

DEPARTMENT OF ENERGY RESEARCH INFRASTRUCTURE  
ACT OF 2017

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FEBRUARY 13, 2018.—Committed to the Committee of the Whole House on the State  
of the Union and ordered to be printed

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Mr. SMITH of Texas, from the Committee on Science, Space, and  
Technology, submitted the following

R E P O R T

[To accompany H.R. 4376]

[Including cost estimate of the Congressional Budget Office]

The Committee on Science, Space, and Technology, to whom was referred the bill (H.R. 4376) to direct the Secretary of Energy to carry out certain upgrades to research equipment and the construction of a research user facility, and for other purposes, having considered the same, report favorably thereon without amendment and recommend that the bill do pass.

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## COMMITTEE STATEMENT AND VIEWS

## PURPOSE AND SUMMARY

The purpose of H.R. 4376, the “Department of Energy Research Infrastructure Act of 2017,” is to provide for technological innovation through the prioritization of upgrades of key user facilities at Department of Energy (DOE) national labs from the existing Federal investment in basic research and fundamental scientific discovery by the DOE Office of Science.

The bill authorizes an upgrade to the Advanced Light Source (ALS-U) at Lawrence Berkeley National Laboratory, the Linac Coherent Light Source II High Energy Upgrade (LCLS-II-HE) at the Stanford Linear Accelerator Center National Laboratory, and the construction of the Facility for Rare Isotope Beams (FRIB) at Michigan State University.

## BACKGROUND AND NEED FOR LEGISLATION

DOE is the leading federal sponsor of research in the physical sciences, and operates world-class, open-access user facilities around the country at the DOE national laboratories. These facilities include the supercomputers, x-ray light sources, photon sources, and neutron sources necessary to conduct ground-breaking basic research, and host approximately 30,000 researchers annually from around the world.

The Committee recognizes that these best-in-the-world science facilities uniquely enable research conducted through the DOE Office of Science and other federal sponsors of basic research, and facilitate revolutionary discoveries about the atomic structure, properties, and dynamics of materials. The next transformative breakthroughs in innovative energy technologies will likely arise from a strong foundation in basic research, particularly in the study of and development of unique materials, for which the facilities authorized in this bill provide critical capabilities.

This legislation relies on the assessments of the Department and the scientific community, primarily through the long-range planning function of the DOE Office of Science Basic Energy Sciences Advisory Committee (BESAC) and the Nuclear Science Advisory Committee (NSAC). Both advisory committees, chartered under the Federal Advisory Committee Act (FACA) and comprised of representatives from universities, national laboratories, and industries involved in relevant areas of research, provide official technical advice to the Department and other federal agencies on the national program priorities for basic energy sciences and nuclear science research.

Based on the recommendations provided in the most recent reports issued from each advisory committee, H.R. 4376 authorizes the completion of upgrades and construction of scientific user facilities necessary to undertake the next generation of transformative research in these areas. Under this legislation, the Secretary of Energy is directed to provide for an upgrade to the ALS at Lawrence Berkeley National Laboratory (LBNL) and a high energy upgrade to the LCLS-II at Stanford Linear Accelerator Center National Laboratory (SLAC) under the Basic Energy Sciences (BES) program within the DOE Office of Science. The Secretary is also directed to complete the construction of FRIB, located at Michigan

State University, under the Office of Nuclear Physics (NP) within the DOE Office of Science.

The ALS is a specialized particle accelerator that generates bright beams of x-ray light for scientific research. Electron bunches travel at nearly the speed of light in a circular path, emitting ultraviolet and x-ray light in the process. The light is directed through about 40 beamlines to numerous experimental end-stations, where scientists conduct research in a wide variety of fields, including materials science, biology, chemistry, physics, and the environmental sciences. The ALS-U will employ new technology to produce highly focused beams of soft x-ray light that are up to 1000 times brighter than current capability. Soft x-rays, like those produced at the ALS, are optimal for probing the electronic structure of chemicals and materials.

LCLS-II is the world's first hard x-ray free-electron laser. Scientists use its strobe-like pulses to take crisp pictures of atomic motions, watch chemical reactions unfold, probe the properties of materials and explore fundamental processes in living things. The LCLS-II-HE will build on the success of LCLS-II to ensure that the U.S. maintains a world-leading capability for advanced research in chemistry, materials, biology and energy. LCLS-II-HE will provide a major jump in capability—moving from 120 pulses per second to 1 million pulses per second, and will enable researchers to perform experiments in a wide range of fields that are now impossible.

The Department's longstanding support and prioritization of both the ALS upgrade and the high energy upgrade to LCLS-II is documented in a publication of the Office of Science titled, "Facilities for the Future of Science: A Twenty-Year Outlook," published November 2003, and its publication of "Four Years Later: An Interim Report on Facilities for the Future of Science: A Twenty-Year Outlook," published August 2007. In June 2016, the BESAC released a report titled, "Report on Facility Upgrades," which identified the ALS-U and the LCLS-II-HE as two of the five priority upgrade projects within BES. In this report, the BESAC determined that the ALS-U and the LCLS-II-HE are absolutely central to U.S. contributions to world leading science and that both projects are ready to proceed with construction.

DOE nuclear physics research programs support the experimental and theoretical research needed to discover, explore, and understand all forms of nuclear matter. Within the area of low energy nuclear physics research, FRIB will advance the understanding of rare nuclear isotopes and the evolution of the cosmos. FRIB, which is currently under construction, is a one-of-a-kind, linear accelerator user facility that will use fast, stopped, and reaccelerated rare isotope beams to allow researchers to study a variety of rare isotopes and their properties.

FRIB will expand the foundational understanding of nuclear structure, the atomic interactions of nuclear species, and the origin of elements, and will enable critical nuclear science research across a wide breadth of fields, ranging from medicine to astrophysics.

The Department's longstanding support of the construction of a rare isotope accelerator is documented in a publication of NSAC titled, "Opportunities in Nuclear Science, A Long-Range Plan for the Next Decade," published April 2002. In December 2007, NSAC rec-

commended the construction of FRIB in its publication of “The Frontiers of Nuclear Science, A Long Range Plan,” and in October 2015, NSAC listed the completion of FRIB construction as one of the committee’s highest priorities in its publication titled, “Reaching for the Horizon: The 2015 Long Range Plan for Nuclear Science.”

Further, this legislation requires that, to the maximum extent practicable, the Secretary of Energy shall ensure that the start of full operations of the FRIB occurs before June 30, 2022, the start of full operations of the LCLS-II-HE occurs before December 31, 2025, and the start of full operations of ALS-U occurs before December 31, 2026.

#### LEGISLATIVE HISTORY

On November 18, 2015, the Energy Subcommittee held a hearing titled, “Recommendations of the Commission to Review the Effectiveness of the National Energy Laboratories.” Witnesses were: Mr. TJ Glauthier, Co-Chair, Commission to Review the Effectiveness of the National Energy Laboratories; Dr. Jared L. Cohon, Co-Chair, Commission to Review the Effectiveness of the National Energy Laboratories; Dr. Peter Littlewood, Director, Argonne National Laboratory.

On March 22, 2016, the Committee held a hearing titled, “An Overview of the Budget Proposal for the Department of Energy for Fiscal Year 2017.” The witness was The Honorable Ernest Moniz, Secretary of Energy, U.S. Department of Energy.

On June 15, 2016, the Energy Subcommittee held a hearing titled, “Innovation in Solar Fuels, Electricity Storage, and Advanced Materials.” Witnesses were: Dr. Nate Lewis, Professor, California Institute of Technology; Dr. Daniel Scherson, Professor, Case Western Reserve University; Dr. Collin Broholm, Professor, Johns Hopkins University; Dr. Daniel Hallinan Jr., Assistant Professor, Florida A&M University—Florida State University College of Engineering.

On June 28, 2017, the Energy Subcommittee and the Research and Technology Subcommittee held a hearing titled, “Material Science: Building the Future.” Witnesses were: Dr. Matthew Tirrell, Deputy Laboratory Director for Science and Chief Research Officer, Argonne National Laboratory; Dr. Laurie Locascio, Acting Associate Director for Laboratory Programs and Director, Material Measurement Laboratory, National Institute of Standards and Technology; Dr. Adam Schwartz, Director, Ames Laboratory; Dr. Fred Higgs, John and Ann Doerr Professor of Mechanical Engineering, Rice University.

On July 19, 2017, the Committee held a hearing titled, “Energy Innovation: Letting Technology Lead.” Witnesses were: Dr. Jacob DeWitte, President and CEO, Oklo; Dr. Gaurav N. Sant, Associate Professor and Henry Samueli Fellow, Department of Civil and Environmental Engineering, Henry Samueli School of Engineering and Applied Science, University of California, Los Angeles; Dr. Venky Narayanamurti, Benjamin Peirce Research Professor of Technology and Public Policy, John A. Paulson School of Engineering and Applied Science, Harvard University; Mr. Kiran Kumaraswamy, Market Development Director, AES Energy Storage.

On November 13, 2017, Energy Subcommittee Vice Chair Stephen Knight introduced H.R. 4376, which was referred solely to the Committee.

On November 15, 2017, the Committee on Science, Space, and Technology approved and ordered reported H.R. 4376 by voice vote.

#### COMMITTEE VIEWS

##### *Advanced Light Source upgrade*

H.R. 4376 authorizes a seven-year upgrade to the ALS described in the publication approved by the BESAC on June 9, 2016, titled, “Report on Facility Upgrades.” This includes the development of a multi-bend achromat lattice to produce a high flux of coherent x-rays within the soft x-ray energy region and a suite of beamlines optimized for this source. The Committee concurs with the assessment of the Department and the most recent BESAC report that the completion of this upgrade is essential to maintaining world-leading science here in the United States.

The ALS upgrade authorized in this legislation will utilize new advances in accelerator technologies to produce soft x-ray beams that are several orders of magnitude brighter than the current ALS beamlines. In order to ensure the on-schedule, on-budget construction of this project, the Committee included a timeline and sufficient annual authorizations in this legislation requiring the Department to complete the ALS upgrade by the close of 2026.

##### *Linac Coherent Light Source*

H.R. 4376 also authorizes the LCLS-II-HE six-year upgrade described in the June 9, 2016, BESAC “Report on Facility Upgrades,” including the development of experimental capabilities for high energy x-rays to reveal fundamental scientific discoveries. The Committee concurs with the assessment of the Department and this most recent BESAC report that the completion of this upgrade is essential to maintaining world-leading science here in the United States.

The LCLS-II-HE upgrade authorized in this legislation will provide researchers with the imaging capability necessary to advance discoveries in chemistry, materials science, biology, and energy. In order to ensure the on-schedule, on-budget construction of this project, the Committee included a timeline and sufficient annual authorizations in this legislation requiring the Department to complete the LCLS-II-HE upgrade by the close of 2025.

##### *Facility for Rare Isotope Beams*

Finally, H.R. 4376 authorizes completion of the FRIB to advance the understanding of rare nuclear isotopes and the evolution of the cosmos. This facility could also potentially be used to produce medical isotopes for diagnostic and therapeutic needs. While construction of the FRIB began in fiscal year 2014 and is already over 70 percent complete, the Committee believes that an authorization of specific annual funding for the remaining construction and necessary instrumentation is required to ensure this vital project is completed on time and on budget by June, 2022.

The Committee also acknowledges the essential support for fundamental nuclear science from DOE NP, including the Nuclear

Theory subprogram which increases the knowledge base that will ultimately identify new frontiers for future experiments in nuclear science. The Committee also encourages NP to continue its research efforts to explore novel concepts and rare decay processes relevant for the production of critical isotopes that support medical applications.

#### SECTION-BY-SECTION

##### *Sec. 1. Short title*

Department of Energy Research Infrastructure Act of 2017.

##### *Sec. 2. Advanced Light Source upgrade*

This section authorizes the ALS-U over seven years. This upgrade will ensure that DOE can maintain ALS's status as a world class soft x-ray facility and allow scientists to study the structure and behavior of materials at extremely small scales.

##### *Sec. 3. Linac Coherent Light Source II High Energy upgrade*

This section authorizes the LCLS-II-HE over six years. This upgrade will provide a major jump in imaging capability and will enable researchers to perform experiments in chemistry, materials, biology and energy that are now impossible.

##### *Sec. 4. Facility for Rare Isotope Beams*

This section authorizes the completion of construction of FRIB over five years. This facility will enable the study of a variety of rare isotopes and their properties, in order to expand our understanding of nuclear structure, the atomic interactions of nuclear species, and the origin of elements.

#### EXPLANATION OF AMENDMENTS

There were no amendments to this bill.

#### COMMITTEE CONSIDERATION

On November 15, 2017, the Committee met in open session and ordered reported favorably the bill, H.R. 4376, by voice vote, a quorum being present.

#### APPLICATION OF LAW TO THE LEGISLATIVE BRANCH

Section 102(b)(3) of Public Law 104-1 requires a description of the application of this bill to the legislative branch where the bill relates to the terms and conditions of employment or access to public services and accommodations. This bill authorizes an upgrade to the ALS-U at LBNL, the LCLS-II-HE at the Stanford Linear Accelerator Center National Accelerator Laboratory, and the construction of the FRIB at Michigan State University. As such, this bill does not relate to employment or access to public services and accommodations.

#### STATEMENT OF OVERSIGHT FINDINGS AND RECOMMENDATIONS OF THE COMMITTEE

In compliance with clause 3(c)(1) of rule XIII and clause (2)(b)(1) of rule X of the Rules of the House of Representatives, the Commit-

tee's oversight findings and recommendations are reflected in the descriptive portions of this report.

#### STATEMENT OF GENERAL PERFORMANCE GOALS AND OBJECTIVES

H.R. 4367 would provide for technological innovation through the prioritization of Federal investment in basic research and fundamental scientific discovery through the upgrade of key user facilities at DOE national labs.

#### DUPLICATION OF FEDERAL PROGRAMS

No provision of H.R. 4376 establishes or reauthorizes a program of the Federal Government known to be duplicative of another Federal program, a program that was included in any report from the Government Accountability Office to Congress pursuant to section 21 of Public Law 111-139, or a program related to a program identified in the most recent Catalog of Federal Domestic Assistance.

#### DISCLOSURE OF DIRECTED RULE MAKINGS

The Committee estimates that enacting H.R. 4376 does not direct the completion of any specific rule makings within the meaning of 5 U.S.C. 551.

#### FEDERAL ADVISORY COMMITTEE ACT

The Committee finds that the legislation does not establish or authorize the establishment of an advisory committee within the definition of 5 U.S.C. App., Section 5(b).

#### UNFUNDED MANDATE STATEMENT

Section 423 of the Congressional Budget and Impoundment Control Act (as amended by Section 101(a)(2) of the Unfunded Mandate Reform Act, P.L. 104-4) requires a statement as to whether the provisions of the reported bills include unfunded mandates. In compliance with this requirement the Committee has received a letter from the Congressional Budget Office included herein.

#### EARMARK IDENTIFICATION

H.R. 4376 does not include any congressional earmarks, limited tax benefits, or limited tariff benefits as defined in clause 9 of rule XXI.

#### COMMITTEE ESTIMATE

Clause 3(d)(2) of rule XIII of the Rules of the House of Representatives requires an estimate and a comparison by the Committee of the costs that would be incurred in carrying out H.R. 4376. However, clause 3(d)(3)(B) of that rule provides that this requirement does not apply when the Committee has included in its report a timely submitted cost estimate of the bill prepared by the Director of the Congressional Budget Office under section 402 of the Congressional Budget Act.

BUDGET AUTHORITY AND CONGRESSIONAL BUDGET OFFICE COST  
ESTIMATE

With respect to the requirements of clause 3(c)(2) of rule XIII of the Rules of the House of Representatives and section 308(a) of the Congressional Budget Act of 1974 and with respect to requirements of clause (3)(c)(3) of rule XIII of the Rules of the House of Representatives and section 402 of the Congressional Budget Act of 1974, the Committee has received the following cost estimate for H.R. 4376 from the Director of Congressional Budget Office:

U.S. CONGRESS,  
CONGRESSIONAL BUDGET OFFICE,  
*Washington, DC, December 18, 2017.*

Hon. LAMAR SMITH,  
*Chairman, Committee on Science, Space, and Technology,  
House of Representatives, Washington, DC.*

DEAR MR. CHAIRMAN: The Congressional Budget Office has prepared the enclosed cost estimate for H.R. 4376, the Department of Energy Research Infrastructure Act of 2017.

If you wish further details on this estimate, we will be pleased to provide them. The CBO staff contact is Janani Shankaran.

Sincerely,

KEITH HALL,  
*Director.*

Enclosure.

*H.R. 4376—Department of Energy Research Infrastructure Act of  
2017*

Summary: H.R. 4376 would authorize the appropriation of funds to support the upgrade and construction of research equipment and facilities administered by the Department of Energy's (DOE's) Office of Science. CBO estimates that implementing H.R. 4376 would cost \$836 million over the 2018–2022 period, assuming appropriation of the authorized amounts.

Enacting H.R. 4376 would not affect direct spending or revenues; therefore, pay-as-you-go procedures do not apply.

CBO estimates that enacting H.R. 4376 would not increase net direct spending or on-budget deficits in any of the four consecutive 10-year periods beginning in 2028.

H.R. 4376 contains no intergovernmental or private-sector mandates as defined in the Unfunded Mandates Reform Act (UMRA).

Estimated cost to the Federal Government: The estimated budgetary effect of H.R. 4376 is shown in the following table. The cost of this legislation falls within budget function 250 (general science, space, and technology).



	By fiscal year, in millions of dollars—					
	2018	2019	2020	2021	2022	2018–2022
INCREASES IN SPENDING SUBJECT TO APPROPRIATION						
Advanced Light Source Upgrade:						
Authorization Level .....	20	50	80	80	52	282
Estimated Outlays .....	11	34	62	76	65	247
Linac Coherent Light Source II Upgrade: <sup>a</sup>						
Authorization Level .....	0	55	80	80	54	269
Estimated Outlays .....	0	30	61	76	66	233
Facility for Rare Isotope Beams: <sup>b</sup>						
Authorization Level .....	2	103	104	105	106	420
Estimated Outlays .....	1	57	88	104	105	357
Total:						
Authorization Level .....	22	208	264	265	212	971
Estimated Outlays .....	12	121	211	256	236	836

Numbers may not add up to totals because of rounding.

<sup>a</sup>H.R. 4376 would authorize the appropriation of \$20 million in 2018 for upgrades to the Linac Coherent Light Source II. On an annualized basis, Public Law 115–90 provided \$188 million in 2018 for this project. As a result, CBO estimates that H.R. 4376 would not authorize an increase in spending subject to appropriation in 2018.

<sup>b</sup>H.R. 4376 would authorize the appropriation of \$101 million in 2018 for construction of the Facility for Rare Isotope Beams. On an annualized basis, Public Law 115–90 provided \$99 million in 2018 for this project. As a result, CBO estimates that H.R. 4376 would authorize an increase in spending subject to appropriation in 2018 by \$2 million, the difference between the authorized amount and annualized appropriated amount.

#### BASIS OF ESTIMATE

##### *Spending subject to appropriation*

Under current law, DOE’s Office of Science supports basic research in the physical sciences and operates a system of national scientific user facilities. The office received an appropriation of \$5.4 billion in 2017 and the same amount on an annualized basis for 2018; that amount includes funding for construction and upgrades of equipment and research facilities. Under current law, no specific sums are authorized to be appropriated to DOE for those purposes after 2018.

H.R. 4376 would authorize appropriations totaling \$971 million over the 2018–2022 period for the following specific projects:

- \$282 million for upgrades to the Advanced Light Source;
- \$269 million for upgrades to the Linac Coherent Light Source II; and
- \$420 million for construction of the Facility for Rare Isotope Beams.

The bill also would authorize the appropriation of \$53 million in 2023 and \$6 million in 2024 for those projects.

According to DOE, the upgrade of the Advanced Light Source is in the design phase, and the upgrade of the Linac Coherent Light Source II and construction of the Facility for Rare Isotope Beams are nearing completion. In 2017, the agency spent \$300 million for those two projects.

Based on historical spending patterns, CBO estimates that if the authorized amounts are appropriated, implementing H.R. 4376 would cost \$836 million over the 2018–2022 period and \$194 million after 2022.

Pay-As-You-Go considerations: None.

Increase in long-term direct spending and deficits: CBO estimates that enacting H.R. 4376 would not increase net direct spending or on-budget deficits in any of the four consecutive 10-year periods beginning in 2028.

Mandates: H.R. 4376 contains no intergovernmental or private-sector mandates as defined in UMRA.

Estimate prepared by: Federal costs: Janani Shankaran; Mandates: Jon Sperl.

Estimate approved by: H. Samuel Papenfuss, Deputy Assistant Director for Budget Analysis.

