—DOE seal of approval. We are looking at ways in which neighborhoods can, if they sign up—a bunch of them, en mass, can sign up—that they can go to a provider for energy efficiency work and get a huge quantity discount, so the truck can go from house to house to house to do the energy audit, another truck can go to house to house to house to blow in the installation or seal the leaky ducts. So, it's a—kind of a mass production of energy efficiency, with contractors who are trustworthy.

So, we are designing programs like that. We're going to be piloting them. If they work, we will aggressively say that this is the way you actually get more value. So, it's—in addition to the funding, it's actually to give the homeowners the assurance that, when they borrow money or spend their own money, that they will really recoup that.

Senator SHAHEEN. Thank you. My time is up.

The CHAIRMAN. Senator Risch.

Senator RISCH. Thank you, Mr. Chairman.

Thank you, Secretary Chu, for coming here today.

Actually I'm going to reserve my questions. I know we're going to have a hearing in 2 weeks on the loan programs. As the Secretary knows, because we've had a number of discussions about the importance of the loan guarantee programs to the nuclear industry, to move the renaissance forward, I'm going to have a lot of questions in that regard.

So, thank you very much. Thank you for coming. We'll have a little chat about that in a couple weeks.

Thank you.

The CHAIRMAN. Senator Murkowski, do you have some additional questions?

Senator MURKOWSKI. Mr. Chairman, I have some additional questions, but I'll submit them for the record, because we're running short of time.

I want to make a comment. This follows on the heels of the conversation that you had with Senator Corker about the impatience on commissioning the Blue Ribbon Commission.

Secretary, I want to assure you that I believe you have the support of many here in the Senate. You've come before this paneland strongly stated your support for whether it's areas of nuclear or to Senator Bunning's question about how we advance clean coal, how we move toward the renewables and the efficiencies. I think you believe in the balanced energy portfolio that is imperative for this country.

I find it a little disturbing that the questions that I presented to you, specifically asking whether or not the White House was barring any research into particular areas of nuclear, and then in my opening comments I made reference again to this Energy Daily article that apparently goes back to a letter between you and those within the administration on perhaps some differences in approach. We understand that you're not going to have everybody lineup, you will have your budget guys coming at it from one perspective and the policy folks coming at it from another.

But, I would like to encourage you to hold tight to these principles. You have stated you want to exit this job with your integrity as a scientist intact. I hate to take things out of context or say that whatever the press writes is what we believe but there is wording here that says, "It reinforces the suggestions by some industry officials that the Obama White House is overstuffing energy efficiency and renewable energy at the expense of more traditional generation sources like coal and nuclear," and then it goes on to say how you have "made the case for these other energy areas," whether it's in nuclear, or the fossil fuels.

I would just remind you that there are many of us looking to support all that is available within this balanced energy portfolio. I think we know that we have technological opportunities we need to allow time to bear out. We need to be a little more aggressive and more risktaking in some of these other areas.

Like Senator Dorgan, I look forward to the list of what you might put out in this white paper on what ARPA-E is doing. I would ask you to hold tough and keep pushing for the balance in the energy technology portfolio, because I really do believe that's how we're going to get to meaningful reductions in our emissions.

I have a particular question that I want to pose to you about how we're doing with ocean energy and its potential, but I'll look forward to those comments in writing.

Secretary CHU. OK.

The CHAIRMAN. Do you have any final message for us, Mr. Secretary? We appreciate all of your time this morning.

Secretary CHU. Just reiterate how important this is to—the whole energy issue is—how important it is to America's economic prosperity. I see it as very—tied, because energy reaches into everything. If one recognizes that, you know, we don't know what the price of oil's going to be a year from now, but probably, 10 and 20 years from now, there's a pretty good bet it's going to be higher than it is today.

I, again, assert, given the sea change that I've seen developing countries like China, that we will be living in a carbon-constrained environment worldwide. There's an opportunity to lead in this transition, technically, that we can then use for both internal consumption and for export.

There are a lot of smart people who are very concerned about this. Not everybody agrees with everyone else. But, we try to work through these—and on a science base—evidence-based decision-making processing, and try to get to the best solution that will be the best for America's economic prosperity and for our environment for security, and energy security, as well.

You know, I have certain opinions, and not everybody always agrees with everything I say, and so I just see that as an opportunity for me to try once again.

The CHAIRMAN. Thank you again for all your time.

That will conclude our hearing.

[Whereupon, at 11:48 a.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

RESPONSES OF THE HON. STEVEN CHU TO QUESTIONS FROM SENATOR BINGAMAN

Question 1. The President's budget for fiscal year 2010 proposes $15 billion allocated over 10 years for energy R&D starting in fiscal year 2012.

a. Given the magnitude of research that must be accomplished in such areas a carbon sequestration, biofuels and nuclear energy—do you think this level of funding is adequate to meet long-term climate goals?

Answer. In October 2009 President Obama noted that "nations everywhere are racing to develop new ways to produce and use energy, and the nation that wins this competition will be the nation that leads the global economy." The Department's FY 2011 budget request for energy research and development invests in those new ways to produce and use energy—in such areas as carbon sequestration, biofuels, and nuclear energy, where we have strong programs which this budget continues to support. The Department's FY 2011 research and development budget request fully supports the Administration's commitment to create jobs through development of a clean energy economy, invest in advanced science, research and innovation, and improve energy efficiency to help curb greenhouse gas emissions which contribute to climate change.

Question 2. Many of the models of climate legislation indicate that the price increase imposed on transportation fuels from cap and trade is too small to change driving behavior. This means that, even though the transportation sector is responsible for 1/3 of our emission, market forces alone are unlikely to reduce emissions from vehicles. Does this make research and development investments in the transportation sector more important than in other sectors that will receive stronger price signals? What are the technologies that you view as having the most potential in this area?

Answer. Meeting the President's goals of combating climate change and reducing our dependence on oil will require significant investments in advanced technologies across all sectors. The existing cap and trade legislative proposals are unlikely to significantly reduce the transportation sector's greenhouse gas (GHG) emissions alone in the near future. This sector's emissions will be regulated under existing Clean Air Act (CAA) authority as has been proposed for light-duty vehicles by the EPA in 2009. Furthermore, technologies developed for one sector (such as low-carbon power from renewable sources) may be used in the transportation sector. The American Recovery and Reinvestment Act included $90 billion in clean energy investments, including those for improvements to the Nation's power grid to facilitate a smarter grid, and grants for the next generation of advanced batteries. In addition, the Department maintains a portfolio of Research Development and Demonstration projects to further the goals of energy security, environmental quality, and economic growth. The proposed FY 2011 budget includes $220 million for biofuels and biomass R&D and $325 million for advanced vehicle technologies.

The Vehicle Technology Programs include many programs to reduce of the transportation sector on petroleum. Technologies that may be deployed in the near future include efficiency improvements to internal combustion engines, hybrid-electric power trains, and other efficiency improvements such as weight reduction and aerodynamic improvements that reduce drag. The Department is active in advancing energy storage, especially batteries, necessary for commercializing Plug-in Hybrid Electric Vehicles (PHEVs) and Battery Electric Vehicles (BEVs). Finally, one of the goals of the DOE's Biomass program is to transform domestic biomass resources into cost competitive low carbon biofuels. In the longer-term, an entirely new propulsion and fuel distribution system relying on more efficient low-or zero-carbon fuels (such as hydrogen fuel cells) may be developed.

Question 3. Many of the technologies we will need to meet the long-term goals of climate change are expected to have long development times. This would seem to argue strongly for front-loading the research and development investment dollars towards the beginning of any climate program, rather than having them increase over time. Would you agree with this investment structure?

Answer. No, not necessarily. The urgency of our climate change goals, indeed, calls for rapid development and deployment of advanced climate change technologies, This, in turn, implies intensive early-stage efforts and, given the uncertainty of research and outcomes, the pursuit of multiple paths toward a desired end. Both can add to costs compared to a more deliberate approach. This might imply front-loading. This model also comports with the principle of government's role of underwriting the early and higher risk phases of a technology's development. On the other hand, the more expensive phases of research occur in the prototype development, testing, evaluation, scaling-up, and large-scale demonstration phases of a technology's development. Even when the government's share of the later-stage costs is defrayed by industry cost-sharing, its costs alone may be substantial and far overshadow those of the early-stage work. Each technology is likely to be different. It is best not to generalize.

Question 4. The Department has a very wide portfolio of research spanning basic to applied. If these funds were to become available, where do you think the greatest need and payoff is?

Answer. As my testimony outlined, the Department's strategic priorities are three. First, the Department must lead the nation's efforts to transition to a low-carbon economy by developing and deploying clean and efficient energy technologies, increasing generation capacity and improving our transmission capabilities. Second, we must invest in scientific discovery and innovation to find solutions to pressing energy challenges and maintain American economic competitiveness. Third, we must enhance national security by ensuring the safety, security and effectiveness of the nuclear stockpile without testing and; reducing the threat posed by the proliferation of nuclear weapons and material; and providing safe and effective nuclear propulsion for the U.S. Navy. Supporting these priorities, the Department has requested in FY 2011 a set of activities that are believed to be necessary to ensure deliberate progress and ultimate success. Collectively, the activities and their requested amounts form an efficient and cost-effective portfolio. We would not encourage further adjustments.

Question 5. You were on the National Academies Panel that resulted in the report "America's Energy Future." This report has two principal findings on base load power (1) demonstrate Carbon Capture and Storage on 15-20 new and retrofit plants with a variety of feedstocks and geologies before 2020 and (2) demonstrate whether evolutionary nuclear technologies are viable in constructing 5 plants within the next decade.

a. Do you agree with these findings?

Answer. One finding of the National Academies report states that "achieving substantial reductions in CO_2 emissions from the electricity sector is likely to require a portfolio approach involving the accelerated deployment of multiple technologies: energy efficiency; renewables; coal and natural gas with CCS; and nuclear." In general, we agree with this finding and the President's FY 2011 Budget request supports such a portfolio by building upon the investments made in FY 2009, FY 2010, and the American Reinvestment and Recovery Act of 2009 which lay the foundation of our transition to a clean energy economy. Specifically, the report recommends that we "assess the viability of CCS for sequestering CO_2 from coal- and natural-gas-fired electricity generation." Furthermore, the report notes that "building large quantities of new generation of any technology requires learning, licensing, permitting, and public acceptance. The urgency of getting started on these demonstrations to clarify future deployment options cannot be overstated." Through execution of Recovery Act projects and Fossil Energy R&D base programs, the Department is well positioned to begin to demonstrate a suite of CCS technologies covering multiple stationary sources and geologic reservoirs at the scale necessary to assess the commercial viability of CCS. Various regulatory and legal barriers, including the issue of long-term liability for CCS must be resolved prior to widespread adoption and deployment of this technology. In addition, the President acknowledged the need for comprehensive action by creating an interagency CCS task force to identify the barriers to commercial deployment of CCS technologies and assess the viability of CCS as a future deployment option. The interagency CCS task force is examining the adequacy of currently planned demonstration programs as part of this effort.

However, it is important to note that our investments in CCS support a broader portfolio approach to addressing our climate and energy challenges. The findings are

also consistent with the President's call for new nuclear construction in his latest budget request increasing the Department of Energy's FY2011 Federal loan guarantee authority to $54,5 billion for companies planning to build nuclear power plants.

Question 6. As you are aware other nations have viewed their investment in energy R&D as a way to develop new markets and hence create job. Can you explain where you think the United States is relative to other Asian nations such as China and Japan?

Answer. Asian countries such as Japan and China are actively investing in clean energy technologies. Japan, for instance, has a stated goal of accelerating the introduction of renewable energy technologies to address both their energy security needs and to promote the development of green industries. The Ministry of Economy, Trade, and Industry has established a team to identify the appropriate mix of regulatory measures, public support and private sector voluntary efforts to encourage deployment of energy technologies. As an example of Japanese policy for photovoltaic generation—an area where government can play a significant role in technology development and where the Japanese anticipate significant development—a buyback program of surplus electricity was established in November 2009. The Japanese government is strongly supporting Smart Grid demonstration projects as one way to build market share.

In the case of China they vaulted past Denmark, Germany, Spain and the United States last year to become the world's largest maker of wind turbines. China has also leapfrogged the West in the last two years to emerge as the world's largest manufacturer of solar panels. And the country is pushing equally hard to build nuclear reactors and the most efficient types of coal power plants. Renewable energy industries in China have seen rapid expansion recently, with employment reaching 1.12 million in 2008 and climbing by 100,000 a year, according to the government-backed Chinese Renewable Energy Industries Association. China intends for wind, solar and biomass energy to represent 8 percent of its rapidly growing electricity generation capacity by 2020. That compares with less than 4 percent now in China. The National Development and Reform Commission is drafting a plan to accelerate the development of strategic emerging industries including the new energy industry.

While Japan, China and other Asian nations are moving aggressively toward clean energy applications, the United States has a very robust energy R&D investment environment of its own due to both public and private sector involvement. In addition to R&D investments by leading energy companies and innovative start-ups, the Recovery Act provides crucial Federal investments in basic and applied energy R&D. The Obama administration is committed to building upon these investments, particularly through research, development, demonstration, and deployment of clean energy technologies that can help transition the United States to a low-carbon economy. Moreover, while much of the manufacturing of clean energy goods occurs in China, significant innovations in clean energy are still taking place within the United States due to the ingenuity and entrepreneurship of the American workforce.

Question 7. The department has made a concentrated effort on accelerating the breakthroughs in basic research into applied research and commercialization. There is some confusion up here on all the efforts underway, let me list them (1) Genomes-to-Life Centers, (2) Energy Frontier Centers, (3) Energy Innovation Hubs and (4) ARPA-E. Can you briefly update the committee how all of these efforts reinforce each other?

Answer. How R&D is managed can impact the pace of innovation. Taken together, DOE's new and ongoing programs in energy R&D and technology demonstration and deployment—the recently launched Energy Frontier Research Centers, ARPA-E, and the Energy Innovation Hubs—comprise a robust portfolio of unique energy R&D modalities that complement each other and that maximize the Nation's ability to achieve energy breakthroughs as quickly as possible.

Each of the programs you mentioned has unique characteristics and distinct purposes.

DOE established three Bioenergy Research Centers (BRCs) in September 2007 under the Office of Science's Biological and Environmental Research (BER) program as part of its Genomic Sciences program (formerly called "Genomes to Life"). Each BRC is funded at $25 million per year. The DOE BioEnergy Science Center is led by Oak Ridge National Laboratory; the DOE Great Lakes Bioenergy Research Center is led by the University of Wisconsin-Madison in partnership with Michigan State University; and the Joint BioEnergy Institute is led by Lawrence Berkeley National Laboratory. Chosen through a competitive merit review process, the BRCs are designed to accelerate fundamental scientific breakthroughs needed to make production of cellulosic biofuels (biofuels from nonfood plant fiber) cost-effective on a national scale. The BRC model is inherently multidimensional and multidisci-

plinary, using a large, highly integrated research team to achieve rapid scientific breakthroughs and solutions. In just two years, the BRCs have had notable success in integrating research and accelerating its pace, as reflected in the volume of peer-reviewed publications and patent disclosures and applications produced by the BRCs.

Energy Frontier Research Centers (EFRCs) advance a broad range of fundamental science relevant to real-world energy systems. Each focuses on the long term basic research needed to overcome roadblocks to revolutionary energy technologies in a particular area. They are mostly multi-institutional centers composed of a self-assembled group of investigators, often spanning several science and engineering disciplines. This research is both "grand challenge" and "use inspired" fundamental science motivated by the need to solve a specific problem, such as energy storage, photoconversion, and CO_2 sequestration. The choice of topics was at the discretion of the applicants in response to a funding opportunity announcement that solicited broadly across grand challenge and use inspired science with a funding range of $2-5 million per year per project. We expect that the EFRCs will contribute key breakthroughs with deep and lasting impact on a range of future energy technologies; in exceptional cases breakthroughs in the EFRCs could be picked up in the near term by ARPA-E, the Department's technology programs, or the private sector.

The Energy Innovation Hubs are explicitly modeled on the BRCs. The Hubs will assemble a large group of investigators spanning science, engineering, and policy disciplines who will focus on solutions to a single critical national need identified by the Department. Top talent drawn from the full spectrum of R&D performers—universities, private industry, non-profits, and government laboratories—will drive each Hub to become a world-leading R&D center in its topical area. Each Hub's management structure must empower scientist-managers to act decisively to direct and redirect the course of research to maximize the rate of progress. Initial awards will be competed among R&D performers. Funding for the initial year for each of the first three Hubs is $22 million, with an expectation of $243 million annually in the subsequent four years, for a maximum of $119.2 million per Hub over the five-year term, subject to Congressional appropriations. In FY 2011, DOE is requesting $34 million for an additional Hub, including one-time funding of $10 million for start-up needs, excluding new construction. We expect each Hub to accelerate significantly the pace of scientific and technological innovation in its area of concentration.

ARPA-E supports research of potentially high commercial impact that the private sector deems too risky for investment. ARPA-E follows DARPA's highly entrepreneurial approach to mission-oriented R&D by funding scientists and engineers to move transformational energy technology rapidly beyond the risk barriers that prevent its translation from bench scale to the marketplace. Hence, ARPA-E does not fund discovery science nor does it support incremental improvements to current technologies. ARPA-E invests in advanced technologies that address U.S. technological gaps which if successful, will leapfrog over current approaches. ARPA-E program directors take a hands-on approach to managing their R&D activities. Funding is dependent on the needs of the project, and may range from $500,000 to as much as $10 million. Projects are selected on the basis of their potential to move rapidly towards commercialization; they will be evaluated at the 2-3 year mark, and will not be extended without demonstrable progress.

The Hubs and BRCs, the EFRCs, and ARPA-E are complementary and together constitute a robust R&D strategy for accelerating energy technology innovation. The EFRCs focus on expanding the fund of knowledge at the beginning of the energy innovation pipeline; they represent a long term investment in the basic scientific research that will uncover new ground for future energy technologies. Discoveries in EFRCs should propagate to the Hubs and BRCs, ARPA-E and across the Department's applied R&D programs. ARPA-E focuses on overcoming risk bottlenecks and inefficiencies at the back end of the energy innovation pipeline that frustrate commercialization of promising, but risky, energy technologies. The larger investments of Hubs and BRCs are reserved for the most critical strategic R&D areas. The Hubs and BRCs integrate all facets of the energy innovation pipeline into a centrally-managed R&D activity; this investment level and management model ensures the fastest possible pace of scientific discovery and technological innovation.

Question 8. Where do you see the focus of the "Fossil Energy" division of the DOE going into the future? Presently there is a great deal of carbon capture and sequestration R&D occurring at the DOE that is linked to coal. Is there any intention on the part of the Administration to broaden the scope of the existing CCS program to include other industrial applications, such as retrofits to refineries, cement manufacturing plants, steel mills, and so forth?

Answer. The Office of Fossil Energy has done extensive work in carbon capture and storage (CCS) related to fossil energy facilities. Since over half of the Nation's electricity is produced by coal-fired power plants and coal has a greater emission of CO_2 per unit of electricity produced than oil and natural gas, the emphasis on capturing carbon dioxide from this sector is essential. Electricity generation using carbon based fuels is responsible for over a third of the CO_2 emissions in the U.S. and globally.

Although the amount of CO_2 from other industrial sources is smaller than coal, since the storage of CO_2 is generally indifferent to the source of CO_2, obtaining CO_2 from industrial sources is also an important pathway to pursue. Therefore, DOE recently released a Funding Opportunity Announcement for Industrial Carbon Capture and Storage from ARRA funding that will provide over $1.32B for large-scale industrial CCS projects from industrial sources (cement plants, chemical plants, refineries, steel and aluminum plants, and manufacturing facilities). Many of the carbon capture technologies being developed are applicable to both the utility and industrial sectors.

Question 9. As new gas plays are set to begin production in the near future—is there any research that you feel could be conducted at the DOE to encourage the safe, efficient production of these unconventional resources?

Answer. The United States' technically recoverable natural gas resource is estimated at more than 1,800 trillion cubic feet (TCF) according to the Annual Energy Outlook 2010 Early Release. This would be equivalent to almost a hundred years of natural gas supply at current U.S. usage rates. Shale gas production is one of the most rapidly expanding trends in onshore domestic oil and gas exploration and production today. State and local governments set the permitting requirements and monitor compliance of hydraulic fracturing activities.. The Department of Energy does not have a regulatory role concerning hydraulic fracturing. However, the EPA has initiated a study to explore environmental concerns on water resources related to broad application of hydraulic fracturing and the Department of Energy is participating in the study.

Question 10. Given that we need to start rapidly deploying clean energy technologies today and in the near future if we are going to meet our energy and climate goals, how is DOE balancing its research, development, and deployment portfolio between longer term, breakthrough research and more near term applied development and deployment activities? I am thinking in particular of the grid scale energy storage program, where some technologies are nearly ready for the demonstration phase, but significant R&D is still needed for significant improvements.

Answer. The Department takes a systems approach to its research investments and works to ensure that the offices engaged in basic and applied research integrate their efforts. With regard to energy storage, the Office of Electricity Delivery and Energy Reliability has the lead within the Department for applied energy storage research, development, analysis, and demonstrations associated with the electric grid. The program works closely with the Office of Science which conducts basic research in energy storage materials and the fundamental mechanisms that underpin electricity storage. The Office of Science recently selected six Energy Frontier Research Centers to support energy storage research. In addition, the Advanced Research Projects Agency-Energy (ARPA-E) focuses on developing leapfrog solutions for high capacity, utility-scale energy storage applications. ARPA-E recently selected several innovative energy storage projects for funding as a result of its first solicitation for breakthrough technologies. Also, the Office of Energy Efficiency and Renewable Energy evaluates where energy storage systems can support the application of renewable technologies it develops and sponsors demonstrations of on-site energy storage technologies to support renewables deployment.

RESPONSES OF THE HON. STEVEN CHU TO QUESTIONS FROM SENATOR MURKOWSKI

Question 1a. In a time of significant budget constraints, long-range technologies such as fusion ene gy can often become easy targets for cuts. The U.S. has committed over $1B to provide components, personnel and direct funding for the construction of the ITER project in France. This scientific facility intends to demonstrate the scientific and technological feasibility of fusion energy; yet, it is just one of the steps required to eventually development a fusion power plant.

In your opinion, should the U.S. continue to invest in long-range technologies such as fusion?

Answer. Fusion research is a high-risk, high-payoff endeavor. The promise of fusion is an energy system whose fuel would be obtained from seawater and from plentiful supplies of lithium in the earth and whose resulting radioactivity is modest compared to fission; and it would emit no greenhouse gases into the atmosphere.

But, the scientific risks are admittedly substantial, and overcoming them will require sustained levels of investment over many years.

We believe the U.S. should continue such investment in fusion energy research, however, because of its unmatched potential to radically transform global energy usage in the long term. Failing to invest could leave the U.S. at a serious competitive disadvantage to countries which continue their substantial and sustained investments in fusion energy research.

Question 1b. Is the U.S. domestic fusion program sufficiently robust to fully utilize the potential discoveries from the ITER experiments and have the next set of facilities and research priorities been sufficiently established to move fusion from a science project to an energy project?

Answer. Today, the domestic fusion community is engaged in a robust program of research at major U.S. facilities which furthers the science, trains the next generation of fusion researchers, and sustains U.S. leadership in many aspects of the fusion sciences. The U.S. research program has been particularly effective in improving the ITER design. For example, the "dynamic range" of the plasmas that ITER will be capable of creating has been significantly increased in large part through U.S. intellectual leadership, and that leadership is expected to continue to make major contributions as the ITER program advances.

Question 2. Many coastal communities across the nation, including a number of isolated villages in Alaska that rely on diesel generators, have ready access to clean wave, tidal, and ocean energy resources if the technology can be advanced. What is the Department doing to support bringing these new technologies on-line and can more be done sooner to hasten the development of this industry?

Answer. The following means and strategies will serve to identify and focus the needs of the emerging water power industry, and enable prioritization of RDD&D requirements and quantification of the potential barriers of this emerging industry. Ultimately, reducing the industry's barriers to deployment may result in significant cost savings and reductions in GHG emissions, reliance on carbon emitting power generation, and fuel imports.

Strategies for marine and hydrokinetic (MHK) technology development and testing include:

- Facilitate in-water device testing for higher maturity technologies
- Support rigorous device testing process for developing technologies
- Support R&D to identify technology improvement opportunities
- Collect and disseminate validated cost and performance data for technologies and projects

Strategies for MHK market development, project siting and resource assessments include:

- Study and validate estimates of extractable energy by resource and technology type
- Support the generation of site-specific environmental data
- Improve the prediction, monitoring, and evaluation of environmental impacts
- Collect, synthesize, evaluate and disseminate existing impact information
- Build consensus among stakeholders on a framework to minimize and mitigate potential impacts
- Develop and disseminate information that directly affects the MHK industry
- Engage in strategic partnerships with wave, tidal, and ocean thermal technology developers and industry to develop a roadmap for technology development and deployment to accelerate water power industry growth and the creation of workforce needs in shipyards, port facilities, and related maritime industries.

Question 3. Your Department has worked hard to expand federal aid for geothermal development. I appreciate the speed in which you allotted the roughly $400 million provided in last February's stimulus package to reinvigorate the geothermal program at DOE—a program that had been on life support as recently as three years ago. I also appreciate that you are providing aid to both conventional geothermal vent projects and for research and demonstration efforts on enhanced geothermal systems. I am curious where you see the program now heading and whether you would support efforts to more fully implement Section 625 of Energy Independence and Security Act of 2007 that crafted a federal grant program to help build geothermal projects, especially in areas where electricity is costing more than 150% of the national average?

Answer. The Department's Geothermal Technologies Program (GTP) recognizes the importance of addressing the "high-cost regions," through the development of geothermal projects, as directed in Section 625 of the Energy Independence and Se-

curity Act of 2007. Specifically, GTP included "projects in high electricity cost regions" as a program policy factor in the selection process in three of its Recovery Act Funding Opportunity Announcements (FOAs):

- Recovery Act—Geothermal Technologies Program: Ground Source Heat Pumps (DE-F0A-0000116);
- Enhanced Geothermal Systems Research, Development, and Demonstration (DEPS36-08G098008); and
- Recovery Act: Geothermal Technologies Program (DE-FOA-0000109).

At least seven of the awards from GTP's recent Recovery Act FOAs were made to projects in high cost regions. GTP's plans to continue considering high cost regions as a program policy factor during the project selection process.

Question 4. Section 803 of the 2007 Energy Independence and Security Act authorized a grant program to provide grants of up to 50% of the cost of building renewable energy projects—all types of renewable energy projects—in Alaska. So far the Department has never proposed any funding to implement the act, even though the cost of energy in Alaska, especially in rural Alaska, is averaging about nine times more than in the Lower 48 states. Would you support some funding to begin to implement the program to help get more wind, solar, geothermal, small hydro and ocean energy projects underway in Alaska?

Answer. To date the Department of Energy (DOE) has not requested any funds to implement section 803 of EISA. The Department uses appropriated resources to support competitive and formula-based grants for renewable development. Some examples of renewable investments made through Recovery Act allocations in Alaska include:

1. Naknek Electric, geothermal project—$12.4 million;
2. University of Alaska Fairbanks-Alaska Center for Energy and Power, geothermal for Pilgrim Hot Springs—$4.6 million;
3. Fort Yukon/Council of Athabascan Tribal Governments, biomass development—$1.2 million;
4. Haida Corporation, Reynolds Creek Hydroelectric—$1.1 million;
5. Kootznoowoo Inc, Thayer Lake Hydroelectric—$1.1 million;
6. Chaninik Wind Group, Village energy smart grid and wind-diesel hybrid systems—$750,000;
7. Cook Inlet Tribal Council, weatherization apprenticeships and building feasibility study—$253,000;
8. Native Village of Eyak, wind energy resource assessment—$248,000;
9. Chickaloon Village, renewable energy feasibility study—$244,000; and
10. Central Council of Tlingit and Haida Indians, weatherization $200,000.

Through the National Renewable Energy Laboratory's (NREL) Transforming Energy in Alaska (TEA) effort, DOE is currently supporting the Cold Climate Housing Research Center's Sustainable Northern Shelter near net zero residential building program; the Alaska Center for Energy and Power's monitoring program for wind-solar-diesel hybrid power systems; and the Renewable Energy Alaska Project's Alaska Efficiency Challenge. In addition, NREL has provided technical assistance to the state, numerous village utilities, private industry tidal and in-stream hydrokinetic developers, Native corporations, and others. Other TEA initiatives under NREL include publication of a document on Renewable Energy and Energy Efficiency Opportunities and Challenges in Alaska, a research paper on workforce development, and encouraging private industry to invest in renewable energy in Alaska to foster local job creation. TEA has recently begun drafting a village biomass development handbook that will be valuable for accelerating biomass projects in rural Alaska.

Direct funding under the Recovery Act has also supported the State Energy Program ($28 million), Weatherization Assistance Program ($18.5 million), and Energy Efficiency and Conservation Block Grants ($12 million to tribes and $16.5 million to the state of Alaska) in Alaska. The ten examples listed above are all part of these programs.

Another DOE-led initiative that is being implemented by both NREL and the National Energy Technology Laboratory (NETL) is the conversion of U.S. Coast Guard facilities heating from diesel fuel to biomass where available. The current focus within Alaska has been on the USCG Kodiak base, the largest in the country, as well as bases in Sitka, Juneau, Ketchikan, and Cordova. This effort, when fully implemented, may provide enough demand to establish wood pellet markets in southeast and south central Alaska from local suppliers.

Question 5. I wanted to thank you for your comments last week regarding the practice of hydraulic fracturing and that it can be conducted safely. In the DOE's plans for R&D, do you foresee any opportunity to help provide certainty to natural

gas consumers that we'll continue to see a stable supply as long as these drilling techniques continue safely?

Answer. The United States' technically recoverable natural gas resource is estimated at more than 1,800 trillion cubic feet (TCF) according to the Annual Energy Outlook 2010 Early Release. This would be equivalent to almost a hundred years of natural gas supply at current U.S. usage rates. Shale gas production is one of the most rapidly expanding trends in onshore domestic oil and gas exploration and production today. Consistent with the President's FY 2011 budget request to repeal the Ultra-Deepwater and Unconventional Natural Gas mandatory program and to request no funding for Fossil Energy's Oil and Natural Gas programs, hydraulic fracturing R&D will not be continued in 2011.

Hydraulic fracturing involves the pumping of a fracturing fluid under high pressure into a formation, such as shale, to generate fractures or cracks in the target rock formation. This allows the natural gas to flow out of the formation and into a production well. Ground water is protected during the fracturing process by a combination of the casing and cement that is installed when the well is drilled. State and local governments set the permitting requirements and monitor compliance of hydraulic fracturing activities. The Department of Energy does not have a regulatory role concerning hydraulic fracturing. However, the EPA has initiated a study to explore environmental concerns on water resources related to broad application of hydraulic fracturing and the Department of Energy is participating in the study.

Question 6. Since you began as Energy Secretary, you've stayed above the fray on some of the more controversial issues surrounding fossil fuels. Between your travels and your efforts at running the numbers of what we use, as well as our infrastructural capacities, has your outlook for the role of natural gas in a cleaner energy economy been augmented at all?

Answer. Natural gas will continue to play a large role in diversifying our energy supply and increasing our energy security. Natural gas will also help enable renewable energy technologies expansion in the market.

Question 7. According to a Department of Energy report entitled Energy Demands on Water Resources, Report to Congress on the Interdependency a/Energy and Water, the amount of water consumed per MWh of electricity produced from a Concentrating Solar Power (CSP) plant with wet cooling is approximately twice as much as fossil fuel facilities and is generally higher than a nuclear plant with the same type of cooling technology. Given the significant amount of water used by CSP and the prolonged drought plaguing the southwest, how will the Department of Energy ensure that solar energy development does not deplete scarce western water resources?

Answer. Nuclear and coal power plants are typically water-cooled and consume between 400 and 750 gallons of water per megawatt-hour (MWh) of electricity produced. A recent study done by the engineering firm Worley-Parsons for the National Renewable Energy Laboratory compared an air-cooled parabolic trough solar power plant to a water-cooled one.[1] This study found that a water-cooled trough plant consumes about 950 gallons of water per MWh, whereas an air-cooled solar plant consumes only 70 gallons per MWh—93 percent less water use than wet cooling and up to 90 percent less water than a typical nuclear or coal power plant. Air cooling is not as efficient as water cooling and so adds an estimated five percent to the levelized cost of electricity. Solar power plants can also use hybrid dry/wet cooling systems, which are air-cooled throughout the year but use some cooling water on the hottest days. Such systems would have a water usage and an electricity cost somewhere between the values for air-cooled and water-cooled plants depending on the ratio of air to water cooling.

Question 8. According to National Renewable Energy Lab, the voluntary renewable energy market is responsible for half of all green power in the United States. At a conference this past fall, I understand that you committed to looking into how a Federal Renewable Electricity Standard and/or a Cap-and-Trade program may inadvertently impact the voluntary energy market. For example, the state of Oregon's Attorney General has stated that double counting renewable energy credits may violate consumer protection standards. What is the result of your examination?

Answer. There are a few issues that arise with respect to how a federal renewable electricity standard (RES) may interact with voluntary renewable energy markets, including issues of double counting and treatment of existing contracts. Regarding carbon cap and trade legislation, the primary issue is whether voluntary renewable energy purchasers will affect overall greenhouse gas emissions (i.e., whether their purchases result in true environmental benefits), These issues are important and will continue to be examined.

Question 9. With all the attention that has been given to the back-end of the fuel cycle as we look to expand the use of nuclear power to reduce our greenhouse gas

emissions, it is easy to forget the front-end of the fuel-cycle. Does the Department of Energy have a policy to increase domestic supplies of uranium?

Answer. The Department of Energy agrees that the nation must have access to an adequate supply of uranium fuel to support the Administration's view that nuclear energy should be an important part of our country's energy mix going forward. However, the Department does not have a specific policy on uranium mining, as this does not come within the Department's jurisdiction. With regard to the construction of new front-end fuel cycle facilities in the United States, the Department is authorized to make available $2 billion in loan guarantees to qualified applicants, and applications for loan guarantees for two proposed enrichment facilities are presently being evaluated by the Department's Loan Guarantee Program Office.

RESPONSES OF THE HON. STEVEN CHU TO QUESTIONS FROM SENATOR WYDEN

Question 1a. As we discussed in the hearing, I believe it is important to make sure that the technology that is developed in the U.S. is also manufactured in the U.S. This production can supply the domestic market and foreign ones, creating and sustaining good American jobs. The Department of Energy (DOE) plays a major role in technological research, development and demonstration, and is also playing a growing part implementing domestic production incentives, like those found in section 48C of the Internal Revenue Code. What practices or procedures does the DOE have in place to consider the export potential of U.S. technology that is financed and produced in response to federal initiatives? Is there any coordination or consultation with the other relevant federal agencies or other stakeholders? What coordination measures does DOE intend to put in place in order to maximize the assets of DOE and other relevant agencies like the U.S. Department of Commerce?

Answer. When making investments in clean energy technologies, DOE does consider the potential global benefit of a given technology. DOE also participates in several interagency groups that address deployment and export of clean energy technology. The most prominent of the working groups is the Trade Promotion Coordinating Committee (TPCC) Working Group on Alternative Energy. The TPCC was established by Executive Order 12870 and includes representatives of more than 20 agencies involved in trade, exports and clean energy. DOE is working with the Department of Commerce and other agencies to invigorate the TPCC clean energy export efforts to provide greater opportunities for U.S clean energy technology companies.

Question 1b. What additional coordination measures do you intend to put in place with the Commerce Department to address export clean energy technology opportunities and foreign competition?

Answer. DOE and Commerce are working together, directly through the TPCC Working Group on Alternative Energy to identify and implement effective clean energy export initiatives. The Working Group is seeking to leverage all of the relevant USG programs on export promotion in a coordinated effort that provides the most value to U.S. clean technology companies and enhances their ability to compete effectively in global markets. This effort by the Working Group will include, but is not limited to, examining the best potential export markets for specific technology deployment, addressing export financing needs of U.S. companies, and ensuring that U.S. companies have a level playing field to fairly compete in overseas markets.

Question 2. Europe has invested roughly a $100 million dollars in its wave energy research center in Scotland, while here at home DOE has invested just a few million dollars on our wave energy centers in Hawaii and Oregon. How are you factoring the research activities of other countries into your own Energy Department research funding priorities?

Answer. The Office of Energy Efficiency and Renewable Energy's (EERE) marine and hydrokinetic (MHK) technologies program (including ocean wave research) provides U.S. input into the development of international standards for MHK technologies, partners with the global community and Federal regulatory agencies, coordinates in international partnerships, and facilitates DOE's leadership role in investigating the potential environmental impacts of ocean energy systems. The FY 2011 budget request for Water Power is about $40 million, of which MHK and Conventional Hydro (CH) each receive about half.

Question 3. What criteria and procedures does the Department use to measure the trade and sensitivity of clean energy technologies in establishing its research, development, and commercialization funding priorities?

Answer. Central to the Department's R&D mission is spurring development of clean energy technologies, the results of which are intended to drive innovation across the economy and enhance American competitiveness. Finding innovative and affordable ways to transition our economy to a low carbon future is one of our top

three strategic priorities. When setting investment priorities, DOE does weigh the potential benefits of a technology's application globally, such as technologies that permit the low-carbon use of coal. The Department also considers employment and trade impacts of clean energy technologies, selectively, on a case-by-case basis in establishing priorities for investments in technology development and deployment.

RESPONSE OF THE HON. STEVEN CHU TO QUESTION FROM SENATOR BROWNBACK

Secretary Chu, I appreciate your willingness to appear before our committee and talk about the research and development needs of your agency regarding medium and long-term climate concerns. I am hoping you are also considering the needs of private companies that are also working to develop new technologies that will help DOE and this country meet the medium and long-term challenges of climate change. I agree that research and development is the key to better understanding our impact on our surrounding world.

As you know, I am a strong supporter of the cellulosic ethanol industry. I believe that technology can go a long ways towards energy independence. Cellulosic ethanol is being produced in the laboratory for less than $2.25 a gallon. We need DOE to help take the R and D to the next level by helping commercialize that industry. Congress has provided DOE with the authority necessary to implement a robust loan guarantee program. Yet, the cellulosic industry is struggling to build it first plant, despite having a shovel ready plant waiting for financing in Kansas.

Question 1. Mr. Secretary, I would like to ask you to discuss with the committee your plans for commercializing the cellulosic industry.

Answer. The Departments' Biomass Program and Loan Guarantee Program work in conjunction to support the development of cellulosic ethanol from research and development, demonstration and piloting, and finally, full commercial scale-up. In 2009, the Department's Biomass Program utilized over $610 million dollars in Recovery Act funds to increase investments in integrated biorefineries at the pilot and demonstration scale as well as for biofuels infrastructure activities. This Recovery Act funding is in addition to the over half of a billion dollars of DOE investments in integrated biorefinery projects from Fiscal Years 2007 through 2010. The purpose of DOE's investments in pilot, demonstration, and small commercial scale biorefineries is to generate techno-economic data from their operations in order to validate full commercial-scale readiness. Once a technology has been proven in the pilot and demonstration phase, it may be eligible for a DOE loan guarantee to support the project's full commercial scale up.

RESPONSES OF THE HON. STEVEN CHU TO QUESTIONS FROM SENATOR MENENDEZ

Question 1. Secretary Chu, it has been almost a year since the Recovery Act became law and, although selections have been announced, the $4 billion in Smart Grid Demonstration and Investment Grants have not actually been delivered to recipients. Can you tell us when this money will actually go out the door and explain why the long delay?

Answer. The Smart Grid Investment Grant (SGIG) and the Smart Grid Demonstration (SGD) programs are managed by the Office of Electricity Delivery and Energy Reliability (OE). SGIG project selections were announced on October 27, 2009. SOD project selections were announced on November 24, 2009. Since the selections were made the Department has been in discussions with selectees for thel 00 SGIG and 32 SGD projects that were selected for grants.

While it generally takes a month or more after selection until grants are awarded, several factors have complicated finalization of awards. First, many of the selected organizations have never received grants from the Federal Government before and are not familiar with policies, processes, and procedures associated with government grants. Second, the scope and technical complexity of the projects involve more than typical levels of collaboration between the Department and the selected organization on topics such as cost-benefit analysis, interoperability, cyber security, and Recovery Act-required provisions and reporting requirements.

The Department obligated more than $2 billion of the $3.4 billion for SGIG and more than $500 million of $620 million for SGD grants in December 2009. However, the selected organizations have raised a number of significant but similar cross-cutting issues that have to be addressed, so discussions with all selectees are ongoing. Issues include Buy American provisions in the Recovery Act, the applicability of the Davis-Bacon Act, property ownership rights for equipment purchases, and potential problems with obtaining approvals from local regulatory or oversight agencies such as Public Utility Commissions. These issues are being addressed, and several organizations have recently expressed willingness to move on to award.

The remaining issue of significant importance to many of the organizations is the tax treatment of grant receipts. Because DOE has no jurisdictional authority on tax related issues, DOE is working with the Department of Treasury and Internal Revenue Service and is providing requested information to them in order to, facilitate any guidance that may be issued.

The Department is working expeditiously to address remaining issues so that grants can be awarded as soon as possible.

Question 2. Secretary Chu, I applaud the Department's work to improve wind technology and increase the use of wind energy in the United States. Today's utility wind programs focus on land-based, low altitude wind—that is wind turbines 300 feet and below. Offshore wind and wind at higher altitudes, between 1,500 and 3,000 ft are much stronger and more consistent. Can you tell us what steps the DOE is taking, or investments it maybe making, to help harness offshore wind and high altitude wind and its vast energy resource? Has the Department's Advanced Research Projects Agency-Energy (ARPA-E) funded any of these projects?

Answer. Offshore wind energy can contribute substantial amounts of clean, domestic, renewable electricity to the nation's energy supply. The National Renewable Energy Laboratory estimates that U.S. offshore wind resources, including the Great Lakes, technically may have the potential to produce in excess of 2500 Gigawatts of electric power. The Department's 20% Wind Energy by 2030 report concludes that at least 54 Gigawatts of this potential could realistically be developed by 2030. The commercialization and deployment of offshore wind energy, however, faces many challenges that require targeted research and development (R&D) efforts.

The Department is investing in R&D projects that will address the barriers to offshore wind energy deployment and facilitate the growth of a sustainable, domestic offshore wind industry. In Fiscal Years 2009 and 2010, the Department has funded projects totaling over $95 million, including $77 million through the American Recovery and Reinvestment Act of 2009, to address the technical, environmental, and siting challenges to offshore wind energy deployment. In addition, the Department's Fiscal Year 2011 budget request proposes a significant allocation of funds to support offshore wind deployment.

Department of Energy leaders have met with several companies developing high-altitude wind energy technologies to discuss the potential of this resource, as well as the barriers to successful deployment. Although the Department will continue to monitor high altitude energy concepts, it is not currently funding any research in this area.

The Advanced Research Projects Agency—Energy (ARPA-E) funded two wind programs, PAX Streamline and FloDesign Wind, during its initial funding opportunity announcement. While neither are considered high altitude wind or offshore wind technologies, both are viewed as non-traditional technologies that are transformational. PAX Streamline uses "blown wind" technology that creates a virtual airfoil by jetting compressed air out of orifices along a wing and has the potential to introduce a radical simplification to the manufacture and operation of wind turbines. FloDesign is a shrouded, axial-flow wind turbine capable of delivering significantly more energy per unit swept area with greatly reduced rotor loading as compared to existing horizontal axis wind turbines and current duct augmented wind turbines.

Response of the Hon. Steven Chu to Question From Senator Sessions

Nuclear power is clearly a clean source of domestic energy that the American people support. And it has a role to play in reducing our dependence on foreign oil and reducing air pollutants. Nuclear power plants will provide long term economic benefits. It creates jobs, and the direct and indirect spending will strengthen local communities. Nuclear generated electricity is the serious solution for a clean energy future.

Congress authorized $18.5 billion for nuclear loan guarantees in the 2005 Energy bill, hoping to revive development of the carbon-free source of energy. It has been five years and we are still waiting for the first loan guarantee to be issued. You have stated it is complicated but the Department plans to issue its first loan soon.

Question 1a. In what time frame do you ultimately foresee the Federal Government issuing the first loan guarantee?

Answer. The Loan Programs continue to be a priority at the Department of Energy and are getting the attention, departmental resources and oversight they need. In September 2009, the Department of Energy issued its first loan guarantee to Solyndra, a photovoltaic solar company based in Fremont, California for $535 million. In the same month, the Department also issued a loan to Ford Motor Company for $5.9 billion. After loan authority was first provided for nuclear power facilities

in 2008, the 2008 Nuclear Power Facilities solicitation received 15 applications seeking $93.2 billion in loan guarantee authority. In April 2009, the Department selected four applications for final due diligence and underwriting, including outside legal, engineering, environmental, and market analysis. Each loan guarantee is a unique, complex financial instrument involving extensive negotiations with the applicant. Long development lead times are necessary for completing all of the steps preceding the issuance of loan guarantees for major energy projects.

Question 1b. Why has it taken so long for the Department to make a decision?

Answer. The projects seeking loan guarantees use innovative energy technologies and complex, tailored financial structures, requiring both in-depth due diligence (on the technical, financial, and legal aspects of each transaction) and extended negotiations to protect taxpayer dollars. That said, since the Program was first funded in 2007, the Department has made good progress. We have worked aggressively to assemble a staff of highly qualified project finance experts with significant private sector and government experience. The program has issued eight separate solicitations and reviewed hundreds of applications. In addition to the two projects brought to financial close, the Loan Programs have issued seven conditional commitments, some of which are expected to proceed to closing in the coming months. In October 2009, The Loan Guarantee Program initiated the Financial Institution Partnership Program, a streamlined set of standards designed to expedite DOE's loan guarantee underwriting process and leverage private sector expertise and capital for the efficient and prudent funding of eligible projects.

At the beginning of 2009, the Loan Guarantee Program had only sixteen MI time federal employees. Currently, we have fifty-three federal employees supported by more than thirty contractors. These increased resources combined with diligent adherence to our principles of thorough review, detailed analysis and firm deal negotiation will result in substantially increased deal flow while maintaining our commitment to protecting the interests of the American taxpayer.

Question 1c. What does the Department need to move forward?

Answer. The Loan Programs face various challenges in meeting your mandates and goals. We have begun to address a number of the internal challenges and continue to improve and refine our processes. For example, we have already re-designed and streamlined the organization and simplified the application and review process. We shortened our intake and screening procedures, created sector-specific deal teams, and are now in the process of standardizing the application submission process. As a result, program underwriting capacity and efficiency are increasing.

Question 2. President Obama has said that he supports nuclear energy if we can solve the waste problem. However, Yucca Mountain is "off the table" and any questions from Congress are deflected by pointing to the Blue Ribbon Commission but the Department of Energy (DOE) has not announced the members of the panel. In fact, in an article titled, "Chu Sidesteps 'Family' Nuke Dispute; Backs Responsible Gas Frocking," you were asked when DOE would announce the Commission members and you responded that "only that the initiative was moving ahead."

- Would you please elaborate on that statement?
- Where exactly is the Department in the decision-making process?
- When will the "promised" Blue Ribbon Commission on nuclear waste be established? Can we get a firm date?

Answer. The members of the Blue Ribbon Commission on America's Nuclear Future (Commission) were announced in a press release (www.energy.gov/news/print/8584.htm) issued by the Department on January 29, 2010. The charter for the Commission was approved and filed with the appropriate Congressional offices on March 1, 2010, and has been published in the Federal Register (http://www.energy.govinews/documents/BRC_Charter.pdf). The Commission was directed to produce an interim report within 18 months and a final report within 24 months of its inception. The first meeting of the Commission will be held in Washington, D.C., on March 25-26, 2010.

Question 3. If the Commission's options are being limited before the panel is even formed by not allowing Yucca Mountain to be an option, will the panel propose alternative locations or recommend a site selection process?

Answer. The Blue Ribbon Commission is not a body that would recommend potential waste disposal sites or a process for selecting them. Rather, pursuant to Section 3 of its charter, the Commission's purpose is "to conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle." The Commission is also to provide advice, evaluate alternatives, and make recommendations for a new plan to address these issues. The Department awaits the Commission's advice, evaluation and recommendations.

Question 4. If Yucca Mountain is not an option, when do you anticipate ceasing payments from the Nuclear Waste Fund to the State of Nevada?

Answer. The FY 2011 budget did not request any funds for malcing payments from the Nuclear Waste Fund to the State of Nevada in FY 2011.

Question 5. The OMB has proposed barring DOE research on fast reactor recycling of nuclear waste and technical support for licensing of small, modular light-water reactors.

- Do you agree with the policy direction proposed by OMB concerning allowable nuclear energy research and development activities?
- What would be the effects of this type of proposal?

Answer. The Budget provides the Department fairly broad latitude in determining which reactor technologies to research, including small modular and certain fast reactor designs. Depending on the ultimate waste management path chosen, fast reactors may be part of a long-term method of addressing the nuclear waste question and in that context, some continued R&D is appropriate. The Department has historically pursued fast reactor R&D in the context of spent fuel recycling. DOE works with partners in the Generation IV International Forum on certain fast reactor technologies and this work continues to be supported in the 2011 Budget.

Regarding small modular reactors (SMRs), the Department requested $38.9 million in its FY 2011 budget proposal to conduct cost-shared nuclear technology R&D and development of advanced computer modeling and simulation tools that demonstrate and validate new design capabilities of innovative SMR designs, solicit and consider, through a competitive process, up to two SMR designs for financial cost-share assistance, support codes and standards development, and fund R&D activities for advanced non-light water reactor small modular designs, including high-temperature designs and ones and that utilize fast spectrum neutrons and associated fuel and reactor technologies, which offer added functionality and affordability. These funds will help illustrate the potential of the nascent SMR technology. The Department believes that there is a need and a market in the United States for SMRs.

Question 6. In your opinion, do you believe that hydraulic fracturing can be extracted safely without threatening water supplies?

Answer. Hydraulic fracturing involves the pumping of a fracturing fluid under high pressure into a formation, such as shale, to generate fractures or cracks in the target rock formation. This allows the natural gas to flow out of the formation and into a production well. Ground water is protected during the fracturing process by a combination of the casing and cement that is installed when the well is drilled. The water that is produced along with the gas after drilling and fracturing of the well must be managed through a variety of mechanisms, including underground injection, treat' ent and discharge, and recycling in a way that protects surface and ground water resources. State and local governments set the permitting requirements and monitor compliance of hydraulic fracturing activities. Please note that hydraulic fracturing when using diesel fuel is regulated under the Safe Drinking Water Act's Underground Injection Control program. The Department of Energy does not have a regulatory role concerning hydraulic fracturing. However, the EPA has initiated a study to explore environmental concerns on water resources related to broad application of hydraulic fracturing and the Department of Energy is participating in the study.

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