

**AN OVERVIEW OF THE
DEPARTMENT OF ENERGY
RESEARCH AND
DEVELOPMENT BUDGET
FOR FISCAL YEAR 2013**

HEARING
BEFORE THE
COMMITTEE ON SCIENCE, SPACE, AND
TECHNOLOGY
HOUSE OF REPRESENTATIVES
ONE HUNDRED TWELFTH CONGRESS

SECOND SESSION

THURSDAY, MARCH 1, 2012

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CONTENTS

Date of Hearing

	Page
Witness List	2
Hearing Charter	3

Opening Statements

Statement by Representative Ralph M. Hall, Chairman, Committee on Science, Space, and Technology, U.S. House of Representatives	13
Written Statement	14
Statement by Representative Eddie Bernice Johnson, Ranking Minority Mem- ber, Committee on Science, Space, and Technology, U.S. House of Rep- resentatives	15
Written Statement	16

Witnesses:

Dr. Steven Chu, U.S. Secretary of Energy	
Oral Statement	18
Written Statement	19
Discussion	22

Appendix 1: Answers to Post-Hearing Questions

Dr. Steven Chu, U.S. Secretary of Energy	52
------------------------------------------------	----

Appendix 2: Additional Material for the Record

Analysis of Impacts of a Clean Energy Standard as Requested by Chairman Bingaman, November 2011	123
Charts Submitted by Representative Rohrabacher	155

**AN OVERVIEW OF THE
DEPARTMENT OF ENERGY
RESEARCH AND DEVELOPMENT BUDGET
FOR FISCAL YEAR 2013**

THURSDAY, MARCH 1, 2012

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

The Committee met, pursuant to call, at 9:36 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Ralph Hall [Chairman of the Committee] presiding.

RALPH M. HALL, TEXAS
CHAIRMAN

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

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*An Overview of the Department of Energy Research and
Development Budget for Fiscal Year 2013*

Thursday, March 1, 2012
9:30 a.m. to 12:00 p.m.
2318 Rayburn House Office Building

Witnesses

Dr. Steven Chu, *U.S. Secretary of Energy*

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

HEARING CHARTER

*An Overview of the Department of Energy Research and Development Budget
for Fiscal Year 2013*

Thursday, March 1, 2012
9:30-12:00
2318 Rayburn House Office Building

PURPOSE

On Thursday, March 1, 2012, the Committee on Science, Space, and Technology will hold a hearing entitled "*An Overview of the Department of Energy Research and Development Budget for Fiscal Year 2013.*" The purpose of the hearing is to examine energy policy and budget priorities related to the President's Fiscal Year (FY) 2013 budget request, including activities within the DOE offices of Science, Energy Efficiency and Renewable Energy, Advanced Research Projects Agency–Energy, Fossil Energy, Nuclear Energy, Electricity Delivery and Energy Reliability, and the Loan Guarantee Program Office.

WITNESS

Dr. Steven Chu, U.S. Secretary of Energy. Dr. Chu was confirmed as the 12th Secretary of Energy on January 20, 2009. Prior to his appointment 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. He is the co-winner of the 1997 Nobel Prize for Physics.

Department of Energy (DOE) Spending
(dollars in millions)

Program	FY11 Actual	FY12 Enacted	FY13 Request	FY13 Request versus FY12 Enacted	
				\$	%
Office of Science					
<i>Advanced Scientific Computing Research</i>	410.3	440.9	455.6	14.7	3.3
<i>Basic Energy Sciences</i>	1638.5	1688.1	1799.6	111.5	6.6
<i>Biological and Environmental Research</i>	595.2	609.6	625.3	15.7	2.6
<i>Fusion Energy Sciences</i>	367.3	401.0	398.3	(2.7)	(0.7)
<i>High Energy Physics</i>	775.6	790.9	776.5	(14.4)	(1.8)
<i>Nuclear Physics</i>	527.7	547.4	526.9	(20.5)	(3.7)
Office of Science*	4897.3	4873.6	4992.1	118.5	2.4
Energy Efficiency and Renewable Energy (EERE)					
<i>Hydrogen and Fuel Cell Technologies</i>	95.8	103.6	80.0	(23.6)	(22.8)
<i>Biomass and Biorefinery Systems</i>	180.0	199.3	270.0	70.8	35.5
<i>Solar Energy</i>	259.6	289.0	310.0	21.0	7.3
<i>Wind Energy</i>	78.8	93.3	95.0	1.7	1.8
<i>Geothermal Technology</i>	37.0	37.9	65.0	27.1	71.5
<i>Water Power</i>	29.2	58.8	20.0	(38.8)	(66.0)
<i>Vehicle Technologies</i>	293.2	328.8	420.0	91.2	27.7
<i>Building Technologies</i>	207.3	219.2	310.0	90.8	41.4
<i>Advanced Manufacturing**</i>	105.9	115.6	290.0	174.4	150.9
Energy Efficiency and Renewable Energy (EERE)*	1771.7	1809.6	2337.0	527.4	29.1
Nuclear Energy***	806.0	858.7	770.4	(88.3)	(10.3)
Electricity Delivery and Energy Reliability R&D	102.1	99.1	103.4	4.3	4.3
Fossil Energy R&D	434.1	346.7	420.6	73.9	21.3
ARPA-E	179.6	275.0	350.0	75.0	27.3
Loan Guarantee Program Office	179.5	6.0	9.0	3.0	50.0
Totals:	8370.3	8268.7	8982.5	713.8	8.6

*Total program funding; minor and non-S&T accounts at SC and EERE are not shown.

**Industrial Technologies Program renamed as Advanced Manufacturing Office in FY 2013.

*** Total Office of Nuclear Energy; includes Facility Management and Idaho Safeguards and Security

BACKGROUND

The Department of Energy (DOE) funds a wide range of research, development, demonstration, and commercial application activities. DOE's primary mission is to "advance the national economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex."¹ In order to fulfill its mission, DOE operations are guided by five strategic themes: energy security, nuclear security, scientific discovery and innovation, environmental responsibility, and management excellence.

The overall FY 2013 budget request for DOE is \$27.2 billion, which represents a \$855.5 million or 3.2 percent increase over FY 2012 levels. Approximately one third of this amount is dedicated to programs within the Committee on Science, Space, and Technology's jurisdiction. The balance of DOE's funding is allocated to the National Nuclear Security Administration (NNSA), to maintain our stockpile of nuclear weapons, and Defense and Non-Defense Environmental Management (EM) programs, to manage the cleanup of nuclear weapons production and government-sponsored nuclear energy research.

DOE R&D PROGRAMS AND OFFICES

Office of Science

The total FY 2013 budget request for the Office of Science (SC) is \$5.0 billion, a \$118.4 million or 2.4 percent increase over the FY 2012 levels. The mission of the Office of Science is the delivery of scientific discoveries, capabilities, and major scientific tools to transform the understanding of nature and to advance the energy, economic, and national security of the United States. In support of this mission, SC supports basic research in the following areas: advanced scientific computing, basic energy sciences, biological and environmental research, fusion energy sciences, high energy physics, and nuclear physics. SC's operations take place in three main areas: selection and management of research (47 percent of SC's FY 2013 budget request); operation of world-class, state-of-the-art scientific facilities (38 percent); and design and construction of new facilities (14 percent).

SC also supports several ongoing interagency initiatives such as the Networking and Information Technology Research and Development program; the National Networking Initiative; the United States Global Change Research Program; and the Climate Change Technology Program. SC provides approximately 45 percent of Federal support of basic research in the physical sciences and key components of the Nation's basic research in biology and high-end computing.

Office of Science budget and activities are divided into the following six major program areas:

Basic Energy Sciences (BES) requests \$1.8 billion, an increase of \$111.5 million (or 6.6 percent) over FY 2012 levels. BES supports basic research into the fundamental building blocks necessary for advancing new energy technologies, and maintains world-class research facilities to develop new knowledge and facilitate advances in areas such as materials science and chemistry. BES requests funding for ongoing operation of two existing Energy Innovation Hubs:

¹ All DOE mission statement quotes come from the cited office's website.

\$24.2 million for the fourth fiscal year of the Fuels from Sunlight Hub, administered by the Chemical Sciences, Geosciences, and Biosciences subprogram; and \$24.2 million for the second year of the Batteries and Energy Storage Hub, administered by the Materials Sciences, and Engineering subprogram.

In order to realize significant research gains and advance new research methodology, in 2009 BES initiated the creation of Energy Frontier Research Centers (EFRCs.) EFRCs are individually funded between \$2-5 million per year to conduct focused research from a small team to solve “grand challenges” associated with disruptive scientific advances. DOE requests continued funding for all 46 existing EFRCs in FY 2013.

Biological and Environmental Research (BER) would receive \$625.3 million in the President’s budget, which is \$15.7 million (2.6 percent) over FY 2012 funding. BER examines fundamental biological systems, climate, and environmental sciences. Specifically, BER researches genomics, drivers of climate change, and deeper environmental issues. The request also includes support for the three DOE Bioenergy Research Centers, the Joint Genome Institute, and Environmental Molecular Sciences Laboratory.

The majority of the requested increase is directed to the Climate and Environmental System Science subprogram, which increases \$11.6 million (17.1 percent). This funding will support a “next-generation ecosystem experiment, begun in 2012, focused on the relationship between climate change and Arctic permafrost ecosystems and will initiate a new activity exploring the relationship between climate and tropics ecology.”²

The budget would provide \$455.6 million for **Advanced Scientific Computing Research (ASCR)**, an increase of \$14.7 million (3.3 percent) over FY 2012 levels. Within ASCR, the two primary subprograms face different funding profiles for FY 2013. The Mathematical, Computational, and Computer Sciences Research subprogram would receive an increase of \$28.1 million (18.1 percent) to focus on the challenge of data-intensive science and develop the computational capacity for future super-computing needs. The High Performance Computing and Network Facilities subprogram request decreases by \$13.3 million (4.6 percent) from FY 2012 enacted levels. The budget request includes \$68.5 million to continue investigating the potential for an exascale computing system aimed at increasing computational capacity by a thousand-fold.

The request for **Fusion Energy Sciences (FES)** is \$398.3 million, a decrease of \$2.7 million (0.7 percent) below FY 2012 funding. FES supports research to improve fundamental understanding of matter at very high temperatures and densities needed to develop fusion energy. The contribution to the international ITER project, a partnership to demonstrate the first fusion prototype, is \$150 million, an increase of \$45 million (42.9 percent) above FY 2012 enacted funding.

The FY 2013 funding request for **High Energy Physics (HEP)** is \$776.5 million, a \$14.3 million (1.8 percent) decrease from the enacted FY 2012 level. HEP probes the basic relationship between space and time, the elementary constituents of matter and energy, and the interactions

² Department of Energy, FY 2013 Congressional Budget Request, Volume 4, p. 148.

between them. This effort is concentrated on three scientific frontiers: the energy frontier, the intensity frontier, and the cosmic frontier.

Nuclear Physics (NP) would receive \$526.9 million, a decrease of \$20.4 million (3.7 percent) below FY 2012 funding. This program supports research to discover and understand various forms of nuclear matter. It also supports the production and development of techniques to make isotopes that are in short supply for medical, national security, environmental, and other research applications.

Energy Efficiency and Renewable Energy

The mission of the Office of Energy Efficiency and Renewable Energy (EERE) is to “strengthen the United States’ energy security, environmental quality, and economic vitality in public-private partnerships.” EERE supports this mission statement by: “Enhancing energy efficiency and productivity; bringing clean, reliable and affordable energy technologies to the marketplace; and making a difference in the everyday lives of Americans by enhancing their energy choices and their quality of life.” EERE participates in many crosscutting activities with other departments, as well as within DOE offices, including collaborations with the Office of Science, the Advanced Research Projects Agency - Energy, Office of Electricity, Fossil Energy, Federal Energy Management Program, and the Loan Guarantee Program Office.

The Administration’s budget request of \$2.3 billion for EERE represents a \$527.4 million (29.1 percent) increase over FY 2012 levels. This reflects the President’s continued emphasis on increasing spending to develop clean energy technologies. Additionally, EERE requests statutory language allowing the Secretary of Energy to transfer up to \$100 million to the Defense Production Act Fund.

The proposed funding for the **Solar Energy** program is \$310 million, an increase of \$21 million (7.3 percent) over FY 2012 levels. This request continues to support the Administration’s “SunShot” initiative. A primary component of this initiative is EERE’s “Dollar-a-Watt” program to make solar energy cost-competitive with fossil fuels without subsidies. To achieve this goal, solar generation needs to reach a five to six cents/kWh equivalent installed price for solar photovoltaics (PV) energy by 2020, or reduce the installed cost of solar electricity by approximately 75 percent from current costs. In order to achieve the SunShot goals, the budget requests additional emphasis on late-stage technology development activities. Market transformation activities receive an increase of \$10.2 million (32 percent) and the manufacturing and SunShot validation subprogram receives a \$25.3 million (30 percent) increase above FY 2012 levels.

The FY 2013 funding request for the **Wind Energy** program is \$95 million, an increase of \$1.7 million (1.9 percent) over FY 2012 enacted levels. The request focuses funding on activities to develop offshore wind technology, and aims to address financial, regulatory, technical, environmental, and social issues associated with offshore wind.

The FY2013 **Biomass and Biorefinery Systems** budget request is \$270 million, an increase of \$70.7 million (35.5 percent) over the FY 2012 level. This program aims to develop and transform domestic, renewable, and abundant biomass resources into cost-competitive, high performance biofuels, biopower, and bioproducts through targeted planning, research,

development and demonstration. DOE is seeking legislative authority to transfer funds under the Defense Production Act to coordinate EERE biofuel activities with the Navy and U.S. Department of Agriculture. The FY 2013 also includes an increased focus on bio-oil and downstream process technologies to produce final biofuel products.

The proposed funding level for the **Geothermal Technology** program is \$65 million, an increase of \$27.1 million (71.7 percent) over FY2012. The funding increase is almost exclusively dedicated to the Enhanced Geothermal Systems (EGS) subprogram. The subprogram will focus on EGS reservoir creation and monitoring technologies at EGS field test sites and will evaluate EGS stimulation techniques.

The Administration's budget request provides a total of \$20 million for the **Water Power** program, which is a \$38.8 million (66 percent) decrease from FY 2012 enacted levels. The program funds incremental hydropower development and demonstrates marine and hydrokinetic (MHK) technologies. According to the budget, the reduction in funding is due to progress in multiyear research projects intended to improve conventional hydropower. The program will focus on MHK technologies and developing open water testing for MHK devices.

The **Hydrogen and Fuel Cell Technologies** (HFCT) program requests \$80 million; a \$23.6 million or 22.8 percent decrease from FY 2012 levels. The budget states that the decrease reflects previous year progress on fuel cell technologies. FY 2013 efforts will be directed to deploying fuel cells with industry and government partners.

The budget request for the **Buildings Technologies Program** (BTP) is \$310 million, a \$174.4 million (41.4 percent) increase over FY 2012 levels. BTP supports efforts to improve the energy efficiency of new and existing homes and buildings primarily through advanced building technologies, controls, systems, and whole-building design; demonstration of integrated approaches for construction; bringing transformational tools to the market place; supporting the ENERGY STAR program; supporting the adoption, training, and enforcement of building codes; and promulgating and finalizing efficiency standards as required by law. The Energy Efficient Buildings Systems Design Hub is administered by BTP.

BTP also supports the President's *Better Buildings Initiative*, which aims to achieve a 20 percent improvement in commercial building energy efficiency by 2020. The program will expand demonstration and testing activities associated with retrofitting commercial and residential buildings. In addition to ongoing research, development, and demonstration (RD&D) activities, BTP Equipment and Buildings Standards requests an additional \$40 million in part to initiate six new conservation standards rulemaking.

The **Vehicle Technologies Program** (VTP) requests \$420 million, an increase of \$91.2 million (27.7 percent) over the FY 2012 level. VTP is centered on achieving the President's goal to place one million electric vehicles on the road by 2015. The FY 2013 increase reflects an increased emphasis on advanced battery technology and manufacturing to reduce system cost. VTP will also focus on improving Heating Ventilation Air Conditioning system technologies.

The **Advanced Manufacturing Office** (AMO, formerly the Industrial Technologies Program), request is \$290 million, an increase of \$174.4 million (150.9 percent) over FY2012 levels. The

mission of AMO is to research, develop and demonstrate at a “convincing scale new energy-efficient manufacturing processes and materials technologies to reduce the energy intensity and life-cycle energy consumption of manufactured products and promote a corporate culture of continuous improvement in energy efficiency”³ for existing manufacturing facilities.

In FY 2013, AMO’s Systems Integration activities would increase over \$100 million to develop and demonstrate manufacturing processes. DOE requests \$20 million for the second year of the Critical Materials Energy Innovation Hub to explore new technologies in order to increase the supply or reduce critical materials demand for energy efficiency and renewable energy technologies. AMO additionally seeks statutory authority to transfer funds under the Defense Production Act to reduce cost and accelerate the availability of certain technologies for both commercial and defense applications.

The Advanced Research Projects Agency –Energy

The Administration requests \$350 million in FY 2013 for the Advanced Research Projects Agency – Energy (ARPA-E), an increase of \$75 million or 27.3 percent over FY 2012 levels. In FY 2013, ARPA-E will emphasize (1) \$184 million for Transportation Systems, including batteries and systems for electric vehicles and development of market competitive fuels using domestic resources such as natural gas; and (2) \$130 million for Stationary Power, including challenges associated with “power electronics, solar, wind, osmotic power, smart grid technologies, natural gas, geothermal, and waste heat capture.”⁴

Established in 2007 by the America COMPETES Act (P.L.110-69), ARPA-E is statutorily charged with developing energy technologies that result in “(i) reductions of imports of energy from foreign sources; (ii) reductions of energy-related emissions, including greenhouse gases; and (iii) improvement in the energy efficiency of all economic sectors.” Initially provided with \$400 million in American Recovery and Reinvestment Act (ARRA) (P.L.111-5) funding, ARPA-E did not receive a direct appropriation in FY10, though it did receive a \$15 million transfer from the Office of Science.

In FY 2011, ARPA-E was provided \$180 million in funding, of which \$130 million for 60 projects has thus far been awarded. The six program areas funded in FY 2011 included Plants Engineered to Replace Oil (PETRO), High Energy Advanced Thermal Storage (HEATS), Rare Earth Alternatives in Critical Technologies (REACT), Green Electricity Network integration (GENI), and Solar Agile Delivery of Electrical Power Technology (Solar ADEPT). In FY 2012, ARPA-E plans to issue funding opportunity announcements (FOA) for Hybrid Energy Storage Modules (HESM), natural gas for transportation, Small Business Innovation Research (SBIR), and a FOA open to any transformational energy technology.

Fossil Energy R&D

The DOE Office of Fossil Energy (FE) supports R&D focused on coal (including clean coal technologies), gas, and petroleum and also supports the Federal government’s Strategic Petroleum Reserve. The President’s total budget request for FE is \$650.8 million. Of that, FE’s R&D budget is \$420.6 million, an increase of \$73.9 million (21.3 percent) above FY12 enacted

³ DOE FY 2013 Congressional Budget Request, Volume 3, p. 131.

⁴ Department of Energy, *Detailed Budget Request Volume 4*, p. 417.

levels. The FY 2012 level of \$533.7 million included a rescission of \$187 million resulting from termination of a major carbon capture and sequestration (CCS) demonstration project funded in a previous fiscal year. The base budget request for FE R&D, before accounting for this rescission, represents a decrease of \$105.2 million, or 19.7 percent.

Coal R&D is funded at \$275.9 million, the bulk of which focuses on advancing carbon capture and sequestration (CCS) efforts. FY 2013 Carbon Capture subprogram efforts are dedicated to achieving FE's goal to accomplish post-combustion carbon dioxide capture at no more than a 35 percent increase in electricity costs. The program is also identifying technologies to acquire commercial value of sequestered carbon through Carbon Capture, Utilization, and Sequestration activities to improve the economic viability of CCS technology. The Carbon Storage subprogram is mostly focused on maintaining funding for regional carbon sequestration partnerships to study the viability of long-term geologic storage in various formations.

The Clean Coal Power Initiative (CCPI) does not request additional funding to support CCS demonstration projects. In FY 2013, CCPI will continue to monitor the progress of the current portfolio of demonstration projects funded through ARRA. The Hydrogen from Coal, Coal to Coal Biomass to Liquids, and Solid Oxide Fuel Cells subprograms are all proposed to be eliminated.

The Natural Gas Technologies R&D program request is \$17 million, \$12 million of which is proposed for a new interagency R&D initiative by DOE, the Environmental Protection Agency, and the U.S. Geological Survey to "understand and minimize the potential environmental, health, and safety impacts of shale gas development through hydraulic fracturing...including the key research recommendations received from the Subcommittee of the Secretary of Energy Advisory Board."⁵

The FY13 budget request proposes to terminate Unconventional Fossil Energy Technologies programs, including the elimination of \$50 million for the Ultra-Deep and Unconventional Natural Gas Other Petroleum Resources Research Program.

Nuclear Energy

The primary mission of the Office of Nuclear Energy (NE) is to "advance nuclear power as a resource capable of meeting the Nation's energy, environmental, and national security needs by resolving technical, cost, safety, proliferation resistance, and security barriers through research, development, and demonstration as appropriate."

The FY13 budget request for NE is \$770.4 million, a \$88.3 million (10.3 percent) decrease below FY 2012 levels. NE's primary R&D programs are Nuclear Energy Enabling Technologies, or NEET, (\$65.3 million); Light Water Reactor Small and Modular Reactor Licensing Technical Support (\$65 million); Reactor Concepts RD&D (\$73.6 million); and Fuel Cycle R&D (\$175.4 million). The primary NE research accounts total \$382.4 million, a \$68.5 million or 15.2 percent decrease from FY 2012. The majority of this decrease is proposed to come out of the Reactor Concepts program (-\$41.2 million), specifically activities related to the Next Generation Nuclear Plant (NGNP) (-\$19.2 million), advanced small modular reactors (-\$9.5 million), and advanced reactor concepts (-\$9.5 million).

⁵ Department of Energy Budget Highlights, p. 51.

The budget request consolidates funding previously provided in the Energy and Water Development Appropriation "Other Defense Activities" account into the NE funding line. Thus, the budget requests \$95 million for security at NE's primary national research facility, Idaho National Laboratory, as part of NE, rather than part of "defense activities."

The Fuel Cycle R&D program includes \$59.7 million for the third year of the Used Fuel Disposition Research and Development subprogram, which examines issues associated with managing the back end of the nuclear fuel cycle. The subprogram intends to carry out key recommendations put forth in the *Blue Ribbon Commission on America's Nuclear Future Report to the Secretary of Energy*, such as researching and developing storage, transportation, and disposal technologies for spent fuel and nuclear waste. To assist with this research, NE requests \$10 million be appropriated from the Nuclear Waste Fund for activities associated with the disposal of high-level radioactive waste, as required by the Nuclear Waste Policy Act.

In FY 2013, NE requests \$24.6 million for the Energy Innovation Hub for Modeling and Simulation known as Consortium for Advanced Simulation of Light Water Reactors (CASL). CASL is creating a "virtual reactor model" of an operating nuclear reactor to "simulate reactor behavior and improve the safety and economics of reactor operations by simulating proposed solutions to reactor power production increases and reactor life and license extensions."⁶

Electricity Delivery and Energy Reliability

The mission of the Office of Electricity Delivery and Energy Reliability (OE) is to "lead national efforts to modernize the electric grid; enhance security and reliability of the energy infrastructure; and facilitate recovery from disruptions to energy supply." Research and Development within OE is funded at \$103.4 million in the President's FY13 budget request. This reflects an increase of \$4.3 million (4.3 percent) over FY12 levels.

OE's R&D programs focus on clean energy transmission and reliability, smart grid R&D, energy storage, and cyber security for energy delivery systems. OE concentrates on potential strains on the electric system as electric generation shifts towards low-carbon energy sources, specifically associated intermittency problems from wind and solar generation. OE aims to support these objectives through advanced grid modeling and extensive technological breakthroughs in energy storage. The President requests \$20 million for the creation of an Electricity Systems Hub to be administered by OE. The new Hub would "address the critical issues and barriers associated [with] modernization of the electric grid."⁷

Loan Guarantee Program Office

Title 17 of the Energy Policy Act of 2005 authorizes DOE to make loan guarantees to encourage early commercial use of new or significantly improved technologies in energy projects. Projects supported must avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases; employ new or significantly improved technologies; and offer a reasonable prospect of repayment of the principal and interest on the guaranteed obligation.

⁶ Department of Energy FY 2013 Congressional Budget Request, Volume 3, p. 340.

⁷ *DOE Budget Highlights*, p. 32.

According to the budget request, the Loan Guarantee program has awarded over \$16 billion in loan guarantees for 26 renewable energy projects, and has made additional commitments that have not yet closed totaling over \$10 billion. The FY 2013 budget requests \$38 million for administrative operations "to focus on portfolio management and monitoring activities on the existing portfolio as well as originating new loan guarantees to utilize remaining loan authority in the nuclear power, front-end nuclear, fossil, and renewable and energy efficiency sectors."⁸ The Administration proposes to offset requested spending with an equivalent amount of fee collections for a net-zero budget request.

⁸Ibid, p. 52.

Chairman HALL. Okay. The Committee on Science, Space, and Technology will come to order. And I say good morning and welcome to today's hearing entitled "An Overview of the Department of Energy Research and Development Budget for Fiscal Year 2013." In front of all of us here are packets containing the written testimony, biography, and Truth-in-Testimony disclosure for today's witness, the Secretary of Department of Energy, Dr. Steven Chu. And we are honored of course to have you, sir.

I want to welcome everyone here today for the hearing on the President's fiscal year 2013 budget request for the Department of Energy, and in particular I want to extend a warm welcome to you, Mr. Secretary, for appearing before the Committee yet again this year. We may occasionally have strong disagreements, but we thank you for your service and for your willingness to appear before this Committee.

This is the President's fourth budget submission in Congress, so its general priorities, and my concerns with them, should come as no surprise. As in the years past, the budget calls for massive increases in green energy programs while flat-lining or cutting programs devoted to basic research and the advancement of the domestic production of reliable and affordable sources of energy, such as oil, natural gas, coal, and nuclear. The lack of balance in this approach is disappointing, and I hope and expect that Congress is going to reject it.

Last year, I used a gambling term to highlight my concern with the President's budget, specifically the extent to which President Obama "doubled-down" on his energy and climate agenda in light of the continued struggling economy, trillion-dollar deficits, rising gas prices, and fuel supply concerns driven by Middle East turmoil. All of these issues remain today, and some, such as the price of gas, have been further exacerbated. After a year in which American taxpayers saw their money wasted in high-profile failures of government-backed, so-called clean energy companies, it is surprising that DOE now uses that same term, "double-down," to describe the Department's budget proposal. In this context, I think I can at least understand the Administration's use of a gambling metaphor to describe its plans for risking taxpayer dollars.

Last year, the centerpiece of the President's energy policy proposal to Congress was enactment of a Clean Energy Standard to mandate the purchase of certain types of "clean" electricity. At the time the President announced it, the cost of his proposal was not clear, so I asked DOE's Energy Information Administration to calculate projected costs under various scenarios. The best estimate scenario found that nationwide electricity prices would increase almost 30 percent by 2035, and gross domestic product would be reduced by approximately \$100 billion annually. A comparable analysis requested by the Senate yielded similar results.

In light of the data from DOE, the President continues to push for a mandate that Americans purchase more expensive electricity, while other countries seek to make energy cheaper for their citizens. This is especially disappointing and should again be soundly rejected by Congress, as was the previous proposal to increase the cost of energy through a cap-and-trade scheme. Meanwhile, gasoline prices approach record highs, placing additional energy costs

on consumers, causing pain not only at the pump but also in every other sector of the American economy that depends upon affordable fuel to deliver goods and services.

In response, the President ironically calls for an “all-of-the-above” energy strategy but continues to propose policies that in reality show his lack of concern with gasoline prices. His Administration continues to actively take steps that place upward pressure on oil prices. He delayed offshore drilling permits and blocked production of the Outer Continental Shelf and the Alaska National Wildlife Refuge. He thwarted construction of the Keystone Pipeline. He proposed through EPA and other agencies costly new regulations. And he proposed eliminating or cutting R&D programs aimed at advancing domestic production and supply of oil and natural gas resources.

Had the President moved forward with the “all-of-the-above” energy policies, he would understand that producing America’s natural resources makes a difference—just as American ingenuity makes a difference. It may take the American public to convince the President to approve the pipeline and expand domestic production. I hope today’s hearing provides an opportunity to address these topics further.

I now recognize Ranking Member Ms. Johnson for her statement.
[The prepared statement of Mr. Hall follows:]

PREPARED STATEMENT OF CHAIRMAN RALPH M. HALL

I want to welcome everyone here today for this hearing on the President’s Fiscal Year 2013 budget request for the Department of Energy, and in particular I want to extend a warm welcome to Secretary Chu for appearing before the Committee yet again this year. We may occasionally have strong disagreements, but we thank you for your service and your willingness to appear before this Committee.

This is the President’s fourth budget submission to Congress, so its general priorities—and my concerns with them—should come as no surprise. As in years past, the budget calls for massive increases in green energy programs while flat-lining or cutting programs devoted to basic research and the advancement of the domestic production of reliable and affordable sources of energy, such as oil, natural gas, coal, and nuclear. The lack of balance in this approach is disappointing, and I hope and expect Congress will reject it.

Last year I used a gambling term to highlight my concern with the President’s budget, specifically the extent to which President Obama “doubled-down” on his energy and climate agenda in light of the continued struggling economy, trillion-dollar deficits, rising gas prices, and fuel supply concerns driven by Middle East turmoil. All of those issues remain today, and some—such as the price of gas—have been further exacerbated. After a year in which American taxpayers saw their money wasted in high-profile failures of government-backed, so-called clean energy companies, it is surprising that DOE now uses that same term, “double-down,” to describe the Department’s budget proposal. In this context, I think I can at least understand the Administration’s use of a gambling metaphor to describe its plans for risking taxpayer dollars.

Last year, the centerpiece of the President’s energy policy proposal to Congress was enactment of a Clean Energy Standard to mandate the purchase of certain types of “clean” electricity. At the time the President announced it, the cost of his proposal was not clear, so I asked DOE’s Energy Information Administration to calculate projected costs under various scenarios. The best estimate scenario found that nationwide electricity prices would increase almost 30% by 2035, and gross domestic product would be reduced by approximately \$100 billion annually. A comparable analysis requested by the Senate yielded similar results.

In light of this data from DOE, the President continues to push for a mandate that Americans purchase more expensive electricity, while other countries seek to make energy cheaper for their citizens. This is especially disappointing and should

again be soundly rejected by Congress, as was his previous proposal to increase the cost of energy through a cap-and-trade scheme.

Meanwhile, gasoline prices approach record highs, placing additional energy costs on consumers, causing pain not only at the pump but also in every other sector of the American economy that depends upon affordable fuel to deliver goods and services. In response, the President ironically calls for an “all-of-the-above” energy strategy but continues to propose policies that in reality show his lack of concern with gasoline prices. His Administration continues to actively take steps that place upward pressure on prices. He delayed offshore drilling permits and blocked production in the Outer Continental Shelf and the Alaska National Wildlife Refuge. He thwarted construction of the Keystone Pipeline. He proposed through EPA and other agencies costly new regulations. And he proposed eliminating or cutting R&D programs aimed at advancing domestic production and supply of oil and natural gas resources.

Had the President moved forward with “all-of-the-above” energy policies, he would understand that producing America’s God-given natural resources makes a difference—just as American ingenuity makes a difference. It may take the American public to convince the President to approve the pipeline and expand domestic production. I hope today’s hearing provides an opportunity to address these topics further.

I now recognize Ranking Member Johnson for her opening statement.

Ms. JOHNSON. Thank you very much, Mr. Chairman, and thank you for calling this hearing. And let me thank Secretary Chu for being willing to come. I am always delighted to be in the presence of a Nobel Laureate because I know I can learn a lot.

I am just trying to figure out how to start this. I will be the first to say that on balance I am not particularly happy with this budget request. I think that too many worthwhile programs will be cut while others will not be increased enough. Still, I applaud the Administration for making tough decisions and prioritizing in a time of fiscal austerity. It is undoubtedly a painful but useful exercise. And in better times, these programs would receive the funding they need.

However, I cannot help but lament the fact that we find ourselves in this position to begin with and I feel that Congress has to accept its share of the blame. We in Congress could acknowledge the immense challenges in energy that lobby for us and have the foresight to know that increased investment across the energy technology spectrum, from basic to applied research and demonstration, will pay untold dividends for future generations. We could recognize the role that truly fundamental discovery-driven research and large user facilities play in positioning the United States at the center of mankind’s quest to better understand our universe.

Instead, unfortunately, this Congress seems content to put DOE in a corner and tell it to figure out how to do more with less. We say we want to run government more like business. Well, businesses need revenue or they don’t grow, they don’t innovate, and they don’t succeed. We could start to raise the needed revenue by pulling back the unnecessary tax breaks and subsidies enjoyed by the most profitable and wealthiest companies and individuals in this country and we could use those resources to invest in our scientific talent and infrastructure and in development of new, cleaner, more efficient, and cheaper energy technologies.

I am under no illusion that change will come overnight. We are just beginning to chip away at the multigenerational energy problem, the scale and complexity of which few of us can grasp. But we have to start now if we want to make a positive impact for future generations. We can begin by giving up on the notion that the en-

ergy market has ever been or ever will be a free market. In a perfect world, consumers would be empowered with the knowledge and resources to make informed choices about their energy use, and investors would be willing to take bigger risks on companies that are driven to create the cleanest and most efficient technologies. But we are just not there yet. Until we see more competition from emerging sectors, the energy markets will not be free.

Some of my colleagues on the other side of the aisle decry DOE's investment of clean energy technologies—in clean energy technologies—as somehow skewing the market by picking winners and losers and crowding out private investment. Yet the very energy industries my colleagues hold out as exemplars of the free market—oil, gas, nuclear, and coal—are the ones that have benefitted most from the government largesse, and curiously, the ones they hold out as most deserving of continued taxpayer-funded research.

From high efficiency gas turbines to coal plants to nuclear reactors developed at federal labs with federal dollars to the directional drilling and hydraulic fracturing practices that have led to the shale gas boom of today, we have seen how government research can pay off, but it required decades of federal investment, the overwhelming majority of which was focused on fossil and nuclear energy. These technologies have kept energy costs low to consumers and our industrial base and allowed the economy to grow to what it is today. But it is time to level the playing field and introduce real competition to the markets. And that is where the priorities set by this budget request come into play. We have to find the greatest value for the taxpayer's dollar, and today, it is in the emerging energy technology sectors that can most benefit from government support. We have seen how federal dollars can be the seed capital for private sector innovation and how even small government investments can be leveraged to provide scientific breakthroughs and technological advances that private industry by itself cannot—or at least will not—accomplish.

We also know well that without federal sponsorship of fundamental research in physical sciences, America will fall behind in these fields. These are investments in people and ideas that have paid off in the past, and I hope that we can demonstrate the foresight to know that they will continue to pay off in the future.

Thank you and I yield back.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF RANKING MEMBER EDDIE BERNICE JOHNSON

Thank you, Chairman Hall, for calling this hearing today to review the Administration's fiscal year 2013 budget request for the Department of Energy's civilian research programs. And, thank you, Secretary Chu, for joining us today to provide your perspective on how these proposals were developed, and insight into the President's vision for both the Department and the role of energy in our economy.

I will be the first to say that, on balance, I am not particularly happy with this budget request. I think that too many worthwhile programs would be cut, while others will not be increased enough. Still, I applaud the Administration for making tough decisions and prioritizing in a time of fiscal austerity. It is undoubtedly a painful but useful exercise, and in better times these programs would receive the funding they need. However, I cannot help but lament the fact that we find ourselves in this position to begin with, and I feel that Congress has to accept its share of the blame.

We in Congress could acknowledge the immense challenges in energy that lie before us, and have the foresight to know that increased investment across the energy technology spectrum—from basic to applied research and demonstration—will pay untold dividends for future generations. We could recognize the role that truly fundamental discovery-driven research and large user facilities play in positioning the U.S. at the center of mankind's quest to better understand our universe.

Instead, unfortunately, this Congress seems content to put DOE in a corner and tell it to figure out how to do more with less. We say we want to run government more like business. Well, businesses need revenue or they don't grow, they don't innovate, and they don't succeed. We could start to raise the needed revenue by pulling back the unnecessary tax breaks and subsidies enjoyed by the most profitable and wealthiest companies and individuals in this country. And we can use those resources to invest in our scientific talent and infrastructure, and in development of new, cleaner, more efficient and cheaper energy technologies.

I am under no illusion that change will come overnight. We are just beginning to chip away at a multi-generational energy problem, the scale and complexity of which few of us can grasp. But we have to start now if we want to make a positive impact for future generations.

We can begin by giving up on the notion that the energy market has ever been, or will ever be, a free market. In a perfect world, consumers would be empowered with the knowledge and resources to make informed choices about their energy use, and investors would be willing to take bigger risks on companies that are driven to create the cleanest and most efficient technologies. But we are just not there yet. Until we see more competition from emerging sectors, the energy markets will not be free.

Some of my colleagues on the other side of the aisle decry DOE's investment in clean energy technologies as somehow skewing the market by picking winners and losers and crowding out private investment. Yet, the very energy industries my colleagues hold out as exemplars of the free market—oil, gas, nuclear and coal—are the ones that have benefitted most from government largesse and, curiously, the ones they hold out as most deserving of continued taxpayer-funded research.

From high-efficiency gas turbines for coal plants, to nuclear reactors developed at federal labs with federal dollars, to the directional drilling and hydraulic fracturing practices that have led to the shale gas boom of today, we have seen how government research can pay off. But it required decades of federal investment, the overwhelming majority of which was focused on fossil and nuclear energy.

These technologies have kept energy costs low for consumers and our industrial base, and allowed the economy to grow to what it is today. But, it is time to level the playing field and introduce real competition to the markets, and that is where the priorities set by this budget request come in to play. We have to find the greatest value for the taxpayer dollar, and today it is in the emerging energy technology sectors that can most benefit from government support.

We have seen how federal dollars can be the seed capital for private sector innovation, and how even small government investments can be leveraged to provide scientific breakthroughs and technological advances that private industry by itself cannot accomplish. We also know well that without federal sponsorship of fundamental research in the physical sciences, America will fall behind in these fields. These are investments in people and ideas that have paid off in the past, and I hope that we can demonstrate the foresight to know that they will continue to pay off in the future.

Thank you, and I yield back.

Chairman HALL. I thank you, Ms. Johnson.

And if there are Members who wish to submit additional opening statements, your statements can be added to the record at this point or whenever you want to.

At this time, I would like to introduce our witness, Dr. Steven Chu, who serves as the Secretary of Energy. Dr. Chu is currently serving as the 12th Secretary of Energy. He is a distinguished scientist and has devoted his scientific career to the search for new solutions to our energy challenges.

Prior to his service as Secretary, Dr. Chu was a Director of DOE's Lawrence Berkeley National Lab and was a Professor of Physics in molecular and cell biology at the University of California

Berkeley. He is a co-winner of the 1997 Nobel Prize for physics. That is quite an honor.

As our witness should know, testimony is limited to five minutes, after which the Members of the Committee will have five minutes each to ask questions. We have for you flexibility as you need because it is an honor to have you here. We know your schedule and we thank you for your time. So at this time we will recognize you for as much time as you require. And thank you for being here.

**STATEMENT OF MR. STEVEN CHU,
SECRETARY, U.S. DEPARTMENT OF ENERGY**

Secretary CHU. Thank you, Chairman Hall, for those kind remarks. And also Ranking Member Johnson, Members of the Committee, thank you for the opportunity to discuss the Department of Energy's fiscal year 2013 budget request.

To promote economic growth and strengthen security, President Obama has called for an "all-of-the-above" strategy that develops every source of American energy. The President wants to fuel our economy with domestic sources of energy while increasing our ability to compete in the clean energy race.

The Department's Fiscal Year 2013 budget request of \$27.2 billion is guided by the President's vision, our 2011 Strategic Plan, and our inaugural Quadrennial Technology Review. It supports leadership in clean energy technologies and invests in science and innovation to promote economic prosperity. Decades ago, the Energy Department support helped develop the technologies that have allowed us to tap into America's abundant shale gas resources. Today, our investments can help advance technologies that will unlock the promise of renewable energy and energy efficiency.

The budget request invests approximately \$4 billion in our energy programs. It advances progress in areas from solar to offshore wind to carbon capture, and utilization and storage, to smart grid technologies. It will also help reduce America's dependence on foreign oil, which every day places a crushing burden on families and on our economy. As the President and I have said, there is no silver bullet and there are no easy answers, but we can and must pursue a serious, long-term, all-of-the-above approach that diversifies our energy mix, protects consumers from the high price of gas, harnesses American resources, and creates jobs here at home. That is exactly what this budget does.

The budget request also invests \$770 million in a nuclear energy program to help develop the next generation of nuclear power technologies, including small modular reactors. It includes funding for continued nuclear waste R&D, which aligns with the recommendation of the Blue Ribbon Commission on America's Nuclear Future.

As we move to a sustainable energy future, America's fossil energy resources will continue to play an important role in our energy mix. The budget request includes \$12 million as part of a larger R&D initiative by the Departments of Energy, Interior, and EPA to understand and minimize the potential environmental health and safety impacts of natural gas development through hydraulic fracturing. The budget also promotes energy efficiency to help Americans save money by saving energy, and it sponsors R&D on

industrial materials and processes to help U.S. manufacturers cut costs.

To maximize our energy technology efforts in areas such as batteries, biofuels, and electric grid technologies, we are coordinating research and development across our basic and applied research programs and ARPA-E. Competing in the new energy economy requires our country to harness all of our resources, including American ingenuity.

To help keep the United States at the forefront of science and technology, the budget request includes \$5 billion for the Office of Science to support basic research that could lead to new discoveries and help solve energy challenges. These funds support progress in materials science, basic energy science, advanced computing, and more. They also provide America's researchers and industries with state-of-the-art tools.

The budget request continues to support Energy Frontier Research Centers, which aim to solve specific scientific problems to unlock new clean energy development. It also supports the five existing Energy Innovation Hubs and proposes a new Hub in electricity systems. Through the Hubs, we are bringing together our Nation's top scientists and engineers to achieve game-changing energy goals.

Additionally, the budget request includes \$350 million for ARPA-E to support research projects that could fundamentally transform the way we use and produce energy. ARPA-E invests in high-risk, high-reward research projects that, if successful, could create the foundation for entirely new industries. Eleven projects that received a total of \$40 million from ARPA-E over the last two years have done such promising work that they now have attracted more than \$200 million in combined private sector funding. Taken together, our research initiatives will help rev up America's great innovation machine to accelerate energy breakthroughs. In addition to strengthening our economy, the budget request also strengthens our security by providing \$11.5 billion for the National Nuclear Security Administration.

The budget request makes strategic investments to promote our prosperity and our security. At the same time, we recognize the country's fiscal challenges and are cutting back where we can. We are committed to performing our work efficiently and effectively. We are also breaking down barriers to make it easier for businesses to move technologies from our national labs to the marketplace, which can help the United States seize technological leadership.

Countries around the world recognize the energy opportunity and are moving aggressively to lead. This is a race we can win, but we must act with fierce urgency.

Thank you, and now I am pleased to answer your questions.
[The prepared statement of Secretary Chu follows:]

PREPARED STATEMENT OF MR. STEVEN CHU,
SECRETARY, U.S. DEPARTMENT OF ENERGY

Chairman Hall, Ranking Member Johnson, and Members of the Committee, thank you for the opportunity to appear before you today to discuss the President's Fiscal Year 2013 Budget request for the Department of Energy.

To promote economic growth and strengthen national security, President Obama has called for “an all-out, all-in, all-of-the-above strategy that develops every source of American energy—a strategy that is cleaner and cheaper and full of new jobs.” The President wants to fuel our economy with domestic energy resources while increasing our ability to compete in the global clean energy race.

Although the United States has reclaimed the title of world leader in clean energy investments, we are at risk of falling behind again unless we make a sustained federal commitment to supporting our domestic clean energy economy. To compete globally, America has to do more than invent technologies; we also have to produce and sell them. Our country faces a stark choice: we can create jobs making and exporting the energy technologies of tomorrow or we can cede leadership to other countries that are investing in these industries. As President Obama reiterated in his State of the Union address, passing a Clean Energy Standard is a vital step that Congress can take to broaden our clean energy market and promote U.S. leadership.

Making the most of America’s energy resources is a pillar of the President’s economic blueprint to build an economy that lasts. The Energy Department also supports other key elements of the President’s agenda including leading in innovation; reducing our dependence on oil; cutting costs for families, businesses, and manufacturers through energy efficiency; and reducing nuclear dangers worldwide.

Guided by the President’s vision, the Department’s 2011 Strategic Plan and our inaugural Quadrennial Technology Review, our FY 13 budget request of \$27.2 billion invests in the following priorities:

- Accelerating the transformation of America’s energy system, and securing U.S. leadership in clean energy technologies;
- Investing in science and innovation to promote our Nation’s economic prosperity; and
- Keeping Americans safe by enhancing nuclear security through defense, non-proliferation, and environmental cleanup.

These priorities will be enabled through a continuing commitment to fiscal responsibility and management excellence.

Leading in the Energy Technologies of the 21st Century

Last year, a record \$260 billion was invested globally in clean energy, and trillions of dollars will be invested in the coming decades. To seize this market and job creation opportunity, the President’s budget request invests in programs that advance research, development, manufacturing and deployment of the energy technologies of the future.

Decades ago, support from the Energy Department helped to develop the technologies that have allowed us to tap into America’s abundant shale gas resources. Today, our investments can help us advance technologies that will unlock the promise of renewable energy and energy efficiency.

The budget request invests approximately \$4 billion in our energy programs. It supports the Department’s SunShot initiative to make solar energy cost-competitive with any other form of electrical energy, without subsidy, by the end of the decade. It advances technological progress in areas ranging from offshore wind to carbon capture, utilization and storage to smart grid and energy storage. And it helps reduce our dependence on oil by developing the next generation of biofuels and accelerating research in advanced batteries and fuel-efficient vehicle technologies.

Leadership in nuclear energy technologies is also essential to our ability to compete globally. The budget request invests \$770 million in the nuclear energy program to help develop the next generation of nuclear power technologies, including small modular reactors. It also includes funding for continued R&D on the storage, transportation and disposal of nuclear waste, which also aligns with the recommendations of the Blue Ribbon Commission on America’s Nuclear Future.

As we move to a sustainable energy future, America’s fossil energy resources will continue to play an important role in our energy mix. President Obama is committed to developing our oil and gas resources in a safe and sustainable manner. Last year, our oil import dependence was at its lowest level in 16 years, oil production reached its highest level in eight years, and natural gas production set a new record. Building on this progress, the Energy Department’s budget request includes \$12 million as part of a \$45 million priority research and development initiative by the Departments of Energy, the Interior, and the Environmental Protection Agency to understand and minimize the potential environmental, health, and safety impacts of natural gas development through hydraulic fracturing (fracking).

The budget request also promotes energy efficiency to create jobs and to help Americans save money by saving energy. It supports home weatherization and calls

for passage of the HOME STAR program to provide incentives to homeowners to make energy efficiency upgrades. It also invests in research and development to improve building efficiency and supports the President's "Better Buildings" Initiative to catalyze private sector investment in commercial building efficiency. Finally, the budget request sponsors R&D on industrial materials and processes to help U.S. manufacturers cut costs and improve their global competitiveness.

To maximize our energy technology efforts, the Department is breaking down silos and coordinating research and development across our program offices. Modeled after our SunShot initiative, we're bringing together our basic and applied research programs and ARPA-E to harmonize their work in areas including batteries, biofuels and electric grid technologies.

And to encourage manufacturing and deployment of clean energy technologies, the President has called for renewing and extending proven tax incentives including the Production Tax Credit, the 1603 cash payment in lieu of tax credit program and the Advanced Energy Manufacturing Tax Credit, known as 48C.

As industry, Congress, and the American people make critical energy decisions and require greater understanding of domestic and international energy markets, it's important that we adequately fund the Energy Information Administration, the nation's premier source of independent statistical information about energy production and use. That is why the budget request includes \$116 million for EIA.

Unleashing U.S. Innovation to Create Jobs and Lead in the Global Economy

Competing in the new energy economy will require our country to harness all of our resources, including as the President said, the "one critical, renewable resource that the rest of the world can't match: American ingenuity." A key part of our country's success has been our leadership in science and technology, but we can't take that leadership for granted. According to the National Science Foundation's 2010 Science and Engineering Indicators report, from 1996 to 2007 the average annual growth of R&D expenditures in the United States was about five to six percent, compared to more than 20 percent in China.

To help keep the United States at the forefront of science and technology, the budget request invests in cutting-edge research that could spur new jobs and industries. This includes \$5 billion for the Office of Science to support basic research that could lead to new discoveries and help solve our energy challenges. These funds support progress in materials science, basic energy science, advanced computing and more. They also provide America's researchers and industries with state-of-the-art tools to help take their work to the next level.

The budget request continues to support Energy Frontier Research Centers. The Energy Frontier Research Centers are working to solve specific scientific problems to unlock new clean energy development. So far, the EFRCs have published more than 1,000 peer-reviewed papers and filed more than 90 patent applications or patent/invention disclosures. Researchers are reporting multiple breakthroughs in areas ranging from advanced battery technology and solar energy to solid-state lighting and nuclear power.

The budget request also supports the five existing Energy Innovation Hubs and proposes a new Hub in electricity systems. Through the Hubs, we are bringing together our Nation's top scientists and engineers to achieve game-changing energy goals. The Hubs continue to make progress. For example, the Modeling and Simulation for Nuclear Reactors Hub has released the first versions of its software that, upon completion, will simulate a virtual model of an operating physical reactor. The Fuels from Sunlight Hub has filed multiple invention disclosures and published scientific papers. And the Energy Efficient Building Systems Hub is developing advanced building modeling tools and has built one of the country's first 3-D building design labs.

Additionally, the budget request includes \$350 million for the Advanced Research Projects Agency for Energy, known as ARPA-E, to support research projects that could fundamentally transform the ways we use and produce energy. ARPA-E has invested in roughly 180 high-risk, high-reward research projects that, if successful, could create the foundation for entirely new industries. These companies and research teams are working toward a prototype of a battery that has double the energy density and one-third the cost of batteries in 2010, bacteria that use carbon dioxide and electricity to make fuel for cars, grid scale electricity storage and other potentially game-changing breakthroughs. Eleven projects that received \$40 million from ARPA-E over the last two years have done such promising work that they have now received more than \$200 million in combined private sector funding.

Taken together, our research initiatives will help rev up America's great innovation machine to accelerate energy breakthroughs.

Nuclear Safety and Security

In addition to strengthening our economy, the budget request also strengthens our security by providing \$11.5 billion for the Department's National Nuclear Security Administration. NNSA plays a key role in achieving President Obama's nuclear security objectives.

As the United States begins the nuclear arms reduction required by the New START treaty, the science, technology, and engineering capabilities within the nuclear security enterprise will become even more important to sustaining the U.S. nuclear deterrent. The budget request includes \$7.6 billion for Weapons Activities, a five percent increase over the FY 2012 enacted levels. This increase provides a strong basis for transitioning to a smaller yet still safe, secure, and effective nuclear stockpile. It also strengthens the science, technology, and engineering base of our enterprise. The budget request also includes \$1.1 billion for the Naval Reactors program to ensure the safe and reliable operation of reactors in nuclear-powered submarines and aircraft carriers and to fulfill the Navy's requirements for new nuclear propulsion plants that meet current and future national defense requirements.

Additionally, the budget request supports NNSA's critical work to prevent nuclear terrorism—one of the most immediate and extreme threats to global security and of one President Obama's top priorities. It includes \$2.5 billion to implement key nuclear security, nonproliferation, and arms control activities. It supports efforts to detect, secure, and dispose of dangerous nuclear and radiological material around the world. And it will help the Department to fulfill its role in accomplishing the President's goal of securing all vulnerable nuclear materials worldwide in four years.

Finally, the budget request includes \$5.7 billion for the Office of Environmental Management to continue progress cleaning up the Nation's Cold War nuclear sites.

Fiscal Responsibility and Management Excellence

The Department of Energy's FY 13 budget request makes strategic investments to promote our country's future prosperity and security. At the same time, we recognize the country's fiscal challenges and our responsibility to invest in much-needed programs while cutting back where we can. That is why the President's budget request eliminates \$4 billion in inefficient and unnecessary fossil fuel subsidies.

Given the urgency of the challenges we face, the Department is committed to performing our work efficiently and effectively. We are streamlining our organization to improve performance and save taxpayer money. For example, the Department achieved approximately \$330 million in strategic procurement savings in FY 11. We are taking several other steps such as reducing the size of our vehicle fleet, cutting back travel costs, and consolidating Web sites.

We are also breaking down barriers to make it easier for businesses to move technologies from our national labs to the marketplace, which can help the United States seize technological leadership and create jobs. For example, we've started a program which makes it easier, quicker, and less costly for start-up companies to sign option agreements to license national lab technologies. And to make it easier to work with the labs, we've reduced the advanced payment requirement and streamlined the Cooperative Research and Development Agreement contract and approval process.

Throughout American history, the Federal Government has played a critical role in supporting industries that are important to our prosperity and security, from aviation and agriculture to biotechnologies and computer technologies. We should continue to do so today to lead in the new clean energy economy. Countries in Europe, Asia, and throughout the Western Hemisphere recognize the energy opportunity and are moving aggressively to lead. This is a race we can win, but we must act with fierce urgency.

Thank you, and now I am pleased to answer your questions.

Chairman HALL. Sir, I thank you for your testimony.

And I remind members that Committee rules limit questioning to five minutes. We try to stay as close to that as we can.

The Chair at this point will open the round of questions. And I recognize myself for five minutes.

Mr. Secretary, two years ago the Obama Administration unilaterally shut down the Yucca Mountain project and threw U.S. nuclear waste management policy into disarray. President Obama created a "Blue Ribbon Commission" at the same time his Administration

dismantled the existing Nuclear Waste Management program. I ask a question of you and I want you to answer yes or no because I know how very great you are strengthening a yes or weakening a no or vice versa. You are capable—I do ask—and if you can't give me a yes or no answer, tell me you don't want to.

Did you tell the Blue Ribbon Commission they could not consider Yucca Mountain in their report?

Secretary CHU. That was not in the charge of the Blue Ribbon Commission.

Chairman HALL. Well, now, you are not answering me yes or no. Can you do that if you can? I am going to assume that you did.

To date, taxpayers have spent—is that okay?

Secretary CHU. That was not—

Chairman HALL. I don't want to suppress you. If you can tell me no as quick as you can say yes, why, I would like to hear it.

Secretary CHU. It was not in the charge of the Blue Ribbon Commission.

Chairman HALL. Okay. All right. To date, taxpayers have spent over \$15 billion to study and prepare Yucca Mountain to serve as a repository and you know that. You know all about it. Additionally, since the creation of the Blue Ribbon Commission, the taxpayers' liability for not accepting ownership of radioactive waste by 2020 increased 21 percent to almost \$21 billion. With the massive investment and decades of study already completed on Yucca Mountain, why refuse to allow the Blue Ribbon Commission to even entertain the idea or even to consider that Yucca Mountain could be a part of America's nuclear waste policy management?

Secretary CHU. The Blue Ribbon Commission was not designed as a siting commission. It was designed to look broadly at the back end of the fuel cycle. I think it was an extraordinary committee with able leadership, General Scowcroft and Representative Hamilton, and it came up with a number of recommendations that we hope Congress will consider very seriously. We in the Department of Energy have established a taskforce to look at these recommendations.

Chairman HALL. Well, regardless of whether Yucca Mountain has a future—and apparently it doesn't—do you think there is a value in completing the scientific and technical review of the science suitability and making the results public to where people themselves can make their own decision on it whether you were right or wrong?

Secretary CHU. Right now, the decision is before the courts and we are awaiting the decision. Of course, in the meantime we are looking at the recommendations of the Blue Ribbon Commission because I think everybody agrees that the backend of the fuel cycle needs the attention of the country and we need solutions.

Chairman HALL. Last year, when you testified in this Committee, I asked you what impact the President's Clean Energy Standards would have on energy cost. And that is for American energy consumers who have to make that payment. You committed to having the Energy Information Administration examine the economic impact of the Clean Energy Standard, which they did at my request. And I thank you for that.

And I ask unanimous consent to insert this into the hearing record. And without objection, it is so ordered.

[The information may be found in Appendix 2.]

Chairman HALL. Are you aware that that exercise and the findings of EIA—are—you are aware of that, aren't you?

Secretary CHU. I am aware of many of the findings of EIA. I can't say that I remember exactly everything that they said.

Chairman HALL. Well, this is yours or your people—

Secretary CHU. Right.

Chairman HALL [continuing]. And you produced this.

Secretary CHU. That is correct.

Chairman HALL. Let me provide this. Then let me help you. Let me provide just a brief summary of the results. Under the Clean Energy Standards similar to what President Obama proposed and as you outlined to me last year, the report found these things: household electricity will increase by \$115—that can't be \$115 per person per year in 2025 and by \$211 per person in 2035. Nationwide expenditures on electricity will increase by \$41 billion in 2025 and by \$77 billion in 2035. Nationwide manufacturing employment would decline by a million jobs in 2025. And in his State of Union Address, the President reiterated his calls for Congress to mandate this Clean Energy Standard that we have here.

Why is the President pursuing a policy to increase electricity cost on Americans? Can you give me an answer for that? Or you may not agree that he is, but I think the facts cry out that he is costing us and not drilling whether you like the word of how fossil fuels cause some problems, and of course they cause some problems. I am part of that problem because I was here when we wrote the Clean Air Act and we put the EPA in there to have a balancing figure, and that gave the EPA the strength that they are using now to push energy people around. And I resent that and I think everybody on this Committee resents it.

I just—do you agree that any clean energy mandate, no matter how flexible it is, will increase the cost of electricity?

Secretary CHU. First, let me respond to what you said about the President. The President by no means wants to increase the energy bills in America. He is very committed to making available both affordable and clean energy. What the EIA studies do typically is they look at existing technologies. They cannot—and they are acting responsibly and they do this for that reason. They cannot presume that there will be technological advances in the future so they say this is what we see today based on today's technologies.

But having said that—may I—

Chairman HALL. Sure. I am over my time but go ahead.

Secretary CHU. I will try to be very brief. Having said that, it is the Department of Energy's mission to bring down these costs and it is our goal. And we feel that it is only a matter of when, not if, clean energy will be as competitive as any form of energy.

Chairman HALL. That may be so. I can't argue the future with you, but I know about the past and I know how energy people feel and I know that energy States are being punished and the people are losing.

My time is up. Recognize Ms. Johnson.

Ms. JOHNSON. Thank you very much, Mr. Chairman. I would like to make this statement prior to my question and would like to note that while I do not object to Chairman Hall submitting for the record his analysis of the Clean Energy Standard, I do want to make it clear that it is one of several such analyses of the CES that should be considered.

I am concerned that this analysis was designed from the start to show a worst-case scenario for the impacts of Clean Energy Standard on the economy, leaving out a number of critical factors that would have painted a more comprehensive and accurate picture of CES as it would actually be implemented. I urge my colleagues and the public to review some of the more rigorous and comprehensive analyses such as those directed by outside stakeholders and Senate Energy Committee Chairman Bingaman before coming to a conclusion about the role new energy technologies will play in the future.

I might have some questions of the Secretary on this topic and make additional comments and the statement for the record, but thank you. I will now begin my questions.

The Department of Energy's Quadrennial Technology Review sought to set priorities within the Department's portfolio. It finds that energy technologies addressing the transportation sector have been historically underfunded as compared to stationary energy. Do you believe there should be a different balance between transport and stationary energy within the DOE portfolio?

Secretary CHU. Yes, very much so. In fact that was one of the conclusions of our Quadrennial Technology Review. Given the high price of gasoline, we said what can we do in the Department of Energy to advance technologies to reduce the cost of transportation for every American family? And so we were aligned with the idea that, first, we wanted alternatives. Diversification means that you are no longer solely dependent on oil for transportation. We were going to invest—we were going to be investing in technologies that can improve the gas mileage, again, but keeping costs the same or even reducing costs but increasing the gas mileage of automobiles that would also make our cars competitive internationally. We were going to be doing biofuels investments and battery investments.

I am very happy to say that a company the Department of Energy invested in two days ago made an announcement that they now have a battery that has doubled the energy capacity with the same manufacturing costs. It is going to be—it is validated by a third party and so this is going to be great news because that means we can reduce the cost of plug-in hybrids, electric vehicles, and can imagine a day in the near future where you might see a \$20,000 car all electric, the operating cost—it would save American families over \$1,000 a year to have such a car.

Ms. JOHNSON. Thank you. How does the fiscal year 2013 budget address these findings that energy for the transport sector has been underfunded compared to electricity?

Secretary CHU. Pardon? Could you repeat that again?

Ms. JOHNSON. The budget—how does it address—

Secretary CHU. Oh, fine. Fine, thanks.

Ms. JOHNSON. Yes.

Secretary CHU. It appears in several ways—first, in energy efficiency and renewable energy technologies. We have a lot of effort

in batteries there. Our ARPA-E program is investing in very, very innovative, short-term, two-year funding for batteries. Office of Science is investing in the more fundamental aspects of science, the kind of science that when done at Argonne National Laboratories 10 years ago has worked its way into today's current batteries, but we want to fund science that five years and 10 years from today will further reduce the cost of batteries. We also fund biofuels so that next-generation biofuels can be competitive without subsidy with oil at, let us say, \$80 a barrel. This would be very exciting.

Ms. JOHNSON. Thank you very much.

I yield back, Mr. Chair.

Chairman HALL. I thank you, Ms. Johnson, and I will have an answer for you when we take our second group as to your surprise at my position.

Recognize Mr. Sensenbrenner for five minutes.

Mr. SENSENBRENNER. Thank you very much, Mr. Chairman.

Mr. Secretary, thank you for coming here.

When President Bush left office, the average price of gas was \$1.85. Now, it is at \$3.65 and going up, a doubling of gas prices under the Obama Administration's watch. The President has said that he is going to look for every single area we can make an impact and help consumers in the month ahead. You said yesterday in another Congressional hearing in answer to a question by Congressman Nunnelee whether your overall goal was to lower the price of gasoline. And you said no. Now, I somewhat want to expand on the Chairman's statement that energy States are being punished. I think all American consumers are being punished, and as the price of gas goes up, money that can be invested in our already fragile economy is taken out of consumers' pockets. Did you want to retract what you said yesterday and help everybody working on at least slowing this spike in the price of gas and then lowering it?

Secretary CHU. We very much want to not only slow the price but reverse the price increase in gasoline. If one reads my entire statement, it was very consistent with that. As I said in my opening remarks, we definitely feel the pain that every American and every business feels when the price of gasoline goes up. We have been focused in my time as Secretary of Energy and the President's time since taking office on trying to first do what we can with the tools we have available to decrease the prices. And the tools we have available in the Department of Energy are that we want to diversify our energy supplies because—

Mr. SENSENBRENNER. Well—

Secretary CHU [continuing]. We want to increase the production of oil—

Mr. SENSENBRENNER [continuing]. Okay, but—

Secretary CHU [continuing]. And gas but also diversity—

Mr. SENSENBRENNER [continuing]. You know, meanwhile the price of gas has gone up by 100 percent on your watch. And this is unacceptable. And I remember four years ago, the President, some of his supporters were complaining about the price of gas going up in the last year of the Bush Administration. Before you got your present job, you made a statement that you wanted to see the price of gas reach the prices that exist in Europe, and those are

somewhere between \$7 and \$9 a gallon depending upon what country you are in. Can you retract that statement now, or is that still your goal and the goal of the Administration?

Secretary CHU. That is not my goal. But let me—

Mr. SENSENBRENNER. Then will you retract the statement?

Secretary CHU. Everything I have done as Secretary of Energy is to first try to lower the prices by—we have invested in ways to increase production. We have invested in other ways in batteries and biofuels and energy efficiency to help the American public.

Mr. SENSENBRENNER. Well—

Secretary CHU. But—

Mr. SENSENBRENNER [continuing]. You know, there have been bans on offshore drilling, we have the President vetoing the Keystone XL pipeline, gas is subject to the law of supply and demand, and as economies get better, they use more energy. And there have been obstructions in increasing the supply that can be refined and sold to American consumers.

Secretary CHU. First, let me also point out that when the President took office, the economy was in freefall. When the world goes into a terrible recession, that has a downward effect on gasoline prices. The price of oil—and the most clear correlation is between gasoline prices is—

Mr. SENSENBRENNER. Well, with all due respect, Mr. Secretary, the economy is not that healthy, employment is down in the United States in the last three years, unemployment is still higher than it was in January of 2009. You know, I have seen a trend that production will be increased on private land but not on federal land. And when is this Administration going to end the lockup increasing production on federal land? That will increase the production as well. The President did say he was going to put everything on the table and it seems to me that there are still a lot of items under the table that can increase production and maybe reduce the price of gas that this Administration is turning its back on. When is that going to change?

Secretary CHU. Let me first finish my answer from the previous question. The economy was in freefall. In a severe recession, the price of gasoline goes down. The economy is coming back slowly. It is very—we are doing—

Mr. SENSENBRENNER. Well, the economy is coming back slowly, but the price of gas has gone up 100 percent in the last three years, and that is going to retard the economy coming back faster and more people getting jobs and more investment in creating jobs in the private sector. You know, all this doesn't add up. And, you know, I admire you for getting a Nobel Prize in physics. I don't think you would do very well in getting one in economics.

And my time is up and I yield back the balance of my time.

Chairman HALL. You are doing such a good job I yield to you another minute if you need it to let him answer some of these things.

Mr. SENSENBRENNER. I will be happy to let him answer.

Secretary CHU. As I said before, the economy is rising. The President is very concerned; I am very concerned about the high price of gas. We are very concerned as gasoline prices and oil prices increase that that can have a dampening effect on the economy. That is why we are so focused on this and that is why the tools we

have—that I have in the Department of Energy are focused on what we can do both in the near-term future, but also in the mid- and long-term future. The President has said very clearly that there is no single silver bullet, and that is why we applaud the rising production of gasoline and natural gas. That is why we are working with industry to see how we can get natural gas to be used for part of our transportation needs, and all those other—

Mr. SENSENBRENNER. Well, sir, you know, with all due respect, there is a silver bullet and it is going right in the wallet of the American consumer with the doubling of the price of gas on this Administration's watch. That has got to stop and I haven't seen you withdraw either your 2008 statement or the answer that you gave to Congressman Nunnelee yesterday. Thank you.

Chairman HALL. The gentleman's time has more than expired. The Chair recognizes Ms. Fudge for five minutes.

Ms. FUDGE. I thank you, Mr. Chairman.

And thank you so much, Mr. Secretary, for being here today.

Mr. Secretary, in my home State of Ohio, manufacturing is a major industry and we have many unemployed workers, as you might imagine, whose skills are not being used. I see that you have a \$150 million increase for the Advanced Manufacturing Office. Could you please tell me what kinds of technologies will be developed with the extra money and how it will help spur economic growth and employment in manufacturing States such as Ohio?

Secretary CHU. Sure. One of the things—let me give you one example in Advanced Manufacturing. We know that composite materials—these are carbon composite materials in particular—can play an incredible role in a lot of technologies, from airplanes to automobiles to just lighter-weight stronger materials. So we have a carbon composite facility that allows industries—U.S. industries—to come in and try different things in this facility, new manufacturing methods to lower the cost.

Ms. FUDGE. Where is the facility?

Secretary CHU. This is actually in Oak Ridge.

Ms. FUDGE. Go ahead.

Secretary CHU. Okay. Oak Ridge National Laboratory. So that is just one example of what we are trying to do in advanced manufacturing, again going directly to the goal of the Department of Energy and the goal of every action I have taken since I have become the Secretary of Energy, which is to help make more efficient automobiles, make them more efficient so the American consumers can purchase these automobiles and have less of a gasoline bill. And that is what we are doing as much as we can, all the tools to lower the prices—not to lower the prices but to help—we certainly want to lower the prices of gasoline, but we also want to have people use less.

Ms. FUDGE. Thank you.

Mr. Secretary, Ohio has experienced at least 11 earthquakes in less than a year. The Ohio Seismic Network believes that they are tied to wastewater injection wells. I understand that the 11 earthquakes in Ohio are not necessarily related to the hydraulic fracturing technology but to the disposal of all the high volumes of hydraulic fracturing wastewater going into injection wells. It is my understanding that compared to conventional oil and gas develop-

ment, hydraulic fracturing will require significantly larger quantities of water. Is that true? And if so, how will all of this water be disposed of if not in injection wells?

Secretary CHU. Well, we certainly are looking very carefully at the role of any sort of liquid and fluid injection into rocks and what their role might be in seismic events. We certainly have a lot of expertise in that. We feel that one does not want to triple—most of the seismic events are events that are so small in magnitude that people cannot feel them, but we certainly are very, very concerned and we are doing research into the extent that wastewater injection or any fluid injection into rocks could trip off a more significant event. And so this is one of the things that we do in the Department of Energy is to do research so that one could extract the gas and the gas liquids from fracking, but we do it in an environmentally safe way. And so we are committed on that path.

Ms. FUDGE. So to go back to the question, are you saying you are studying how to dispose of the waste, or what are you saying?

Secretary CHU. Well, there are two questions. The question is what is the role—as you noted in your opening statement—what is the role of fluid injection in triggering seismic events? And what can we do? So first, we need to establish what the role is. There is a very thoughtful piece written by a staffer, Professor Mark Zoback, on this, who was actually part of our Secretary of Energy Advisory Board Subcommittee, on trying to develop ways so we can extract natural gas with fracking in an environmentally responsible way. And so I think—I recommend you read that paper because it looks at what are the issues and also what is actually happening vis-a-vis water injection into the ground.

Ms. FUDGE. Mr. Secretary, I will have to get with your office on that.

But just in an effort to be considerate of the time of my colleagues, Mr. Chairman, I will yield back.

Chairman HALL. I thank the gentlelady.

Mr. Rohrabacher, California, for five minutes. We will have a vote on the Floor in a little bit and we will comment on that when you finish, Mr. Rohrabacher.

Mr. ROHRABACHER. Yes, thank you very much.

Secretary Chu, I saw that NASA in their budget request included funding to restart the plutonium-238 production to—and this is powering deep space projects. I also noticed there is not a corresponding item in the DOE's budget request. Now, is plutonium production going to be restarted at NASA, and what is your expectation that NASA will cover all the costs of this program?

Secretary CHU. I think we are working with NASA on that. The plutonium, as you noted, is used as an energy source for deep space missions. The probes are so far away solar power is not viable. And so we are working, too, with NASA on how the generation of that energy source—

Mr. ROHRABACHER. Well, if we are going to have a long-term space strategy, we need to make sure that this isn't lost in the shuffle because that is an important factor in having a successful deep space program.

Let me ask you about the reactor program. I am very concerned that it seems that the spending that I have here—and I am sub-

mitting this, Mr. Chairman, these charts for the record at this point. Mr. Chairman, submitting this for the record.

Chairman HALL. Without objection.

[The information may be found in Appendix 2.]

Mr. ROHRABACHER. And it seems to indicate that we are spending money or you are proposing to spend money in a way that when it comes to reactors, nuclear reactors, that instead of going with the new reactors, the high-temperature reactors like Toshiba's S4s or GE's Prism or General Atomic's EM2, that instead what we are doing is focusing more resources and higher percentage resources on older light-water reactor-type technologies. Even though they are smaller modular reactors, it is still light-water stuff that is 50-year-old technology. Now, why are we doing that? Why are we not focusing on developing this new technology that could actually eat the waste and eliminate some of these problems about Yucca Mountain and everything, but instead spending our money on old technology?

Secretary CHU. Well, the small modular reactors I wouldn't call specifically as old technology.

Mr. ROHRABACHER. Well, as long as it is based on light water, it is an old concept.

Secretary CHU. The reason we are doing this is because there is a recognition that many of the power sites in the United States could not accommodate—and around the world—could not accommodate large reactors on the scale to 1 to 1.5 gigawatts. The electrical infrastructure would not accommodate that. And there is a race among countries. South Korea has already approved one of the small modular reactors in South Korea. But we are very concerned. This is something again that will help American industry because we believe these small modular reactors—

Mr. ROHRABACHER. Secretary, you and I both agree on that. The only—what we are disagreeing on is whether or not the money that is going into these small modular reactors is going to go into a high-temperature version or a light-water version of the reactor. And I am—I—for the life of me I can't understand when the high-temperature gas-cooled reactors, the reactors that we have here—as I say, Toshiba and both GE and General Atomics, these are—companies have—this is available. Why aren't we backing the companies up on the new stuff rather than light-water reactors? I mean—anyway, you get my point and I hope you would seriously look into that and consider a restructuring of that priority.

One last area and I have only got one minute left. I am very concerned that we are not having an honest discussion on energy with this Administration. And I am talking about you, sir. I am talking about generally what we have—and I sat through the State of the Union. The President was taking both sides of every issue. And, you know, it is all of the above and then we know that just a few days before he said it is going to be all of the above to us, he was nixing, you know, the Keystone Pipeline. And I think we need to have a much more honest discussion on this. The American people are suffering right now. We got—we are not going to help manufacturing in these States that we just heard about if all the consumer money is being drained away and spending it on gasoline. And we

are not going to have more gasoline until we have more production of gas and oil.

And I have got 20 seconds left, so let me just say I noticed you are requesting \$12 million to look at fracking. I hope it is not—that this is not what it appears to be from the rest of the Administration, \$12 million that is spent on how to find out ways of stopping fracking, because fracking is what is going to bring down the cost of oil and gas and going to permit manufacturers to sell their products because people have money in their pocket rather than just putting it in the gas station. So I am hoping that that is not the case, but it seems to me, Mr. Chairman, everything indicates what we heard from the EPA and hopefully not with this \$12 million expenditure that you are requesting that this Administration is committed not to opening up new oil and gas but to try and find ways of stopping it, getting those guys who are producing our oil and gas. And that needs to—we need to have an honest discussion of what our priorities really are. And I don't think we are getting it and again, not from you, but, frankly, from the President of the United States on this.

Thank you very much, Mr. Chairman.

Chairman HALL. The gentleman yields back. We do have a vote on. We have about eight minutes. The Committee will stand in recess until five minutes after the conclusion of the last vote. I hope everybody comes back. And we will try to be a little more honest—

[Recess.]

Chairman HALL. Thank you for your patience.

And the Chair now recognizes Mrs. Bonamici for five minutes.

Ms. BONAMICI. Thank you very much, Mr. Chairman.

Thank you, Mr. Secretary, for your service and for recognizing and mentioning the importance of reducing our dependence on foreign oil and fossil fuels. I was pleased to see that your testimony discusses ARPA-E, and you mentioned the innovative work being done in the area of battery design. Well, I am proud that one of those projects is taking place in Oregon, how there is a company called ReVolt Technology, and ReVolt has brought this innovative zinc-air battery research and also jobs to our community. And we have seen firsthand the importance of the ARPA-E program. And I see that the Administration has proposed increasing ARPA-E funds by \$75 million, and I wonder if you could elaborate on the importance of this increased funding in enabling us to continue building on these new technologies such as the new generation battery technologies that will help Americans move away from fossil fuel consumption.

Secretary CHU. Sure. The design of ARPA-E was very focused. A short-term company or research group comes in with a specific idea. The tenure of these grants is something on the order of two years, very short-term, modest amounts of money to just push it over the edge. Very promising technologies, but we also designed in the *America Competes Act* that we wanted ARPA-E to really look for game-changing events, not incremental progress but game-changing events. And after two years, it ends and you get private sector funding or it gets picked up by someone else. And so that has proven to be very successful, as I note in my testimony. A

small amount of money has been leveraged—\$40 million has already been leveraged to private sector investments of over \$200 million. And we expect going forward that that number will even grow.

Ms. BONAMICI. Thank you. And I agree that it is a good investment.

And also you speak about the need to invest in clean and renewable energy and ensuring that we have that access to clean renewable domestic energy as a matter of both national and economic security. Now, there is also some promising work being done in Oregon about the development of wave energy technology, and I know that is true with other coastal areas as well. So in addition to providing another means of energy production, we have also seen the research and development and manufacturing benefits.

So it is critical that when we talk about domestic renewables, we also include in these discussions the encouraging developments around wave technology. And I wonder if you could address that issue as well.

Secretary CHU. We certainly we are looking at all forms of new technologies. Kinetic wave technology is one; geothermal is another one. So it is not just restricted to solar and wind. And then the wind technologies, we think that on-land wind is being established, so we are concentrating on how those technologies can work in a marine environment, again because it is the research that we are really pushing.

Ms. BONAMICI. Sure. And—terrific. I just want to follow up. I just had a discussion with someone about the wave energy buoys with wind turbines on top, so I think we just really need to look at all options for making sure we have renewable sources of energy. So thank you for your work.

And Mr. Chairman, I will yield back the balance of my time.

Chairman HALL. The gentlelady yields back.

Dr. Broun, Georgia, five minutes.

Dr. BROUN. Thank you, Mr. Chairman.

Mr. Secretary, I believe that the Federal Government should not be picking winners and losers in the marketplace. It seems to me that DOE has repeatedly proven that this Administration is clueless when it comes to making good business investments and that it also tends to side with political crony companies. Unfortunately, the Department's political favors come with more than a billion-dollar price tag that will have to be paid for by American taxpayers.

Time and time again, we have seen companies like Abound Solar, Beacon Power, A123 Batteries, and of course Solyndra receive millions and billions of dollars just to drop jobs. In addition to those 465 million that went to Tesla Motors to make a luxury electric car with a sticker price of \$100,000, worst kind of corporate welfare. In the President's Energy budget, the few people to be able to afford those cars would receive a \$10,000 tax subsidy. How can President Obama justify asking for more than a half a billion dollars in additional funding for his preferring green programs?

Secretary Chu, you tell me why you think your department deserves more taxpayer money to blow through given your abysmal

track record. What grade would you say you deserve for the management of the DOE resources over the last three years?

Secretary CHU. Well, I would give myself a pretty good grade, because if you look at what we have done and what we have supported and the breakthroughs that have occurred during this tenure, I think it speaks very well. As I said before, the battery research has been going extremely well, way ahead of what we thought was the schedule. We are very focused on a lot of the grid technologies on solar technologies. And as another example of the Bioenergy Research Centers, which were started in the previous Administration, have done extremely well and we are continuing funding for those. A lot of the inventions and technologies are now being licensed by companies and they are entering the pilot productions. So there are many successes in the technologies that the Department of Energy has supported. And the private sector, American industries are picking up these technologies.

Dr. BROUN. So what grade would you give yourself, A to F?

Secretary CHU. Oh, I don't know.

Dr. BROUN. What grade would you give yourself?

Secretary CHU. There is always room for improvement, maybe an A minus.

Dr. BROUN. Sir, I give you a D minus or an F. Somebody who makes a 69 on a test fails. Now, you do have some successes. I appreciate the loan to the Georgia Power Company to put in place the two new reactors there at Plant Vogtle, the first reactor that has been authorized in over 30 years. We need to have the ability to put in place nuclear reactors very quickly. I would like to see a template so that if a company followed that template, they could just go ahead with the construction that the government would oversee it just to make sure it was being followed, but they wouldn't have to spend millions or billions of dollars in just trying to get approval from the Nuclear Regulatory commission, particularly as anti-nuclear as this Administration has been.

But you all have had failure after failure after failure. Sir, I am not sure why we should give you any more money because I think you have failed. Like I say, I believe you have got a D minus or an F at best.

I yield back, Mr. Chairman.

Chairman HALL. Gentleman yields back. Mr. Secretary, just for your knowledge, if you have ever been asked that question before, you are entitled to know how the Chairman did when asked that question. One time I made four Fs and a D, and my dad punished me for spending too much time on one subject.

All right. Who do we recognize? Recognize Mr. Luján.

Mr. LUJÁN. Mr. Chairman, thank you very much.

And Dr. Chu, in your prepared testimony you state that with the New START Treaty, the science, technology, and engineering capabilities within the nuclear security enterprise will become even more important to sustaining the U.S. nuclear deterrent. President Obama, during his State of the Union this last year, said "today the discoveries taking place in our federally financed labs and universities could lead to new treatments that kill cancer cells but leave healthy ones untouched." He goes on to say that, "We

shouldn't gut these investments in our budget. Don't let other countries win the race to the future."

I would like to focus on this theme of nurturing the scientific engineering capabilities of the NNSA laboratories. With the 2013 budget request, NNSA's budget will have increased about 10 percent from 2011, yet over the same two-year time frame, the budget of Los Alamos National Laboratory will have decreased by about 10 percent. This is about a \$300 million decrease in just two years and choked the scientific and engineering capabilities at our lab. Because of these budget cuts, the lab has requested a voluntary reduction and forced incentive program with the goal of eliminating 400 to 800 jobs. This reduces the true source of scientific and engineering capability, the men and women who have served the Nation there who have the experience and training that is difficult and expensive to replace.

And finally, a recent National Academies' report, one that distrustful oversight by NNSA, in which individual transactions are reviewed at every step, is harming the vitality and long-term viability of the science and engineering capability at the NNSA labs. When you combine all of this distrustful and harmful oversight with the significant loss of personnel and reduction of funding over multiple years, you get a very damaging set of events that could do permanent harm to the lab and my district in the northern part of New Mexico.

So, Mr. Secretary, I have a lot of respect for you, but I have a lot of concern as to what has happened with Los Alamos. As I look at the budget, it looks like Los Alamos took a much greater hit than any of the other labs, and quite honestly, almost as much as the other labs combined. So, Mr. Secretary, what I am looking for is some assurance and some long-term commitment, one, to see how we can fix the arbitrary hits that look—that were targeted to Los Alamos, as well as a commitment to Los Alamos National Laboratory.

Secretary CHU. Well, certainly, Los Alamos National Laboratory is an excellent laboratory, but within our budget constraints going forward, we do have to make hard decisions, but certainly Los Alamos is going to be an essential part of the future of the NNSA laboratories. Those hard decisions need to be made, but we feel that they have not only a very rich past but also an outstanding group of scientists and engineers in that laboratory and will be a vital part of the NNSA mission.

Mr. LUJÁN. I appreciate it, Mr. Secretary, and I look forward to hopefully meeting with you soon with Senator Bingaman. I know a request has gotten in with yourself and Mr. D'Agostino and we look forward to having those conversations about the commitment to Los Alamos.

And Mr. Chairman, I want to quickly turn to all of this conversation and attacks on President Obama with increasing gas prices. You know, report after report shows that production is up under this Administration. Under President Barack Obama, production is up. The Republicans in this Congress voted against an amendment that I offered on the Floor of the House and in Committee, in the Natural Resources Committee, when there was a provision in front of us to increase production in the Gulf.

My amendment was real simple. It said during tough economic times, let us make a commitment—because I know how to count; my dad taught me how to count very young—and we knew the bill was going to pass. But what we asked our colleagues from the other side of the aisle was if we are going to pass this bill, let's at least commit to keep any new production in the United States for American consumption and to be refined in the United States. I couldn't get one of my colleagues from other side of the aisle to support that amendment. Ranking Member Markey offered something similar as well, which was defeated overwhelmingly.

Last year, there were many individuals that provided testimony in the Senate talking about the problems with speculation. Mr. Tillerman, the boss of ExxonMobil, admitted last week that the price—and this was back in 2011, early 2011 or in May—that the price of oil based purely on supply and demand should be \$60 to \$70 a barrel. The reason it is above \$100 a barrel, Tillerman explained, is due to the oil majors using futures contracts to lock into high prices. And we see article after article—the Commodities Future Trade Commission plans to issue a report next month talking about these problems. If we are serious about doing something now, we should tap the reserves we have and crack down on speculation, Mr. Chairman. And I think that enough is enough with the rhetoric. Let us do something real. We can get this done together, and there is support from all sides.

And with that, Mr. Chairman, I yield back.

Chairman HALL. I accept your yielding back and I admire you as a good Member and as a member of a great family of public servants from your State. I don't agree with you very much on your analysis of the President, though, and you don't expect me to, do you?

Mr. LUJÁN. Mr. Chairman, I think that is why we are friends. As the good Governor King from New Mexico used to say, some of my friends are for it and some of my friends are against it, and I will support my friends.

Chairman HALL. There you go.

I now recognize a very patient—probably might be the best Member over here who looks around and scolds me when I go over and I am trying not to do that. But I recognize Ms. Adams for 10 minutes.

Mrs. ADAMS. Thank you, Mr. Chair.

Chairman HALL. Well, I am trying to get along with you.

Mrs. ADAMS. I appreciate it.

Secretary Chu, I sit here and I listen and that is what I do probably most intently because of my background as a law enforcement officer. I tend to listen to all the words being said. So I am going to ask you some questions and I would just appreciate a simple yes or no. All right? We don't need to do a back-and-forth or anything like that. I listen with great intent. As the Chairman asked you if Yucca Mountain was completely left out of the equation during the Committee, you said not in the charge. Would that not mean, yes, it was left out?

Secretary CHU. The intent of Yucca Mountain was——

Mrs. ADAMS. I—again, yes or no. It is just simple questions.

Secretary CHU. Yes or no——

Mrs. ADAMS. Okay. Let's move on to something a little bit easier since these are your words. I heard Chairman Sensenbrenner ask you some questions and I just wanted to know for the record do you still agree with your statement back in 2008, "Somehow, we have to figure out how to boost the price of gasoline to the levels in Europe." Do you agree with your statement you made in 2008 or have you changed your mind? Yes or no?

Secretary CHU. We are working—I am working to decrease the price in—whatever tools we have—

Mrs. ADAMS. Secretary Chu, do you stand by your statement, yes or no, in 2008?

Secretary CHU. I do not want to raise the price of gasoline; I want to lower the price of gasoline. And all my actions as Secretary of Energy—

Mrs. ADAMS. Did you not say last Tuesday to Congressman Alan Nunnelee's question that it was not the goal—overall goal of the Administration to lower gas prices?

Secretary CHU. That is incorrect. What I had said if you would read the full statement—what I said was we are working very hard to lower the gasoline prices with the tools the Administration has, but in addition to that, specifically in the Department of Energy, we are trying to diversify the supply so that that will help the American consumers—the American families who are feeling terrible pain to actually—

Mrs. ADAMS. Well, currently, in—

Secretary CHU [continuing]. Have other choices.

Mrs. ADAMS. You are right; they are feeling the pain and I hear about it when I go back to my district. We have got hardworking taxpayers who will put more money into their gas tanks. Would you not agree that when the fuel costs go up, everything goes up for our American people, everything from food to electricity to everything? Would you agree with that? Yes or no?

Secretary CHU. I would agree that when the price of oil and the price of gasoline and diesel go up, that affects our economy in a very deep way, and that is why when—

Mrs. ADAMS. And it affects every aspect of Americans' lives.

Secretary CHU. And we are—that is why we are so focused on developing alternatives—

Mrs. ADAMS. Well, then, you said earlier—and again, I am listening; I am trying to write as quickly—not to lower gas—you were talking about gas prices, not to lower it, then certainly we want to lower it, but we want people to use less. So when you go back to your 2008 comments about having it rise up to the levels of Europe and then you go back to two days ago when you made your comment about it was not the Administration—the goal—overall goal of the Administration to lower gas prices. Then today, when you are in here saying not to lower—but certainly you want it to be lower, but you want people to use less. Doesn't that go back to the original statement that in 2008 when you said somehow we have to figure out how to make gasoline prices—boost the price of gasoline to the levels of Europe?

Secretary CHU. It absolutely does not go back to that statement. As you look at all my actions and all that we are trying to do in the Department of Energy—

Mrs. ADAMS. Well, that is just it. I have looked at your actions. I have looked at your actions and I have seen where taxpayers' money—hard-earned taxpayer money in this economy was sent to Solyndra when everyone, all the emails that—everything that I have seen showed that there was a problem. Yet we have gas prices on the rise and I heard my colleague say 100 percent. I have at least figured out it is over 89 percent. And I have a Secretary who is in one Committee saying one thing, two days later telling me a different statement, but back in '08 basically along the same lines of what you were saying two days ago.

So I appreciate your comments, Secretary, but the actions and the words are not going together, and I am really concerned that your 2008 comments and statements are coming to fruition for the American people, and that worries me. I know from talking to people back home their electricity has gone up, their gasoline has gone up, and they are concerned that this Administration is not taking that seriously. So I would like for you to take that back with you to the Administration. People are hurting, and they want this Administration to do the right thing.

We have sent them bill after bill, to the Senate. to allow for the drilling of our own resources. We have sent them and the Administration has denied the Keystone Pipeline. These are things that would help the American people today—today, Secretary Chu.

And I yield back.

Chairman HALL. The gentlelady yields back.

Recognize Mr. Tonko, the gentleman from New York, for five minutes.

Mr. TONKO. Thank you, Mr. Chair. And Mr. Chair, allow me to associate my comments with those of Representative Luján, who I thought was spot on about the issue.

And Secretary Chu, welcome and thank you for responding in professional capacity and enduring.

Secretary Chu, I understand the Administration made some tough choices in this budget, and I have a question related to one of those tough choices, cuts that impact our Brookhaven National Lab, an important facility in New York State. I understand the number of operating hours of the Relative Heavy Ion Collider, or RHIC, will be cut in half compared to the facility's operating hours this year. Even this year, it will not be running to full operating capacity. As you know, this is an important research facility for the nuclear physics community. And in addition to the reduced operation time, the funding reduction will also impact facility maintenance and upgrades to ensure its long-term productivity. We have a long-term investment in this facility and I know these are tough times, but I do not believe we should jeopardize our ability to continue use of important research tools like the RHIC. This does not send a positive message to our students and scientists who rely on access to these community facilities to do their research.

So my question would be what plans are there at the Department to ensure that the continuity of the research being done by students and researchers there can be maintained under reducing operating hours?

Secretary CHU. Well, as you pointed out, RHIC, the Relativistic Heavy Ion Collider, is an important part of our Nuclear Physics

portfolio, but as you also pointed out, we face tough decisions and the tough decisions on all the worthy projects we have to fund. And so we will have to look at these things very carefully, but certainly the past discoveries of RHIC are applauded and I have met their very exciting team. But again, it is one of these very hard things. We haven't made specific plans on specifically going forward, but all the things and all the benefits and all the opportunities of RHIC do get weighed with all the other things. But, you know, we have a budget deficit, and we also have to act responsibly.

Mr. TONKO. Um-hum. Well, it seems unlikely that we would be able to afford to build a new facility to do this work, so should we not be maintaining the RHIC and other unique DOE facilities to make the most of our investment? I would hope—I hear what you are saying, but I would hope that we could see the dividends that come because of this investment and how critical they are to our innovation into the future.

Secretary CHU. I am not sure how to—because is there a question that I can respond to?

Mr. TONKO. Well, you know, some have suggested, well, we might be able to build a new facility to do this work but I would think that would deny the efforts made to date and the outstanding track record that exists there.

Secretary CHU. I am not sure who said that or anything but I think we want to use the facilities we have and as we contemplate new facilities, I mean, these are tough budget times. So we—again I am not sure who made that statement but I don't think this is being seriously considered but I can certainly get back to you on that.

Mr. TONKO. Okay. And again thank you for the thoughtful dialogue. I think it is what we need these days with so many complex issues. And I just think that it needs—and can be done—in an atmosphere of respect. So thank you for responding in sound professional and thoughtful—

Secretary CHU. Right.

Mr. TONKO [continuing]. Manner here this morning and afternoon.

Thank you, Mr. Chair. I yield back.

Chairman HALL. And I thank you for yielding back a minute, very thoughtful of you and appreciate it.

The Chair recognizes Mr. Hultgren, State of Illinois.

Mr. HULTGREN. Thank you, Mr. Chairman.

Mr. Secretary, in 2006 you testified before the Rising Above the Gathering Storm panel. You said, “In funding ARPA-E, it is critical that its funding not jeopardize the basic research supported by the Department of Energy’s Office of Science. The Committee’s recommendations are prioritized and its top recommendation in the area of research is to increase the funding for basic research by 10 percent per year over the next seven years.” Mr. Secretary, you said that. That is your quote; those are your words that you said. So I want to take a look at the charts that we are going to put up on the screen breaking down your budget request, and I believe the Committee can also put a copy up so everybody can see it here.

This is a chart that we put together. It is maybe a little bit difficult to see, but I will walk through it with you quickly. It shows

your request for percentage changes in various programs on the vertical axis, and on the horizontal axis it shows the range of research activities from basic research, which is on the right below the line, to applied research bordering on State industrial policy on the left. Those numbers show a pretty clear story. Fundamental science research is cut and the President's industrial policy is boosted. How can you with a straight face tell me that you haven't funded the President's pet projects in industrial policy at the expense of fundamental research?

Secretary CHU. Well, as your chart shows, we are seeking a 2.4 percent increase in the Office of Science. The Office of Science is what we call our basic research program within the Department of Energy. The request is for roughly \$5 billion. ARPA-E is just a beginning new program and their request was for a much smaller amount, \$350 million. And so if one puts into perspective those two budgets, we still remain very committed to funding the Office of Science, which is our more basic research program.

Mr. HULTGREN. Well, again, I think as you go through the ones on the right and going further to the right I see Fermilab, which is very important to me, I have heard my colleagues on the other side of the aisle also talking about research facilities being slashed, Fermilab, eight percent cut. Other pet projects again getting that increase. But again this discrepancy of almost a 30 percent increase versus two percent versus -8 percent. I don't know how you justify that with your own statement that says you were looking to increase basic scientific research, which is our national laboratories by 10 percent per year, and yet here you are cutting it by eight percent.

Secretary CHU. Well, you are now talking about the Fermilab specific request budget. What we are trying to work through is a plan to go forward in terms of the long baseline experiments and also what we are trying to work out and how to go forward in the Deep mine in South Dakota. And so again if you—you can look at percentage increases or you can look at absolute dollars, and when we look at the absolute dollars of the Office of Science, we have increased that budget and I am very, very supportive of increasing that budget. ARPA-E, again, it is very small compared to the Office of Science.

Mr. HULTGREN. Well, I want to work with you on making sure that we follow through on that. What I see with some of the projects there specifically dealing with South Dakota is it is on life support right now. I mean it is barely enough to keep it operational. And then with—we were talking about this with Dr. Holdren last week. The steps of this budget—it is on crutches right now and we are breaking the crutches away from that project with this budget. I am fearful of that because I really think we are going and taking something valuable away to our kids and our grandkids the great opportunities that we have had to pursue science and basic scientific research. We are failing our future if we undercut that with these projects.

I am passionate about Fermilab, but I am passionate about other laboratories that I don't represent as well and want to see that same commitment there. I recognize the fiscal year 2013 budget is constrained with so many pressures, discretionary spending caps,

but this imbalance seems to represent a definite and indefensible trend to retrench on discovery science and promote more applied research. You neglect to balance the portfolio, which leaves the fundamental discovery science in disarray.

And I just wonder is this the proper direction for the Department when investments in basic scientific research really underpin the Nation's science and technology enterprise?

Secretary CHU. Well, very quickly, I would say I agree with you. The Office of Science is a very important part of our program, and we want to see that budget grow and increase and it does form the underpinnings of everything that leads to it, including all the underpinnings of the companies that are using discoveries in the Office of Science and in energy—clean energy, renewable energy, ARPA-E. And the Office of Science does form the basis of all that.

Mr. HULTGREN. Well, I hope we can follow through on that and see—I think we are seeing that clearly there is money there, and there is money that doesn't have to be taken away from some of this basic scientific research and we can bulk up that amount.

Mr. Secretary, I do thank you for your service, and I do appreciate the ability to be able to discuss things, but it really does seem clear to me that this is an anti-science budget aimed at pushing short-term political agendas. I really do believe it is going to hurt our long-term economic competitiveness, our scientific enterprise, and our country.

With that I yield back.

Chairman HALL. Gentleman yields back.

Chair recognizes Mrs. Lofgren, lady from California, five minutes.

Ms. LOFGREN. Well, thank you very much, Mr. Chairman.

And Dr. Chu, it is good to see you as well.

You know, in 1995 when I was a brand new Member of the House of Representatives, there was a very conservative Republican Congressman for the East Bay, Congressman Bill Baker. I am sure you remember Bill, and he recruited me and other people into an effort to pursue the National Ignition Facility at the Lawrence Livermore lab. And even though Bill is no longer a Member of Congress, that bipartisan support for the project has continued to this very day. And as you know, the project, the National Ignition Facility, has a key role to play in terms of our stewardship, and it is the lead effort in inertial confinement fusion. Are you aware, Dr. Chu, that if you look at the NNSA budget rules that will be applied, the bottom line for NIF is that if this budget remains as it is, they will essentially have to close and "mothball" next year?

Secretary CHU. No, I don't believe that is true. Certainly, we do not want that to happen. They have—it is—construction has been completed. They are entering—over the last year entering into very exciting—

Ms. LOFGREN. Two shots a day.

Secretary CHU [continuing]. Exciting experimental stage and we are looking forward to when they can actually prove that you can get what we call ignition, that more energy is going to come out than went in.

Ms. LOFGREN. Well, if I can, Dr. Holdren was here a couple of weeks ago. I asked him the same question, and he was honest

enough to say he didn't know. And he called me back afterwards to follow up, and he agreed that the funding and mothballing the experiment after we spent over \$4 billion on the capital, equipment, and to get to where we are would not be a smart thing to do. I called out—I mean the labs are not allowed to call us and lobby, but they do have to answer us when we call out there. And I was told that the net result would be mothballing NIF if this budget is retained by the lab.

And so I am looking at ITER, which is—you know, we are 10 percent of that effort and it is a long ways away if ever from getting—so we are proposing to increase their budget by \$45 million; at the same time we are going to shut down NIF and hundreds of American scientists will be laid off while we are sending money to this international effort that may never get started. How could that be—how can that be a smart decision?

Secretary CHU. Well, first, let me—my knowledge of what is happening with the NIF program, it is—as you pointed out, this is a very important part of our NNSA budget. It enables us to more deeply understand the physics we need to understand going forward for our nuclear security. And so I know of no plans. To the best of my knowledge, and we can get back to you on this, the funding is adequate for NIF to continue because we need that facility. It has just been constructed.

Ms. LOFGREN. I know that. I was at the opening, as were you.

Secretary CHU. Right. And under no circumstances do we have plans to mothball a facility that is working and just been constructed.

Ms. LOFGREN. Well, if I may, Mr. Chairman, I believe—I mean obviously I wouldn't have raised this if I hadn't been led to believe that that is in fact the case. So what I would like to do if I may is follow up with you. If necessary, we will do a bipartisan effort to defund the ITER contribution and redirect it to this effort if we need to. And I have already been talking to my friends on the other side of the aisle. I think we would have a bipartisan effort if we have to do that. But perhaps we can pursue this further off-calendar.

I wanted to do a quick question on the advanced computing. There is a reduction of 4.6 percent in the High-Performance Computing and Network Facilities subprogram. I am not sure how that is going to work. Can you explain the impact on the whole program from that reduction?

Secretary CHU. What we are doing—there has been a growth phase. We think high-performance computing is one of the keys to what the Department of Energy does, because high-performance computing enables industry to actually—

Ms. LOFGREN. We are for it.

Secretary CHU [continuing]. Skip design cycles very much—

Ms. LOFGREN. Absolutely important.

Secretary CHU. We are laying plans to do to the next step. For example, the high-performance computer at Oak Ridge, the Jaguar computer, will go from probably like several petaflops where it is today to perhaps as much as 20 petaflops. In the meantime, we are laying plans to go to exascale, because we think this simulation

high-performance computing is showing repeatedly it can help U.S. industry avoid design engineering steps.

Ms. LOFGREN. No, I get all of that. The question, though, is what is the impact of the proposed decrease, the 4.6 percent decrease? Is it not a problem? And also is the exascale proposal put forward by the Berkeley lab, is that funded in this budget?

Secretary CHU. The exascale—I mean an exascale is being developed in the Department of Energy.

Ms. LOFGREN. Right.

Secretary CHU. We haven't made any determination about where it is going to go. And indeed we are working with industry because as we improve the petaflop scale computers we have in the Department of Energy, we are also looking and getting positive feedback from industry to actually partner—

Ms. LOFGREN. Right.

Secretary CHU [continuing]. With industry to develop radically new technologies for this next—

Ms. LOFGREN. I wonder, Mr. Chairman, I know my time is up, but if we could just ask Dr. Chu what the impact of the 14 percent—4.6 percent decrease would be, which was my original question.

Secretary CHU. Right. We can get back to you on the details.

If the Chairman will allow me just 20 seconds on ITER?

Chairman HALL. I don't know how I could keep you from it.

Secretary CHU. Well—

Chairman HALL. Yes, the Chair will make that—I went a minute-and-a-half over. Be my guest.

Secretary CHU. I just wanted to respond—to point out—

Chairman HALL. Sir, you are entitled to—

Secretary CHU. Okay, thank you.

Chairman HALL [continuing]. Testify.

Secretary CHU. That the ITER project, over 80 percent of the funds will be spent in the United States and on contracts in companies and national laboratories in the United States. And it is an international obligation we have and so—and we don't see it as actually in conflict with NIF.

Ms. LOFGREN. Well, I have supported ITER in the past, but it is premised on a robust scientific effort here in the United States. And if the information I have is correct that we would be mothballing NIF, I could no longer support, you know, increasing our funding to EDER. And it is decades away from beginning operation. So you know, there are plenty of scientists who have told me without regard to the budget that they no longer have confidence that the project is even going to succeed because of the political support and the budget problems. But that is a separate question.

I thank the Chairman for letting me have a little more time.

Chairman HALL. The gentlelady yields back.

Mrs. Biggert, Illinois, five minutes.

Mrs. BIGGERT. Thank you, Mr. Chairman. As usually happens, the last two members have skirted around the issues that I wanted to ask questions about but not quite the same.

The budget repeatedly highlights President Obama's commitment to doubling the budget of key basic research programs at the Office of Science, along with NIST and NSF. But the budget request for

the Office of Science is proposed to increase by only 2.4 percent, and at that rate, it is going to take about 30 years to double the budget and doesn't account for inflation. Meanwhile, the programs such as EERE and ARPA-E are proposed to increase by 29 percent and 27 percent. Do you think, then, that funding for the Office of Science really is a low priority for DOE?

Secretary CHU. No, it is not a low priority. It is a priority. It is a high priority. As you well know, I spent my life doing fundamental science, and I know the value of fundamental science and what it leads to.

Mrs. BIGGERT. Okay. Then—and then going to the Exascale Computing Initiative and it is a joint program between science and NNSA—

Secretary CHU. NNSA.

Mrs. BIGGERT [continuing]. And it seems that there appears to be an uncertainty regarding the funding for the NNSA's matching participation with no firm number in the budget request, and I hope that the Administration is committed to this joint venture and all the progress that the United States has made in supercomputing. But does the Department—do you think that that budget—that they are going to commit to a certain budget? And does the Department intend to deliver its exascale report to the Hill soon?

Secretary CHU. Well, we—the Department of Energy is very committed to developing exascale computing because we see clearly all the advantages it will give not only the scientific community, but the industrial base in the United States. The NNSA, as you well know, is under significant budget strain. Our first responsibility in NNSA is to tend to the nuclear security of the United States and we hope that they can continue participation. But we do remain committed to making sure that we lead in exascale computing.

Mrs. BIGGERT. But you don't have any figures yet—

Secretary CHU. No.

Mrs. BIGGERT [continuing]. For NNSA.

Secretary CHU. But the Department does think that exascale computing is one of the frontiers that the United States should certainly invest in.

Mrs. BIGGERT. Okay. And then the 2012 appropriations had—for the study, and do you—

Secretary CHU. Yes.

Mrs. BIGGERT [continuing]. Know when that will be?

Secretary CHU. I can get back to you on exactly when—

Mrs. BIGGERT. Okay.

Secretary CHU [continuing]. They expect it delivered.

Mrs. BIGGERT. All right. Then just one other quick question—the budget request, \$10 million from a Nuclear Waste Fund in fiscal year 2013, what is the purpose of this request and what is it going to be used for?

Secretary CHU. Yes. First, we have commenced this study within the Department to look at the recommendations of the Blue Ribbon Commission. And also we would love to work with Congress in those recommendations as well. One of the things that the Blue Ribbon Commission felt was very important is we have out of our 200—we have roughly 104 operating nuclear reactors, but there are

a number of sites where the reactors are no longer operating and yet we still have spent fuel there.

Mrs. BIGGERT. Okay.

Secretary CHU. And what we wanted to do was to begin to have the spent fuels put in dry cask storage with an envelope and get it licensed by the Nuclear Regulatory Agency so that they can be safely transported out of those now-dormant reactor sites because of all the security and issues that—at least to consolidate those few sites.

Mrs. BIGGERT. Okay. Then one more quick question. And this is—involves Keystone. I am really worried about the fact that we are not going to have Keystone, and I cannot understand how we would let this go. And right now the Canadians are over in China negotiating with them to send the oil there. And I think that is such a mistake when we are trying to reduce our dependence on foreign oil and particularly the hostile countries that provide it. And we would just let this go when we—I know that you have already talked about working on the bottom part of this and going forward with that, and yet we have no resolution or the Administration has vetoed it.

Secretary CHU. The Administration did not veto it. When Congress said you have to make a decision at this time, the State Department said we have to look at the environmental impacts at this time. And so it has not been vetoed. The Administration and we in the Department of Energy have applauded the fact and it was well known that the first bottleneck in this—

Mrs. BIGGERT. And that was taken care of.

Secretary CHU. It is being taken care of by several companies cushioning to Houston and Louisiana. The second bottleneck is between Chicago and cushioning. Those plans are also underway—

Mrs. BIGGERT. I understand that.

Secretary CHU [continuing]. And it is very important to clear up these domestic bottlenecks because then we can continue to develop the oil in North Dakota—

Mrs. BIGGERT. If we have—if we will have the oil by the time that all these things are cleared up.

Secretary CHU. Well, as I said, you know, the—you know that the same Keystone people are now working with, for example, the State of Nebraska on the crucial parts of the pipeline being built in the United States, which are going forward.

Mrs. BIGGERT. Thank you.

Thank you very much. Yield back.

Chairman HALL. I thank the gentlelady.

Recognize Mr. Miller, gentleman from North Carolina, for five minutes.

Mr. MILLER. Thank you, Mr. Chairman.

Secretary Chu, I congratulate you for your modesty in not wearing your Nobel medallion to appear today. I am not sure it would have made any difference in how you were treated, but if it had been me, I think I probably would have worn it.

There have been—well, one of the most spectacularly successful government programs is DARPA, not just doing research that nobody else would have done but getting transformational research to the marketplace. One of the proposals of the Augustine report, *Ris-*

ing *Above the Gathering Storm*, there was bipartisan support for in this Committee. Chairman Boehlert supported it, Bart Gordon supported it, was ARPA-E, a program modeled after DARPA for energy to do the kind of research that otherwise would not get done because it is more likely than not that any given research would be fruitless. But the research that did work out could change things in a dramatic way.

But there is also criticism that ARPA-E projects duplicate other research at the front end of their research and that it crowds out private sector funding at the back end, and it is hard to get things to the marketplace unless there is some overlaps, some kind of handoff to private sector funding. How do you identify—and also it is kind of hard to find research in which nobody has done any research to see that as a promising area of research. How do you identify the research that ARPA-E will do? Do you duplicate research that is being done or has been done by the private or by the public sector? And then how do you make that pass-off to private sector development? Do you crowd out public investment?

Secretary CHU. Well, thanks for the question. First, there is a big distinction between the research that ARPA-E funds and the research, for example, that the Office of Science funds. The Office of Science funds research that lays foundational science that could lead to energy innovations. ARPA-E is focused on very short-term grants, typically two years, and modest amounts of money that can push something over the top. In some of those grants, they go to universities. Other grants go to small startup companies where there is a melding of public and private dollars. But we also tried to identify those things where a small starting company would not have the resources to take a next step. And in many cases—in most cases what we try to do—or a large company says, all right, you know, this is too much to swing for the fences, but if we are willing to get some assistance from ARPA-E, we will try these dramatic attempts.

And that was the philosophy of DARPA and that is the philosophy of ARPA-E, something where you could not possibly imagine, for example, some way of—a global positioning satellite system. It is a great triumph of DARPA to look very far into the future and say, you know, it might be possible to use this system in military applications, but it now turns out to have fantastic commercial applications. But in ARPA-E, those things that we fund are these very short-term—now. There are certain spaces. We identified in ARPA-E, for example, power electronics. These are the electronics that convert high voltage to low voltage or DC to AC or AC to DC. For whatever reason, the university system wasn't investing in power electronics to build up a base of that. And if you talk to any companies, they would love to hire people trained in power electronics. We identify power electronics as a real growth industry. About 30 percent of electricity goes through some sort of power electronics today, but in 15 years or so we are expecting 80 percent to go. The industry wants this and we are helping companies develop power electronics and we are also trying to get universities to fund power electronics faculty.

So the ARPA-E funding in power electronics says if we can make a transistor—not a silicon transistor but like a silicon carbide, we

have entered in funding with a company making fantastic power electronics, very high voltage, high current so you can regulate power much more efficiently, much more inexpensively. Again, we see this as a great opportunity for American prosperity because these things are things we think the United States should be leading in. And again, it is a very identified target.

Mr. MILLER. Thank you, Mr. Chairman. My time is expired.

Chairman HALL. I thank the gentleman. Now, probably you save the best for the last normally, but I don't ever like to say anything until the last at my age for today I am talking about.

I recognize you, Mr. Harris, and I am going to ask for a minute or so to visit with Ms. Johnson. Okay with you?

Mr. HARRIS. Certainly. Anything you want, Mr. Chairman.

Listen, thank you, Dr. Chu. And I—you know, I share the—what my colleague from North Carolina says. I appreciate a Nobel Prize winner coming in front of us, especially one in physics. I told you before I never understood it. I was a physiologist, not a physicist. You know, I respect that. But that does give us—and I know from personal experience that sometimes scientists like that kind of get a little tunnel vision. To someone with a hammer, everything looks like a nail.

You talked about breakthroughs and of course that should be what I think the Department of Energy is all about. I am going to ask you a question. Would you agree with me that the biggest energy breakthrough in the last three years and one month has been that the cost of natural gas is one-half of what it was when the President took office, yet the price of gasoline is twice as high so that in fact there is a breakthrough that has led to a hugely important energy source. Would you agree that that really is—to someone looking objectively, that is really the largest breakthrough that has occurred in energy in this country?

Secretary CHU. I would agree that that it certainly has been a breakthrough but it had a long birth period.

Mr. HARRIS. Sure, but I mean the halving of a price—

Secretary CHU. Um-hum.

Mr. HARRIS [continuing]. In one energy source while another source is doubled now and we think is still going up—and by the way, you know, I thank you—I hope that your bias from before when you were Secretary and said we should have European-style prices, I hope you had an epiphany, you and the President and that, in fact, that is probably not a good thing now. But let's look at what the Department does. The Department's budget next year has one-fifth of one percent of its spending on natural gas, one-fifth of one percent. It is smaller than the increase in solar spending. Would you say that the Administration kind of missed the boat on this natural gas phenomenon that really some people look at and say is the future and the real breakthrough in American energy?

Secretary CHU. Well, I agree with you that the ability to capture natural gas from shale rock was wonderful—is wonderful. The Department of Energy funded this from about 1978 to 1992.

Mr. HARRIS. And how much in the last three years?

Secretary CHU. Well, right now, what we are doing is we are going to the next new thing in gas. We are funding methane hydrates. This is in collaboration with industry but we also have

helped bring Japan on board because we think methane hydrates might be another form. It is too early to tell. Just as we funded drilling and hydraulic fracturing many, many years ago when industry did not think it was viable—

Mr. HARRIS. Sure. What is your budget level on methane hydrates?

Secretary CHU. It is very small but we—

Mr. HARRIS. Okay. So it is even less than one-fifth of one percent?

Secretary CHU. Yes.

Mr. HARRIS. So this huge new energy source, the real breakthrough, the Department is spending one-fifth of one percent. All right. Well, your time is precious. I appreciate that. You can't spend all your time on everything, so I am going to ask you about this email—this June 2011 email where a Solyndra employee described what they learned from Bank of America financiers involved in that Prologis loan negotiation. A quote from the email is, "on three occasions this week, he thought that the deal was dead but Secretary Chu"—so he being the financier—"but Secretary Chu personally pulled it off. Chu shared with the team that this deal went to higher levels in the Obama Administration to gain approval than any other transaction in the Loan Guarantee Program and that he personally committed to seeing it through to successful conclusion." Now, is that kind of true? I mean is what that person says kind of a realistic summary of what went on? And of course remembering that Prologis at that time was going to contract with Solyndra at a time when Solyndra was renegotiating its whole deal with the government and in fact got, you know, was secondary in—you know, that whole—and you know the whole deal. Is that a pretty accurate summary, that you were personally involved at a level different from other deals?

Secretary CHU. I strongly supported the Prologis loan application because I thought it was a wonderful way of financing in a measured way—financing—letting warehouses use their rooftop space—

Mr. HARRIS. Sure. Was there a breakthrough new technology involved?

Secretary CHU. No.

Mr. HARRIS. No, there was no breakthrough. And this was how big a loan guarantee?

Secretary CHU. Well, it was going out in stages.

Mr. HARRIS. Yeah, and what was the total? Wasn't it over a billion dollars?

Secretary CHU. Pardon?

Mr. HARRIS. Was it over a billion dollars?

Secretary CHU. No, it was not a billion.

Mr. HARRIS. And how—so how much total?

Secretary CHU. I think \$750 million.

Mr. HARRIS. Oh, I am sorry, only three-quarters of a billion. Okay. So what specific actions did you take with regards to this loan different from the actions you took on other loans? Because, again, this is not breakthrough technology. And you know, I have been a supporter of ARPA-E. I think that is where the Department ought to be concentrating. So when it—so when things happened

with Solyndra which, again, Solyndra is not breakthrough technology. Let's be honest. You know, hydrofracturing is breakthrough technology. Solyndra really was just, you know, a little bit better than what we have had. So what it appears has happened is that your time, which is of basic science, I would think would be saying, look, let's make some really innovative changes in energy. Instead, it appears to have been taken up to forward a deal where Solyndra is involved, where, you know, the objective person would look and say, you know, it looks kind of like what you are doing is you are, you know, saving Solyndra from an embarrassment to the Administration by in fact interjecting yourself into the Prologis negotiation at a different level than you have interjected yourself into any other one. And again that is what this person says.

Secretary CHU. That is untrue. I—

Mr. HARRIS. Which part?

Secretary CHU. Solyndra—the fact that Solyndra had a minor, minor role in that—in fact, I was quite the opposite. I wanted Prologis. It was an innovation in a business model, as you know, can really revolutionize things. My concern was that we thought that—I thought that this was a very, very good business model to put wholesale generation of electricity on warehouse rooftops. My concern actually was to not having anything to do with the future of Solyndra—it was completely different. In fact, I voiced concerns; shouldn't we be looking for alternatives to Solyndra for the first little bit? And so it was quite the opposite from what might be portrayed.

Mr. HARRIS. Did you attempt to stop the negotiation between Prologis and Solyndra?

Secretary CHU. No. That was between two companies. But what I did raise is my concern that I wanted Prologis to go forward and was concerned if Solyndra could supply those things. But again the good news is that solar modules are essentially a commodity—and as the prices are going down—and the good news about this, again, is that the price of solar modules has dropped fourfold in the last three years.

Mr. HARRIS. But Mr. Secretary, the cost is still far more because one of the statements—and Mr. Chairman, I will wrap it up—one of the statements in your testimony is that one goal is to bring down solar energy prices by the end of the decade to be the cheapest source of electricity.

Secretary CHU. As cheap as any other source of energy.

Mr. HARRIS. Correct. Now, Secretary Chu, at 2.50 a million BTU for natural gas, you really think that solar by the end of this decade, the point where you were unwilling to invest in natural gas, you still think that is the best investment we can do to keep our energy prices low in this country? You think you can achieve that at 2.50 a million cubic foot? And again since we are going to control it, it is not going to be at the vagaries of an international market to some extent.

Secretary CHU. Well, if you look at projections made by, for example, the EIA or projections made by Bloomberg New Energy Finance, they are projecting the price of natural gas-generated electricity be something on the scale of 5.5, 6 cents a kilowatt hour.

Mr. HARRIS. Do you know what their projection is for natural gas last month? Their last projection from 2010 was where natural gas prices—

Secretary CHU. I know what the Bloomberg New Energy Finance's projection for the cost of electricity from the generation of natural gas. That was first quarter 2012 and that is the one—the number—

Mr. HARRIS. I will let you in on it. A year and a half ago, they projected—this is how good we are at projecting prices. They thought it was going to be \$5 a million cubic foot. It is \$2.50.

Secretary CHU. Right.

Mr. HARRIS. The Administration, at many different levels, is just behind the curve on this. But I respect you and I thank you for being here and I just hope that you take the view that natural gas is important enough to invest in it.

Thank you very much.

And thank you. I am sorry I ran way over, Mr. Chairman, but thank you for your indulgence.

Chairman HALL. Well, at least you waited a long time to do it. Thank you for good questions, and thank you for your answers.

And I indicated in an opening statement that I was going to answer Ms. Johnson but I know when I am overmatched. I am going to put something in the record if she doesn't object to it. It is the primary scenario and the analysis I am asking to put in the record was by Senator Bingaman. It was in the Senate and shows electricity prices would rise nationally by 21 percent in 2035 and regionally by as much as 69 percent. That is one person in one body's idea on it. And without objection, I want to put this into the record. It is so ordered.

[The information may be found in Appendix 2.]

Chairman HALL. And I want to thank you very much. I don't sound like I appreciate you near as much as I do, but you have answered our questions and we have agreed and disagreed. You said that the pipeline wasn't cancelled but its head is down in the water and it's down there bubbling and it is going to drown if—you give me hope that he is going to reconsider and I am—between the two of us here, I am going to make you a prediction if you don't mind, and you can hold me to it. I think this President is going to listen to the American people and I hope he does. I think he is political enough to. I predict he is going to recapture this pipeline for us because it is the thing that he ought to do and the people are going to demand it. And I think he is going to do that.

I also think where he knocked out ANWR—and that is 60 years of energy—quickly did that and it has been going down every since, really and truly that is a hard, cold fact. I predict that we are going to—he is going to open up some drilling because the people are going to demand it, and the President is very political. I think he is going to answer. I predict that he is going to. Now, I owe you a beer or a dinner or whatever if my predictions are wrong, but maybe you will owe me one if I am right, okay?

Secretary CHU. I would be glad to share a beer with you.

Chairman HALL. All right. I thank you, of course, for your very valuable testimony and Members for their questions.

And Members of the Committee might have additional questions for you, Mr. Secretary, and we will ask you to respond to those in writing. And the record will remain open for two weeks for additional comments from Members.

I thank all of you for your patience. Thank you, Ms. Johnson, for your good work and your good questions. And once again, Mr. Chairman, thank you and God bless you. Thank you, sir.

Secretary CHU. Thank you.

Chairman HALL. We are adjourned.

[Whereupon, at 12:04 p.m., the Committee was adjourned.]

ANSWERS TO POST-HEARING QUESTIONS

ANSWERS TO POST-HEARING QUESTIONS

*Responses by Dr. Steven Chu,
U.S. Secretary of Energy*

**Questions Submitted by Chairman Ralph M. Hall,
Committee on Science, Space and Technology**

**U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY**

Questions for the Record

*An Overview of the Department of Energy Research and Development Budget
For Fiscal Year 2013*

Thursday, March 1, 2012

9:30 a.m. to 12:00 p.m.

2318 Rayburn House Office Building

QUESTION FROM REPRESENTATIVE HALL

Q1. President Obama recently said we could replace “up to 17 percent of the oil we import for transportation” with algae.

a. What is the approximate equivalent cost of a gallon of algae-based fuel right now, and how long does DOE believe it will take to be economically competitive with oil?

A1a. In addition to cellulosic biomass materials, algae can be a sustainable feedstock to replace petroleum-based fuels like diesel and jet fuels. DOE is currently sponsoring research and development (R&D) at labs and universities and is building first-of-a-kind pilot facilities with Sapphire and Algenol to validate feasibility. However, current costs need to be reduced by 3 to 5 times to be economically competitive. Economic competitiveness depends on both technology readiness (including how well the scale and continuous operations risks are addressed) and the cost of capital to construct and operate based on a reasonable rate of return on investment. Because there is no industry consensus on many of these factors, the projected costs of algal biofuels can vary dramatically.

Many factors go into cost per gallon of algal biofuels analyses, including but not limited to:

- (1) The type of facility envisioned (i.e. open reactors versus closed photobioreactors versus heterotrophic reactors; briny water versus freshwater; evaporative harvesting versus dissolved air flotation harvesting; dry extraction versus wet extraction; trans-esterification versus hydrotreating conversion);
- (2) The envisioned scale of the algae production and conversion facility;

- (3) The annual areal productivity of the cultivated algae;
- (4) The appropriate values of any co-products (i.e. fish/shrimp meal) or co-services (i.e. CO₂ credit, wastewater remediation) generated alongside algal biofuels as additional revenue streams; and
- (5) The type of desired fuel end product, such as hydrotreated renewable jet (HRJ) fuel or biodiesel.

Just as the cost projections vary, the estimates of the time to commercial readiness vary depending on the type of algae process. For a heterotrophic algae process that is based on well-characterized continuous fermentations, the timeline to being economically competitive against oil on a technology readiness basis is expected to be shorter than an open pond or closed photoreactor based process. Individually, each of these producers may find niche opportunities that allow them to offer fuels on a cost-competitiveness basis due to certain co-products or co-services credits. DOE believes it will take more than 10 years for algal biofuels to be economically competitive with oil at the 1-5 billion gallon scale envisioned by the Energy Independence and Security Act (EISA) of 2007 Renewable Fuel Standard.

- b. Please provide a description, including activities and funding, for DOE-supported research on algae-based fuel over the last forty years.
- A1b. DOE-supported applied research on algal biofuels began in the 1970's with the Office of Fuels Development's Aquatic Species Program (ASP), which focused on the production of biodiesel from lipid-producing microalgae. The research thrusts during the ASP included studies on applied biology, algae production systems innovations, and resource

availabilities analyses. The results from the 18 years of the ASP are summarized in the 294-page NREL Report (TP-580-24190), titled "A Look Back at the U.S. Department of Energy's Aquatic Species Program: Biodiesel from Algae".¹

DOE's Biomass Program renewed its RD&D efforts on algal biofuels in 2008 by convening leading researchers and commercial entities at the National Algal Biofuels Technology Roadmap Workshop. The workshop highlighted analysis gaps and technology development opportunities that were the subjects of a competitive solicitation on an R&D consortium released in FY2009 with \$49 million dollars of DOE investment from the American Reinvestment and Recovery Act. The awardee, the National Alliance for Advanced Biofuels and Bioproducts (NAABB) algae consortium, is led by the Donald Danforth Plant Sciences Institute and consists of multidisciplinary researchers from 37 different U.S. institutions who are focusing on algal biology, cultivation, harvesting, extraction, conversion and end-use.

The Recovery Act also allowed the Biomass Program to invest in three algae pilot and demonstration-scale integrated biorefineries- Sapphire Energy Inc., Algenol LLC, and Solazyme Inc., at DOE funding shares of \$50 million, \$25 million, and \$22 million, respectively. Sapphire focuses on an open pond based approach to cultivate algae, while Algenol is pursuing a closed photobioreactor. Both companies use photosynthetic algae, as opposed to Solazyme, which is pursuing a heterotrophic fermentation approach.

¹ For a copy of the report, please download from <http://www.nrel.gov/docs/legosti/t598/24190.pdf>

From FY2010 through FY2011, the DOE Biomass Program supported additional R&D projects, of which 31 were reviewed at the Algae Platform Peer Review. For these projects, the requested information is summarized below in Table 1.

During this time, a number of other DOE projects on algae were funded from the DOE Office of Fossil Energy, DOE ARPA-E, and DOE Office of Science, including beneficial CO₂ reuse in oil producing algae, genetic pathways identification for algae hydrocarbon production, and dewatering technologies.

Table 1. Summary of DOE Biomass Program Active Algae Projects from FY2010 to FY2011

Project Title	Presenter	Performing Organization	Project Type	Approximate DOE Share
NAABB An Algal Biofuels Consortium	Jose Olivares	Los Alamos National Laboratory	Consortium	\$49M
Algal Biofuels via Innovative Harvesting and Aquaculture Systems	Jeff Kanel	Renewable Algal Energy	Feedstock Logistics	\$1.5M
Large-Scale Production of Fuels and Feed from Marine Microalgae	Jeff Obbard	Cellana	Consortium	\$9M
Sustainable Algal Biofuels Consortium	John McGowen	Arizona State University	Consortium	\$6M
Consortium for Algal Biofuels Commercialization	Paul Falkowski	CABComm	Consortium	\$9M
Research for Developing Renewable Biofuels from Algae	George Oyler	University of Nebraska Lincoln	Congressionally Directed Funding	\$1.9M
Algal Biofuel Pathway Baseline Costs	Andy Aden	NREL	Analysis & Sustainability	Less than \$1M
Algae Life Cycle Assessment with GREET	Ed Frank	Argonne National Lab	Analysis & Sustainability	Less than \$1M
Development of Renewable Biofuels Technology by Transcriptomic Analysis and Metabolic Engineering of Diatoms	Mark Hildebrand	University of California - San Diego	Feedstock Production	Less than \$1M

Improving cost effectiveness of algae-lipid production through advances in nutrient delivery and processing systems	K.C. Das	University of Georgia	Feedstock Production	Less than \$1M
Production of higher alcohols liquid biofuel via acidogenic digestion and chemical upgrading of industrial biomass streams.	Peter van Walsum	University of Maine	Conversion	Less than \$1M
Extremophilic Microalgae: Advanced Lipid and Biomass Production for Biofuels and Bioproducts	Brent Peyton	Montana State University	Feedstock Production	Less than \$1M
Macroalgae GIS Analysis	Guri Roesijadi	Pacific Northwest National Laboratory	Analysis & Sustainability	Less than \$1M
Microalgae Analysis	Mark Wigmosta	PNNL	Analysis & Sustainability	Less than \$1M
Algae-Based Biofuels Integrated Assessment Framework: Development, Evaluation, and Demonstration	Deborah Newby	INL	Analysis & Sustainability	Less than \$1M
Collaborative: Algae-based Integrated Assessment Framework	Richard Skaggs	PNNL	Analysis & Sustainability	Less than \$1M
US-Israel Algal Biofuels (NREL)	Robert Baldwin	National Renewable Energy Lab	Analysis & Sustainability	Less than \$1M
Pond to Wheels Algae Biodiesel Life Cycle Assessment	Howard Passell	Sandia National Labs	Analysis & Sustainability	Less than \$1M
New technology: Improving Microalgal Oil Production Based on Quantitative Analysis of Metabolism	Jorg Schwender	Brookhaven National Laboratory	Feedstock Production	Less than \$1M
Microalgae Harvesting/Dewatering and Drying	Deborah Newby	INL	Feedstock Logistics	Less than \$1M
Efficient use of algal biomass residues for biopower production with nutrient recycle	Eric Jarvis	National Renewable Energy Laboratory	Feedstock Production	Less than \$1M
Pond Crash Forensics	Todd Lane	Sandia National Laboratories	Feedstock Production	Less than \$1M
Human Health Risk Assessment of Algal Production Systems: Toxins and Toxic Components, Harmful VOCs, Metal Speciation/Bioconcentration, and Pathogenic Microorganisms	Chris Yeager	SRNL	Analysis & Sustainability	Less than \$1M

Associated with Large-Scale Algae Cultivation Systems				
Human Health Risk Assessment of Algal Production Systems: Toxins and Toxic Components, Harmful VOCs, Metal Speciation/Bioconcentration, and Pathogenic Microorganisms Associated with Large-Scale Algae Cultivation-LANL WBS#9.6.1.7	Enid (Jeri) Sullivan	Los Alamos National Laboratory	Analysis & Sustainability	Less than \$1M
Algal-Based Renewable Energy for Nevada	Christian Fritsen	Desert Research Institute	Congressionally Directed Funding	\$1.5M
Development of Pollution Prevention Technologies	Juergen Poile	Brooklyn College	Congressionally Directed Funding	Less than \$1M
Exploiting aquatic flowering plants (duckweed) as a source of bioenergy	Rob Martienssen	Cold Spring Harbor Laboratory	Congressionally Directed Funding	\$2.8M
Developing new alternative energy in Virginia: Bio-diesel algae	Patrick Hatcher	Old Dominion University	Congressionally Directed Funding	Less than \$1M
US-Canada Algal Biofuels Partnership	Philip Pienkos	NREL	Feedstock Production	Less than \$1M
Modeling and Visualizing Algae Biofuel Production Potential in Canada	Howard Passell	Sandia National Labs	Analysis & Sustainability	Less than \$1M
Canada Algal Collaboration-PNNL	Jon Magnuson	PNNL	Conversion Interface	Less than \$1M

c. Please also describe the focus and objectives associated with the \$14 million in algae R&D funding proposed by the President in February.

A1c. DOE issued a competitive funding opportunity announcement, titled "Advancements in Sustainable Algal Production" (ASAP) to accelerate efforts to increase the scalability of algae production. Awards made as a result of this Funding Opportunity Announcement (FOA) will support achieving the Biomass Program's mission to transform the nation's renewable biomass into sustainable and cost-competitive biofuels. Projects will be funded with up to \$14 million of FY2012 appropriations. Upon successful completion of go/no-go evaluations and contingent upon both the availability of funds and the continued

alignment of project scope to DOE priorities, select projects may receive additional funds to continue past the initial performance periods.

The ASAP FOA outlines two Topic Areas: (1) Innovative technologies to reduce water and nutrients, and (2) Regional Algal Feedstock Testbed (RAFT) Partnerships. The RAFT Partnerships are to carry out the following functions: (1) develop user facilities that serve as engines for algal technology innovation and validation, and (2) create regional, long-term cultivation data necessary to understand and validate algae biomass production.

In addition to the \$14 million to fund competitively selected projects from the ASAP FOA, the FY2012 budget includes an additional \$15.3 million for algae research, development and demonstration activities. These funds support additional algae technology development and analytical efforts being conducted by the DOE National Laboratories, an innovative algal harvesting technology being pursued by a small business based in Kingston, Tennessee that was originally selected under the DOE SBIR/STTR Phase III Xcelerator initiative, a project anticipated to be selected from an R&D solicitation for innovations in Photosynthetic Biorefineries that leverages NSF funding, and a project anticipated to be selected under the recent Bio-Oil Stabilization and Commoditization Funding Opportunity Announcement (FOA) aimed at improving the infrastructure compatibility of algal bio-oils with existing refineries.

In FY 2013, the Biomass Program requested appropriations to support the issuance of a new FOA aimed to improve algal strain robustness and productivity, as well as to improve algal harvesting/dewatering efficiency. These R&D objectives were identified as

barriers in the National Algal Biofuels Technology Roadmap document. The need for continued innovations in these particular areas is confirmed by research reports, as well as initial resource, techno-economic, and lifecycle findings.

QUESTION FROM REPRESENTATIVE HALL

- Q2. In response to a question regarding DOE's issuance of a loan guarantee to Prologis, you were asked if there was a "breakthrough new technology involved" to which you responded "no." You later stated you "thought it was a very, very good business model to put wholesale generation of electricity on warehouse rooftops" and Prologis was an "innovation in a business model."

Please describe in detail why the private sector would not back the "very, very good business model" such as that proposed by Prologis, and why taxpayer dollars should be risked deploying established and widely available technologies.

- A2. Project Amp is mostly supported by private sector financing unguaranteed by DOE. 55 percent of all of the project's costs will be borne by private equity and 20 percent of the debt will be unguaranteed. Therefore, approximately 2/3rds of the project's costs will be provided by the private sector.

The DOE loan guarantee was awarded to Project Amp under authority provided by Sec. 406 of the American Recovery and Reinvestment Act of 2009 which amended Title XVII of the Energy Policy Act of 2005. The amendment, Sec. 1705, established a temporary program for the rapid deployment of renewable energy and electric power transmission projects, notwithstanding Sec. 1703. While the Sec. 1705 portfolio of loans supports a mixture of innovative and commercial technologies, the program has facilitated the rapid deployment of renewable energy and electric transmission projects consistent with statute.

- Project Amp's financing structure requires each of its phases to meet stringent credit requirements. It also continuously enhances the credit of the project through the cross-collateralization of all of the installations selling power to investment grade utilities. The

successful example of Project Amp will serve as a springboard for future utility-scale distributed solar development.

QUESTION FROM REPRESENTATIVE HALL

- Q3. The first recommendation from the Blue Ribbon Commission on America's Nuclear Future was to pursue a "consent-based siting process." On March 6, 2012, the Nye County, NV Board of County Commissioners—the local government authority where Yucca Mountain is located—sent you a letter requesting consideration to host a permanent repository for high-level radiological waste. Further, a recent poll suggested 62 percent of Nevadans would support the use of Yucca Mountain for research purposes. Given the consent of the local stakeholders, will you commit to working with the Nye County Board of Commissioners to open Yucca Mountain, as a part of a consent-based process? Does DOE consider Yucca Mountain a potential interim storage site option? If not, why not?
- A3. The Administration is giving full consideration to the BRC recommendations as we work to define a path forward. The Administration will be providing additional information later this year, and will work with Congress to implement a new strategy to manage our nation's used nuclear fuel and nuclear waste.

QUESTION FROM REPRESENTATIVE HALL

Q4. Your testimony stated that the President's budget eliminates \$4 billion in "inefficient and unnecessary" subsidies to the oil and gas industry.

- a. How much of the \$4 billion you reference is estimated to come from the "Section 199" provision that allows deductions for domestic manufacturing? Please also describe and quantify the tax provisions that comprise the remainder.

A4a. Eliminating the manufacturing tax deduction for oil/gas for FY 2013 would account for \$574 million of \$4.753 billion in tax savings identified in the President's Budget.

For FY 2013 all the oil/gas tax changes (and their revenue impacts) are:

1. Repeal Enhanced Oil Recovery Credit	(0)
2. Repeal Credit for Oil and Gas Produced from Marginal Wells	(0)
3. Repeal Expensing of Intangible Drilling Costs	(\$3,490)
4. Repeal Deduction for Tertiary Injectants	(\$7)
5. Repeal Exception to Passive Loss Limitations for Working Interests in Oil and Natural Gas Properties	(\$9)
6. Repeal Percentage Depletion for Oil and Natural Gas Wells	(\$612)
7. Repeal Domestic Manufacturing Tax Deduction for Oil and Natural Gas Companies	(\$574)
8. Increase Geological and Geophysical Amortization Period for Independent Producers to Seven Years.	(\$61)
TOTAL FOR 2013 (\$ million)	(\$4,753)

- b. Is the oil and gas industry uniquely eligible for the Section 199 deduction, or are other sectors of the economy eligible as well? If the latter, approximately what percentage of the overall cost of the deduction is claimed by the oil and gas industry, versus all other sectors of the economy?

A4b. The deduction applies to all qualifying manufacturing industries. Eliminating this

deduction for oil and gas companies would increase tax revenues by \$574 million for that year.

- c. If all companies that undertake domestic manufacturing are eligible for this deduction, does the Administration support eliminating the deductions to all companies, or just those involved in oil and gas?

A4c. The proposed elimination of the domestic deduction for manufacturing activities applies only to fossil fuel industries. It would remain intact for all other qualifying industries.

QUESTION FROM REPRESENTATIVE HALL

- Q5. The Keystone XL Pipeline would deliver an estimated 830,000 barrels of oil per day to U.S. refineries, greatly alleviating pressures that contribute to current high gas prices. Unfortunately the President rejected the pipeline in January, citing environmental concerns. Specifically, the President's statement rejecting construction of the pipeline said that "Congressional Republicans prevented a full assessment of the pipeline's impact, especially the health and safety of the American people, as well as our environment." This objection appears to be centered on the technical question of whether the pipeline can be built safely.

To this end, please describe DOE's involvement in sharing input and advice related to the President's decision to reject construction of the Keystone XL Pipeline. Please also provide your current assessment of the pipeline's impact on the health and safety of the American people, as well as the environment. Are there any potential environmental or technical issues associated with the pipeline that cannot be addressed?

- A5. DOE provided information to the State Department concerning the potential impact of the Keystone XL pipeline proposal on U.S. oil imports from Canada and other countries, use of Canadian oil within each of the five Petroleum Administration for Defense Districts (PADDs) and world-wide greenhouse gas emissions. DOE's input is referenced in the draft and final Environmental Impact Statement (EIS). DOE did not assess the potential environmental or technical issues associated with the pipeline and does not have any analytical judgments on those matters, which are properly the purview of an EIS and within the purview of the State Department.

QUESTION FROM REPRESENTATIVE HALL

- Q6. In his State of the Union address, President Obama said “This country needs an all-out, all-of-the-above strategy that develops every available source of American energy.”

Three days later, the Administration announced it was blocking the development of oil shale on over a million acres of Federal lands. The land had been opened for development by the Bush Administration and is estimated to contain more oil than Saudi Arabia’s proven reserves, but was declared off-limits by the Obama Administration.

Please explain why oil shale is not part of the Administration’s “all-of-the-above” strategy, and how the strategy can be reasonably described as “all-of-the-above” when such immense resources are excluded?

- A6. Oil shale holds the potential to be a significant component of our Nation’s energy portfolio, but a number of economic, technical, and environmental questions need to be addressed before commercial-scale development takes place on Federal lands. The Department of the Interior has issued a series of leases for oil shale research, development, and demonstration projects on Federal lands. As these projects progress, we hope to better understand the feasibility and impacts of large-scale oil shale development. This information will be used to inform decisions about future commercial leasing.

QUESTION FROM REPRESENTATIVE HALL

Q7. President Obama recently gave a speech on gas prices in which he said “I have directed my administration to look for every single area where we can make an impact and help consumers in the months ahead.” Please reconcile this statement with the Administration’s proposal to eliminate \$50 million in R&D funding aimed at expanding safe production of oil and gas. This program (known as the Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources), supports development of next-generation technologies important to ensuring domestic production of oil and gas is maintained and even increased. The program was highlighted by the Secretary of Energy Advisory Board (SEAB) as an effective program that should be enhanced and supported.

If the President truly wants to support “every single area” that could lead to lower gas prices and increased energy production, why is he proposing to eliminate this R&D program?

A7. Mandatory R&D funding from EPA Act Sec. 999 is too inflexible a mechanism to adequately address environmental and safety concerns in the dynamic and rapidly evolving hydraulic fracturing space. The Administration has sought to refocus this funding to support research with significant potential public benefits, including activities consistent with high priority Secretary of Energy Advisory Board recommendations.

QUESTION FROM REPRESENTATIVE HALL

- Q8. After a year of investigation, details surrounding the Solyndra loan guarantee are still coming to light. Publicly released documents show you personally intervened to advance a loan guarantee to Prologis Last June, as Solyndra's extreme financial difficulties were becoming apparent. Prologis' loan guarantee provided an avenue to advance its "Project Amp" which coincidentally purchased solar panels from Solyndra.

In an email between a Solyndra employee and its financiers, the Solyndra employee stated "on three occasions this week he thought that the [Project Amp] deal was dead, but Secretary Chu personally pulled it off. Chu shared with the team that this deal went to higher levels in the Obama Administration to gain approval than any other transaction in the Loan Guarantee Program and that he personally committed to seeing it through to a successful conclusion."

- 8a. What specific actions did you take regarding this loan guarantee that you did not for others, and why did you give special treatment to the Prologis Project Amp proposal?
- A8a. Secretary Chu's decision to support Project Amp was not related to Solyndra or any other

solar panel manufacturers that may eventually supply this project. The reason for Secretary Chu's interest in Project Amp should be clear: it is the largest rooftop solar undertaking in U.S. history; it is expected to generate enough renewable electricity to power over 88,000 homes; it will support over one thousand jobs across the country; and it has the potential to revolutionize the way rooftop solar is deployed in the United States. Congress directed the Department to support just such projects under the Recovery Act's Sec. 1705 loan program.

DOE has not been alone in its support of Project Amp. Through the use of DOE's Financial Institution Partnership Program (FIPP), Project Amp was able to attract private sector support from Bank of America Merrill Lynch. NRG Energy, one of the Nation's largest and most respected electric power companies, has committed to fund (with Prologis) the equity required during the first 18 months of the project.

While Solyndra was an early partner with Prologis and was a potential panel supplier for a small initial phase of Project Amp, DOE was not involved in Prologis' decision to purchase panels from Solyndra. Moreover, this arrangement ultimately was intended to represent only approximately 15MW of the 733 MW of Project Amp and was contemplated long before the Project Amp application was submitted to DOE. Similarly, the Department's interest in Project Amp was not in any way diminished when Solyndra filed for bankruptcy and Prologis decided not to use Solyndra panels for the first phase of the project. Once Prologis notified DOE of its proposed change, the Department lent Prologis its full support, bringing the new information to DOE's Credit Review Board expeditiously, and the Board confirmed its recommendation to support the Project.

Secretary Chu did participate in high-level policy discussions around the Amp transaction regarding the transaction's consistency with the Recovery Act's policy objectives. While the proposed transaction included a five-year draw period, the transaction that closed has a four-year draw period, aligning the transaction more closely the Recovery Act's objectives. This change was the result of interagency policy discussions at the principal level.

- 8b. Please describe the differences associated with the level of involvement of senior DOE and White House political officials in the Prologis loan process, and explain why this deal involved officials at higher levels in the Obama Administration than any other in the Loan Guarantee Program.
- A8b. The role of senior DOE officials in the Project Amp transaction was consistent with that of the other transactions completed under the Sec. 1705 program. While not every transaction required senior-level attention to policy matters, those that did were given the appropriate

attention. As previously mentioned, Project Amp was one of the projects that required senior-level attention to policy matters, given the proposed tenor of the loan's draw period.

QUESTION FROM REPRESENTATIVE HALL

The budget repeatedly highlights President Obama's commitment to doubling the budget of key basic research programs at the Office of Science along with that of NIST and NSF. However, the budget request for the Office of Science is proposed to increase by only 2.4 percent. At that rate, it would take almost 30 years to double the budget, and that doesn't even account for inflation that would occur during that time. Meanwhile, DOE's green energy programs, such as EERE and ARPA-E, are proposed to increase by 29 percent and 27 percent, respectively.

Q9a. Why is funding for the Office of Science such a low priority relative to other DOE R&D programs?

A9a. The \$4.99 billion dollar FY 2013 request for the Office of Science represents a strong commitment by the Administration to maintain our Nation's investments in basic scientific research as part of the ongoing commitment to doubling the combined budget for these three agencies. The FY2013 requests for the Office of Science, EERE, and ARPA-E reflect the Administration's judgment that there is exceptional potential for near-term breakthroughs in clean energy technologies, and the Budget balances these priorities in a manner that is consistent with the Budget Control Act of 2011.

Q9b. In testimony before this Committee in 2006 you said "[i]n funding ARPA-E, it is critical that its funding not jeopardize the basic research supported by [DOE's] Office of Science. The [National Academy of Sciences] recommendations are prioritized and its top recommendation in the area of research is to increase the funding for *basic research* by 10 percent per year over the next seven years."

Do you still agree with the NAS panel recommendation that the Office of Science should be the top research priority within DOE, and that ARPA-E funding should not jeopardize Office of Science funding? If so, how do you explain the lack of balance in the President's request?

A9b. Since FY 2006, budget requests and appropriations have led to significant growth for the Office of Science from \$3.6 billion to \$5.0 billion (a 39 percent increase), which demonstrates the priority placed on basic research across two Administrations and several Congresses. These sorts of sustained investments in basic research are essential to the Nation's long term prosperity. The Department places a strong emphasis on coordination

of its basic and applied research programs to ensure that new breakthroughs in basic science drive new technologies and that scientific research is informed by the barriers encountered by technology developers. The Department's FY 2013 budget as a whole constitutes a strong commitment to DOE's research programs; it balances opportunities in basic and applied research. ARPA-E's \$350 million budget is 7 percent of the Office of Science budget, and I do not feel ARPA-E is jeopardizing our basic research funding.

QUESTION FROM REPRESENTATIVE HALL

Q10. The FY13 budget request proposes \$45 million in new spending for an interagency effort (with EPA and USGS) to study the impacts of hydraulic fracturing. The budget provides very little description of what this funding is intended to be used for.

- a. Please provide a detailed description of what specific issues DOE intends to examine with the requested funding. Please also describe DOE's plans regarding transparency, peer-review, and stakeholder input associated with the proposed hydraulic fracturing research.

A10a. On April 13, 2012 DOE, the Environmental Protection Agency, and the Department of the

Interior's U.S. Geological Survey signed a Memorandum of Agreement formalizing a multi-agency collaboration on unconventional oil and gas research. Through this collaboration, a robust Federal F&D plan is being developed, taking into account the recommendations of the Secretary of Energy's Advisory Board (SEAB) Natural Gas Subcommittee. DOE's role in this initiative will focus on priorities identified by the interagency collaboration in a research plan to be formed over the next nine months within its area of core research competencies, including wellbore integrity, flow and control; green technologies; and systems engineering, imaging and materials.

- b. Please detail, by activity description and funding level, activities in the President's DOE budget request aimed at expanding supply and production of natural gas.

A10b. The President's DOE budget request includes \$17 million for Natural Gas Research. This

research is aimed at ensuring the safe and environmentally sustainable production of natural gas from shale formations (\$12 million) and conducting work on gas hydrates (\$5 million).

QUESTION FROM REPRESENTATIVE HALL

Q11. As Secretary of Energy, do you support construction of new coal-fired power plants in the absence of significant carbon controls?

A11. The decision to propose new coal-fired power plants is best made by utility companies in response to market conditions that make it favorable to do so. The approval of a project with or without carbon controls is the decision of the regulatory and permitting authorities, and others in the States that have jurisdiction over such projects.

QUESTION FROM REPRESENTATIVE HALL

Q12. DOE's coal research activities are almost exclusively focused on developing carbon capture and sequestration technology, the *goal* of which is to limit the increase in the cost of electricity to 35% above traditional pulverized coal plants. How much specific **non-CCS** R&D is proposed in the Administration's FY 2013 coal R&D budget?

a. What is DOE doing to **lower** the cost of coal-fired electricity?

A12a. The cost of coal-fired electricity is ultimately a function of significant market factors. The focus of the Department's coal R&D is on integration of CCUS technologies with different types of power plant configurations (pulverized coal, IGCC, oxy-fuel combustion). However, the Department does conduct research and development (R&D) on advanced clean coal technologies that will bring costs down over time. The Department also conducts demonstration projects that allow first-of-a-kind clean coal technologies to be utilized on a commercial scale. These activities have been shown to reduce costs over the long run, and allow for more efficient, cleaner, and more affordable technologies to be used in the marketplace.

b. Does DOE's Office of Fossil Energy FY 13 budget request include any coal R&D that will help utilities comply with recent and forthcoming EPA regulations?

A12b. The Office of Fossil Energy (FE) is conducting research on advanced technologies for new plants that will help meet all environmental regulations. However, many of these technologies are specific to gasification-based and oxy-combustion processes and are not applicable to existing coal-fired power plants.

There is no specific funding in the budget related to R&D that will help existing plants comply with recent regulations. The recent EPA regulations, including the Mercury and

Air Toxics Rule (MATS), and the Cross-State Air Pollution Rule (CSAPR), have been designed to include compliance options that are commercially available technologies. Many of these technologies, including Flue Gas Desulphurization, and more recently, Activated Carbon Injection, were funded in the past by FE and developed with communication between EPA and DOE. Forthcoming regulations, focused on cooling water intake structures and coal ash, are also being developed with compliance methods that include commercially available technology. The development and implementation of EPA rules has always been subject to the availability of appropriate technology solutions, and DOE will continue to support this methodology.

QUESTION FROM REPRESENTATIVE HALL

- Q13. RWI, a leading scientific and policy research center in Germany, conducted a study of the German push for renewable energy, analyzing the costs and effect on job creation. The report concludes:

“Although Germany’s promotion of renewable energies is commonly portrayed in the media as setting a ‘shining example in providing a harvest for the world,’ we would instead regard the country’s experience as a cautionary tale of massively expensive environmental and energy policy that is devoid of all economic and environmental benefits.”

The report further warns that policymakers, including in the US, should scrutinize Germany’s experience. Your testimony stated America is “at risk of falling behind again [in clean energy investments] unless we make a sustained federal commitment to supporting our domestic clean energy economy.”

- a. Is the biggest risk really that we might “fall behind,” or is a greater risk that we fail to learn from the mistakes of countries like Germany regarding renewable energy subsidies, especially with national debt approaching \$16 trillion?

- A13a. While implementation of Germany’s feed-in tariff program has resulted in a slight increase in electricity prices, it has also led to a decrease in the cost of solar photovoltaic installations, while supporting domestic jobs and increased domestic energy production.

The economic stakes are high, and the U.S. may risk falling behind our global competitors who are seizing the economic opportunity by investing more heavily and establishing market policies that convey a strategic advantage. One recent energy investment analysis report estimates that the annual global clean energy market is worth \$260 billion, up 32% from 2009, and that it is expected to grow significantly.

- b. Has DOE conducted any sort of analysis or scrutiny of the German program or others in Europe? If not, why not? If so, please provide summarize the findings and lessons learned.

A13b. DOE closely tracks the efforts of other countries related to the research, development, and deployment of energy technologies, for possible domestic application. While the German experience with subsidies for solar photovoltaic (PV) technologies offers lessons of interest to U.S. policymakers, it is important to note that U.S. federal mechanisms for renewable energy deployment do not make use of the feed-in tariff (FIT) model that underlies German support for renewable energy deployment. As such, the German experience is not directly comparable to U.S. efforts to promote renewable energy.

Additionally, Germany is a high-latitude country with a sub-optimal solar resource. Despite this constraint, Germany's subsidy program has resulted in higher market penetration and a lower installed cost of solar PV, independent of subsidies², than in the U.S., which has a significantly more favorable resource base. Though German financial support for renewables has resulted in modest increases in electricity prices, it has also resulted in increased domestic jobs in the manufacturing, installation, and maintenance sectors.

² "Tracking the Sun IV: An Historical Summary of the Installed Cost of Photovoltaics in the United States from 1998 to 2010," Lawrence Berkeley National Laboratory, September 2011.

QUESTION FROM REPRESENTATIVE HALL

- Q14. The Manhattan Institute recently released a new study titled: "*The High Cost of Renewable Electricity Mandates*." The study analyzed electricity rates in states with mandates as well as states without mandates. It found "a pattern of starkly higher rates in most states with RPS mandates compared with those without mandates. The gap is particularly striking in coal-dependent states—seven such states with RPS mandates saw their rates soar by an average of 54.2 percent between 2001 and 2010, more than twice the average increase experienced by seven other coal-dependent states without mandates."

The study goes on to say that "Put another way, the higher cost of electricity is essentially a de facto carbon-reduction tax, one that is putting a strain on a struggling economy and is falling most heavily, in the way that regressive taxes do, on the least well-off among residential users."

Still, the Administration is intent on forcing a very similar mandate at a national level. Do you agree with the basic findings of this study—namely that electricity rates will go up if Americans are forced to buy electricity from more expensive sources? If not, why not?

- A14. The President has not set an energy policy focused on a federal Renewable Portfolio Standard (RPS). Instead, the President has proposed a Clean Energy Standard (CES) to keep our energy supply clean, affordable, and secure. A CES is a flexible, market-based approach with annual targets for electricity from diverse, domestic sources, including renewable energy as well as nuclear power, efficient natural gas, and clean coal. The policy would enable businesses and entrepreneurs to determine the best way to achieve the targets, ensuring that clean energy is produced wherever it makes the most economic sense. By establishing a market for domestic clean energy technologies, this policy would move billions of dollars of capital off of the sidelines and into investments that drive innovation and create jobs. The Administration is confident that a well-designed CES would promote innovation and investment in the clean energy economy while ensuring that all consumers throughout the country, regardless of income, continue to enjoy access to affordable, reliable electricity.

With respect to a renewable portfolio standard, the Energy Information Administration (EIA) has, over the past few years, analyzed several legislative proposals for such policies. Through these analyses, EIA has found that numerous policy details can significantly influence the impact of the policy on key indicators such as the price of electricity, generation mix, cost to consumers, cost to industry, and even achievement of the targeted generation share. These key parameters include the existence and level of any limits on the price of renewable energy credits; exemptions for certain classes of utilities or exclusion of certain generation from requirements of the program; the ability to “bank” early compliance credits; and the existence of “credit multipliers,” “set-aside” targets, and tiered compliance systems that incentivize specific technologies within the suite of eligible technologies. Because of the importance of policy design, it is impossible to characterize the impacts of a federal RPS policy in the abstract.

The cited Manhattan Institute study shows results that are significantly at odds with prior studies on price impacts of State RPS policies. This study suffers from numerous methodological weaknesses, including but not limited to a failure to properly account for factors other than RPS policy that may affect differences in electricity prices among States and over time. In addition, it appears to attribute to RPS policy changes in price that occurred in certain states prior to the existence of any RPS policy and/or any significant RPS targets; failing to identify any plausible mechanism by which an RPS policy could affect prices prior to its introduction into law or prior to any significant generation requirements above baseline renewable generation levels.

QUESTION FROM REPRESENTATIVE HALL

Q15. Has the Obama Administration considered the negative consequences the President's anti-energy policies would have on independent petroleum producing small businesses?

- a. Has the Department of Energy examined how much additional tax burden would be shouldered by those independent producers under the President's proposals to eliminate tax deductions? If not, will you conduct such an analysis?

A15a. The Administration believes that to foster the clean energy economy of the future and reduce the Nation's reliance on fossil fuels that contribute to climate change, it is appropriate to repeal tax provisions that preferentially benefit fossil fuel production. Oil and gas subsidies are costly to the American taxpayer and do little to reduce energy prices. Removing these lower-priority subsidies would reduce greenhouse gas emissions and generate \$38.6 billion of additional revenue over the next 10 years. This \$38.6 billion represents only a small percentage of domestic oil and gas revenues – about one percent over the coming decade. These terminations free up resources to invest in clean energy development and production, which is critical to the Nation's long-term economic growth and competitiveness.

- b. How would this impact the ability for those companies to hire additional employees and provide abundant and affordable energy? Has DOE considered the impact on total energy production due to higher taxes?

A15b. The Administration believes that to foster the clean energy economy of the future and reduce the Nation's reliance on fossil fuels that contribute to climate change, it is appropriate to repeal tax provisions that preferentially benefit fossil fuel production. Oil and gas subsidies are costly to the American taxpayer and do little to reduce energy prices. Removing these lower-priority subsidies would reduce greenhouse gas emissions and

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QUESTION FROM CONGRESSMAN HALL

Q16. The Department is requesting appropriations language for the Energy Efficiency and Renewable Energy account allowing you to transfer “up to \$100,000,000 to the Defense Production Act Fund for activities of the Department of Energy pursuant to the Defense Production Act of 1950.” What additional activities would this transfer authority allow that DOE cannot undertake under existing statutory authority?

A16. The authority allows the Department of Energy (DOE) to transfer funds to the Defense Production Act Fund to be dispersed for activities with mutual benefit to the respective missions of DOE's Energy Efficiency and Renewable Energy (EERE) program and the Department of Defense (DoD). This arrangement provides a streamlined approach for both Departments to issue joint solicitations and appropriately fund contracts that will result in first, demonstration of innovative technology, and then second, provide production capacity for products with defense applications. The Defense Production Act provides for strengthening the domestic production of components, technologies, or industrial resources, such as biofuels, that the DoD determines are critical for the execution of the national security strategy of the United States.

DOE is seeking the authority to fund vendor demonstration of production capability for innovative biofuels, suitable for use by defense aircraft and ships. As part of a partnership with the Defense Department, DOE would fund work for development and scale-up activities to develop and demonstrate the biomass technology to make these fuels.

QUESTION FROM CONGRESSMAN HALL

Q17. The Office of Energy Efficiency and Renewable Energy (EERE) Advanced Manufacturing Office is requesting \$100 million in new funding to “demonstrate manufacturing processes.”

- a. Please describe what specific manufacturing process demonstration projects DOE will fund and how applications will be reviewed and selected.

A17a. DOE projects funded through the Advanced Manufacturing Office (AMO) are selected through an open and competitive process using criteria tailored to help achieve the key objectives of the program. For example, plans for AMO’s Manufacturing Demonstration Facilities (MDFs) solicitation include asking applicants to propose topic areas that will have broad-reaching and/or transformational impact to reduce energy use, demonstrate the use of materials for energy technologies, create new products and processes, and support the domestic manufacturing base.

While DOE has not yet issued a solicitation for the MDFs, the objectives established for this initiative describe an MDF as a collaborative, shared infrastructure focused on manufacturing research, development, and demonstration (RD&D) in different technical focus areas. In addition, MDFs will enhance opportunities for U.S. manufacturers to develop, use, and demonstrate energy efficient, rapid, flexible manufacturing technologies. In operation, the MDFs will provide the manufacturing community, particularly small- to medium-size enterprises, with access to physical and virtual tools as well as expertise for prototyping new technologies and optimizing critical manufacturing processes.

Through the Innovative Manufacturing Initiative (IMI), another RD&D program, AMO is currently completing a competitive selection for industry-led cost-shared technology R&D

and demonstration projects within broadly identified priority technology domains such as Reactions and Separations; High Temperature Processing; Waste Heat Minimization and Recovery; and Sustainable Manufacturing. Also included as possible research domains in this first IMI solicitation are Innovative Materials topic areas potentially including Thermal and Degradation Resistant Materials; Highly-Functional, High-Performance Materials; and Lower Cost Materials for Energy Systems. Industry response to the IMI solicitation was widespread and diverse. AMO received more than 1,400 total Letters of Intent through this solicitation. 78% of responses from industry were from small enterprises (fewer than 500 people). Only a small percentage of these Round One proposals will be funded. Awardees are expected to be announced publicly.

AMO also remains committed to combined heat and power and former Industrial Technologies Program demonstration projects currently in its portfolio so long as these projects continue to meet their technical milestones.

- b. Manufacturers have significant financial incentives to institute energy efficiency improvements that will save them money. Please describe the barriers to implementation that limit private industry from undertaking energy efficiency improvements that will be demonstrated by this program.

A17b. There are a number of barriers that can limit private industry from undertaking energy efficiency technology development and demonstration. Examples of barriers include: 1) taking on increased technical risk without guarantee of return on investment, 2) total cost/size of investment required, and 3) the ability to develop a new technology or process to a meaningful scale under production-pertinent environments.

AMO helps to address those barriers by: 1) providing the manufacturing community access to expertise for prototyping new technologies and optimizing critical manufacturing processes, 2) providing the data necessary to establish the manufacturing viability of innovations, and 3) facilitating the efficient use of capital resources (both public and private) so that one set of physical and virtual tools is made available to many potential innovators. The provision of these benefits is of particular use to small- and medium-sized enterprises that face larger hurdles for access to both physical resources and expertise.

QUESTION FROM REPRESENTATIVE HALL

Q18. Section 1007 of the Energy Policy Act of 2005 (P.L. 109-58) gave the Secretary of Energy the ability to use "other transactions authority," and Section 3118 of the National Defense Authorization Act of 2011 (P.L. 111-383), extended this authority through September 30, 2015.

Q18 (a) Which offices of the Department has the Secretary delegated this authority?

A18 (a) The authority can only be delegated to a Presidentially appointed Senate confirmed position/person. The Secretary delegated the authority to the Under Secretary of Energy.

Q18(b) Provide a list all technology investment agreements (TIAs) DOE has entered into to date, beginning with the first TIA finalized in November 2007 with Range Fuels for funding to design, construct, and operate an integrated biorefinery to produce primary ethanol from lignocellulosic feedstock.

Q18(c) For each TIA identified above, please provide the following: amount of DOE funding; amount of cost-sharing; technical objectives; description of the extent to which the TIA contributed to broadening if the technology and industrial base available for meeting DOE's mission needs; and extent to which the TOIA has fostered new relationships an practices.

A18(b)&(c). Please refer to included table attached.

QUESTION FROM REPRESENTATIVE HALL

Q19. Advanced materials are frequently identified as a challenge associated with developing the next-generation of nuclear power plants. What advanced materials research and development is DOE proposing in FY13?

A19. The Department of Energy (DOE) is proposing to perform advanced materials research and development to characterize and provide the required design bases for new materials that can withstand the harsher environments of advanced reactors for longer periods of operation. This research also aims to develop materials that have better performance in accident scenarios. These materials could be used in small modular reactors and high-temperature gas-cooled reactors, as well as liquid metal- and salt-cooled reactors.

Specifically, these efforts will include the assessment of modern graphites, high-temperature structural alloys, and structural composites needed for construction of critical components, such as reactor pressure vessels and piping, core supports and other reactor internals, heat exchangers, fuel cladding, and power conversion equipment. These more radiation-resistant, advanced materials will allow the reactors to operate at higher temperatures and pressures over longer timeframes, thereby increasing the efficiency of electricity production and the safety of the reactor. This research will also develop and validate the bases for improvements in the national codes and standards required for eventual regulatory approval of such materials usage in advanced reactors.

QUESTION FROM REPRESENTATIVE HALL

Q20. The Office of Nuclear Energy's budget for 2013 overall will see a 10 percent reduction from FY12 appropriated funds. One of the changes that mask this reduction is the \$95 million for Idaho Site-Wide Safeguards and Security Program that has been moved into the Office of Nuclear Energy. What was the reason for this proposed move?

A20. The request to transfer the Idaho National Laboratory (INL) Safeguards and Security (S&S) program from the Other Defense Activities (ODA) Appropriation to the Nuclear Energy (NE) Appropriation did not impact the overall NE funding request level. It is just a coincidence that the total cost of the transfer was similar to the overall reduction in the NE Appropriation.

The Department believes there is merit in transferring the INL S&S program into the NE Appropriation. This transfer is consistent with how the Department requests funds for other S&S programs. The request also aligns all NE programs within one appropriation, which will allow trade-offs among NE programs without impacting non-NE programs within the ODA Appropriation.

QUESTION FROM REPRESENTATIVE HALL

- Q21. Please provide an update on the status of the Next Generation Nuclear Plant (NGNP) and the project's overall outlook and upcoming milestones.
- A21. The Next Generation Nuclear Plant (NGNP) Demonstration Project continues to concentrate on high temperature reactor research and development (R&D) activities, interactions with the Nuclear Regulatory Commission (NRC) to develop a licensing framework, and activities related to establishment of a public-private partnership as discussed in the Department's letter to Congress on October 17, 2011. Ongoing R&D to support development of high temperature gas-cooled reactors (HTGR) is focused on qualification of TRISO coated particle fuel, qualification of graphite and high temperature materials to be used in HTGR construction, and on computational methods for ensuring the safety and performance of these advanced reactor designs. This year the project expects to complete compacting process qualification testing for the commercial fuel manufacturing. Post-irradiation examination of the first samples of new nuclear grades of graphite tested will be completed by June 30, 2012. Finally, the Department is preparing to release a solicitation to obtain analyses, data, and information on the long term commercial viability of NGNP technology. This contract is expected to be awarded by the end of this fiscal year.

QUESTION FROM REPRESENTATIVE HALL

- Q22. During a Committee hearing on the Blue Ribbon Commission's Report to the Secretary of Energy, former NRC Chairman Richard Meserve stated that there are not any barriers to constructing a reprocessing facility in the United States. However, the Nuclear Regulatory Commission currently lacks the regulatory guidelines for such a facility. Please clarify whether or not there is an existing and workable framework at the NRC for licensing and building a reprocessing facility.
- a. Is DOE supportive of creating a regulatory framework in which a reprocessing facility could be licensed and constructed? If so, how will DOE support moving forward with such a project?
- A22. Questions about the NRC's regulatory framework for reprocessing should be directed to the NRC. The DOE and the NRC maintain an effective working relationship relative to advanced fuel cycle technology R&D.

QUESTION FROM REPRESENTATIVE HALL

- Q23. Abound Solar, a recipient of a \$400 million DOE loan guarantee, has laid off a substantial portion of its workforce and delayed plans to open a new manufacturing facility. Reportedly, Abound Solar has drawn down \$70 million of the total loan guarantee amount. Please provide the current status of the Abound Solar project, including its ability to meet performance milestones included in the contractual terms stipulated by the agreement.
- a. How does DOE evaluate the performance of the individual loan guarantees and decide whether a recipient is meeting performance expectations?
- A23a. DOE's LPO teams perform extensive due diligence of each applicant and its business case prior to loan closing, followed by continual monitoring, review and analysis until the loan is repaid in full. This due diligence and review is performed by multi-disciplinary teams of engineers, attorneys, accountants, industry consultants and financial analysts, with additional expertise called upon as required.

In some projects, the due diligence and analysis identifies a number of steps in the development of the business case considered critical to making and keeping the project financially viable, as well as performance indicators that will help DOE loan monitoring teams evaluate whether the approved plan remains on track. In some cases, the key steps are reflected in specific milestones that must be accomplished by a date certain (e.g., unit throughput, process yield, solar cell efficiency level, etc.), while in other cases, DOE staff requires regular reporting of performance information (e.g., EBITDA, quality level, sales per employee, cost per unit) that is indicative of project health.

Finally, DOE loan monitoring staff continually factor this information into project budgets and dynamic financial forecasting models to ascertain whether changes in the

project or business have affected projections of the borrower's ability to repay the loan when due.

Project milestones and financial covenants are typically highly negotiated and tightly specified prior to the closing of the loan. In the case of performance indicators and financial projections, staff analysts and consultants continually assess actual results and new assumptions using projection models to determine whether the approved forecast has materially changed. DOE recognizes and expects that business conditions and business plans will change during a multi-year project. If an analysis indicates that a previously approved business plan is no longer viable, DOE generally requires the borrower to revise the plan to DOE's satisfaction.

- b. Given the circumstances surrounding Abound Solar's performance, is DOE allowing it to draw down on the remaining \$330 million in funding? If so, why?
- A23b. As is the case for all projects within DOE's portfolio, Abound's access to DOE funding was predicated on the project continuing to meet required conditions and milestones. Among the conditions to DOE's approval of additional funding, Abound was required to provide an updated business plan that was acceptable to DOE in its sole discretion. As you are likely aware, Abound filed for bankruptcy on July 2, 2012 and funding disbursements on the loan had been halted in August 2011.

QUESTION FROM REPRESENTATIVE NEUGEBAUER

- Q1. I understand that the budget is proposing to spend \$170 million in funding left over from prior appropriations to issue new loan guarantees.
- Q1a. Is that correct, and if so, how many new loan guarantees do you expect to issue, what will the total amount of those loans be, and what is the expected timing of these awards?
- A1a. As you know, the §1703 loan program was adopted as part of Energy Policy Act of 2005 to provide financing support to advanced technologies on reasonable terms. The 2012 appropriations provided an additional \$170 million in appropriated credit subsidy to support §1703 loan guarantees for innovative renewable energy or efficient end-use energy technologies and brought the balance of guaranteed loan volume authority to \$1.5 billion for projects where the credit subsidy cost is funded by the project sponsor.

Authority to enter into new loan guarantees under §1705 loan program sunset September 30, 2011 -- a deadline by which projects had to not only complete due diligence and close on their loans, but also start construction. Faced with a large volume of projects, but a limited number able to meet this mandate, in May 2011 the Department sent letters to more than three dozen project sponsors, informing them that they would not qualify under §1705, but could be considered in the future for loan guarantees under the §1703 program. As the letter noted, this was not a statement of the quality or worthiness of those projects; it was simply a matter of timing.

Following the completion of the Independent Consultants Review by Mr. Herb Allison, the Department has developed a process for considering pending applications for the available §1703 funding. On April 5, 2012, the Department commenced this process by sending a letter to project sponsors with pending applications that may qualify for the

§1703 funding referred to above, asking them if they still wanted to be considered for a loan guarantee.

The exact number of projects and the total dollar value of the loan guarantees in the §1703 renewable energy pipeline will depend on the government's assessment of the risk level of the projects selected and the sponsors willingness to continue to pursue a loan guarantee.

Q1b. I also understand that you recently stated you were receiving "mixed signals" from Capitol Hill regarding the future of the loan program. Given the troubled history of this program, why should Congress allow that \$170 million to be risked? Have you or others in the administration at any point considered that perhaps that \$170 million would be better spent if it went to deficit reduction or higher priority research programs?

A1b. From solar energy to wind to biofuels and more, the global market for clean energy technologies reached \$260 billion last year and is growing rapidly, according to one recent energy investment report. Recognizing the enormous economic opportunities ahead, countries like China, Germany, and others around the world have established programs to provide government-backed financing for innovative technologies and companies. Such support is crucial because private lenders are often unwilling or unable to absorb the risks associated with financing truly innovative or advanced technology projects at scale until such projects have been proven in the marketplace.

By any measure, the Energy Department's loan programs have helped the United States keep pace in the fierce global race for clean energy technologies. Over the past three years, the loan programs have invested in some of the world's biggest, most innovative, and most ambitious clean energy projects to date, supporting a balanced portfolio of

American clean energy projects that are creating tens of thousands of jobs nationwide and are expected to provide power to nearly three million U.S. households.

In part because of these cutting edge projects and the private sector investment enabled through the loan program, the United States has nearly doubled renewable energy generation since 2008, and last year U.S. solar installations grew by nearly 110 percent.

But given how intense the global competition is – China offered \$30 billion in government-backed financing to solar companies in 2010 alone – we cannot afford to stop moving forward.

Our historic investment in clean energy is paying off, and it will come back to us many times over – in jobs, in clean energy for our communities, and in leadership in the technologies of the 21st century.

QUESTION FROM REPRESENTATIVE NEUGEBAUER

- Q2. The Administration has indicated openness to yet again tapping the Strategic Petroleum Reserve in an attempt to ease short-term gas prices. However, according to your Department's own reports, the Administration's release of 30 million barrels from the Strategic Petroleum Reserve from last June has yet to be replenished. In fact, while sales of the reserves last June brought in \$3.3 billion, higher prices could now result in us paying \$4 billion to replenish that oil, costing the American taxpayers an additional \$700 million.
- a. Why has the oil not yet been replenished?
- A2a. The 2013 Budget reflects plans to repurchase 27 million barrels of oil for the SPR over a five year period beginning in FY 2013 assuming market conditions are favorable.
- b. What conversations have you had with the White House about tapping the SPR again?
- A2b. The purpose of the Strategic Petroleum Reserve is to mitigate the impacts of supply interruptions. There have been increasing disruptions in the supply of oil to the global market over the past several months, which pose a substantial risk to global economic growth. In response, major producers have increased their output while drawing prudently on excess capacity. Looking ahead to the likelihood of further disruptions in oil sales and the expected increased demand over the coming months, we are monitoring the situation closely and will work with our partners in the International Energy Agency to take appropriate action to ensure that the market is fully and timely supplied.
- c. Has the Administration considered the necessity of replenishing current balances in the SPR before hastily releasing more oil, putting us at an even greater risk to legitimate emergencies and severe shortages?

A2c. The 2013 Budget reflects plans to repurchase 27 million barrels of oil for the SPR over a five year period beginning in FY 2013 assuming market conditions are favorable. The SPR currently holds 696 million barrels of crude oil, which should be sufficient to mitigate any adverse impacts to the United States from a shortage or interruption of energy supplies or for the United States to meet its obligations under the international energy program. Based on EIA data for 2010, imported oil accounted for less than 50 percent of the oil consumed in the United States for the first time in 13 years.

- d. Did your Department estimate price projections that would affect the replenishment of SPR supply following the drawdown? What role did that play in the President's decision?

A2d. The 2011 SPR drawdown was conducted to meet the obligations of the United States under the international energy program, pursuant to section 161(d) of the Energy Policy and Conservation Act.

- e. Do you believe that current economic conditions and oil supply represent a true emergency or "severe supply interruption?"

A2e. Absent an actual or imminent supply interruption, there are no plans to release crude oil from the SPR. The purpose of the Strategic Petroleum Reserve is to mitigate the impacts of supply interruptions. There have been increasing disruptions in the supply of oil to the global market over the past several months, which pose a substantial risk to global economic growth. In response, major producers have increased their output while drawing prudently on excess capacity. Looking ahead to the likelihood of further disruptions in oil sales and the expected increased demand over the coming months, we are monitoring the

situation closely and will work with our partners in the International Energy Agency to take appropriate action to ensure that the market is fully and timely supplied.

f. How might a depleted SPR affect our ability to respond to potential future disruptions in supply?

A2f. The SPR sold approximately 30 million barrels in 2011, only 4 percent of the Reserve's total stocks. The current inventory of 696 million barrels is equivalent to roughly 82 days of US imports and provides adequate protection for any near-term oil situation.

QUESTION FROM REPRESENTATIVE LIPINSKI

- Q1. The proposed reduction to the SMR Licensing Technical Support program is small – just \$2 million – but this program was originally conceived as a 5-year, \$450 million partnership with private companies. With the first two years significantly below the anticipated funding trajectory, I am concerned that these funding shortfalls could turn into significant overall cost increases – something we have seen in other complex engineering projects. Secretary Chu, do you anticipate being able to meet the expectations of SMR industry partners, and how are we coordinating with them to make sure the program stays on track?
- A1. In the FY12 appropriation, DOE received \$67 million for the SMR Licensing Technical Support program and believes the program is on track. A Funding Opportunity Announcement will be released soon for the program and the Department will start executing the complex solicitation review process to establish the joint projects with industry.

QUESTION FROM REPRESENTATIVE LIPINSKI

- Q2. The cuts to the SMR Advance Concepts R&D program are even more substantial – over 30 percent. Secretary Chu, what impact will this cut have on research programs, especially at our national labs, and on the Department’s goal of deploying innovative technologies in 15-20 years?
- A2. The impact of the reduced budget will be negligible on the long term scope and pace of progress for R&D supporting advanced SMR concepts that could be deployed in the next 15-20 years. The program conducts R&D in the areas of materials, safety and licensing issues, components and technology development and energy conversion, and is applicable to multiple technology options.

QUESTION FROM REPRESENTATIVE LIPINSKI

Q3. Secretary Chu, I am concerned that the proposed budget cuts are leading to squandered opportunities with hydrogen fuel cells, including the H-Prize program. I realize that, by their nature, prize challenges won't always be met. However, I am concerned by the fact that the DOE did not appear to put as much effort in the H-Prize program as it did into the L-Prize program. Can you contrast these two programs, tell me what you learned from the failure of the first H-prize, and tell me why the \$1 M H-Prize purse wasn't re-used for a second competition?

A3. The Department values prize challenges including the H-Prize to help incentivize innovation and complement existing funding. In fact, significant efforts were made with the first H-Prize, including a competitive solicitation to select an administration entity and a competition to address one of the key challenges – hydrogen storage. Through stakeholder input, specific technical criteria were set, and an independent test facility was selected to perform the review and assessment of Prize finalists. One of the key lessons learned was the importance of designing a topic that is both innovative and achievable in a reasonable timeframe while generating broad interest across the research community. Before issuing another H-Prize competition, the Department is soliciting feedback from stakeholders through a request for information (RFI). The RFI was released on March 19, 2012 for a second H-Prize competition.

<https://www.fedconnect.net/FedConnect/?doc=DE-FOA-0000680&agency=DOE>.

The input from the RFI will be used to design the challenge topic and will allow a suitable and effective H-Prize challenge to be conducted in FY 2012 as planned. The funds remaining from the original \$1 million H-Prize (funded from FY 2008 and FY 2009 appropriations) will be used for this new competition.

QUESTION FROM REPRESENTATIVE LUJAN

In the Energy Policy Act of 2005 a Technology Commercialization Fund was created within the Dept. of Energy to promote promising energy technologies for commercial purposes.

Q1 (a): What is the status of this fund?

A1 (a): The Department is making the improvement of its innovation and commercialization ecosystem a top priority, and Technology Commercialization Fund (TCF) is part of the overall plan. The objective is to increase the number of technologies commercialized. This goal is consistent with Section 1001 of the Energy Policy Act (EPACT) of 2005 which requires that 0.9 percent of the annual amount made available for applied energy research, development, demonstration, and commercial application be used towards technology transfer and commercialization activities.

Q1 (b): Which offices are contributing their 0.9%?

A1 (b): Offices maintaining a technology commercialization fund are Energy Efficiency and Renewable Energy, Fossil Energy R&D, and Nuclear Energy.

Q1 (c): How is the fund is being managed and by whom?

A1 (c): Consistent with the Act, the Technology Transfer Coordinator works collaboratively with each program to assist with planning and discuss execution of technology transfer and commercialization activities that fulfill Congressional and Departmental objectives. Starting in FY 2012, the Coordinator will also work with the programs to develop consistent goals, strategies, and performance criteria to provide accountability for technology transfer and commercialization results. At the end of each fiscal year, the Coordinator collaborates with all applicable programs and DOE

offices in order to complete the required annual report to Congress on progress in meeting the goals set forth in the technology transfer execution plan.

Q1 (d): How the funds are being utilized?

A1 (d): The Coordinator will propose improvements to existing activities, synergies with other Departmental initiatives, and new opportunities. Participating programs will maintain their focus on their technological priorities while benefiting from the Coordinator and inter-agency expertise..

QUESTION FROM REPRESENTATIVE McNERNEY

Some members of the fusion community have concerns about cuts to domestic fusion research programs in favor of increased support for international programs.

Q1 (a): How will funding cuts affect students at the Massachusetts Institute of Technology and other facilities working on fusion?

A1 (a): At MIT, there are 29 graduate students currently involved in research on the Alcator C-Mod tokamak. Under the proposed budget, it is expected that up to 13 of these students will be able to complete their research using data from experiments conducted during FY 2012 and receive their Ph.D. degrees in 2013. An additional 5 students might be able to complete their research if additional running time on C-Mod is possible at the end of FY 2012 or in early FY 2013 within the Congressional Request. The remaining 11 students will not be able to complete their current research projects. Where appropriate, the Office of Fusion Energy Sciences will work with MIT to find research homes for those students who can best benefit from bridging their current research to other facilities.

Regarding the total impact within the program, we note that in FY2012 325 full time equivalent students (well over 400 individuals) are supported through the Office of Science to conduct research in the fusion and plasma sciences. The 29 full time MIT students represent a little less than 10% of that total student population. Overall, compared to FY 2012, we estimate there will be a reduction of about 62 full time equivalent students engaged in Office of Science supported fusion and plasma science.

- Q1 (b): How will our long-term understanding of fusion science be affected by a decrease in research funding?
- A1 (b): Although the proposed budget will present challenges, it will allow the United States (U.S.) to continue to have an impactful fusion program. The proposed budget will enable a U.S. program that makes significant contributions to resolving vital issues in fusion research thereby building the scientific foundation needed to develop a fusion energy source. It positions the program to obtain a high level of scientific return of our investment in ITER; address gaps in materials science required for harnessing fusion energy; continue to steward the broader plasma sciences, taking advantage of cross-agency synergies; and provide opportunities for U.S. scientists to do research on billion-dollar-class, new international superconducting facilities where technology investments will enable access to a new class of scientific questions not available within the U.S..
- Q1 (c): How could cuts affect the ongoing research at Lawrence Livermore National Laboratory?
- A1 (c): Total Fusion Energy Sciences funding to LLNL in FY 2012, spread over a number of research projects, amounted to \$11,129,000. In the FY 2013 Budget Request, LLNL funding for materials research and for NSTX collaborations are not affected. Research collaborations between LLNL and DIII-D will be reduced by 9.6%, and theory and computation research at LLNL by 14%. LLNL funding in the areas of diagnostics, high energy density laboratory plasmas, and laboratory general plasma science are scheduled for review in competitive solicitations in FY 2013.

QUESTION FROM REPRESENTATIVE McNERNEY

- Q2. The Department's budget for wind energy technologies includes important objectives to increase "the number of certified small wind systems and reduce the cost of energy of small and midsize wind turbines used in community and distributed electricity systems to compete with the retail electricity rates." These distributed wind turbines contribute to the President's clean energy goals.
- a. How does the Department plan to meet these objectives for small and distributed wind turbines?
- A2a. While wind technology used in community and distributed applications remains a priority for DOE, the Department has recently increased its emphasis on less mature wind technologies used in offshore applications, as indicated by FY 2012 plans and the FY 2013 budget request. DOE does, however, plan to continue to support activities related to achieving its goal for small wind technology, which is to increase the number of small wind turbine models certified to performance and safety standards from a 2010 baseline of zero to 40 by 2020. The FY 2012 milestone associated with this goal is to certify five models. Planned activities towards meeting this goal are standards development and completing the establishment of the Small Wind Certification Council and four regional small wind turbine testing centers. Product certification is essential for providing consumers, policy makers, and lenders with transparent, third-party-verified small wind turbine performance and safety information. State renewable energy programs are establishing lists of 'qualified' small wind turbines for incentive programs based on the process for certification developed with support from DOE.

The Department is also currently supporting research, analysis, and modeling to establish near-term cost of energy targets for midsize turbine technology and utility scale technology used in distributed applications, with the goal of being competitive with national average retail electricity rates. Work activities related to achieving this goal include economic analysis, next generation midsize turbine R&D, standards development, and technology transfer support.

QUESTION FROM REPRESENTATIVE MILLER

- Q1. ARPA-E has been described as covering unique “white spaces” in energy science and technology that neither industry nor other government programs are willing to fully undertake alone, and then accelerating advances to the marketplace as quickly as possible. In fact, this is what it was instructed to do by the COMPETES Act. Yet, there is some disagreement and confusion about how ARPA-E overlaps with, or builds upon, previous private or government efforts, and how it attracts follow-on funding. Some contend that any overlap is inappropriate as it “crowds out” private investment or duplicates other government programs, and that efforts to attract follow-on investment are similarly inappropriate. Yet, it would be difficult, and possibly unwise, for ARPA-E to limit its activities to funding only those ideas that have not had any other public or private interest, especially given the potential value of later-stage research that is necessarily built upon previous work. Furthermore, many important scientific breakthroughs and technological advances might be overlooked if ARPA-E and its performers are not proactive in promoting and demonstrating them to potential investors, technology developers and customers. Again, these concerns are specifically addressed in COMPETES.
- Q1a. Does ARPA-E duplicate the efforts of other government programs or “crowd out” private investment? How are these “white spaces” identified?
- A1a. ARPA-E coordinates and leverages each of its programs and ensures that ARPA-E provides unique value within the rest of DOE. For instance, to improve coordination within DOE, ARPA-E has formed a Panel of Senior Technical Advisors (PASTA). PASTA consists of Assistant Secretaries (or their Technical Appointees) of all the relevant applied energy offices as well as the heads of all the relevant offices in the Office of Science. In addition, the Director of ARPA-E actively coordinates with the Director of the Office of Science, offices and programs falling under the purview of the Office of the Under Secretary for Energy, as well as the Under Secretary for Science. The Department has now formed Integrated Technology Teams along techno-industrial lines (i.e. solar; storage; biofuels; carbon capture, utilization & storage; grid) that span the Office of Science, Applied Energy Offices and ARPA-E. These teams ensure that each of

these offices play unique roles, while ensuring that the work is coordinated and the whole is bigger than the sum of its parts.

Before announcing a new program, ARPA-E undertakes a comprehensive process to identify a technology “white space” that is not likely being addressed by the private sector or other Federal Agencies. ARPA-E technical staff begin by reviewing the scientific literature to identify potential program areas. Next, ARPA-E technical staff examine the current state of the art, the main players in this space, and the major technology challenges. If ARPA-E concludes that a technology white space exists, ARPA-E technical staff organize a workshop, bringing in relevant players from industry, academia, and government to further refine the concept for a potential program. If the workshop is successful, ARPA-E may issue a funding solicitation containing market-based cost and performance metrics that, if achieved, could displace the prevailing technology.

Applicants are required to disclose in their applications whether they submitted the same or similar concepts to ARPA-E, other Federal agencies, or private investors. In addition, applicants are required to disclose prior and current sources of funding for the proposed research project and related work. Finally, applicants are required to provide a detailed explanation for lack of support from existing sources of funding. For example, large businesses are required to explain why the proposed project is not being sponsored internally.

During the merit review process, ARPA-E utilizes expert reviewers from industry, academia, and government to rate and provide comments on applications. These

reviewers help ARPA-E to avoid any with projects funded by other Federal agencies and private investors.

Upon the execution of the funding agreement, ARPA-E invites industry representatives to participate in its meetings with recipients. These meetings enable a free exchange of ideas and encourage collaboration with potential commercialization partners.

ARPA-E recipients are required to disclose in their quarterly performance reports any new funding received from public or private sources. This ensures transparency and enables ARPA-E to make appropriate funding determinations.

- Q1b. To be safe, should ARPA-E fund only concepts and performers that have not had any previous private sector or government investment, and therefore forego sponsoring potentially important research just because the concept or performer have had some form of previous investment at some stage of development? How does ARPA-E ensure that it is not merely funding what the private sector would otherwise do on its own?
- A1b. ARPA-E supports its statutory mission to accelerate “transformational technological advances in areas that industry by itself is not likely to undertake because of technical and financial uncertainty.” ARPA-E is careful to not fund any specific and discrete technical idea that had previously received money from industry. To be clear though, some ARPA-E performers have received funding from public or private sector sources for research projects that are distinctly different from their ARPA-E project. ARPA-E sets market-based cost and performance metrics in technology areas that if met could displace the prevailing technology. ARPA-E is technology agnostic and selects among competing new technologies based upon their potential to meet our cost and performance metrics. ARPA-E seeks to create competition between performers.

Applicants are required to disclose in their applications whether they submitted the same or similar concepts to ARPA-E, other Federal agencies, or private investors. In addition, applicants are required to disclose prior and current sources of funding for the proposed research project and related work. Finally, applicants are required to provide a detailed explanation for lack of support from existing sources of funding. For example, large businesses are required to explain why the proposed project is not being sponsored internally.

Q1c. Should ARPA-E encourage or discourage follow-on investment in the successful projects it sponsors, or should it be passive in that regard and hope that interested investors or customers notice?

A1c. ARPA-E is always pleased when research projects it has funded succeed in securing follow-on funding and eventual success in the commercial marketplace. However, ARPA-E believes this is a result of the technical progress made by the recipient. ARPA-E provides aggressive market-based cost and performance metrics, dependable project funding, active program management, and technology-to-market assistance, such as the Technology Showcase at the annual ARPA-E Energy Innovation Summit.

However, ARPA-E does not pick winners; rather, ARPA-E creates the competition. It funds multiple competitive and parallel approaches to reach the same performance and cost target of technology with very aggressive technical milestones and deliverables. After the technology is de-risked, ARPA-E then lets the private sector pick the ones that are best for business. A successful project is one that meets the technical milestones and deliverables over the course of the award period. ARPA-E sets the bar high and builds

into funding agreements milestones and deliverables that, if met, would not only overcome a specific technical barrier but also bring a technology closer to market deployment. We believe this makes the technology more attractive for future private investment.

QUESTION FROM REPRESENTATIVE MILLER

- Q2. Please comment on the need for coordinated federal activity in the area of critical materials. Would legislation to support inter-agency cooperation help align and leverage the important work taking place at DOE and other agencies?
- A2. DOE shares your interest in coordination across the federal government. Federal activity in critical materials is coordinated through the White House Office of Science and Technology Policy (OSTP). OSTP convenes a critical and strategic mineral supply chains workgroup with subgroups that focus on critical materials prioritization, R&D prioritization, and information availability and transparency. Each of these subgroups is building on relevant work across the government. For example representatives from DOE and DOD co-chair the group on critical materials prioritization. Thus, the prioritization methods being developed build on the assessment work done by both DOE and DOD. A representative from DOE chairs the R&D prioritization group. This group is crafting a cohesive R&D roadmap drawing on input from representatives from many agencies.
- Q2a. What is in the FY2013 budget to address the country's critical material concerns? What type of federal support is necessary to support the development of a domestic critical materials industry?
- A2a. DOE's role in supporting a domestic critical materials industry is primarily to support innovative research, development and demonstration (RD&D) of new technologies and processes. Supporting this research, particularly in a university setting, also can lead to the development of human capital. The FY2013 budget includes the second year of funding for the Critical Materials Hub, managed by the Energy Efficiency

and Renewable Energy's (EERE) Advanced Manufacturing Office. The hub's FY2012 funding is \$20 million.

In addition, there are a number of other DOE research programs that incorporate critical materials research into their ongoing work. For example, the Materials Discovery, Design and Synthesis research supported by the Office of Basic Energy Sciences within the Office of Science builds the fundamental knowledge that is the basis for material substitutes and new manufacturing process development. Ongoing work by EERE's Vehicle Technologies and Wind Technologies Programs more directly support the development of substitutes for magnets, motors and generators. With FY2012 funding, ARPA-E initiated a new program called Rare Earth Alternatives in Critical Technologies (REACT) that seeks to fund early-stage technology alternatives that reduce or eliminate the dependence on rare earth materials by developing substitutes for electric vehicle motors and wind generators. In addition, ARPA-E's 2012 Open Funding Opportunity Announcement has critical materials as one of its subtopics of interest.

- Q2b. While policy signals are essential, given the strategic interest in developing domestic capabilities, should the federal government also help support the financing of critical materials production facilities?
- A2b. The Administration has moved forward on a number of general policies to support manufacturing in the past year, which can also support the domestic critical materials processing. For example, the Advanced Manufacturing Partnership (AMP) was recently established in response to recommendations by the President's Council of Advisors on Science and Technology. AMP is helping create a coherent national innovation policy for manufacturing. The AMP Steering Committee has developed a set of recommendations around three pillars: enabling innovation, securing the talent pipeline and improving the

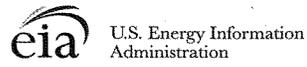
business climate. This framework is also applicable to critical materials processing. In addition, the President's Framework for Business Tax Reform was issued jointly by the White House and the Department of the Treasury in February 2012. This Framework emphasizes the importance of strengthening manufacturing and innovation, stating "as we expand manufacturing in the United States, the tax code should encourage doing so in way that is sustainable and that puts the United States in the lead in manufacturing the clean energy technologies of the future." In many cases critical materials processing is an early stage of the supply chain for clean energy manufacturing, which could benefit from the support via the aforementioned activities conducted by the Federal government.

- A2c. Many existing DOE programs do not reach far enough back in the supply chain to provide support for critical materials development and processing. For example, while lithium production is essential to electric vehicle battery production, lithium development and processing activities are not supported by the Department's vehicles or batteries programs. Is it appropriate for DOE program offices to support the development of a full supply chain, encompassing critical materials?
- A2c. Materials processing and separations are among the priority research topics identified in the R&D plan in DOE's 2011 Critical Materials Strategy. Specifically, improving separation and processing of critical materials will support the diversification of the global supply chains. There are a number of R&D challenges that exist in the area. Many traditional separation processes are inefficient and environmentally unfriendly. These processes require the use of harsh solvents and reagents, have long processing times and are very capital intensive. Improving these processes or developing new, more efficient methods would cut costs, reduce energy use, and improve environmental performance across the full supply chain. The Office of Science supports some fundamental work that

informs the development of new processes. In addition, these research topics are of interest to DOE's SBIR as well as the upcoming Critical Materials Innovation Hub.

Technology Investment Agreements							
Effective Date	Title	Awardee	DOE Funding	Cost Share	Technical Objectives	Contribution to Technology and Industrial Base for DOE mission	Fostering New Partnerships
10/1/2007	Design, Construction, Building, and Operation of an Integrated Biorefinery	Range Fuels Soperton Plant, LLC	\$76M	\$280M	To help facilitate the design, construction, and operation of a commercial scale biorefinery for production of ethanol and other products from a minimum of 700 dry metric tonnes per day of lignocellulosic feedstocks	A commercial entity will participate with DOE in a design/build of a first-of-its-kind facility, helping to commercialize a new biofuels process and technology by validating the design and operation at scale	By undertaking cost-shared development and deployment activity, the project could serve as model for future private-sector investments in biofuels, bioproducts, and energy production.
10/1/2008	Design, Construction, Building, and Operation of an Integrated Biorefinery	POET Project Liberty, LLC	\$76.2M	\$117.6M	To provide funding for final design, construction, equipment, start-up, commissioning, and operation reporting of plant capable of producing 700 Dry Metric Tonnes per day of lignocellulose feedstock	A commercial entity will participate with DOE in a design/build of a first-of-its-kind facility, helping to commercialize a new biofuels process and technology by validating the design and operation at scale	By undertaking cost-shared development and deployment activity, the project could serve as model for future private-sector investments in biofuels, bioproducts, and energy production.
1/15/2010	Low-Contract Drilling Technology to Enable Economic Engineered Geothermal Systems (EGS) Wells	Foro Energy, Incorporated	\$9.1M	\$9.1M	To develop a new hybrid thermal/mechanical drilling technology for much faster drilling with less wear and tear on a drill bit	Foro Energy will develop potentially transformational drilling technology that lowers drilling costs for geothermal wells by increasing drill rates up to 10-fold relative to conventional technology	Arrangement allows non-Federal participant in technology development that would not otherwise have participated and encourages future private-sector investment and deployment
2/22/2010	Breakthrough High Efficiency Shrouded Wind Turbine	FloDesign Wind Turbine Corporation	\$8.3M	\$8.3M	To develop a new high efficiency shrouded wind turbine able to deliver significantly more energy per unit of swept area	FloDesign Wind's Mixer Ejector Wind Turbine has the potential to be the next generation wind turbine by providing significantly lower first and life costs compared to traditional horizontal axis wind turbines	Arrangement allows non-Federal participant in technology development that would not otherwise have participated and encourages future private-sector investment and deployment
2/26/2010	Macroalgae Butanol	E. I. DuPont De Nemours and Company	\$8.9M	\$8.9M	To develop a commercially viable process for fermentative production of isobutanol from macroalgae	DuPont will develop a commercially viable process for isobutanol production from macroalgae offering potentially significant advantages over fossil fuels and ethanol currently made from corn, sugarcane, and second generation cellulosic biomass	Arrangement allows non-Federal participant in technology development that would not otherwise have participated and encourages future private-sector investment and deployment
9/29/2011	U.S. Photovoltaic Manufacturing Initiative (PVMC)-Enabling America's Solar Revolution	The Research Foundation on behalf of the College of Nanoscale Science and Engineering at SUNY Albany and others	\$62.5M	\$180.4M	To establish the U.S. Photovoltaic Manufacturing Consortium, which will coordinate a multi-faceted industry-driven collaborative Research and Development (R&D) initiative	Through its potential consortium members and business experience in the semiconductor industry, PVMC seeks to stimulate U.S. PV manufacturing industry growth, accelerate commercialization of next generation PV technologies, and increase significantly the U.S. share of global PV market	The project allows the creation of new relationships/partnerships among participants at the prime and sub-tier levels that will result in better PV manufacturing technology and enhance the competitiveness of the U.S. PV manufacturing industry

Mr. Deel



Analysis of Impacts of a Clean Energy Standard

as requested by Chairman Bingaman

November 2011



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This report was prepared by the U.S. Energy Information Administration (EIA), the statistical and analytical agency within the U.S. Department of Energy. By law, EIA's data, analyses, and forecasts are independent of approval by any other officer or employee of the United States Government. The views in this report therefore should not be construed as representing those of the U.S. Department of Energy or other Federal agencies.

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Preface

This report addresses an August 2011 request to the U.S. Energy Information Administration (EIA) from Senator Jeff Bingaman, Chairman of the U.S. Senate Committee on Energy and Natural Resources, for an analysis of the impacts of a Clean Energy Standard (CES). The request, outlined in the initial letter and later amended (Appendix A), sets out specific assumptions and scenarios for the study.

Contents

Contacts	i
Preface	ii
Contents	iii
Figures	iv
Tables.....	iv
Introduction	1
Background	1
Alternative Cases	2
Results.....	5
BCES case impacts relative to the <i>AEO2011</i> Reference case.....	5
Alternative Case Results	11
Appendix A: Request Letters	18
Appendix B: Summary Tables	22
Appendix C: Map of NEMS Electricity Market Module Regions	26

Figures

Figure 1. Total Net Electricity Generation	5
Figure 2. Total Non-Hydroelectric Renewable Generation.....	6
Figure 3. Electricity Sector Carbon Dioxide Emissions	7
Figure 4. BCES Impact on Electricity and Natural Gas Prices (BCES Difference from Reference case).....	7
Figure 5. Total Electricity Expenditures	9
Figure 6. Natural Gas Expenditures, Not Including the Electric Power Sector	10
Figure 7. Annual Gross Domestic Product	10
Figure 8. BCES Impact on Employment and Real GDP, Percent Difference (BCES Difference from Reference case).....	11
Figure 9. Total Net Electricity Generation in Alternative Cases, 2025.....	12
Figure 10: Total Net Electricity Generation in Alternative Cases, 2035.....	12
Figure 11. Total Non-hydroelectric Renewable Generation in Alternative Cases, 2025	13
Figure 12. Total Non-hydroelectric Renewable Generation in Alternative Cases, 2035	13
Figure 13. Electric Power Sector Carbon Dioxide Emissions in Alternative Cases, 2025 and 2035	14
Figure 14. Impacts on National Average Electricity Prices in Alternative Cases, 2025 and 2035	15
Figure 15. Impacts on Delivered Natural Gas Prices in Alternative Cases, 2025 and 2035	17

Tables

Table 1. BCES Clean Energy Goals and Credit Coverage Requirements	2
Table 2. Clean Energy Goal and Credit Shares Across Select Cases ¹	4
Table 3. BCES Regional End-use sector Average Prices (2009 cents/kWh).....	8
Table 4. Regional Average Electricity Prices in Alternative Cases, 2025 (2009 cents/kWh).....	16
Table 5. Regional Average Electricity Prices in Alternative Cases, 2035 (2009 cents/kWh).....	16
Table B1. The BCES and alternative cases compared to the Reference case, 2025	22
Table B2. The BCES and alternative cases compared to the Reference case, 2035	24

Introduction

This report responds to a request from Senator Jeff Bingaman, Chairman of the U.S. Senate Committee on Energy and Natural Resources, for an analysis of a national Clean Energy Standard (CES). The request, as outlined in the letter included in Appendix A, sets out specific policy assumptions for the study.

Background

A CES is a policy that requires covered electricity retailers to supply a specified share of their electricity sales from qualifying clean energy resources. Under a CES, electric generators would be granted clean energy credits for every megawatt-hour (MWh) of electricity they produce using qualifying clean energy sources. Utilities that serve retail customers would use some combination of credits granted to their own generation or credits acquired in trade from other generators to meet their CES obligations. Generators without retail customers or utilities that generated more clean energy credits than needed to meet their own obligations could sell CES credits to other companies.

The design details of a CES can significantly affect its projected impacts. Chairman Bingaman's request sets out a base CES specification and several variants. The base CES specification, henceforth referred to as the Bingaman CES (BCES) case, has various provisions describing the definition of clean energy, the allocation of credits, and the dates when target milestones become binding, as described below:

- All generation from existing and new wind, solar, geothermal, biomass, municipal solid waste, and landfill gas plants earns full BCES credits.
- Incremental hydroelectric and nuclear generation from capacity uprates at existing plants and from new plants earns full BCES credits.
- Generation from existing nuclear and hydroelectric capacity does not receive any BCES credits. However, the total generation from these two sources counts towards the overall clean energy sales goal of the policy. Generation from these sources is reflected in the policy through a reduced requirement for holding BCES credits.
- Partial BCES credits are earned for generation using specific technologies fueled by natural gas or coal, based on a calculated crediting factor that reflects the carbon intensity of each technology relative to that of a new supercritical coal plant. These technologies include coal plants which capture and sequester their carbon dioxide emissions (0.9 BCES credits), natural gas plants that also sequester their carbon dioxide emissions (0.95 BCES credits), existing natural gas combined-cycle units (0.48 BCES credits), new gas combined-cycle units (0.59 BCES credits), existing gas combustion turbines (0.16 BCES credits), new gas combustion turbines (0.45 BCES credits), and integrated gasification combined-cycle (IGCC) coal plants without carbon capture (0.15 BCES credits).
- The BCES target for the share of retail electricity sales from clean energy sources starts at 45 percent in 2015 and ultimately reaches 95 percent in 2050. However, as noted above, the requirement to hold BCES credits is generally reduced by generation from existing nuclear and hydroelectric capacity, which counts toward the clean energy targets but does not earn BCES credits.

Table 1 below shows both the overall BCES case clean energy targets and the estimated requirement for covering sales with BCES credits given projected generation from existing nuclear and hydroelectric

capacity. For example, in the Reference case¹ projection for 2035, these generation sources account for about 24 percent of sales, so the 80-percent clean energy goal requires that 56 percent (80 percent minus 24 percent) of sales be covered by BCES credits

- BCES clean energy goals increase linearly between the milestones shown in Table 1, with a 2-percentage point annual increase between 2020 and 2035 and a 1-percentage point annual increase in the first 5 years of the BCES and between 2035 and 2050.
- There is no sunset date for the requirements, so the 95-percent clean energy goal remains in effect beyond 2050.
- All electricity providers are covered by the requirement, regardless of ownership type or size.
- BCES credits can be banked for use in a subsequent year. There is no limit on how many credits may be held or for how long they may be held.
- The BCES operates independently of any State-level policies. The same underlying generation can be used to simultaneously comply with the BCES and any State generation requirements, if otherwise allowed for by both Federal and State law.

Table 1. BCES Clean Energy Goals and Credit Coverage Requirements

Year	Overall Clean-Energy Goal	Percentage of Total Sales that Must be Covered by BCES Credits
2015	45%	17%
2020	50%	23%
2025	60%	34%
2030	70%	45%
2035	80%	56%
2040	85%	62%
2045	90%	68%
2050	95%	74%

Like other EIA analyses of energy and environmental policy proposals, this report focuses on the impacts of those proposals on energy choices in all sectors and the implications of those decisions for emissions and the economy. This focus is consistent with EIA's statutory mission and expertise. The study does not account for any possible health or environmental benefits that might be associated with the BCES policy.

Alternative Cases

As noted above, Chairman Bingaman also requested that several variations of the base CES specification be analyzed. The first three cases listed, the All Clean, Partial Credit, and Revised Baseline cases, examine several alternative treatments for existing nuclear and hydroelectric generation facilities, giving them either a partial or a full credit for generation. The Partial Credit case also includes an alternative treatment for the crediting of qualifying fossil generation.

¹ The reference case in this report includes some revisions to the *AEO2011* Reference case. The primary changes include an improved representation of interregional capacity transfers for reliability pricing and reserve margins. Also, capacity expansion decisions incorporate better foresight of future capital cost trends by including expectations of the commodity price index.

All Clean case (AC): Generation from existing nuclear and hydroelectric capacity receives full credit. As indicated in Table 2, in this case, the requirement to hold BCES credits is equivalent to the overall clean energy goal.

Partial Credit case (PC): Generation from all natural gas combined-cycle units without carbon capture equipment receives one-half credit. Gas combustion turbines and coal plants without carbon capture do not receive credit. However, generation from existing nuclear and hydroelectric plants each receive one-tenth of a credit, which provides an added incentive to continue operating existing capacity of these types relative to the BCES case. As shown in Table 2, the requirements to hold BCES credits are adjusted from the BCES case to account for the differing crediting scheme and to maintain the overall goal for clean energy generation.

Revised Baseline case (RB): Electricity service providers may subtract generation from existing nuclear and hydroelectric capacity from their sales baseline when calculating their clean energy requirement. Although the requirement for covering sales with BCES credits shown in Table 2 differs slightly from the requirements in the BCES case, this case is meant to achieve the same overall goal for clean energy use. Removing generation from existing nuclear and hydroelectric facilities from the sales baseline and adjusting the target to compensate for this change provides an incentive to continue operating existing nuclear and hydroelectric facilities.

The next four cases potentially reduce the amount of clean energy stimulated by the CES, either by exempting small electricity suppliers from meeting the target (“Small Utilities Exempt”), capping the maximum credit price paid by suppliers (“Credit Cap 2.1” and “Credit Cap 3.0”), or decreasing total electricity demand through increased efficiency standards (“Standards and Codes”).

Small Utilities Exempt case (SUE): Electricity suppliers with annual sales lower than 4 million MWh are exempt from the clean energy requirements. They may produce and sell BCES credits, but they do not need to hold them. As with the Revised Baseline case, the effective sales basis is reduced in this case relative to the BCES case; however, unlike the BCES case, there is no adjustment to the mandatory target applied to each affected utility. As shown in Table 2, the clean energy target as a percent of covered sales in the SUE case is the same as in the BCES case. However, as a percent of total sales, the CES in the SUE case is less stringent than in the BCES case.

Credit Cap 2.1 case (C2.1): The price of BCES credits is effectively capped through the availability of unlimited alternative compliance credits starting at a price of 2.1 cents per kilowatthour in 2015 and rising 5 percent per year above the rate of inflation each year thereafter. Although neither the goal nor the mandatory targets is changed in this case from the BCES case, the amount of clean energy generation achieved may be less than the indicated goal/target to the extent that alternative compliance credits are used for compliance in lieu of credits from actual clean energy generation.

Credit Cap 3.0 case (C3.0): Unlimited alternative compliance credits are made available starting at a price of 3.0 cents per kilowatthour in 2015 and rising 5 percent per year above the rate of inflation each year thereafter. Although neither the goal nor the mandatory targets are changed in this case from the BCES case, the amount of clean energy generation achieved may be less than the indicated goal/target to the extent that alternative compliance credits are used for compliance in lieu of credits from actual clean energy generation.

Standards and Codes case (S+C): Adds additional rounds of efficiency standards for currently covered products as well as new standards for products not yet covered. Efficiency levels assume improvement similar to those in *Energy Star* or Federal Energy Management Plan (FEMP) guidelines. The Standards and Codes case corresponds to

the Expanded Standards and Codes case that was part of *AEO2011*. More information about the assumptions underlying this case can be found in [Appendix E of the *AEO2011*](#).

With the exception of the SUE case, all of the alternative cases described above share the goal in the BCES case of covering 80 percent of total national sales with generation from clean energy by 2035. However, the number of credits required in each case varies because of differences in the sales baselines and the number of credits assigned to different technologies, particularly with respect to the treatment of generation from existing hydroelectric facilities and nuclear plants (Table 2). In the BCES, AC and PC cases all sales are covered by the credit program. In the RB case, covered sales are reduced by the generation from existing hydroelectric and nuclear plants and, in the SUE case, they are reduced by sales from small utilities.

Focusing on 2035, in the BCES case 56 percent of total sales must be covered by credits. As described above, the credit share required in the BCES case is below the 80 percent clean energy goal because projected generation coming from existing hydroelectric and nuclear plants does not earn credits but still counts towards the overall clean energy goal. In the AC case, the share of sales that must be covered by credits equals the overall clean energy goal because all generation from hydroelectric and nuclear plants, whether existing or new, earn credits. In the PC and RB cases, the share of total sales that must be covered by credits is very similar to that in the BCES case. The shares are slightly higher in the PC case because generation from existing hydroelectric and nuclear plants earns a small share of credits in this case. In the SUE case, the share of total sales that must hold credits is significantly lower than in the BCES case because sales from small utilities are not required to hold credits. These small utilities account for roughly 25 percent of sales so the overall credit share required is lower by about that amount.

Table 2. Clean Energy Goal and Credit Shares Across Select Cases¹

Year	Overall Clean-Energy Goal ¹	Required Clean Energy Target as a Percent of All Sales					SUE as a Percent of Covered Sales
		BCES	AC	PC	RB	SUE	
2015	45%	17%	45%	20%	23%	12%	17%
2020	50%	23%	50%	26%	32%	17%	23%
2025	60%	34%	60%	37%	46%	25%	34%
2030	70%	45%	70%	48%	60%	34%	45%
2035	80%	56%	80%	58%	74%	42%	56%
2040	85%	62%	85%	64%	80%	46%	62%
2045	90%	68%	90%	70%	87%	50%	68%
2050	95%	74%	95%	76%	94%	54%	74%

¹ Goal is expressed as a percent of all sales, except for the Small Utilities Exempt (SUE) case, where it is expressed as a percent of covered sales, as specified in the modified request letter for this study (see Appendix A). In 2035, covered sales in the SUE case are about 75 percent of national sales, reducing the effective clean energy goal to about 60 percent of national sales. For the C2.1 and C3.0 cases, the realized clean energy goal may fall below the 80 percent national target due to the use of alternative compliance credits.

Results

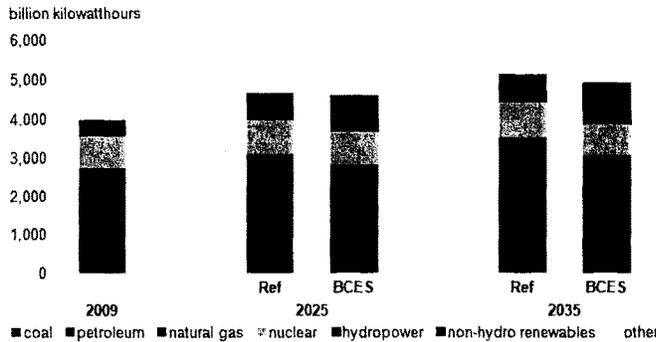
BCES case impacts relative to the AEO2011 Reference case

The BCES policy changes the generation mix, reducing the role of coal technologies and increasing reliance on natural gas, non-hydro renewable and nuclear technologies (Figure 1, Tables B1 and B2). Coal-fired generation, which in the Reference case increases by 23 percent from 2009 to 2035, decreases by 41 percent in the BCES case over the same period. Relative to the Reference case, where natural gas generation grows steadily throughout the projection period, natural gas generation in 2025 is 34-percent higher and 53-percent higher in 2035. Under the BCES policy, non-hydro renewable technologies grow at the fastest rate, increasing from 146 billion kilowatthours in 2009 to 601 billion kilowatthours in 2025 and 737 billion kilowatthours in 2035. These totals are 60 percent and 75 percent greater than the 2025 and 2035 Reference case projections, respectively.

The BCES case provides different incentives to existing and new nuclear power plants because only the latter earn credits. Nearly 65 gigawatts of new capacity are installed by 2035 in the BCES case compared to approximately 6 gigawatts in the Reference case. Generation from existing nuclear plants does not qualify for credits and, as a result, more than 14 gigawatts of this capacity are taken out of service, while less than 2 gigawatts of capacity are retired in the Reference case.

Since fossil-fueled generation that captures and sequesters carbon emissions is given nearly full BCES credit, the BCES spurs 47 gigawatts of coal capacity to be retrofitted with carbon capture and sequestration (CCS) equipment by 2035. Nearly all of these retrofits occur in the final 10 years of the forecast period, with less than one gigawatt of capacity retrofitted by 2025. No new coal plants with CCS are added in the BCES case beyond the small amount found in the Reference case.

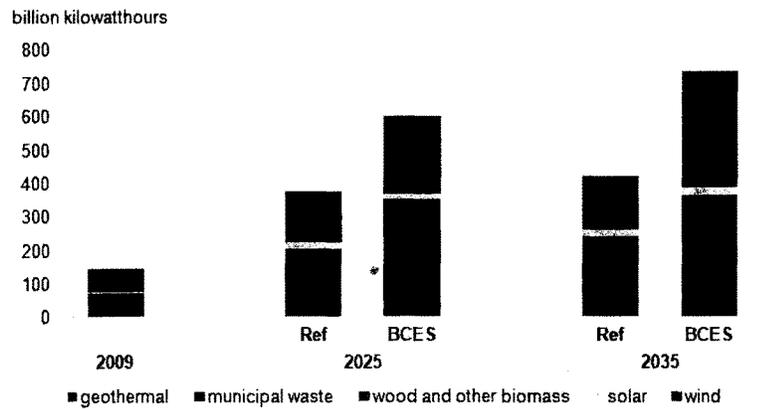
Figure 1. Total Net Electricity Generation



Source: U.S. Energy Information Administration, National Energy Modeling System, runs refa11.d082611b and cesbingbk.d100611a

Among renewable sources, wind and biomass have the largest generation increases under the BCES (Figure 2, Tables B1 and B2). Under the BCES policy, 2035 wind generation is more than five times its 2009 level. Total 2035 wind generation under the BCES is more than double the 2035 level in the Reference case. Biomass generation shows robust growth, as well, within the BCES framework. All of the growth in biomass use relative to the Reference case is attributable to co-fired generation, which reaches 187 billion kilowatthours in 2025 before declining to 156 billion kilowatthours in 2035 as coal-fired plants that co-fire biomass are retired.

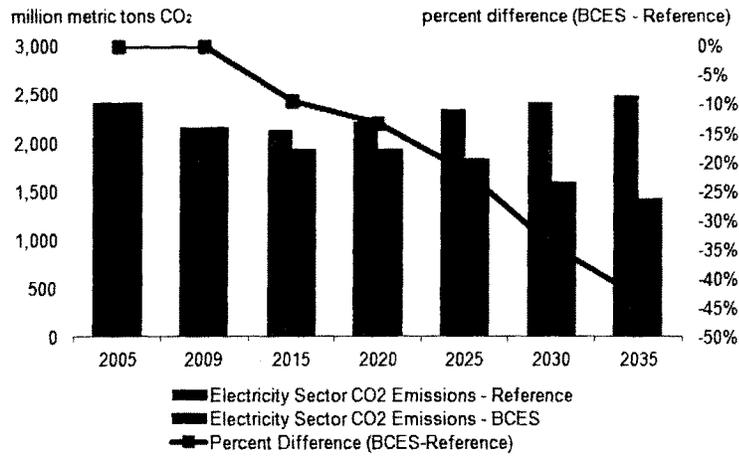
Figure 2. Total Non-Hydroelectric Renewable Generation



Source: U.S. Energy Information Administration. National Energy Modeling System, runs refhall.d082611b and cesbingbk.d100611a.

Under the BCES, projected annual electricity sector carbon dioxide emissions are 22 percent below the Reference case level in 2025 and 43 percent lower in 2035 (Figure 3, Tables B1 and B2). In the Reference case electricity-sector carbon dioxide emissions increase modestly over the projection period, reaching annual emissions of 2,345 million metric tons of carbon dioxide (MMTCO₂) in 2025 and growing further to 2,500 MMTCO₂ emitted in 2035. Over the 2009-to-2035 period, cumulative CO₂ emissions are 20 percent lower in the BCES case than they are in the Reference case.

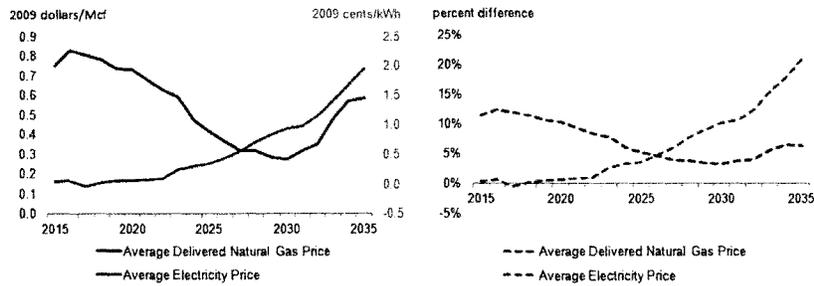
Figure 3. Electricity Sector Carbon Dioxide Emissions



Source: U.S. Energy Information Administration. National Energy Modeling System, runs refhal.d082611b and cesbingbk.d100611a.

The BCES has a negligible impact on electricity prices through 2022, but prices rise in later years. (Figure 4, Tables B1 and B2). In the early years of the projection period, there is negligible impact on average end-use electricity prices, as the requirement to hold BCES credits is modest. As shown in Table 1, the share of total sales that must be covered by credits does not exceed 45 percent until after 2030. This is important because, while coal-fired plants do not receive BCES credits, efficient combined cycle plants receive 0.48 credits for each megawatt-hour they generate, more than retailers purchasing their output are required to hold until after 2030. This effectively reduces the cost of most natural gas-fired generation until the later years of the projections. Electricity prices do grow later in the projections, reaching 21 percent above the Reference case level by 2035 in the BCES case.

Figure 4. BCES Impact on Electricity and Natural Gas Prices (BCES Difference from Reference case)



Source: U.S. Energy Information Administration. National Energy Modeling System, runs refhal.d082611b and cesbingbk.d100611a.

While average end-use electricity prices increase nationally after 2020 in the BCES case, the increase is not the same across all regions (Table 3). In 2025, when national average electricity prices in the BCES case are projected to be 3.6 percent above the Reference case level, regional projected prices are below the Reference case level in 1 of the 22 regions including New England (NEWE) and California (CAMX) which already have significant generation from eligible clean energy resources. By 2035, prices are below the Reference case level in only one region, MRO East (MROE), reflecting the significant share of qualified end-use generation projected to be co-produced in that region by facilities producing cellulosic biofuels to comply with the Federal Renewable Fuels Standard. The regions with the highest price increases in 2035 (by percent) are the SERC Central Region (SRCE) (69.2-percent increase) and the WECC Northwest Region (NWPP) (61.5-percent increase). The two regions with the highest increases in terms of cents per kilowatthour in 2035 are NPCC Long Island (NYLI), where prices increase by 5.2 cents/kWh and SERC Central (SRCE), where prices increase by 4.2 cents/kWh.

Natural gas prices also increase in the BCES case, particularly in the early years of the projections (Figure 4, Tables B1 and B2). Early in the projection, natural gas prices rise as generation from natural gas increases to comply with the BCES and bank credits for future use. As new capacity is built and other clean technologies continue to be expanded, the natural gas price premium over the Reference case gradually declines. Natural gas price impacts reach their height in 2016, where prices are \$0.83/ thousand cubic feet (12 percent) higher than in the Reference case.

Table 3. BCES Regional End-use Sector Average Prices (2009 cents/kWh)

Region	2009	2025		2035	
		Reference	BCES	Reference	BCES
ERCT - ERCOT All	10.4	9.2	9.0	10.0	11.6
FRCC - FRCC All	11.6	10.9	12.0	11.2	13.6
MROE - MRO East	9.3	7.5	7.0	7.3	5.9
MROW - MRO West	7.6	6.8	8.0	6.9	8.9
NEWE - NPCC New England	15.7	13.6	12.2	13.1	14.3
NYCW - NPCC NYC/Westchester	19.9	16.8	16.7	16.9	19.6
NYLI - NPCC Long Island	18.1	16.7	17.4	16.6	21.3
NYUP - NPCC Upstate NY	11.6	11.9	11.1	12.6	14.4
RFCE - RFC East	12.2	10.7	11.7	10.9	12.4
RFCM - RFC Michigan	9.6	8.7	9.0	9.0	11.1
RFCW - RFC West	8.6	8.5	8.5	9.9	11.0
SRDA - SERC Delta	7.5	7.3	7.2	7.5	9.7
SRGW - SERC Gateway	7.8	6.5	6.7	7.0	8.8
SRSE - SERC Southeastern	9.1	8.7	8.9	8.5	10.3
SRCE - SERC Central	7.8	6.0	7.2	6.0	10.2
SRVC - SERC VACAR	8.6	8.1	9.1	8.3	11.2
SPNO - SPP North	7.9	7.6	8.9	7.5	8.9
SPSO - SPP South	6.9	7.8	8.0	8.5	10.4
AZNM - WECC Southwest	9.8	9.5	9.5	10.4	11.3
CAMX - WECC California	13.3	14.6	13.1	13.2	14.0
NWPP - WECC Northwest	7.0	4.6	5.4	5.2	8.4
RMPA - WECC Rockies	8.2	9.0	9.4	9.4	11.1
U.S. Average	9.8	9.0	9.4	9.4	11.3

BCES electricity price is 10-25 percent greater than the Reference case electricity price

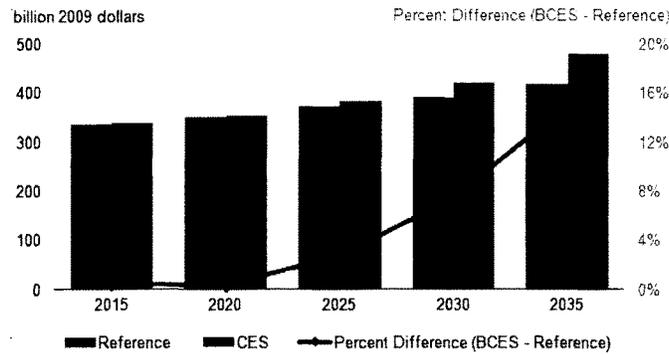
BCES electricity price is 25 percent or more greater than the Reference case electricity price

Source: U.S. Energy Information Administration, National Energy Modeling System, runs refhall.d082611 and cesbingbk.d100611a.

Note: See Appendix C for a map of the NEMS electricity market module regions.

Electricity expenditures increase in the BCES case after 2020 as a result of higher electricity prices (Figure 5, Tables B1 and B2). However, because electricity sales decrease later in the forecast period relative to the Reference case, the impact on electricity expenditures is smaller than the impact on electricity prices. In 2025 and 2035, total annual electricity expenditures across all sectors in the BCES case are 2.8 percent and 15.1 percent above the projected Reference case level, respectively. Household average annual electricity expenditures similarly increase over the projection horizon. In 2025, average household electricity expenditures are \$1,198 in the BCES case – \$36 above the Reference case. This difference increases to \$170 in 2035 between the two cases (\$1,366 versus \$1,196).

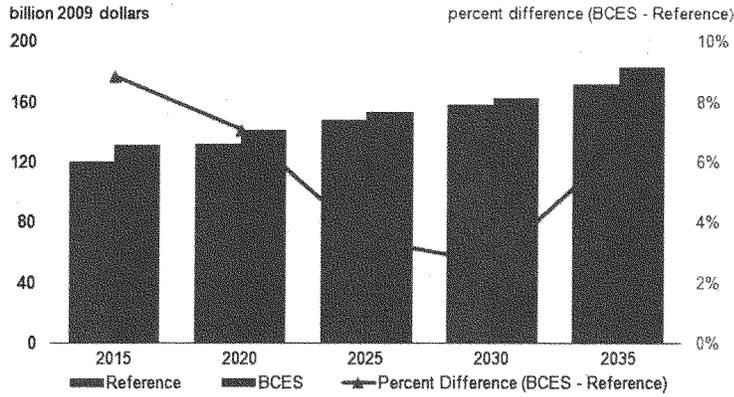
Figure 5. Total Electricity Expenditures



Source: U.S. Energy Information Administration. National Energy Modeling System, runs refhal.d082611b and cesbingbk.d100611a.

Higher natural gas prices also lead to increased natural gas expenditures outside the electricity sector in the BCES case (Figure 6, Tables B1 and B2). In 2025, non-electric natural gas expenditures in the BCES case are 3.4 percent higher than Reference case levels. This differential increases to 6.5 percent by 2035. Natural gas expenditures in the electric power sector experience upward pressure from both higher prices and higher consumption, but the impact of those changes on ultimate consumers is reflected in their electricity expenditures.

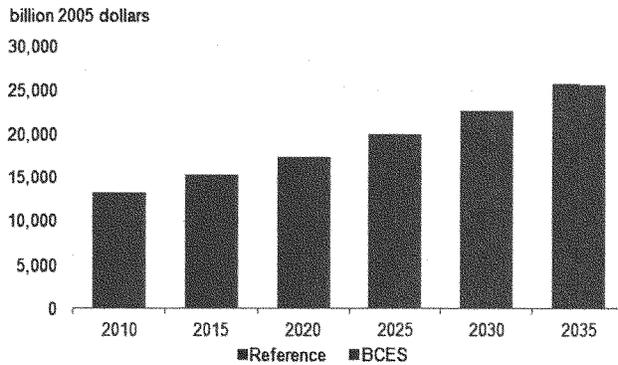
Figure 6. Natural Gas Expenditures, Not Including the Electric Power Sector



Source: U.S. Energy Information Administration. National Energy Modeling System, runs refhall.d082611b and cesbingbk.d100611a.

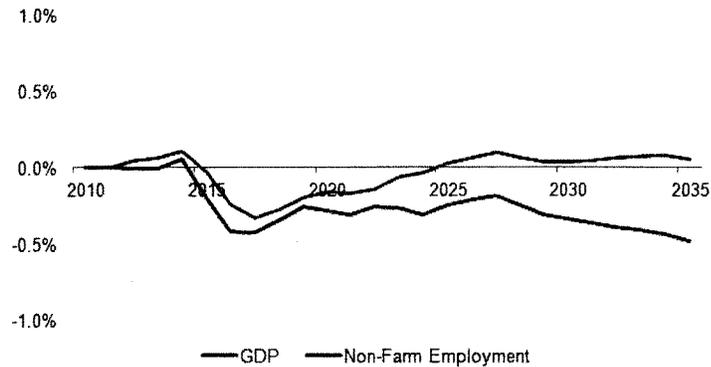
The BCES case reduces projected real Gross Domestic Product (GDP) relative to the Reference case, with a peak difference in the GDP level of less than half of one percent in 2035 and generally lower impact in earlier years. (Figures 7 and 8, Tables B1 and B2). GDP grows at an average annual rate of 2.67 percent between 2009 and 2035 in the BCES case, just slightly below the Reference case growth rate of 2.69 percent.

Figure 7. Annual Gross Domestic Product



Source: U.S. Energy Information Administration. National Energy Modeling System, runs refhall.d082611b and cesbingbk.d100611a.

Figure 8. BCES Impact on Employment and Real GDP, Percent Difference (BCES Difference from Reference case)



Source: U.S. Energy Information Administration, National Energy Modeling System, runs refhall.d082611b and cesbingtk.d100611a.

Alternative Case Results

As described earlier, EIA also prepared alternative cases that vary certain aspects of the CES policy. This section briefly describes the main impacts of these alternative cases.

As in the BCES case, each of the alternative cases shows reductions in coal generation and increases in natural gas, renewable and nuclear generation (Figures 9 and 10). Because each of the alternative cases maintains the basic structure of giving renewable generation a full credit and no credits to conventional coal generation, all of the cases show renewable electricity generation growth relative to the Reference case. Natural gas and nuclear generation levels vary across the cases. The All Clean (AC), Partial Credit (PC) and Revised Baseline (RB) cases all show greater nuclear generation than in the BCES case. Each of these cases contains provisions aimed at providing some credit to existing nuclear plants which results in greater nuclear generation and lower coal generation. The highest nuclear generation occurs in the PC case where it reaches levels 9.7 percent and 62.2 percent greater than the BCES case in 2025 and 2035, respectively. This generation is 8.2 percent and 46.3 percent above the Reference case levels in those same years.

The shift away from coal is smaller in the cases with credit price caps, as compliance is achieved by making alternative compliance payments. This is particularly true in the Credit Cap 2.1 (C2.1) case where renewable generation is the smallest among alternative cases. Both this case and the Small Utilities Exempt (SUE) case, where suppliers with sales of less than four million MWhs are exempt from meeting the targets, have the largest coal generation as a result of the ability to comply without needing as much clean generation. The role played by fossil-fueled technologies that sequester carbon emissions varies across the cases, with larger amounts seen in the AC and RB cases that tend to have higher CES credit prices that spur the use of higher-cost technologies.

Non-hydroelectric renewable generation increases relative to the Reference case in all of the alternative cases, but it varies among them (Figures 11 and 12). The lowest level among the alternative cases in 2035 occurs in the C2.1 case where utilities rely on making alternative compliance payments rather than increasing clean generation, while the highest level occurs in the C3.0 case. In the C3.0 case, the option to make alternative compliance payments at a higher rate than in the C2.1 case results in coal generation between the levels in the BCES and C2.1 cases. However, the credit price levels in the C3.0 case are not high enough to support the high levels of new

nuclear capacity seen in the other alternative cases, leading to a slightly higher level of non-hydro renewable generation than occurs in those cases.

Figure 9. Total Net Electricity Generation in Alternative Cases, 2025

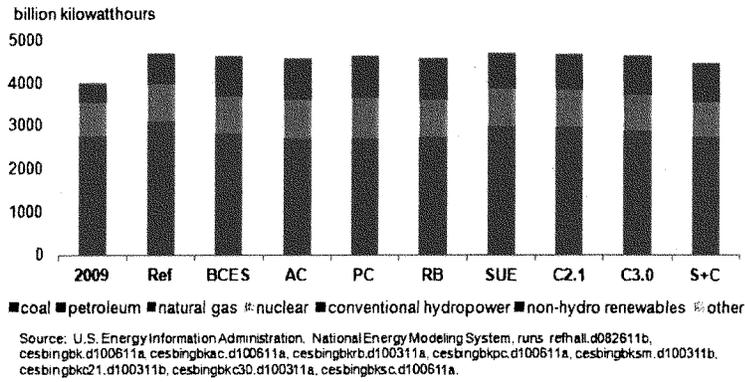


Figure 10: Total Net Electricity Generation in Alternative Cases, 2035

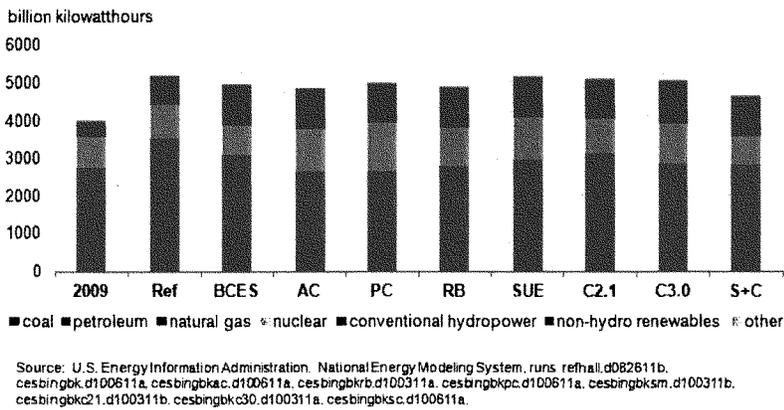
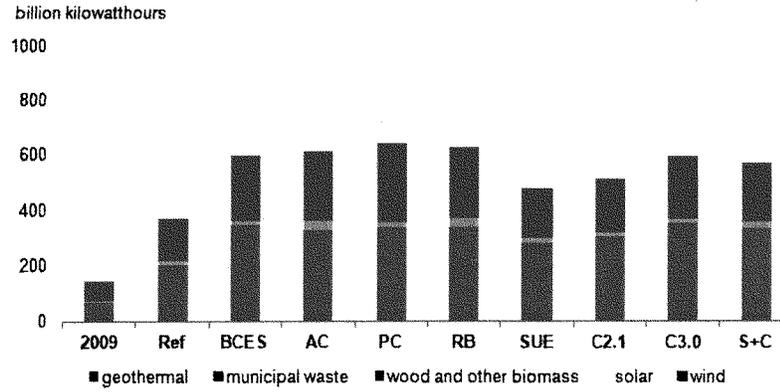
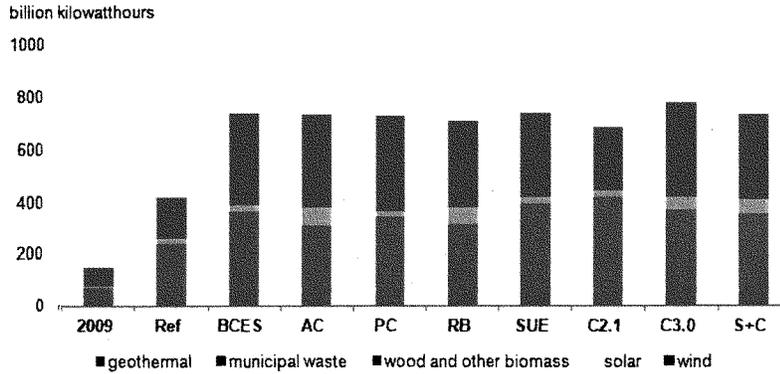


Figure 11. Total Non-hydroelectric Renewable Generation in Alternative Cases, 2025



Source: U.S. Energy Information Administration. National Energy Modeling System, runs refhall.d082611b, cesbingbk.d100611a, cesbingbkac.d100611a, cesbingbkrb.d100311a, cesbingbkpc.d100611a, cesbingbksm.d100311b, cesbingbk21.d100311b, cesbingbk30.d100311a, cesbingbksc.d100611a.

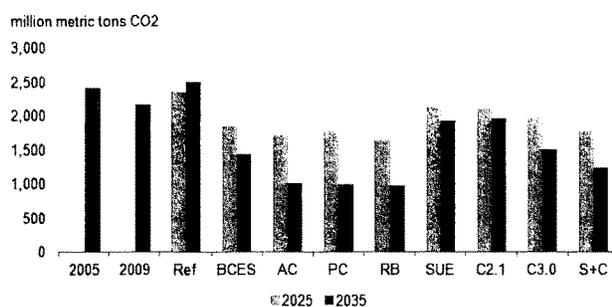
Figure 12. Total Non-hydroelectric Renewable Generation in Alternative Cases, 2035



Source: U.S. Energy Information Administration. National Energy Modeling System, runs refhall.d082611b, cesbingbk.d100611a, cesbingbkac.d100611a, cesbingbkrb.d100311a, cesbingbkpc.d100611a, cesbingbksm.d100311b, cesbingbk21.d100311b, cesbingbk30.d100311a, cesbingbksc.d100611a.

While all alternative cases achieve carbon dioxide emissions reductions in the electric power sector relative to the Reference case, there are significant differences across cases (Figure 13). Trends in emissions directly reflect the generation mix. The cases with the largest emissions reductions, the RB, PC, and AC cases, achieve between 25 percent to 31 percent lower emissions in 2025 than in the Reference case. By 2035, their electricity sector carbon dioxide emissions fall to levels 60 percent to 63 percent below the Reference case, much larger than the 43 percent reduction seen in the BCES case. The larger emissions reductions in these cases occur because of incentives in them to continue operating existing nuclear plants while retiring additional coal plants. The opposite occurs in the SUE, C3.0, and C2.1 cases where the exclusion of small utilities from coverage or the credit price cap reduce the amount of clean energy needed for compliance.

Figure 13. Electric Power Sector Carbon Dioxide Emissions in Alternative Cases, 2025 and 2035



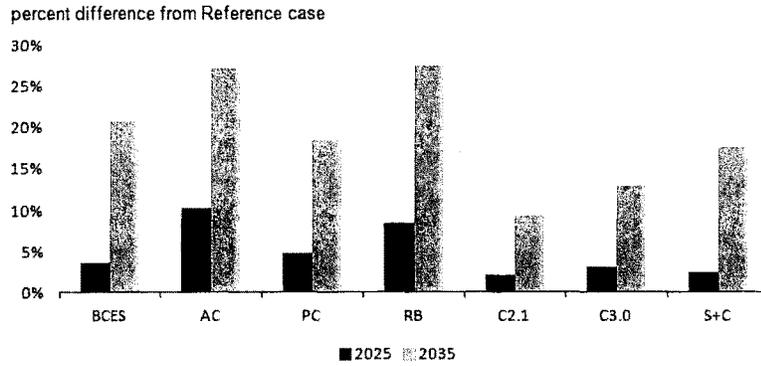
Source: U.S. Energy Information Administration. National Energy Modeling System, runs: refall.d082611b, cesbingok.d100611a, cesbingokac.d100611a, cesbingokrb.d100311a, cesbingokpc.d100611a, cesbingoksm.d100311b, cesbingokc21.d100311b, cesbingokc30.d100311a, cesbingoksc.d100611a.

Each of the alternative cases causes average end-use electricity prices to rise relative to the Reference case by 2035, but there is a wide range of price changes (Figure 14). As in the BCES case, 2025 electricity price increases among the alternative cases are modest. The only case where 2025 electricity prices exceed Reference case prices by more than 10 percent is the AC case, where they are 10.3 percent higher. This occurs because the required credit share is much higher in the AC case, exceeding the credits given to natural gas combined cycle plants by 2018, much earlier than in the other cases. In contrast, the only case shown in Figure 14 to have a 2035 average electricity price that is not at least 10 percent above the Reference case projected price is the Credit Cap 2.1 case. Average 2035 electricity prices among all cases, however, are less than 30 percent higher than Reference case prices in that same year. The two cases with the highest percentage increases in 2035 prices are the Revised Baseline case and the All Clean case, each having prices that are approximately 27 percent higher than the Reference case. The electricity price in the Standards and Codes case does not reflect the higher level of expenditures needed for structures and equipment to meet more stringent codes and standards.

Electricity prices from the SUE case are not displayed in Figure 14, because EIA is not able to disaggregate the price impacts of exempt small utilities from those of larger covered utilities. Average price impacts in this case are subject to misinterpretation given that there is likely to be a considerable divergence in the price impacts on customers of exempt and non-exempt electricity providers. Price impacts in this case will vary depending on how

the value of the credits earned by clean energy generators serving uncovered small utilities flows through to electricity prices. If the credits from these generators generally flow with the electricity to the small utilities they serve, the electricity prices to the customers of the exempt providers could actually fall because of revenue they earn selling the credits to non-exempt providers. However, the degree to which this might occur is uncertain.

Figure 14. Impacts on National Average Electricity Prices in Alternative Cases, 2025 and 2035



Source: U.S. Energy Information Administration. National Energy Modeling System, runs refhall.d082611b, cesbingbk.d100611a, cesbingbkac.d100611a, cesbingbkrb.d100311a, cesbingbkpc.d100611a, cesbingbksm.d100311b, cesbingbk21.d100311b, cesbingbk30.d100311a, cesbingbksc.d100611a.

Regional electricity prices also vary widely across cases (Tables 4 and 5). As with the national prices, the magnitude of the regional price impacts compared to the Reference case depends on the overall stringency of the targets and whether or not the compliance costs are capped. Generally, the largest price increases in percentage terms occur in regions where Reference case prices are relatively low (e.g. NWPP) or where prices are below the national average in regions that are heavily dependent on coal. As in the BCES case, prices in the MROE region decrease across all alternative cases by 2035. The All Clean and Standards and Codes cases cause the greatest number of regions (15 out of 22) to experience price increases of more than 25 percent in 2035. However, as noted in the discussion of the BCES case results, electricity expenditure impacts in the Standards and Codes case are ameliorated by lower levels of electricity use.

Table 4. Regional Average Electricity Prices in Alternative Cases, 2025 (2009 cents/kWh)

Region	2025									
	Ref	BCES	AC	PC	RB	C2.1	C3.0	S+C		
ERCT - ERCOT All	10.4	9.2	9.0	10.9	9.1	9.6	9.0	8.9	10.9	
FRCC - FRCC All	11.6	10.9	12.0	12.7	12.0	12.1	11.3	11.4	12.7	
MROE - MRO East	9.3	7.5	7.0	7.7	6.9	7.3	7.2	7.0	7.7	
MROW - MRO West	7.6	6.8	8.0	7.9	8.1	8.0	7.4	7.4	7.9	
NEWE - NPCC New England	15.7	13.6	12.2	14.6	12.5	13.7	13.3	12.8	14.6	
NYCW - NPCC NYC/Westchester	19.9	16.8	16.7	18.2	16.7	17.4	16.7	16.3	18.2	
NYLI - NPCC Long Island	18.1	16.7	17.4	19.6	17.4	18.6	17.2	17.3	19.6	
NYUP - NPCC Upstate NY	11.6	11.9	11.1	13.2	11.2	12.2	11.8	11.5	13.2	
RFCE - RFC East	12.2	10.7	11.7	12.7	10.8	11.5	10.6	12.0	12.7	
RFCM - RFC Michigan	9.6	8.7	9.0	9.9	9.1	9.3	9.1	8.9	9.9	
RFCW - RFC West	8.6	8.5	8.5	10.1	9.5	9.7	8.9	8.9	10.1	
SRDA - SERC Delta	7.5	7.3	7.2	6.5	7.0	7.1	7.2	7.2	6.5	
SRGW - SERC Gateway	7.8	6.5	6.7	8.3	6.8	7.6	6.5	6.6	8.3	
SRSE - SERC Southeastern	9.1	8.7	8.9	9.0	8.9	8.9	8.9	8.9	9.0	
SRCE - SERC Central	7.8	6.0	7.2	6.7	7.3	7.1	6.8	7.1	6.7	
SRVC - SERC VACAR	8.6	8.1	9.1	8.5	9.2	8.9	8.7	8.8	8.5	
SPNO - SPP North	7.9	7.6	8.9	9.1	8.6	9.0	7.8	8.4	9.1	
SPSO - SPP South	6.9	7.8	8.0	9.1	8.0	8.5	8.1	8.0	9.1	
AZNM - WECC Southwest	9.8	9.5	9.5	9.8	10.0	9.8	9.7	9.6	9.8	
CAMX - WECC California	13.3	14.6	13.1	13.2	13.1	13.2	13.2	13.1	13.2	
NWPP - WECC Northwest	7.0	4.6	5.4	4.7	6.0	5.5	5.6	5.3	4.7	
RMPA - WECC Rockies	8.2	9.0	9.4	11.0	9.9	10.2	9.2	9.3	11.0	
U.S. Average	9.8	9.0	9.4	9.4	9.5	9.7	9.2	9.3	9.4	

BCES/alternative case electricity price is 10-25 percent greater than the Reference case electricity price
 AC/alternative case electricity price is more than 25 percent above the Reference case electricity price
 Source: U.S. Energy Information Administration, National Energy Modeling System, runs refat.d082611b, cesbingbk.d100611a, cesbingbkac.d100611a, cesbingbkrb.d100311a, cesbingbkpc.d100611a, cesbingbkscm.d100311b, cesbingbkpc21.d100311b, cesbingbkpc30.d100311a, cesbingbkpc.c.d100611a.

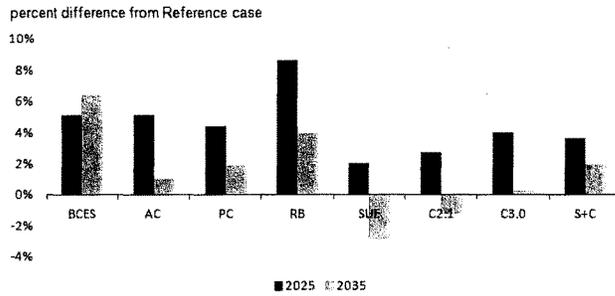
Table 5. Regional Average Electricity Prices in Alternative Cases, 2035 (2009 cents/kWh)

Region	2035									
	Ref	BCES	AC	PC	RB	C2.1	C3.0	S+C		
ERCT - ERCOT All	10.4	10.0	11.6	14.2	11.5	13.0	10.4	10.8	14.2	
FRCC - FRCC All	11.6	11.2	13.6	14.6	13.5	14.3	12.7	13.0	14.6	
MROE - MRO East	9.3	7.3	5.9	4.1	6.2	4.7	6.5	6.3	4.1	
MROW - MRO West	7.6	6.9	8.9	8.0	9.3	9.1	8.6	8.8	8.8	
NEWE - NPCC New England	15.7	13.1	14.3	16.3	13.1	15.5	12.5	12.6	16.3	
NYCW - NPCC NYC/Westchester	19.9	16.9	19.6	21.5	18.9	20.3	17.5	17.9	21.5	
NYLI - NPCC Long Island	18.1	16.6	21.5	24.1	20.4	22.5	18.1	19.1	24.1	
NYUP - NPCC Upstate NY	11.6	12.6	14.4	16.6	13.2	15.4	12.6	12.8	16.6	
RFCE - RFC East	12.2	10.9	12.4	15.7	12.9	14.3	11.3	11.2	15.7	
RFCM - RFC Michigan	9.6	9.0	11.3	10.7	10.6	11.5	10.0	10.4	10.7	
RFCW - RFC West	8.6	9.9	11.0	13.1	11.0	12.6	10.0	10.2	13.1	
SRDA - SERC Delta	7.5	7.5	9.7	7.4	8.2	8.1	8.1	8.6	7.4	
SRGW - SERC Gateway	7.8	7.0	9.6	11.7	9.2	10.6	7.7	8.5	11.7	
SRSE - SERC Southeastern	9.1	8.5	10.3	10.3	10.4	10.6	9.8	10.4	10.9	
SRCE - SERC Central	7.8	6.0	10.2	8.2	9.6	9.4	8.3	8.9	8.2	
SRVC - SERC VACAR	8.6	8.3	11.2	10.1	10.8	10.1	10.0	10.3	10.1	
SPNO - SPP North	7.9	7.5	8.9	10.1	9.0	9.6	8.1	8.7	10.1	
SPSO - SPP South	6.9	8.5	10.4	12.7	9.8	11.0	9.0	9.5	12.7	
AZNM - WECC Southwest	9.8	10.4	11.3	11.5	11.4	11.1	11.2	11.4	11.5	
CAMX - WECC California	13.3	13.2	14.0	13.2	14.0	13.3	13.2	13.5	13.2	
NWPP - WECC Northwest	7.0	5.2	5.4	5.6	7.9	6.2	7.5	7.3	5.6	
RMPA - WECC Rockies	8.2	9.4	11.1	12.6	11.7	12.3	10.4	11.0	12.6	
U.S. Average	9.8	9.4	11.3	11.3	11.1	11.6	10.2	10.6	11.9	

BCES/alternative case electricity price is 10-25 percent greater than the Reference case electricity price
 AC/alternative case electricity price is more than 25 percent above the Reference case electricity price
 Source: U.S. Energy Information Administration, National Energy Modeling System, runs refat.d082611b, cesbingbk.d100611a, cesbingbkac.d100611a, cesbingbkrb.d100311a, cesbingbkpc.d100611a, cesbingbkscm.d100311b, cesbingbkpc21.d100311b, cesbingbkpc30.d100311a, cesbingbkpc.c.d100611a.

Natural gas price impacts are significant early in the projection period, but largely moderate by 2035 (Figure 15). In 2035, price impacts across cases are generally less than 5 percent, when compared to the Reference case. However, impacts on gas prices are generally more significant in the earlier years of the program. By 2025, impacts in three cases, All Clean, Revised Baseline, and Partial Credit, exceed 4 percent, with the Revised Baseline case exceeding 8 percent. Cases with reduced need for clean energy generation – the Small Utility Exemption case, the Standards and Codes case, and the two credit price cap cases – have more modest gas price impacts in the near-term. In 2025, only the Revised Baseline case, where natural gas generation in 2025 significantly exceeds the BCES case level, shows a larger impact on natural gas prices than the BCES case.

Figure 15. Impacts on Delivered Natural Gas Prices in Alternative Cases, 2025 and 2035



Source: U.S. Energy Information Administration. National Energy Modeling System, runs: refnall.d082611b, cesbingbk.d100611a, cesbingbkac.d100611a, cesbingbkbr.d100311a, cesbingbkpc.d100611a, cesbingbksm.d100311b, cesbingbk21.d100311b, cesbingbk30.d100311a, cesbingbksc.d100611a.

Appendix A: Request Letters

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United States Senate

COMMITTEE ON
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 WASHINGTON, DC 20540-5000
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August 16, 2011

Mr. Howard Gruenspecht
 Acting Administrator
 Energy Information Administration
 1000 Independence Ave. SW
 Washington, DC 20585

Dear Mr. Gruenspecht:

Over the past decade, Congress has considered many different legislative proposals to drive the development and deployment of clean generating technologies in the power sector and reduce the greenhouse gases resulting from the generation of electricity. During the current Congress I have focused my attention in this regard on a policy to establish a national Clean Energy Standard (CES) that would require an increasing percentage of electricity to be generated from clean sources. To this end, the Senate Committee on Energy and Natural Resources put forward a white paper seeking public input on the design of a CES. As the next step in the development of a legislative proposal, I am writing to request that you conduct an analysis of the effects of such a national Clean Energy Standard (CES) under a series of different scenarios.

The primary elements of the proposal to analyze should be as follows:

- The entities subject to the CES include all electric service providers that sell electricity to retail consumers. The base against which the clean requirement should be calculated is defined as all electric utility retail sales in a given calendar year.
- The yearly clean energy targets should ramp linearly from the current state of qualifying clean energy generation to an overall target of 80% clean energy in 2035 and holding at 80% indefinitely beyond 2035.
- Full or partial clean energy credits should be awarded to generators with a lower carbon-intensity (as measured on a carbon dioxide equivalency basis) than that of new supercritical coal generation ("new scrubbed coal plant" as defined in Table 8.2 of *Assumptions to the Annual Energy Outlook 2011*, <http://www.era.gov/forecasts/aeo/assumptions/pdf/electricity.pdf>). Zero emissions generation technologies should receive 1 credit for each MWh of retail electricity sold. Fossil generation with a carbon intensity equal to or greater than new supercritical coal should receive zero credits. Partial credits should be awarded to fossil-fuel utilities generating with a lower carbon-intensity than supercritical coal.

- proportional to their improvement over supercritical coal per MWh.
- Clean energy credits may be banked indefinitely.
- Generation from existing nuclear and hydroelectric utilities should be counted towards the overall target, but they should not be awarded credits. That is, the sum of all credited generation and generation from existing nuclear and hydroelectric plants should equal, by 2035, 80 percent of sales. The target for credited generation would therefore be reduced by the generation from existing nuclear and hydroelectric plants.

In addition, please also conduct the seven additional "sensitivity runs" identified below to consider the effects of changing certain important policy variables in the core policy:

Alternate crediting mechanisms

- 1) Award credits to all existing clean generation.
- 2) Deduct generation from existing hydroelectric and nuclear generation plants from the base against which a utility's requirement is calculated.
- 3) Credit technologies as follows.
 - New and updated nuclear generation, new and incremental hydroelectric generation, and renewable generation should receive 1 credit per MWh of retail electricity sold.
 - New and existing Natural Gas Combined Cycle (NGCC) generators should receive 0.5 credits per MWh of retail electricity sold.
 - Coal equipped with carbon capture and storage at greater than 90% capture efficiency should receive 0.9 credits per MWh of retail electricity sold.
 - Natural Gas equipped with carbon capture and storage at greater than 95% capture efficiency should receive 0.95 credits per MWh of retail electricity sold.
 - Existing nuclear and hydroelectric generators should receive 0.1 credits per MWh of retail electricity sold.

Exclusion of small utilities

- 4) Exempt all utilities selling less than 4 million MWh per year from compliance with the standard.

Alternative compliance payments

- 5) Allow compliance alternately to be achieved through a payment that begins at 2.1 cents per kilowatt hour and rises at an inflation-adjusted rate of 5% per year.
- 6) Allow compliance alternately to be achieved through a payment that begins at 5.0 cents per kilowatt hour and rises at an inflation-adjusted rate of 5% per year.

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September 30, 2011

Dr. Howard Gruenspecht
 Acting Administrator and Deputy Administrator
 Energy Information Administration
 1000 Independence Ave. SW
 Washington, DC 20585

Dear Dr. Gruenspecht:

Upon further consideration of the design parameters for a Clean Energy Standard (CES), I would like to modify my original request for modeling dated August 16, 2011 as follows:

Please use the following set of overall targets for clean energy:

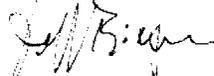
Year of compliance	Overall Clean Energy Target
2015	45%
2020	50%
2025	60%
2030	70%
2035	80%
2040	85%
2045	90%
2050	95%

The overall clean energy targets should be increased linearly between each interim target, and hold constant after 2050.

The overall clean energy target for each of the modeling scenarios I have requested should equal the percentage of the total retail sales generated by clean energy as calculated using the methodology included in the original request. In each scenario the total clean energy required to be generated based on covered sales, plus any non-targeted clean energy (existing nuclear and hydro generation, if applicable), should be equal to the share of all electricity sales indicated in the table above. The sole exception is in model scenario #4, in which utilities with annual sales of less than 4,000,000 MWh are exempt from having a compliance obligation. For scenario #4, the overall clean energy targets should be applied only to the total retail sales from utilities with annual retail sales greater than 4,000,000 MWh.

Thank you for your attention to this request. I ask that my staff be briefed prior to the release of information. Should you or your staff have any questions, please contact Kevin Rennett with the Senate Committee on Energy and Natural Resources at (202) 224-7826.

Sincerely,



Jeff Bingaman
Chairman

Appendix B: Summary Tables

Table B1. The BCES and alternative cases compared to the Reference case, 2025

	2009	2025	2025							
	Ref	Ref	BCES	All Clean	Partial Credit	Revised Baseline	Small Utilities	Credit Cap 2.1	Credit Cap 3.0	Stnds+ Cds
Generation (billion kilowatthours)										
Coal	1,772	2,049	1,431	1,305	1,387	1,180	1,767	1,714	1,571	1,358
Petroleum	41	45	43	44	44	44	45	45	45	43
Natural Gas	931	1,002	1,341	1,342	1,269	1,486	1,164	1,193	1,243	1,314
Nuclear	799	871	859	906	942	889	878	857	843	826
Conventional Hydropower	274	306	322	319	300	321	316	298	312	322
Geothermal	15	25	28	25	31	24	27	22	23	24
Municipal Waste	18	17	17	17	17	17	17	17	17	17
Wood and Other Biomass	38	162	303	289	295	301	241	266	314	296
Solar	3	18	18	33	18	35	18	18	18	21
Wind	71	153	233	251	285	252	179	193	226	216
Other	18	16	16	16	16	16	16	16	16	16
Total Generation	3,981	4,665	4,612	4,547	4,603	4,566	4,669	4,640	4,627	4,452
Capacity (gigawatts)										
Coal	317	323	278	254	275	252	297	298	288	267
Petroleum	116	87	86	85	92	86	88	91	90	83
Natural Gas	351	382	407	400	383	407	395	384	385	391
Nuclear	101	110	109	115	119	112	111	108	106	105
Conventional Hydropower	78	79	83	82	78	82	81	79	80	83
Geothermal	2	3	4	3	4	3	4	3	3	3
Municipal Waste	4	4	4	4	4	4	4	4	4	4
Wood and Other Biomass	7	17	17	17	17	17	17	17	17	17
Solar	2	11	11	17	11	18	11	11	11	12
Wind	32	53	77	86	97	86	61	67	78	75
Other (including pumped storage)	24	25	25	25	25	25	25	25	25	25
Total	1,033	1,095	1,101	1,089	1,106	1,093	1,094	1,087	1,087	1,065

150

Table B1. The BCES and alternative cases compared to the Reference case, 2025 (cont)

	2009		2025		2025						
	Ref	Ref	BCES	All Clean	Partial Credit	Revised Baseline	Small Utilities	Credit Cap 2.1	Credit Cap 3.0	Stnds + Cds	
Prices (2009 cents/kWh)											
Credit Price	0.0	0.0	6.1	6.4	5.9	8.3	2.9	3.4	4.9	6.0	
Electricity Price	9.8	9.0	9.4	10.0	9.5	9.8	8.9	9.2	9.3	9.3	
Residential	11.5	10.7	11.2	11.7	11.3	11.5	10.7	11.0	11.1	11.2	
Commercial	10.1	9.3	9.5	10.2	9.7	10.0	9.1	9.4	9.5	9.4	
Industrial	6.8	6.3	6.5	7.0	6.6	6.9	6.2	6.4	6.5	6.4	
Average Delivered Natural Gas Price (2009 dollars/Mcf)	7.5	8.1	8.5	8.5	8.4	8.7	8.2	8.3	8.4	8.3	
Expenditures (billion 2009 dollars)											
Total Electricity Expenditures	350	373	383	399	387	396	370	379	382	365	
Residential Electricity Expenditures	156	157	161	167	162	165	156	159	160	152	
Household Electricity Expenditures (2009 Dollars/Household)	1,379	1,162	1,198	1,237	1,205	1,227	1,158	1,181	1,189	1,124	
Natural Gas Expenditures	156	187	211	212	209	227	197	201	206	206	
Electricity Sector Natural Gas Expenditures	34	39	59	57	57	70	48	51	54	57	
Non-Electricity Sector Natural Gas Expenditures	122	148	153	155	152	158	149	151	152	149	
CES Compliance											
Credits Required (percent of sales)			31	59	35	34	25	25	28	0	
Credits Achieved (percent of sales)			33	60	36	34	25	25	34	0	
Generation Achieved (percent of sales)			44	72	71	49	35	36	40	0	
Total Electricity Sales (billion kilowatthours) ¹	3,556	4,105	4,073	3,981	4,065	4,022	4,128	4,089	4,080	3,924	
Emissions											
Sulfur Dioxide (short tons)	5.7	4.1	3.4	3.3	3.2	3.3	3.8	3.3	3.2	3.0	
Nitrogen Oxide (short tons)	2.0	2.0	1.8	1.7	1.7	1.5	1.9	2.0	1.9	1.7	
Mercury (short tons)	40.7	29.1	19.4	17.6	18.3	15.9	24.4	23.4	21.1	18.1	
Carbon Dioxide (million metric tons CO ₂)	2,160	2,345	1,840	1,704	1,762	1,623	2,118	2,082	1,955	1,762	
Macroeconomic											
GDP (billion 2005 dollars)	12,881	20,012	19,963	19,947	19,951	19,947	19,994	19,990	19,983	19,942	
Per Capita GDP (thousand 2005 dollars/person)	42	56	56	56	56	56	56	56	56	56	
Employment, Non-Farm (million)	131	156	156	156	156	156	156	156	156	156	
Employment, Manufacturing (million)	12	16	16	16	16	16	16	16	16	16	

¹ Excludes sales in Alaska and Hawaii

Source: U.S. Energy Information Administration, National Energy Modeling System, runs rehalf.d082611b, cesbingbk.d100611a, cesbingbk.c.d100611a, cesbingbrb.d2100311a, cesbingkpc.d100611a, cesbingksm.d100311b, cesbingk21.d100311b, cesbingk30.d100311a, cesbingksc.d100611a.

Table B2. The BCES and alternative cases compared to the Reference case, 2035

	2009	2035	2035							
	Ref	Ref	BCES	All Clean	Partial Credit	Revised Baseline	Small Utilities	Credit Cap 2.1	Credit Cap 3.0	Stnds + Cds
Generation (billion kilowatthours)										
Coal	1,772	2,184	1,044	747	936	737	1,629	1,619	1,212	983
Petroleum	41	47	43	43	43	44	45	44	43	42
Natural Gas	931	1,293	1,980	1,840	1,658	2,007	1,277	1,432	1,582	1,778
Nuclear	799	868	783	1,114	1,269	999	1,105	932	1,048	748
Conventional Hydropower	274	314	312	319	300	323	322	322	329	321
Geothermal	15	42	49	51	55	50	53	50	51	52
Municipal Waste	18	17	17	17	17	17	17	17	17	17
Wood and Other Biomass	38	181	295	243	271	245	323	350	301	285
Solar	3	21	24	65	22	66	23	25	47	53
Wind	71	159	351	355	363	327	319	241	360	325
Other	18	16	16	16	16	16	16	16	16	16
Total Generation	3,981	5,142	4,916	4,811	4,950	4,831	5,131	5,049	5,007	4,620
Capacity (gigawatts)										
				1						
Coal	317	330	260	249	269	249	304	305	290	243
Petroleum	116	87	83	83	86	83	84	86	82	81
Natural Gas	351	455	496	458	448	483	443	455	470	450
Nuclear	101	110	155	142	163	127	141	118	138	138
Conventional Hydropower	78	81	83	82	78	83	83	83	84	83
Geothermal	2	6	6	7	7	7	7	7	7	7
Municipal Waste	4	4	4	4	4	4	4	4	4	4
Wood and Other Biomass	7	20	20	20	20	20	20	20	20	20
Solar	2	13	14	33	13	33	13	14	24	26
Wind	32	55	116	120	123	109	105	81	119	108
Other (including pumped storage)	24	25	25	25	25	25	25	25	25	25
Total	1,033	1,185	1,263	1,222	1,236	1,221	1,228	1,198	1,262	1,185

152

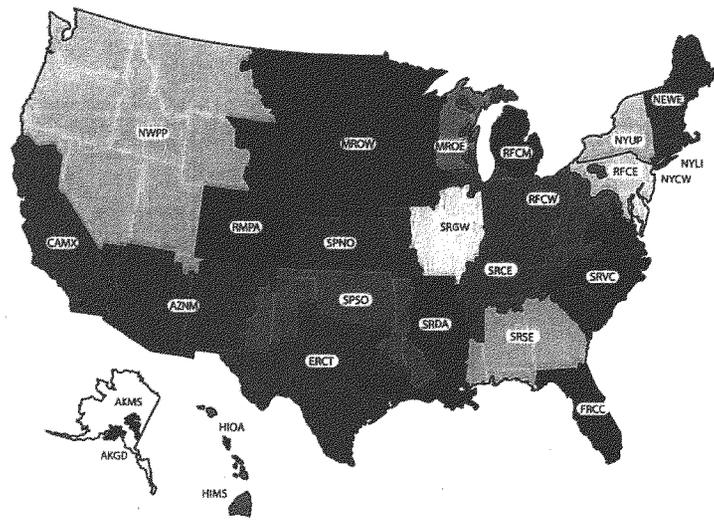
Table B2. The BCES and alternative cases compared to the Reference case, 2035 (cont)

	2009	2035		2035						
	Ref	Ref	BCES	All Clean	Partial Credit	Revised Baseline	Small Utilities	Credit Cap 2.1	Credit Cap 3.0	Stnds + Cds
Prices (2009 cents/kWh)										
Credit Price	0.0	0.0	11.6	11.4	9.9	13.7	4.7	5.6	8.0	10.6
Electricity Price	9.8	9.4	11.3	11.9	11.1	12.0	9.5	10.2	10.6	11.0
Residential	11.5	10.9	13.0	13.5	12.8	13.5	11.2	11.9	12.3	13.0
Commercial	10.1	9.4	11.4	12.0	11.2	12.1	9.5	10.3	10.6	11.0
Industrial	6.8	6.5	8.2	8.7	8.0	8.8	6.6	7.3	7.6	8.0
Average Delivered Natural Gas Price (2009 dollars/Mcf)	7.5	9.2	9.7	9.3	9.3	9.5	8.9	9.1	9.2	9.3
Expenditures (billion 2009 dollars)										
Total Electricity Expenditures	350	417	480	490	471	498	423	445	456	436
Residential Electricity Expenditures	156	176	201	205	197	207	179	187	192	176
Household Electricity Expenditures (2009 Dollars/Household)	1,379	1,196	1,366	1,398	1,342	1,409	1,217	1,276	1,307	1,198
Natural Gas Expenditures	156	227	279	261	256	277	217	230	241	253
Electricity Sector Natural Gas Expenditures	34	55	97	80	79	94	52	59	67	84
Non-Electricity Sector Natural Gas Expenditures	122	171	182	180	176	183	165	171	174	169
CES Compliance										
Credits Required (percent of sales)			56	80	58	74	42	56	56	56
Credits Achieved (percent of sales)			55	77	58	52	35	32	44	55
Generation Achieved (percent of sales)			72	92	93	70	45	43	56	70
Total Electricity Sales (billion kilowatthours) ¹	3,556	4,428	4,220	4,085	4,225	4,136	4,435	4,328	4,282	3,938
Emissions										
Sulfur Dioxide (short tons)	5.7	3.7	2.7	1.7	2.5	1.6	3.5	3.6	3.3	2.8
Nitrogen Oxide (short tons)	2.0	2.0	1.4	1.0	1.1	0.9	1.8	1.9	1.5	1.3
Mercury (short tons)	40.7	29.2	14.5	11.1	13.5	11.4	21.4	22.2	16.1	13.7
Carbon Dioxide (million metric tons CO ₂)	2,160	2,500	1,428	1,008	986	962	1,921	1,950	1,491	1,235
Macroeconomic										
GDP (billion 2005 dollars)	12,881	25,686	25,562	25,528	25,563	25,610	25,641	25,650	25,606	25,472
Per Capita GDP (thousand 2005 dollars/person)	42	66	66	65	66	66	66	66	66	65
Employment, Non-Farm (million)	131	171	171	171	171	171	171	171	171	171
Employment, Manufacturing (million)	12	13	13	13	13	13	13	13	13	13

¹ Excludes sales in Alaska and Hawaii

Source: U.S. Energy Information Administration, National Energy Modeling System, runs rehall.d082611b, cesbingk.d100611a, cesbingkac.d100611a, cesbingkbr.d2100311a, cesbingkbc.d100611a, cesbingkbs.d100311b, cesbingkcc.d100311b, cesbingkcd.d100311a, cesbingkcs.d100611a.

Appendix C: Map of NEMS Electricity Market Module Regions



154

M. Rohabani

