DEFENSE NUCLEAR WASTE DISPOSAL—Continued

Program and Financing—Continued

Identification code 089–0244–0–1–053		2016 actual	2017 est.	2018 est.
	Memorandum (non-add) entries:			
1941	Unexpired unobligated balance, end of year	6		
	Change in obligated balance:			
	Unpaid obligations:			
3000	Unpaid obligations, brought forward, Oct 1	11	9	6
3010	New obligations, unexpired accounts		6	30
3020	Outlays (gross)	–2	–9	–12
3050	Unpaid obligations, end of year	9	6	24
	Memorandum (non-add) entries:			
3100	Obligated balance, start of year	11	9	6
3200	Obligated balance, end of year	9	6	24
	Budget authority and outlays, net:			
	Discretionary:			
4000	Budget authority, gross			30
	Outlays, gross:			
4010	Outlays from new discretionary authority			12
4011	Outlays from discretionary balances	2	9	
4020	Outlays, gross (total)	2	9	12
4180	Budget authority, net (total)			30
4190	Outlays, net (total)	2	9	12

The Defense Nuclear Waste Disposal appropriation was established by the Congress as part of the 1993 Energy and Water Development Appropriation (P.L. 102–377), in lieu of payment from the Department of Energy (DOE) into the Nuclear Waste Fund for activities related to the disposal of defense high-level waste from DOE's atomic energy defense activities.

Object Classification (in millions of dollars)

Identification code 089–0244–0–1–053		2016 actual	2017 est.	2018 est.
	Direct obligations:			
25.1	Advisory and assistance services		6	2
25.2	Other services from non-Federal sources			1
25.4	Operation and maintenance of facilities			27
99.9	Total new obligations, unexpired accounts		6	30

ENERGY PROGRAMS

Federal Funds

SCIENCE

For Department of Energy expenses including the purchase, construction, and acquisition of plant and capital equipment, and other expenses necessary for science activities in carrying out the purposes of the Department of Energy Organization Act (42 U.S.C. 7101 et seq.), including the acquisition or condemnation of any real property or facility or for plant or facility acquisition, construction, or expansion, and purchase of not more than 16 passenger motor vehicles for replacement only, including one ambulance and one bus, $4,472,516,000, to remain available until expended: Provided, That of such amount, $168,516,000 shall be available until September 30, 2019, for program direction.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.

Program and Financing (in millions of dollars)

Identification code 089–0222–0–1–251		2016 actual	2017 est.	2018 est.
	Obligations by program activity:			
0001	Basic Energy Sciences	1,798	1,845	1,555
0002	Advanced Scientific Computing Research	602	620	722
0003	Biological and Environmental Research	593	608	349
0004	High Energy Physics	777	793	673
0005	Nuclear Physics	602	616	503
0006	Fusion Energy Sciences	428	437	310
0007	Science Laboratories Infrastructure	140	113	76
0008	Science Program Direction	191	185	168
0009	Workforce Development for Teachers and Scientists	34	19	14
0010	Safeguards and Security	103	103	103
0011	Small Business Innovation Research	190		
0012	Small Business Technology Transfer	28		
0799	Total direct obligations	5,486	5,339	4,473
0801	Science (Reimbursable)	554	520	520
0900	Total new obligations, unexpired accounts	6,040	5,859	4,993
	Budgetary resources:			
	Unobligated balance:			
1000	Unobligated balance brought forward, Oct 1	41	10	8
1021	Recoveries of prior year unpaid obligations	71		
1050	Unobligated balance (total)	112	10	8
	Budget authority:			
	Appropriations, discretionary:			
1100	Appropriation	5,350	5,340	4,473
1121	Appropriations transferred from other acct [089–0213]	14		
1121	Appropriations transferred from other acct [089–0321]	30		
1121	Appropriations transferred from other acct [089–0309]	8		
1121	Appropriations transferred from other acct [089–0318]	4		
1121	Appropriations transferred from other acct [089–0319]	15		
1121	Appropriations transferred from other acct [089–0251]	1		
1131	Unobligated balance of appropriations permanently reduced	–3	–3	
1160	Appropriation, discretionary (total)	5,419	5,337	4,473
	Spending authority from offsetting collections, discretionary:			
1700	Collected	525	520	520
1701	Change in uncollected payments, Federal sources	–6		
1750	Spending auth from offsetting collections, disc (total)	519	520	520
1900	Budget authority (total)	5,938	5,857	4,993
1930	Total budgetary resources available	6,050	5,867	5,001
	Memorandum (non-add) entries:			
1941	Unexpired unobligated balance, end of year	10	8	8
	Change in obligated balance:			
	Unpaid obligations:			
3000	Unpaid obligations, brought forward, Oct 1	4,386	4,731	4,496
3010	New obligations, unexpired accounts	6,040	5,859	4,993
3020	Outlays (gross)	–5,624	–6,094	–5,479
3040	Recoveries of prior year unpaid obligations, unexpired	–71		
3050	Unpaid obligations, end of year	4,731	4,496	4,010
	Uncollected payments:			
3060	Uncollected pymts, Fed sources, brought forward, Oct 1	–411	–405	–405
3070	Change in uncollected pymts, Fed sources, unexpired	6		
3090	Uncollected pymts, Fed sources, end of year	–405	–405	–405
	Memorandum (non-add) entries:			
3100	Obligated balance, start of year	3,975	4,326	4,091
3200	Obligated balance, end of year	4,326	4,091	3,605
	Budget authority and outlays, net:			
	Discretionary:			
4000	Budget authority, gross	5,938	5,857	4,993
	Outlays, gross:			
4010	Outlays from new discretionary authority	2,059	2,922	2,533
4011	Outlays from discretionary balances	3,565	3,172	2,946
4020	Outlays, gross (total)	5,624	6,094	5,479
	Offsets against gross budget authority and outlays:			
	Offsetting collections (collected) from:			
4030	Federal sources	–348	–250	–250
4033	Non-Federal sources	–177	–270	–270
4040	Offsets against gross budget authority and outlays (total)	–525	–520	–520
	Additional offsets against gross budget authority only:			
4050	Change in uncollected pymts, Fed sources, unexpired	6		
4070	Budget authority, net (discretionary)	5,419	5,337	4,473
4080	Outlays, net (discretionary)	5,099	5,574	4,959
4180	Budget authority, net (total)	5,419	5,337	4,473
4190	Outlays, net (total)	5,099	5,574	4,959

Advanced Scientific Computing Research.—The Advanced Scientific Computing Research (ASCR) program supports research in applied mathematics and computer science; delivers the most advanced computational scientific applications in partnership with disciplinary science; advances computing and networking capabilities; and develops future generations of computing hardware and tools for science, in partnership with the research community and U.S. industry. The strategy to accomplish this has two thrusts: developing and maintaining world-class computing and network

facilities for science; and advancing research in applied mathematics, computer science and advanced networking. The program supports the development, maintenance, and operation of large high performance computing and network facilities, including the Leadership Computing Facilities at Oak Ridge and Argonne National Laboratories, the National Energy Research Scientific Computing Facility at Lawrence Berkeley National Laboratory, and the Energy Sciences Network.

Maximizing the benefits of U.S. leadership computing in the coming decades will require an effective national response to increasing demands for computing capabilities and performance, emerging technological challenges and opportunities, and competition with other nations. The DOE will sustain and enhance its support for high performance computing (HPC) research, development, and deployment as part of the federal strategy in partnership with the Department of Defense (DOD) and the National Science Foundation (NSF).

Within the context of this coordinated federal strategy, the DOE Office of Science (SC) and the DOE National Nuclear Security Administration (NNSA) are overseeing the Department's Exascale Computing Initiative (ECI), which began in 2016. The ECI focuses on delivering advanced simulation through an exascale-capable computing program, with an emphasis on sustained performance on science, national security mission applications, and increased convergence between exascale and large-data analytic computing. To meet ECI goals, research and development (R&D) will be accelerated to overcome key exascale challenges in parallelism, energy efficiency, and reliability, leading to deployment of exascale systems in the 2021 timeframe. Acceleration or advancement is defined as a fifty-fold increase in sustained performance over today's computing capabilities, enabling applications to address next-generation science, engineering, and data problems.

Basic Energy Sciences.—The Basic Energy Sciences (BES) program supports fundamental 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 and to support DOE missions in energy, environment, and national security. Key to exploiting such discoveries is the ability to create new materials using sophisticated synthesis and processing techniques, precisely define the atomic arrangements in matter, and control physical and chemical transformations. The energy systems of the future will revolve around materials and chemical changes that convert energy from one form to another.

The research disciplines that BES supports—condensed matter and materials physics, chemistry, geosciences, and aspects of physical biosciences—are those that discover new materials and design new chemical processes that touch virtually every important aspect of energy resources, production, conversion, transmission, storage, efficiency, and waste mitigation. BES research provides a knowledge base to help understand, predict, and ultimately control the natural world and helps build the foundation for achieving a secure and sustainable energy future. BES also supports world-class, open-access scientific user facilities consisting of a complementary set of intense x-ray sources, neutron sources, and research centers for nanoscale science. BES facilities probe materials with ultrahigh spatial, temporal, and energy resolutions to investigate the critical functions of matter—transport, reactivity, fields, excitations, and motion—and answer some of the most challenging grand science questions. BES-supported activities are entering a new era in which materials can be built with atom-by-atom precision and computational models can predict the behavior of materials before they exist.

Biological and Environmental Research.—The Biological and Environmental Research (BER) program supports fundamental research and provides scientific user facilities to achieve a predictive understanding of complex biological, earth, and environmental systems for energy and infrastructure resilience and sustainability.

The program seeks to understand the biological, biogeochemical, and physical principles needed to predict a continuum of processes from the molecular and genomics-controlled smallest scales to environmental and ecological processes. Starting with the genetic potential encoded by organisms' genomes, BER Biological System Science research seeks to define the principles that guide the translation of the genetic code into functional proteins and the metabolic and regulatory networks underlying the systems biology of plants and microbes as they respond to and modify their environments. This predictive understanding can enable more confident redesign of microbes and plants for sustainable biofuels production, improved carbon storage, and controlled biological transformation of materials such as nutrients and metals in the environment. BER Earth and Environmental Systems Sciences research advances the fundamental understanding of dynamic, physical, and biogeochemical systems processes required to systematically develop Earth system models for predictive tools and approaches that may inform policies and plans for future energy and resource needs.

Fusion Energy Sciences.—The Fusion Energy Sciences (FES) program mission is to expand the fundamental understanding of matter at very high temperatures and densities and to build the scientific foundation needed to develop a fusion energy source. This is accomplished through the study of plasma, the fourth state of matter, and how it interacts with its surroundings.

The next frontier for the major international fusion programs is the study of the burning plasma state, in which the fusion process itself provides the dominant heat source for sustaining the plasma temperature. Production of strongly self-heated fusion plasma will allow the discovery and study of a number of new scientific phenomena relevant to fusion energy. These include the effects of highly energetic fusion -produced alpha particles on plasma stability and confinement; the strongly non-linear coupling that will occur among fusion alpha particles, pressure-driven self-generated current, turbulent transport, and boundary-plasma behavior; the properties of materials in the presence of high heat and particle fluxes and neutron irradiation; and the self-organized nature of plasma profiles over long time scales. To support the program mission and its major focus, the U.S. fusion program has four elements: Burning Plasma Science: Foundations; Long Pulse; High Power; and Discovery Plasma Science. To achieve these research goals, FES invests in experimental facilities of various scales, international partnerships leveraging U.S. expertise, large-scale numerical simulations based on experimentally validated theoretical models, development of advanced fusion-relevant materials, and invention of new measurement techniques.

High Energy Physics.—The High Energy Physics (HEP) program mission is to understand how the universe works at its most fundamental level by discovering the elementary constituents of matter and energy, probing the interactions among them, and exploring the basic nature of space and time. The HEP Program offers research opportunities for individual investigators and small-scale collaborations, as well as very large international collaborations. A world-wide program of particle physics research is underway to discover what lies beyond the Standard Model. Five intertwined science drivers of particle physics provide compelling lines of inquiry that show great promise for discovery: use the Higgs boson as a new tool for discovery; pursue the physics associated with neutrino mass; identify the new physics of dark matter; understand cosmic acceleration, dark energy, and inflation; and explore new particles, interactions and physical principles. The program enables scientific discovery through a strategy organized along three frontiers of particle physics: 1) The Energy Frontier, where researchers accelerate particles to the highest energies ever made by humans and collide them to produce and study the fundamental constituents of matter. This requires some of the largest machines ever built; 2) The Intensity Frontier, where researchers use a combination of intense particle beams and highly sensitive detectors to make extremely precise measurements of particle properties, study some of the rarest particle interactions predicted by the Standard Model of particle physics, and search for new physics; and 3) The Cosmic Frontier, where researchers seek to reveal the nature of dark matter and dark energy by using naturally occurring particles to explore new phenomena. The highest-energy particles ever observed have come from cosmic sources, and the ancient light from distant galaxies allows the distribution of dark matter to be mapped and perhaps the nature of dark

SCIENCE—Continued

energy to be unraveled. Investments in Theoretical and Computational Physics, which provides the framework to explain experimental observations and gain a deeper understanding of nature, and Advanced Technology R&D, which fosters fundamental research into particle acceleration and detection techniques and instrumentation, support these three frontiers. Many of the advanced technologies and research tools originally developed for high energy physics have also proven applicable to other sciences, as well as industry, medicine, and national security.

Nuclear Physics.—The Nuclear Physics (NP) program mission is to discover, explore, and understand all forms of nuclear matter. Although the fundamental particles that compose nuclear matter —quarks and gluons— are themselves relatively well understood, exactly how they interact and combine to form the different types of matter observed in the universe today and during its evolution remains largely unknown. Nuclear physicists seek to understand not just the familiar forms of matter we see around us, but also exotic forms such as those which existed in the first microseconds after the birth of the cosmos and that exist today inside neutron stars. The NP program addresses three tightly interrelated scientific thrusts: 1) how the strong nuclear force assembles quarks and gluons into protons and neutrons; 2) the structure of nuclei and how the known elements are produced in the cosmos; and 3) what evidence for science beyond our present understanding can be discovered in the decays of nuclei and the properties of the neutron.

The NP program continues support for the high-priority efforts and capabilities to maintain U.S. leadership in some areas of nuclear science. Specifically, it supports high-priority research of the nuclear physics community, as well as the development of cutting-edge approaches for producing isotopes critical to the nation, including ground breaking research on the production of alpha emitting isotopes in sufficient quantity to enable clinical trials for cancer therapy. Mission readiness is maintained for the production of radioactive isotopes that are in short supply for research and a wide array of applications.

Science Laboratories Infrastructure (SLI).—The Science Laboratories Infrastructure (SLI) program supports scientific and technological innovation at the Office of Science (SC) laboratories by funding and sustaining mission-ready infrastructure and fostering safe and environmentally responsible operations. The program provides state-of-the-art facilities and infrastructure that are flexible, reliable, and sustainable in support of scientific discovery. The SLI program also funds Payments in Lieu of Taxes to local communities around the Argonne, Brookhaven, and Oak Ridge National Laboratories.

Safeguards and Security.—The Safeguards and Security (S&S) program is designed to ensure appropriate security measures are in place to support the SC mission requirement of open scientific research and to protect critical assets within SC laboratories. This is accomplished by providing physical controls that will mitigate possible risks to the laboratories' employees, nuclear and special materials, classified and sensitive information, and facilities. The S&S program also provides funding for cyber security for the laboratories' information technology systems to protect electronic data while enabling the SC mission.

Workforce Development for Teachers and Scientists.—The Workforce Development for Teachers and Scientists (WDTS) program mission is to help ensure that DOE has a sustained pipeline of science, technology, engineering, and mathematics (STEM) workers. This is accomplished through support of undergraduate internships, graduate thesis research, and visiting faculty programs at the DOE laboratories; and annual, nationwide, middle- and high-school science competitions culminating in the National Science Bowl in Washington, D.C. These investments help develop the next generation of scientists and engineers to support the DOE mission, administer programs, and conduct research.

Program Direction.— Science Program Direction supports a highly skilled Federal workforce to develop and oversee SC investments in research and scientific user facilities. SC investments deliver scientific discoveries and major scientific tools that transform our understanding of nature and advance the energy, economic, and national security of the United States. In addition, SC provides public access to DOE scientific findings to further leverage the Federal science investment and advance the scientific enterprise. SC requires highly skilled scientific and technical program and project managers, as well as experts in areas such as acquisition, finance, legal, construction, and infrastructure management, human resources, and environmental, safety, and health oversight. SC plans, executes, and manages basic science research programs that address critical national needs. Oversight of DOE's basic research portfolio, which includes grants and contracts supporting nearly 19,000 researchers located at 300 universities and other institutions and 17 national laboratories, as well as supervision of major construction projects, is a Federal responsibility.

Object Classification (in millions of dollars)

Identification code 089–0222–0–1–251		2016 actual	2017 est.	2018 est.
	Direct obligations:			
	Personnel compensation:			
11.1	Full-time permanent	104	101	96
11.3	Other than full-time permanent	2	2	2
11.5	Other personnel compensation	1	1	2
11.8	Special personal services payments	2	2	.....
11.9	Total personnel compensation	109	106	100
12.1	Civilian personnel benefits	33	32	31
21.0	Travel and transportation of persons	4	4	4
23.1	Rental payments to GSA	1	1	1
23.2	Rental payments to others	2	2	2
23.3	Communications, utilities, and miscellaneous charges	3	3	3
25.1	Advisory and assistance services	24	23	23
25.2	Other services from non-Federal sources	34	33	33
25.3	Other goods and services from Federal sources	29	28	28
25.4	Operation and maintenance of facilities	3,307	3,219	2,697
25.5	Research and development contracts	148	144	144
25.7	Operation and maintenance of equipment	1	1	1
26.0	Supplies and materials	2	2	2
31.0	Equipment	223	217	200
32.0	Land and structures	659	641	500
41.0	Grants, subsidies, and contributions	908	883	704
99.0	Direct obligations	5,487	5,339	4,473
99.0	Reimbursable obligations	553	520	520
99.9	Total new obligations, unexpired accounts	6,040	5,859	4,993

Employment Summary

Identification code 089–0222–0–1–251		2016 actual	2017 est.	2018 est.
1001	Direct civilian full-time equivalent employment	917	881	785

ADVANCED RESEARCH PROJECTS AGENCY—ENERGY

(INCLUDING CANCELLATION OF FUNDS)

For Department of Energy administrative expenses necessary in carrying out the activities authorized by section 5012 of the America COMPETES Act (Public Law 110–69), $20,000,000, to remain available until September 30, 2019: Provided, That of the unobligated balances from prior year appropriations available under this heading, $46,367,000 is hereby permanently cancelled: Provided further, That no amounts may be cancelled from amounts that were previously designated by the Congress as an emergency requirement pursuant to a concurrent resolution on the budget or the Balanced Budget and Emergency Deficit Control Act of 1985: Provided further, That of the funding made available under this heading for ARPA-E projects in prior Acts, $45,000,000 shall be available for program direction, to remain available until expended: Provided further, That no amounts may be repurposed pursuant to this paragraph from amounts that were designated by the Congress as an emergency requirement pursuant to a concurrent resolution on the budget or the Balanced Budget and Emergency Deficit Control Act of 1985.

Note.—A full-year 2017 appropriation for this account was not enacted at the time the budget was prepared; therefore, the budget assumes this account is operating under the Further Continuing Appropriations Act, 2017 (P.L. 114–254). The amounts included for 2017 reflect the annualized level provided by the continuing resolution.