NEW DIRECTIONS FOR ENERGY RESEARCH AND DEVELOPMENT AT THE U.S. DEPARTMENT OF ENERGY

HEARING

BEFORE THE

COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED ELEVENTH CONGRESS

FIRST SESSION

MARCH 17, 2009

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NEW DIRECTIONS FOR ENERGY RESEARCH AND DEVELOPMENT AT THE U.S. DEPARTMENT OF ENERGY

TUESDAY, MARCH 17, 2009

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
Washington, DC.

The Committee met, pursuant to call, at 10:03 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Bart Gordon [Chair of the Committee] presiding.

U.S. HOUSE OF REPRESENTATIVES

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Hearing On

New Directions for Energy Research and Development at the U.S. Department of Energy

Tuesday, March 17, 2009
10:00 a.m. – 12:00 p.m.
2318 Rayburn House Office Building

WITNESSES LIST

Dr. Steven Chu
Secretary of Energy
U.S. Department of Energy

HEARING CHARTER

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

New Directions for Energy Research and Development at the U.S. Department of Energy

TUESDAY, MARCH 17, 2009
10:00 A.M.—12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

PURPOSE

On Tuesday, March 17, 2009, the Committee on Science and Technology will hold a hearing entitled *"New Directions for Energy Research and Development at the U.S. Department of Energy."* The purpose of the hearing is to receive testimony on the Administration's near-term objectives and priority issues for the research and development (R&D) activities under the Offices of Science, Energy Efficiency and Renewable Energy, Fossil Energy, Nuclear Energy, Electricity Delivery and Energy Reliability, and the Loan Guarantee Program. The discussion will also focus on the Department's plans for spending the funds allocated under both the *American Recovery and Reinvestment Act of 2009* and the *Fiscal Year 2009 Omnibus Appropriations Act*. Finally, Secretary Chu will address some features of the Department's organization that impede scientific innovation and the remedies being considered to address them.

WITNESS

- **Dr. Steven Chu,** U.S. Secretary of Energy. Prior to his appointment as the 12th Secretary of Energy, Dr. Chu was the Director of DOE's Lawrence Berkeley National Laboratory, and a professor of Physics and Molecular and Cell Biology at the University of California. In 1997 he was the co-winner of the Nobel Prize for Physics.

BACKGROUND

The FY 2010 Budget Request to Congress

As has been typical of presidential transitions in recent history President Obama chose to delay submission of a detailed FY 2010 Budget Request and instead released a summary document that provides an overview of the President's budget proposals. The three-page excerpt for the Department of Energy is attached. Detailed budget documents will be transmitted to Congress in April.

The budget document proposes $26.3 billion for the Department of Energy in FY 2010. In recent years the civilian energy R&D programs have made up approximately one-third of the total DOE budget, with other programs related to nuclear weapons and environmental clean-up comprising the rest. Of particular note in this budget is the President's commitment to double overall federal funding for basic sciences, with significant increases expected for the DOE Office of Science. The FY 2009 Omnibus Appropriations bill currently allocates $4.8 billion for Office of Science, and the *American Recovery and Reinvestment Act* included $1.6 billion.

Other Administration priorities listed in the proposal include encouraging commercialization of innovative energy technologies through the Loan Guarantee Program, developing advanced coal technologies such as carbon capture and sequestration, modernizing the Nation's electric transmission infrastructure through Smart Grid and storage technologies, and promoting the research, development, demonstration and deployment of clean energy technologies.

The budget request is also expected to increase support for promising, but exploratory and high-risk research activities with potential to deliver radically new technologies, such as those proposed to be carried out by the new Advanced Research Projects Agency for Energy (ARPA–E). Modeled on a similar program in the Defense Department, ARPA–E was authorized in the *America COMPETES Act of 2007* to be a small and nimble organization that conducts such high-risk, high-reward en-

ergy technology R&D through collaborations between government, academia and industry. Together the FY 2009 Omnibus and the Recovery Act provide $415 million for start-up and initial operations of ARPA–E.

The American Recovery and Reinvestment Act of 2009

The *American Recovery and Reinvestment Act* allocated approximately $39 billion to DOE. The bulk of this is dedicated to making the country more efficient through activities such as weatherization of low-income homes, retrofitting federal facilities, and implementation of State and local efficiency programs. In addition to the funds mentioned above for the Office of Science and ARPA–E, a significant amount was provided for next generation energy technologies through DOE's applied energy R&D programs.

Of the funds allocated for the Office of Energy Efficiency and Renewable Energy (EERE), the Recovery Act specified $2.5 billion for R&D. Of that amount, $800 million is directed to biomass, $400 million to geothermal, and the remainder is to be directed amongst the other R&D programs including: wind, solar, hydrogen, vehicle technologies, industrial technologies, and energy efficiency. An additional $2 billion is directed to grants for advanced battery manufacturing.

The Office of Electricity Delivery and Energy Reliability (OE or EDER) receives approximately $4.5 billion to modernize the electric transmission infrastructure through deployment of smart grid and energy storage technologies. The Office of Fossil Energy is allocated $3.4 billion for the development of technologies to capture and sequester carbon dioxide. Finally, the Innovative Technology Loan Guarantee Program authorized in EPAct 2005 receives $6 billion, most of which is to be devoted to rapid deployment of proven clean energy technologies.

The Recovery Act represents an unprecedented one-time increase in funding for DOE. Effective use of Recovery Act funding requires DOE to transfer the funds to the appropriate government and private sector entities in a timely manner and with an appropriate level of transparency and accountability. The Inspector General's office at DOE and the Government Accountability Office are allocated additional funds in the Recovery Act to provide additional oversight of these expenditures.

Organizational Challenges at the Department of Energy

The priorities and mission of the Department of Energy have shifted over time. Roughly two-thirds of the Department's budget is still devoted to the production and maintenance of the Nation's nuclear weapons stockpile and clean-up of the environmental legacy of weapons production dating from its history with the Manhattan Project and its parent organization, the Atomic Energy Commission. The remaining third of the budget is devoted to a wide array of basic and applied energy research and development activities that are managed currently by two Under Secretaries, four Assistant Secretaries, and two Directors. It has been argued that DOE's stovepiped organization and management of its laboratory system have led to operational inefficiencies and poor coordination across the Departments research programs. A number of solutions have been proposed over the years to streamline operations and ensure transparency and accountability while fostering innovation.

One proposal is to place all civilian R&D programs under the authority of the Under Secretary for Science for the purpose of improving coordination and management of DOE's energy research, development, and demonstration programs. Currently, one Under Secretary is responsible for applied energy R&D as well as Environmental Management, Legacy Management, and Civilian Radioactive Waste Management. The Under Secretary for Science is responsible for basic research activities conducted by the Office of Science. The current division of authority over these programs does not facilitate development of a comprehensive, consistent strategy for translating basic research discoveries into technological applications. Realignment would allow one Under Secretary to focus on all energy research and technology development programs, while the other focuses on important environmental stewardship programs.

Another proposal involves using external agencies to regulate DOE's laboratories. DOE is unique in maintaining a large internal bureaucracy to regulate its own environmental, safety, and health performance. Applying external regulatory oversight to DOE's laboratories would reduce costs and remove inherent conflicts of interest by transferring DOE's worker safety compliance role to the Occupational Safety and Health Administration (OSHA) and the nuclear safety compliance role to the Nuclear Regulatory Commission (NRC).

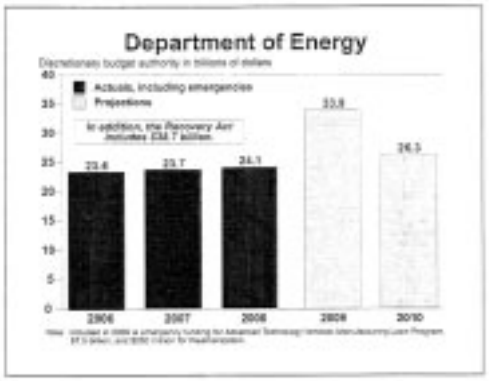
DEPARTMENT OF ENERGY

Funding Highlights:

- Begins to build a new economy that is powered by clean and secure energy through funding provided in the 2010 Budget and the $39 billion provided for energy programs in the American Recovery and Reinvestment Act of 2009.
- Provides significant increases in funding for basic research and world-leading scientific user facilities to support transformational discoveries and accelerate solutions to our Nation's most pressing problems – including the development of clean energy.
- Supports economic investment and positions the United States as the world leader in climate change technology.
- Accelerates the transition to a low-carbon economy through increased support of the development and deployment of clean energy technologies such as solar, biomass, geothermal, wind, and low-carbon emission coal power.
- Builds on the $11 billion provided in the Recovery Act for smart grid technologies, transmission system expansion and upgrades, and other investments to modernize and enhance the electric transmission infrastructure to improve energy efficiency and reliability.
- Supports and encourages the early commercial deployment of innovative, clean energy technologies through loan guarantees.
- Reduces security risks through the detection, elimination, and securing of nuclear material and radiological sources worldwide while maintaining the safety, security, and reliability of the nuclear weapons stockpile.
- Continues the Nation's efforts to reduce environmental risks and safely manage nuclear materials.

Invests in the Sciences. As part of the President's plan to double Federal investment in the basic sciences, the 2010 Budget, along with the $1.6 billion provided in the Recovery Act for the Department of Energy's basic science programs, provides substantially increased support for the Office of Science. The Budget increases funding for improving our understanding of climate science and continues the United States' commitment to international science and energy experiments. The Budget also expands graduate fellowship programs that will train students in critical energy-related fields.

Encourages the Early Commercial Use of New, Innovative Energy Technologies that Will Reduce Greenhouse Gas Emissions. The Budget supports loan guarantees for inno-



vative energy technologies including renewable energy projects, transmission projects, and carbon sequestration projects that avoid, reduce, or sequester air pollutants and greenhouse gases while simultaneously creating green jobs and contributing to long-term economic growth and international competitiveness.

Advances the Development of Low-Carbon Coal Technologies. The Budget supports Carbon Capture and Storage technology, and along with the $3.4 billion provided in the Recovery Act for low-carbon emission coal power and industrial projects, these funds will help allow the use of our extensive domestic coal resource while reducing the impacts on climate change.

Invests in Smart, Energy Efficient, Reliable Electricity Delivery Infrastructures. The Budget provides support for the Office of Electricity Delivery and Energy Reliability as part of the President's investment plan to modernize the Nation's electric grid. It includes: energy storage; cyber-security and investments in research, the development and demonstration of smart grid technologies that will accelerate the transformation of the Nation's energy transmission and distribution system; enhancement of security and reliability of energy infrastructure; and facilitating recovery from disruptions to the energy supply.

Invests in Clean Energy Technologies to Reduce Dependence on Foreign Oil and Accelerate the Transition to a Low-Carbon Economy. The Budget provides support for accelerating research, development, demonstration, deployment, and commercialization of clean energy technologies, including biofuels, renewable energy, and energy efficiency projects. These investments will reduce dependence on foreign oil and create long-term, sustainable economic growth in the green industries of the future.

Reduces Proliferation Risks and Ensures the Safety, Security, and Reliability of the Nuclear Weapons Stockpile Without Nuclear Testing. The Budget supports increased efforts to secure and dispose of nuclear material and invests in innovative science and technology to detect and deter nuclear smuggling and the development of weapons of mass destruction programs. Development work on the Reliable Replacement Warhead will cease, while continued work to improve the nuclear stockpile's safety, security, and reliability is enhanced with more expansive life extension programs.

Focuses on the Cleanup and Management of Radioactive Waste and Nuclear Materials. The Budget focuses on improved performance and accountability for the environmental legacy of the Nation's nuclear weapons program by addressing health and safety risks across the country. The Yucca Mountain program will be scaled back to those costs necessary to answer inquiries from the Nuclear Regulatory Commission, while the Administration devises a new strategy toward nuclear waste disposal.

Chair GORDON. This meeting will come to order. Good morning and welcome everyone. I am very pleased to have our new Secretary of Energy, Dr. Steven Chu, here to testify this morning on the new directions of the energy research at the Department of Energy.

As a preview to the more detailed budget proposal we will see from the Administration in April, this hearing provides an opportunity for Secretary Chu to discuss the Administration's priorities for energy research and development.

The Department has a critical task ahead in energy and climate research and technology development.

And make no mistake. At this time, gas prices may be low and the effects of climate change may not be apparent to everyone, but this will not last. We must take action now to become a cleaner, more efficient energy economy. To do this we must diversify our sources of energy by expanding the use of renewable energy and by using fossil resources more cleanly and efficiently.

I believe that nuclear energy will also be a part of this equation, but I have concerns about the management of its waste. And Dr. Chu, this committee stands ready to work with you to develop the appropriate R&D path forward for that disposal concern.

As a key member of the National Academies' *Gathering Storm* panel, Dr. Chu was intimately involved in laying the groundwork for the Advanced Research Projects Agency for Energy, or ARPA–E. As you know, this passed by an overwhelming, bipartisan support out of this committee. This committee will continue to work with the Secretary to ensure its success. I look forward to hearing about the status of the ARPA–E start-up.

The $39 billion allocated to DOE in the Recovery Act funds a wide range of activities spanning the innovation spectrum from basic research to supporting the market for new energy technologies. It also presents a historic opportunity to put people to work building a more sustainable future for the country. However, when it comes to the taxpayer money, we must work together to ensure these funds are spent wisely.

In this hearing we will have only a few brief opportunities to cover a range of issues, but I consider this the beginning of a productive partnership with Secretary Chu. Dr. Chu, I look forward to your testimony, and I thank you for appearing before the Committee this morning.

And now, the Chair recognizes Mr. Hall for an opening statement.

[The prepared statement of Chair Gordon follows:]

PREPARED STATEMENT OF CHAIR BART GORDON

Good morning and welcome. I am very pleased to have our new Secretary of Energy, Dr. Steven Chu here to testify this morning on the new directions for energy research at the Department of Energy.

As a preview to the more detailed budget proposal we will see from the Administration in April, this hearing provides an opportunity for Secretary Chu to discuss the Administration's priorities for energy research and development.

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Dr. Chu, I look forward to your testimony, and I thank you for appearing before the Committee this morning.

Mr. HALL. Mr. Chairman, I do thank you for holding this hearing today, and I would like to extend my welcome to Secretary Chu. It is good to have you here, and I look forward to working with you as we continue to tackle our energy challenges, and there are quite a few of them.

I am pleased to see the level of commitment in the President's budget supporting research and development in the important fields of renewable energy and basic energy. As we all know, renewable energy is going to be an important and necessary part of the energy portfolio as we go forward with the dual goals of energy independence and a clean environment. I am also pleased that the President's budget contained a boost toward developing low-carbon coal technologies. I have always been supportive of using this very abundant domestic resource for providing our country's energy needs. With widespread commercial use of carbon capture and sequestration technology, our country can hopefully have the option of replacing imports of oil and gas with coal-to-liquids fuels and methane gas from coal.

What I haven't seen or heard is what the plans are for oil and gas research and development going forward. I believe in the "all-of-the-above" answer to our energy problems, and that includes using domestic sources of oil and natural gas. Research and development in these fields does not benefit the major oil companies, but it does benefit the small independent oil and gas producers who should be helped in their efforts to bring our domestic supplies to the market rather than penalized at every step. I am very disappointed that the President recommended that the Ultra Deepwater and Unconventional Natural Gas and Other Petroleum Research program be repealed. The prior Administration made this recommendation as well as Congress, and Congress has repeatedly said to the President and to the prior administration, you are wrong, and we funded this valuable program anyway. I like George Bush, and I flew west with him to sign the bill that included this provision in it and usually they turn and hand the pencil to someone. All he said was, Ralph Hall is with me, because he just want-

ed some coffee from Air Force One. What he didn't know was I had five of his cups in my briefcase at that time.

But the Ultra Deep Program is paid for by the federal lease royalties, rents, and bonuses paid by oil and gas companies, not taxpayers, and it will make the government more money in the long run as the resulting research and development will lead to increased royalties, rents, and bonuses paid by oil and gas companies. And Mr. Chairman, in order to stress the importance of this issue, I would ask to include this document with highlights from the RPSEA Project Portfolio in the record.

Chair GORDON. With no objection, this will be made part of the record.

[The information follows:]

HIGHLIGHTS FROM RPSEA PROJECT PORTFOLIO

Optimization of Infill Well Locations in Wamsutter Field; University of Tulsa, $440,000 for 36 months. This project represents an example of the application of new technology to increase the gas recovery from an existing field. Additional gas that is produced from existing fields using existing infrastructure diminishes the need for development in new, environmentally sensitive areas.

Novel Concepts for Unconventional Gas Development in Shales, Tight Sands and Coal Beds; Carter Technologies, $91,000 for 12 months. Carter Technologies is a small, entrepreneurial company that was funded by RPSEA to evaluate novel concepts for increasing the contact between a gas well and the associated reservoir. These concepts have the potential to provide an easier to control alternative to hydraulic fracturing, and could decrease the water use associated with unconventional gas development.

Petrophysical Studies of Unconventional Gas Reservoirs Using High-Resolution Rock Imaging; Lawrence Berkeley Laboratory, $1,100,000 for 36 months. The storage and movement of fluids, including natural gas, through the pore spaces of extremely fine-grained shale reservoirs requires different models and predictive tools than those developed over the last 50+ years for conventional reservoirs. This project is intended to make fundamental pore-scale investigations of shale reservoir properties, resulting in the physical understanding necessary to develop the models that will be crucial for effective decision-making regarding the planning and execution of the development of shale gas resources.

Comprehensive Investigation of the Biogeochemical Factors Enhancing Microbially Generated Methane in Coal Beds; Colorado School of Mines, $860,000 for 24 months. Methane present in coal beds may have been generated over very long time scales. This project is investigating the potential for microbially accelerating the generation of methane from coal, potentially leading to the conversion of coal to much cleaner methane.

Field Site Testing of Low-Impact Oil Field Access Roads: Reducing the Footprint in Desert Ecosystems; Texas A&M University, $444,939 for 24 months. The roads required to provide access to drilling sites have an impact on ecosystems lasting beyond the time that the roads are in use. This project is testing concepts for temporary roads that would be removable with minimal long-term impact on the ecosystem. Such road systems may find application in any system where the need for access for a short time (e.g., for construction) is greater than the need for long-term access in sensitive ecosystems.

Work that would be done if additional funding was available: Natural gas in shale formations represents a potentially very large domestic resource that could provide clean hydrocarbon fuels to help manage the transition to an entirely sustainable energy economy. Both policy decisions and investment decisions regarding this resource require better knowledge of the magnitude of the resource and the technical challenges associated with developing it. RPSEA has funded such studies in a limited number of areas (Alabama, Utah, Illinois Basin), but such resource and basin analysis studies covering the entire domestic shale resource base would materially impact the effective and appropriate utilization of the resource.

Mr. HALL. Thank you. I will hand it to him. And I will have more to say about this during the question and answer, but I just want to urge the Secretary and President Obama to reconsider their position on this program. I am also interested in hearing about this Administration's decision to move away from the idea of storing spent nuclear fuel at the Yucca Mountain repository in Nevada and how that decision will or will not affect the current application for new plants and the future of nuclear energy in our country. Nuclear energy of course is also part of the "all-of-the-above" energy solution and should be considered a power house in our energy arsenal. Out of all of the emissions-free options, it produces the most energy and is the most reliable, and I urge the Secretary to make sure it remains a part of this mix.

I look forward to working with you and look forward to your testimony and the ensuing discussion on the very important work that is being done by the Department of Energy, a department that I think is probably the number one department for the future of this country and to the position that we are taking in trying to produce our own energy and not rely on nations that don't really trust us and that we could do without and keep those billions of dollars within the confines of the 50 states. With that, I yield back my time.

[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF REPRESENTATIVE RALPH M. HALL

Mr. Chairman, thank you for holding this hearing today. I'd like to extend my welcome to Secretary Chu. It's good to have you here, and I look forward to working with you as we continue to tackle our energy challenges.

I am pleased to see the level of commitment in the President's budget supporting research and development in the important fields of renewable energy and basic energy. As we all know, renewable energy will be an important and necessary part of our energy portfolio as we go forward with the dual goals of energy independence and a clean environment. I am also pleased that the President's budget contained a boost towards developing low-carbon coal technologies. I have always been supportive of using this abundant domestic resource for providing our country's energy needs. With widespread commercial use of carbon capture and sequestration technology, our country can hopefully have the option of replacing imports of oil and gas with coal-to-liquids fuels and methane gas from coal.

What I haven't seen or heard is what the plans are for oil and gas research and development going forward. I believe in the "all-of-the-above" answer to our energy problem, and that includes using domestic sources of oil and natural gas. Research and development in these fields does not benefit the major oil companies, but it does benefit the small independent oil and gas producers who should be helped in their efforts to bring our domestic supplies to the market rather than penalized at every turn. I am very disappointed that the President recommended that the Ultra Deepwater and Unconventional Natural Gas and Other Petroleum Research program be repealed. The prior Administration made this recommendation as well and Congress repeatedly said "you're wrong" and funded this valuable program anyway. The Ultra Deep program is paid for by federal lease royalties, rents, and bonuses paid by oil and gas companies—not taxpayers, and it will make the government more money in the long run as the resulting R&D will lead to increased royalties, rents, and bonuses paid by oil and gas companies. I will have more to say about this during Q&A, but I just want to urge the Secretary and President Obama to reconsider their position on this program.

I am also interested in hearing about the Administration's decision to move away from the idea of storing spent nuclear fuel at the Yucca Mountain repository in Nevada and how that decision will or will not affect the current applications for new plants and the future of nuclear energy in our country. Nuclear energy is of course also part of the "all-of-the-above" energy solution and should be considered a power house in our energy arsenal. Out of all the emissions-free options, it produces the

most energy and is the most reliable, and I urge the Secretary to make sure it remains a part of the mix.

I look forward to Secretary Chu's testimony and the ensuing discussion on the very important work being done at the Department of Energy.

Chair GORDON. Thank you, Mr. Hall, and I certainly agree with you. Dr. Chu, you will find that our committee tries to work in collaboration. Everything we got here is bipartisan and most often is unanimous. And so we hope to be an asset for you in that regard.

If there are other Members who wish to submit additional opening statements, your statements will be added to the record at this point.

[The prepared statement of Mr. Costello follows:]

PREPARED STATEMENT OF REPRESENTATIVE JERRY F. COSTELLO

Chairman Gordon, thank you for calling today's hearing on this very important topic. Secretary Chu, we appreciate you being with us this morning. I look forward to hearing in greater detail your thoughts and ideas on how we can be more productive in terms of our energy research and development. We want to work with you and President Obama to make progress in this area. It is imperative that we work together in a bipartisan way to develop clean energy sources for the future while simultaneously maximizing the benefits of our fossil energy resources.

Of course, each of us has particular concerns with how this work will proceed. Whether it is how a cap-and-trade regime will work and its effects on utility bills across the country, or how to distribute our research dollars for maximum impact, there will be disagreements. However, I am confident we can come together to make real strides toward a cleaner energy future. Importantly, the Obama Administration has made a strong early commitment to science, through both funding and emphasizing its importance to our economy and society, and this has been well received.

As I have discussed with you before, I come from a state with large coal reserves and I want to develop ways to use it as cleanly as possible. We really have no choice, as over half of our electricity comes from coal. One of my singular disappointments from the Bush Administration, as we discussed in the Energy and Environment Subcommittee again last week, was its decision to walk away from the FutureGen Project, which not only dealt a blow to bipartisanship, but set our efforts back to develop carbon sequestration by as much as a decade. I will have questions regarding your thoughts on FutureGen going forward, but offer it up as example of how we can work together on an important project that serves the energy needs of our entire nation.

I mentioned cap-and-trade earlier, and while I know that all of the details of the Administration's plan have yet to be released, I will be interested to hear your thoughts on this concept. We need to be very careful about how such a plan is constructed, as the economic dislocations of too much, too soon, could be very severe.

A further point I will ask about is the regulation of DOE's laboratories. I have sponsored legislation in the past to have this function done externally, and, given your strong background in this area, am very interested to hear your thoughts on this issue and if it is a concept you are interested in pursuing.

Mr. Chairman, thank you again for your attention to these issues and for your leadership. I am excited to begin our work with Secretary Chu and anticipate a great working relationship.

[The prepared statement of Mr. Carnahan follows:]

PREPARED STATEMENT OF REPRESENTATIVE RUSS CARNAHAN

Chairman Gordon, Ranking Member Hall, thank you for hosting this important hearing on *"New Directions for Energy Research and Development at the U.S. Department of Energy."* Secretary Chu, thank you for appearing before the Committee. I look forward to working with you over the course of the 111th Congress and beyond to address the Nation's critical challenges relating to energy.

As co-founder of the Congressional High-Performance Buildings Caucus, I am particularly interested in the Department of Energy's plans for promoting energy efficiency in the built environment. As you know, our homes, offices, schools, and other buildings consume 40 percent of the primary energy and 70 percent of the electricity in the U.S. annually. These buildings also account for 39 percent of U.S. CO_2 emissions each year. With over $15 billion allocated in the Stimulus Bill to weatherizing

the homes of low-income families, "greening" federal buildings and to State and local efficiency programs, the DOE has the crucial responsibility of ensuring that this investment is spent wisely.

Going forward, investing in high-performance buildings must be a long-term priority. I am particularly encouraged by DOE's Building Technologies Program. Mr. Secretary, I am curious to hear your thoughts on how this important initiative can reach its strategic goals of developing the technologies and designs for zero-energy homes and commercial buildings by 2020 and 2025, respectively. I am also pleased to see your plans for transformational research into computer design tools that will lead to energy consumption reductions of up to 80 percent. I am also interested to know your views on the role of Congress in supporting the continued adoption of green building practices across the United States.

As a Member of the Subcommittee on Research and Science Education, I share your commitment to developing the next generation's science and engineering talent. I look forward to collaborating with you to increase funding for basic research while ensuring that taxpayer dollars are spent effectively.

In closing, thank you again, Chairman Gordon, for calling this important hearing. Secretary Chu, I look forward to your testimony.

[The prepared statement of Mr. Mitchell follows:]

PREPARED STATEMENT OF REPRESENTATIVE HARRY E. MITCHELL

Thank you, Mr. Chairman.

Today we will discuss the Energy Department's near-term objectives and priority issues for research and development activities.

I look forward to hearing from the Secretary of Energy, Dr. Steven Chu, about research and development activities for clean energy technologies.

With over 300 days of sunshine a year in Arizona, I strongly believe that we have an opportunity to brighten America's future by investing in solar energy research and development. Investing in solar energy will not only help to reduce our nation's dependence on foreign oil, it will also create jobs and help spur economic growth.

In Arizona, we've seen how the advancement of solar energy research can lead to the development of large-scale solar opportunities. Arizona Public Service and Abengoa Solar are developing the world's largest solar plant outside of Gila Bend. The Solana solar generating station will create 1,500 to 2,000 jobs and provide clean, emission-free energy for 70,000 homes. Solana is expected to ultimately spur $1 billion in economic development.

I look forward to hearing from Dr. Chu about his priorities for the Department of Energy.

I yield back.

[The prepared statement of Mr. Wilson follows:]

PREPARED STATEMENT OF REPRESENTATIVE CHARLES A. WILSON

Thank you, Mr. Chairman, for holding this important hearing. I appreciate having the opportunity to participate this morning.

Secretary Chu, I would like to welcome you to the Committee this morning; I look forward to hearing your views on our nation's energy research and development efforts. In addition, I look forward to hearing your views regarding coal and the important role it will play as we begin the transition to a low-carbon economy.

As all of you here today know, coal is our nation's most abundant resource and it must play a role in bridging the gap to our energy future. Today, coal serves as the single largest fuel source for the generation of electricity worldwide, and is essential to the U.S. economy. Everyday, coal provides affordable and reliable energy to millions of households, businesses, and manufacturing facilities throughout our nation. Furthermore, in my home State of Ohio and around this country, coal is not only a valuable source of electricity, but it is a valuable source of jobs. The Ohio coal industry directly employs over 3,000 individuals each year.

Today, America is in the midst of a long-term energy crisis. And as the climate change debate continues to intensify in Congress, we must find ways to balance our nation's energy, economic and environmental needs. We are all excited about the future of alternative energy and the idea of weaning ourselves off foreign resources, but we must be realistic about the short-term needs that an energy intense nation will require. We cannot disregard an important "home-grown" resource like coal that we already have in abundance.

As Congress moves forward on this important issue, clean coal technology and carbon capture and sequestration technology must play a key role. The $3.4 billion

for clean coal technologies including carbon capture and sequestration provided in the *American Recovery and Reinvestment Act* is a good step, but more must be done. It is important that Congress and the Department of Energy continue to invest in this vital technology so that as a nation we can truly reduce greenhouse gas emissions and move toward energy independence.

I look forward to hearing your testimony today Secretary Chu and look forward to working together in the future.

[The prepared statement of Mr. Diaz-Balart follows:]

PREPARED STATEMENT OF REPRESENTATIVE MARIO DIAZ-BALART

It is clear that the Administration's cap-and-trade proposal is a deeply flawed and economically damaging plan that calls for increasing taxes on everyday energy use, burdening Americans at the gas pump and as they struggle to pay monthly electricity bills. Hardworking families, small businesses, and manufacturers cannot afford this massive new tax increase.

Today, the Associated Press reported, in an article included below, that China's lead climate negotiator said any fair international agreement to curb gases blamed for global warming would not require China to reduce emissions caused by manufactured goods intended to be exported.

I strongly agree with the Energy Secretary that all nations, including China, must work to limit their carbon emissions. The Administration should not proceed with a climate change proposal that could damage the American economy particularly when the Chinese refuse to take meaningful reforms to reduce their carbon emissions.


The Washington Post

China Hopes Climate Deal Omits Exports

Chair GORDON. Dr. Chu, we normally ask our witnesses to limit their testimony to five minutes. However, since you are the only person on the panel and the star of the show, we don't want to limit you. We are interested in hearing your plans and how you want to take the Department of Energy into the future, and so at this time, please begin.

STATEMENT OF DR. STEVEN CHU, SECRETARY OF ENERGY, U.S. DEPARTMENT OF ENERGY

Dr. CHU. Thank you. Chairman Gordon, Ranking Member Hall, Members of the Committee, thank you for the opportunity to appear before you today to talk about the *New Directions for Energy Research and Development at the U.S. Department of Energy.*

Today, we import roughly 60 percent of our oil, draining resources from our economy and leaving it vulnerable to supply disruptions. Much of that oil is controlled by regimes that do not share our values, weakening our security. Additionally, if we continue our current rates of greenhouse gas emissions, the consequences of our climate could be disastrous.

In the near-term, President Obama and this Congress have already taken a key step toward meeting these challenges by passing the *American Recovery and Reinvestment Act of 2009.* This legislation will put Americans back to work while laying the groundwork for a clean energy economy.

Getting this money into the economy quickly, carefully, and transparently is a top priority for me. I know that your constituent states, cities, and businesses are eager to move forward, and are seeking more information about how to access this funding. I have met with many of them already, and we will have much more detail in the coming weeks.

With that introduction, I would like to turn to a topic that is near and dear to my heart: how can we better nurture and harness science to solve our energy and climate change problems? I have spent most of my career in research labs as a student, as a researcher, a faculty member. I took on the challenge of being Secretary of Energy in part for the chance to ensure that the Department of Energy Laboratories and our country's universities will generate ideas that will help us address our energy challenges. I also strongly believe that the key to our prosperity in the 21st century lies in our ability to nurture our intellectual capital in science and engineering. Our previous investments in science led to the birth of the semiconductor, computer, and bio-technology industries that have added greatly to our economic prosperity. Now, we need similar breakthroughs on energy.

We are already taking steps in the right direction, but we need to do more. First, we need to increase funding. As part of the President's plan to double federal investment in the basic sciences, the 2010 budget provides substantially increased support for the Office of Science, building on the $1.6 billion provided in the Recovery Act for the Department of Energy's basic sciences programs.

We also need to refocus our scarce research dollars. In April, a more detailed fiscal year 2010 budget will be transmitted to Congress. This budget will improve energy research, development, and deployment at DOE in several ways. First, we need to develop science and engineering talent. The fiscal year 2010 budget supports graduate fellowship programs that will train students in energy-related fields. I will also seek to build on the DOE's existing research strengths by attracting and retaining the most talented scientists.

The second area I want to discuss is the need to support transformational research. What do I mean by transformational tech-

nology? I mean technology that is game-changing, as opposed to merely incremental. For example, in the 1920s and '30s, when Bell Laboratories was focused on extending the life of vacuum tubes, another much smaller research program was started to investigate a completely new device based on a revolutionary new advance in the understanding of the microscopic world, quantum mechanics. The result of this transformational research was the transistor, which transformed communications, allowed the computer industry to blossom, and changed the world forever.

DOE must strive to be the modern version of the old Bell Labs in energy research. Because the payoffs from research in transformational technologies are both higher risk and longer-term, government investment is critical and appropriate. We are already funding this type of research in biofuels. As this committee knows, we have funded three bioenergy research centers, one at the Oak Ridge National Laboratory, one led by the University of Wisconsin in Madison, in collaboration with Michigan State University, and one led by Lawrence Berkeley National Laboratory. Each of these centers is targeting breakthroughs in biofuel technology development that will be needed to make abundant, affordable, low-carbon biofuels a reality.

We need to do more transformational research at DOE to bring a range of clean energy technologies to the point where the private sector can pick them up, including gasoline and diesel-like biofuels generated from lumber waste, crop wastes, solid waste, and non-food crops; automobile batteries with two to three times the energy density that can survive 15 years of deep discharges; photovoltaic solar power that is five times cheaper than today's technology; computer design tools for commercial and residential buildings that will 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 resources such as wind or solar power can become base-load power generators.

This is not a definitive list, or a hard set of technology goals, but it gives a sense of the type of technologies and benchmarks I think we should be aiming for. We will need transformational research to attain these types of goals. To make it happen, we will need to re-energize our national labs as centers of great science and innovation.

At the same time, we need to seek innovation wherever it can be found. The new Advanced Research Projects Agency–Energy will open up research funding to the best minds in the country, wherever they may be. ARPA–E will identify technologies with potential to become the next generation of revolutionary energy systems and products, while it will make a major impact on our twin problems of energy security and climate change.

I want to thank this committee for your leadership in championing the creation of ARPA–E. ARPA–E will accomplish its mission by funding high-risk, high-payoff R&D, performed by industry, academia, not-for-profits, national laboratories, and consortia. ARPA–E will bring the DARPA style of transformational R&D management to focus on energy problems and opportunities. I

pledge to you we will have this program up and running as soon as possible.

The third area I would like to discuss is that DOE needs to foster better research collaboration, both internally and externally. We will better integrate national lab, university, and industry research. And we will seek partnerships with other nations. For example, increased international cooperation on carbon capture and storage technology could reduce both the cost and time of developing the range of pre- and post-combustion technologies that are needed to meet the climate challenge.

Finally, while we work on transformational technologies, DOE must also improve its efforts to demonstrate next-generation technologies and to deploy demonstrated clean energy technologies at scale. The loan guarantee program will be critical to these efforts by helping to commercialize technologies, and the Recovery Act funding for weatherization and energy efficiency block grant programs will accelerate the deployment of energy efficient technologies.

So I am excited about the prospect of improving DOE's clean energy research, development, and deployment efforts. I thank you, and I would be glad to answer your questions at this time.

[The prepared statement of Dr. Chu follows:]

PREPARED STATEMENT OF STEVEN CHU

Chairman Gordon, Ranking Member Hall, and Members of the Committee, thank you for the opportunity to appear before you today to talk about new directions for energy research and development at the Department of Energy.

Today, we import roughly 60 percent of our oil, draining resources from our economy and leaving it vulnerable to supply disruptions. Much of that oil is controlled by regimes that do not share our values, weakening our security. Additionally, if we continue our current rates of greenhouse gas emissions, the consequences for our climate could be disastrous.

If we, our children, and our grandchildren are to prosper in the 21st century, we must decrease our dependence on oil, use energy in the most efficient ways possible, and lower our carbon emissions. Meeting these challenges will require both swift action in the near-term and a sustained commitment for the long-term to build a new economy, powered by clean, reliable, affordable, and secure energy.

During his recent address to a Joint Session of Congress, President Obama reiterated his commitment to reducing our dependence on oil and sharply cutting greenhouse gas emissions. I look forward to working with others in the Administration and with Members of Congress to meet the President's goal of legislation that places a market-based cap on carbon pollution and drives the production of more renewable energy in America. Such legislation will provide the framework for transforming our energy system to make our economy less carbon-intensive, and less dependent on foreign oil.

In the near-term, President Obama and this Congress have already taken a key step by passing the *American Recovery and Reinvestment Act of 2009.* This legislation will put Americans back to work while laying the groundwork for a clean energy economy.

American Recovery and Reinvestment Act

I would like to highlight a few of the energy investments in that law.

First, the Recovery Act will put people to work making our homes and offices more energy efficient. It includes $5 billion to weatherize the homes of low-income families; a $1,500 tax credit to help homeowners invest in efficiency upgrades; $4.5 billion to "green" federal buildings, including reducing their energy consumption; and $6.3 billion to implement state and local efficiency and renewable programs.

The Recovery Act also includes $6 billion for loan guarantees and more than $13 billion in tax credits and financial assistance instruments (grants and cooperative agreements) that may leverage tens of billions in private sector investment in clean energy and job creation. This will help clean energy businesses and projects to get

off the ground, even in these difficult economic times. The bill also makes investments in key technologies, such as $2 billion in advanced battery manufacturing, and $4.5 billion to jump-start our efforts to modernize the electric grid. These funds will help us ensure that the research investments we have already made will be carried forward to the market results and clean energy economy we seek.

Getting this money into the economy quickly, carefully, and transparently is a top priority for me. I know that your constituent states, cities, and businesses are eager to move forward, and are seeking more information about how to access this funding. I have met with many of them already, and we will have much more detail in the coming weeks.

I know the Title XVII loan guarantee program is of great interest and concern to this committee. We are already in the process of making improvements to this important program that I believe will satisfy many of these concerns. We should be in a position to guarantee the first loans under this program soon.

We have put in place a set of processes in the Department to get Recovery Act funds out the door quickly to good projects, with an unprecedented degree of transparency. This will make a significant down payment toward the Nation's energy and environmental policy goals. With this Recovery Act spending, we are creating jobs and we are providing incentives for private capital to move off the sidelines and back into the energy markets.

Reshaping Energy Research, Development, and Deployment

With that, I would like to turn to a topic that is near and dear to my heart: how we can better nurture and harness science to solve our energy and climate change problems. I have spent most of my career in research labs—as a student, as a researcher, and as a faculty member. I took the challenge of being Secretary of Energy in part for the chance to ensure that the Department of Energy Laboratories and our country's universities will generate ideas that will help us address our energy challenges. I also strongly believe that the key to our prosperity in the 21st century lies in our ability to nurture our intellectual capital in science and engineering. Our previous investments in science led to the birth of the semiconductor, computer, and bio-technology industries that have added greatly to our economic prosperity. Now, we need similar breakthroughs on energy.

We're already taking steps in the right direction, but we need to do more.

First, we need to increase funding. As part of the President's plan to double federal investment in the basic sciences, the 2010 Budget provides substantially increased support for the Office of Science, building on the $1.6 billion provided in the Recovery Act for the Department of Energy's basic sciences programs.

We also need to refocus our scarce research dollars. In April, a more detailed FY 2010 budget will be transmitted to Congress. This budget will improve energy research, development, and deployment at DOE: by developing science and engineering talent; by focusing on transformational research; by pursuing broader, more effective collaborations; and by improving connections between DOE research and private sector energy companies.

Developing Science and Engineering Talent: Several years ago, I had the honor and privilege of working on the *"Rising Above the Gathering Storm"* report of the National Academy of Science. One of the report's key recommendations is to step up efforts to educate the next generation of scientists and engineers. The FY 2010 budget supports graduate fellowship programs that will train students in energy-related fields. I will also seek to build on DOE's existing research strengths by attracting and retaining the most talented scientists.

Focusing on Transformational Research: The second area that I want to discuss is the need to support transformational technology research. What do I mean by transformational technology? I mean technology that is game-changing, as opposed to merely incremental. For example, in the 1920's and 1930's, when AT&T Bell Laboratories was focused on extending the life of vacuum tubes, another much smaller research program was started to investigate a completely new device based on a revolutionary new advance in the understanding of the microscopic world: quantum physics. The result of this transformational research was the transistor, which transformed communications, allowed the computer industry to blossom, and changed the world forever.

DOE must strive to be the modern version of the old Bell Labs in energy research. Because the payoffs from research in transformational technologies are both higher risk and longer-term, government investment is critical and appropriate.

Here is an example of current DOE transformational research. As this committee knows, we have funded three BioEnergy Research Centers—one at the Oak Ridge National Laboratory in Oak Ridge, Tennessee; one led by the University of Wisconsin in Madison, Wisconsin, in close collaboration with Michigan State University

in East Lansing, Michigan; and one led by the Lawrence Berkeley National Laboratory. Each of these centers is targeting breakthroughs in biofuel technology development that will be needed to make abundant, affordable, low-carbon biofuels a reality. While these efforts are still relatively new, they are already yielding results, such as the bioengineering of yeasts that can produce gasoline-like fuels, and the development of improved ways to generate simple sugars from grasses and waste biomass.

We need to do more transformational research at DOE to bring a range of clean energy technologies to the point where the private sector can pick them up, including:

1. Gasoline and diesel-like biofuels generated from lumber waste, crop wastes, solid waste, and non-food crops;
2. Automobile batteries with two to three times the energy density that can survive 15 years of deep discharges;
3. Photovoltaic solar power that is five times cheaper than today's technology;
4. 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
5. Large scale energy storage systems so that variable renewable energy sources such as wind or solar power can become base-load power generators.

This is not a definitive list, or a hard set of technology goals, but it gives a sense of the types of technologies and benchmarks I think we should be aiming for. We will need transformational research to attain these types of goals. To make it happen, we will need to re-energize our national labs as centers of great science and innovation.

At the same time, we need to seek innovation wherever it can be found—the new Advanced Research Projects Agency–Energy (ARPA–E) will open up research funding to the best minds in the country, wherever they may be. ARPA–E will identify technologies with the potential to become the next generation of revolutionary energy systems and products, which will make a major impact on our twin problems of energy security and climate change.

I want to thank this committee for your leadership in championing the creation of ARPA–E. ARPA–E will accomplish its mission by funding high-risk, high-payoff R&D, performed by industry, academia, not-for-profits, national laboratories, and consortia. ARPA–E will bring the DARPA style of transformational R&D management to focus on energy problems and opportunities. I pledge to you we will have this program up and running as soon as possible.

Broader, More Effective Collaboration: DOE also needs to foster better research collaboration, both internally and externally. My goal is nothing less than to build research networks within the Department, across the government, throughout the Nation, and around the globe. We'll better integrate national lab, university, and industry research. And we will seek partnerships with other nations. For example, increased international cooperation on carbon capture and storage technology could reduce both the cost and time of developing the range of pre- and post-combustion technologies needed to meet the climate challenge.

Speeding Demonstration and Deployment: While we work on transformational technologies, DOE must also improve its efforts to demonstrate next-generation technologies and to help deploy demonstrated clean energy technologies at scale. The loan guarantee program will be critical to these efforts by helping to commercialize technologies, and the Recovery Act funding for weatherization and energy efficiency block grant programs will accelerate the deployment of energy efficient technologies.

Conclusion

I am excited about the prospect of improving DOE's clean energy research, development, and deployment efforts. The Nation needs better technologies to fully meet our climate and energy challenges, and DOE can be a major contributor to this effort.

We already have ample technology to make significant, near-term progress toward our energy and climate change goals. The most important of these is energy efficiency, which will allow us to reduce costs and conserve resources while still providing the same energy services. The potential there is huge, as is the potential to increase the use of existing technologies such as wind, solar, and nuclear. We will move forward on all of these fronts and more, as we invest in the transformational research to achieve breakthroughs that could revolutionize our nation's energy future.

Thank you. I would be glad to answer your questions at this time.

BIOGRAPHY FOR STEVEN CHU

Dr. Steven Chu, distinguished scientist and co-winner of the Nobel Prize for Physics (1997), was appointed by President Obama as the 12th Secretary of Energy and sworn into office on January 21, 2009.

Dr. Chu has devoted his recent scientific career to the search for new solutions to our energy challenges and stopping global climate change—a mission he continues with even greater urgency as Secretary of Energy. He is charged with helping implement President Obama's ambitious agenda to invest in alternative and renewable energy, end our addiction to foreign oil, address the global climate crisis and create millions of new jobs.

Prior to his appointment, Dr. Chu was Director of DOE's Lawrence Berkeley National Lab, and professor of Physics and Molecular and Cell Biology at the University of California. He successfully applied the techniques he developed in atomic physics to molecular biology, and since 2004, motivated by his deep interest in climate change, he has recently led the Lawrence Berkeley National Lab in pursuit of new alternative and renewable energies. Previously, he held positions at Stanford University and AT&T Bell Laboratories.

Professor Chu's research in atomic physics, quantum electronics, polymer and biophysics includes tests of fundamental theories in physics, the development of methods to laser cool and trap atoms, atom interferometry, and the manipulation and study of polymers and biological systems at the single molecule level. While at Stanford, he helped start BioX, a multi-disciplinary initiative that brings together the physical and biological sciences with engineering and medicine.

Secretary Chu is a member of the National Academy of Sciences, the American Philosophical Society, the Chinese Academy of Sciences, Academica Sinica, the Korean Academy of Sciences and Technology and numerous other civic and professional organizations. He received an A.B. degree in mathematics, a B.S. degree in physics from the University of Rochester, a Ph.D. in physics from the University of California, Berkeley as well as honorary degrees from 10 universities. Chu was born in Saint Louis, Missouri on February 28, 1948. He is married to Dr. Jean Chu, who holds a D.Phil. in Physics from Oxford and has served as Chief of Staff to two Stanford University Presidents as well as Dean of Admissions. Secretary Chu has two grown sons, Geoffrey and Michael, by a previous marriage.

In announcing Dr. Chu's selection on December 15, 2008, President Obama said, "the future of our economy and national security is inextricably linked to one challenge: energy . . . Steven has blazed new trails as a scientist, teacher, and administrator, and has recently led the Berkeley National Laboratory in pursuit of new alternative and renewable energies. He is uniquely suited to be our next Secretary of Energy as we make this pursuit a guiding purpose of the Department of Energy, as well as a national mission."

DISCUSSION

Chair GORDON. Thank you, Dr. Chu, and exciting is the right term. You have an exciting portfolio, an important portfolio, and I wish you the very best of luck.

ARPA–E

First of all, at this time we will begin questions, and I recognize myself for five minutes. As you know, I am eager to see ARPA–E established, and I appreciate your comments. In your comment you said that you wanted to see it or it would be up and running as soon as possible, and I don't doubt your commitment. But could you give us a little better idea of some kind of rough timeline that you see getting ARPA–E up and running and have you assigned a team to serve as any kind of a start-up staff? How do you envision ARPA–E coordinating its R&D with other programs in the national labs?

Dr. CHU. I met with a team of people that was trying to see what the structure should be like. I think it is very consistent with this committee's views. I did ask specifically how long it would take. I didn't like the answer. The answer was, quite frankly—the first pass answer was one year, and so I instructed them, go back, and I want to see exactly on the timeline why it would take so long. There might be regulations, things like that, and I have not gotten back the answer to that.

So I hope it would take much shorter than one year.

Chair GORDON. As I had I think mentioned to you earlier, I know that DARPA has some programs that are available to pass off if you think that those are appropriate. You also received $400 million in the Recovery package. You know, how long is that going to last and what are your thoughts on spending those dollars? How much will that be used toward start-up versus actual implementing a program?

Dr. CHU. Well, we first were already looking around for the head of the ARPA–E program. I would hope—again, I was a little dismayed by the first pass, why it would take so long. But I think we are going to do things simultaneously. We are discussing drafting requests for proposals, so even as we search for a director and the key personnel, and so because it is part of the economic recovery, you know, we want to start actually funding projects hopefully in significantly less than one year.

Chair GORDON. Well, I think double or tripling tracking is the appropriate way to go. I mean, so often around here we have to get through one thing and then the next thing and then the next thing, you know. There can be those parallel tracks. There is draft legislation in the Senate that includes a provision to ensure that all ARPA–E project teams will be industry-led. Do you feel this is an appropriate direction to give ARPA–E or should it have more flexibility?

Dr. CHU. I would like it to have more flexibility. Certainly having an all-industry led may not be a problem. Just as the old ARPA program, it funded universities, it funded other research, it funded industries, it funded start-up companies, it funded established companies. And really, I would like to throw the door open to any and all and just pick the best ideas.

Chair GORDON. I would agree. I think flexibility is the key to ARPA–E's success, and you take whatever model is best for the particular situation that is before you. Do you have any thoughts as to a timeframe on ARPA–E, when it needs to be reviewed by the National Academies?

Dr. CHU. Actually, when it gets reviewed, the best way—in my opinion, the best way when you're starting something is to look at it very, very early, just in case you feel it is getting off the tracks. But the National Academy review has certain time constraints, and so I would probably have an internal review maybe working with this committee and others in Congress within a year to actually see what is going on because if it is—long-term things can be avoided if you catch things early. And so within a year of the start, the first six months you look at the proposals that have been recommended. Are these good choices? Are the people in place good people who are making the right decisions? And remember that the idea of this

new funding mechanism is that it is a very small, very select group of people that are unconstrained by the usual things, so they can really make the best decisions and to focus on those three-year time scales. It is not stewardship, it will give you money for a very short period of time. After maybe five years, that is it. Get it done. And after three to five years, you better get some other sponsor. Industry better pick it up or something. And actually, nothing focuses the mind like you know what, the termination of funding.

COORDINATING CARBON CAPTURE AND SEQUESTRATION

Chair GORDON. Sure. Well, you get it, and I am glad that we have got you there. In your testimony you say, my goal is nothing less than to build research networks within the Department, across the government, throughout the Nation, and around the globe. This is something that I have an interest in since that so many of our major research projects, carbon capture and sequestration, things of this nature are going to be so expensive, and I think that we live in a world where, you know, that is sort of "them that has got it and them that don't." And we are in the "don't" category to a great extent. And so I think it benefits us to collaborate with other nations both intellectually as well as financially. And I think G8 a while back had a resolution concerning CCS. Can you give us some of your thoughts in terms of what are those best areas of opportunity for international cooperation, and I would like to better understand what that vehicle could be. You know, money is going to be involved, and it seems to me that you are going to have to have a head-of-state to head-of-state agreement and a commitment to provide the funds, but then there is also going to have to be some type of an international protocol that has got to be set up, a treaty or whatever. What are your thoughts? Do we go, each one will be different or is there a form for them all?

Dr. CHU. Okay. So let us start from the basic premise that when you build a coal power plant, most of that money is in infrastructure. You don't order a coal power plant and put it on a boat and ship it, similarly with a building. So when—first, let me back off and say that we don't actually know today what the best technology will be. There are a couple of approaches, both pre-combustion and post-combustion capture. One thing is for sure, we have to develop some post-combustion capture because 99-point something percent of all the coal plants are pulverized coal, conventional coal plants. It will take some time to prove the technology, say roughly 10 years. In the meantime, we will be still building—the world will still be building lots of conventional coal plants. So even if we develop a pre-combustion strategy going forward, there are all those investments in the post-combustion that we have to make.

So there are several strategies that countries are looking at. I have been talking with all of the equivalent to the energy ministers in various countries. When I say how can we share what we know, I mean it in a really intimate way so that their engineers and people who are operating the—because they are actually there in these pilot programs. It is the lessons learned in actually running the thing that is important. That is the technical know-how. Because you can't—the IP issue in my mind is less important because most of this construction will be in the home country, like a building. So

I think if we have the engineers and the people who are actually there learning the actual, real-life experiences as we operate these power plants, so if Great Britain wants to build one, if China wants to build one, and Denmark wants to build one and we build one, we say, okay. This is the menu of things that we need to explore. If country X does one, we do another one, and oh, by the way, we will have you send over your people so you are there with us and learning the lessons in real time, and similarly the United States can be over there. It would be harder to craft an agreement where money goes overseas, especially in these economic times because that money, the billions of dollars for example the United States wants to spend on these pilot programs, it would be better spent in this country because it is part of the economic recovery, and similarly in all the other countries. But sharing the technical knowledge is something very different. And so you build up a common pool of knowledge mostly by being on site and sharing those lessons.

When I talk about that, so far I have gotten a very good reception. Now, how you get this crafted into a working agreement is really the issue. But right now, now is the time, because many countries—Europe is talking about 10 to 12 carbon sequestration pilot experiments or pre-commercial plants. We are talking of several here in the United States. China is talking of at least one. And within a year or so, it will be decided what is going to be done. So this is the time to actually get those terms.

Chair GORDON. Do you need any more tools to arrange these agreements?

Dr. CHU. Well, it is mostly as you say partly a State Department issue, but it is partly an energy issue. We will find out as soon as—I was just meeting with the representatives from China and DRC and RDC, one of those two, and I was really interested in finding out—we will know what we need as soon as we actually start to craft an agreement, an actual agreement.

Chair GORDON. I don't want to take up too much time. Can you give me real quickly two or three other prime areas for international cooperation energy?

Dr. CHU. Buildings. The same reason. If you get together and try to design for example software tools to help architects and structural engineers design an energy-efficient building, this is actually pretty sophisticated stuff. We don't understand how to design energy efficient buildings, and the reason I can say this is when we tried to build a more energy-efficient building, let us say reducing the energy by 50 percent, 80 percent, typically we fall short of the design goal. The actual performance is less than the design. And if you look at a scatter plot the more aggressively we try to design an energy-efficient building, the less efficient it becomes.

Chair GORDON. We are going to have to go into the—can you just give me the technologies? It is very interesting——

Dr. CHU. Building efficiency, software design tools.

Chair GORDON. Okay. Any other areas of international cooperation you think would be beneficial?

Dr. CHU. I think in some of the other things—certainly software design tools for building, building efficiency, automobile efficiency. But then it gets—there are some issues quite frankly that you get

into intellectual property (IP) and other issues. And so I am looking at those things which are—the investments will be made in that country, like buildings, like power plants where I don't see as much of a barrier.

Chair GORDON. Thank you, and thank you, Mr. Hall, for your patience there and you are recognized.

Mr. HALL. I am always patient with the Chairman, and I join the Chairman in lauding your appointment, not just Democrats but some Republicans. Knowing your history, your background, and your ability to serve, we are pleased with your confirmation, and I think you know that. I also have not been able to give our leader the assistance that he would like for me to give him on ARPA–E, but it is the law of the land now, and I hope that it is going to be as beneficial as Chairman Gordon set out in his leadership of its passage, and I certainly support working it out for the greatest good for the greatest number which is our goal always in what we do here.

THE ULTRA DEEPWATER AND UNCONVENTIONAL NATURAL GAS AND OTHER PETROLEUM RESOURCES RESEARCH PROGRAM

Mr. Secretary, let me just go right into what I am disappointed in. I am disappointed to see that the President's fiscal year 2010 budget proposes to terminate the Ultra Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research program. And I know you are familiar with that. It has been passed many times. It has been voted on several times by the House and Senate, and it is working. At first blush, the proposed termination appears to be part of an across-the-board effort to reduce or eliminate federal incentives for the domestic oil and gas industry and to belittle the importance, belittle the necessity of fossil fuels, and I strongly disagree with this policy. Every incremental BTU of domestic natural gas is important as every additional kilowatt hour of solar energy in terms of reducing our dependence on oil imports. Currently 33 percent of domestic natural gas production is from coal bed methane in tight formations such as shale, all of which is the outgrowth of DOE funded R&D in this area.

However, rather than simply talk about the energy security aspects on this issue, I would like to focus on the scientific aspects of the Ultra Deepwater and Unconventional Research and ask you several specific questions in that regard, sir. First, I understand that the Administration's rationale is that this research benefits the large domestic oil and natural gas producers and that they can otherwise pay for this research, and that is why President Bush changed his mind about it in the last part of his service and made efforts to repeal it which, once again, the House and the Congress rejected and supported this program. I am very sincere with you on that, and I really want to talk with you later on it. I spent a lot of time with the previous Secretary of Energy, and he was operating under a situation of where the President wasn't really for it in the last analysis, but he remained true to the oath he took and worked well with us. I respected the support of the person that appointed him, as I do you. These are the things that I want to point out. The University of Tulsa received $440,000 for a 36-month

project of Optimization of Infill Well Locations in Wamsutter Field to increase production in existing wells, and Texas A&M University received $444,969 for a 24-month project to field test low-impact oil field access roads to reduce environmental footprints in desert areas. Three, the Colorado School of Mines received $860,000 for a 24-month program to investigate biochemical factors to enhance a generation of methane from coal to produce cleaner methane. And I could go on and on. But I think you get my point.

These are not the major oil companies. They are national labs and research institutions that are benefiting and are serving and are partnering with this and energy efforts. This is as much a scientific thrust as it is an energy thrust, and all of these cases of existing research projects appear to me to represent cutting-edge, high-risk science led by university research teams. And I am aware that each of these projects includes significant cost share provided by industry.

Mr. Secretary, do you believe that the oil and gas industry left to its own devices would fund these types of research projects? I don't think so. Would you not agree that the character of these research projects is similar to the type of research projects funded by DOE Office of Science?

Dr. CHU. Well, actually, the type of research that you just described, for example, improving our ability to recover oil from reservoirs, we typically only get about 30 percent, even with the advanced and enhanced oil recovery methods, we typically get 30, maybe at most 40 percent of the oil in the ground. The rest of it is with today's technology unrecoverable. And so I think it is appropriate for the Department of Energy to be funding things like that. You know, the injection of CO_2 for enhanced oil recovery is something that has been proven to be commercially viable. There are other opportunities of injecting, for example, microbes deep in the strata, which liberates some of the oil and allow it to be pumped out. Those things I actually think it is appropriate that the Department of Energy fund.

Mr. HALL. I appreciate the fact that I believe you will discuss it with us and then we can talk to you about it. If we could talk to the former Secretary as he was loyal to a President that objected and was on the other side, I was not accustomed to being on the other side of George Bush, but on this situation I surely was not there.

Second, are you aware that there are currently 92 applications from universities and national labs, state agencies, and private R&D technology development companies totaling $105 million that have been peer reviewed and are awaiting action? I am told that these projects are immediately ready to proceed and would immediately employ researchers and supporting personnel. Should this not qualify for use of some of the stimulus fund?

Dr. CHU. Actually, I am not aware of the details of the proposals, and I certainly will look into it.

Mr. HALL. But you are open to——

Dr. CHU. Yes.

Mr. HALL.—submitting them to you? And finally, Mr. Secretary, I would like to ask you if you have personally reviewed the quality of research supported by this program? If not, could you provide me

with your assurance that you will personally look into this and give me your assessment prior to taking any further actions in the funding issue? I greatly respect your scientific credentials and would welcome your personal review.

Dr. CHU. I have not——

Mr. HALL. I am not alone in this because up and down this row we voted for this program more than once, and we think that we are getting energy from this program that we wouldn't get if we didn't have this energy. And it is being paid for by the energy we do get, so it is no cost to the taxpayers actually. And I want to talk to you about it.

Dr. CHU. Okay. I am looking forward to talking to you about it. I actually didn't know. I will confess that the Deep Water ocean recovery was actually supporting these other things of enhanced oil recovery on land, so I would be looking forward to talking to you.

Mr. HALL. And I thank you, and I thank the Chairman for letting me go over a little bit.

Chair GORDON. Mr. Wu, you are recognized for five minutes.

STANDARDS AND INTER-OPERABILITY FOR CAP-AND-TRADE AND SMART GRID

Mr. WU. Thank you, Mr. Chairman. Welcome, Mr. Secretary. You have blown into town like a breath of fresh air. I love your talk about transformational technologies. For the moment, I would like to invite you to talk a little bit about more mundane things like standards and inter-operability and matrix with respect to two areas, one is proposed cap-and-trade legislation and the other is for the proposed Smart Grid.

With respect to cap-and-trade legislation, as you see it, are there remaining matrix or measurement issues both with respect to measuring for the cap and quantifying and measuring for the trading units, and can the National Institute of Standards and Technology or other measurement groups be helpful in creation of both the legislation and the regulatory format to follow?

Dr. CHU. I think in terms of the measurements, I am not deeply connected to how one evaluates things. You are talking of for example overall life cycle emissions for a cement industry or steel or——

Mr. WU. Whether one views it as life cycle or even just measuring at one moment in time and accurately doing so.

Dr. CHU. Right.

Mr. WU. Two different problems.

Dr. CHU. Right, and so the measurement itself, it does become important if an estimate of how much carbon is being emitted, would it influence how much allowances one would have. I did not know, sir, that this was that controversial. I do know there are varying degrees in an industry, let us say, in a cement industry, varying degrees of how efficient some plants are. But I didn't realize—you know, you look at plant X or a coal-burning plant and, you know, you see these ratings. The most efficient coal-burning plants are, let us say, 42 percent efficient, the least efficient are actually in the mid-low 20's. I would expect that the estimates of how much emissions these plants were making per amount of energy produced was not that controversial. If it is, that would be an issue.

I would certainly look into that. That is the sense I am getting from your question.

Mr. WU. Yes, I am trying to get my arms around it, and I was hoping that you knew more than I did. And it looks like we both have some research to do in the——

Dr. CHU. Right. Give me some time and to see how controversial the estimates would be is specifically the question I think I am hearing.

Mr. WU. Yes, and then life cycle estimates are another——

Dr. CHU. Right.

Mr. WU. Then with respect to Smart Grid, in a prior energy bill, we put in some language on inter-operability, and I wanted to get your take on the current status of two different issues; one is inter-operability of different components of a Smart Grid, and the other is the issue of open source versus proprietary software to operate significant parts of a Smart Grid.

Dr. CHU. Yes. This is something I did look into almost within the first few weeks. I have only been here for only a couple weeks anyway, so I guess everything I have looked into is in the first couple of weeks. But in any case, yes, I think in the 2005 Energy Act there was a committee that DOE in cooperation with NIST to get some standards, and I have to say that I have been somewhat disappointed. They are just beginning to sort of arrange the seating chart around the negotiating table to put it in foreign diplomacy language. So we have held a couple of meetings with people from NIST to say this has to be fast-tracked because this has been going on for almost two years. The issue is essentially that—first, I am in favor of open standards, very much in favor of industry actually coming together and agreeing on an open standard, and so I am pushing very, very hard that this thing really get moving. I have talked to several people. Even before becoming Secretary of Energy, I have talked to people from many of the companies like Siemens and ABB, I talked to the CEO of General Electric very recently. Every time I talk to them, they say we are all in favor of this, and I say, well, let us stop jockeying for a slight commercial advantage. It is too important, which is what standards negotiations are all about.

So what we are doing—the plan now is—also FERC is in on this—is the distribution centers. These are the really big-dollar stuff, you know, the digital relays, the transformers, that have to have a communications standards system. Those standards have to be developed first. The commercial, you know, consumer stuff is the last thing. So at least we said we have got to get what we want in the standards, and we have to get it very quickly.

It has been a week or two since that meeting. I haven't gotten feedback. That is the other thing I found out is, you know, you typically have to get a next meeting with deliverables for that meeting in order to actually make sure it goes forward. But this is very much on my radar screen.

Mr. WU. Well, I wrote a part of that language referring to the 2005 legislation. I wrote part of that language at 40,000, so I attached to it and if I can help you get some results on that from NIST or other agencies, I would very much like to work with you on that.

Dr. CHU. Yes, I think as we develop these pilot experiments in Smart Grids, unless you have the communication standards in place, people are very afraid to make millions and tens of millions and perhaps even hundreds of millions of dollars of investment because of the retrofit. So the standards thing very early is something that is very important. You know, I have actually raised it with the President, and he has actually said he would be willing to go into a meeting. I said we should lock them up in the room and say don't come out until you have a standard.

Chair GORDON. Thank you very much, Mr. Wu. Secretary Chu, I told you early on that four years goes very quickly, and you are seeing the rope-a-dope that can make it go that way. So you absolutely have got the right idea. It takes that leadership. You have got to push it down to make it work.

Dr. Bartlett is recognized.

PEAK OIL AND SECURITY CONCERNS

Mr. BARTLETT. Thank you very much. Welcome aboard, sir. To the extent that we have not been as aggressive as we might have in finding new oil fields, to the extent that we have not done what we might well have done in enhanced oil recovery, I am encouraged because that means there is going to be a little bit more oil for my 10 kids, my 16 grandkids, and my two great-grandkids.

We have been relating ourselves to oil as if it were infinite, that there would be no end to it. That of course is not true. There is such a thing as peak oil. It was predicted by M. King Hubbert in 1956 for our country. Right on schedule it occurred in 1970, and although we have drilled more oil wells than all the rest of the world put together, we cannot make M. King Hubbert a liar.

A couple of years ago I led a codel to China, and we were talking about energy. And they began their discussion of energy by noting post-oil. There will be a post-oil world, of course. We think in terms of the next election which for us in Congress is never less than two years away, and in the business world they kind of think in terms of the next quarterly report. If they can't make that look good, why, the stockholders are going to be angry at them.

In that part of the world they tend to think in terms of generations and centuries. Of course, there will be a post-oil world. Hyman Rickover gave a great speech, I think probably the most insightful speech of the last century. It was given 52 years ago, the 14th day of this May, to a group of physicians in St. Paul, Minnesota. And in that speech he noted that the age of oil would be but a blip in the history of man, he said in the 8,000 year recorded history of man. He had no idea then how long the age of oil would last, but he said how long it lasted was important in only one regard. The longer it lasted, the more time would we have to plan an orderly transition to other energy sources. Of course, we have not been doing that. We have been behaving as if oil is forever.

I am concerned, sir, about the lack of urgency in our country and indeed around the world. Business as usual will not suffice. China is buying up oil all over the world. In today's world it makes no difference who owns the oil. The person who comes with the dollars buys the oil. Why, sir, do you think China is buying up oil all over the world and what do you think our response ought to be to that?

Dr. CHU. China has been following somewhat America's economic development. It is buying oil because as its economy grows, it needs more oil.

Mr. BARTLETT. But sir, today you don't need to own the oil. To have the oil, you simply come with the dollars and you buy the oil. Why are they buying the oil?

Dr. CHU. Are you saying—well, they are establishing—my understanding is they are establishing relationships with countries as did the United States and does the United States in terms of the oil suppliers, but I agree with you, oil is a commodity. It is on the market, and you can buy from one supplier or another supplier.

Mr. BARTLETT. At the same time, they are buying up this oil all over the world, they are very aggressively building a Blue Water Navy. Can you imagine, sir, that the day may come when the Chinese tell us, I am sorry guys, but we own the oil and we have 1,300,000,000 and 900 million of them live in rural areas and through the miracle of communications, they know the benefits of an industrialized society and they are demanding it, and we are not going to share our oil with you. To make that a reality, wouldn't they have to have a big Blue Water Navy?

Dr. CHU. Well, I think this goes to a larger question of why the United States should work very hard for energy independence and oil independence, and there are two ways of doing this. One is to develop sources at home, one is to develop alternative sources, for example, biofuels which I personally believe if we do the science correctly can be a huge addition to liquid transportation fuel. Another thing is use less oil by making more efficient cars, personal vehicles, electric vehicles, so we can off-load and transfer the personal transportation needs to electricity which then there is a wider palate of options available.

The thing the United States can do best instead of jockeying for positions is to actually decrease our importation of oil in a significant way by all the above-mentioned things. And so that is the best thing we can do, and this is something we should do.

Mr. BARTLETT. Thank you, sir, and thank you Mr. Chairman.

Chair GORDON. Thank you, and Dr. Baird is recognized for five minutes.

ARRA, OCEAN ACIDIFICATION, AND CONSUMER BEHAVIOR

Mr. BAIRD. Thank you, Mr. Chairman. Thank you, Mr. Secretary. I am going to be very quick with five questions, then you can answer them in the time available.

First, I would like you to speak briefly about the constraint on the administrative costs on DOE that were imposed on the stimulus and how that would affect you. Second, could you talk a little bit about CO_2's impact on the oceans, particularly ocean acidification? Third, your views on behavior change and conservation as a quick response to both our energy and our climate overheating. Fourth, the role of forest products in renewable energies. And finally, if you have time left, a little bit about the national labs. Thank you.

Dr. CHU. Okay. So the first is a technical issue. Thank you for the questions. In the *Economic Recovery Act,* there is—in order to, for example, administer the loans and to make sure that the money

is wisely invested and to have proper oversight, you need additional administrative costs. In the other agencies, they were given one percent of the total to administer those costs. This is an example. For some reason not clear to me, the Department of Energy was given one-half of a percent.

Mr. BAIRD. So as important as energy is, we have said we sort of shorted you. You only get half of what the other agencies get.

Dr. CHU. Right. To administer the loans, for example, and the things that we need to do to make sure that the money is given out wisely, that there is proper oversight, and things of that nature. So that is worrisome.

Mr. BAIRD. I would hope we can try to address that. We will do what we can to help.

Dr. CHU. In terms of the CO_2 impact, there are many impacts. I share your concern that perhaps the oceans are not mentioned enough. What happens is as the CO_2 in the atmosphere increases, more carbon dioxide is absorbed in the oceans. It becomes more acidic. Today the oceans are about 30 percent more acidic than they were in pre-industrial revolution times. It is significant. And when the ocean becomes more acidic, several things are known to happen. Coral is threatened, the little critters that when you go snorkeling hit your snorkel mask. They have calcium carbonate shells. Those organisms actually, when the pH gets too low, and they are at pH seven, what is going to happen is that they will lose their ability to capture the carbon and put it in their shells and actually construct their shells. So lab experiments where they just deliberately make it more acidic, they find that they lose their ability. When that happens, the whole food chain in the ocean is at risk.

Now that is not going to happen any time soon, but these are some of the issues that one is concerned about.

In terms of behavior change, this is something that if you look in the history of how you get the United States to respond very quickly, we should be paying more attention to this. If you consider what happened in World War II, there were posters saying that we should save energy, especially transportation fuel, because any drop we saved in energy and transportation fuel could be used in our wartime effort. And there was a great deal of input, and Americans rose to the challenge and it became their patriotic duty to save energy. Now we have a similar situation. If you save energy, for example, by getting more fuel-efficient cars, you decrease the demand. That will keep the prices down. There is a lot less carbon in the atmosphere, and we are less dependent on foreign oil.

And so I think it is a three-for, if you will, in terms of not only patriotic duty to our country but actually to the world. And I think to get this notion that it is good in many, many ways to think about decreasing your consumption of energy, whether it be turning off light bulbs or your computers after you are done or buying a more fuel-efficient car, when that opportunity arises, these are all things that we need to do. The United States has convinced a younger generation that it is not cool to smoke cigarettes, and that has changed behavior. And I think we should convince the younger generation and the older generation that it is actually cool to save

energy and become much more energy efficient. This is something that the world really needs.

So this change of behavior is something America has been able to do in the past, and we have the tools. I am all for talking more about that.

And in terms of—you mentioned forest products. This goes to the question of biofuels. You know, already these biofuel programs in our national labs have already altered yeast and bacteria so that the yeast and bacteria, when fed simple sugars, can produce not just ethanol but a gasoline-like fuel and diesel-like fuel and jet plane-like fuel. And so now they are working on increasing our productivity to make it economically viable.

The good thing about the feed stock is they want to use all of the lumber wastes, the agricultural wastes that include wheat straw, rice straw. Half the corn stover can be used. The other half has to be ploughed back into the fields, but half the corn stover can be used. All the agricultural waste that we either burn or we let rot that ends up into microbes, turn that into carbon dioxide and methane, we should be converting that to either helping coal-burning plants or better still, converting this into transportation fuel, again to help break our oil dependency.

This is something that the national labs and the Department of Energy is working very hard in doing because this is could be a significant, this could be half our non-diesel jet plane transportation fuel. And finally, the national lab systems——

Chair GORDON. Doctor, we are going to have to get to the national labs later, if that is okay.

Dr. CHU. Okay.

Chair GORDON. I am sure that will be of interest to other folks, too.

Ms. Biggert is recognized.

NUCLEAR ENERGY AND WASTE REPROCESSING

Ms. BIGGERT. Thank you, Mr. Chairman, and I welcome you Mr. Secretary. You and I have had a brief conversation earlier on nuclear energy. I would like to get to that, but just before I do that, I am going back to a question that Chairman Gordon asked you, and that was about the technology transfer on an international basis. Section 1001 in the EPACT bill of 2005 addressed the issue of having a new technology transfer coordinator and working group appointed to have a basis of working with developing countries to employ clean, efficient energy technologies and then listed the barriers and the concerns. I don't know if you have worked with that or have a coordinator in place.

Dr. CHU. No, I don't have a coordinator yet.

Ms. BIGGERT. Okay. I refer you to this bill. It is Public Law 109–58 also. But you and I have discussed very briefly nuclear energy and reprocessing, and I was concerned to hear that you moved beyond the repository of Yucca Mountain, the decision of the Administration. And I really am concerned about that. So where does that leave the Department of Energy in regards to reprocessing and the next generation of nuclear plants?

Dr. CHU. Well, first, let me start by saying that I do firmly believe that nuclear energy has to be part of our energy supply in this century for sure because it is carbon-free.

So in terms of the waste, what the NRC has said is that if you store the waste in dry can storage at current sites, it is safe for decades from leakage into the environment. So that means we have time to develop a much more comprehensive plan. I am working, I know the Senate has already begun to talk about this, of—and we have independently but would like to work with Congress in this to put together a very blue-ribbon panel of experts, of technical experts and wise people who can help us devise recommendations for a comprehensive plan and a fresh look at how we can store nuclear waste and eventually dispose of it.

The whole Yucca Mountain issue is that the landscape has changed over the 20, 25 years when this first started. The conditions for—first it started as 10,000 years and it had to be retrievable. Then Appeals Court ruling said no, if science says the leakout rate could extend to a million years, so be it. Then it should be a million years and yet still be retrievable. So the conditions changed, and so I would like a committee to say, okay, let us take a fresh look at the things and what is our best strategy for moving forward on nuclear power.

Ms. BIGGERT. President Carter shut this down what, 25, 30 years ago, and that really has set the United States back on nuclear energy. But over the past 30 years, our national labs have been conducting research on Yucca Mountain. And your laboratory was part of that, many of the scientists. And it really has—you know, some of our—hundreds of our best scientists and engineers have been working on this, and it just seems like this is such a setback. This research has been incorporated into the Yucca Mountain license application which is now before the NRC. It just seems like we are just going back to page one again and starting over, and I think that if we are ever going to end our dependence on foreign oil, that nuclear has to be in the long-term the one that will take us over the top and really solve that problem. I don't know if you received the comprehensive briefings on the deficiencies of Yucca Mountain science and by whom, but I really am concerned about this and I think that we really have a lot of permits out there for new type of reactors, and if we don't move now, I don't know when this is going to happen. This is a real setback.

Dr. CHU. Well, I do share your feeling that we do not want to start—I want to see the restarting of the nuclear industry in the United States. So the goal that you and I both share—the other thing is that I fully intend to fund research in developing recycling methods that are proliferation-resistant.

Ms. BIGGERT. But I think that has already happened, and I know Argonne has worked on that in Idaho. There has been a lot of research on that already, and there are some demonstration projects. And we were really ready to go two years ago.

Dr. CHU. Okay. So my understanding of that, certainly Argonne and people in Idaho have been looking at modifying the original PUREX[1] process which is——

[1] Plutonium Uranium Extraction

Ms. BIGGERT. Right.

Dr. CHU.—the process that France uses.

Ms. BIGGERT. Now it is a EUREX.[2]

Dr. CHU. Now it is a EUREX process, but those people who developed those feel it is not ready for piloting, that there are still issues——

Ms. BIGGERT. Who are those people?

Dr. CHU. Those people are people like Phil Fink. He used to be at Argonne. He is now in charge of that program in Idaho. I think he is very, very knowledgeable. Those are people who I do have a lot of trust in, and they are saying that we need to do more research before we build pilot plants.

Chair GORDON. Thank you, and Ms. Giffords is recognized for five minutes.

SOLAR ENERGY

Ms. GIFFORDS. Thank you, Mr. Chairman, and thank you, Mr. Secretary, for coming before our committee today. It is no big surprise for Members here that I am very passionate about my home State of Arizona and solar energy. When you think about over 300 days of sunshine that Arizona has, other western states, and frankly the whole country, really, I mean, comparing where we are with other countries, specifically Germany, Japan, of course Spain, I believe the United States is missing an incredible opportunity.

So I was really delighted to hear your comments earlier about your emphasis for DOE to start pushing for I think five times cheaper technology for photovoltaics, but I would like to specifically ask you about the actions for DOE under your leadership in terms of engaging with the private sector for solar. Could you be a little bit more specific?

Dr. CHU. Well, it depends—see, normally what has happened in the past is the Department of Energy will do some science, invest in some science, and get some patents and license the patents. I would want to go forward in an era where we begin to work with companies in a much more intimate way to get sort of—while the work is being done, I think companies do bring a lot of experiences in the sense that they are more tuned to manufacturability issues than anyone in a laboratory. And so one of the things I have heard in the past is that—you know, I was in Silicon Valley in the Bay Area, and there are a lot of photovoltaic companies there. And when I hear things like, well, the research direction in a particular laboratory, we stopped paying attention because in an effort to achieve a world record of incrementally better efficiency, they have gone away from manufacturability. I am thinking to myself, this is not good.

And so I think that it is ultimately going to be the cost of manufacturability and whether it is—you pick a number, whether it is 22 percent for silicon versus 22.5 percent or for the very advanced ones, the multi-colored ones of going from 39 to 40 percent, it is not as important as getting the cost down.

And so that is one of the things I would really dearly love to have is that the companies who have to deal with the manufacturability

[2] Enriched Uranium Extraction

issues are actually there side by side with the scientists in the national labs and the universities.

Ms. GIFFORDS. I was laughing. You go to the Bay Area. It seems like everyone has got a business card, has got a solar energy business card. You know, it is an incredible melting pot for a lot of that technology. My concern is not just from the patent side, but I don't see enough demonstration projects actually taking place. There is a lot of R&D going on, a lot of money in that area, but in terms of actually rolling the projects out, I don't see enough of it.

Dr. CHU. Well, I think the loan guarantee will help some of that. I think renewable portfolio standards which create a draw of the market will also help some of that. But solar thermal, for example, large-scale solar thermal right now is less expensive than photovoltaic, and there are some projects that are being considered. In California I know of at least one that should be given a chance. These are a couple hundred megawatt projects, very significant projects, which also have in it some energy storage as well because you can store the heat. And I agree. So those things should be demonstrated, and I think the loan guarantees and things like that will help.

Ms. GIFFORDS. One of the areas I think we can get our biggest bang for the buck is with our United States military. I had a chance to visit Nellis Air Force Base last year, and this is an incredible, great success story in terms of the public-private partnership. When you look at the DOD, 80 percent of all of the Federal Government's energy is used by the DOD, and I believe that military bases provide us the best ability to in a very quick way, unlike a lot of areas of our Federal Government, to put projects, to install projects, get them going. And I am just curious about DOE's ability to partner with DOD and put some of these demonstration projects—if you are working on that and if it is on your radar screen.

Dr. CHU. It is now, but it certainly is true that the Department of Defense does—they have a lot of land as well, and so they actually have the ability to test a lot of things in solar energy as one example. So I will look into it.

Ms. GIFFORDS. I am looking forward to working with you, Mr. Secretary. Thank you, Mr. Chairman.

Chair GORDON. Thank you. Mr. Bilbray has five minutes.

MORE ON NUCLEAR ENERGY

Mr. BILBRAY. Thank you, Mr. Chairman. Mr. Secretary, I was just kind of listening to the conversation. I probably have one of the most environmentally sensitive, you know, parts of California, the coastal area of North San Diego. In fact, one of my communities would probably pride themselves on environmental sensitivity and was pushing renewables way back in the '80s. I happen to represent the first city that outlawed wind generators within their jurisdiction, too. So one of the biggest concerns that I have coming from local government was how much government is standing in the way. Let me first say, as a former member of the L.A. Resource Board in California, knowing your record, I was really excited to hear that the Administration was looking to you to take this position, and I really feel good about it. I really feel good about

it for one reason. You were somebody, along with your other directors of the Department of Energy, to stand up and be willing to say what needed to be said and not worry about the political repercussions, and I think that says a lot about the Administration, that they were willing to choose somebody who had said something that might not have been politically correct at the time but was scientifically essential to be said. Your position in August, along with the other secretaries on the absolute essential part that nuclear power is going to play in climate change issues, shows that you were brave enough to say that. I think more people like yourself standing up will send a signal to everybody that, you know, those who were so prejudiced against this clean form of energy need to rethink their prejudice.

At this time, with what you know, would you agree that the disposal issue is not the overwhelming blocking barrier that some people have thought it was back in the '70s and the '80s?

Dr. CHU. I think we can find a solution to disposal. Maybe call me stupid or crazily optimistic because there is time, because we can work out better solutions. The safety I think is less of an issue as well. I think the newer generation reactors are going to be far safer. In fact, ultimately we will have passively safe reactors in the sense that you lose control of your reactor completely and you won't get a melt-down.

The issue actually is a commercial issue. How do you increase the licensing speed because these are $5–$8 billion reactors, and if you have a 12-year licensing and building plan, that is many billions of dollars which is not generating revenue.

Mr. BILBRAY. Again, this falls in that category, does government allow the technology to be used, like the wind generator. Down the line on the technology issue, we talk about setting efficiency goals and trying to think, allowing people to think outside the box. Right in with a lot of these kinds of challenges, does our regulation guidelines allow that? I will give you an example. In my district, I have got Aptera which is developing a new car that went out and started reverse engineering, designing the most aerodynamic, most efficient system, was able to develop a car that gets over 100 miles to the gallon at this time, with the potential of going out to 200 with hybrids. But when the company applied to the Advanced Technology Vehicle Manufacturing Loan program, even though the vehicle passes all the crash tests, all the safety tests, everything that we perceive as being a car, because the scientists saw that having a second wheel in the back caused 25 percent reduction, they went to a three-wheeled vehicle, because it was three and not four wheels, it was not allowed to apply for this loan. Would you strongly support the modification of these kind of arbitrary lines so that they reflect outcome rather than process?

Dr. CHU. I certainly would look into that, whether it is, you know, a three-wheeled car is not a car, which is essentially your question, you know. If it does all the things a car does, it might be a car.

Mr. BILBRAY. I think so. In fact, Mr. Secretary, after you are finished with this hearing, if you go downstairs, the car is out front as an example of the kind of things we need to do rather than having regulations to block it.

BIOFUELS

Speaking of government regs, you make a reference to the fact that we need to be looking at gasoline-like biofuels rather than working off of alcohol that takes a gallon-and-a-half to match traditional fuels. And in fact, let me just take another shot at ethanol which I never pass up a chance as former member of the Air Board, Duke just came out with a study that said from the greenhouse point of view, it would be better never to plant the corn than to use corn-based ethanol. But when you talk about these non-food crops, would you be including in that the algae technology that we are seeing developed around the country?

Dr. CHU. Yes. You know, one doesn't really know whether the best solution to biofuels are biofuels through the conversion of the lignocellulose material or through the growing of algae which actually can grow directly lipids that can be converted to oils and diesel-like oils. The verdict is not in. The thing about the lignocellulose is in a certain sense it is more ready for prime time only because we have lots of agricultural waste already. The issue with algae is you would have to prepare land or ocean specifically for this. There is also issues of whether it escapes into the wild. But I am all for looking at algae, don't get me wrong.

Mr. BILBRAY. There was a reference to——

Chair GORDON. Thank you, Mr. Bilbray.

Mr. BILBRAY. Okay. Thank you, Mr. Chairman.

Chair GORDON. Mr. Hall is going to lead a delegation downstairs to see if your vehicle quacks a little bit later. Ms. Edwards is recognized.

Ms. EDWARDS. Thank you, Mr. Chairman, and thank you, Dr. Chu, for being here today.

DOE LOAN GUARANTEE PROGRAM

I have a couple questions about the Loan Guarantee Program under Title XVII. When the program was started, I wasn't in Congress at the time but I believe that it was to, and I will use the words in the legislation, to avoid, reduce, or sequester air pollutants and greenhouse gases, employ new or significantly improved technologies, and provide you with the prospect of repayment. And so I have some questions about the rules that were promulgated by the Department for the Loan Guarantee Program and wonder what the rationale under this legislative language is for guaranteeing loans to a mature technology, rather than making significant investments in some of the innovative technologies than perhaps traditional financing that is available to them. And then I would like you to address the question of the risk to taxpayers under the Loan Guarantee Program because the taxpayer essentially absorbs 100 percent of that, and I think we have already seen in our capital markets that when all of that is absorbed by the taxpayers, the markets just don't function very well and the risk is shared with the innovator. So I wondered if you could address these.

Dr. CHU. Sure. Well, first, in terms of the loan guarantees, there is a scoring of a loan. If an industry makes an application, if it is a relatively mature industry like wind, you know that if you run the business correctly, it is likely that the business will be success-

ful and the loan will be repaid. And so there is an official way of scoring these loans. The higher the risk of the loan, the more—you have to have an allowance that says okay, there is a higher probability it won't be repaid. So then it doesn't go as far. I mean, right now, the idea was that there is quite a bit of leveraging ten to one that you know, if the loan is $100 million, you put in $10 million that you expect will be the average default rate. As you take on higher-risk industries and you have to score this as best you can, then the default rate will be naturally be higher but it is higher-risk.

But actually I agree with you. We should be making some higher-risk loans, and we have looked into this. That would be of the amount of money, you can have—now, the higher-risk loans are more experimental, and so you make a smaller attempt at trying to get this thing going. But there is nothing wrong with saying that there might be a 30 percent chance of a default for a loan but it could be more game-changing. So that is another way of trying to introduce innovative technology. And so there have been discussions now in the Department of Energy. I have been discussing this, that a small fraction of our loans could be higher-risk that could be much more innovative, much more likely to fail but could lead to bigger changes in the long run.

Ms. EDWARDS. And so you are about to announce some of the loan guarantees, and so can you assure us though there is not—those won't be guarantees in the much more mature technologies like, you know, liquid coal and nuclear?

Dr. CHU. Well——

Ms. EDWARDS. I don't see that that falls within the description of what the program was designed to do.

Dr. CHU. No, for example, in nuclear, there has been $18.5 billion to help restart the nuclear industry. And so that has been a carve-out for nuclear and those loans are designated to helping companies. You know, we have had a dormant nuclear industry for the last 30 years, the last one nuclear reactor that has been started in the early middle '70s.

Ms. EDWARDS. I know, Dr. Chu. There are some of us down on this end in particular who remain skeptics of that——

Dr. CHU. Okay.

Ms. EDWARDS.—of those kinds of significant investments in nuclear technology. Just as I close out here because I would like you to address at some other point later, it seems that these guarantees for nuclear though are going out before the licensing. So there is a lot of time between here and there in billions of dollars in investment, and I wonder if those billions, given where we are with climate and our energy crunch, what if that money actually couldn't be better spent for better purposes, especially when the nuclear industry investment is going to be the one that will, you know, save us from fossil fuels.

Dr. CHU. Well, I think there is no one single technology that is going to save us, and in fact, quite frankly, you know, with fossil—carbon capture and sequestration is one of those things. But right now where we are in the United States is we have only 2.8 percent roughly of our nation's electricity generated with renewables, excluding hydro which is six or seven percent. And so it is going to

take a while to ramp that up, and the costs are—in wind it is becoming competitive, but they are not there yet for photovoltaics, costs without subsidy. And there are distribution issues, there are storage issues.

I for one would dearly love to see us transition to all renewable, solar, wind, things like that by mid-century, but one doesn't really know if one can do that. So you put the pedal to the floor on that, but you also try to ensure that while we are transitioning, you clean up coal as much as you can and don't forget that the rest of the world, notably China and India, will not turn their back on coal. So that is why it is so important to try to develop commercially viable sequestration methods.

So I think you just have to do all these things. You have heard this before, there are no silver bullets.

Chair GORDON. Thank you, Ms. Edwards. Mr. Smith is recognized.

CORN-BASED ETHANOL

Mr. ADRIAN SMITH. Thank you, Mr. Chairman, and Mr. Secretary, thank you for your service and your willingness to come here today and share with you I think one of our most pressing needs relating to energy, the economy, the environment, and I appreciate the mention of so many sources of energy here today.

There was mention of corn-based ethanol prior from one of my colleagues on this end of the dais. If you could elaborate perhaps. Truly I come from a District that is relating to corn-based ethanol and livestock production. So it creates a need for balance, and I was wondering if you could speak to further research on corn-based ethanol so that we can be even more efficient. I know we have come a long way already using less water, making the ratios better. If you could elaborate on that.

Dr. CHU. Well, corn-based ethanol I view as—you know, if you do the life cycle cost and there are varying opinions about this, but in the end, it brings you a little reduction, you know, in the amount of fossil fuel invested versus net fuel gone out. But the potential for the lignocellulose or the algae approach is far higher. So right now, you know, if you take and you look at all these underlying assumptions for corn-based—and also in CO_2, the net CO_2 reductions, we are talking about net fossil reductions of 20 percent and CO_2 reductions of a similar nature. But the promise of the lignocellulose and algae can be 90 percent. Now, in the end, farmers will be happy to plant anything that they can make some money on. So rather than saying we have to protect corn-based ethanol, I think if we develop technologies that can use a lot of the existing infrastructure in the fermentation of starches like corn, it is the same type of infrastructure, there will be yeast and bacteria that will convert grasses and agricultural waste into fuel. I don't really see personally a conflict in terms of rural American farmers. In fact, I have given a couple of talks over the years to that part of the country, and they would like very much to be using their agricultural waste and also to be growing these grasses because these are perennials. In autumn time, the nutrients, especially the nitrogen, is drawn back and the precious minerals are drawn back into the roots. You chop off the top part. The cell wall where the cel-

lulose is, the energy stuff. We don't use the nitrogen. And so that means a big decrease in the energy inputs from fertilizer which is made from natural gas to ammonia fertilizer is eliminated. A lot of the inputs in the diesel tractor fuel is eliminated.

So less capital investment of the farmer each year because each year the farmer makes a gamble, you know, a significant capital investment to yield a crop. So if they can get a similar return or better return on investment, a similar overall net, they would be very happy. So I think, you know, corn-based ethanol, think of it as a transition crop to get Americans used to the idea that you can grow transportation fuel. But it is by far and away not the ideal. And that is why we are investing much more in lignocellulose or algae. That is why, for example, BP which invested in the University of California at Berkeley, Berkeley Lab in Illinois, half-a-billion dollars because they weren't interested in ethanol from starches like corn. They were saying that is not the long-term future.

Mr. ADRIAN SMITH. It seems that the commercial viability of cellulosic ethanol—for 10 years we have been told that it is about five years off. How close are we?

Dr. CHU. I think you are getting a different class of people going to this, and this is true of the energy sector in general, not that people who were working on it 10 years ago were lesser scientists, but I think now there is a real mobilization. I mean, six years ago, I decided that the energy and climate change problem was so serious that I was willing to forego a very, very comfortable life at Stanford as a professor and run a national lab which is much less comfortable. And for the same reason why I took this job which is even less comfortable, that many scientists are thinking that this issue—this is one of the most important issues that science and technology has to solve in the coming decades. And it is becoming such an important issue and an internationally important issue because as commented in this committee, it does help define geopolitical stands around the world as well.

So international security, you know, economic prosperity, environmental concerns all say that we have got to solve the problem. Because of that, just as in World War II, many scientists volunteered and enlisted to serve their country. I am seeing now many scientists thinking if there is something I can do on energy, what can I do? And they are trying to teach themselves. Also, a new idealism in America's youth in college, that they are actually thinking of going for science and engineering because they see this as the way to serve the world and their country.

So when you have that enthusiasm in the scientific and engineering world and you harness it properly, I think you can get—we can expect much greater progress. And this is what the Department of Energy funding really is all about, quite frankly. Take advantage of that.

Chair GORDON. Thank you, Mr. Secretary. Hopefully this is the new Sputnik. Mr. Smith, hopefully also that shucks and cobs have a future so that we can call a win. Ms. Fudge is recognized.

THE ECONOMICS OF EMISSIONS TRADING

Ms. FUDGE. Thank you, Mr. Chairman. Good morning, Mr. Secretary. Mr. Secretary, I am from the State of Ohio. Currently the

State of Ohio gets about 86 percent of its electricity from coal. This gives us an advantage for luring manufacturers, of course, because of the cost, the lower cost of coal. As a result, we have many industries that are very energy intensive: paper, steel, plastics, fertilizer that rely upon coal to keep their prices competitive which is especially important during this troubling economic time. Our exports as a nation have decreased dramatically.

And so I am asking, given the Administration's support of a 100 percent auction for a cap-and-trade program that will likely raise electricity rates for consumers and especially manufactures like those in the State of Ohio, has there been any discussion as to how can we work to minimize the economic effects that a cap-and-trade program will have on these industries to ensure that their national and global competitiveness is not compromised?

Dr. CHU. Well, you are raising a very important issue. The cap-and-trade bill will likely increase the cost of electricity, and so a lot—so under the Administration's plan of using a significant part of that money—first, there are two issues. There is the poor part of society that has to be guarded against, and so a part of the Administration's plan is to try to ensure that the poorer segments of our society are not really hurt.

With regard to, you know, increasing the costs, it is—let me go straight to the heart of the matter. Many of these costs will be passed onto the consumers, but the issue is how does it actually—how do we interact in terms of the rest of the world? If other countries don't impose a cost on carbon, then we would be at a disadvantage. I think the only way to do this is to—and already the Administration and others before it have talked about it—that you have to think about if you have something that is manufactured in another country that is not including the cost of emitting the carbon, because there is a cost in emitting the carbon to society. If country X doesn't do this, then I think we should look at considering perhaps duties that would offset that cost. We are beginning to talk about that in terms of what we call local pollution costs, like sulfur dioxide and nitrous oxide, so that will help level the playing field.

Now, in the end, I think one hopes that all countries will include the cost of this energy, and I really think about it as including the so-called external costs that are folded into the direct price now. But if a country does not do that, in order to protect American industries, we ought to think about something like that.

SAVING ENERGY IN INDUSTRY

Ms. FUDGE. Thank you. And just my second question would be that as we talk about, and you mentioned that, we need to try to sell industries that it is cool to save energy. So we do have the Industrial Technologies Program in the Office of Energy Efficiency and Renewable Energy. This important program does help manufacturers identify ways to reduce their energy usage and thus preserve capital which, you know, of course they can reinvest in their company. Can I go home and tell the manufacturers in my District who have hard about the success of this program that they can expect to finally see additionally funding for the Industrial Tech-

nologies Program when the President's detailed budget is finally released?

Dr. CHU. I hope so. I think there are—I think in very energy-intensive industries, at least some of them I know about, they too themselves are looking very hard at the manufacturing processes or chemical processes because if they save just a little bit on making it more efficient, this is tens of millions, hundreds of millions of dollars, it matters a great deal to the companies. And the more forward-looking companies, they are much more aggressive about this because they see in the long term energy costs just increasing because in the long term, as noted before, you know, energy, oil, natural gas production will eventually peak and decline, plateau and then finally decline.

So I think the energy efficiency of industries and companies is a very big deal, and the Department of Energy will do what it can as much as possible to help encourage the companies to look at their own businesses.

Chair GORDON. Thank you, Ms. Fudge, for getting those important issues here on the table. We need to talk about them. And Dr. Ehlers is recognized.

Mr. EHLERS. Thank you, Mr. Chairman, and thank you, Secretary Chu for being here. I will give you a little relief. I have very few questions, several statements and comments, but I hope we will have some private time as physicists to talk about my questions later.

Dr. CHU. Maybe the Chairman can give you an extra five minutes.

Mr. EHLERS. I doubt it. There is a Majority here in the Minority.

Chair GORDON. You want to go home for dinner, don't you?

PROGRAM COMMENTS

Mr. EHLERS. First of all, I am absolutely delighted with your appointment, and I have been very disappointed for some time in what I consider the failure of the Department of Energy to really meet the important energy challenges of our nation, and I am really looking forward to your leadership. I hope it becomes a renaissance similar to the days when Glenn Seaborg and the Atomic Energy Commission really got the ball started on this. So I am looking forward to great things.

I also want to commend the Department. Recently they had a competition for a facility for rare isotope beams, and I want to commend you and especially the Department. I thought they did a very fair process and evaluation, and obviously those of us in Michigan are pleased with the result. But I think it was a model of how it should be done and how the Department can work with the universities.

On that score, that is the one strong point I see for ARPA–E. I was not overjoyed with the way it ended up being structured, but I think this is a golden opportunity for the Department of Energy to essentially take a role that the National Science Foundation fills for many other areas of research, and I hope ARPA–E really fulfills that promise and brings the universities in. We have so much talent available in the universities, and I don't think the Department of Energy has adequately made use of the university resources in

the past 20 years or so. The one exception to that of course is Ray Orbach who did a marvelous, marvelous job in the Office of Science in the past eight years, and we made so much progress there and I assume you will be eager to continue that progress as well.

A few comments on some of the other issues. There is a lot of talk about sequestration. I am still very much a doubter. I think just looking at it, it looks to me like it is going to be very difficult to do in an economically feasible way, particularly when you are talking about China and India doing it. Obviously we have the resources to do it, at least we hope that we do. But I just have to register some skepticism on counting a lot on clean coal or sequestration to deal with the carbon problem. And that is going to take a lot of work on your part and our part as well.

It has always bothered me in talking about Yucca Mountain. We have always talked about disposal of nuclear waste. You are not disposing of them, they are still there. And I think that has been a fallacy all along. We thought we could dispose of them. We can't. We can perhaps transform them into a more benign form, and that is a possibility. But I think we should get rid of that word disposal and talk about nuclear storage, particularly monitored, retrievable storage, and things of that sort.

On solar energy, you put a lot of emphasis on solar energy, but you seemed to imply the use of large facilities to produce electricity from solar energy. I am of a different mind. Since solar energy is—there are huge, huge amounts of solar energy available, but it is very diffuse and that makes it difficult to use. It is low-quality energy. And I think we ought to recognize that. I think the best answer, if you have a diffuse source, then have diffuse collectors. I would like to have every home in America shingled to solar shingles instead of asphalt shingles, and that brings up the other issue you raised. If you are going to do that, one of the most pressing needs is going to be safe, efficient, economical storage of electrical energy. You referred to it in the context of automobiles. I think maybe equally or perhaps maybe even more important in homes, if we can in fact develop good solar shingles that are dependable, long lasting, et cetera, we need a storage mechanism. And right now, batteries are too expensive, too clunky, too difficult. And I would hope that the Department would be able to make some major contributions in terms of battery development and particularly returning that industry to America instead of depending on other countries to do the research.

So that is pretty much my short sermon for today, and I hope you will take those comments in mind.

Chair GORDON. Thank you, Dr. Ehlers. We will let you be on the next panel. Mr. Wilson is recognized.

COAL-TO-LIQUID TECHNOLOGY

Mr. WILSON. Thank you, Mr. Chairman. Thank you, Mr. Secretary, coming before our committee today. My question goes back to clean-coal technology. On several occasions the President has said he supports clean coal technology. Mr. Secretary, right now I have a coal-to-liquid plant that is fully permitted in my District. I happen to believe that coal-to-liquid is a good form of clean-coal

technology. I am interested in what your opinion is as to clean coal and clean-coal technology?

Dr. CHU. I think coal-to-liquid with the capture of significant part of the carbon, the excess carbon, is something that is worth looking at. I will go further to say that when you start doing coal-to-liquids, the first thing you do is gasify and then you assemble it. It is an old process invented through World War II by the Germans.

When you do it with agricultural waste and coal as the feed stock and capture the excess carbon, when you produce the fuel and burn it, of course, that carbon in that fuel is released back to the atmosphere, but you can actually provide—for example, if it is oil, biobased, you can actually provide a net sink of carbon dioxide because the plant is grabbing carbon dioxide out of the air. Some of it goes back in the form of carbon dioxide when you burn it, but you are actually capturing a lot of carbon dioxide if you can get sequestration to work which, with all due respect, I think there is a reasonable chance. Then it becomes a net sink.

And so there are proposals out of getting also hybrid plants, so coal with bio material to liquids that capture the excess carbon dioxide and it could be a hybrid plant in the sense that you can also use it to generate electricity. And so I think Professor Bob Williams at Princeton is one of the major proponents of this. I know that Dow Chemical is looking at this as a—because they are, you know—Dow Chemical is essentially a carbon company. They buy forms of carbon, for example, natural gas and petroleum, and turn it into other forms of carbon, namely plastic. And so if they could get biowaste or even coal as their feed stock, that would be a nice thing to do. And if you can capture the carbon and sequester it economically, then it is clean in the process.

So I think those are the things that I am personally looking into to see if they have a ghost of a chance of working.

Mr. WILSON. Mr. Chairman if I may, Mr. Secretary, again, we have done studies as far as on the carbon sequestration and have found numerous oil wells as you alluded to earlier, somewhere between one-half and three-fourths still with oil content. That could be replaced and you can pump the carbon to them.

The next issue we stumble with then becomes the Loan Guarantee Program. It is just so much more prohibitive to a clean-coal technology versus one that would not be. Do you have any thoughts on that? I realize earlier you said about the risk that is directly related to them.

Dr. CHU. That is right. I mean, the risks of—again, if it is a technology that hasn't been tried before, there is a great deal of risk for that. And so then it is scored much more seriously, and then we have a certain amount of money we can use to guarantee the loans, because you are expecting certain losses. And so that is the issue. We may make fewer loans the riskier it is.

Mr. WILSON. Well, when you look at the grand scheme of things and with the way nuclear is doubling in price and continuing to go forward, I really hope that the Department will look at what the opportunities are with using coal, and investing in it may be much less expensive than going to continue with the nuclear. And as the Chairman said recently, we still wind up with the rods at the end

of time. And so what do we do? I mean, how do we move forward if we have a mentality that keeps us from moving forward with clean coal?

Dr. CHU. Well, it again goes back to the fundamental question: can we develop methods of capturing the carbon? Most of the cost is in actually the capture. It is not in the storage. The storage and monitoring are—I know a couple of my personal friends who are experts in this, and we have been doing experiments on a couple of million tons a year in various sites around the world. And the Department of Energy is sponsoring more in the sequestration part, whether it can be done safely, adequately monitored. But it is the capture part that is the real cost, and we have got to figure out ways of doing that better.

Mr. WILSON. Thank you, Mr. Secretary. Thank you, Mr. Chairman.

Chair GORDON. Thank you, Mr. Wilson. What we have all been waiting for, Mr. Rohrabacher is recognized for five minutes.

SKEPTICISM OF GLOBAL CLIMATE CHANGE

Mr. ROHRABACHER. Thank you, Mr. Chairman, and happy St. Patrick's Day to us all. Mr. Secretary, it really is refreshing to hear your testimony today, and I look forward to working with you in the years ahead and am very pleased with your appointment to this important position. But let me not disappoint my Chairman by noting that it has now been seven years since there has been any warming recorded on the planet. That is why I guess people have changed the wording to—now it is not global warming, now it is, you know, something to do with climate change. There are prominent scientists, more and more prominent scientists, every day joining the ranks of those who are suggesting that the whole global warming theory is bogus, and I would add 10 names of prominent scientists which I will at every one of our hearings who are now joining the ranks, prominent scientists, heads of major university science departments throughout the world, and I will now submit a list of 10 of those names for the record.

Chair GORDON. Without objection.

Mr. ROHRABACHER. Thank you.

[The information follows:]

LIST OF NAMES FOR THE RECORD
FROM CONGRESSMAN DANA ROHRABACHER

List of ten scientists who refute the theory of Anthropogenic Global Warming (AGW)

1. Geophysicist Robert Woock, senior geophysicist at Stone Energy in Louisiana, Past President of the Southwest Louisiana Geophysical Society, Master's in geology: "I do not see any evidence in nature or data to suggest that we are in any anthropologic climate cycle."
2. Senior Chemist Glenn Speck
3. Hungarian Physicist and environmental researcher Dr. Miklós Zágoni: "Anthropogenic greenhouse gas emission cannot generate global warming, neither in the past, nor in the future."
4. Paleontologist Dr. Eduardo Tonni, the principal investigator for the Committee for Scientific Research of the province of Buenos Aires (CIC) and head of the Paleontology Department at the University of La Plata

5. Senior Meteorologist Dr. Wolfgang P. Thuene: "The hypothesis of a natural and a man-made 'greenhouse effect,' like eugenics, belongs to the category 'scientific errors.'"
6. Physicist F. James Cripwell: "AGW (Anthropogenic Global warming) is a myth."
7. Hydrologist and geologist Mike McConnell
8. Meteorologist Brad Sussman: "Believing that mankind is unequivocally responsible for global warming is the ultimate arrogance."
9. Meteorologist Peter R. Leavitt: "There is insufficient hard evidence to conclude that AGW is a significant factor in climate if it is a factor at all."
10. NASA Astronaut and Physicist Walter Cunningham

Mr. ROHRABACHER. Thus, cap-and-trade and carbon sequestration are wastes of money. They are aimed at the global warming theory. However, your efforts for energy, self-sufficiency, and protecting the health of human beings by having cleaner fuels is certainly appreciated here, and I will be very happy to work with you on those areas in the future.

NUCLEAR AND SPACE-BASED SOLAR ENERGY

Let me note for a couple of examples, I would draw your attention to the work done at the University of California at Davis which is aimed at biotech and the production of energy in that way. I would also call your attention—and again, I very much appreciate your openness to nuclear energy, and I would suggest that one way we can have cooperation internationally, to cut down the cost of getting to the point where nuclear energy is brought back on line, is the development of the high-temperature gas-cooled reactor which lends itself to cooperation with the Russians and gets rid of a lot of the problems we talked about including the Yucca Mountain problem. In fact, there would be less waste stored at Yucca Mountain if we used high-temperature gas-cooled reactors.

And finally, let me mention to you and your attention to a report that I have here which is a report that suggests that space-based solar power could be brought into service in a very cost-effective way. We could use it to provide energy to third-world countries without having to build huge plants in those third-world countries, we could provide energy for our military in emergency situations, and I might suggest that this committee would be able to work with you because we also oversee NASA, and it would be also be an area of great international cooperation again with the Russians to build space solar-powered units that could provide clean electricity for the world.

Those are just a few thoughts. I wondered if you had any thoughts in space solar power and the high-temperature gas-cooled reactor?

Dr. CHU. With space-based solar power, I know I think it is Marty Hoffert who is a big fan of this. I will be frank. I am a little bit skeptical. Anything you put up in space costs a lot of money.

Mr. ROHRABACHER. You know, the Russians have cheap ways of getting things into space. We should be trying to develop our own cheap ways of getting into space. How about the high-temperature gas-cooled reactor?

Dr. CHU. High-temperature gas-cooled reactors is something we should and will be looking into because it also—if there are really

high temperatures, it opens up the possibility of generating hydrogen, and the hydrogen is like a battery, quite frankly.

Mr. ROHRABACHER. There is a high-temperature gas-cooled reactor, the only one I know functioning, in Japan.

Dr. CHU. Right.

Mr. ROHRABACHER. I visited that facility and would suggest that it really offers a lot of promise.

One last thing. There are a lot of other ideas that offer great promise to producing clean electricity, and I might add again, I could care less about—I believe the global warming theory is bogus, but clean energy to protect people's health and to provide energy self-sufficiency is a great goal which you can count on cooperation from all of us. There are things developed—just one last concept—there is a fellow out in California, Mr. Chairman, that has a paint that is based on nanotechnology. I have been encouraging this company in this development that will make houses into solar collectors which are much more efficient even than photovoltaic cells. Have you heard about this?

Chair GORDON. We will have to hear about it later, if that is okay.

Mr. ROHRABACHER. Thank you.

Chair GORDON. Mr. Rohrabacher, you never disappoint. I thank you for being here. Let me, if I could, maybe lay out some rules of the road for the rest of the hearing if no one has an objection. We had told the Secretary that he could be able to get out by noon, but we are going to impose upon him to stay for another 15 minutes until a quarter-after. So, you know, we want to try to be crisp. Unfortunately I have another obligation, and Mr. Wu is going to take over here.

Let me just say, Mr. Secretary, again, thank you for being here. At first view, someone might not think that you are all that exciting, but this has been a very exciting hearing and exciting topic, and it is going to be fun moving forward with you. Mr. Lipinski is recognized.

Mr. LIPINSKI. Thank you, Mr. Chairman. Is this microphone working? It is working, isn't it? All right. I will try to stay away from, you know, I want to get up and start wandering around. Now I have this microphone. But let me say, Dr. Chu, I have been trying to figure this out. People call you Dr. Chu, Mr. Secretary. I think maybe Dr. Secretary, I don't know of that is the correct way to refer to you, but I was excited when you were nominated to be the Secretary of Energy. I know that a couple years ago, I think it was about two years ago, I sat down with you at Lawrence Berkeley Lab. You came to visit, we had lunch, and at that time I was very impressed by, you know, obviously with, you know, Bell. Your knowledge of—your field is great, but on top of that, much more importantly, especially in this job, is your ability to really very fluently discuss and understand and deal with the policies. So I was excited when you were named the Secretary of Energy.

PLANS FOR RESEARCH AND DEVELOPMENT COLLABORATION

I wanted to bring up something that we had talked about, start out about something we had talked about during that lunch and it was brought up earlier, was the Energy Biosciences Institute, a col-

laboration between the Lawrence Berkeley Laboratory (LBL), University of Illinois at Urbana-Champagne, and BP. I think that this integration of the national labs, universities, and industry are very critical. I know you feel the same way, and in your confirmation hearing you stated that DOE will better integrate national lab, university, and industry research. So I wanted to throw a general question out to you about what specifically do you want to do at DOE? What do you want to see DOE do differently maybe including funding initiatives or models in order to make this collaboration really work well? And let me throw this other question out there while we are on this issue. We want to integrate universities and labs along with industry, but what about any problems or real competition to some extent between universities and the labs? Because that is also an issue that sometimes does come up. But I am just interested in what you would like to see and what your plans are at DOE to help this collaboration.

Dr. CHU. Well, in terms of the further integration of industry with universities and with the national labs, I would like to see consortia of companies or individual companies actually work with scientists at these universities actually develop the intellectual properties together. That goes a long way. So a very quick story. I was asked to go and give a dedicating speech for Dow Chemical in Midland. So I flew over there, gave a speech, and talked to the chief technology officer, CEO, and others, and then they came over to the Lawrence Berkeley Lab. We decided that we had a lot in common, so they came over and chatted a little bit more and said, well, look. This is no good if I am just talking to the chief technology officer. We have got to get our scientists and engineers to talk to each other. So the next time they came over, we had a one-day thing where the scientists or engineers from Dow would talk about their four talks and they would talk about their projects, and the people at the University of California–Berkeley and Berkeley Lab which is very integrated—actually, roughly 270 of our scientists are professors at UC—listened and said, so the intent was, this is what Dow is interested in developing. Do we have some knowledge that can help them? And to make a long story short, one of the chemists at Dow said, we like to make water-soluble products. We don't want to water in our processes because water absorbs a lot of heat, it undergoes phase changes, all that loses energy, and we are trying to drive out the energy costs. So we actually don't want our processes to use water because you have got to recycle the water anyway. You can't just dump it out. So we would rather use organic liquids.

So I leaned over to one of our chemists. Did you know that, you don't want water in your processes? No. And how would they? They go to the sink, they turn the tap, and water comes out free.

So when we start or when people in universities start to do research, again, it goes back to manufacturability, it goes back to industrial processes. Industry actually knows a lot more about those things. And so rather than go down a line and develop intellectual property that ends up being not very practical from an industrial point of view, let us get them together early. And so this is what I mean by industrial collaboration. We were working industrial collaboration with United Technologies to try to put together a consor-

tium of companies that pre-IP,[3] this is pre-competitive research that all companies can use for building efficiencies that could work with Berkeley Lab and UC–Berkeley, again with the same idea in mind. So it is things like that, I think, we have the opportunity to work on.

Mr. LIPINSKI. I thank you and I look forward to working with you. I also want to—I won't do it now, but at some time in the near future, I would like to talk to you about the Advanced Battery Manufacturing program funded in the American Recovery Act, and as I look forward to working with you even though you did go from Stanford to Berkeley, I won't hold that against you. Yes, I was a Stanford grad.

Dr. CHU. Well, I have loyalties in both institutions as you must know, deep loyalties in both.

Mr. WU. [Presiding] Divided loyalties. Dr. Chu, let me assure you that I find you very exciting. Next the gentleman from Georgia, Dr. Broun. And let me just mention to Members that although you have the absolute ability to take your full five minutes, if you want to consider your fellow Members and take two or three minutes instead, then we will be able to get through all of the folks who are asking questions by 12:15. Dr. Broun, please proceed.

Mr. BROUN. Dr. Secretary, do you realize that there is absolutely no, in fact zero, consensus in the scientific community about human-induced global warming?

Dr. CHU. No, I don't. I beg to differ, actually.

MORE CLIMATE CHANGE DENIAL

Mr. BROUN. You are absolutely dead wrong, Mr. Secretary. There are a tremendous number of scientists who would absolutely debunk any human causes of global warming, and I think just for scientific integrity, I ask that you go and look at those things because there is no consensus. Are you and this Administration absolutely determined to shut down the U.S. economy, to put people out of work, markedly raise the prices of food, medication, all goods and services which will particularly hurt people on a limited income and the poor, to pursue a policy, this cap-and-trade, I call it cap-and-tax policy, that is not only questionable scientifically but in fact has been shown scientifically that human activity and carbon dioxide release has very minimal if any at all significant effects on global warming. Are you all so determined that you are going to shut down the economy and hurt these folks to pursue these kinds of policy?

Dr. CHU. Well, the primary goal in this Administration first and foremost is to get the economy going again, that the unemployment rates of exceeding eight percent are very, very scary, the shut-down of the credit markets. All these things are very, very scary. I mean, one out of twelve Americans is now out of work. And so first and foremost, we need to restart the economy because there is a lot of pain out there.

Now, given that, I don't think, seriously disagree—that what we are trying to do in the *Economic Recovery Act* is to start to build the United States toward more energy independence, toward much

[3] Intellectual Property

more efficient use of energy and developing new sources of energy, rebuilding—add to the transmission and distribution and infrastructure. All those things are also increasing the investments that will help the economy restart. In addition to that, it helps in the overall goals of our economic prosperity, our working toward foreign oil dependency, decreasing that, and getting off the dependency, and the environmental issues.

We do apparently have fundamental disagreements on what the science is saying. Let me just say in terms of that that science is a very peculiar sort of thing in that if a scientist comes along and disproves what most of the scientists think and it turns out to be right, that scientist is actually hailed as a hero. I mean, that is the fundamental structure of science. Einstein comes along and says Newton was pretty good, but he got some things wrong in certain areas of very high velocities, for example, or high gravitation. He is a hero. People who developed quantum mechanics similarly. They overthrew the prevailing view, and they get Nobel prizes for that.

So the protection of science and the truth will come out in the end is because of that fundamental issue. And so yes, if scientists come forward and show that this is all wrong, they will be heroes. People are constantly checking and doing things. But again, when I started to look into this maybe six, eight years ago, started as an amateur but read more and more about it, I became more and more convinced that these are very real issues.

Mr. BROUN. Well, sir, I am a physician. I am a scientist. I am an applied scientist, and I believe in scientific integrity. If you will look at a lot of other writings that are peer reviewed, there are many sources of data that show that human-induced global warming is a myth. And I request that you take off your blinders and bias and look because there are many, many scientists who would debunk this whole idea, and it is going to kill our economy and it is going to particularly hurt poor people and people on limited incomes. And to go down this track is going to kill our economy. We are spending too much, we are taxing too much, we are borrowing too much, and we have just got to stop it. I think everybody on this committee, everybody in Congress wants to see the economy going again. But going down this track of cap-and-trade or cap-and-tax is the wrong way to go. Thank you, sir.

Mr. WU. I thank the gentleman. The gentleman from Kentucky, Mr. Chandler.

ELECTRIC VEHICLES AND BATTERIES

Mr. CHANDLER. Mr. Secretary, congratulations to you and best regards from your friend, Lynn Peters, back in Kentucky. I would like for you if you could to talk a little bit about electric cars. Do you believe that they are indeed the future of our personal transportation system, and could you give us a little bit of a timeline on the development of them, development of batteries, development of distribution system, et cetera. Thank you.

Dr. CHU. Okay. Very quickly, yes, I think electric cars have great promise because most people, they are not going to work for long-distance travel. They are not going to work for long distance transportation, but most Americans I have understood travel typically

40 miles or less, 50 miles or less per day to and from work. So if you can get electric vehicles that have a range of 48 miles with some back-up, that could off-load a lot of the oil we import, a significant amount of it, and give us more options for generating electricity. It also by the way allows a dual use in that if you have solar panels on your roof, for example, you can charge up your battery of your car. It allows you to buy energy at nighttime when it is very inexpensive, there is excess capacity, and use that. And so the investments in power generation—so there is a lot of very good things about electric vehicles.

You put your finger right on the nub of the issue, the battery. All the other parts we know how to do very well, and right now we don't have batteries that can survive deep discharges. You know, the Prius battery is held between 40 and 60 percent of full charge the entire lifetime of the battery, and usually actually much tighter for most of it, 55 to 45 percent because if you deep discharge the batter—well, we do the experiment on our laptop computers. After a couple of years of deep discharging, guess what? It is holding half the energy. And that is bad because right now, the cost of batteries is quite high as well. You know, the estimates for example of the Chevy Volt, that battery that give you that 40-mile range, will be of scale, $10,000, $12,000. So that battery is a significant part of the total cost of the car, and it better last the lifetime of the car.

So now, the good news is I know some battery research that has promise. There are great opportunities once you—in a former life before I took this job, I was actually on to be signed to the board of a battery start-up company. And there are certain areas which actually have an incredible amount of progress that can be made, batteries that could be inherently much safer, safer in the sense that they won't go in these very high-temperature fires. This particular company developed an electrolyte, that is to allow the lithium ions to go across, that is inherently non-flammable. If you can create a much safer battery, that also will drive down manufacturing costs a great deal because it is the very tight manufacturing tolerances of our current lithium-ion technology that drive the costs way up.

The materials, the cobalt that is used on the cathode side, we need to substitute. There are real opportunities in batteries that I see that could give this factor of two or three in energy density and make it much less flammable. That means you ease up on the very tight manufacturing tolerances that would drive down the cost as well.

So I am actually hopeful, but you know, you are asking me to predict when this new generation battery will occur. All I can say is again, going back to this other view that people are—batteries are a big deal, not only for cars but for large-scale energy storage for residential storage, for building storage because if we can get the batteries, and going to your point originally that there are a lot of applications for batteries. Even to level out the transience when clouds roll over a solar farm or the wind stutters a little bit, you actually need batteries. So there are many, many applications. And one of the things I would like to do is not only invest in batteries for cars but batteries for all these other applications.

Mr. CHANDLER. It has been very informative.

Mr. WU. I thank the gentleman. The gentleman from Florida, Mr. Diaz-Balart.

MORE ON EMISSIONS TRADING

Mr. DIAZ-BALART. Thank you, Mr. Chairman. I want to thank you also, sir. I agree with Mr. Wu, and you have actually been attempting to answer the questions. I really appreciate that.

I think we can all agree that reducing emissions, reducing pollution, reducing foreign sources of oil and helping the economy as you mentioned, particularly helping the economy is essential to any policy that we pursue. I want to talk a little bit about cap-and-trade as is in the President's proposed budget or as Mr. Broun referred to as cap-and-tax. I want to throw some facts out there that a number of different groups put out, and I think there is pretty much a consensus. Many, including the EPA, and many others estimate that there would be a decline in GDP if cap-and-tax is implemented. A number of groups estimate that it would be a loss of millions of jobs. Again, a number of different groups. Just about everyone understands and there is a consensus that cap-and-tax or cap-and-trade will increase electricity rates, you mentioned that yourself a little while ago, on American families, on American businesses, by anywhere between 44 to 129 percent which by the way is way above what the President is proposing to subsidize some families in his budget. So they are way above that. Gasoline price increases between 61 cents and $2.53 per gallon. Natural gas cost increases between 108 percent and 146 percent. To sum it up best, you know, the President's own OMB directorate who used to be at CBO stated September 18, "Costs will be passed along to the consumers in the form of higher prices for energy." I don't think that is debatable. Again, that was Mr. Orszag. He also stated that a 15 percent cut in CO_2 emissions, which by the way is 80 percent less than as signed in the President's budget, would be an average annual household cost of $1,300. These are substantial numbers. So these are some of the facts.

Now, you stated in your testimony in answering the questions, by the way, which I think are right that the United States by the way can't do this alone. Obviously China being the big, 800-pound gorilla as far as the CO_2 emissions. Associated Press today has an article where they quote that the Chinese Director of Climate Change at the Department of Climate Change saying that no, China will not be charged for that, that the U.S. importers of products made in China that produce high CO_2 are going to have to pay the cost, in essence.

So look, in essence, like you mentioned, you know, it is good to be cool to be energy efficient. Clearly, quoting another one of those sayings, China just said no, one more time. This is the same China that just recently harassed the U.S. military ship, the same China that murders dissenters. We know who we are dealing with.

So here is the question. That being the case and you stated in other words, I don't want to put words in your mouth, but obviously we can't do it alone, China being the big player, will this Administration then change the policy regarding cap-and-trade or cap-and-tax or will it go forward regardless of those facts on how it will

affect the economy and particularly if China says no, you know, we are not going to play? And how will policy be guided by the cost on the U.S. economy and the U.S. family, regardless? Because again as I said, that that partial subsidy just won't cut it. The numbers are there. They are really pretty plain. So will this Administration and will you look at all those facts, and are you willing then to take a step back and say we are not going to do this because the price is too high, the economic price is too high, and China just won't play?

Dr. CHU. Well, I——

Mr. DIAZ-BALART. China and others, I guess, too. It is not only China. China is the big one, but there are a lot of others that——

Dr. CHU. Well, there are two 800-pound gorillas when it comes to carbon emissions, China and the U.S., I think, two countries together—China recently passed the United States, but those two countries emit approximately half of all the carbon in the world.

I am not—I don't—you know, my understanding of the costs are far less. I do know the IPC and also IPCC in its latest report and also the Stern Review report that Nicholas Stern chaired, those two reports estimate a larger coal carbon emissions down to a level which the climate scientists feel is prudent. Risk management is somewhere between one and two percent of GDP. Now, the cost of one or two percent of GDP is not insignificant by a long shot. That is a lot of money. But then you have to weigh that against what could possibly happen if we did business as usual. So then it becomes an issue of what those potential risks could be. And while one can't say with 100 percent certainty that such-and-such will happen, it is again talking about probabilities.

Mr. DIAZ-BALART. I am sorry, sir, but we can say with certainty the cost to the economy. I mean, that we can say.

Dr. CHU. That is true.

Mr. DIAZ-BALART. Okay.

Dr. CHU. So let me—risk management in the following sense. One can't say with certainty that your house will burn down. In fact, in most cases, your house does not burn down and yet we all have fire insurance because it is part of that because should disaster strike, it is very important. So let us pretend there is an 80 percent certainty that the western part of the United States will lose a lot of its pine forests and there would be less snow pack, therefore less storage of water, the economic cost of that could be much, much higher. It would be much, much higher. And so it is not 99 percent certain, but say it is 80 percent certain and we as a country will have to decide whether we want to pay this extra money, and it is real money to invest. And so that is really the issue that——

Mr. DIAZ-BALART. But again, how about the issue of China saying no?

Dr. CHU. China saying no to what?

Mr. DIAZ-BALART. To them paying for—I am sorry, Mr. Chairman but I am—they are basically saying no, the United States has to pay for our emissions.

Dr. CHU. I think it is very important that all countries, developing countries and developed countries, start to limit their carbon.

Mr. DIAZ-BALART. But if they say no, do we continue to pursue this policy or do we not?

Dr. CHU. I think I am actually optimistic that China—because China realizes that the consequences of climate change are very real to their country as well, the economic cost.

Mr. DIAZ-BALART. But if they say no was my question.

Dr. CHU. We talked about in terms of international trade, of adjusting duties as a way because again, we don't want to disadvantage our industries at home.

Mr. WU. I thank the gentleman and the Secretary. We are running hard up against Chairman Gordon's 12:15. I want to give Mr. Tonko his five minutes, but if he would proceed quickly, and if it is possible for the other three Members who are here to ask something quickly with the Secretary's forbearance?

Dr. CHU. Sure.

Mr. WU. Thank you. Mr. Tonko, the gentleman from New York.

BATTERY DEVELOPMENT AND ADVANCING EFFICIENCY

Mr. TONKO. Thank you, Mr. Chairman, and Secretary Chu, thank you for joining us today. I do believe that President Obama expressed great leadership when he nominated you to be Secretary, and I am empowered for all energy consumers by your appointment. I share the vision that President Obama and you have etched for this nation in terms of innovation as it relates to energy, and I particularly appreciate the boldness with which you have expressed that vision and the laser-sharp focus. I appreciate the research and development impacts you think we need to continue and deepen, and certainly one who expressed a concern for energy efficiency so that we can focus on demand-side solutions rather than just supply-side.

Quick question. On advanced battery technology of which you spoke and rightfully for transportation sectors and for energy generation and other aspects, what is your thinking in terms of diversifying that sort of battery technology? Should we go down the path of one type of battery or should we make it the efforts, the mission, of your agency to encourage diversification amongst battery technologies?

Dr. CHU. Definitely diversification. You know, we intend to find what we think are the most promising ideas. No, we don't want the whole world marching toward, you know, incremental improvements of a specific technology. Absolutely, we want—and so again, it actually goes to the issue of different types of batteries for different uses as well.

Mr. TONKO. Thank you. And also with energy efficiency, I served as Chairman of the Energy Committee of the New York State Assembly for 15 years and then went on to become President and CEO of NYSERDA, the New York State Energy Research and Development Authority. All of the work we have done in efficiency, not just for manufacturing but businesses of all kinds, but dairy farms, where tremendously powerful statements that reduced the demand. We are per capita one of the most gluttonous, the most gluttonous societies in terms of fossil fuel consumption. The efficiency in the stimulus package is encouraging, but I know it is a

function of resources. We need much more. What are your thoughts on how we can best advance the efficiency agenda?

Dr. CHU. I think part of it is helping people realize just how low-hanging this fruit really is, or as I like to say, it is fruit on the ground, ready to be picked up. Let me just give you one example. Refrigerator standards, the energy-efficient refrigerators from the 1975 until today, the energy consumption in the refrigerator, went down to only 25 percent of the refrigerators of 1975. Had we been using those inefficient refrigerators of 1975 today, we would be using a lot more energy. How much? More energy than all the renewables than we produce today.

Mr. TONKO. Thank you. Just a final comment. I would encourage us to strongly focus on developing resources for energy retrofits, efficiency retrofits for our workplaces and our homes. But thank you very much for your leadership.

Mr. WU. I should have known better than to expect public servants and a professor to be brief. The gentleman from South Carolina, Mr. Inglis.

Mr. INGLIS. Thank you, Mr. Chairman.

Mr. WU. Quickly, please.

ALTERNATIVE EMISSIONS PRICING STRUCTURES

Mr. INGLIS. Dr. Secretary, thank you for your service. You know, I wonder if even we could stipulate to the folks that say there is no climate change, even if that is true, perhaps we could get them to come along to try to break the addiction to oil and to create the jobs of the future by doing what they know or will soon find out, I think has to be done which you have to internalize the externals associated with some fuels that we use. And if you do that, then we unleash the power of the marketplace to do what those who we have heard from today who don't think there's any climate change, nevertheless want to do, which is see the private sector succeed.

I wonder if the best way to do it, though, is not by cap-and-trade which we have already heard tagged as a tax increase and a system that will trade credits that when Wall Street is not very favored right now, and it got 48 votes for cloture in the Senate before all of that, before a recession and before the Wall Street disasters. I wonder if a revenue-neutral carbon tax that is transparent, that starts with a reduction of taxes in payroll, creates no additional take to the government and that does what you very wisely pointed out has a bolder adjustment so that we don't disadvantage American manufacturing vis-à-vis other manufacturers, I wonder if that is our collaboration opportunity to go forward to a solution for America even with folks who doubt the underlying premise of climate change. Do you think it is possible?

Dr. CHU. Well, I think the Administration is very strongly going toward cap-and-trade and supports cap-and-trade, and there are other issues for wanting to do that. Let me just say that Europe is going this way, and so whatever we do, we have to interface with the rest of the world community to make these programs look similar. But as you correctly said, it is about incorporating all the external costs of our energy into the product we buy, just as when we decide we are going to treat sewage. Does it increase the cost of water? Absolutely, but the overall cost actually goes down be-

cause the consequences of putting untreated sewage in a river downstream are much, much higher than just treating the sewage. It is also true of sulfur dioxide, that it does increase the cost, but it doesn't really. It puts the cost actually where it should be, in the project itself.

And so I think we are in total agreement. But you know, I think cap-and-trade has the advantage, at least one advantage, and that is it is easier to interface where the rest of the world is going.

Mr. INGLIS. Thank you, Mr. Chairman.

Mr. WU. I thank the gentleman. The gentleman from New Mexico, Mr. Luján. Two minutes each for the last two questions, please.

Mr. LUJÁN. Thank you, Mr. Chairman. I don't think I will take that long. Mr. Secretary, it is an honor to be here with you today as well. I recently extended an investigation to visit Los Alamos National Laboratories, and I hope that we can begin to engage in a dialogue on when we can get you out there to really highlight some of the areas where there is research taking place in Los Alamos and the areas of sciences with global climate change, supercapacitor energy storage, hydrogen fuel cell technology, and carbon sequestration. What I want to emphasize though, Mr. Secretary, is the reason that we are here today which is with the emphasis of this committee hearing is in the new direction for energy research and development for the U.S. Department of Energy. I applaud the efforts of yourself and the Administration and the team that has been put together that has embraced science and technology, not for any other reason use science and technology to prevent progress but to encourage progress, to advance job creation, not eliminate job opportunities as we move forward with the economy and the economic conditions that we are facing as a nation.

Mr. Chairman, I will submit my question specifically to the Secretary for consideration later, but Mr. Secretary, we are at a critical time right now, and with your courage and based on science and technological advances, the work that can be done to get us on a right footing and to make sure that this nation has a foundation in order to become a leader in the world before others will follow, is something that I really appreciate, and I look forward to working with you. Thank you, Mr. Secretary.

Mr. WU. I thank the gentleman. The gentleman from Florida, Mr. Grayson.

FUSION ENERGY

Mr. GRAYSON. Thank you, Mr. Secretary, and thank you, Mr. Chairman. If we had commercial fusion power today, we would have energy independence, we would reduce or eliminate oil imports, and we would have no CO_2 emissions at all from that particular source of power.

Now, in the case of fission, we went from military applications to commercial energy applications in less than 10 years. In the case of fusion which had military applications for 50 years and we are still waiting for those commercial applications, despite 50 years' worth of effort. We have lost our lead in fusion research to the European Union, and now we are number two at best in an area that is bound to be an important part of the 21st-century economy. And I am wondering if the reason is simply money. I understand it has

been estimated that $100 billion would be enough to develop the commercial application of fusion energy and to free our economy from the dependence on mid-East oil. $100 billion is less than we spent on the AIG bail-out, it is less than one year of the cost of the war in Iraq, and if that were the case, then we would be free for all time.

I am wondering, Mr. Secretary, do you favor a Manhattan-project style approach to this problem that would dramatically increase our spending on fusion energy in order to make us energy independent?

Dr. CHU. I support a Manhattan-style investment of this country and the world in all the parts of energy supply and demand that can reduce—you know, so that we can as a world transition to a sustainable use of energy.

Fusion is a difficult question because it is a very long time scale. They are very hard problems, and I think dramatically increasing the budget for fusion, right now the International Thermonuclear Experimental Reactor (ITER) project has a path to go. It is still an experiment, and ultimately even if ITER works very, very well, there would be then as anticipated a so-called demo-style type of thing, still a pre-deployment thing but getting on the way to there. And the time scale for that is you know, sort of mid-century. And it depends on ultimately the cost of fusion. If we can get fusion's cost down, that is the real issue. First we have to show that you can do more than break even, that it really is going to give a lot of yield. There are other prospects. The one they should be looking at I think is these so-called hybrid solutions of fission and fusion. The fusion creates high-energy neutrons that are used to convert a lot of the radioactive fuel and burn down the long-lived radioactive isotopes. So there are prospects like that. But ultimately, there is a timeline. If we, you know, increase the funding by a factor 10, will we get there 10 times faster? I actually think not. You know, it is a very, very hard nut to crack in terms of getting the controlled, sustainable fusion that we need. And it has to be economically viable.

And so we are not there yet in terms of even—you know, so I am all for continuing to do research in fusion. I am all for looking at, you know, out of left field new ways of doing fusion. I mean the ITER project, the toka mak-style thing is one possibility. You know, the path of that has now been charted, and the world is following that but there may be other opportunities.

CLOSING

Mr. WU. I thank the gentleman, and I thank the Secretary. And before we bring the hearing to a close, I want to thank Dr. Chu for testifying before the Committee today. The record will remain open for two weeks for additional statements from the Members and for answers to any follow-up questions the Committee may ask of the witness. The witness is excused, and the hearing is now adjourned.

[Whereupon, at 12:27 p.m., the Committee was adjourned.]

Appendix:

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Steven Chu, Secretary of Energy, U.S. Department of Energy

Questions submitted by Chairman Bart Gordon

Q1. There is a significant problem with integrating and coordinating related research, development, and demonstration activities across the Department. In particular, the applied research programs, like solar and biofuels R&D efforts in the Office of Energy Efficiency & Renewable Energy, are not well integrated with the Office of Science's more cutting-edge programs in the same areas. I know you recognize this is as a serious issue and are planning to address it in both existing and new programs. However, while, such initiatives are a good start, I believe that one critical step in mitigating this problem is to have all basic and applied energy R&D programs report to a single Under Secretary, as was the intention when the Under Secretary for Science was first proposed as the Under Secretary for Energy & Science. This would also allow the other Under Secretary to focus entirely on Environmental Management, Legacy Management, and Civilian Radioactive Waste Management, which has thus far occupied the vast majority of that Under Secretary's time. As noted in a letter sent to you on March 9, 2009, the Committee counsels have found that you already have the legal authority to do this. What is the logic in keeping these programs separate under different Under Secretaries when you have the discretion to realign them?

A1. One of my highest priorities is a tighter coupling between Department's basic and applied research activities. The best organizational model to accomplish that depends upon the tasks at hand, the particular individuals on the leadership team, and the "culture" established for that team.

Most importantly, I have established a highly collaborative senior leadership team and am working with them to propagate that style and attitude throughout the Department. This alone should be very effective in promoting integration, independent of the particular roles and responsibilities among the leadership team.

In addition, the responsibilities of the Under Secretary for Science currently follow those recommended by the 2003 Secretary Energy Advisory Board Task Force on the Future of Science Programs:

> The Under Secretary for Science would have both Department-wide and line responsibilities. He or she should serve as the chief science officer for the Department as a whole, overseeing the science officers within Department's missions. As chief science officer, the new Under Secretary will require a crosscutting Department-wide forum to coordinate and integrate science across the entire Department. The Department of Energy should consider emulating crosscutting management structures used by other federal agencies to assist their chief scientists or chief engineers to coordinate and integrate department-wide. The Under Secretary for Science would also have line responsibility for the Office of Science, which might report to him or her through an Assistant Secretary.

The role is thus designed to promote integration of all basic and applied research across the Department, including that in the NNSA (consistent with classification considerations).

I will, of course, closely monitor the extent to which these steps are having the desired impact and will not hesitate to make changes as might be required in the future.

Q2. DOE is unique in maintaining a large internal bureaucracy to regulate its own environmental, safety, and health performance. While the cost of such a regulatory regime is considerably higher than it would be at a comparable non-DOE facility, there is no indication that this makes DOE facilities demonstrably safer. As a test case at Lawrence Berkeley National Laboratory demonstrated several years ago, applying external regulatory oversight to DOE's non-nuclear weapons laboratories could reduce costs and remove inherent conflicts of interest, chiefly by transferring DOE's worker safety compliance role to OSHA and the nuclear safety compliance role to NRC. Do you have plans to implement external regulation to the Department's non-weapons research and oversight activities? If not, please provide the rationale for maintaining DOE's self-regulatory regime, and include documentation demonstrating that it is the most cost-effective way to ensure optimal environmental, safety and health performance.

A2. Prior to my role as Secretary of Energy, I was the Director at Lawrence Berkeley National Laboratory, so I am personally familiar with the costs and impacts on operational efficiency that can result from bureaucracy, overlapping oversight, and overly-restrictive requirements. As Secretary of Energy, I am firmly committed to improving business efficiency and reducing overhead within DOE. As I have stated on several occasions, increased efficiency, particularly in our national laboratories, is essential as one means of making more resources available for key energy programs that are important to the national economy, environment, and energy security.

It is important to recognize that DOE has achieved an exemplary safety record through its current regulatory approach. For example, DOE's injury and illness rates have shown a continuous downward trend since 1996 and DOE sites have achieved and sustained injury and illness rates that are significantly lower than the rates for comparable industries. In fact, DOE injury and illness rates are as good as the best-in-class for comparable commercial industries.

The question of external regulation of DOE sites and laboratories was extensively evaluated in the 1995–2002 timeframe, including the pilot program at the Lawrence Berkeley National Laboratory in the 1997–1998 timeframe. As I understand it, the potential cost savings, potential benefits, potential impacts, and transition costs were a matter of considerable debate, and Congress and DOE ultimately made the decision not to pursue the external regulation option, citing the questionable benefits and transition costs. Instead, DOE took a number of actions intended to improve DOE's regulation of environment, safety, and health at DOE sites and laboratories. As one important example, DOE replaced many of its internal directives with regulations that govern nuclear safety and worker safety and health. These regulations provided for increased predictability and stability in the regulatory approach and, in many aspects, the regulations that govern DOE laboratories are essentially similar to those that apply to other industries with similar hazards.

Nevertheless, I believe that changes are needed to improve efficiency and I am committed to making appropriate changes. In making changes, however, we must ensure that we do not degrade safety or cause adverse impacts to our workers, the public, or the environment.

I am currently evaluating the options for increasing the efficiency of DOE laboratories, reducing the bureaucracy, streamlining oversight, and identifying and eliminating or revising those requirements that stifle efficiency and innovation but do not substantially enhance safety. In evaluating these options, we plan to rely heavily on the insights from the previous studies and pilot programs and we will be seeking input from the affected parties including the Occupational Safety and Health Administration, DOE laboratory directors, and Members of Congress. We are concurrently examining other options that will improve efficiency of DOE's current regulation approach, including options for streamlining oversight and improving DOE directives by ensuring that they promote flexibility and efficiency as well as ensure safe and compliant operations.

Q3. The President's New Energy for America Plan includes a goal to "Ensure 10 percent of our electricity comes from renewable sources by 2012, and 25 percent by 2025." A part of this energy will come from sustainably-harvested renewable biomass. Right now the Office of Biomass at DOE focuses almost entirely on biomass as it relates to liquid transportation fuels. Are there plans to increase the scope of the Office of Biomass to include research in the area of biopower, including both thermal and electricity from biomass?

A3. The Department currently includes biopower as part of the integrated biorefinery platform as a co-product with the production of advanced biofuels and bioproducts, consistent with the FY 2009 appropriation. The FY 2010 request does not change the scope of the Office of Biomass, but the Department is continually reviewing its priorities in light of evolving policy priorities, advances in research, authorizing legislation, and availability of funds. Biopower projects tend to be at a commercial stage, making them potential candidates for the Department's Loan Guarantee Program.

Questions submitted by Representative Lynn C. Woolsey

Q1. There has been a lot of talk about holding off on global climate change legislation until the economy recovers, even though I believe that if done correctly we can stimulate the economy with this legislation. What are your thoughts on the consequences of putting off actions to address global climate change, and how soon do you think we must act?

A1. Despite the economic downturn, global emissions are expected to continue to rise over the next few years and, in the absence of significant global action on climate change, throughout the coming decades. In order for greenhouse gas (GHG) concentrations to stabilize at any level, GHG emissions must not just stabilize, but must decrease. The sooner that decrease begins, the lower the corresponding climate impacts. Given the potential for 'tipping points' and irreversible impacts with very negative consequences, it is in our interest to act as soon as possible. With that in mind, the Administration is leveraging the considerable investment being made through the *American Recovery and Reinvestment Act of 2009* to lay the groundwork for domestic emissions reductions while reinvigorating the economy.

Q2. Although I know that you must recuse yourself from issues specific to Berkeley Lab, I would like to hear your thoughts about the Solar Energy Research Center's (SERC) as a model for conducting game-changing energy research. Why is this type of program important? What steps are you taking to develop and fund this approach more broadly?

A2. The Solar Energy Research Center (SERC) at Lawrence Berkeley National Laboratory is a multi-disciplinary and multi-investigator center for tackling one of the most challenging issues in energy sciences—the production of chemical fuels from sunlight, carbon dioxide, and water using artificial systems. This challenge often is referred to as developing "artificial photosynthesis." The approach recognizes the complexity and magnitude of the research challenge and therefore integrates the collective expertise of many scientists to accelerate research towards the goal.

This collaborative approach also forms the basis for the 46 new Energy Frontier Research Centers (EFRCs) awarded in FY 2009 and for the eight Energy Innovation Hubs proposed in the FY 2010 DOE budget request. These two programs differ in scale—funding for the EFRCs ranges from $2–5 million annually while funding for the Hubs is $25 million annually—but the philosophy of assembling teams of researchers to tackle problems of great scale and scope is the same.

Questions submitted by Representative Russ Carnahan

Q1. Secretary Chu, as you know our homes, offices, schools, and other buildings consume 40 percent of the primary energy and 70 percent of the electricity in the U.S. annually. These buildings also accounts for 39 percent of U.S. CO_2 emissions each year. Clearly, we must address these inefficiencies in our built environment. I am encouraged by DOE's Building Technologies Program which works to improve the efficiencies of buildings and bring us closer to net-zero-energy buildings. Where do you see this program heading in the future?

A1. One goal of the program is enabling the cost-effective construction of net-zero energy homes by 2020, and net-zero energy commercial buildings by 2025. The significant increase for FY 2010 is highlighted by the creation of a new Buildings Technologies Energy Innovation Hub for Energy Efficiency Building Systems Designs. This Hub will bring critical interdisciplinary talent to bear on new breakthrough materials, technologies, processes and techniques needed for continued progress toward these goals and for future generations of high-performance, intelligent, green homes and buildings, as well as systems building controls.

Additionally, the program will develop a new strong focus on improving the efficiency of the existing building stock through targeted whole-building R&D, operation and maintenance, smart-grid interface, and smart equipment and appliance research. To make sure research advances are adopted and utilized effectively, the program is aggressively engaging the market with deployment programs such as the Builders Challenge, Home Performance with Energy Star, home labeling with the EnergySmart Home Scale (E–Scale), the National Commercial Building Alliances, EnergySmart Schools and Hospitals, and model building code promotion to ensure research advances are adopted and utilized effectively. A very high priority is the promulgation of energy conservation standards for consumer products and commercial and industrial equipment to assure the American public has available the most energy efficient equipment and products that are technically feasible and economically justified.

Q2. Secretary Chu, how effective are current methods for coordinating the green building activities across federal agencies?

A2. The Department of Energy (DOE) currently coordinates green buildings across federal agencies in three primary ways: greening the Federal Government's own buildings, conducting research and development on green building technologies, and outreach and education with the public at large.

To effectively green the Federal Government's own buildings and lead by example for the whole nation, DOE's Federal Energy Management Program chairs the Interagency Sustainability Working Group (ISWG). The ISWG includes active members from the major federal agencies and meets monthly to coordinate interagency activities on green buildings and sustainability. The ISWG helps to facilitate the Federal Government's implementation and integration of green building laws, regulations, presidential directives, and other federal policies.

One measure of the Federal Government's progress is the number of buildings and square footage certified under the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) rating system. As of December 2008, there were 123 certified Federal LEED buildings, totaling about 14 million square feet, and located in 19 different federal agencies. The number of Federal LEED certified projects has increased annually, while federal construction funding has remained relatively stable. Moreover, Federal LEED buildings represent more than five percent of all LEED certified buildings, whereas federal buildings total about 1.5 percent of all buildings in the U.S. All of this indicates that the Federal Government is leading the way by investing in its buildings in a smarter, more environmentally friendly manner. In recognition of its accomplishments, the ISWG received a 2007 White House Closing the Circle Award for Leadership in Environmental Stewardship.

To coordinate interagency green building R&D activities, DOE co-chairs the Subcommittee on Buildings Technology Research and Development with the National Institute of Standards and Technology. The National Science and Technology Council Committee on Technology established this subcommittee to provide R&D guidance; serve as a forum for collection, analysis and dissemination of federally funded research results; and interact with federal agencies that own, lease, construct or provide financial assistance to facilities.

In addition, DOE and the General Services Administration (GSA) have begun to carry out the requirements of the *Energy Independence and Security Act of 2007* (EISA 2007) (Pub. L. 110–140). For example, EISA established the Office of Commercial High-Performance Green buildings in DOE and the Office of Federal High-Performance Green Buildings in GSA. DOE and GSA are establishing a high-performance green building clearinghouse which is expected to be operational by the end of 2009. Both offices work in concert with the Interagency Sustainability Working Group.

Q3. To what extent and by what means should Congress extend federal efforts to facilitate and support adoption and implementation of green building measures throughout the United States?

A3. The green building movement has grown over the past 20 years, and there are numerous voluntary rating and certification systems, including the United States Green Building Council's Leadership in Energy and Environmental Design, Green Globes, National Home Builders Association Green Program, DOE–EPA Energy Star Homes and Commercial Buildings, among others.

In order to facilitate a broader acceptance and implementation of green building practices and products, several actions may be needed. These actions include establishing a definition of what constitutes a green home or building based on standardized testing and measurement protocols, standardized labeling of building performance based on common measurement protocols, requirements for disclosure of actual performance to prospective owners or occupants, and reform of building appraisal and financing to capture the value-added of measured high-performance in real estate transactions. The effectiveness, reliability and durability of green building materials, practices and products need to be fully demonstrated prior to incorporation of green building provisions into building codes and standards. The Federal Government's current role in these regulatory areas could assist in such demonstration.

Question submitted by Representative Charles A. Wilson

Q1. One conversion option for a coal facility is burning biomass. In many cases, it is more cost-effective to co-fire the facility, using both coal and biomass, instead of replacing the equipment necessary to fully convert the plant to biomass. Currently, production tax credits only apply to plants burning 100 percent biomass. Would you support some kind of incentive to promote the co-firing option?

A1. The Department supports incentives that seek to promote the use of renewable sources of energy including biomass. The renewable production tax credit (PTC) applies to any level of biomass co-fired with coal. The power plants do not have to burn 100 percent biomass in order to qualify for the PTC. According to the expanded

definition of "open-loop biomass" promulgated by the IRS, many forms of biomass co-fired with coal qualify for the PTC. In addition, H.R. 2454, the proposed *"American Clean Energy and Security Act of 2009,"* would permit biomass with coal to be a qualified renewable electricity source (with the portion that is biomass counting as renewable) for the Combined Efficiency and Renewable Electricity Standard. The Department supports the continuing incentive provided by the PTC to encourage the use of renewable energy technologies such as biomass.

Questions submitted by Representative Ben R. Luján

Q1. In New Mexico, we are aptly positioned to support solar energy development. How will the Recovery Act's funding for renewable energy R&D help the development of both distributed generation and utility-scale solar energy technologies, and help solve many of the storage and transmission issues we are currently facing?

A1. Recovery Act funding for renewable energy R&D will be used to fund multiple efforts that directly support the development of both distributed generation and utility-scale solar energy technologies, as well as storage and transmission technologies. Specific efforts include:

- $51.5 million to expand investment in advanced photovoltaic concepts and high impact technologies;
- $40.5 million to overcome barriers to solar energy deployment, including grid integration issues, obstacles to solar energy adoption in cities, and a shortage of trained solar energy installers;
- $25.6 million to support utility-scale concentrating solar power, including $18 million for the National Solar Thermal Test Facility at Sandia National Laboratory to better support industry technology development and system testing needs.

Recovery Act efforts on storage and transmission issues also include:

- Competitive opportunities to facilitate high penetration of PV in a distribution system, enable widespread deployment of small modular PV systems, and demonstrate integration of PV and energy storage into Smart Grid applications;
- Support Solar Energy Grid Integration Systems development through private sector partnerships with Sandia National Laboratory.

Q2. As a former Public Regulation Commissioner, I heard concerns from my constituents about renewable energy transmission. Regarding transmission lines, can you discuss what research is being done to develop high capacity conveyance materials?

A2. The Department's FY 2010 budget request includes $22 million to support research efforts in Advanced Cables and Conductors under the Office of Electricity Delivery and Energy Reliability. This program area recognizes, in particular, the role that High Temperature Superconducting (HTS) wire can play in meeting the need for greater power transfer capabilities, increased capacity, and greater flexibility. In FY 2010, efforts will focus on mitigating the alternating current or AC losses generated in existing second generation (2G) HTS wire architectures; this is a critical step in developing high capacity materials suitable for transmission cable applications.

Q3. What kind of new technologies are being developed in geothermal energy to accommodate both lower temperature waters (closer to surface) and "hot rock" (deep under surface)? Can you elaborate on any resource assessment initiatives, for example, examining the use of abandoned oil and gas bore holes to access heat?

A3. The Geothermal Technologies Program (GTP) at the Department of Energy is currently seeking research and development projects through a competitive solicitation with the goal of developing new technologies to enable the United States to better access low-temperature resources. DOE will use up to $50 million in Recovery Act funding to award up to ten cooperative agreements in support of geothermal energy production from oil and gas fields, geopressured fields, and low-temperature resources throughout the United States.

Widespread but underutilized low-temperature geothermal resources (below 300 degrees Fahrenheit) present an immediate opportunity to economically increase the Nation's supply of clean, renewable geothermal energy. Geopressured fields are

over-pressured reservoirs that contain thermal energy in hot water, kinetic energy from pressure, as well as natural gas. In co-produced fluid systems, oil and gas wells produce hot water along with hydrocarbons. The GTP expects to demonstrate as much as 20 megawatts-electric from these projects throughout the United States. Success in these projects, will, over several decades, enable continually increased amounts of geothermal electricity generation.

To address further resource assessment needs, the GTP will renew an existing interagency agreement with the United States Geological Survey (USGS) using Recovery Act funds. USGS concluded a geothermal resource assessment of the western United States in late 2008 that estimated the presence of 30,033 MWe of undiscovered but accessible conventional geothermal potential. The renewed agreement will allow the USGS to extend the geothermal resource assessment nationwide and to include the complete range of geothermal resources including low temperature, significant depths (greater than six km), as well as geopressured and co-produced fluids from oil and gas wells.

Q4. Congress has entrusted the Department of Energy with a very large amount of taxpayer dollars for Research and Development. I am very concerned that this money be spent quickly to stimulate the economy. In doing so, what do you envision the funding split will be between the Office of Science laboratories and the NNSA laboratories?

A4. The $1.6 billion appropriated for Office of Science is not yet fully allocated, but our current estimate is that about $1.1 billion will go to DOE national laboratories. Of that $1.1 billion, about $7 million is currently allotted to the Los Alamos, Lawrence Livermore, and Sandia National Laboratories. However, there is still unallocated funding that may increase the allocation to NNSA laboratories. For instance, $277 million of Recovery Act funding is planned for Energy Frontier Research Centers; Los Alamos and Sandia may receive sub-awards on some of these university-led awards, but the specific amounts have not yet been finalized.

Q5. I am aware that the NNSA laboratories have significant expertise in the areas of global climate change. How do you plan to utilize expertise in this and other non-weapons fields at the NNSA labs?

A5. NNSA laboratories have a rather unique expertise in large-scale integrated simulations that is readily applicable to problems of national interest. Historically, the NNSA labs, Los Alamos and Lawrence Livermore in particular, have played important roles in the understanding of climate. For example, over the last few years Los Alamos scientists have completely re-thought the way that computers model the flow of sea ice, which has led to new predictions about global climate change. Lawrence Livermore scientists played a major role in a recently-released report on computer climate models and their ability to simulate current climate change, and the laboratory is a global repository of data and tools. As key national assets, I intend to use the NNSA labs as an important part of meeting my priorities.

Q6. With Los Alamos and Sandia in my state, could you explain to me some of the types of science work you would envision being accomplished with funding from the stimulus at each of these facilities?

A6. The Office of Science has several Recovery Act projects that will support activities at Los Alamos and Sandia National Laboratories. The Nuclear Physics program plans to send funding to Los Alamos for enhanced isotope production efforts at the Isotope Production Facility at the Los Alamos Neutron Science Center (LANSCE) and investments in isotope production and processing capabilities. In addition, Los Alamos is collaborating with Brookhaven National Laboratory on the PHENIX Forward Vertex detector project for the Relativistic Heavy Ion Collider and will receive Recovery Act funding as part of this effort. The Basic Energy Sciences program plans to provide Sandia and Los Alamos National Laboratories funding from the Recovery Act to support the Center for Integrated Nanotechnologies Facility to expand its capabilities in the High-Performance Computer Cluster, Imaging Microscopes, and X-ray Diffraction instruments.

In addition, the Nuclear Physics program is currently evaluating proposals received in response to two Funding Opportunity Announcements that were issued using Recovery Act funding: Applications of Nuclear Science and Technology and R&D on Alternative Isotope Production Techniques. These competitive solicitations are aimed at universities, industry, and national laboratories; and Los Alamos and Sandia were both eligible to apply under these announcements. Also, the Fusion Energy Sciences program is evaluating proposals received in response to a request to all current participants in the Innovative Confinement Concepts (ICC) program. Los Alamos is a participant in the ICC program and was eligible to apply.

Questions submitted by Representative Gary C. Peters

Q1. There has been a growing recognition that one tool for meeting our climate and energy goals will include electrification of our transportation sector, and the Recovery Act along with the energy bill of 2007 provided very aggressive authorizations and funding to support this nascent technology industry. It is clear that batteries are at the forefront of this industry, and a lot of investment has been made in the area of passenger vehicle battery technologies. What is being done to support the development of advanced technologies for commercial trucks and heavy duty vehicles?

A1. The Department is leading a government/industry partnership that supports the development of advanced technologies for commercial trucks and heavy duty vehicles. The overall goal of the 21st Century Truck Partnership is to accelerate the introduction of advanced truck and bus technologies that use less fuel, have greater fuel diversity, meet future emissions standards and are cost-effective. The Department's FY 2010 Budget request doubles the funding for commercial vehicle R&D to approximately $50 million. Also, the Department has allocated approximately $75 million of *American Recovery and Reinvestment Act* (Recovery Act) funding to promote advanced technologies for commercial vehicles. The Department will utilize these Recovery Act funds along with appropriated funds to release a competitive solicitation that will request commercial vehicle manufacturers and supplier teams to develop systems-level solutions for increasing the overall freight-moving efficiency by 50 percent (based on total fuel consumption) for the standard Class 8 heavy truck/trailer combination. Additional fossil fuel displacement may be realized in some technology configurations through the use of renewable, non-petroleum-based fuels. Technology areas to be supported with these funds include: high efficiency engine systems; alternative fuels; heavy-duty hybrid systems; and reduction of aerodynamic drag, tire rolling resistance, vehicle weight and engine idling.

Q2. Foreign governments (such as China, Japan, and Korea) are making significant investments in battery and vehicle technologies. Are U.S. federal efforts comparable to what these foreign governments are doing? Do we risk losing global competitiveness in this field if we fail to do more?

A2. The figures for the amount of foreign investment in battery and vehicle technologies are not always available and foreign investments often are not readily quantifiable. However, in general DOE believes that the U.S. is investing in battery and vehicle R&D in amounts that are comparable to foreign countries such as China, Japan and Korea. The U.S. has an excellent track record in developing these new technologies, but has not always succeeded in commercializing the technologies as they develop.

Approximately $2 billion in Recovery Act funds will help establish approximately $4 billion (with participant cost-share) in new manufacturing capability to produce advanced batteries and electric drive components required to commercialize advanced vehicles such as plug-in hybrids. These funds will significantly defray the capitalization costs of these new facilities, helping U.S. manufacturers compete against established global businesses. This solicitation closed on May 19th and up to 40 awards are expected to be announced later this summer. The Department believes this investment, along with ongoing technology R&D, will ensure U.S. competitiveness in advanced battery and vehicle technologies.

Q3. I understand there has been a great deal of interest in the Department's "Section 136" Advanced Technology Vehicles Manufacturing Loan Program. With credit markets frozen, federal loans are virtually the only means through which auto companies can secure the financing to continue development of this technology. Are the Department's current resources adequate to meet the demand for this program?

A3. Since its establishment in October following the passage of the *Continuing Appropriations Act of 2009,* the Department has hired federal staff to manage and execute the Advanced Technology Vehicles Manufacturing Loan Program; contracted for outside financial advisors, market advisors and law firms to review applications; and conducted technical evaluations of applications, which now number over 100. An additional appropriation was obtained in 2009 to cover contract expenses. A substantial number of these applications have now been reviewed and applicants notified of their eligibility to proceed to the next step of the process. We have negotiated with those farthest along and expect to be in position to announce conditional commitments shortly. In every case we are moving with all deliberate speed while assuring that appropriate measures are undertaken to protect taxpayers' interests.

Q4. I have been following the FRIB competition closely. I am very supportive of the overall budget for the Office of Science, and I understand the importance of maintaining a balanced portfolio. In that light, can you tell me what funding level the FRIB project will need for FY 2010?

A4. The FY 2010 budget includes a request for $9,000,000 to continue R&D, *National Environmental Policy Act* (NEPA) review, and conceptual design activities aimed at developing the Facility for Rare Isotope Beams (FRIB).

Questions submitted by Representative Ralph M. Hall

General

Q1. How do you plan to handle technology transfer on the domestic and international fronts? For example, will the Department of Energy, as authorized in Section 1611 of the Energy Policy Act of 2005, *continue to work with developing countries to deploy greenhouse gas intensity reducing technologies, and, if so, under what programs? As an example, do you see the Asia Pacific Partnership playing a continued role in the transfer and demonstration off CCS technologies to China and India?*

A1. DOE supports domestic and international technology transfer. Domestically, the national laboratories and facilities conduct technology transfer programs. The DOE Technology Transfer Policy Board continues to examine how technology transfer is done across the DOE Complex to determine ways in which the process can be done more effectively. Internationally, DOE continues its work with developing countries to deploy technologies that will reduce greenhouse gas intensities. Examples of this work are the Asia Pacific Partnership and bilateral programs with developing countries that have significant GHG emissions. The Administration has proposed a significant increase in the development assistance programs to deploy clean energy technology to developing countries in the 2010 Budget. These funds would be managed by the Departments of State and Treasury.

Q2. Does the Department have an inventory of developed or developing greenhouse gas intensity reducing technologies that are suitable for transfer, deployment, and commercialization in developing countries? If so, how often is it updated?

A2. In January 2009 the report, *Strategies for the Commercialization and Deployment of Greenhouse Gas Intensity-Reducing Technologies and Practices,* was submitted to the President and Congress in fulfillment of the requirements of the 2005 amendments to Sections 1610(c)(1), 1610(e), 1610(g)(1) and 1610(g)(4)(A) of the *Energy Policy Act of 1992.* Annex A of the report, Inventory of Greenhouse Gas-reducing Technologies, identifies over 400 GHG-reducing technologies.[1] Some of these technologies are available commercially or can be deployed in the near-term.

Numerous technologies that can reduce GHG emissions already exist, but within a wide spectrum of technical readiness. Many are mature enough now to be used commercially, such as compact fluorescent light bulbs and hybrid vehicles. Others are in earlier stages of development, such as production of hydrogen from photobiological processes or Generation IV nuclear plants. For the purpose of the report, "suitability for commercialization and deployment" was interpreted as a level of technical maturity such that the technology can be readied for commercial use now or imminently through product development (e.g., size, operational standards, production engineering, etc.), even if the technology faces economic, regulatory, or policy challenges that could inhibit its wider deployment.

The technologies identified in the Inventory of Greenhouse Gas-Reducing Technologies are all considered potentially suitable for transfer, deployment, and commercialization in developing countries. Transfer, deployment, and commercialization of such technologies depend in part on countries having the infrastructure and enabling environment, including IPR protections, to take full advantage of such technologies. The report was issued in January 2009 and therefore the inventory is current. It will be updated on an as needed basis.

Q3. Senator Bingaman recently released a draft energy bill that included a Grand Challenges Research Initiative that would establish a Grand Challenges in Energy Research Initiative for the purposes of integrating basic and applied sciences to solve the Grand Challenges of Energy. Do you support this initiative? How would it fit into the current structure at DOE and also with what ARPA–

[1] Available online at *http://www.climatetechnology.gov/Strategy-Intensity-Reducing-Technologies.pdf*

E is intended to do? In other words, how is it similar to and different from what is currently being done at DOE and would be done at ARPA–E?

A3. I fully support the intended goals of the Grand Challenges Research Initiative outlined in the Senate Energy Committee bill, which is why I have proposed the Energy Innovation Hubs in the FY 2010 budget request. The Hubs will compliment the new Energy Frontier Research Centers (EFRCs) and ARPA–E—each has a distinctly different and important role in our energy R&D portfolio to maximize our chances of achieving breakthrough energy solutions.

Let me briefly explain the differences. EFRCs are small-scale collaborations among researchers around the country, primarily at universities and other institutions. They focus on accelerating the fundamental scientific discoveries that will be the foundation for the transformational energy technologies of the future, and they are funded at $2 to $5 million per year.

ARPA–E is a highly entrepreneurial-focused program that swings for home runs, developing potentially breakthrough technologies that are too risky for industry to fund. ARPA–E will implement DARPA's approach to mission-oriented R&D by funding scientists and technologists (sometimes by forging and nurturing partnerships of its own design) to accelerate an immature energy technology with exceptional potential beyond the risk barriers that prevent its translation from the bench to the marketplace. It will seek out the best ideas and move quickly to help bring the idea to enough maturity that industry can take over development, bringing the technology to market. ARPA–E will look for the best opportunities to meet its mission areas of improving energy security and curbing climate change by making programmatic investments lasting two to five years. ARPA–E will then move on to the next big idea, shifting into and out of areas depending on the opportunities for transformational change.

The Energy Innovation Hubs, modeled on the Department's successful Bioenergy Research Centers, will focus significant resources on our most critical energy technology challenges. Each Hub will comprise a highly collaborative team spanning many disciplines, ideally working under one roof. By bringing together top talent across the full spectrum of R&D performers—including universities, private industry, non-profits, and national laboratories—each Hub is expected to become a world-leading R&D center in its topical area. The Hubs will support cross-disciplinary R&D focused on the barriers to transforming its energy technologies into commercially deployable materials, devices, and systems. The budget proposal is for each Hub to be funded at $25 million per year for a five-year term, with additional start-up funding of $10 million in the first year for renovation (but not "bricks and mortar"), equipment, and instrumentation.

Q4. Does your Agency have any studies to help us understand what 'energy security' or 'energy independence' actually mean? People toss those terms around all the time very loosely, but it's not clear to me what exactly is meant, or how one measures our progress towards that goal, or if that goal can or should be reached anytime in the next twenty years. Do we have good metrics to help us understand if we are making progress, or if some technologies might help us make progress faster?

A4. The concepts of "energy security" and "energy independence" have many dimensions, especially with regard to U.S. policies and practices both globally and domestically. In terms of the U.S. dependence on imported energy, energy security policy is designed to prevent disruption in energy imports, address the impact if such disruptions occur, and mitigate the length and severity of any disruptions to prevent serious harm to the U.S. economy and national security. In order to reduce the potential for energy import disruptions, the United States encourages global energy supply diversity; operates an open and competitive market, consistent with our international trade obligations, to encourage importers to sell to customers in the United States; fully integrates diverse imports into the U.S. energy economy; limits political intervention in energy markets; and provides global leadership to promote transparent and competitive international oil and natural gas trading and investment opportunities.

More broadly in relation to the domestic economy, energy security requires domestic policy decisions and market practices to encourage and permit further development of an economically viable, competitive, largely renewable and environmentally sustainable energy economy, recognizing the U.S. economy's full integration in the global market. This requires accelerating the development and deployment of alternative energy technologies and effectively addressing related climate change and environmental impacts—which should also help reduce our dependence on foreign energy sources. Over time, these steps should also help reduce financial outflows for

conventional resources and contribute to mitigating the effects of global warming while building a new competitive, efficient, clean market-based energy economy. Indeed, promoting technological innovation is crucial to expanding the role of renewable energy sources in motor vehicle fuels; developing and deploying a more efficient electric power sector, improving energy efficiency throughout the economy, and developing expanded public transit and rail services.

Overall, a generation-long move toward greater efficiency in energy use and the use of domestic renewable energy can help to reduce our oil demand, address climate concerns, and further strengthen national energy security. The Energy Information Administration (EIA) provides more information on oil, natural gas, and electricity disruptions and vulnerabilities as well as other events that affect global energy security.

Q5. Does it concern the Department of Energy that a policy of placing duties or tariffs on imported goods manufactured in countries that refuse to set a price on carbon may result in trade related barriers maintained by foreign countries on the export of greenhouse gas intensity reducing technologies? In Title XVI of the Energy Policy Act of 2005, *Congress authorized the United Sates Trade Representative to identify such trade barriers and negotiate with foreign countries for the removal of such barriers.*

A5. A recent World Bank study found that removing tariffs and non-tariff barriers for four clean energy technologies in 18 high GHG-emitting developing countries could result in trade gains of 13 percent. Clean energy technology is a growth market offering substantial export opportunities for the United States.

At the same time, however, we acknowledge the concerns of certain U.S. manufacturers, particularly in those sectors that are energy- and trade-intensive, that the compliance burden of reducing greenhouse gas emissions could lead to "emission leakage" to countries that do not also require such reductions. Any shifting of production to other countries could lead to the unintended effect of reducing the effectiveness of our domestic efforts to reduce greenhouse gas emissions. Climate change is a global environmental challenge and, while remaining consistent with our existing international obligations, the Administration wants to ensure that the U.S. response is not weakened by the failure of other countries to take action.

The Administration believes that the best approach to address concerns with emission leakage is to negotiate a new international climate change agreement that ensures that all the major emitters take long-term, significant actions to reduce their greenhouse gas emissions. The Waxman-Markey bill acknowledges this as the first-best approach as well.

In short, engaging major GHG emitting countries, and major trading partners, to ensure that they commit to significant and verifiable actions to combat climate change would be the most effective way to ensure a level playing field for U.S. manufacturing sectors.

Oil & Gas

Q6. The President's budget blueprint talks about funding for low-carbon coal technologies, but does not mention any support for oil and gas R&D. In fact, the budget proposes to repeal the Ultra Deepwater Program that was enacted into law in the Energy Policy Act of 2005. *Will you please tell us what plans DOE has to continue fossil fuel R&D for not only coal but also oil and gas?*

A6. The oil and gas R&D program plans to focus its research on methane hydrate, a potentially huge, future gas resource and possible carbon storage opportunity. Methane hydrate occurs where natural gas and water exist at cool temperatures and high pressures—in the Arctic, below the permafrost and in deep sub-sea sediments. The world methane hydrate resource is estimated to be larger than the conventional natural gas resource, for example, the Alaska North Slope has an estimated 85 trillion cubic feet (TCF) of undiscovered, technically recoverable gas in methane hydrates compared to 37.5 TCF in conventional deposits.

The DOE program aims to have the technology needed for methane production from arctic hydrate by 2015 and from offshore hydrate by 2025. The program plans to conduct the world's first long-term production test of methane hydrate deposits in the Alaska North Slope in 2010–2011. The program will also be conducting the first test of CO_2 injection into a methane hydrate reservoir to produce natural gas and store carbon in Alaska in 2010–2011.

Q7. In the Recovery Act, $400 million was set aside for geothermal energy R&D. In the Energy Independence and Security Act *(EISA)* of 2007, *the geothermal provision included a section on geothermal energy production from oil and gas*

fields and recovery and production of geopressured gas resources—Section 616. Does DOE plan to implement this section which was authorized at $10 million a year?

A7. Yes. Through the Recovery Act funding, the Department's Geothermal Technologies Program is implementing Section 616 of the *Energy Independence and Security Act.* Geothermal energy resource development from oil and gas operations is an untapped opportunity which would use high temperature water currently treated as a waste. The Department's goal is to demonstrate the technical and economic feasibility of geothermal energy production from these non-conventional geothermal resources.

Through a funding opportunity announcement issued recently, DOE will award up to 20 grants or cooperative agreements for up to $50 million in support of geothermal energy production from oil and gas fields, geopressured fields, and low temperature resources throughout the United States.

Coal

Q8. You said in your testimony that you would like to expand international collaboration on demonstrating carbon capture and sequestration. Will you tell us more about this and your plans for FutureGen? Do you foresee willing international cooperation in light of how our international partners were treated after the restructuring of FutureGen?

A8. After several meetings between DOE officials and representatives from the FutureGen Industrial Alliance, Inc. (Alliance), an agreement has been made to once again pursue the FutureGen project in Mattoon, Illinois. Under the terns of the provisional agreement between DOE and the Alliance, DOE will issue a National Environmental Polity Act (NEPA) Record of Decision on the project by the middle of July 2009, with the following activities to be pursued from the end of July 2009 through early 2010: Rapid restart of preliminary design activities; Completion of a site-specific preliminary design and updated cost estimate; Expansion of the Alliance sponsorship group; Development of a complete funding plan, and; Potential additional sub-surface characterization. The Department's maximum anticipated financial contribution for the project is $1.073 billion, $1 billion of which comes from Recovery Act funds for Carbon Capture and Storage (CCS) research. FutureGen is expected to have a strong international element and would include outreach to all interested countries, including those who were previously engaged with FutureGen.

Nuclear

Q9. In light of the Administration's decision to move beyond a repository at Yucca Mountain, where does that leave DOE in regards to reprocessing and the next generation of nuclear plants?

A9. The Department is pursuing long-term, science-based nuclear R&D through its Generation IV Nuclear Energy Systems and the Fuel Cycle R&D programs. Gen IV R&D will focus on answering key research questions that could help establish the viability of next-generation nuclear energy technologies or could be useful in extending the operating life of existing light water reactors (LWRs). Fuel Cycle R&D will focus on wide variety of fuel and waste-related topics, such as research on separations technologies and systems and on waste forms with predictable, long-term behavior and enhanced resistance to long-term degradation suitable for a variety of potential environments. These efforts could enable beneficial changes to the way in which nuclear fuel and waste is managed.

Q10. Do you believe that nuclear energy is an important part of our current and future energy mix? Will the plan to scrap Yucca affect in any way the ability for companies today to go forward with building new plants?

A10. Nuclear power currently supplies nearly 20 percent of the Nation's electricity and approximately 70 percent of its greenhouse gas-free electricity. Nuclear power will continue to play a role in our energy mix. It can help achieve our energy security and climate goals, and the Department is committed to supporting such use in a safe and secure manner that minimizes proliferation concerns.

The Department believes reevaluating options for spent fuel should not affect the ability of companies to go forward with plans for new nuclear power plants. The Secretary has announced his intent to convene a blue-ribbon commission to evaluate all spent fuel options and consider long-term solutions.

Biofuels

Q11. Recently an application was submitted to EPA requesting approval for the use of up to 15 percent ethanol in gasoline which was justified in part on the basis that this increase would lead to "increased energy security." Has DOE performed or sponsored (or are you aware of) any studies which support the contention that raising the maximum allowable amount of ethanol in gasoline from 10 percent to 15 percent will lead to "increased energy security"?

A11. DOE has not performed any specific studies that investigate the impact of specific blend levels on increased energy security.

The renewable fuel standard (RFS), established by Section 202 of the *Energy Independence and Security Act of 2007* was enacted in part to improve energy security. The RFS calls for increasing the volume of renewable fuels to 36 billion gallons by 2022. In 2008, about nine billion gallons of ethanol were produced and consumed. The majority of ethanol is consumed in the E10 market and a small amount is absorbed as E85. If ethanol continues to be the dominant renewable fuel in the market, deployed via blends of 10 percent ethanol in gasoline, the U.S. will not be able to use the amount specified in RFS targets (15.2 billion gallons per year) by 2012 unless significant additional volumes of ethanol are sold as E85.

Q12. DOE is currently co-sponsoring a significant amount of research aimed at investigating vehicle emissions—energy and emissions control system durability characteristics while operating on gasoline containing greater than 10 percent ethanol. This research is expected to take at least two to three years to complete. Is DOE planning to change or refocus their research on mid-level ethanol blends in any way in light of a petition recently submitted requesting approval for the use of up to 15 percent ethanol in gasoline? If so, how?

A12. In 2007, the Department of Energy (DOE) began evaluating the potential impacts of E15 and E20 on emissions, durability, operability, drivability, and materials when used in conventional vehicles and non-road engines. Throughout the process, DOE has worked closely with the Environmental Protection Agency (EPA) to ensure that data from DOE's test program can assist EPA in effectively evaluating waiver requests.

Last October, DOE reported results from a "quick look study" which included emissions testing on 16 vehicles as well as 28 small non-road engines. Regulated tailpipe emissions for the 16 vehicles either decreased or showed no statistically significant change with increased ethanol content relative to gasoline.

Since completion of these initial tests, DOE has been engaged in a wide range of additional vehicle testing. Recognizing the need to expedite testing, particularly regarding emissions over the full-useful life of vehicles, DOE has significantly increased funding for this effort and is now simultaneously using three facilities rather than just one to conduct testing. As a result, a substantial amount of data on full-useful life emissions will be available in approximately one year, coinciding with the completion of several other studies. These studies will provide significant information to assist EPA in (1) making a determination as to whether E15 or E20 can be viably used in conventional vehicles and (2) setting renewable fuel volume levels for 2011 in light of its determination on E15 or E20.

Q13. To what extent will the EPA's impending proposal on the treatment of the greenhouse gas impacts associated with indirect land-use changes caused by the increased use of some biofuels (e.g., corn-based ethanol) cause DOE to shift research priorities in its biomass R&D program?

A13. Research priorities for DOE's Biomass Program will not shift as a result of EPA's proposed treatment of greenhouse gas impacts associated with indirect land-use changes. Current R&D work with Purdue University is focused on better understanding and developing DOE's ability to analytically assess indirect land use change impacts on biofuels using the Global Trade and Agriculture Project (GTAP) model. The data utilized in existing models such as GTAP represent the best available, but need to be continually and significantly improved as we develop new models in the future.

The Department's Biomass Program will continue to focus on the development and sustainability of cellulosic and advanced biofuels, which show very positive greenhouse gas benefits with or without assessing an indirect land use "penalty."

Q14. A number of research efforts are looking at ways to convert plant sugars directly into "green gasoline," avoiding the fermentation process used to produce ethanol in today's biorefineries. With respect to distillates, interest is growing in so-called "renewable diesel" which is chemically similar to petroleum-based

diesel, yet produced by a process that relies on animal- or vegetable-based feedstocks. Green gasoline and renewable diesel have been shown to be superior to ethanol and biodiesel in that they can be transported and stored using the same infrastructure currently devoted to petroleum products. To what extent is DOE R&D focused on improving the cost-effectiveness of green gasoline and renewable diesel?

A14. DOE is conducting R&D on green gasoline and renewable diesel as part of the Office of Biomass's existing thermochemical platform. The current portfolio contains research into pyrolysis and fuel synthesis from pyrolysis oil as well as synthesis gas clean up for use as an intermediate to fuels. In addition, Recovery Act funding will be used to establish a research consortium specifically targeting the research to overcome barriers to cost effective production of biomass derived hydrocarbon fuels.

The Office of Biomass Program's Integrated Biorefinery Platform is currently funding two projects to demonstrate the conversion of biomass to Fischer Tropsch (FT) liquids at existing pulp and paper mills. These FT liquids will be further processed into renewable diesel. Also, a pilot and demonstration scale solicitation funded by the Recovery Act will accept applications producing green gasoline and renewable diesel.

Q15. We've heard claims about cellulosic ethanol being "right around the comer" for over 20 years now. It's my understanding that industry is not going to meet the RFS2 mandate of 100 million gallons in 2010, nor future mandates in the next several years. How long does it take between the introduction of a new technology at commercial scale before it can be rapidly scaled up? For example, what does DOE think are reasonable targets for the RFS2 cellulosic mandates, accepting that the current mandates are far too optimistic?

A15. It can take up to ten years from the introduction of a new technology to be scaled up to commercial scale. This time frame can be even more difficult to ascertain given the challenging economic climate and extreme variations in energy prices.

Currently, the Biomass Program has a total of 12 biorefinery projects in development. The four commercial projects authorized under section 932(d) of the *Energy Policy Act* (EPAct) *of 2005* are expected to deliver the first commercial scale production of cellulosic biofuels. Of the four projects, two have initiated construction; a third is expected to enter into a Technology Investment Agreement and start the construction phase of the project early in FY 2010. The fourth project will likely reach a phase two agreement and initiate the construction phase later in FY 2010. The construction phase of the last two projects will be funded by the Recovery Act. The eight remaining projects are in various phases of development.

They are all demonstration projects with construction anticipated in the 2011–2012 timeframe.

Collectively, these 12 projects represent over 100 million gallons of biofuel production annually; however, they have all experienced delays due to deteriorating market conditions. Based on current schedules, none of the projects will be producing commercial volumes in 2010. However, we expect the first facilities to come on line in the 2011–2012 time frame.

Consequently, the Department believes that meeting the 2010 target for cellulosic biofuels set by the RFS2 will be extremely challenging. However, the RFS2 does provide the Environmental Protection Agency (EPA) authority to adjust the cellulosic targets. Although the initial targets may need adjustments, it is anticipated that once the existing projects and those represented in the Recovery Act Biorefinery Funding Opportunity start production, the out-year RFS2 cellulosic biofuel goals can be met.

Q16a. In 2007 language in the RFS2 attempted to provide technology neutrality so that all feedstocks and technologies had an opportunity to develop. I congratulate the Department on their recent modification which allows technologies such as Amyris LS9 Gevo and others to utilize currently available feedstocks such as sugarcane, sugars, and sorghums to demonstrate their technologies. We all support the development of cellulosic technologies but it would be wrong to require these other advanced technologies to wait for feedstocks to be produced from only cellulosic material at this point in time do you agree?

A16a. The Department does agree that certain advanced technologies will need to use more readily available feedstocks to foster the development of their technology. This research is supported by the Biomass Program's recent Integrated Biorefinery Pilot and Demonstration Funding Opportunity funded by the Recovery Act. This solicitation has six different topic areas which allow for cellulosic biomass, algae, or

any renewable biomass (other than corn starch) to compete for the production of fuels and bioproducts on either a pilot or demonstration scale.

Q16b. Additionally your new modification requires an 80 percent life cycle reduction. The provision in the RFS for advanced biofuels is only 50 percent. Why the difference? Why not harmonize with the EPA rule for the long-term?

A16b. The reason for the difference is that advanced biofuels explored under Section 207 of the *Energy Independence and Security Act* (EISA) require a higher greenhouse gas reduction requirement of 80 percent versus 50 percent. Ultimately, it is not only the harmonization of the greenhouse gas reduction requirements that are anticipated, but also their optimization. To allow for the most rapid progression and dissemination of advanced biofuels technologies, the Department made a decision to allow for their advancement under this announcement utilizing the broader definition of advanced biofuels and allowable feedstocks contained in Section 207. This definition is less stringent than that contained in EISA Section 201 but as noted contains a more stringent greenhouse gas reduction requirement.

Cap-and-Trade

Q17. In your testimony, in talking about the President's goal of passing a cap-and-trade bill, you state that "Such legislation will provide the framework for transforming our energy system to make our economy less carbon-intensive, and less dependent on foreign oil." How will the R&D going on at DOE be affected by the passage of a cap-and-trade bill?

A17. A cap-and-trade program would not have direct impacts on DOE R&D efforts unless there are provisions in the legislation that specify that proceeds from auction allowances are allocated to DOE R&D investment. A cap-and-trade system would help drive the clean energy transformation of the U.S. economy by driving increased private-sector spending on energy efficiency, renewable energy, carbon capture and storage, Smart Grid, and other clean energy technologies.

Cap-and-trade legislation would also encourage increased private-sector R&D spending on low-carbon technologies.

Question submitted by Representative Dana Rohrabacher

Q1. You mentioned cost concerns whenever "putting things in space" is mentioned, and rightly so. The NSSO Study Report on Space-Based Solar Power, which I mentioned, states that the technology vectors are converging towards economic feasibility—not only for domestic use, but for forward deployed troops, for disaster recovery areas around the globe, and for a host of other "off-grid" activities. This report specifically takes into account the realities of cost concerns regarding space access. The report states that this system can provide baseload power, is pollution free, has no carbon emissions (which I know is among your goals, whether I agree with it or not), and can eliminate our reliance on foreign sources of energy (which I strongly do agree with). But in order to attain these benefits, the Federal Government needs to "retire a major portion of the technical risk" and "become an early demonstrator/adopter/customer" of Space-Based Solar Power. Will you use some portion of your significantly increased R&D budget toward these goals?

A1. The Department currently has no plans to support projects specifically focused on space-based solar systems. DOE's Solar Energy Technologies Program is focused on terrestrial solar applications to increase solar-based electricity generation and to achieve grid parity by 2015. However, several technologies under development have the characteristics—high efficiency, light weight, and radiation resistance—that space-based solar systems require. These technologies, which include CIGS (copper indium gallium selenide), concentrating solar power, and concentrating photovoltaics—could be adapted for space-based applications.

Questions submitted by Representative Brian P. Bilbray

Fusion Research

Q1. The continuation of U.S. participation in ITER provides an opportunity for U.S. scientists to continue their contributions to magnetic fusion energy research, and signals a significant investment in this potential future energy source. What additional investments are needed—either in existing or new domestic initiatives

or via additional international collaborations—so that the U.S. is prepared to move forward with a demonstration fusion power plant at the end of the ITER experiment? What is the Department's plan for making these investments?

A1. ITER is a large-scale international research collaboration that plans to build, operate, and eventually de-commission the world's first burning plasma fusion reactor. A successful fusion energy program requires not only the success of ITER, but additional research in a number of areas. Currently, the Fusion Energy Sciences (FES) program is in the process of identifying the remaining scientific challenges that need to be addressed in order to make fusion a potential future energy source. FES will use this information to develop a long-range strategic plan.

Q2. The U.S. has made a large national investment in the National Ignition Facility (NIF) at LLNL and this device is now preparing for the National Ignition Campaign which is expected to demonstrate the first large energy gain in a laboratory fusion experiment. Clearly the U.S. can lead the world in this type of controlled fusion research. What is the Department's plan for capitalizing upon this investment and opportunity once ignition and gain is demonstrated on NIF, and how will the Secretary ensure that institutional barriers within the DOE organization do not hinder the Nation from seizing this opportunity?

The current rate of progress in fusion research will not provide the Nation with the ability to pursue energy-producing demonstration reactors anytime in the foreseeable future. What resources is the Administration prepared to seek in order to provide a definitive determination of the feasibility of energy production from fusion energy?

A2. Successful completion of the National Ignition Campaign (NIC) on NIF will represent a large step forward in consolidating our scientific knowledge base for creating fusion by inertial confinement; however, a significant amount of research and development would still be required in making inertial fusion into an attractive power source. The National Nuclear Security Administration (NNSA) also has plans to utilize the results of NIC to produce a stable, reproducible ignition platform. In addition, NNSA and the Office of Science's Fusion Energy Sciences program have undertaken a joint program in High Energy Density Laboratory Plasmas to prepare us to exploit the scientific information coming from NIF, for both energy applications and other important national needs. We expect that this collaboration will provide an important starting point for efficient and effective interaction between NNSA and non-NNSA researchers in inertial fusion energy sciences and other high energy density research areas in the future.

The Administration is examining all potential options for enhancing the Nation's energy security, especially the development of short-term solutions. Fusion represents a compelling longer-term option, which holds the possibility of energy by mid-century on the present track of R&D. We look forward to discussing the funding requirements for the entire portfolio of clean energy solutions with Congress in the coming months and years.

Q3. In light of recent news reports about Cold Fusion research by the Navy's SPAWAR in partnership with a [San Diego-based] private sector company, what are the DOE's plans regarding this potentially ground-breaking technology?

A3. The Office of Science (SC) and Office of Nuclear Energy recently received a briefing on the Cold Fusion research by the Navy's SPAWAR in partnership with a private sector company. The company was encouraged to have further discussions with several offices within SC. If the company wishes to submit a proposal for funding to any part of the DOE, including the recently established Advanced Research and Projects Agency–Energy (ARPA–E), then, just like any other proposal, it must go through a peer review to determine its scientific merit before any funding decision could be made.

Smart Grid/Energy Storage

Q4. Mr. Secretary, your statement did not make reference to Smart Grid and advanced energy storage. Clearly, these are key components to achieving meaningful advances in the areas of renewable energy and distributed generation and it is my understanding that the Department is planning a robust portfolio of research funding opportunities on these topics. Can you provide us with a preview of how the Department plans to allocate research funding in these areas, and the degree to which these opportunities will be open to university researchers?

A4. The Department's FY 2010 budget request for the Office of Electricity Delivery and Energy Reliability includes $67 million for Smart Grid activities, and $15 mil-

lion for energy storage research. This funding includes support for an energy innovation hub focused on smart materials and power electronics. In FY 2010, the Innovation Hub will be solicited through a competitive process, which is intended to include university researchers.

Biofuels Research

Q5. In your testimony, you note that DOE has "funded three Bioenergy Research Centers—one at the Oak Ridge National Laboratory in Oak Ridge, Tennessee; one led by the University of Wisconsin in Madison, Wisconsin, in close collaboration with Michigan State University in East Lansing, Michigan; and one led by the Lawrence Berkeley National Laboratory. Each of these centers is targeting breakthroughs in biofuel technology development that will be needed to make abundant, affordable, low-carbon biofuels a reality. While these efforts are still relatively new, they are already yielding results, such as the bioengineering of yeasts that can produce gasoline-like fuels, and the development of improved ways to generate simple sugars from grasses and waste biomass. We need to do more transformational research at DOE to bring a range of clean energy technologies to the point where the private sector can pick them up, including: 1. Gasoline and diesel-like biofuels generated from lumber waste, crop wastes, solid waste, and non-food crops . . ." *Does the Department now plan to fund similar national centers on a broader range of potential transportation fuel technologies, including non-food crop feedstocks such as algae? If so, could you outline the Department's plan for doing so?*

A5. The Office of Science believes that the three integrated research centers now working on the development of cost-effective biofuels from cellulose (non-food plant fiber) represent an optimal investment. We have considered both the range of scientific challenges in this area and the resources of the scientific community working in this field. The work of the DOE Bioenergy Research Centers is supplemented by additional systems biology research related to bioenergy, primarily grants to individual investigators within the Genomic Science program in the Office of Science's Biological and Environmental Research program. There is also important applied research related to biofuels, including algal biofuels, underway or planned by the Office of Energy Efficiency and Renewable Energy. Using Recovery Act funding, the Energy Efficiency Office's Biomass program intends to issue a Funding Opportunity Announcement to address research and development efforts related to algal advanced biofuels. DOE expects to publish the announcement in the summer of 2009. The special notice announcing this intent was posted on the Energy Efficiency website on May 5, 2009.

Q6. In response to a question posed by Senator Lamar Alexander (R–TN) during a March 11th Senate Budget Committee hearing, you agreed that algae was indeed promising, but that it required a "tremendous amount of surface area" to cultivate. Algae actually produce over 14 times more BTUs of energy per acre per year than corn. Would you agree that you and your staff at the Department of Energy (DOE) should seek to learn more about algal biofuel technologies from companies like Sapphire Energy, a company located in La Jolla that recently tested its algal jet fuel on a commercial dual engine jet with great success, to correct such misperceptions?

A6. Certain types of micro-algae can accumulate high concentrations of energy-dense storage lipids, which can be turned into biofuels. It is true that if a higher concentration of these lipids can be achieved, then a smaller surface area will be required to produce the same amount of biofuel. However, additional research and development is needed to reduce cost of algal biofuels production, due to substantial scale-up barriers. The Department is very interested in the potential of algae, and recently held the National Algal Biofuels Technology Roadmap workshop in December 2008 to solicit input from leading experts, such as Sapphire Energy. It is our plan to use this Roadmap to inform future R&D efforts on algal biofuels.

Q7. How is the DOE poised to help algae companies like Sapphire, which currently has a shovel-ready pre-commercial project in Las Cruces, NM, succeed? And how will the DOE help algae companies achieve a level playing field with cellulosic ethanol companies that have had years of money and research and development support from the DOE and its national labs?

A7. The DOE recently announced a Notice of intent to use $50 million of Recovery Act funding to fund an algal biofuels consortium. The consortium will be a multidisciplinary team selected via a competitive peer-reviewed solicitation process. Industry leaders, such as Sapphire Energy, are encouraged to participate. This consor-

tium is part of a larger DOE effort to accelerate the development of advanced fungible biofuels (non-ethanol). In addition, algae companies are welcome to compete in our solicitation for pilot and demonstration-scale integrated biorefinery.

Q8. Given the clear statement of congressional intent in the FY09 omnibus regarding research into alternative transportation fuels derived from non-food crops, such as algae, (see bill language following this question) what can you tell us about DOE's plan for spending the $800 million designated in the stimulus bill for biomass research? Title III, Energy Efficiency and Renewable Energy Biomass and Biorefinery Systems R&D—the bill includes $217,000,000 for integrated research and development on biomass and biorefinery systems. The Department should pursue development of biofuels from non-food sources, especially those with the largest potential to sequester industrial carbon dioxide, such as algae, that are also compatible with gasoline and diesel fuels.

A8. The $800 million for biomass related projects from the Recovery Act includes: $480 million for integrated pilot- and demonstration-scale biorefineries; $176.5 million for increased investment in existing commercial-scale biorefinery projects; $85 million to create research consortia for infrastructure-compatible and algal biofuels; $25 million for sustainability research through the Office of Science Bioenergy Research Centers and to establish a user-facility/small-scale integrated pilot plant; $20 million to optimize flex-fuel vehicles operating on high octane E85 fuel, to evaluate the impact of higher ethanol blends in conventional vehicles, and to upgrade existing refueling infrastructure to be compatible with fuels up to E85; and $13.5 million to expand the pretreatment capacity and options at the National Renewable Energy Laboratory Integrated Biorefinery Research Facility.

Spent Nuclear Fuel Storage

Q9. In the absence of Yucca Mountain, what would be your plan for the disposition of DOE-spent fuel and high level waste accumulating at DOE EM cleanup sites at Hanford, Idaho and Savannah River? Without Yucca Mountain, what is your plan to comply with current agreements between the Federal Government and the states that require the removal of these radioactive materials on a stipulated and binding legal agreement?

A9. For the near-term, existing Departmental policy for managing High-Level Waste (HLW) and Spent Nuclear Fuel (SNF) remains unchanged. Current plans provide for safe storage of the material for one to two decades. With adequate maintenance and surveillance, it is estimated these materials could be stored at our sites for a longer period of time, potentially as long as 100 years, and still be safely retrieved. The Administration intends to convene a "blue-ribbon" panel of experts to evaluate alternative approaches for meeting the federal responsibility to manage and ultimately dispose of spent nuclear fuel and high-level radioactive waste from both commercial and defense activities.

Q10. Do you know what the current estimated liability is? In your view, if the Yucca program does not go forward, is not properly funded or is otherwise terminated, what in your view would be the total estimated liability if U.S. utilities filed for full breach of contract with DOE?

A10. The Department has estimated the liability resulting from the delay in beginning waste acceptance in 1998 would be $12.3 billion, assuming performance beginning in 2020. The amount of government liability that might result from a "full" breach of contract would be based on a number of variables that are not quantifiable at this time.

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