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U.S. Department of Energy

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Subcommittee on Energy & Water Development

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Thank you Chairman Simpson, Ranking Member Kaptur, and distinguished members of the Committee. I am pleased to come before you today to discuss the President's FY 2016 Budget Request for the Office of Science in the Department of Energy (DOE). I also want to thank you for your support of the Office of Science (SC) in the recent FY 2015 Omnibus appropriations bill, which we are now implementing.

At the end of 2013, policymakers came together on a bipartisan basis to partially reverse sequestration and to pay for higher discretionary funding levels with long-term reforms. We have seen the positive consequences of that bipartisan agreement for our ability to invest in areas ranging from research and manufacturing to strengthening our military. We have also seen the positive consequences for the economy, with an end to mindless austerity and manufactured crises contributing to the fastest job growth since the late 1990s. The President's Budget builds on this progress by reversing sequestration, paid for with a balanced mix of commonsense spending cuts and tax loophole closers, while also proposing additional deficit reduction that would put debt on a downward path as a share of the economy.

Meanwhile, the President has made clear that he will not accept a budget that reverses our progress by locking in sequestration going forward. Locking in sequestration would bring real defense and non-defense funding to the lowest levels in a decade. As the Joint Chiefs and others have outlined, that would damage our national security, ultimately resulting in a military that is too small and equipment that is too old to fully implement the defense strategy. It would also damage our economy, preventing us from making pro-growth investments in areas ranging including basic research, exascale computing, and facilities construction and operation at the Department of Energy. As the President has stated, he will not accept a budget that severs the vital link between our national and economic security, both of which are important to the Nation's safety, international standing, and long-term prosperity.

The FY 2016 Budget Request is an excellent budget for the Office of Science, with an increase of 5.3 percent over the FY 2015 Enacted level. We continue our distinguished history of making important investments in basic research, scientific user facilities, and facility construction across our six program areas. As you know, the Office of Science is the Nation's largest source of funding for basic research in the physical sciences.

I would like to highlight a few key features of the FY 2016 Request. First, exascale computing and disciplinary computational sciences continue to be a top priority for the Department and for the Office of Science. There is a substantial increase of $80 million in Advanced Scientific Computing Research (ASCR) to advance rapidly toward an exascale machine. We also continue with additional funding in Basic Energy Sciences (BES) for computational work on material sciences, which was initiated in FY 2015 and has transformational potential for a broad range of energy applications.

Second, our Budget Request is responsive to the 2014 High Energy Physics Advisory Panel (HEPAP) Particle Physics Project Prioritization Panel (P5) report. I was impressed with the very broad outreach to the large high energy physics community, and I am pleased that the community has united behind the recommendations of the report. Most notably, the Request contains $20.0 million for the Long Baseline Neutrino Facility at Fermi National Accelerator Laboratory (Fermilab). The Office of Science and Fermilab continue to work together to properly internationalize this project, following the recommendation of the P5 subpanel.

Finally, scientific user facility operations and construction remain an extremely important part of the Office of Science budget. The Linac Coherent Light Source upgrade project at SLAC and the Facility for Rare Isotope Beams project at Michigan State University reach the peak year of their construction funding profiles in FY 2016. Most of our user facilities are funded to operate at or near optimal levels. In Fusion Energy Sciences, we expect the newly upgraded National Spherical Torus Experiment at Princeton Plasma Physics Laboratory to resume operations for a 14-week run. The Office of Science is committed to operating and constructing world-leading user facilities.

Additional details on our six program areas are below:

Advanced Scientific Computing Research (ASCR) supports research to discover, develop, and deploy computational and networking capabilities to analyze, model, simulate, and predict complex phenomena important to DOE. The ASCR budget increases $80 million or 14.8 percent relative to the FY 2015 appropriation.

The FY 2016 Budget Request for ASCR makes significant new investments in research and partnerships to advance the Department's goals for capable exascale computing. Capable exascale computing will mean a thousand- fold increase in performance over today's systems when used for science applications important to the DOE mission and the High Performance Computing (HPC) scientific community. Exascale computing will address the next generation of scientific, engineering, and large-data problems, advancing the Department's science missions into the next decade.

There is a sizable increase in investment in Research and Evaluation Prototypes. In this activity, ASCR will competitively select R&D partnerships with U.S. vendors to initiate the design and development of node and system designs suitable for exascale systems. These efforts will influence the development of exascale prototypes.

Included in the ASCR Request is $10.0 million for the Computational Science Graduate Fellowship (CSGF). Training the next generation of computational scientists to understand the challenges and complexities of massively parallel exascale systems is a top priority for ASCR and the Nation. The CSGF program was singled out as an example by the Advanced Scientific Computing Advisory Committee as a key investment in workforce development supported by the Office of Science.

Basic Energy Sciences (BES) supports research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies. The BES budget increases $116 million or 6.7 percent from the FY 2015 appropriation.

The FY 2016 Request continues funding for computational modeling in materials science, which invests in the scientific foundation and tools for predictive design of functional materials. This activity supports the Administration's Materials Genome Initiative for Global Competitiveness that was initiated in June 2011, and it will continue to significantly improve U.S. modeling capabilities. The Computational Materials Sciences activity also supports the second year of research awards that will be issued in FY 2015; additional funds are requested for underrepresented research topics in predictive design of functional materials. A new investment in midscale instrumentation is also requested to develop cutting-edge electron scattering tools to advance the forefront of ultrafast science.

Additional funding is requested for the Energy Frontier Research Centers (EFRCs) to invest in strategic areas of basic energy sciences that are not represented or are underrepresented in the current EFRC portfolio. Beginning in FY 2016, the EFRC program will transition to a biennial solicitation. All EFRCs will undergo a mid-term review in FY 2016 to assess progress toward meeting scientific research goals

and DOE will issue a Funding Opportunity Announcement for approximately five new EFRC awards in FY 2016.

The FY 2016 Request for BES will support ongoing core research activities at or above the FY 2015 Enacted level. Funding for the Batteries and Energy Storage Energy Innovation Hub will continue as planned. The Fuels from Sunlight Energy Innovation Hub is undergoing a review for a possible renewal for a final term with a maximum duration of five years; a renewal decision will be made in the second quarter of FY 2015.

In FY 2016, BES will support near optimal operations of five x-ray light source facilities, two neutron source facilities, and five Nanoscale Science Research Centers. FY 2016 will be the first full year of operations for the newly constructed National Synchrotron Light Source-II (NSLS-II). It is the latest example of the Office of Science's tradition of building world-class user facilities on-budget and on-time. In the case of NSLS-II, the project was completed under-budget and ahead of schedule. The Linac Coherent Light Source-II project will ramp up construction activities, reaching its peak year of funding in FY 2016. The Advanced Photon Source Upgrade and the NSLS-II Experimental Tools (NEXT) major item of equipment projects will be supported as planned. FY 2016 is the last year of funding for the NEXT project.

Biological and Environmental Research (BER) supports fundamental research and scientific user facilities to achieve a predictive understanding of complex biological, climatic, and environmental systems for a secure and sustainable energy future. The BER budget increases by $20.4 million or 3.4 percent relative to the FY 2015 appropriation.

The Request of $193.0 million continues support for research in Genomic Science, including $75.0 million requested for core research at the DOE Bioenergy Research Centers to provide a scientific basis for sustainable and cost effective bioenergy production. These efforts are complemented by continued research on potential plant feedstocks for bioenergy purposes, new efforts to understand the sustainability of bioenergy production, and biosystems design efforts to modify plants and microbes for bioenergy purposes. The budget requests $69.5 million for the DOE Joint Genome Institute to provide scientific users with plant and microbial genome sequences of the highest quality and advanced capabilities to analyze, interpret, and manipulate genes in support of bioenergy, biosystems design and environmental research.

The BER Request for Climate and Environmental Science supports fundamental science and research capabilities that enable advances in ecosystem process science, climate science, and modeling research.

BER's integrated portfolio includes research on clouds, aerosols, and the terrestrial carbon cycle. Our understanding of the interdependence between climate and ecosystems is enabled by SC's unique facilities and long-term observing capabilities - most managed by DOE national laboratories - to collect and analyze data to understand climate processes. These facilities include: The Atmospheric Radiation Measurement Climate Research Facility (ARM) to understand cloud-aerosol-precipitation interactions with the Earth's radiant energy balance; Ameriflux to measure ecosystem carbon, water, and energy fluxes to support environmental research; and Next Generation Ecosystem Experiments (NGEE) to explore ecological, biogeochemical, and soil process interactions of sensitive and climatically interesting ecosystems. Data from ARM, NGEE, and Ameriflux are coordinated under SC's data informatics capability, enabling efficient use and integration by the scientific community. SC's Leadership Computing Facilities at Oak Ridge National Laboratory and at Argonne National Laboratory, enable research to understand earth and environmental system process interactions based on synthesis of complex data sets.

In FY 2016, the BER Request for Climate Model Development and Validation combines advanced code development and numerical methods with ARM data to design an Earth system model with sub-10 km resolution that can adequately represent extreme events and can be run on next-generation and exascale computers. The Request also funds foundational work in support of the Department's Energy-Water Nexus crosscut. Specifically, tandem investments in Climate and Earth System Modeling and Integrated Assessment activities support an advanced, integrated data, modeling, and analysis platform to improve understanding and inform decision-making of coupled energy-water systems for a broad range of users and at multiple scales. The request also supports subsurface biogeochemical research that advances fundamental understanding of coupled physical, chemical, and biological processes controlling both the terrestrial component of the carbon cycle and the environmental fate and transport of DOE-relevant contaminants, and supports the Environmental Molecular Sciences Laboratory (EMSL).

Fusion Energy Sciences (FES) supports research to expand the fundamental understanding of matter at very high temperatures and densities and to build the scientific foundation of fusion energy. The FES budget decreases $47.5 million or 10.2 percent from the FY 2015 appropriation.

After the first year of experimental operations with the upgraded device in FY 2015, funding for operations of the National Spherical Torus Experiment Upgrade (NSTX-U) user facility will support 14 weeks of run time in FY 2016. FES will support a strong research program to develop the improved understanding of the spherical torus configuration required to establish the physics basis for next-step

facilities, broaden scientific understanding of plasma confinement, and maintain U.S. world leadership in spherical torus research.

Twelve weeks of research operations at the DIII-D facility are planned for FY 2016, with experiments focusing on high-priority, advanced tokamak issues. Areas of research will include studies of transport and radiative processes in detached divertor conditions, and disruption physics and mitigation systems. Additionally, the request supports targeted upgrades for DIII-D such as installation of new magnet power supplies for the 3D and shaping coils, and continued work on improving the neutral beam heating control system.

The Alcator C-Mod facility will continue operation in FY 2015 to complete student research and critical experimental work before the facility ceases operations by the end of FY 2016.

Funding is provided for the U.S. contributions to the ITER project to support the U.S. ITER Project Office operations, the U.S. cash contribution to the international ITER Organization, and continued progress on in-kind hardware contributions. These include industrial procurements of central solenoid magnet modules and structures, toroidal field magnet conductor fabrication and diagnostics, and tokamak cooling water system procurement. We are observing closely whether the newly nominated Director General will take steps to improve the management of this project.

The strategic planning process for the domestic Fusion Energy Sciences program is nearing completion. Input for the plan derives from the Fusion Energy Sciences Advisory Committee (FESAC) report *Strategic Planning: Priorities Assessment and Budget Scenarios* released in October 2014 as well as several other recent studies. A series of FES-supported technical workshops to be held in May and June 2015, prompted by the FESAC report, will subsequently refine details of the plan.

High Energy Physics (HEP) supports research to understand how the universe works at its most fundamental level by discovering the most elementary constituents of matter and energy, probing the interactions among them, and exploring the basic nature of space and time itself. The HEP budget increases by $22.0 million or 2.9 percent above the FY 2015 appropriation.

The FY 2016 Budget Request implements the recommendations contained in the P5 subpanel report, unanimously approved by the HEPAP in May of 2014.

Support is requested for full operation of existing major HEP facilities and experiments; the planned construction funding profile for the Muon to Electron Conversion Experiment (Mu2e), and fabrication for recent major items of equipment (MIEs) for the Super Cryogenic Dark Matter Search at the new Sudbury

Neutrino Observatory laboratory (SuperCDMS-SNOLab), the Large Underground Xenon (LUX) –ZonEd Proportional scintillation in Liquid Noble gases (ZEPLIN) experiment (LZ), and the Dark Energy Spectroscopic Instrument (DESI) projects.

Funding is requested to continue support of Major Items of Equipment for the camera for the Large Synoptic Survey Telescope (LSSTcam) project, the Muon g-2 Experiment, and the U.S. contributions to the Large Hadron Collider (LHC) A Toroidal LHC Apparatus (ATLAS) Detector Upgrade, and the LHC Compact Muon Solenoid (CMS) Detector Upgrade.

The internationalization and re-scoping of the Long Baseline Neutrino Experiment to optimize science impact is a major recommendation from the P5 subpanel. HEP will pursue the development of a more capable long baseline experiment by recruiting international partners. To recognize this change, we have adopted the P5 subpanel recommendation of the name change to the Long Baseline Neutrino Facility (LBNF.)

Nuclear Physics (NP) supports research to discover, explore, and understand all forms of nuclear matter, including experimental and theoretical research to create, detect, and describe the varied forms of nuclear matter that can exist, including those that are no longer found naturally. The NP budget increases $29.1 million or 4.9 percent over the FY 2015 appropriation.

The NP FY 2016 Request supports an increase for NP research across the program at universities and laboratories to address important challenges identified by the research community. Fundamental research to understand properties of different forms of nuclear matter are conducted through both experimental and theoretical efforts. Most experiments today in nuclear physics use particle accelerators to collide matter at nearly the speed of light, producing short-lived forms of matter for investigation. Theoretical approaches are based on a description of the interactions of quarks and gluons described by the theory of quantum chromodynamics (QCD).

In FY 2016, operations of the Relativistic Heavy Ion Collider (RHIC) facility are maintained at the FY 2015 level with increases provided for the critical staff, equipment, and materials that are required for effective and reliable support of operations; research is focused on characterizing the perfect quark-gluon liquid discovered in collisions of relativistic heavy nuclei through research on particle flow and jet energy loss. Operations of the A Toroidal Large Hadron Collider (LHC) Apparatus (ATLAS) facility are optimized, exploiting the new capabilities of the Californium Rare Ion Breeder Upgrade (CARIBU) and completing the campaign with the GRETINA gamma ray spectrometer. Beam development and commissioning activities continue to ramp up at the Continuous Electron Beam Accelerator Facility

(CEBAF) as the 12 GeV CEBAF Upgrade project approaches completion and scientific instrumentation is implemented in the experimental halls. The Facility for Rare Isotope Beams (FRIB) at Michigan State University reaches the peak of its construction funding profile in FY 2016. FRIB will provide intense beams of rare isotopes for research in nuclear structure and nuclear astrophysics.

Science Laboratories Infrastructure (SLI)

Ongoing projects that will provide new laboratory buildings, renovated facilities, and upgraded utilities are proceeding towards on-time completion within budget. The request provides continued funding for the Materials Design Laboratory project at Argonne National Laboratory, the Photon Science Laboratory Building project at SLAC National Accelerator Laboratory, and the Integrative Genomics Building project at Lawrence Berkeley National Laboratory. In addition, this request includes increased funding for the Infrastructure Support subprogram. This increase addresses a basic need for renewal of core general purpose infrastructure. The Request also initiates support for nuclear operations at the Oak Ridge National Laboratory that was previously funded by Congressional Direction under the Office of Nuclear Energy.