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Introduction

Thank you, Chairman Frelinghuysen, Ranking Member Visclosky, and members of the committee. I am pleased to come before you today to present the President's Fiscal Year 2013 budget request for the Office of Science at the Department of Energy. I want to thank the committee for its strong support for the Office of the Science, even in this challenging fiscal environment. The Office of Science is the largest source of funding for basic physical science in the United States, and the research and facilities funded by the Office of Science are critical to enhancing U.S. competitiveness and maintaining U.S. leadership in science and technology.

In his State of the Union address in January, President Obama emphasized the importance of basic research and urged Congress to "support the same kind of research and innovation that led to the computer chip and the Internet; to new American jobs and new American industries." The President's FY 2013 budget request for the Office of Science is $5.0 billion, representing an increase of 2.4% over the FY 2012 appropriation. Within the President's request for overall flat discretionary funding, this increase in the Office of Science demonstrates the President's commitment to research and basic science, which is vital to producing the discovery and innovation that will strengthen our competiveness and our scientific leadership.

The Office of Science is doing its part to ensure that the United States is the global leader in clean energy science and technology. Our three Biofuel Research Centers have taken different and complementary paths toward producing the next generation of biofuels. The results speak for themselves: engineering a strain of bacteria that could produce drop-in fuel replacements, developing new crops that are more easily convertible into fuels, and conducting research into sustainable biofuel agricultural practices. Each biofuel center underwent an intense peer review process in November and December of last year, and all received extremely positive scores and comments at the end of this process.

We support 46 Energy Frontier Research Centers (EFRC) across the country, which conduct research into a wide array of materials science and engineering issues related to solving various energy problems. For example, a DOE-funded EFRC has synthesized silicon nanowire solar cells that are able to convert 90% of the photons they absorb into electrons. The cell contains only 2% silicon, and remaining 98% is polymer, reducing the potential cost of solar cells. This is the kind of breakthrough technology we are looking for that can be picked up by industry through ARPA-E or the applied energy programs. We continue to rigorously evaluate each EFRC's performance and scientific output as renewal decisions on the EFRCs will be made in FY 2014.

Our first Energy Innovation Hub, the Fuels from Sunlight Hub, is ramping up operations: hiring staff and acquiring space while already producing scientific output and publications. This hub will work on directly converting sunlight to fuels, such as developing new, more efficient methods of directly using sunlight to produce hydrogen from water.

I would like to thank the committee for its support of the Office of Science's second Energy Innovation Hub, on Batteries and Energy Storage and was funded by the FY 2012 Appropriations Bill. We anticipate a vigorous competition, and the Basic Energy Sciences (BES) program aims to make a selection decision by the end of the summer.

The 10 national laboratories in the Office of Science routinely produce cutting edge science and technology and have a set of user facilities that have benefited U.S. industry. These facilities, our synchrotrons, high performance computers, nanoscience centers and our neutron scattering centers, offer opportunities for even stronger interactions with industry; and we are looking at ways to enhance this activity. There are many examples of industry making use of our facilities, and we have illustrated a few of these in the handouts here.

Our scientific user facilities continue to be the envy of the world. We have demonstrated an x-ray laser for the first time and have made considerable improvements in its performance already. Our synchrotron light sources regularly make key contributions to our understanding of protein structure and materials. Protein crystallography at the Advanced Photon Source has enabled a potential new drug to combat Alzheimer's disease. Our scientific computing facilities enable groundbreaking science including the simulation of the large scale structure of the universe and the design of more fuel efficient car and jet engines. We continue to support research and development to achieve exascale computing, and will deliver a strategic plan on exascale to you soon.

In the Biological and Environmental Research program, the Environmental Molecular Sciences Laboratory integrates computational and experimental capabilities as well as fosters collaboration among disciplines to characterize biological organisms and molecules. The Atmospheric Radiation Measurement facilities, or ARMs, make critical measurements that inform our understanding of the atmosphere and the earth's climate.

While the President's budget has rightfully prioritized research toward clean energy and the environment, we also continue to be the primary funding agency for an array of basic physical sciences that the Office of Science has long supported. The FY 2013 Budget submission reflects a careful prioritization process across several program areas to ensure effective and efficient allocation of resources.

In the High Energy Physics program, operations at the Tevatron collider at Fermilab were completed last fall. In addition, the High Energy Physics (HEP) recently held a workshop to explore domestic opportunities for experiments at the Intensity Frontier. Also, note that we recently measured one of the important characteristics of neutrinos at the Daya Bay experiment. HEP continues to contribute to the energy frontier with experiments at the Large Hadron Collider and the search for the Higgs Boson. In the Cosmic Frontier, Saul Perlmutter's work toward the discovery of the accelerating universe is the latest Office of Science research to be honored with a Nobel Prize – and HEP continues to support research and experiments to reveal the nature of dark energy.

Nuclear Physics budget continues to support the development of next generation facilities. Even in these tight budget times, the President made the Facility for Rare Isotope Beams (FRIB) a priority for funding and has requested $22 million in FY 2013 to keep the project moving forward. The Administration is hopeful that Congress will fund FRIB this year. The FY 2013 budget also continues to support the 12 GeV upgrade to the Continuous Electron Beam Accelerator Facility at Thomas Jefferson National Laboratory.

In Fusion Energy Sciences, the budget includes support for the ITER project, an international fusion experiment involving six nations and the European Union. The U.S. remains committed to the scientific mission of ITER, while maintaining a balanced research portfolio, and will work with ITER partners to accomplish this goal. ITER aims to produce the world's first "burning plasma," which will result in net energy production from sustained thermonuclear reactions. This is the culmination of decades of research in fusion.

I want to emphasize that eighty percent of our ITER funding is spent in the United States, with U.S. designed and constructed components sent to the project site located in France. If you include the support of American scientists working overseas, that share of ITER funds used to support American workers rises to ninety percent. ITER will engage U.S. industry and our national labs in design and construction work for the project. In order to support an increase in ITER funding, we had to make several difficult decisions in the rest of the U.S. fusion program, including an early closure of the Alcator C-Mod tokamak at MIT. Even so the proposed budget for FY13 is not sufficient to keep the project on track and we are discussing with our partners how we might mitigate its effects.

The difficult decisions in Fusion and other areas were not made lightly, and reflect the choices necessary to ensure a strong American infrastructure for innovation. I look forward to working with you, Mr. Chairman, and the rest of the Committee to fully fund the Office of Science budget request. The material that follows will explain, in greater detail, the scientific program that will be supported by this budget request.

Research toward a Clean Energy Future

President Obama noted in his State of the Union address in January, "Nowhere is the promise of innovation greater than in American-made energy." The Office of Science is committed to advancing our scientific understanding of biosystems, advanced materials, and modeling and simulation to enable next-generation energy technologies that will move us away from fossil fuels toward cleaner, more advanced, and more efficient sources of energy.

The Office of Science believes there are several themes upon which we should build our research program to address barriers to new energy technologies.

- **Materials and chemistry by design.** Building on past success in modeling materials, we aim to simulate and possibly even create custom nanoscale and mesoscale structures for scientific advances and manufacturing innovations in solar energy conversion; clean-energy electricity generation; battery and vehicle transportation; and carbon capture, use, and sequestration.
- **Biosystems by design.** Using accumulated knowledge of biology, genetics, sequencing, and microbes, we can now target the development of synthetic biology tools and technologies and integrative analysis of experimental genomic science datasets to design and construct improved biofuels and bioproducts.
- **Modeling and simulation**. Our Leadership Computing Facilities and production computing facilities advance materials and chemistry by design and broadly address energy technology challenges. This continues a long standing practice of the Office of Science to provide the scientific community access to supercomputing expertise and equipment.

The Office of Science's clean energy research builds upon decades of core program funding in BES and the Biological and Environmental Research (BER) program. The rapid deployment and success of the EFRCs and BRCs are directly attributable to the historic strength of their core science program that produced a powerful knowledge base which enables DOE-funded scientists to tackle today's clean energy challenges.

Energy Frontier Research Centers

The EFRCs bring together the skills and talents of a team of investigators to perform energy-relevant, basic research with a scope and complexity beyond that found in standard single-investigator or small-group awards. To help ensure their success, BES provides proactive oversight through regular and frequent interactions with the EFRCs, including meetings with the EFRC Directors as a group, monthly teleconferences, and formal reviews, highlighted by an early management peer review in 2010 and the ongoing mid-term scientific peer reviews in FY 2012. In May 2011, BES brought the EFRC researchers together for a major research meeting, the Energy Frontier Research Centers Summit and Forum, to share progress and build collaborations To ensure communication of scientific research advances, technology needs, and program directions (to avoid duplication), management of the EFRC research includes coordination with other BES research activities and with the DOE technology offices.

Individual EFRCs perform a wide breadth of research in materials science and engineering that are focused on the design, discovery, synthesis, and characterization of novel, solid-state materials that improve the conversion of solar energy and heat into electricity and fuels; improving the conversion of electricity to light; improving electrical energy storage; enhancing materials resistance to corrosion, decay, or failure in extreme conditions of temperature, pressure, radiation, or chemical exposures; taking advantage of emergent phenomena, such as superconductivity, to improve energy transmission; optimizing energy flow to improve energy efficiency; and tailoring materials and processes at the atomic level to maximize catalytic activity. Efforts to bridge disciplines, generate new avenues of inquiry, and accelerate research within the broader community include periodic all-hands meetings, joint symposia and workshops, summer schools, tool development, and principal investigator meetings.

As an example of the innovative research occurring in the EFRCs, Professor Harry Atwater at the California Institute of Technology and his coworkers at the Light-Material Interactions for Energy Conversion EFRC have grown new crystalline silicon nanowires that can be used to make solar cells that convert 90% of the photons they absorb into electrons. Each cell is only 2% silicon, and remaining 98% is polymer, reducing the potential cost of solar cells that could be made from them, possibly manufactured in a roll-to-roll process.

Energy Innovation Hubs

Energy Innovation Hubs are composed of a large, multidisciplinary team of investigators whose research integrates basic to applied research and focuses on a single critical national energy need. They are funded as five-year, potentially renewable projects.

The Batteries and Energy Storage Hub will focus on understanding the fundamental performance limitations of electrochemical energy storage to enable the next generation of electrochemical energy storage technologies. Advanced energy storage solutions have become increasingly critical to the Nation with the expanded deployment of renewable energy sources coupled with growth in the numbers of hybrid and electric vehicles. For the electrical grid, new approaches to electrochemical energy storage can enable inherently intermittent renewable energy sources to meet continuous electricity demand. For vehicles, new batteries with improved lifetimes and storage capacities are needed to expand the range of electric vehicles for a single charge while simultaneously decreasing the manufacturing cost and weight. Today's electrical energy storage approaches suffer from limited energy and power capacities, lower-than-desired rates of charge and discharge, cycle life limitations, low abuse tolerance, high cost, and poor performance at high or low temperatures.

The Batteries and Energy Storage Hub will accelerate the development of energy storage solutions that are well beyond current capabilities and approach theoretical limits. This development will be enabled by cross-disciplinary R&D focused on the barriers to transforming electrochemical energy storage, including the exploration of new materials, devices, systems, and novel approaches for transportation and utility-scale storage. Outside of the Hub, battery research is typically focused on one particular problem or research challenge and thus lacks the resources and the diverse breadth of talent to consider holistic solutions. The Hub will provide an integrated team directed at research to overcome the current technical limits for electrochemical energy storage, bring them to the point where the risk level will be low enough for industry to further develop the innovations discovered by the Hub, and deploy these new technologies into the marketplace.

The Hub's goal is to deliver revolutionary research that will result in new technologies and approaches, rather than to focus on a single technology or on incremental improvements to current technologies. The Hub's ultimate technological impact should go well beyond current research and development activities. While advancing the current understanding of the science that underpins energy storage, the Hub will include the development of working bench-top prototype devices that demonstrate radically new approaches for electrochemical storage and are scalable. These should have the potential to be produced at low manufacturing cost from earth-abundant materials and possess greatly improved properties compared to present commercially available energy storage technologies.

Established in September 2010, the Fuels from Sunlight Hub is designed to bring together a multi-disciplinary, multi-investigator, multi-institutional team to create transformative advances in the development of artificial photosynthetic systems that convert sunlight, water, and carbon dioxide into a range of commercially useful fuels. This Hub, the Joint Center for Artificial Photosynthesis (JCAP), is led by the California Institute of Technology (Caltech) in primary partnership with Lawrence Berkeley National Laboratory. Partners include the SLAC National Accelerator Laboratory and several University of California institutions.

JCAP is composed of internationally-renowned scientists and engineers that seek to integrate decades of community effort in light harvesting and conversion, homogeneous and heterogeneous catalysis, interfacing, membrane and mesoscale assembly, and computational modeling and simulation, with more current research efforts using powerful new tools to examine, understand, and manipulate matter at the nanoscale. By studying the science of scale-up and benchmarking both components (catalysts) and systems (device prototypes), JCAP seeks to accelerate the transition from laboratory discovery to industrial use. As there is currently no direct solar-to-fuels industry in the world, JCAP has the potential for profound environmental and economic impact—establishing U.S. global leadership in renewable energy, reducing our dependence on imported oil, decreasing greenhouse gas emissions, and providing new jobs in an emerging energy technology.

Recently, JCAP scientists developed a new solution to the problem of creating hydrogen directly from sunlight. One challenge in producing hydrogen from water in this manner is the creation of gas bubbles in the water. So, JCAP created a proton exchange membrane (PEM) electrolyzer that generates hydrogen and oxygen from water vapor instead of liquid water. Since water vapor is already a gas, this eliminates the problem of bubble formation in the liquid. The fundamental insights gained from this discovery may lead to an entirely new approach to photoelectrolysis that, in turn, could alter the strategy for building a commercially viable solar-fuels generation system.

Bioenergy Research Centers

The three Bioenergy Research Centers (BRCs) have achieved significant research progress and have received overwhelmingly positive annual evaluations from teams of outside peer reviewers. In four years of operations, BRC researchers have produced 741 peer-reviewed publications and 293 patent disclosures or applications.

There have been several important research achievements, among many other developments, at the BRCs. The Joint BioEnergy Institute (JBEI), at Lawrence Berkeley National Lab, engineered the bacterium E. coli to produce hydrocarbon fuels directly from switchgrass, allowing for the production of "green" gasoline, diesel, and a chemical precursor to jet fuel. At the BioEnergy Science Center at Oak Ridge National Lab, they developed a new genetic strain of switchgrass that increases fuel yields with greatly reduced enzyme loads. The Great Lakes Bioenergy Research Center in Wisconsin produced a key study showing that perennial biofuel crops such as switchgrass can be sustainably grown on Conservation Reserve Program lands while reducing net carbon dioxide emissions.

As BRC researchers move to develop techniques to help scale-up conversion technologies, they will be able to make use of the newly constructed Advanced Biofuels Process Demonstration Unit at Lawrence Berkeley National Laboratory supported by DOE's Office of Energy Efficiency and Renewable Energy.

Multiple centers were necessary to tackle this extremely broad and diverse set of scientific challenges. In supporting three BRCs, the Department sought to bring maximum scientific resources to bear on this national priority. Over time, the three BRCs have come to occupy complementary areas and, through a combination of cooperation and competition, have accelerated the pace of discovery.

In November and December of 2011, BER conducted on-site reviews that evaluated the renewal proposals from each BRC. They were each evaluated by separate external peer review panels of seven to nine reviewers, with one reviewer serving on all three panels. The renewal review teams provided strongly favorable appraisals of the performance of all three BRCs, and were impressed with the productivity and progress of all the centers to date. The review teams strongly recommend renewal of all three BRCs, and BER has accepted that recommendation. The Office of Science proposes renewing all three BRCs in the FY 2013 budget, subject to continued progress and funding.

Investments in Foundational Science

The United States today has significant needs in developing clean energy, and the Office of Science will play a significant role in developing new sources of energy. In addition, this budget request continues our strong commitment to foundational, basic research for innovation and discovery in condensed matter and material physics, chemistry, biology, climate and environmental sciences, applied mathematics, computational and computer science, high energy physics, nuclear physics, plasma physics, and fusion energy sciences. The Office of Science supports over 25,000 investigators from more than 300 academic institutions and all of the DOE laboratories.

Core research funding in the Basic Energy Sciences program is directed to new research efforts to design materials with targeted properties and tailored chemical processes through theory, computation, and modeling, as validated by precise experimental characterization. Discovery of new materials and chemical assemblies with new properties and accurate predictions of their interactions with the environment are crucial to advances in energy technologies, as well as to virtually all industries that use materials in their products and manufacturing. The ultimate goal is to provide the nation with a science-based computational tool set to rationally predict and design materials and chemical processes to gain a global competitive edge in scientific discovery and innovation.

As a direct result of DOE investments over the past decade, the U.S. currently holds clear leadership in high performance computational science and engineering. To continue U.S. leadership in this area, we must address two significant challenges: advancing the Department's science and engineering missions by effectively utilizing our existing hardware and software and supporting research to extend these capabilities and take on even more complex challenges. In the course of our regular assessment of the needs of the scientific community, it is clear that in several areas DOE's simulation and data analysis needs exceed petascale capabilities. This is driving the Office of Science towards exascale computing.

However, there are several critical technology challenges on the path to exascale. There are three critical research challenges that must be overcome in order to achieve exascale computing: reducing power consumption; enabling users to fully utilize an extremely parallel system containing billions of processors; and improving the system's fault tolerance. Hardware R&D efforts in FY 2013 will be focused on early-stage research aimed at reducing the technical risk of some of the most critical technologies necessary for exascale.

In addition, new algorithms will be required that optimize management of data movement. The FY 2013 budget request increases investments across the research portfolio with a focus on the challenges that link data-intensive science and high performance computing, including exascale. These investments will reach across hardware and applications. They will advance critical technologies, mathematical methods, software, tools, middleware, and science applications.

Climate and Environmental Systems research is enhanced by a new focus on increasing the resolution of climate models as well as validation and verification. The funding continues support for the Arctic Next Generation Ecosystem Experiment to improve the representation of the major carbon sinks associated with changes in Arctic permafrost ecosystems in Earth system and regional climate models. In addition, a Next Generation Ecosystem Experiment will be initiated to address poorly understood ecosystem processes that govern biogenic aerosol emissions to the atmosphere, focusing on one of the most climatically-sensitive tropical regions, the Amazon.

The Office of Science coordinates with other agencies that perform climate research through the U.S. Global Change Research Program (USGCRP). This program integrates and coordinates Federal research and applications to assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change. USGCRP recently developed a decadal strategic plan that was used to inform the development of the FY 2013 Budget request. The USGCRP also ensures coordination, avoids overlap and redundancy, and enables communication of each agency's unique resources to each other. The Office of

Science has unique capabilities such as our national labs, expertise in computing and modeling inter-comparison, and the Atmospheric Radiation Measurement (ARM) facility. These assets make DOE a vital contributor toward enhancing our scientific understanding of the earth's climate.

Stewardship of High Energy Physics, Nuclear Physics, and Fusion Science

The President's FY 2013 budget emphasizes use-inspired energy research and foundational research that will lead to new energy and manufacturing technologies for a competitive innovation economy. At the same time, the Budget continues to support research in the areas of high energy physics, nuclear physics, and fusion energy sciences. The Budget seeks to prioritize resources toward research aimed at our most pressing challenges, while maintaining our unique role as national stewards of these research areas.

Fusion Energy Sciences

The Fusion Energy Sciences program request reflects the continued U.S. commitment to the scientific mission of ITER, while maintaining a balanced research portfolio across the program. The ITER experiment aims to produce the world's first "burning plasma," in which thermonuclear reactions will produce net energy for the first time (with a projected amplification factor of ten).

The funding increase of $45 million for the U.S. contributions to the ITER Project bring the FY 2013 request to $150 million and will enable the U.S. to make long-lead procurements as the project enters its construction period. Eighty percent of U.S. ITER funding is spent in the United States. The majority of our ITER obligations are "in-kind," with components designed and built in the U.S. before being shipped to France for final assembly into the ITER apparatus.

The continued long-term success of the U.S. fusion science efforts also depends on maintaining a healthy domestic fusion program. The FY 2013 budget seeks to balance these competing priorities in the context of constrained budgets. Domestic research in most areas is reduced, while program balance is retained. The FY 2013 budget request ceases operations at the Alcator C-Mod tokamak facility at the Massachusetts Institute of Technology. Remaining investments still enable support for a broad program in fusion and plasma science research that will be highly impactful and maintain a vibrant U.S. workforce through, among other means, international partnerships.

Nuclear Physics

The Nuclear Physics program is an important part of the Energy Department's overall scientific research and development program and the FY 2013 budget request supports a portfolio of facility construction and upgrades in addition to core research. This includes $22 million for the Facility for Rare Isotope Beams (FRIB) at Michigan State University (MSU), as well as support for the 12 GeV upgrade at the Continuous Electron Beam Accelerator Facility at Thomas Jefferson National Accelerator Facility. The Office of Science request for FRIB reflects the priority the President places on this very important and worthy project, even in these tight budget times. The proposed funding will keep the project moving forward and allow MSU to continue engineering and planning work. These funds will keep the project moving forward and allow MSU to continue the work necessary to reach critical project milestones.

High Energy Physics

The proposed FY 2013 budget maintains our commitment to support transformational research at all three frontiers of high energy physics. At the Energy Frontier, powerful particle accelerators are used to create new particles, reveal their interactions, and investigate fundamental forces. High priority efforts in FY 2013 include the analysis of legacy Tevatron data and continued support for U.S. participation in research at the Large Hadron Collider at CERN, which includes the support of U.S. based researchers and data centers.

At the intensity frontier, researchers investigate fundamental forces and particle interactions by studying events that rarely occur in nature. The U.S. is uniquely positioned to make advances at the Intensity Frontier. The Office of Science held the *Fundamental Physics at the Intensity Frontier* workshop in December 2011. The workshop identified a number of compelling research questions at the Intensity Frontier that would significantly add to our understanding of the fundamental questions of space, time, energy, and matter.

The FY 2013 budget continues support for Intensity Frontier neutrino research and the planned Muon to Electron Conversion Experiment at Fermilab. It also supports minimal sustaining de-watering efforts at the Homestake Mine in South Dakota.

Earlier this month, the Daya Bay Reactor Neutrino Experiment—a multinational collaboration operating in China and led, on the U.S. side, by the Office of Science—recorded and analyzed the largest set of neutrino reactor data ever collected. The analysis provided unprecedented understanding of the nature of neutrinos and could help explain why the universe is composed mostly of matter rather than anti-matter. Still under construction, the Daya Bay experiment is already the most sensitive experiment in the world for this type of physics and promises to reveal many more insights into the fundamental nature of our Universe.

At the Cosmic Frontier, measurements are made to reveal new insights and information about the nature of dark matter and dark energy to understand fundamental particle properties and discover new phenomena. Saul Perlmutter, Professor of Physics at the University of California, Berkeley, and senior scientist at Lawrence Berkeley National Laboratory, was awarded the 2011 Nobel Prize in Physics, which he shared with Adam G. Riess of Johns Hopkins University and Brian Schmidt of the Australian National University's Mount Stromlo and Siding Spring Observatories. Perlmutter led the Supernova Cosmology Project that, in 1998, was one of the teams that discovered that galaxies are receding from one another faster now than they were billions of years ago—a phenomenon thought to be driven by dark energy. The FY 2013 budget request builds on these successes with a ramp up for engineering and design efforts for the camera of the Large Synoptic Survey Telescope—a National Science Foundation (NSF) project that aims to chart objects in the sky that change or move and trace billions of remote galaxies, providing multiple probes of the mysterious dark matter and dark energy..

Cosmic Frontier experiments may be getting closer to identifying the long-sought dark matter through the observation of high-energy particles. The Fermi Large Area Telescope (LAT), a joint NASA-DOE project assembled at SLAC, observes high-energy electrons, positrons & gamma rays, and can distinguish positrons from electrons through clever use of the Earth's magnetic field. Recent Fermi-LAT measurements extend and confirm earlier intriguing observation of an excess of high-energy positrons that may be a signal for dark matter. Further studies are underway to improve the precision of this result.

The FY 2013 request also supports collaborations with the NSF on research and technology development and experiments designed to directly detect dark matter particles using ultra-sensitive detectors located underground.

Workforce Development
While our largest contribution to STEM education and training is through the support for undergraduates, graduate students, and postdocs included in competitive research grants at universities and DOE national laboratories; the Office of Science's Workforce Development for Teachers and Scientists (WDTS) program helps ensure that DOE and the Nation have a sustained pipeline of highly skilled and diverse science, technology, engineering, and mathematics (STEM) workers.

The FY 2013 request supports several targeted programs that include undergraduate research internships at the DOE laboratories and competitions such as the National Science Bowl.

The Importance of Scientific User Facilities

The Office of Science User Facilities provide the Nation's researchers with the most advanced tools of modern science including accelerators, colliders, supercomputers, light sources, and neutron sources, as well as facilities for studying the nanoworld, the environment, and the atmosphere. About 26,500 researchers from universities, national laboratories, industry, and international partners are expected to use the Office of Science scientific user facilities in FY 2013. Maintaining this domestic infrastructure is critical to the advancement of our innovation economy.

The new BES facilities that are currently under construction—the National Synchrotron Light Source-II (NSLS-II) and the Linac Coherent Light Source-II (LCLS-II)—continue the tradition of BES and the Office of Science providing the most advanced scientific user facilities for the Nation's research community in the most cost effective way. All BES construction projects are conceived and planned with the broad user community and, during construction, are executed on schedule and within cost.

In addition to providing unique facilities for conducting world-leading, breakthrough science, the light sources, neutron sources, electron imaging facilities, and nano-science centers supported by the Basic Energy Sciences program also support R&D at dozens of Fortune 500 companies. Companies in industries as diverse as pharmaceuticals and semi-conductors support their own beamlines at DOE facilities to conduct R&D leading to new products.

The Linac Coherent Light Source (LCLS) (the world's first x-ray free electron laser) provides capabilities that are revolutionizing our ability to image matter at the atomic scale. The intensity and ultrashort duration of LCLS x-ray pulses allow researchers to develop a new approach for determining the three dimensional structures of proteins. The laser's brilliant pulses of x-ray light pull structural data from tiny protein nanocrystals, avoiding the need to use large protein crystals that can be difficult or impossible to prepare. This technique will accelerate the structural analysis of some proteins by several years and will allow scientists to decipher tens of thousands of other macromolecules that are out of reach today, including many involved in energy technologies and biopharmaceutical applications.

Much like the light sources in BES, the computational facilities and programming expertise in ASCR support a wide array of scientific research, as well as directly benefitting U.S. industry. Companies from a wide variety of industries, such as in wind energy and automobiles, have used ASCR facilities for simulation and modeling that lead to product improvement. In at least one case, this research prompted a company to purchase its own supercomputer.

This budget request continues support for upgrades and new facility planning and construction as well as operations at existing facilities. Priority investments include the Linac Coherent Light Source-II project to provide a second, independently controlled laser to the LCLS facility, the Advanced Photon Source Upgrade, and operations of planned 10 petaflop upgrades to the Leadership Computing Facilities at Argonne and Oak Ridge National Laboratories.

Program Direction

Throughout FY 2011, the Office of Science reduced expenses for travel, support services, and other related costs, and operated under a hiring freeze, resulting in sufficient carryover funding to sustain essential operations in the current fiscal year. The overall requested increase for FY 2013 will maintain essential research operations at the FY 2011 level with backfill hiring of essential positions, controlled retention strategies, and targeted recruitment efforts. Backfilled positions include scientific positions at headquarters for science program oversight, personnel to handle nuclear safety and other safety positions, and contract specialists to ensure efficient expenditure of funds.

Science Laboratories Infrastructure

Infrastructure modernization efforts are slowed somewhat due to budget constraints but still intact. The FY 2013 request supports two new project starts—the Utilities Upgrade project at Fermi National Accelerator Laboratory and the Utility Infrastructure Modernization project at Thomas Jefferson National Accelerator Facility. It also supports all four continuing line item construction projects.