Biological and Environmental Research
Funding Profile by Subprogram and Activity

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Biological Systems Science			
Genomic Science			
Foundational Genomics Research	39,260	63,111	67,292
Genomics Analysis and Validation	10,000	10,000	10,000
Metabolic Synthesis and Conversion	39,912	19,462	19,462
Computational Biosciences	12,683	16,395	16,395
Bioenergy Research Centers	75,000	75,000	75,000
Total, Genomic Science	176,855	183,968	188,149
Radiological Sciences			
Radiochemistry and Imaging Instrumentation	17,540	19,410	17,540
Radiobiology	23,926	15,528	10,620
Total, Radiological Sciences	41,466	34,938	28,160
Ethical, Legal, and Societal Issues	1,000	0	0
Medical Applications	4,000	0	0
Biological Systems Facilities and Infrastructure			
Structural Biology Infrastructure	15,765	14,895	14,895
Joint Genome Institute	68,932	68,500	69,187
Total, Biological Systems Facilities and Infrastructure	84,697	83,395	84,082
SBIR/STTR	0	9,184	9,382
Total, Biological Systems Science	308,018	311,485	309,773
Climate and Environmental Sciences			
Atmospheric System Research	27,822	26,392	26,392
Environmental System Science			
Terrestrial Ecosystem Science	28,727	40,274	51,957
Terrestrial Carbon Sequestration Research	2,966	0	0
Subsurface Biogeochemical Research	48,838	27,380	27,380
Total, Environmental System Science	80,531	67,654	79,337

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Climate and Earth System Modeling			
Regional and Global Climate Modeling	31,273	28,659	32,964
Earth System Modeling	35,321	35,569	35,633
Integrated Assessment	11,258	9,853	9,853
Total, Climate and Earth System Modeling	77,852	74,081	78,450
Climate and Environmental Facilities and Infrastructure			
Atmospheric Radiation Measurement Climate Research Facility	45,770	67,977	70,574
Environmental Molecular Sciences Laboratory	51,340	50,324	47,671
Data Management	2,963	2,773	2,773
General Purpose Equipment (GPE)	250	500	500
General Plant Projects (GPP)	700	500	500
Total, Climate and Environmental Facilities and Infrastructure	101,023	122,074	122,018
SBIR/STTR	0	7,871	9,377
Total, Climate and Environmental Sciences	287,228	298,072	315,574
Total, Biological and Environmental Research	595,246[a]	609,557[b]	625,347

[a] Total is reduced by $16,577,000: $14,801,000 of which was transferred to the Small Business Innovation and Research (SBIR) program and $1,776,000 of which was transferred to the Small Business Technology Transfer (STTR) program.
[b] The FY 2012 appropriation is reduced by $2,266,000 for the Biological and Environmental Research Program share of the DOE-wide $73,300,000 rescission for contractor pay freeze savings. The FY 2013 budget request reflects the FY 2013 impact of the contractor pay freeze.

Public Law Authorizations

Public Law 95–91, "Department of Energy Organization Act", 1977
Public Law 109–58, "Energy Policy Act of 2005"
Public Law 110–69, "America COMPETES Act of 2007"
Public Law 111–358, "America COMPETES Act of 2010"

Overview and Benefits

The Biological and Environmental Research (BER) program supports fundamental research and scientific user facilities to address diverse and critical global challenges. The program seeks to understand how genomic information is translated to functional capabilities, enabling more confident redesign of microbes and plants for sustainable biofuel production, improved carbon storage, or contaminant bioremediation. BER research advances understanding of the roles of Earth's biogeochemical systems (the atmosphere, land, oceans, sea ice, and subsurface) in determining climate so we can predict climate decades or centuries into the future, information needed to plan for future energy and resource needs. Solutions to these challenges are driven by a foundation of scientific knowledge and inquiry in atmospheric chemistry and physics, ecology, biology, and biogeochemistry.

BER research uncovers nature's secrets from the diversity of microbes and plants to understand how biological systems work, how they interact with each other, and how they can be manipulated to harness their processes and products. By starting with the potential encoded by organisms' genomes, BER-funded scientists seek to define the principles that guide the translation of the genetic code into functional proteins and the metabolic/regulatory networks underlying the systems biology of plants and microbes as they respond to and

modify their environments. BER integrates discovery- and hypothesis-driven science, technology development, and foundational genomics research into predictive models of biological function for DOE mission solutions.

BER plays a unique and vital role in supporting research on atmospheric processes, climate change modeling, interactions between ecosystems and greenhouse gases (especially carbon dioxide [CO_2]), and analysis of impacts and interdependencies of climatic change with energy production and use. Understanding the Earth's radiant energy balance associated with clouds, aerosols, and atmospheric greenhouse gases represent the largest uncertainty in determining the rate of global climate change. BER supports research on the factors determining this balance—the role of different types of clouds, atmospheric particles, and greenhouse gases. BER also supports research to understand the impacts of climatic change—warmer temperatures, changes in precipitation, increased levels of greenhouse gases, changing distributions of weather extremes—on different ecosystems such as forests, grasslands, and farmland. Finally, BER research seeks understanding of the critical role that biogeochemical processes play in controlling the cycling and mobility of materials in the Earth's subsurface and across key surface-subsurface interfaces in the environment.

BER's scientific impact has been transformative. In 1986, the Human Genome Project gave birth to modern biotechnology and genomics-based systems biology. Today, with its Genomic Sciences Program and the DOE Joint Genome Institute (JGI), BER researchers are using powerful tools of plant and microbial systems biology to pursue breakthroughs needed to develop cost-effective cellulosic biofuels. Our three DOE Bioenergy Research Centers lead the world in fundamental biofuels research.

Since the 1950s, BER has been a critical contributor to climate science research in the U.S., beginning with studies of atmospheric circulation—the forerunners of climate models. Today, BER supports the Community Earth System Model, a leading U.S. climate model, and addresses two of the most critical areas of uncertainty in contemporary climate science—the impact of clouds and aerosols—through support of the Atmospheric Radiation Measurement Climate Research Facility, which is used by hundreds of scientists worldwide.

Through partnership with the Advanced Scientific Computing Research (ASCR) program, BER leverages DOE's high-performance computational modeling, simulation, and data capabilities to address grand challenges in climate and earth system modeling, environmental modeling, and systems biology.

BER pioneered the frontier of subsurface science, discovering novel microorganisms and understanding biogeochemical processes, including the fate of subsurface contaminants. BER's Environmental Molecular Sciences Laboratory (EMSL) at the Pacific Northwest National Laboratory (PNNL) provides powerful suites of instruments and computers to characterize biological organisms and molecules.

Basic and Applied R&D Coordination

BER research underpins the needs of DOE's energy and environmental missions. Fundamental research on microbes and plants to understand the genetic and biochemical mechanisms that control growth, development, and metabolism provides knowledge needed by DOE's Office of Energy Efficiency and Renewable Energy and the U.S. Department of Agriculture to develop new bioenergy crops and improved biofuel production processes that are cost effective and sustainable.

BER research on the transport and transformation of subsurface contaminants provides knowledge needed by DOE's Office of Environmental Management (EM) to develop new strategies for the remediation of weapons-related contaminants at DOE sites and to develop advanced monitoring tools and strategies for use by DOE's Office of Legacy Management. EM's Advanced Simulation Capability for Environmental Management modeling framework will enable better translation of BER fundamental science on subsurface processes to the EM community.

Finally, BER research to understand and predict future changes in the Earth's climate system is needed by DOE's Office of Policy and International Affairs as it develops strategies for our Nation's future energy needs and control of greenhouse gas emissions. The BER Integrated Assessment models continue to be important tools that link climate predictions to evaluations of new energy policies on greenhouse gas emissions as well as to help guide the design criteria for next generation energy infrastructures.

In general, BER coordinates with DOE's applied technology programs through regular joint program

manager meetings, and by participating in their internal program reviews, by participating in joint contractor meetings, and by conducting joint technical workshops.

Program Accomplishments and Milestone

Engineering microbes to directly convert plant material into different "drop-in" biofuels. Bioenergy Research Center scientists at the BioEnergy Science Center and the Joint BioEnergy Institute have metabolically engineered a war chest of different cellulose-degrading microbes to convert inedible plant material directly into different drop-in automotive, diesel, and jet biofuels. This work creates advances in consolidated biomass processing to produce a diversity of biofuels compatible with existing engines.

Assessing carbon impacts of land-use choices for bioenergy crops. Scientists at the Great Lakes Bioenergy Research Center have analyzed impacts of converting former croplands, now existing as grasslands, to various bioenergy production scenarios. Their results show that crop selection and soil management practices have a strong impact on greenhouse gas emission and carbon storage and will inform development of sustainable land management strategies for producing bioenergy crop systems.

Discovering new enzymes from microbes in a cow rumen digesting switchgrass. Scientists at the Joint Genome Institute analyzed the metagenome of the microbes in a cow rumen digesting the bioenergy crop switchgrass, enabling future discoveries of enzymes to break down plant material into simple sugars that could be converted into renewable biofuels.

ARM data improves climate models. Using a ten-year data set that integrates measurements from multiple Atmospheric Radiation Measurement Climate Research Facility (ARM) instruments, scientists have improved our ability to quantify the impact of clouds on climate model uncertainties. This joint effort between the ARMs and the BER Climate and Earth System Modeling activities improves our confidence in future projections of climate models.

EMSL capabilities lead to new catalyst for ethanol conversion. Using microstructure characterization instruments at the Environmental Molecular Sciences Laboratory (EMSL), scientists identified a new catalyst that converts ethanol, including bioethanol, to isobutene in a single step. Isobutene is a versatile feedstock chemical for jet fuel, tire rubber, solvents, gasoline additives, and other applications.

Milestone	Date
Provide to Congress an evaluation of each Bioenergy Research Center, a comparison of each center's achievements with the Department's original targets, and the Department's subsequent recommendation for extension or conclusion of each center.	February 2012
Demonstrate coupled climate models at 20km resolution.	4th Qtr, FY 2012
The average achieved operation time of the BER scientific user facilities as a percentage of the total scheduled annual operating time is greater than 98%.	4th Qtr, FY 2012

Explanation of Changes

Biological and Environmental Research continues support for key core research areas and scientific user facilities in bioenergy, climate, and environmental research. Increased investments target the development of synthetic biology tools and technologies and integrative analysis of experimental datasets. Observational research increases to improve understanding of the priority climatic sensitive regions of the Arctic and tropics, and modeling efforts will shift their emphasis from global scale dynamics to higher resolution scale interactions for these priority regions.

Program Planning and Management

BER uses broad input from scientific workshops[a] and external reviews, including those performed by the National Academies, to identify current and future scientific and technical needs and challenges in current national and international research efforts. BER also receives advice from the Biological and Environmental Research Advisory Committee (BERAC) on the management of its research programs (through Committee of Visitor [COV] reviews), on the direction and focus of its research programs, and on strategies for long-term planning and development of its research activities.

[a] BER scientific workshop reports are available at http://science.energy.gov/ber/news-and-resources

In FY 2011, BERAC issued a report on an overall strategy to inform a long-term vision for BER. A key emphasis of the report was the identification of the greatest scientific challenges in biological, climate, and environmental systems science that BER should address in the long-term (20-year horizon) and how BER should be positioned to address those challenges; the continued or new fields of BER-relevant science that DOE will need to pursue to achieve its future mission challenges; and the future scientific and technical advances needed to underpin BER's complex systems science. The report, "Grand Challenges for Biological and Environmental Research: A Long-Term Vision" [a] identified grand challenges in complex systems and synthetic biology, climate modeling and climate-related ecosystem science, energy sustainability, computing, and education and workforce development.

BER supports research at universities, research institutes, private companies, and DOE national laboratories. All BER-supported research undergoes regular peer review and merit evaluation based on procedures established in 10 CFR 605 for the external grant program and using a similar process for research at the national laboratories. BERAC conducts COV reviews of the merit evaluation conducted by BER subprograms every three years. Results of these reviews and BER responses are posted online[a]. A COV was assembled in 2011 to review Biological System Science Division. Every three years, BER also conducts consolidated onsite merit, operational, management, and safety reviews of each of its user facilities. Results of these reviews are used to address management, scientific, operational, and safety deficiencies.

The BER program is coordinated with activities of over 14 other federal organizations supporting or conducting complementary research. BER Climate Change Research is coordinated with the U.S. Global Change Research Program, an interagency program codified by Public Law 101-606 and involving other federal agencies and departments, and the U.S. Climate Change Technology Program.

Program Goals and Funding

Office of Science performance expectations (and therefore funding requests) are focused on four areas:

Research: Increase our understanding of and enable predictive control of phenomena in complex biological, climatic, and environmental systems sciences.

Facility Operations: Maximize the reliability, dependability, and availability of the SC scientific biological, climatic, and environmental user facilities.

Future Facilities: Build future and upgrade existing facilities and experimental capabilities to ensure the continuing value of the SC scientific user facilities. All construction projects and MIEs are within 10% of their specified cost and schedule baselines.

Scientific Workforce: Contribute to the effort aimed at ensuring that DOE and the Nation have a sustained pipeline of highly skilled and diverse science, technology, engineering, and mathematics (STEM) workers.

[a] http://science.energy.gov/ber/berac/reports/

Goal Areas by Subprogram

	Research	Facility Operations	Future Facilities	Scientific Workforce
Biological Systems Science	70%	30%	0%	0%
Climate and Environmental Sciences	60%	40%	0%	0%
Total, Biological and Environmental Research	65%	35%	0%	0%

Explanation of Funding and Program Changes

(Dollars in Thousands)

	FY 2012 Enacted	FY 2013 Request	FY 2013 vs. FY 2012
Biological Systems Science	311,485	309,773	-1,712
BER is increasing investment in the development of synthetic biology tools and biodesign technologies and integrative analysis of experimental genomic science datasets. The resulting new molecular-level insight into the design, function, and regulation of plants, microbes, and biological communities will contribute toward cost-effective production of next generation biofuels as a major secure national energy resource and the bioeconomy. Support is continued for core research in bioenergy and carbon cycling, including the DOE Bioenergy Research Centers. Radiological science research is decreased as funding for the activities on human nuclear medicine and exposure outcomes at Fukushima Daiichi are completed in FY 2012.			
Climate and Environmental Sciences	298,072	315,574	+17,502
BER observational efforts to describe the interrelationships between climate change in Arctic and tropical ecosystems, including aerosols and clouds, will increase, and modeling efforts will shift their emphasis from global scale dynamics to higher resolution scale interactions for regions that are of primary interest to both the scientific community and stakeholders. Subsurface Biogeochemical Research is reduced on contaminant mobility and on geologic barriers to groundwater contaminant transport.			
Total, Biological and Environmental Research	609,557	625,347	+15,790

Biological Systems Science
Funding Profile by Activity

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Genomic Science			
Foundational Genomics Research	39,260	63,111	67,292
Genomics Analysis and Validation	10,000	10,000	10,000
Metabolic Synthesis and Conversion	39,912	19,462	19,462
Computational Biosciences	12,683	16,395	16,395
Bioenergy Research Centers	75,000	75,000	75,000
Total, Genomic Science	176,855	183,968	188,149
Radiological Sciences			
Radiochemistry and Imaging Instrumentation	17,540	19,410	17,540
Radiobiology	23,926	15,528	10,620
Total, Radiological Sciences	41,466	34,938	28,160
Ethical, Legal, and Societal Issues (ELSI)	1,000	0	0
Medical Applications	4,000	0	0
Biological Systems Facilities and Infrastructure			
Structural Biology Infrastructure	15,765	14,895	14,895
Joint Genome Institute	68,932	68,500	69,187
Total, Biological Systems Facilities and Infrastructure	84,697	83,395	84,082
SBIR/STTR	0[a]	9,184	9,382
Total, Biological Systems Science	308,018	311,485	309,773

[a] In FY 2011, $7,791,000 and $935,000 were transferred to the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, respectively. SBIR/STTR funding is set at 2.95% of non-capital funding in FY 2012 and 3.05% in FY 2013.

Overview

Biological Systems Science is unique in the U.S. science enterprise in integrating discovery- and hypothesis-driven science, technology development, and foundational research on plant and microbial systems. Systems biology is the multidisciplinary study of complex interactions specifying the function of entire biological systems—from single cells to multicellular organisms—rather than the study of individual components. The Biological Systems Science subprogram focuses on utilizing systems biology approaches to define the functional principles that drive living systems, from microbes and microbial communities to plants and other whole organisms.

Key questions that drive these studies include:

- What information is in the genome sequence?
- How is information coordinated between different subcellular constituents?
- What molecular interactions regulate the response of living systems and how can those interactions be understood dynamically and predictively?

The approaches employed include genome sequencing, proteomics, metabolomics, structural biology, high-resolution imaging and characterization, and integration of information into predictive computational models of biological systems that can be tested and validated.

The subprogram supports operation of a scientific user facility, the DOE Joint Genome Institute (JGI), and use of structural biology facilities through the development of instrumentation at DOE's national user facilities. Support is also provided for research at the interface of the biological and physical sciences, and in radiochemistry and instrumentation to develop new methods for real-time, high-resolution imaging of dynamic biological processes.

Explanation of Funding Changes

(Dollars in Thousands)

	FY 2012 Enacted	FY 2013 Request	FY 2013 vs. FY 2012
Genomic Science	183,968	188,149	+4,181
Genomic Science research remains a priority activity, with Foundational Genomics Research increasing for the development of synthetic biology tools and biodesign technologies for plant and microbial systems relevant to bioenergy production, carbon and nutrient cycling, and environmental change. Targeted research in Metabolic Synthesis and Conversion on cellulosic ethanol and biohydrogen decreases, as the DOE Bioenergy Research Centers continue to conduct research on advanced renewable biofuels. Computational Biosciences continues to enable the Systems Biology Knowledgebase tools and integrative analysis of plant and microbial functional genomics experimental datasets.			
Radiological Sciences	34,938	28,160	-6,778
Radionuclide imaging research for real-time visualization of dynamic biological processes in energy and environmentally-relevant contexts continues, while concluding training activities to transfer synthetic and instrumentation knowledge to the nuclear medicine research community. Research is specifically prioritized to enable mechanism-based models that incorporate both radiobiology and epidemiology, reducing activities in cell-to-cell communication, cell aging and senescence, and cell microenvironment. Funding for research informing the exposure outcomes of the Fukushima Daiichi nuclear reactor is completed in FY 2012.			
Biological Systems Facilities and Infrastructure	83,395	84,082	+687
Funding continues to support large-scale, complex genome sequencing and analysis at the Joint Genome Institute, with increasing emphasis on understanding comparative or community-scale plant and microbial genomics. Support continues for the development of instrumentation at SC's synchrotron light sources, neutron sources, and next-generation user facilities for analyzing biological structure-function relationships.			
SBIR/STTR	9,184	9,382	+198
SBIR/STTR funding levels are a set percent of overall research funding.			
Total, Biological Systems Science	311,485	309,773	-1,712

Genomic Science

Overview

The Genomic Science activity supports research aimed at identifying the fundamental principles that drive biological systems relevant to DOE missions in energy, climate, and the environment. These principles guide the translation of the genetic code into functional proteins and the metabolic/regulatory networks underlying the systems biology of plants, microbes, and communities. Advancing fundamental knowledge of these systems will enable new solutions to national challenges in sustainable bioenergy production, understanding the fate and transport of environmental contaminants, and developing new approaches to examine the role of biological systems in carbon cycling, biosequestration, and global climate.

The major objectives of the Genomic Science activity are to determine the molecular mechanisms, regulatory elements, and integrated networks needed to understand genome-scale functional properties of microbes, plants, and communities; develop "-omics" experimental capabilities and enabling technologies needed to achieve a dynamic, system-level understanding of organism and community functions; and develop the knowledgebase, computational infrastructure, and modeling capabilities to advance predictive understanding and manipulation of biological systems.

This Systems Biology Knowledgebase is designed to be an integrated experimental framework for accessing, comparing, analyzing, modeling, and testing Genomic Science data. The first phase of the knowledgebase effort becomes fully operational in FY 2013 with the integration of plant and microbial experimental with genomic sequencing datasets.

The team-based multi-institutional Bioenergy Research Centers focus on innovative research to achieve the basic science breakthroughs needed to develop sustainable and effective methods of producing cellulosic biofuels.

Funding and Activity Schedule

Fiscal Year	Activity	Funding ($000)
FY 2011 Current	Genomic Science activities supported comparative genomic analysis, functional annotation of genes, proteins, and metabolic or regulatory networks, and development of new multi-modal imaging instrumentation for dynamic characterization of biological processes in plants and microbes. The Bioenergy Research Centers performed multidisciplinary research on converting inedible plant biomass to advanced renewable biofuels. The Computational Bioscience activity established a Systems Biology Knowledgebase to develop capabilities for broad researcher access and integration of microbial and plant genomic datasets.	176,855
FY 2012 Enacted	Support continues for core research activities in plant and microbial systems-level functional genomics and for the Bioenergy Research Centers. Foundational Genomics Research supports the development of new synthetic molecular toolkits for understanding natural systems combined with computer-aided design testbeds for the construction of improved biological components, processes, and systems. These toolkits and testbeds will facilitate synthetic biology design engineering and prototyping of improved multi-component biological functional modules with applications in bioenergy production, environmental remediation, and carbon cycling. This new activity was informed by the report from the 2011 Biosystems Design Workshop[a].	183,968

[a] http://science.energy.gov/ber/news-and-resources/

Fiscal Year	Activity	Funding ($000)
	Computational Biosciences will further develop a Systems Biology Knowledgebase to integrate microbial community genomic, proteomic, and transcriptomic experimental data sets from research conducted at the DOE Bioenergy Research Centers, the Joint Genome Institute, and the Genomic Science supported activities. Synthetic biology research, including environmental, ethical, legal, and societal impacts, will be coordinated across the Federal Government. The increase will also support development of new methods for simulation of microbial metabolism and cellular regulation.	
FY 2013 Request	Investment in the development of synthetic biology tools and biodesign technologies and integrative analysis of experimental genomic science datasets will be increased. The resulting new molecular-level insight into the design, function, and regulation of plants, microbes, and biological communities will contribute to cost-effective production of next generation biofuels as a major secure national energy resource. The activity will continue to coordinate across the Federal Government on research on the environmental, ethical, legal, and societal impact of synthetic biology, especially to understand stability and containment of engineered genes in environmental settings. Support continues for core research activities in plant and microbial systems-level functional genomics and networks, with completion of Metabolic Synthesis and Conversion targeted research on cellulosic ethanol and biohydrogen. Based upon the successful outcome of a merit review conducted in FY 2012, the Bioenergy Research Centers will begin a renewal funding period in FY 2013, continuing research on advanced biofuels. Computational Biosciences supports the Systems Biology Knowledgebase effort to develop predictive simulation efforts in microbial community interactions.	188,149

(Dollars in Thousands)

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Foundational Genomics Research	39,260	63,111	67,292
Genomics Analysis and Validation	10,000	10,000	10,000
Metabolic Synthesis and Conversion	39,912	19,462	19,462
Computational Biosciences	12,683	16,395	16,395
Bioenergy Research Centers	75,000	75,000	75,000
Total, Genomic Science	176,855	183,968	188,149

Radiological Sciences

Overview

Radiological Sciences supports radionuclide synthesis and imaging research for real-time visualization of dynamic biological processes in energy and environmentally relevant contexts. The activity has significantly transitioned from its historical focus on nuclear medicine research and applications for health to focus on real-time, whole organism understanding of metabolic and signaling pathways in plants and nonmedical microbes. Radionuclide imaging continues to be a singular tool for studying living organisms in a manner that is quantitative, three dimensional, temporally dynamic, and non-perturbative of the natural biochemical processes. The instrumentation research focuses on improved metabolic imaging in the living systems, including plants and microbial-communities, relevant to biofuels production and bioremediation of interest to DOE. The activity also supports fundamental research on integrated gene function and response of biological organisms to low dose radiation exposure, through systems genetics analysis in model systems and epidemiological studies. This activity contributes a scientific foundation for informed decisions regarding remediation of contaminated DOE sites and for determining acceptable levels of human health protection, for both cleanup workers and the public, in the most cost-effective manner.

Funding and Activity Schedule

Fiscal Year	Activity	Funding ($000)
FY 2011 Current	Research supported the development and use of innovative radiotracer chemistry and complementary radionuclide imaging instrumentation technologies for quantitative *in vivo* measurement of radiotracer concentration and site-specific chemical reactions. Research was initiated to examine epidemiological models for low dose radiation exposure.	41,466
FY 2012 Enacted	Core research activities in radiotracer synthetic chemistry and complementary imaging instrumentation continues; additional activity includes nuclear medicine research with human application as directed by Congress (in the FY 2012 Energy and Water Development Appropriations conference report [H. Rpt. 112-331]), and a report will be prepared for a strategy to continue this research through more appropriate federal agencies with health-focused missions. Research is completed for integrated training in radiotracer synthetic methodology and *in vivo* imaging and detection relevant to nuclear medicine applications. Funds support a limited number of systems genetic studies of integrated gene function and response to the environment, drawing on prior studies of specific gene targets and individual cellular response and focusing only at the tissue or whole organism level. H. Rpt. 112-331 directs continuation of research to help determine health risks from exposures to low levels of ionizing radiation, as well as studies of health impacts at and around the Fukushima Daiichi nuclear plant.	34,938
FY 2013 Request	Funding continues for core research activities in radiotracer synthetic chemistry for real-time visualization of dynamic biological processes in the energy and environmentally-relevant contexts. Funding is completed in FY 2012 for studies of DNA damage and repair in response to low dose radiation of specific gene targets in single cell culture models and for studies informing the exposure risks at the Fukushima Daiichi nuclear plant. Research will be completed for the development of a limited number of systems genetic reference mouse populations. Priority research begins to address integration of mechanism-based models that incorporate both radiobiology and epidemiology.	28,160

(Dollars in Thousands)

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Radiochemistry and Imaging Instrumentation	17,540	19,410	17,540
Radiobiology	23,926	15,528	10,620
Total, Radiological Sciences	41,466	34,938	28,160

Ethical, Legal, and Societal Issues

Overview

The activity addresses ethical, legal, and societal impacts for application of genomic research results in bioenergy, synthetic biology, and nanotechnology. Beginning in FY 2012, research related to the societal benefits and implications of DOE mission areas will be addressed within relevant Genomic Science programmatic activities. Beginning in FY 2013, 5% of funding for synthetic biology and biodesign activities in Foundational Genomics Research will be directed toward this research.

Funding and Activity Schedule

Fiscal Year	Activity	Funding ($000)
FY 2011 Current	Funds supported the completion of individual studies on the societal impacts of synthetic biology and bioenergy.	1,000
FY 2012–2013	Activity is completed.	0

Medical Applications

Overview

This activity supports the design, fabrication, integration, and testing of a 240+ microelectrode visual prosthesis device (the artificial retina). DOE's role in this effort was completed in FY 2011.

Funding and Activity Schedule

Fiscal Year	Activity	Funding ($000)
FY 2011 Current	BER research on the development of the components of an artificial retina was completed in FY 2010. In FY 2011, research was completed on the 240+ electrode artificial retina device integration and final testing and refinement of the assembled device for readiness to transition to pre-clinical testing.	4,000
FY 2012–2013	Activity is completed.	0

Biological Systems Science Facilities and Infrastructure

Overview

Biological Systems Science supports unique scientific facilities and infrastructure related to genomics and structural biology that are widely used by researchers in academia, the national laboratories, and industry. The Joint Genome Institute (JGI) is the only federally funded major genome sequencing center focused on genome discovery and analysis in plants and microbes for energy and environmental applications. High-throughput DNA sequencing underpins modern systems biology research, providing fundamental biological data on organisms, and groups of organisms. By understanding shared features of multiple genomes, scientists can identify key genes that may link to biological function. These functions include microbial metabolic pathways and enzymes that are used to generate fuel molecules, affect plant biomass formation, degrade contaminants, or capture CO_2, leading to the optimization of these organisms for biofuels production and other DOE missions.

The JGI is developing aggressive new strategies for complex genome assembly using next-generation sequencing platforms and genomic analysis tools. The JGI also performs metagenome (genomes from multiple organisms) sequencing and analysis from environmental samples and is developing single cell sequencing techniques on hard-to-culture cells from environments relevant to DOE missions. Technological requirements are driven by the Bioenergy Research Centers and grand challenge proposals submitted by the broader scientific user community.

BER also supports development and use of specialized instrumentation for biology at the major DOE user facilities, such as the synchrotron light sources and neutron facilities. These research facilities enable science aimed at understanding the structure and properties of biological systems at resolution and scale not possible with instrumentation available in university, institute, or industrial laboratories. This information is critical in contributing to our understanding of the relationship between genome, biological structure, and function, leading to practical applications of this knowledge for energy and the environment.

Funding and Activity Schedule

Fiscal Year	Activity	Funding ($000)
FY 2011 Current	The JGI provided access to the scientific user community and the DOE Bioenergy Research Centers to large-scale genome data acquisition and analysis. Support continued for research at established structural biology instrumentation at the synchrotron light sources and neutron facilities.	84,697
FY 2012 Enacted	JGI continues to provide access to the scientific user community and the DOE Bioenergy Research Centers for large-scale genome data acquisition and analysis. Funding supports a greater emphasis on metagenome expression and sequencing of environmental microbial communities or the plant-microbe rhizosphere, improved genome annotation, and functional analysis and verification of genome-scale models. JGI initiates new efforts to transform its capabilities and provide functional genomic interpretations of biological systems in large scale multi-disciplinary environmental and targeted systems biology studies while maintaining operating performance at 98% of scheduled operating time. Support continues for research at established structural biology instrumentation at the synchrotron light sources and neutron facilities, informed by the report of the 2011 workshop on "*Applications of new DOE National User Facilities in Biology*"[a].	83,395

[a] http://science.energy.gov/ber/news-and-resources/

Fiscal Year	Activity	Funding ($000)
FY 2013 Request	The JGI supports a greater emphasis on functional genomics analysis for plants and microbes combining massive sequencing capability with high performance computing for data management, integration, and analysis in conjunction with BER's Systems Biology Knowledgebase effort. JGI continues to utilize new technologies for higher-throughput genome analysis and integration with other proteomic and metabolomic datasets and develop new high-throughput sample processing to ease pre-sequencing sample preparation bottlenecks to large scale sequencing projects. JGI sequencing capabilities also support synthetic biology design efforts. Support continues to develop structural biology instrumentation and end stations and new research capabilities at the synchrotron light sources and neutron facilities.	84,082

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Climate and Environmental Sciences
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(Dollars in Thousands)

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Regional and Global Climate Modeling	31,273	28,659	32,964
Earth System Modeling	35,321	35,569	35,633
Integrated Assessment	11,258	9,853	9,853
Total, Climate and Earth System Modeling	77,852	74,081	78,450
Climate and Environmental Facilities and Infrastructure			
Atmospheric Radiation Measurement (ARM) Climate Research Facility	45,770	67,977	70,574
Environmental Molecular Sciences Laboratory	51,340	50,324	47,671
Data Management	2,963	2,773	2,773
General Purpose Equipment (GPE)	250	500	500
General Plant Projects (GPP)	700	500	500
Total, Climate and Environmental Facilities and Infrastructure	101,023	122,074	122,018
SBIR/STTR	0[a]	7,871	9,377
Total, Climate and Environmental Sciences	287,228	298,072	315,574

[a] In FY 2011, $7,010,000 and $841,000 were transferred to the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, respectively. SBIR/STTR funding is set at 2.95% of non-capital funding in FY 2012 and 3.05% in FY 2013.

Overview

The Climate and Environmental Sciences subprogram focuses on a predictive, systems-level understanding of the fundamental science associated with climate change and DOE's environmental challenges—both key to supporting DOE's science mission. The subprogram supports an integrated portfolio of research from molecular-level to field-scale studies with emphasis on multidisciplinary experimentation and use of advanced computer models. The science and research capabilities supported enable DOE leadership in climate-relevant atmospheric-process research and modeling, including clouds, aerosols, and the terrestrial carbon cycle; large-scale climate change modeling; experimental research on the effects of climate change on ecosystems; integrated analysis of climate change impacts; and advancing fundamental understanding of coupled physical, chemical, and biological processes controlling

contaminant mobility in the environment. The Department will continue to advance the science necessary to further develop predictive climate and earth system models at the regional spatial scale and decadal to centennial time scales, involving close coordination with the U.S. Global Change Research Program and through the international science community.

The subprogram supports three primary research activities and two national scientific user facilities. The two user facilities are the Atmospheric Radiation Measurements Climate Research Facility (ARM) and the Environmental Molecular Sciences Laboratory (EMSL). ARM provides unique, multi-instrumented capabilities for continuous, long-term observations needed to develop and test understanding of the central role of clouds and aerosols on the Earth's climate. EMSL provides integrated experimental and computational resources needed to understand the physical, chemical, and biological processes that underlie DOE's energy and environmental mission areas.

Explanation of Funding Changes

(Dollars in Thousands)

	FY 2012 Enacted	FY 2013 Request	FY 2013 vs. FY 2012
Atmospheric System Research	26,392	26,392	0
Research continues on improved formulations for aerosols, clouds, and aerosol-cloud interactions in order to improve estimates of how these feedbacks have and will impact climate.			
Environmental System Science	67,654	79,337	+11,683
The activity will continue to support a next-generation ecosystem experiment, begun in 2012, focused on the relationship between climate change and Arctic permafrost ecosystems and will initiate a new activity exploring the relationship between climate and tropics ecology. Subsurface biogeochemical research continues to focus on environmental research across scales as a continuum of complex interdependent processes, while reducing emphasis on contaminant mobility and on geologic barriers to groundwater contaminant transport.			
Climate and Earth System Modeling	74,081	78,450	+4,369
Research increases to improve model resolution and enhance model validation and verification as well continue improving the efficiency of data management and analysis.			
Climate and Environmental Facilities and Infrastructure	122,074	122,018	-56
ARM will increase to fully operate the new mobile facility deployed at Oliktok, AK, and permanent site in the Azores, the first permanent midlatitude marine ARM Climate Research Facility site. The Environmental Molecular Sciences Laboratory will decrease as the funding is completed in FY 2012 for the High Magnetic Field Mass Spectrometer. EMSL operations will continue to support users on the advanced capabilities delivered through the Recovery Act.			

(Dollars in Thousands)

	FY 2012 Enacted	FY 2013 Request	FY 2013 vs. FY 2012
SBIR/STTR	7,871	9,377	+1,506
SBIR/STTR funding is set as a percent of overall research funding. In FY 2012 the ARM Climate Research Facility and EMSL capital equipment funding is completed and operations funding increases.			
Total, Climate and Environmental Sciences	298,072	315,574	+17,502

Overview

Atmospheric System Research (ASR) is the primary U.S. activity addressing the two major areas of uncertainty in climate change model projections: the role of clouds and the effects of aerosols on precipitation and the atmospheric radiation balance. This activity coordinates strongly with the ARM, utilizing the facility's continuous long-term datasets that provide measurements of radiation, aerosols, clouds, precipitation, dynamics, and thermodynamics over a range of environmental conditions at climatically diverse locations. The long-term observational datasets are supplemented with laboratory studies and shorter-duration ground-based and airborne field campaigns to target specific atmospheric processes under a diversity of locations and atmospheric conditions. ASR research results are incorporated into Earth System Models developed by Climate and Earth System Modeling to both understand the processes that govern atmospheric components and to advance the Earth System Model capabilities with greater certainty of predictions. Finally, ASR seeks to develop integrated, scalable test-beds that incorporate process-level understanding of the life cycles of aerosols, clouds, and precipitation into dynamic models.

Funding and Activity Schedule

Fiscal Year	Activity	Funding ($000)
FY 2011 Current	Research supported improved understanding and modeling the radiation balance from the surface of the Earth to the top of the atmosphere and how this balance is affected by clouds and aerosols. One focus was evaluation and updating of atmospheric process modules introduced into the Community Earth System Model in 2010.	27,822
FY 2012 Enacted	Research continues using data from the new instruments at the ARM sites to support research, specifically the development of three-dimensional representation of clouds in climate models. Research also continues on marine boundary layer clouds, Arctic clouds and their interactions with aerosols, and processes and atmospheric transformations involving biogenic aerosols.	26,392
FY 2013 Request	Continues process studies and modeling efforts on developing improved formulations for aerosols, clouds, and aerosol-cloud interactions in order to improve estimates of how these feedbacks have and will impact the climate. Specific focuses include Arctic and tropical aerosol-cloud-precipitation interactions, and high altitude (cirrus) clouds and their life cycles and impacts on radiation budget.	26,392

Overview

Environmental System Science supports research that provides scientific understanding of the effects of climate change on terrestrial ecosystems, the role of terrestrial ecosystems in global carbon cycling, and the role of subsurface biogeochemical processes determining flow and transport in the subsurface and how the subsurface and above ground environments interact.

A significant fraction of the carbon dioxide (CO_2) released to the atmosphere during fossil fuel combustion is taken up by terrestrial ecosystems, but the impacts of the timing and magnitude of climatic change, particularly warming, on the uptake of CO_2 by the terrestrial biosphere remains poorly understood. The significant sensitivity of climate models to a terrestrial carbon cycle feedback, and the uncertain sign of that feedback, makes resolving the role of the terrestrial biosphere on the carbon balance a high priority. The research focuses on understanding and modeling the processes controlling exchange rates of CO_2 between atmosphere and terrestrial biosphere, evaluating terrestrial source-sink mechanisms for atmospheric CO_2, and improving the representation of terrestrial ecosystems in coupled earth system models.

Subsurface biogeochemical research supports integrated research, ranging from molecular to field scales, to understand and predict the role that biogeochemical processes play in controlling the cycling and mobility of materials in the subsurface and across key surface-subsurface interfaces in the environment, including environmental contamination from past nuclear weapons production.

Funding and Activity Schedule

Fiscal Year	Activity	Funding ($000)
FY 2011 Current	Continued research to understand and predict important potential effects of climate change and increasing atmospheric CO_2 concentration on mid-latitude and boreal/peatland ecosystems. Continued integrated, multi-disciplinary, multi-scale research to advance a predictive understanding of processes controlling the mobility of radionuclides and nutrients in the environment.	80,531
FY 2012 Enacted	Research continues to focus on potential effects of warming, changes in rainfall, and increasing concentrations of atmospheric CO_2 on terrestrial ecosystems and the terrestrial carbon cycle. A shift in emphasis focuses on a new next-generation ecosystem-climate change experiment to predict changes in Arctic permafrost. Research efforts continue to test and evaluate computer models describing subsurface mobility of radionuclides and nutrients. In addition, experimental research at the three Integrated Field Research Challenge (IFRC) sites will emphasize sites where there are biological and biogeochemical process controls over heavy metal and radionuclide flow and transport, reducing activities at two of the sites.	67,654
FY 2013 Request	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. A second Next Generation Ecosystem Experiment (NGEE) 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 experiment will examine the role of rainfall stress on Amazonian ecosystems and the resulting shifts in released aerosols that serve as cloud condensation nuclei.	79,337

Fiscal Year	Activity	Funding ($000)
	Subsurface Biogeochemical Research continues support to advance the predictive understanding of processes controlling the mobility of radionuclides and nutrients in the environment, including field-based activities at one IFRC site. The focus of the multi-disciplinary field-based investigations will retain a focus to advance a science-based general modeling framework, based on a shift to larger system scales as recommended in the 2010 workshop report, "*Complex Systems Science for Subsurface Fate and Transport*" [a].	

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Terrestrial Ecosystem Science	28,727	40,274	51,957
Terrestrial Carbon Sequestration Research	2,966	0	0
Subsurface Biogeochemical Research	48,838	27,380	27,380
Total, Environmental System Science	80,531	67,654	79,337

[a] http://science.energy.gov/ber/news-and-resources/

Climate and Earth System Modeling

Overview

Climate and Earth System Modeling develops physical, chemical, and biological model components, including the interactions of human and natural earth systems, needed to simulate climate variability and change from decades to centuries at regional and global scales. The research specifically focuses on quantifying and reducing the uncertainties in earth system models. Priority model components include the ocean, sea-ice, land-ice, aerosols, atmospheric chemistry, terrestrial carbon cycling, and dynamical cores.

A unique objective of the BER Climate and Earth System Modeling investments is the study and modeling of both historical and current climate change, with an objective to validate and improve future climate projections based on the prediction successes using existing data testbeds. To rapidly and efficiently advance model capabilities, BER supports a unique and powerful inter-comparison resource for global climate model development, validation, diagnostics, and outputs, using all 23 of the world's leading climate models. This ensures BER can exploit the best available science and practice within each of the world's leading climate research programs. The BER-supported Community Earth System Model is designed by the research community with open access and broad use by climate researchers worldwide; this model provides a critical capacity for regional climate projections, including information on how the frequency of occurrence and intensity of storms, droughts, and heat waves will change as climate evolves. Demonstrating the critical linkages between DOE's climate modeling investments, the scientific priorities for improvement of the community model are based on the outputs of the intercomparison and validation resource. DOE has also provided computational power and expertise to the Earth System modeling community, through its internal partnership between BER and ASCR, innovating code design for optimal model computation on its petascale computers. Investments in the development of reliable climate modeling tools are essential for informing multibillion to trillion dollar investment decision-making processes for infrastructures associated with large-scale deployment of energy supply and transmission.

Funding and Activity Schedule

Fiscal Year	Activity	Funding ($000)
FY 2011 Current	Research focused on incorporating and testing improved representations of specific processes and sub-systems within the coupled models. Efforts have focused on aerosols, convection, ice sheets, and land surface in the coupled climate models; water supply and demand and land use interactions in the integrated assessment models; and evaluations using innovative metrics that span a variety of climate time scales. Research to increase model resolution and computational performance was also conducted, as well as multi-scale process interactions and issues.	77,852
FY 2012 Enacted	Model enhancements will focus on adding additional representations of processes within the coupled models while improving understanding and representations of complex systems dynamics. For example, ice sheet and ocean models will be coupled in the Community Earth System Model to be capable of projecting sea-level rise, and systems dynamics will be explored within and among Earth system and integrated assessment models. Additional work will be centered on improving both the spatial and temporal resolutions required for DOE mission-focused needs. This includes the development of a variable grid coupled climate model, able to produce predictions at 20 km resolution by the 4th quarter of FY 2012. Tools for the dissemination of climate model output in support of the Intergovernmental Panel on Climate Change (IPCC) Assessment Report 5 (AR 5) will be implemented.	74,081

Fiscal Year	Activity	Funding ($000)
FY 2013 Request	Research will focus on the development of an enhanced validation and verification capability to compare models and measurements with common framework and sophisticated software tools. A framework to use ARM measurements to validate the clouds and terrestrial carbon measurements to validate the land model will be included in this toolbox. Research will be increased to enhance resolution of climate models operating on regional scales, and to the expand model diagnostics, databases, and intercomparison studies. Funding will be provided to augment the data and diagnostic technical and analysis capabilities within the national laboratories, so that climate projections carried out in support of the IPCC AR5.	78,450

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Regional and Global Climate Modeling	31,273	28,659	32,964
Earth System Modeling	35,321	35,569	35,633
Integrated Assessment	11,258	9,853	9,853
Total, Climate and Earth System Modeling	77,852	74,081	78,450

Overview

Climate and Environmental Facilities and Infrastructure includes two scientific user facilities, climate data management for the climate science community, and general purpose equipment and plant projects for the Oak Ridge Institute for Science and Education. Two scientific user facilities—the Atmospheric Radiation Measurement Climate Research Facility (ARM) and the Environmental Molecular Sciences Laboratory (EMSL)—provide the broad scientific community with technical capabilities, scientific expertise, and unique information to facilitate science in areas integral to the DOE/BER mission.

ARM is a multi-platform national scientific user facility, providing the world's most comprehensive continuous field measurements of climate data to promote the advancement of atmospheric process understanding and climate models through precise observations of atmospheric phenomena. ARM currently contains three fixed long-term measurement facility sites (in Oklahoma, Alaska, and the western Pacific), two mobile facilities, and an airborne research capability that operates at sites selected by the scientific community. The ARM permanent sites and mobile measurement campaigns are distributed around the world in locations where we most critically need data to incorporate into climate models and improve model performance and predictive capabilities; many of these regions are also of high national and energy security interest. Each of the ARM sites contains scanning radars, lidar systems, and in situ meteorological observing capabilities; the sites are additionally used to demonstrate technologies as they are developed by the community. ARM experiments to study the impact of clouds and aerosols on the Earth's radiative balance address the two most significant scientific uncertainties in climate research. BER is also maintaining the exponentially increasing data archive, with plans for climate projections to have higher resolution, greater sophistication, lower uncertainty, and to better specify tipping points in climate projections (e.g., permafrost thaw and extreme events).

Data sets generated by ARM and from earth system modeling activities are large. The BER data management activity will continue to invest in data-intensive science**.** This research will be in collaboration with the Office of Science's Advanced Scientific Computing Research program.

EMSL provides integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences. With more than fifty leading-edge instruments, EMSL enables users to undertake molecular-scale experimental and theoretical research on aerosol chemistry, biological systems, biogeochemistry, and interfacial and surface science. EMSL thus provides a unique opportunity to use multiple experimental systems to provide fundamental understanding of the physical, chemical, and biological processes that underlie DOE's energy and environmental mission areas, including alternative energy sources, improved catalysts and materials for industrial applications, insights into factors influencing climate change and carbon sequestration processes, and subsurface biogeochemical drivers at contaminated sites.

Funding and Activity Schedule

Fiscal Year	Activity	Funding ($000)
FY 2011 Current	ARM continued its long-term observations from the fixed sites and provided data from new instruments able to produce 3-D cloud evolution and properties, aerosol composition, meteorological conditions, and surface characterization. A joint field experiment with NASA was conducted to study convective cloud systems in Oklahoma. The mobile facilities supported experiments in India to examine the impact of aerosols on the Indian monsoon and in Colorado to examine liquid and mixed-phase clouds.	101,023

Fiscal Year	Activity	Funding ($000)
	EMSL instruments and supercomputer are operated to support research to obtain a fundamental understanding of the physical, chemical, and biological processes including alternative energy sources such as biofuels; biogeochemical interactions that influence subsurface contaminant movement; improved catalysts and materials for industrial applications; and insights into the molecular reactions that influence climate change and carbon sequestration processes. Funding is continued for the High Magnetic Field Mass Spectrometer. Data management activities continue and carbon cycle data holdings are added to the Earth System Grid, a network for sharing model simulations and observations among the modelers.	
FY 2012 Enacted	ARM will continue its long-term measurements for users to address key scientific uncertainties with a goal to achieve 98% of scheduled operating time. Mobile facilities will support the continuation of the India experiment as well an experiment on the Madden Julian Oscillation on Gan Island in the Indian Ocean. The new mobile facility will initially be located at Oliktok Point, AK for three dimensional measurements of cloud and aerosol properties over land, sea, and ice. The new ARM fixed site in the Azores will provide new long-term observations for marine clouds and aerosols. EMSL will continue to support research to obtain a fundamental understanding of the physical, chemical, and biological processes and a goal to achieve 98% of scheduled operating time. Funding is completed for the High Magnetic Field Mass Spectrometer. Data management activities will continue.	122,074
FY 2013 Request	ARM will continue its long-term measurements at fixed and mobile facilities for users to address key scientific uncertainties. The ARM measurements at Oliktok Point, AK and the Azores will be fully operational. EMSL will continue to support research to obtain a fundamental understanding of the physical, chemical, and biological processes. The focus will be to provide users with enhanced access to new capabilities in molecular beam epitaxy and nano-secondary ion mass spectrometry. Data management activities continue for data-intensive science. The activities advance the use of ARM data to inform and validate the earth system model development.	122,018

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Atmospheric Radiation Measurement Climate Research Facility	45,770	67,977	70,574
Environmental Molecular Sciences Laboratory	51,340	50,324	47,671
Data Management	2,963	2,773	2,773
General Purpose Equipment (GPE)	250	500	500
General Plant Projects (GPP)	700	500	500
Total, Climate and Environmental Facilities and Infrastructure	101,023	122,074	122,018

Supporting Information

Operating Expenses, Capital Equipment and Construction Summary

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Operating Expenses	574,548	577,740	615,035
Capital Equipment	17,873	30,917	9,812
General Plant Projects (GPP)	2,825	900	500
Total, Biological and Environmental Research	595,246	609,557	625,347

Funding Summary

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Research	403,114	375,586	403,261
Scientific User Facilities Operations and Research	181,807	201,696	202,327
Major Items of Equipment	7,250	13,820	0
Facility related GPP	2,125	400	0
Other[a]	950	18,055	19,759
Total, Biological and Environmental Research	595,246	609,557	625,347

Scientific User Facilities Operations and Research

(Dollars in Thousands)

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Biological Systems Science			
Structural Biology Infrastructure	15,765	14,895	14,895
Joint Genome Institute	68,932	68,500	69,187
Total, Biological Systems Science	84,697	83,395	84,082
Climate and Environmental Sciences			
Atmospheric Radiation Measurement Climate Research Facility	45,770	67,977	70,574
Environmental Molecular Sciences Laboratory	51,340	50,324	47,671
Total, Climate and Environmental Science	97,110	118,301	118,245
Total Science User Facilities Operations and Research	181,807	201,696	202,327

[a] Includes SBIR, STTR, GPE, and non-Facility related GPP.

Facilities Users and Hours

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Joint Genome Institute[a]			
Achieved Operating Hours	8,760	N/A	N/A
Planned Operating Hours	8,400	8,316	8,784
Optimal hours	8,400	8,316	8,784
Percent of Optimal Hours	104.3%	100.0%	100.0%
Unscheduled Downtime Hours	0	N/A	N/A
Number of Users[b]	940	940	940
Atmospheric Radiation Measurement Climate Research Facility (ARM)[c]			
Achieved Operating Hours	8,110	N/A	N/A
Planned Operating Hours	7,884	7,906	7,906
Optimal hours	7,884	7,906	7,906
Percent of Optimal Hours	102.8%	100.0%	100.0%
Unscheduled Downtime Hours	0	N/A	N/A
Number of Users[d]	1,200	1,200	1,300

[a] JGI Planned and Optimal hours are base on being open 24 hours a day, 7 days a week (less holidays, planned downtime for maintenance, installation of new instrumentation, etc.) Actual hours can differ when maintenance and instrument upgrades, etc. take less time than usual.

[b] All JGI users are remote. Primary users are individuals associated with approved projects being conducted at the JGI in a reporting period. Each user is counted once per year regardless of how many proposals their name may be associated with. Additionally, different users reflect vastly differing levels of JGI resources.

[c] ARM Planned and Optimal hours are base on the average over the fixed sites. The hours are estimated based on planned downtime for maintenance, installation of new instrumentation, weather history of each site, etc. Actual hours can differ when maintenance and instrument upgrades, weather related downtime, etc. take less time than usual.

[d] ARM users are both onsite and remote. A user is an individual who accesses ARM databases or uses equipment at an ARM site. Individuals are only counted once per reporting period at an individual site but may be counted at different ARM sites if they are a user at more than one site.

	FY 2011 Current	FY 2012 Enacted	FY 2013 Request
Environmental Molecular Sciences Laboratory[a]			
Achieved Operating Hours	4,247	N/A	N/A
Planned Operating Hours	4,259	4,296	4,272
Optimal hours	4,259	4,296	4,272
Percent of Optimal Hours	99.7%	100.0%	100.0%
Unscheduled Downtime	12	N/A	N/A
Number of Users[b]	750	750	750
Total Facilities			
Achieved Operating Hours	21,117	NA	NA
Planned Operating Hours	20,543	20,518	20,962
Optimal hours	20,543	20,518	20,962
Percent of Optimal Hours	102.8%	100.0%	100.0%
Unscheduled Downtime Hours	12	N/A	N/A
Number of Users	2,890	2,890	2,990

Structural Biology Infrastructure activities are at Basic Energy Sciences user facilities and the user statistics are included in the BES user statistics.

Major Items of Equipment

(Dollars in Thousands)

	Prior Years	FY 2011 Current	FY 2012 Enacted	FY 2013 Request	Outyears	Total	Comple-tion
Atmospheric Radiation Measurement Climate Research Facility (ARM)							
Dual-Frequency Scanning Cloud Radar for Oliktok, Alaska ARM Site (TEC/TPC)	0	0	3,500	0	0	3,500	2Q FY 2013
Dual-Frequency Scanning Cloud Radar for ARM Azores Climate Activity (TEC/TPC)	0	0	3,070	0	0	3,070	2Q FY 2013
Total ARM TEC/TPC		0	6,570	0			

[a] EMSL Planned and Optimal hours are, in general, based on 12 hours a day (6 am–6 pm), seven days a week (4,380 hours), less holidays (96 hours) and less 25 hours in the second quarter for a planned entire building outage. The leap year, as well as planned downtime for maintenance, installation of new instrumentation, etc. can modify the hours available. Actual hours can differ when maintenance, instrument upgrades, etc. take more or less time than planned.

[b] EMSL users are both onsite and remote. Individual users are counted once per year.

(Dollars in Thousands)

	Prior Years	FY 2011 Current	FY 2012 Enacted	FY 2013 Request	Outyears	Total	Comple-tion
Environmental Molecular Sciences Laboratory (EMSL)							
Next Generation, High Magnetic Field Mass Spectrometer (TEC/TPC)	3,000	7,250	7,250	0	0	17,500	1Q FY 2016
Total BER TEC/TPC		7,250	13,820	0			

Atmospheric Radiation Measurement Climate Research Facility

Dual-frequency scanning cloud radar for the ARM Arctic Climate activity. This instrument will provide the capability to measure cloud properties in a volume and will provide three-dimensional cloud properties at Oliktok, Alaska: essential data for developing high-resolution climate models.

Dual-frequency scanning cloud radar for the ARM Azores Climate activity. This instrument will provide the capability to measure cloud properties in a volume and will provide three-dimensional cloud properties in the Azores: essential data for developing high-resolution climate models.

Environmental Molecular Sciences Laboratory

Next Generation, High Magnetic Field Mass Spectrometer system is a world-leading system to measure and characterize complex mixtures of intact proteins and other biomolecules, aerosol particles, petroleum, and constituents from other types of fluids. The Total Project Cost (TPC) was reviewed and approved at CD-2/3a, Approve Performance Baseline and Authorization to Award Magnet Procurement Contract, on August 30, 2011. The system will enable world-leading proteomics, metabolomics, and lipidomics with application to bioenergy, as well as provide insights relevant to climate science, fossil fuel processing, and catalysis.

Scientific Employment

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Estimate
# University Grants	467	470	480
Average Size per year	$336,000	$340,000	$340,000
# Laboratory Projects	197	195	200
# Permanent Ph.D.s[a]	1,500	1,500	1,515
# Postdoctoral Associates[b]	345	345	350
# Graduate Students[b]	495	495	500
# Ph.D.s awarded[c]	110	110	110

[a] The number of permanent Ph.D.s is estimated. Information is not readily available on the total number of permanent Ph.D. scientists associated with each research project. In addition to the principal investigator for each research project funded by BER, individual projects typically have between 1 and 20 additional Ph.D.-level scientists who are funded collaborators. Information on scientific collaborators is not routinely tracked.

[b] The number of Postdoctoral Associates and graduate students is estimated for national laboratory projects.

[c] The number of Ph.D.s awarded is estimated. Information is not available on the number of Ph.D.s awarded as a result of BER funded research at universities or national laboratories.