Statement of Dr. Ernest Moniz
Secretary of Energy
to the
Committee on Appropriations
United States Senate
on
Driving Innovation through Federal Investments
April 29, 2014

Chairwoman Mikulski, Ranking Member Shelby, and Members of the Committee, I am pleased to be here to discuss the value of Federal investments in research and development.

As the Secretary of Energy, I have the honor of leading one of the Nation's premier agencies for scientific discovery and applied research and development. The mission of the Department of Energy (DOE) is to ensure America's security and prosperity by addressing energy, environmental, and nuclear security challenges through transformative science and technology solutions.

As such, I am happy to be here to address the role that Federal investments at the DOE have in driving innovation, economic growth, and national security in the United States.

The Department of Energy's origin traces back to the unprecedented science and technology challenges of the Manhattan Project. After the Second World War, the Atomic Energy Commission (AEC) continued to provide security through science and technology, supporting the nuclear deterrent through activities such as weapons development and production and through Admiral Rickover's work in creating the nuclear-powered Navy. Building on its scientific and technical expertise, the AEC also played a key role in enabling the Nation's nuclear power industry, which today provides nearly 20 percent of our electricity and produces no carbon emissions.

Following the 1973 oil embargo, energy became a security focus and the AEC was supplemented by numerous Federal energy offices to form the Energy Research and Development Administration and then, in 1977, the Department of Energy. The Department remains a leading force in driving the Nation's scientific and technological innovation enterprise. The Nation's need for this source of innovation remains vital and urgent today for our economic growth, energy security, environmental stewardship, and national security; an enduring Federal role is imperative to ensure our Nation's continued leadership on the world stage.

I will provide some examples of how DOE-sponsored research in basic scientific discovery, applied research, and development has benefited the Nation—through new technologies and sometimes entirely new industries, as well as education of the next generation of scientists and engineers.

Supercomputing

The supercomputer began as an instrument of science but has become a powerful enabling tool of industry and a force for economic growth.

Today more than half (265) of the world's fastest 500 computers—as well as five of the top ten—are located in the United States. This is no accident. It is a direct result of federal investments in supercomputing for science and national security—an investment stewarded at DOE by the Office of Science and the National Nuclear Security Administration (NNSA). The Department's investments in supercomputing have helped establish several high-end American computer manufacturers as the market leaders in the world today.

Rooted initially in pursuing the development of nuclear weapons during the Cold War, the use of supercomputing is fundamental to DOE's scientific research and is the cornerstone of the Nation's Stockpile Stewardship Program. In the absence of testing our nuclear arsenal, we are now able to use a combination of supercomputer-driven modeling and simulation, expert judgment, and validated subcritical and small scale experiments to maintain confidence in our nuclear stockpile without underground testing—a scientific achievement with direct impact on our national security.

By enabling scientists and engineers to conceptualize and test new hypotheses and engineered systems through computational models, DOE advances in supercomputing touch many facets of our lives, from transportation to design and development of materials to development of new, life-saving pharmaceuticals.

In the early 1950s, there was a tremendous growth in the capability of computing machines. John von Neumann, father of scientific computing, recognized that the growth in computing capability needed to be complemented by an investment in the underlying mathematics. Perhaps the most significant achievement of the early AEC applied mathematics program was the development of computational fluid dynamics, especially in the areas of computational hydrodynamics and shock physics. Today, computational fluid dynamics is an important tool for simulation science. Computational modeling and simulation has dramatically furthered our ability to shed light on the functioning of Earth's climate, understand fusion plasmas, explore oil deposits, design airplanes without costly wind tunnels, model blood flow to understand cardiovascular diseases, and ensure safe operation of nuclear reactors, to name a few.

The quest for alternative energy sources in the mid-1970s led to a robust DOE Magnetic Fusion Energy program to simulate the behavior of plasma in a fusion reactor, which required a computer center dedicated to this purpose. The idea that interactive scientific computing could be provided to a national community from a central facility was revolutionary at the time. In 1974 the Controlled Thermonuclear Research Computer Center was founded at Lawrence Livermore National Laboratory as the Nation's first unclassified supercomputer center. It was the model for those that followed, including today's National Energy Research Scientific Computing Center (NERSC) at Lawrence Berkeley National Laboratory.

Building on work in the 1980s on the opportunities presented by parallel computing, DOE's computer science program began research in the 1990s that laid the groundwork for software tools that today are widespread in scientific supercomputing. In 1996, a DOE computer (ASCI Red at Sandia National Laboratory) achieved the first sustained teraFLOPS performance (10^{12} floating-point operations per second) for use in supporting the NNSA Stockpile Stewardship Program. In the mid 2000s, the DOE Office of Science began pushing the boundaries of these advanced computers and today operates Titan at Oak Ridge National Laboratory (27 petaFLOPS – 10^{15} floating-point operations per second) and Mira at Argonne National Laboratory (10 petaFLOPS), which is a sister machine to Sequoia at Lawrence Livermore (20 petaFLOPS).

Today, the leadership-class computers at Oak Ridge and Argonne are unique national facilities and, as with other DOE user facilities, they are open to all researchers, regardless of institutional affiliation, through the Innovative and Novel Computational Impact on Theory and Experiment program, established in 2004.

After an upgrade to 2.3 petaflops in 2009, researchers used Jaguar at Oak Ridge to simulate a magnitude-8 earthquake to assess its impact on the Southern California region; construct extremely reliable simulations of a coal gasifier to develop zero-emissions power plants; and to create detailed models to explain how climate reacts to atmospheric increases in aerosols from volcanic eruptions.

Industry has used the Oak Ridge and Argonne computers to understand how ice forms to improve adoption of wind energy in cold climates by reducing turbine downtime; to develop and test a new, efficient and automatic analytical cooling package process to optimize the design of under-the-hood cooling systems in automobiles; simulate takeoff and landing scenarios to improve software that estimates the characteristics of commercial aircraft including lift, drag and controllability; to model and develop high-efficiency, advanced combustion natural gas engines and technologies for power generation; and undertake molecular dynamic studies to understand the chemical processes that can limit product shelf life of consumer products.

As another example, Sandia's scientific modeling and analysis capabilities helped NASA determine the space shuttle Columbia disaster was caused by foam debris shed from the fuel tank that impacted the orbiter wing during launch.

And the next generation of computers, as we move toward capable exascale systems, promises new capabilities for the computerized design of new materials, ever more accurate and predictive modeling of climate, the 3-D modeling of nuclear reactors, and more effective modeling of combustion, to name just a few possible applications.

The key promise of capable exascale lies in the ability to construct models that match reality in ever great detail, and that are therefore more accurate and predictive. For example, we have been using experiments and computers to model combustion for decades with the goal of improving efficiency and reducing pollution. Today's system can model hydrocarbon combustion in fairly simple geometries, but we still can't accurately model more complex fuels and geometries such as biofuels in jet engines. The Department studies many complex systems which could benefit from predicting long-term behavior—such as the electricity grid, advanced reactor designs, materials under extreme conditions, new energy storage devices, and the reactive transport of contaminants in groundwater.

According to the November 2013 Top 500 list of the most powerful supercomputers in the world, the United States has five machines in the top ten. Titan at Oak Ridge is number two at 27 petaflops. China's 54 petaflop Tianhe-2 tops the list. Through a strong and sustained Federal commitment to the most advanced and capable computing systems we can keep up with and stay ahead of other Nations in this critical area.

User Facilities

DOE operates a nationwide system of 17 national laboratories that provides world-class scientific, technological, and engineering capabilities, including the operation of 30 national scientific user facilities used by over 29,000 researchers from academia, government, and industry. Many of these facilities are focused on foundational technologies like particle accelerators, x-ray light sources, and neutron scattering sources.

Particle Accelerators

Some of the earliest research supported by DOE focused on the development of particle accelerators and their application to nuclear and high-energy physics.

Over the decades, DOE has provided the strong support for U.S. high energy and nuclear physics. It was DOE-supported particle accelerators—the tools of particle physicists—that made possible the discovery of multiple fundamental particles, filling out the so-called Standard

Model of particle physics. Later these accelerators proved to have widespread and unexpected applications beyond fundamental science, such as in the manufacture of semiconductors and medical isotopes.

Particle accelerators at DOE National Laboratories, including the Stanford Linear Accelerator Center, Brookhaven National Laboratory, and later Fermilab were the source of these discoveries, which led to a series of Nobel Prizes in Physics, including those in 1976, 1980, 1988 1990, and 1995. The basic understanding of matter embodied in the Standard Model has provided the essential underpinning, in turn, for countless other advances in both science and technology.

The range of fundamental discoveries that DOE science has supported over the decades is breathtaking, and major discoveries have continued into recent times. For example, in 2005, scientists at Brookhaven's Relativistic Heavy Ion Collider observed a new state of matter, not seen since the earliest moments of the universe, a quark-gluon plasma which proved to be a "perfect liquid," with near-zero viscosity. Study of this perfect liquid is deepening our understanding of the cosmos and of the nature of matter.

These discoveries have revolutionized our understanding of the universe and provided us with new insights both to understand and to improve our world.

But equally important, the quest for discovery has had as its byproduct the creation of wholly new tools and technologies that have had a major impact on our economy and revolutionized our quality of life. It has sometimes been said of the economy that a rising tide lifts all boats. Something similar can be said of research in basic science. The advance of science—even the most fundamental science—inevitably drives the advance of technology and in this way continuously powers our economy and improves our quality of life.

For example, the manufacture of semiconductors—the building block material of our electronic age—makes heavy use of small particle accelerators developed on the coattails of DOE research accelerators. . In addition, many major hospitals have at least one particle accelerator, since accelerators are also widely used in treatment of cancers. And particle accelerators are essential for the creation of key isotopes widely used in modern medicine for imaging and diagnosis.

Indeed, our Office of Nuclear Physics sponsors the manufacture of needed isotopes in short supply—some of them vital for medical diagnosis and treatment—that are not available commercially. To produce these isotopes, researchers use particle accelerators, reactor capabilities and/or processing facilities at Los Alamos, Brookhaven, Oak Ridge, and Idaho National Laboratories. For example, Strontium-82 is a source of rubidium-82, which is used in Positron Emission Tomography—or PET—Scans for cardiac imaging. Production of Strontium-82 was developed at Brookhaven and Los Alamos and has led to wide availability of PET for cardiac imaging, and the Strontium-82 technique constitutes a revolutionary improvement over previous methods of cardiac imaging.

Brookhaven also played a key role the early development of PET technology and in using PET scans for brain imaging. In partnership with researchers from the University of Pennsylvania and NIH, it was Brookhaven scientists who in 1976 developed the very first radioactive “tag”—a molecule known as ^{18}FDG—used in PET Scans. This opened the way for the first studies mapping the activity of the human brain. ^{18}FDG has also been widely used across the world for diagnosis of cancers.

Another example: the recent discovery by Brookhaven and Los Alamos of a new method for producing the isotope Actinium-225 is expected to lead to a major increase in the supply of this alpha-emitting isotope, which shows great promise for treatments of cancer that attack tumors without injuring healthy tissue. Thanks to the new method of production, there will soon be sufficient supply of the isotope for clinical trials.

Particle accelerators are widely used in industry for a range of applications. Particle accelerators can be used to determine the structural integrity of materials. Cereal boxes, juice boxes, salad bags and other items found in the supermarket often include inks and coatings that have been cured with particle accelerators. It is estimated that there are some 30,000 particle accelerators operating worldwide, in both industry and medicine.

Ground was recently broken on a new DOE-funded Facility for Rare Isotope Beams (FRIB) at Michigan State University’s National Superconducting Cyclotron Laboratory. FRIB will provide world-leading capabilities for short-lived radioactive beams; it is a next generation machine that will advance understanding of rare nuclear isotopes and their evolution.

Synchrotron X-Ray Light Sources

Particle accelerators have had a far-reaching impact not just on nuclear and high-energy physics, and on medicine and industry, but also on chemistry, biology, materials science, condensed matter physics, and a range of other scientific disciplines.

That is because a major spin-off of particle accelerators has been synchrotron x-ray light sources. These large facilities use electron accelerators to produce beams of x-ray light that are millions of times brighter and many times more focused than x-rays in a typical doctor’s office. These x-rays permit us to “see” structures at the atomic and molecular level and—in the case of the Linac Coherent Light Source at SLAC—even take “snapshots” of chemical reactions in real time. They are now the premier tools for studying matter at the atomic and molecular scales and are providing major new insights that are enabling us to create new materials, develop more effective batteries, and even find new cures for disease. A number of major pharmaceutical companies operate beamlines at the DOE light sources, using them as a key tool to image proteins and develop new drugs. Roger Kornberg of Stanford University, the 2006 Nobel Prize winner in Chemistry, has stated: “I believe the whole future of drug development lies in synchrotrons.” Kornberg received one of four Nobel Prizes in Chemistry since 2003—including prizes in 2003, 2006, 2009, and 2012—that relied on use of DOE’s x-ray light sources as an indispensable tool of discovery. Because of the diverse breakthroughs applicable to industry and medicine that these tools can enable, x-ray light sources have become an area where nations are competing for pre-eminence. To name just a few of the many breakthroughs attributable to x-ray light sources:

- Researchers from a major auto firm used sophisticated scientific experiments at the Brookhaven’s National Synchrotron Light Source (NSLS) to optimize the chemistry of layered cathode materials to produce an advanced lithium battery with high capacity, long cycle life, and better safety for hybrid and electric vehicle applications.
- Industry researchers used the NSLS and the Advanced Photon Source (APS) at Argonne to understand in detail the internal chemistry of an actual commercial battery while charging and discharging in real time. The result was the development of a new sodium metal halide battery and the construction of a factory that will support more than 300 new jobs.
- A drug firm used unique and complementary capabilities at the Stanford Synchrotron Light Source (SSRL) at SLAC, APS, and the Advanced Light Source (ALS) at Lawrence Berkeley National Laboratory to determine the precise structure of a mutated protein involved in a particularly deadly form of skin cancer and identify potential drug candidates that could stop its spread. The drug proved extremely successful in clinical trials and was approved by the FDA in 2011.
- Researchers from another pharmaceutical firm obtain insights on the function of potential drugs by examining protein structural information using APS beamline data.
- Cement is a widely used building material, but little is known about the nanoscale properties of the “glue” that holds concrete structures together. Studies at the Lawrence Berkeley National Laboratory’s x-ray light source have confirmed a highly ordered arrangement of 3.5-nanometer crystals within calcium silicate hydrate as the most important binding agent in cement. More detailed structural information can result in stronger cement formulations, potentially saving hundreds of millions of dollars in infrastructure maintenance and repair costs.

Neutron Scattering Sources

In addition to x-ray light sources, the Department has also invested in neutron scattering sources. While these sources are useful for examining the structure and property of materials and studying the fundamental properties of the neutron, they also have applications in a broad range of basic and applied scientific disciplines as well as in the private sector. For example, at Oak Ridge National Laboratory, we have the Spallation Neutron Source, the world's most powerful pulsed neutron scattering equipment. This facility is helping us to look inside and better understand the properties of the advanced materials needed to harness and store energy from solar to wind to biomass.

This technology has been essential to the development of many of today's cutting edge clean energy technologies. For example:

- Data from the neutron scattering of shale pores is being used to develop better methods of detecting natural gas for hydraulic fracking.
- The Spallation Neutron Source has been used to study the transport of lithium ions to develop higher-power, longer-lasting batteries.
- The facility has been used to map the residual stress points in engines to improve reliability of diesel components.

In fact, the Spallation Neutron Source has been so successful that one American company has licensed two neutron scintillator technologies developed at Oak Ridge for sale on the global market. Last year alone, more than 720 total users from universities, national laboratories, and private firms took advantage of the Spallation Neutron Source.

Applied Energy Technology R&D

Of course, in addition to pursuing research into basic science and foundational platforms that support scientific discovery across many disciplines, the Department also has a long history of pursuing research and development projects to advance America's energy landscape. The Department pursues its energy technology mission in partnership with universities and the private sector through competitive, merit-reviewed grants and cooperative agreements, as well as through the DOE national laboratories, which provide value to the American taxpayers through a variety of avenues in addition to our user facilities. These efforts have been crucial to the development of technologies from wind-turbines—to lithium ion batteries—to today's solar energy technologies.

To date, third-party evaluators have completed five evaluations covering DOE's research and development investments in solar photovoltaics, wind energy, geothermal technologies, advanced battery technologies for electric-drive vehicles, and vehicle combustion engines. The results of these evaluations found that, from 1976 to 2008, taxpayer investments of $15 billion in these five areas resulted in an estimated economic benefit to the United States of $388 billion—a net return on investment of more than 24 to 1. To elaborate on one specific example, from 1976 to 2008, EERE-supported combustion engine research investments of $931 million—backed by Congress—yielded a total benefit of $70.2 billion,[1] representing a return on investment of approximately 70 to 1 to the U.S. taxpayer.

Competitive Solar Generation

For an example, I will highlight one highly productive collaboration between our National Renewable Energy Laboratory (NREL) in Colorado and a thin-film solar company. As part of a broader effort to develop thin film solar panels and manufacturing technology, this partnership resulted in the company's Ohio factory being able to produce solar modules at a rate of one per minute. This breakthrough has let the company grow from a startup company to become the world's largest manufacturer of thin-film solar modules. In fact, in 2013, they announced that they installed more than 1 gigawatt of solar modules.

And the Department's success in pursuing advanced solar technologies goes beyond our experience with this one company. Since DOE launched our SunShot Incubator program in 2007, $104 million in government funds have leveraged more than $1.8 billion in venture capital and private equity investment—an $18 return for every $1 of federal support.

As just one example, one company that this program supported used the funding to increase the conversion efficiency of its cells from 14 percent to 19 percent increasing electricity output per square foot by over one-third. In fact the company was so successful it was eventually purchased by a major American company, which is continuing to develop the technology.

Our ARPA-E program is also focusing on solar technologies, though from a more high-risk, high-reward approach. ARPA-E supports research projects that could create the foundation for entirely new technological approaches or industries but are too early in their development for private sector investment.

Earlier this year, I announced $30 million in ARPA-E funding to 12 projects across the United States through the "FOCUS" program. FOCUS is working to develop new hybrid solar energy converters and thermal energy storage systems that can deliver low-cost, high-efficiency solar

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[1] U.S. DOE, "Retrospective Benefit-Cost Evaluation of U.S DOE Vehicle Combustion R&D Investments: Impacts of a Cluster of Energy Technologies," May 2010. Value in undiscounted, inflation-adjusted 2008 dollars.

energy. If successful, this means that solar energy from these hybrid systems would be readily available in homes across America—even when the sun isn't shining.

ARPA-E has also supported several technologies that could be used with solar modules, including power conversion devices.

One ARPA-E funding recipient is working with the military to develop a low-cost, energy-dense storage system that could store enough energy to operate a military base for 72 hours in the event of a disruption. They are currently building a micro-grid at the Marine Corps' base in Miramar, California that will use solar power during the day and store it at night in a battery system.

Other ARPA-E innovations

ARPA-E has also been involved in other technologies besides solar. Our ARPA-E program takes a more direct approach to commercialization than our traditional applied energy programs. From day one of a project, they work with awardees to pair each project with a tech-to-market advisor. And just as awardees have to meet technical milestones, they also create tech-to-market milestones to ensure a smooth commercialization process.

Since ARPA-E's first projects were funded in 2009, we have seen some exciting breakthroughs. ARPA-E funded companies and research teams have successfully engineered microbes that use carbon dioxide and hydrogen to make a fuel precursor for cars, developed a one megawatt silicon carbide transistor the size of a fingernail and produced a new hardware device that regulates the flow of power on the electrical grid.

From the program's inception, demand for ARPA-E funding has been very strong. In its first funding opportunity announcement (FOA) in 2009, ARPA-E received 3,685 concept papers, 338 full applications, from which 37 awards were announced, a pattern which was repeated with a similarly over-subscribed second FOA in 2012. And the marketplace is clearly interested in the ARPA-E model too. In just a few short years, 22 ARPA-E projects have attracted more than $625 million in private-sector follow-on funding after ARPA-E's investment of approximately $95 million.

Advanced Manufacturing

The Department is also playing a role in developing advanced manufacturing technologies in the United States. Oak Ridge's 3D printing center is just one example of the Department of Energy's efforts. This center is enabling companies to produce custom titanium medical implants. And the lab is working with a company based in Phoenix to print the entire body of a car in carbon fiber.

DOE is also supporting the development and implementation of advanced manufacturing technologies through Clean Energy Manufacturing Innovation Institutes. These institutes are consistent with the President's vision for a larger multi-agency National Network for Manufacturing Innovation. In addition, DOE contributed to a DOD-led pilot institute based in Youngstown, Ohio, which is also focused on 3D printing. This center is a joint initiative with the Department of Defense.

In January, I was very pleased to travel to North Carolina State University with President Obama to announce the first DOE Clean Energy Manufacturing Innovation Institute, focused on wide bandgap semiconductors for the next generation of energy-efficient, high-power electronic chips and devices. These devices will be faster, smaller, and more efficient in clean energy applications ranging from electric vehicles and industrial motors, to laptop power adaptors and inverters that connect solar panels and wind turbines to the electric grid.

In addition, DOE has launched a $70 million competition for a new Manufacturing Innovation Institute focused on manufacturing advanced composites. The Department's FY 2015 budget request will support the creation and forward funding of at least one additional manufacturing institute.

Shale Gas Revolution

In the 1970s, fears of dwindling domestic natural gas supplies spurred industry to partner with DOE to examine alternative sources of natural gas in unconventional reservoirs. The United States had vast resources of natural gas embedded within deep-underground shale rock formations but technologies did not exist that would allow us to extract them economically. As a result, DOE's Labs—including the National Energy Technology Laboratory (NETL) and Sandia National Laboratory—helped industry catalyze the development of key technology drivers for shale gas production, spurring innovative advances in horizontal drilling, drill bit technology, hydraulic fracturing, and other technologies that made hundreds of trillions of cubic feet of shale gas recoverable. Over a 16-year period, DOE and industry collaboratively carried out research that accelerated the development of technologies now being applied to shale gas reservoirs, including characterization of the shale gas resource in the Appalachian states and elsewhere, multi-stage hydraulic fracturing of horizontal wells, wireless telemetry for improved horizontal drilling, and micro-seismic fracture mapping during well stimulation.

The Federally-funded research and development during the 1970s and 1980s contributed directly to the private sector investments that have transformed the Nation's oil and gas industry. Since the development of these resources began nearly 150 years ago, more than 4 million oil- and gas-related wells have been drilled in the United States. At least 2 million of these have been hydraulically fracture-treated and up to 95 percent of wells drilled today are hydraulically fractured using technologies developed with industry under the Department's collaborative research programs.

The Department continues to work in a multi-agency collaborative to ensure that the development and supply of natural gas is carried out in a manner that is environmentally sound and protective of human health and safety. We are producing more natural gas in the United States than ever before which is helping to increase our economic competiveness and significantly reduce our carbon emissions. Of the natural gas consumed in the United States in 2011, about 95 percent was produced domestically. The Energy Information Administration (EIA-an independent statistical arm of DOE) predicts U.S. natural gas production will increase by 44 percent from 2011 to 2040, growth that will be almost 100 percent attributable to shale gas production.

Advanced Emissions Controls

Another fossil fuel-oriented, DOE-derived suite of technologies that has achieved widespread market penetration is the advanced emissions controls that have directly led to significant reductions of mercury, sulfur dioxide, nitrogen oxide, and particulate matter from the Nation's fleet of coal-fired power plants.

From the early 1980s through the end of 2010, DOE and NETL worked on researching, developing and demonstrating these technologies collaboratively with industry, academia, and other research organizations. DOE's early research brought forward a suite of cost-effective advanced pollution control systems to address acid rain, including wet scrubbers, low-NOx burners, selective catalytic reduction, and fabric filters. NETL's more recent efforts focused on the development and, ultimately, the commercialization of technologies such as activated carbon, sorbent injection, oxidation additives, and scrubber enhancements for controlling emissions of mercury and other air toxics from coal-based power systems. As an example of one of several programs working to improve emissions controls, within DOE's Fossil Energy Program, the Carbon Capture and Storage and the Power System R&D activities also have a mission to research and support secure, affordable, and environmentally acceptable near-zero emissions fossil energy technologies. Thus, today, as a result of the many collaborative efforts across DOE's fossil energy-related programs, 75 percent of U.S. coal-fired power plants use air pollution-control devices that were developed in whole or in part through industry collaborations under NETL's emission control research, development and deployment programs.

Space Exploration

Beyond the expertise that the Department has gained in the nuclear stockpile and the civilian nuclear reactor fleet, our work in nuclear power also extends to major scientific achievements in space. Since 1958, DOE and its predecessor agencies, working in consultation with the National Aeronautics and Space Administration (NASA), have developed reliable, safe, long-duration nuclear power systems for use in outer space. These advances in energy science led to the development of radioisotope power system (RPSs) which have since powered the exploration of every planet in the solar system except Mercury.

DOE designed and produced the RPSs powering the Voyager spacecraft—launched in 1977 and still operating today—which explored Jupiter and Saturn. DOE-designed and produced RPSs will also power the first spacecraft to explore Pluto in 2015.

The Mars Rover, Curiosity, is the largest and most capable rover ever sent to another planet. Curiosity is powered by the DOE-designed and produced Multi-Mission Thermoelectric Generator that uses radioactive decay of plutonium 238 to power and heat the rover. The Generator, which was developed in the 2000s, was assembled and tested at Idaho National Laboratory. The radioisotope generator will provide the rover with an operating lifespan of at least one Mars year, which is 687 Earth days.[2]

DOE has been working closely with NASA to develop revolutionary technologies to aid in deep space exploration. One technology that has the potential to revolutionize human exploration is NASA's Nuclear Cryogenic Propulsion Stage (NCPS) project, being designed at the NASA Marshall Space Flight Center. This concept utilizes a nuclear reactor to provide nearly double the thrust of conventional chemical engines, potentially reducing transit times to Mars by 50 percent. DOE and its national laboratories are providing key support in the areas of reactor modeling and fuel development and qualification.

Our National Laboratories have also contributed to the success of America's space missions through advances in microelectronics. In the 1970's, Sandia National Laboratory established its leadership in radiation-hardened integrated circuits for nuclear weapons. This work was then leveraged by Sandia to provide the Galileo spacecraft the ability to survive Jupiter's radiation belts.

DOE's Office of Science also sponsored work led by Lawrence Berkeley National Laboratory's Saul Perlmutter, which resulted in the co-discovery of the accelerating expansion of the universe—resulting from so-called "dark energy"—for which he shared the 2011 Nobel Prize in physics.

[2] See NASA fact sheet on Curiosity: http://www.jpl.nasa.gov/news/fact_sheets/mars-science-laboratory.pdf

Additional impactful technologies being developed

All the examples I have described to this point are established successes that clearly demonstrate the value of our scientific and research and development investments. There are, of course, many more technologies the Department is pursuing today.

The Department has a strong focus on developing and deploying efficient energy technologies to save families money, to make our existing businesses more competitive while growing new ones, and to reduce greenhouse gas emissions. For example, commercial trucks comprise only 4 percent of vehicles on the road, but they use 21 percent of the fuel consumed in the United States, or 984 million barrels of petroleum per year (2011). Our SuperTruck Initiative partnered multiple major commercial vehicle manufacturers with our National Lab system to model the air flow around long-haul trucks for optimized drag reduction and to design and test innovative engine efficiency technologies, such as a state-of-the-art waste heat recovery system. The SuperTruck partners have demonstrated a 22 percent engine efficiency improvement in the laboratory and developed a full-scale, prototype class 8 heavy-duty truck that demonstrated a 61 percent improvement in freight efficiency during initial on-road testing (compared to a 2009 baseline truck model). Replacing a conventional long-haul truck with a SuperTruck could save the operator as much as 5,000 gallons of fuel and $20,000 annually. If fully deployed across the class 8 long-haul fleet, this adds to an estimated 260 million barrels of petroleum per year, a fuel cost savings of approximately $45 billion.

Within our nuclear weapons program, at Lawrence Livermore National Laboratory, the Department's expertise in supercomputing-driven simulations and materials research in the Joint Munitions Program combined to develop and field the BLU129/B bomb—a 500 pound bomb with a carbon fiber body that is characterized as a "Very Low Collateral Damage Weapon"—within 18 months after a request from commanders in Afghanistan.

For another example on the energy-side of the Department, our Nuclear Energy program is on the leading edge of pioneering work on small modular nuclear reactors, which could transform nuclear power by reducing reactor scale, increasing cost efficiency and price stability, promoting new passive safety standards, and allowing us to sell US-manufactured reactors overseas.

We are also making gains on demonstrating critical carbon capture and sequestration technologies. For example, the National Carbon Capture Center in Wilsonville, Alabama has received DOE funding to test a variety of coal-based carbon dioxide capture technologies under commercial conditions. This and similar projects funded out of DOE's Office of Fossil Energy will ensure the continued and clean contribution of domestic fossil fuels to our Nation's energy supply.

Another recent and prominent focus of the Department has been on developing and deploying technologies to the electric grid, such as synchrophasers— devices that measure electrical waves on the power grid—which will permit operators to see the operations of the grid in real-time, providing critical information for reliability, quality, and faster recovery from disturbances. The Department and multiple National Laboratories are also engaged in identifying—and deploying solutions for—critical cyber security vulnerabilities to the grid. Grid modernization is a major focus of R&D work in the Department, and we are building upon important investments from the Recovery Act to form a collaborative, cross-cutting strategy to support stakeholders around the country as the grid is upgraded.

And, following natural disasters like Hurricanes Sandy and Katrina, the Department of Energy is gearing up to use our core areas of expertise to help communities both before and after natural disasters. Helping states and localities with these events, in coordination with our interagency partners, is yet another way that Federal research and development dollars support the economic well-being of the Nation.

Sustained Commitment to Research

The Department's investments in research and development have had and will continue to have far reaching scientific and economic impacts.

However, nurturing the scientific and research programs as key strategic assets of the United States is made more difficult by sequestration and overall inability to meet budgetary goals. Budgetary cuts have caused reductions in support for research challenges, eroded employee confidence, and resulted in several project cancellations. While it is difficult to estimate the long-term impacts of sequestration cuts, it is clear that in the near-term, DOE has lost or delayed access to key science and technology capabilities that will be difficult to rebuild.

Looking forward, reductions to Federal investments in innovative clean energy research and development would have a significant impact at a time of significant global competition and progress. Reductions to sustainable transportation, renewable energy, and energy efficiency activities would slow and threaten critical domestic priorities, such as making clean, electric-powered vehicles more affordable by 2022; developing the next generation of advanced domestic biofuels; building on past success in doubling the renewable energy generated from wind, solar, and geothermal sources by committing to a second doubling by 2020; strengthening the competitiveness of U.S. companies by investing in projects and institutes to develop new energy-efficient manufacturing processes; and doubling American energy productivity by 2030 and making the commercial building sector 20 percent more efficient by 2020.

We are at a crucial point where sustained investment is necessary to ensure our Nation's future global competitiveness and security at the frontier of scientific and technological innovation. The Department's fiscal year (FY) 2015 budget request maintains robust scientific discovery and research and development programs. The Department also proposes a significant increase in efficiency and renewable energy technologies, as well as grid resiliency and modernization investments, through both the FY 2015 budget and additional investments in the Opportunity, Growth, and Security Initiative.

I am committed to ensuring efficient and effective investment of research funding. Soon after I became Secretary, I asked the Secretary of Energy Advisory Board (SEAB) to convene a task force and deliver a report on the Evaluation of New Funding Constructs for Energy R&D in the DOE. The SEAB task force report was released on March 28th and covers a range of DOE innovation modalities (i.e. Energy Innovation Hubs, Energy Frontier Research Centers, Bioenergy Research Centers, and ARPA-E); it reinforces the Department's serious commitment to effective project management and continuous improvement and notes the urgency for accelerated energy R&D. The report finds that these funding constructs are complementary to existing DOE programs and effective in engaging national laboratories, academia and industry. The report also lists four recommendations, many of which reinforce existing Departmental management practices. I fully intend to build on the recommendations in this report and to increase focus on multi-program coordination of research investments.

In writing the Department of Energy's $27.9 billion budget request for FY 2015, we had to make difficult choices to stay within the discretionary budget caps set by the Bipartisan Budget Act—including choices among research and development investments across the Department. The Opportunity, Growth, and Security Initiative is an example of what more could be done with additional funding in FY 2015, and illustrates why the budget caps in FY 2016 and beyond must be raised so that we can continue making the kinds of investments that have made such a dramatic difference for the American people.

Federal investment through the Department of Energy in research and development for basic science, applied energy, and national security has been a core driver of America's economic growth and progress for over forty years. Strong and sustained Federal investment in these areas will be essential to ensure that growth and progress continue and that America remains a global leader in science and innovation in the future.

Thank you for the opportunity to be here. I look forward to answering your questions.