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DEPARTMENT OF ENERGY SCIENCE FOR THE FUTURE ACT

JUNE 28, 2021.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Ms. JOHNSON of Texas, from the Committee on Science, Space, and Technology, submitted the following

R E P O R T

[To accompany H.R. 3593]

The Committee on Science, Space, and Technology, to whom was referred the bill (H.R. 3593) to provide guidance for and investment in the research and development activities of the Department of Energy Office of Science, and for other purposes, having considered the same, reports favorably thereon with an amendment and recommends that the bill as amended do pass.

CONTENTS

I. AMENDMENT

The amendment is as follows:

Strike all after the enacting clause and insert the following:

SECTION 1. SHORT TITLE.

This Act may be cited as the "Department of Energy Science for the Future Act".

SEC. 2. MISSION OF THE OFFICE OF SCIENCE.

Section 209 of the Department of Energy Organization Act (42 U.S.C. 7139) is amended by adding at the end the following:

"(d) USER FACILITIES.—The Director shall carry out the construction, operation, and maintenance of user facilities to support the mission described in subsection (c). As practicable, these facilities shall serve the needs of the Department, industry, the academic community, and other relevant entities for the purposes of advancing the missions of the Department, improving the competitiveness of the United States, protecting public health and safety, and addressing other national priorities including emergencies.

"(e) COORDINATION.—

"(1) IN GENERAL.—The Secretary—

"(A) shall ensure the coordination of the Office of Science with the other activities of the Department;

"(B) shall support joint activities among the programs of the Department;

"(C) shall coordinate with other relevant Federal agencies in supporting advancements in related research areas as appropriate; and

"(D) may form partnerships to enhance the utilization of and ensure access to user facilities by other Federal agencies.

"(2) OFFICE OF SCIENCE.—The Director—

"(A) shall ensure the coordination of programs and activities carried out by the Office of Science; and

"(B) shall direct all programs which have not recently completed a future planning roadmap consistent with the funding of such programs authorized under the Department of Energy Science for the Future Act to complete such a roadmap.".

SEC. 3. BASIC ENERGY SCIENCES PROGRAM.

(a) DEPARTMENT OF ENERGY RESEARCH AND INNOVATION ACT.—Section 303 of the Department of Energy Research and Innovation Act (42 U.S.C. 18641) is amended—

(1) by redesignating subsections (a) through (e) as subsections (c) through (g), respectively; and

(2) by inserting before subsection (c), as so redesignated, the following:

"(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research and development program in basic energy sciences, including materials sciences and engineering, chemical sciences, physical biosciences, geosciences, and other disciplines, to understand, model, and control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies, address scientific grand challenges, and support the energy, environment, and national security missions of the Department.

"(b) SUSTAINABLE CHEMISTRY.—In carrying out chemistry-related research and development activities under this section, the Director shall prioritize research and development of sustainable chemistry to support clean, safe, and economic alternatives and methodologies to traditional chemical products and processes.";

(3) in subsection (d)(3), as so redesignated—

(A) in subparagraph (C), by striking "and" at the end;

(B) by redesignating subparagraph (D) as subparagraph (E); and

(C) by inserting after subparagraph (C) the following:

"(D) autonomous chemistry and materials synthesis and characterization facilities that leverage advances in artificial intelligence; and";

(4) in subsection (d), as so redesignated, by adding at the end the following:

"(4) ADVANCED PHOTON SOURCE UPGRADE.—

"(A) DEFINITIONS.—In this paragraph:

"(i) FLUX.—The term 'flux' means the rate of flow of photons.

"(ii) HARD X-RAY.—The term 'hard x-ray' means a photon with energy greater than 20 kiloelectron volts.

"(B) IN GENERAL.—The Secretary shall provide for the upgrade to the Advanced Photon Source described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades', including the development of a multi-bend achromat lattice

to produce a high flux of coherent x-rays within the hard x-ray energy region and a suite of beamlines optimized for this source.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the upgrade under this paragraph occurs before March 31, 2026.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph $157,000,000 for fiscal year 2022.

"(5) SPALLATION NEUTRON SOURCE PROTON POWER UPGRADE.—

"(A) IN GENERAL.—The Secretary shall provide for the proton power upgrade to the Spallation Neutron Source.

"(B) PROTON POWER UPGRADE DEFINED.—For the purposes of this paragraph, the term 'proton power upgrade' means the Spallation Neutron Source power upgrade described in—

"(i) the publication titled 'Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in December, 2003;

"(ii) the publication titled 'Four Years Later: An Interim Report on Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in August, 2007; and

"(iii) the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades'.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the upgrade under this paragraph occurs before December 31, 2028.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph $49,800,000 for fiscal year 2022.

"(6) SPALLATION NEUTRON SOURCE SECOND TARGET STATION.—

"(A) IN GENERAL.—The Secretary shall provide for a second target station for the Spallation Neutron Source.

"(B) SECOND TARGET STATION DEFINED.—For the purposes of this paragraph, the term 'second target station' means the Spallation Neutron Source second target station described in—

"(i) the publication titled, 'Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in December, 2003;

"(ii) the publication titled, 'Four Years Later: An Interim Report on Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in August, 2007; and

"(iii) the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades'.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the second target station under this paragraph occurs before December 31, 2030, with the option for early operation in 2029.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the activities under this paragraph, including construction—

"(i) $70,000,000 for fiscal year 2022;

"(ii) $127,000,000 for fiscal year 2023;

"(iii) $204,000,000 for fiscal year 2024;

"(iv) $279,000,000 for fiscal year 2025; and

"(v) $300,000,000 for fiscal year 2026.

"(7) ADVANCED LIGHT SOURCE UPGRADE.—

"(A) DEFINITIONS.—In this paragraph:

"(i) FLUX.—The term 'flux' means the rate of flow of photons.

"(ii) SOFT X-RAY.—The term 'soft x-ray' means a photon with energy in the range from 50 to 2,000 electron volts.

"(B) IN GENERAL.—The Secretary shall provide for the upgrade to the Advanced Light Source described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades', including the development of a multibend achromat lattice to produce a high flux of coherent x-rays within the soft x-ray energy region.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the upgrade under this paragraph occurs before September 30, 2029.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph—

"(i) $75,100,000 for fiscal year 2022;
"(ii) $135,000,000 for fiscal year 2023;
"(iii) $102,500,000 for fiscal year 2024;
"(iv) $25,000,000 for fiscal year 2025; and
"(v) $25,000,000 for fiscal year 2026.

"(8) LINAC COHERENT LIGHT SOURCE II HIGH ENERGY UPGRADE.—

"(A) DEFINITIONS.—In this paragraph:

"(i) HIGH ENERGY X-RAY.—The term 'high energy x-ray' means a photon with an energy in the 5 to 13 kiloelectron volt range.

"(ii) HIGH REPETITION RATE.—The term 'high repetition rate' means the delivery of x-ray pulses up to 1 million pulses per second.

"(iii) ULTRA-SHORT PULSE X-RAYS.—The term 'ultra-short pulse x-rays' means x-ray bursts capable of durations of less than 100 femtoseconds.

"(B) IN GENERAL.—The Secretary shall—

"(i) provide for the upgrade to the Linac Coherent Light Source II facility described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades', including the development of experimental capabilities for high energy x-rays to reveal fundamental scientific discoveries; and

"(ii) ensure such upgrade enables the production and use of high energy, ultra-short pulse x-rays delivered at a high repetition rate.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the upgrade under this paragraph occurs before December 31, 2026.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph—

"(i) $106,925,000 for fiscal year 2022;
"(ii) $125,925,000 for fiscal year 2023;
"(iii) $115,000,000 for fiscal year 2024;
"(iv) $89,000,000 for fiscal year 2025; and
"(v) $49,344,000 for fiscal year 2026.

"(9) CRYOMODULE REPAIR AND MAINTENANCE FACILITY.—

"(A) IN GENERAL.—The Secretary shall provide for the construction of a cryomodule repair and maintenance facility to service the Linac Coherent Light Source II and upgrades to the facility. The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility has the capability to maintain, repair, and test superconducting radiofrequency accelerator components.

"(B) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the activities under this paragraph—

"(i) $19,000,000 for fiscal year 2022;
"(ii) $25,000,000 for fiscal year 2023;
"(iii) $25,000,000 for fiscal year 2024; and
"(iv) $17,000,000 for fiscal year 2025.

"(10) NANOSCALE SCIENCE RESEARCH CENTER RECAPITALIZATION PROJECT.—

"(A) IN GENERAL.—The Secretary shall provide for the recapitalization of the Nanoscale Science Research Centers, to include the upgrade of equipment at each Center supported by the Office of Science on the date of enactment of the Department of Energy Science for the Future Act, to accelerate advances in the various fields of science including nanoscience, materials, chemistry, biology, and quantum information science.

"(B) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the recapitalization under this paragraph—

"(i) $20,000,000 for fiscal year 2022;
"(ii) $30,000,000 for fiscal year 2023;
"(iii) $20,000,000 for fiscal year 2024; and
"(iv) $20,000,000 for fiscal year 2025.";

(5) by adding at the end the following:

"(h) COMPUTATIONAL MATERIALS AND CHEMICAL SCIENCES.—

"(1) IN GENERAL.—The Director shall support a program of research and development for the application of advanced computing practices to foundational and emerging research problems in chemistry and materials science. Research activities shall include—

"(A) chemical catalysis research and development;

"(B) the use of large data sets to model materials phenomena, including through advanced characterization of materials, materials synthesis, processing, and innovative use of experimental and theoretical data;

"(C) co-design of chemical system and chemistry modeling software with advanced computing systems and hardware technologies; and

"(D) modeling of chemical processes, assemblies, and reactions such as molecular dynamics and quantum chemistry, including through novel computing methods.

"(2) COMPUTATIONAL MATERIALS AND CHEMICAL SCIENCES CENTERS.—

"(A) IN GENERAL.—In carrying out the activities authorized under paragraph (1), the Director shall select and establish up to six computational materials and chemical sciences centers to—

"(i) develop open-source, robust, and validated computational codes and user-friendly software, coupled with innovative use of experimental and theoretical data, to enable the design, discovery, and development of new materials and chemical systems; and

"(ii) focus on overcoming challenges and maximizing the benefits of exascale and other high performance computing underpinned by accelerated node technologies.

"(B) SELECTION.—The Director shall select centers under subparagraph (A) on a competitive, merit-reviewed basis. The Director shall consider applications from the National Laboratories, institutes of higher education, multi-institutional collaborations, and other appropriate entities.

"(C) DURATION.—

"(i) A center selected under subparagraph (A) shall receive support for a period of not more than 5 years beginning on the date of establishment of that center, subject to the availability of appropriations.

"(ii) A center already in existence on the date of enactment of the Department of Energy Science for the Future Act may continue to receive support for a period of not more than 5 years beginning on the date of establishment of that center.

"(D) RENEWAL.—Upon the expiration of any period of support of a center under this subsection, the Director may renew support for the center, on a merit-reviewed basis, for a period of not more than 5 years.

"(E) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming center for cause during the performance period.

"(i) MATERIALS RESEARCH DATABASE.—

"(1) IN GENERAL.—The Director shall support the development of a web-based platform to develop and provide access to a database of computed information on known and predicted materials properties and computational tools to accelerate breakthroughs in materials discovery and design.

"(2) PROGRAM.—In carrying out this subsection, the Director shall—

"(A) conduct cooperative research with industry, academia, and other research institutions to advance understanding, prediction, and manipulation of materials and facilitate the design of novel materials;

"(B) develop and maintain data infrastructure at user facilities that generate data to collect, analyze, label, and otherwise prepare the data for inclusion in the database;

"(C) leverage existing high performance computing systems to conduct high throughput calculations, and develop computational and data mining algorithms for the prediction of material properties;

"(D) strengthen the foundation for new technologies and advanced manufacturing; and

"(E) drive the development of advanced materials for applications that span the Department's missions in energy, environment, and national security.

"(3) COORDINATION.—In carrying out this subsection, the Director shall leverage programs and activities across the Department, including computational materials and chemical sciences centers established under subsection (h).

"(4) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out activities under this subsection $10,000,000 for each of the fiscal years 2022 through 2026.

"(j) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $2,727,705,000 for fiscal year 2022;

"(2) $2,828,896,600 for fiscal year 2023;

"(3) $3,019,489,612 for fiscal year 2024;

"(4) $3,161,698,885 for fiscal year 2025; and

"(5) $3,291,651,600 for fiscal year 2026.".

(b) ARTIFICIAL PHOTOSYNTHESIS.—Section 973 of the Energy Policy Act of 2005 (42 U.S.C. 16313) is amended—

(1) in subsection (b), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated for Basic Energy Sciences, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2031."; and

(2) in subsection (c), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated in section 316 of the Department of Energy Research and Innovation Act, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.".

(c) ELECTRICITY STORAGE RESEARCH INITIATIVE.—Section 975 of the Energy Policy Act of 2005 (42 U.S.C.16315) is amended—

(1) in subsection (b), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated for Basic Energy Sciences, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.";

(2) in subsection (c), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated in section 316 of the Department of Energy Research and Innovation Act, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026."; and

(3) in subsection (d), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated in section 316 of the Department of Energy Research and Innovation Act, the Secretary shall make available for carrying out activities under this subsection $20,000,000 for each of fiscal years 2022 through 2026.".

SEC. 4. BIOLOGICAL AND ENVIRONMENTAL RESEARCH.

(a) PROGRAM; BIOLOGICAL SYSTEMS; BIOMOLECULAR CHARACTERIZATION AND IMAGING SCIENCE.—Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) is amended—

(1) by striking subsection (a) and inserting the following:

"(a) PROGRAM.—As part of the duties of the Director authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), and coordinated with the activities authorized under sections 303 and 304 of this Act, the Director shall carry out a program of research and development in the areas of biological systems science and climate and environmental science, including subsurface science, relevant to the development of new energy technologies and to support the energy, environmental, and national security missions of the Department.

"(b) BIOLOGICAL SYSTEMS.—The Director shall carry out research and development activities in genomic science including fundamental research on plants and microbes to increase systems-level understanding of the complex biological systems, which may include activities to—

"(1) accelerate breakthroughs and new knowledge that would enable the cost-effective, sustainable production of—

"(A) biomass-based liquid transportation fuels;

"(B) bioenergy; and

"(C) biobased materials from renewable biomass;

"(2) improve fundamental understanding of plant and microbial processes impacting the global carbon cycle, including processes for removing carbon dioxide from the atmosphere, through photosynthesis and other biological processes, for sequestration and storage;

"(3) understand the microbiome mechanisms used to transform, immobilize, or remove contaminants from subsurface environments;

"(4) develop the computational approaches and integrated platforms for open access collaborative science;

"(5) leverage tools and approaches across the Office of Science to expand research to include novel processes, methods, and science to develop bio-based chemicals, polymers, inorganic materials, including research to—

"(A) advance biosystems design research to advance the understanding of how CRISPR tools and other gene editing tools and technologies work in nature, in the laboratory, and in practice;

"(B) deepen genome-enabled knowledge of root architecture and growth in crops, including trees; and

"(C) develop biosystems design methods and tools to increase the efficiency of photosynthesis in plants; and

"(6) develop other relevant methods and processes as determined by the Director.

"(c) BIOMOLECULAR CHARACTERIZATION AND IMAGING SCIENCE.—The Director shall carry out research and development activities in biomolecular characterization and imaging science, including development of integrative imaging and analysis platforms and biosensors to understand the expression, structure, and function of genome information encoded within cells and for real-time measurements in ecosystems and field sites of relevance to the mission of the Department of Energy."; and

(2) by redesignating subsections (b) through (d) as subsections (d) through (f), respectively.

(b) BIOENERGY RESEARCH CENTERS.—Section 977(f) of the Energy Policy Act of 2005 (42 U.S.C. 16317(f)) is amended to read as follows:

"(f) BIOENERGY RESEARCH CENTERS.—

"(1) IN GENERAL.—In carrying out the program under section 306(a) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(a)), the Director shall support up to six bioenergy research centers to conduct fundamental research in plant and microbial systems biology, biological imaging and analysis, and genomics, and to accelerate advanced research and development of biomass-based liquid transportation fuels, bioenergy, or biobased materials, chemicals, and products that are produced from a variety of regionally diverse feedstocks, and to facilitate the translation of research results to industry. The activities of the centers authorized under this subsection may include—

"(A) accelerating the domestication of bioenergy-relevant plants, microbes, and associated microbial communities to enable high-impact, value-added coproduct development at multiple points in the bioenergy supply chain;

"(B) developing the science and technological advances to ensure process sustainability is considered in the creation of biofuels and bioproducts from lignocellulose; and

"(C) using the latest tools in genomics, molecular biology, catalysis science, chemical engineering, systems biology, and computational and robotics technologies to sustainably produce and transform biomass into biofuels and bioproducts.

"(2) SELECTION AND DURATION.—

"(A) IN GENERAL.—A center established under paragraph (1) shall be selected on a competitive, merit-reviewed basis for a period of not more than 5 years, subject to the availability of appropriations, beginning on the date of establishment of that center.

"(B) APPLICATIONS.—The Director shall consider applications from National Laboratories, multi-institutional collaborations, and other appropriate entities.

"(C) EXISTING CENTERS.—A center already in existence on the date of enactment of the Department of Energy Science for the Future Act may continue to receive support for a period of not more than 5 years beginning on the date of establishment of that center.

"(3) RENEWAL.—After the end of either period described in paragraph (2), the Director may renew support for the center for a period of not more than 5 years on a merit-reviewed basis. For a center in operation for 10 years after its previous selection on a competitive, merit-reviewed basis, the Director may renew support for the center on a competitive, merit-reviewed basis for a period of not more than 5 years, and may subsequently provide an additional renewal on a merit-reviewed basis for a period of not more than 5 years.

"(4) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming center for cause during the performance period.

"(5) ACTIVITIES.—Centers shall undertake research activities to accelerate the production of biofuels and bioproducts from advanced biomass resources by identifying the most suitable species of plants for use as energy crops; and improving methods of breeding, propagation, planting, producing, harvesting, storage and processing. Activities may include the following:

"(A) Research activities to increase sustainability, including—

"(i) advancing knowledge of how bioenergy crop interactions with biotic and abiotic environmental factors influence crop growth, yield, and quality;

"(ii) identifying the most impactful research areas that address the economics of biofuels and bioproducts production; and

"(iii) utilizing multiscale modeling to advance predictive understanding of biofuel cropping ecosystems.

"(B) Research activities to further feedstock development, including lignocellulosic, algal, gaseous wastes including carbon oxides and methane, and direct air capture of single carbon gases via plants and microbes, including—

"(i) developing genetic and genomic tools, high-throughput analytical tools, and biosystems design approaches to enhance bioenergy feedstocks and their associated microbiomes;

"(ii) conducting field testing of new potential bioenergy feedstock crops under environmentally benign and geographically diverse conditions to assess viability and robustness; and

"(iii) developing quantitative models informed by experimentation to predict how bioenergy feedstocks perform under diverse conditions.

"(C) Research activities to improve lignocellulosic deconstruction and separation methods, including—

"(i) developing feedstock-agnostic deconstruction processes capable of efficiently fractionating biomass into targeted output streams;

"(ii) gaining a detailed understanding of plant cell wall biosynthesis, composition, structure, and properties during deconstruction; and

"(iii) improving enzymes and approaches for biomass breakdown and cellulose, hemicellulose, and lignin processing.

"(D) Research activities to improve the feedstock conversion process for advanced biofuels and bioproducts, including—

"(i) developing high-throughput methods to screen or select high-performance microbial strains and communities to improve product formation rates, yields, and selectivity;

"(ii) establishing a broad set of platform microorganisms and microbial communities suitable for metabolic engineering to produce biofuels and bioproducts, as well as high-throughput methods for experimental validation of gene function;

"(iii) developing techniques to enhance microbial robustness for tolerating toxins to improve biofuel and bioproduct yields and to gain a better understanding of the cellular and molecular bases of tolerance for major chemical classes of inhibitors found in these processes;

"(iv) advancing technologies for the use of batch, continuous, as well as consolidated bioprocessing;

"(v) identifying, creating, and optimizing microbial and chemical pathways to produce promising, atom-economical intermediates and final bioproducts from biomass with considerations given to environmentally benign processes;

"(vi) developing high-throughput, real-time, in situ analytical techniques to understand and characterize the pre- and post-bioproduct separation streams in detail;

"(vii) creating methodologies for efficiently identifying viable target molecules, identifying high-value bioproducts in existing biomass streams, and utilizing current byproduct streams;

"(viii) identifying and improving plant feedstocks with enhanced extractable levels of desired bioproducts or bioproduct precursors, including lignin streams; and

"(ix) developing integrated biological and chemical catalytic approaches to valorize and produce a diverse portfolio of advanced fuels and bioproducts.

"(6) INDUSTRY PARTNERSHIPS.—Centers shall establish industry partnerships to translate research results to commercial applications.

"(7) COORDINATION.—In coordination with the Bioenergy Technologies Office of the Department, the Director shall support interdisciplinary research activities to improve the capacity, efficiency, resilience, security, reliability, and affordability, of the production and use of biofuels and bioproducts, as well as activities to enable positive impacts and avoid the potential negative impacts that the production and use of biofuels and bioproducts may have on ecosystems, people, and historically marginalized communities.".

(c) LOW-DOSE RADIATION RESEARCH PROGRAM.—Section 306(e)(8) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(c)(8)), as redesignated under subsection (a), is amended—

(1) in subparagraph (C), by striking "and";

(2) in subparagraph (D), by striking the period at the end and inserting a semicolon; and

(3) by adding at the end the following:

"(E) $40,000,000 for fiscal year 2025; and

"(F) $50,000,000 for fiscal year 2026.".

(d) LOW-DOSE RADIATION AND SPACE RADIATION RESEARCH PROGRAM.—Section 306(f) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(d)), as redesignated under subsection (a), is amended to read as follows:

"(f) LOW-DOSE RADIATION AND SPACE RADIATION RESEARCH PROGRAM.—

"(1) IN GENERAL.—The Secretary of Energy, in consultation with the Administrator of the National Aeronautics and Space Administration shall carry out a basic research program on the similarities and differences between the effects of exposure to low-dose radiation on Earth, in low Earth orbit, and in the space environment.

"(2) PURPOSE.—The purpose of this program is to accelerate breakthroughs in low-dose and low dose-rate radiation research and development as described in subsection (d) and to inform the advancement of new tools, technologies, and advanced materials needed to facilitate long-duration space exploration.".

(e) CLIMATE, ENVIRONMENTAL SCIENCE, AND OTHER ACTIVITIES.—Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) is further amended by adding at the end the following:

"(g) EARTH AND ENVIRONMENTAL SYSTEMS SCIENCES ACTIVITIES.—

"(1) IN GENERAL.—As part of the activities authorized under subsection (a), and in coordination with activities carried out under subsection (b), the Director shall carry out earth and environmental systems science research, in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, which may include activities to—

"(A) understand, observe, and model the response of Earth's atmosphere and biosphere to increased concentrations of greenhouse gas emissions and any associated changes in climate, including frequency and intensity of extreme weather events;

"(B) understand the coupled physical, chemical, and biological processes to transform, immobilize, remove, or move carbon, nitrogen, and other energy production-derived contaminants such as radionuclides and heavy metals, and understand the process of sequestration and transformation of these, carbon dioxide, and other relevant molecules in subsurface environments;

"(C) understand, observe, and model the cycling of water, carbon, and nutrients in terrestrial systems and at scales relevant to resources management;

"(D) understand the biological, biogeochemical, and physical processes across the multiple scales that control the flux of environmentally relevant compounds between the terrestrial surface and the atmosphere; and

"(E) inform potential natural mitigation and adaptation options for increased concentrations of greenhouse gas emissions and any associated changes in climate.

"(2) PRIORITIZATION.—In carrying out the program authorized under paragraph (1), the Director shall prioritize—

"(A) the development of software and algorithms to enable the productive application of environmental systems and extreme weather in climate and Earth system prediction models in high-performance computing systems; and

"(B) capabilities that support the Department's mission needs for energy and infrastructure security, resilience, and reliability.

"(3) ENVIRONMENTAL SYSTEMS SCIENCE RESEARCH.—

"(A) IN GENERAL.—As part of the activities described in paragraph (1), the Director shall carry out research to advance an integrated, robust, and scale-aware predictive understanding of environmental systems, including the role of hydrobiogeochemistry, from the subsurface to the top of the vegetative canopy that considers effects of seasonal to interannual variability and change.

"(B) CLEAN WATER AND WATERSHED RESEARCH.—As part of the activities described in subparagraph (A), the Director shall—

"(i) support interdisciplinary research to significantly advance our understanding of water availability, quality, and the impact of human

activity and a changing climate on urban and rural watershed systems, including in freshwater environments;

"(ii) consult with the Interagency Research, Development, and Demonstration Coordination Committee on the Nexus of Energy and Water for Sustainability established under section 1010 of the Energy Act of 2020 (division Z of the Consolidated Appropriations Act, 2021) on energy-water nexus research activities; and

"(iii) engage with representatives of research and academic institutions, nonprofit organizations, State, local, and tribal governments, and industry, who have expertise in technologies, technological innovations, or practices relating to the energy-water nexus, as applicable.

"(C) COORDINATION.—

"(i) DIRECTOR.—The Director shall carry out activities under this paragraph in accordance with priorities established by the Secretary to support and accelerate the decontamination of relevant facilities managed by the Department.

"(ii) SECRETARY.—The Secretary shall ensure the coordination of activities of the Department, including activities under this paragraph, to support and accelerate the decontamination of relevant facilities managed by the Department.

"(4) CLIMATE AND EARTH MODELING.—As part of the activities described in paragraph (1), the Director, in collaboration with the Advanced Scientific Computing Research program described in section 304 and other programs carried out by the Department, as applicable, and in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, shall carry out research to develop, evaluate, and use high-resolution regional climate, global climate, Earth system, and other relevant models to inform decisions on reducing greenhouse gas emissions and the resulting impacts of a changing global climate. Such modeling shall include—

"(A) integrated capabilities for modeling multisectoral interactions, including socioeconomic factors as appropriate, which may include the impacts of climate policies on social and regional equity and well-being, and the interdependencies and risks at the energy-water-land nexus;

"(B) greenhouse gas emissions, air quality, energy supply and demand, and other critical elements; and

"(C) interaction among human and Earth systems informed by interdisciplinary research, including the economic and social sciences.

"(5) MID-SCALE FUNDING MECHANISM.—

"(A) IN GENERAL.—Any of the activities authorized in this subsection may be carried out by competitively selected mid-scale, multi-institutional research centers in lieu of individual research grants, or large-scale experiments or user facilities.

"(B) CONSIDERATION.—The Biological and Environmental Research Advisory Committee shall provide recommendations to the Director on projects most suitable for the research centers described in subparagraph (A).

"(h) BIOLOGICAL AND ENVIRONMENTAL RESEARCH USER FACILITIES.—

"(1) IN GENERAL.—The Director shall carry out a program for the development, construction, operation, and maintenance of user facilities to enhance the collection and analysis of observational data related to complex biological, climate, and environmental systems.

"(2) FACILITY REQUIREMENTS.—To the maximum extent practicable, the user facilities developed, constructed, operated, or maintained under paragraph (1) shall include—

"(A) distributed field research and observation platforms for understanding earth system processes;

"(B) analytical techniques, instruments, and modeling resources for understanding the physical, chemical, and cellular processes of biological and environmental systems;

"(C) integrated high-throughput sequencing, advanced bioanalytic techniques, DNA design and synthesis, metabolomics, and computational analysis; and

"(D) such other facilities as the Director considers appropriate, consistent with section 209 of the Department of Energy Organization Act (42 U.S.C. 7139).

"(3) EXISTING FACILITIES.—In carrying out the program established in paragraph (1), the Director is encouraged to evaluate the capabilities of existing user facilities and, to the maximum extent practicable, invest in modernization of those capabilities to address emerging research priorities.

"(4) USER FACILITIES INTEGRATION AND COLLABORATION PROGRAM.—

"(A) IN GENERAL.—The Director shall support a program of collaboration between user facilities as defined under this subsection to encourage and enable researchers to more readily integrate the tools, expertise, resources, and capabilities of multiple Office of Science user facilities (as described in section 209(d) of the Department of Energy Organization Act (42 U.S.C. 7139)) to further research and advance emerging technologies.

"(B) ACTIVITIES.—The program shall advance the integration of automation, robotics, computational biology, bioinformatics, biosensing, cellular platforms and other relevant emerging technologies as determined by the Director to enhance productivity and scientific impact of user facilities.

"(5) EARTH AND ENVIRONMENTAL SYSTEMS SCIENCES USER FACILITIES.—

"(A) IN GENERAL.—In carrying out the activities authorized under paragraph (1), the Director shall establish and operate user facilities to advance the collection, validation, and analysis of atmospheric data, including activities to advance knowledge and improve model representations and measure the impact of atmospheric gases, aerosols, and clouds on earth and environmental systems.

"(B) SELECTION.—The Director shall select user facilities under paragraph (1) on a competitive, merit-reviewed basis. The Director shall consider applications from the National Laboratories, institutes of higher education, multi-institutional collaborations, and other appropriate entities.

"(C) EXISTING FACILITIES.—To the maximum extent practicable, the Director shall utilize existing facilities to carry out this subsection.

"(6) COORDINATION.—In carrying out the program authorized in paragraph (1), the Director shall ensure that the Office of Science—

"(A) consults and coordinates with the National Oceanic Atmospheric Administration, the Environmental Protection Agency, the National Aeronautics and Space Administration, the Department of Agriculture, the Department of the Interior, and any other relevant Federal agency on the collection, validation, and analysis of atmospheric data; and

"(B) coordinates with relevant stakeholders, including institutes of higher education, nonprofit research institutions, industry, State, local, and tribal governments, and other appropriate entities to ensure access to the best available relevant atmospheric and historical weather data.

"(i) COASTAL ZONE RESEARCH INITIATIVE.—

"(1) IN GENERAL.—The Director shall carry out a research program, in consultation with the National Oceanic and Atmospheric Administration, to enhance the understanding of coastal ecosystems. In carrying out this program, the Director shall prioritize efforts to enhance the collection of observational data, and shall develop models to analyze the ecological, biogeochemical, hydrological and physical processes that interact in coastal zones.

"(2) NATIONAL SYSTEM FOR COASTAL DATA COLLECTION.—The Director shall establish, in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, an integrated system of geographically diverse field research sites in order to improve the quantity and quality of observational data, and that encompass the major land water interfaces of the United States, including—

"(A) the Great Lakes region;
"(B) the Pacific coast;
"(C) the Atlantic coast;
"(D) the Arctic; and
"(E) the Gulf coast.

"(3) EXISTING INFRASTRUCTURE.—In carrying out the programs and establishing the field research sites under paragraph (1) and (2), the Secretary shall leverage existing research and development infrastructure supported by the Department, including the Department's existing marine and coastal research lab.

"(4) COORDINATION.—For the purposes of carrying out the programs and establishing the field research sites under the Initiative, the Secretary may enter into agreements with Federal Departments and agencies with complementary capabilities.

"(5) REPORT.—Not less than 2 years after the date of the enactment of the Department of Energy Science for the Future Act, the Director shall provide to the Committee on Science, Space, and Technology and the Committee on Appropriations of the House of Representatives and the Committee on Energy and Natural Resources and the Committee on Appropriations of the Senate a report examining whether the system described in this section should be established as a National User Facility.

"(j) TECHNOLOGY DEVELOPMENT.—The Director shall support a technology research program for the development of instrumentation and other research tools re-

quired to meet the missions of the Department and to provide platform technologies for the broader scientific community. Technologies shall include but are not limited to—

"(1) cryo-electron microscopy;

"(2) fabricated ecosystems;

"(3) next generation sensors including quantum sensors for biological integration and bioproduction;

"(4) technologies to accelerate data analysis; and

"(5) plant and microbial phenotyping for gene discovery.

"(k) EMERGING TECHNOLOGIES.—

"(1) IN GENERAL.—The Secretary shall establish within the Biological and Environmental Research program an initiative focused on the development of engineered ecosystems through the application of artificial intelligence, novel sensing capabilities, and other emerging technologies.

"(2) INTERAGENCY COORDINATION.—The Secretary shall coordinate with the Director of the National Science Foundation, the Administrator of the National Oceanic and Atmospheric Administration, the Director of the U.S. Geological Survey, and other relevant officials to avoid duplication of research and observational activities and to ensure that activities carried out under this initiative are complimentary to those currently being undertaken by other agencies.

"(3) REPORT.—Not later than 180 days after the enactment of this Act, the Secretary shall provide a report to the Committee on Science, Space, and Technology of the House, and the Committee on Energy and Natural Resources of the Senate, on the activity mandated in subsection (k).

"(l) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $820,360,000 for fiscal year 2022;

"(2) $886,385,200 for fiscal year 2023;

"(3) $956,332,164 for fiscal year 2024;

"(4) $1,020,475,415 for fiscal year 2025; and

"(5) $1,099,108,695 for fiscal year 2026.".

SEC. 5. ADVANCED SCIENTIFIC COMPUTING RESEARCH PROGRAM.

(a) ADVANCED SCIENTIFIC COMPUTING RESEARCH.—Section 304 of the Department of Energy Research and Innovation Act (42 U.S.C. 18642) is amended—

(1) by redesignating subsections (a) through (c) as subsections (b) through (d), respectively; and

(2) by inserting before subsection (b), as so redesignated, the following:

"(a) IN GENERAL.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out, in coordination with academia and relevant public and private sector entities, a research, development, and demonstration program to—

"(1) steward applied mathematics, computational science, and computer science research relevant to the missions of the Department and the competitiveness of the United States;

"(2) develop modeling, simulation, and other computational tools relevant to other scientific disciplines and to the development of new energy technologies and other technologies;

"(3) advance computating and networking capabilities for data-driven discovery; and

"(4) develop advanced scientific computing hardware and software tools for science and engineering.";

(3) in subsection (c) (as redesignated under paragraph (1))—

(A) by striking "The Director" and inserting the following:

"(1) DIRECTOR.—The Director"; and

(B) by adding at the end the following:

"(2) COORDINATION.—The Under Secretary for Science shall ensure the coordination of the activities of the Department, including activities under this section, to determine and meet the computational and networking research and facility needs of the Office of Science and all other relevant energy technology and energy efficiency programs within the Department and with other Federal agencies as appropriate.";

(4) by amending subsection (d), as so redesignated, to read as follows:

"(d) APPLIED MATHEMATICS AND SOFTWARE DEVELOPMENT FOR HIGH-END COMPUTING SYSTEMS AND COMPUTER SCIENCES RESEARCH.—

"(1) IN GENERAL.—The Director shall carry out activities to develop, test, and support—

"(A) mathematics, statistics, and algorithms for modeling complex systems relevant to the missions of the Department, including on advanced computing architectures; and

"(B) tools, languages, programming environments, and operations for high-end computing systems (as defined in section 2 of the American Super Computing Leadership Act (15 U.S.C. 5541).

"(2) PORTFOLIO BALANCE.—

"(A) IN GENERAL.—The Director shall maintain a balanced portfolio within the advanced scientific computing research and development program established under section 976 of the Energy Policy Act of 2005 (42 U.S.C. 16316) that supports robust investment in—

"(i) applied mathematical, computational, and computer sciences research needs relevant to the mission of the Department, including foundational areas that are critical to the advancement of energy sciences and technologies and new and emerging computing technologies; and

"(ii) associated high-performance computing hardware and facilities.

"(B) EXASCALE ECOSYSTEM SUSTAINMENT.—

"(i) SENSE OF CONGRESS.—It is the sense of Congress that the Exascale Computing Project has successfully created a broad ecosystem that provides shared software packages, novel evaluation systems, and applications relevant to the science and engineering requirements of the Department, and that such products must be maintained and improved in order that the full potential of the deployed systems can be continuously realized.

"(ii) IN GENERAL.—The Secretary shall seek to sustain and evolve the ecosystem referenced in clause (i) to ensure that the exascale software stack and other research software will continue to be maintained, hardened, and otherwise optimized for long-term use on exascale systems and beyond and reliable availability to the user community."; and

(5) by inserting after subsection (d) the following:

"(e) NEXT GENERATION COMPUTING PROGRAM.—

"(1) IN GENERAL.—The Secretary shall establish a program to develop and implement a strategy for achieving computing systems with capabilities beyond exascale computing systems. In establishing this program, the Secretary shall—

"(A) maintain foundational research programs in mathematical, computational, and computer sciences focused on new and emerging computing needs within the mission of the Department, including post-Moore's law computing architectures, novel approaches to modeling and simulation, artificial intelligence and scientific machine learning, quantum computing, edge computing, extreme heterogeneity, and distributed high-performance computing; and

"(B) retain best practices and maintain support for essential hardware, applications, and software elements of the Exascale Computing Program that are necessary for sustaining the vitality of a long-term capable software ecosystem for exascale and beyond; and

"(C) develop a Department-wide strategy for balancing on-premises and cloud-based computing and scientific data management.

"(2) REPORT.—Not later than one year after the date of the enactment of this Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives, and the Committee on Energy and Natural Resources of the Senate, a report on the development and implementation of the strategy outlined in paragraph (1).

"(f) ARCHITECTURAL RESEARCH IN HETEROGENEOUS COMPUTING SYSTEMS.—

"(1) IN GENERAL.—The Secretary shall carry out a program of research and development in heterogeneous and reconfigurable computing systems to expand understanding of the potential for heterogeneous and reconfigurable computing systems to deliver high performance, high efficiency computing for Department of Energy mission challenges. This shall include research and development that explores the convergence of big data analytics, simulations, and artificial intelligence to drive the design of heterogenous computing system architectures.

"(2) COORDINATION.—In carrying out this program, the Secretary shall ensure coordination between research activities undertaken by the Advanced Scientific Computing Research program and materials research supported by the Basic Energy Sciences program within the Department of Energy Office of Science.

"(g) ENERGY EFFICIENT COMPUTING PROGRAM.—

"(1) IN GENERAL.—The Secretary shall support a program of fundamental research, development, and demonstration of energy efficient computing and data

center technologies relevant to advanced computing applications, including high performance computing, artificial intelligence, and scientific machine learning.

"(2) EXECUTION.—

"(A) PROGRAM.—In carrying out the program under paragraph (1), the Secretary shall—

"(i) establish a partnership for National Laboratories, industry partners, and institutions of higher education for codesign of energy efficient hardware, technology, software, and applications across all applicable program offices of the Department, and provide access to energy efficient computing resources to such partners;

"(ii) develop hardware and software technologies that decrease the energy needs of advanced computing practices, including through data center co-design; and

"(iii) consider multiple heterogeneous computing architectures in collaboration with the program established under subsection (f) including neuromorphic computing, persistent computing, and ultrafast networking; and

"(iv) provide, as appropriate, on a competitive, merit-reviewed basis, access for researchers from institutions of higher education, National Laboratories, industry, and other Federal agencies to the energy efficient computing technologies developed pursuant to clause (i).

"(B) SELECTION OF PARTNERS.—In selecting participants for the partnership established under subparagraph (A)(i), the Secretary shall select participants through a competitive, merit review process.

"(C) REPORT.—Not later than one year after the date of the enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives, and the Committee on Energy and Natural Resources of the Senate, a report on—

"(i) the activities conducted under subparagraph (A); and

"(ii) the coordination and management of the program under subparagraph (A) to ensure an integrated research program across the Department.

"(h) ENERGY SCIENCES NETWORK.—

"(1) IN GENERAL.—The Secretary shall provide for upgrades to the Energy Sciences Network user facility in order to meet the research needs of the Department for highly reliable data transport capabilities optimized for the requirements of large-scale science.

"(2) CAPABILITIES.—In carrying out paragraph (1), the Secretary shall ensure the following capabilities:

"(A) To provide high bandwidth scientific networking across the continental United States and the Atlantic Ocean.

"(B) To ensure network reliability.

"(C) To protect the network infrastructure from cyber-attacks.

"(D) To manage transport of exponentially increasing levels of data from the Department's National Laboratories and sites, user facilities, experiments, and sensors.

"(E) To contribute to the integration of heterogeneous computing frameworks and systems.

"(i) COMPUTATIONAL SCIENCE GRADUATE FELLOWSHIP.—

"(1) IN GENERAL.—The Secretary shall support the Computational Science Graduate Fellowship program in order to facilitate collaboration between graduate students and researchers at the National Laboratories, and contribute to the development of a diverse and inclusive computational workforce to help advance research in areas relevant to the mission of the Department.

"(2) FUNDING.—From within funds authorized to be appropriated for Advanced Scientific Computing Research Program, the Secretary shall make available for carrying out the activities under this section—

"(A) $21,000,000 for fiscal year 2022;

"(B) $22,050,000 for fiscal year 2023;

"(C) $23,152,500 for fiscal year 2024;

"(D) $24,310,125 for fiscal year 2025; and

"(E) $25,525,631 for fiscal year 2026.

"(j) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $1,126,350,000 for fiscal year 2022;

"(2) $1,222,674,500 for fiscal year 2023;

"(3) $1,324,320,715 for fiscal year 2024;

"(4) $1,431,660,115 for fiscal year 2025; and

"(5) $1,535,090,121 for fiscal year 2026.".

(b) QUANTUM SCIENCE NETWORK.—

(1) DEFINITIONS.—Section 2 of the National Quantum Initiative Act (15 U.S.C. 8801) is amended—

(A) by redesignating paragraph (7) as paragraph (8); and

(B) by inserting after paragraph (6) the following:

"(7) QUANTUM NETWORK INFRASTRUCTURE.—The term 'quantum network infrastructure' means any facility, expertise, or capability that is necessary to enable the development and deployment of scalable and diverse quantum network technologies.".

(2) DEPARTMENT OF ENERGY QUANTUM NETWORK INFRASTRUCTURE RESEARCH AND DEVELOPMENT PROGRAM.—(A) Title IV of the National Quantum Initiative Act (15 U.S.C. 8851 et seq.) is amended by adding at the end the following:

"SEC. 403. DEPARTMENT OF ENERGY QUANTUM NETWORK INFRASTRUCTURE RESEARCH AND DEVELOPMENT PROGRAM.

"(a) IN GENERAL.—The Secretary of Energy (referred to in this section as the 'Secretary') shall carry out a research, development, and demonstration program to accelerate innovation in quantum network infrastructure in order to—

"(1) facilitate the advancement of distributed quantum computing systems through the internet and intranet;

"(2) improve the precision of measurements of scientific phenomena and physical imaging technologies;

"(3) develop secure national quantum communications technologies and strategies; and

"(4) demonstrate these capabilities utilizing the Department's Energy Sciences Network User Facility.

"(b) PROGRAM.—In carrying out this section, the Secretary shall—

"(1) coordinate with—

"(A) the Director of the National Science Foundation;

"(B) the Director of the National Institute of Standards and Technology;

"(C) the Chair of the subcommittee on Quantum Information Science of the National Science and Technology Council established under section 103(a); and

"(D) the Chair of the subcommittee on the Economic and Security Implications of Quantum Science;

"(2) conduct cooperative research with industry, National Laboratories, institutions of higher education, and other research institutions to facilitate new quantum infrastructure methods and technologies, including—

"(A) quantum-limited detectors, ultra-low loss optical channels, space-to-ground connections, and classical networking and cybersecurity protocols;

"(B) entanglement and hyper-entangled state sources and transmission, control, and measurement of quantum states;

"(C) quantum interconnects that allow short range local connections between quantum processors;

"(D) transducers for quantum sources and signals between optical and telecommunications regimes and quantum computer-relevant domains, including microwaves;

"(E) development of quantum memory buffers and small-scale quantum computers that are compatible with photon-based quantum bits in the optical or telecommunications wavelengths;

"(F) long-range entanglement distribution at both the terrestrial and space-based level using quantum repeaters, allowing entanglement-based protocols between small- and large scale quantum processors;

"(G) quantum routers, multiplexers, repeaters, and related technologies necessary to create secure long-distance quantum communication; and

"(H) integration of systems across the quantum technology stack into traditional computing networks, including the development of remote controlled, high performance, and reliable implementations of key quantum network components by leveraging the expertise, infrastructure and supplemental investments in the Energy Sciences Network User Facility;

"(3) engage with the Quantum Economic Development Consortium (QED–C) to transition component technologies to help facilitate as appropriate the development of a quantum supply chain for quantum network technologies;

"(4) advance basic research in advanced scientific computing, particle and nuclear physics, and material science to enhance the understanding, prediction, and manipulation of materials, processes, and physical phenomena relevant to quantum network infrastructure;

"(5) develop experimental tools and testbeds in collaboration with the Department's Energy Sciences Network User Facility necessary to support cross-cut-

ting fundamental research and development activities with diverse stakeholders from industry, National Laboratories, and institutions of higher education; and

"(6) consider quantum network infrastructure applications that span the Department of Energy's missions in energy, environment, and national security.

"(c) LEVERAGING.—In carrying out this section, the Secretary shall leverage resources, infrastructure, and expertise across the Department of Energy and from—

"(1) the National Institute of Standards and Technology;

"(2) the National Science Foundation;

"(3) the National Aeronautics and Space Administration;

"(4) other relevant Federal agencies;

"(5) the National Laboratories;

"(6) industry stakeholders;

"(7) institutions of higher education; and

"(8) the National Quantum Information Science Research Centers.

"(d) RESEARCH PLAN.—Not later than 180 days after the date of the enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate, a 4-year research plan that identifies and prioritizes basic research needs relating to quantum network infrastructure.

"(e) STANDARD OF REVIEW.—The Secretary shall review activities carried out under this section to determine the achievement of technical milestones.

"(f) FUNDING.—Out of funds authorized to be appropriated for the Department of Energy's Office of Science, there shall be made available to the Secretary to carry out the activities under this section, $100,000,000 for each of fiscal years 2022 through 2026.

"SEC. 404. DEPARTMENT OF ENERGY QUANTUM USER EXPANSION FOR SCIENCE AND TECHNOLOGY PROGRAM.

"(a) IN GENERAL.—The Secretary of Energy (referred to in this section as the 'Secretary') shall establish and carry out a program (to be known as the 'Quantum User Expansion for Science and Technology program' or 'QUEST program') to encourage and facilitate access to United States quantum computing hardware and quantum computing clouds for research purposes in order to—

"(1) enhance the United States quantum research enterprise;

"(2) educate the future quantum computing workforce; and

"(3) accelerate the advancement of United States quantum computing capabilities.

"(b) PROGRAM.—In carrying out this section, the Secretary shall—

"(1) coordinate with—

"(A) the Director of the National Science Foundation;

"(B) the Director of the National Institute of Standards and Technology;

"(C) the Chair of the Quantum Information Science of the National Science and Technology Council established under section 103(a); and

"(D) the Chair of the subcommittee on the Economic and Security Implications of Quantum Science;

"(2) provide researchers based within the United States with access to, and use of, United States quantum computing resources through a competitive, merit-reviewed process;

"(3) consider applications from the National Laboratories, multi-institutional collaborations, institutions of higher education, industry stakeholders, and any other entities that the Secretary determines are appropriate to provide national leadership on quantum computing related issues; and

"(4) consult and coordinate with private sector stakeholders, the user community, and interagency partners on program development and best management practices.

"(c) LEVERAGING.—In carrying out this section, the Secretary shall leverage resources and expertise across the Department of Energy and from—

"(1) the National Institute of Standards and Technology;

"(2) the National Science Foundation;

"(3) the National Aeronautics and Space Administration;

"(4) other relevant Federal agencies;

"(5) the National Laboratories;

"(6) industry stakeholders;

"(7) institutions of higher education; and

"(8) the National Quantum Information Science Research Centers.

"(d) SECURITY.—In carrying out the activities authorized by this section, the Secretary, in consultation with the Director of the National Science Foundation and the Director of the National Institute of Standards and Technology, shall ensure proper security controls are in place to protect sensitive information, as appropriate.

"(e) FUNDING.—Out of funds authorized to be appropriated for the Department of Energy's Office of Science, there shall be made available to the Secretary to carry out the activities under this section—

"(1) $30,000,000 for fiscal year 2022;
"(2) $50,000,000 for fiscal year 2023;
"(3) $70,000,000 for fiscal year 2024;
"(4) $90,000,000 for fiscal year 2025; and
"(5) $100,000,000 for fiscal year 2026.

"(f) EQUITABLE USE OF HIGH-PERFORMANCE COMPUTING CAPABILITIES.—

"(1) SENSE OF CONGRESS.—It is the sense of Congress that machine learning algorithms can exhibit biases that cause harm to historically marginalized communities.

"(2) POLICY.—In leveraging high-performance computing systems for research purposes, including through the use of machine learning algorithms for data analysis, the Secretary shall ensure that such capabilities are employed in a manner that mitigates and, to the maximum extent practicable, avoids harmful algorithmic bias and equitably addresses challenges impacting different populations, including historically marginalized communities.".

(B) The table of contents in section 1(b) of the National Quantum Initiative Act is amended by inserting after the item relating to section 402 the following items:

"Sec. 403. Department of energy quantum network infrastructure research and development program.
"Sec. 404. Department of energy quantum user expansion for science and technology program.".

SEC. 6. FUSION ENERGY RESEARCH.

(a) FUSION ENERGY RESEARCH.—Section 307 of the Department of Energy Research and Innovation Act (42 U.S.C. 18645) is amended—

(1) in subsection (b)—

(A) in the matter preceding paragraph (1), by striking "As part of" and inserting the following:

"(1) IN GENERAL.—As part of";

(B) by redesignating—

(i) paragraphs (1) and (2) as subparagraphs (A) and (B), respectively (and by adjusting the margins of such subparagraphs accordingly); and

(ii) in subparagraph (B) (as redesignated by clause (i)), subparagraphs (A) and (B) as clauses (i) and (ii), respectively (and by adjusting the margins of such clauses accordingly); and

(C) by adding at the end the following:

"(2) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated under subsection (r), there are authorized to be appropriated to the Secretary to carry out activities described in paragraph (1) $50,000,000 for each of fiscal years 2022 through 2026.";

(2) in subsection (d)(3)—

(A) by striking the period at the end and inserting "and $40,000,000 for fiscal year 2026."; and

(B) by striking "(o)" and inserting "(r)"; and

(3) in subsection (e)(4)—

(A) by striking the period at the end and inserting "and $75,000,000 for fiscal year 2026."; and

(B) by striking "(o)" and inserting "(r)";

(4) in subsection (i)(10)—

(A) In the matter preceding subparagraph (A), by striking "(o)" and inserting "(r)";

(B) in subparagraph (D), by striking "; and" and inserting a semicolon;

(C) in subparagraph (E), by striking the period at the end and inserting "; and"; and

(D) by adding at the end the following:

"(F) $45,000,000 for fiscal year 2026.";

(5) in subsection (j)—

(A) by striking "The Director" and all that follows through the period and inserting the following:

"(1) IN GENERAL.—

"(A) ESTABLISHMENT.—Within 180 days of enactment of the Department of Energy Science for the Future Act, the Director shall establish at least 2 national teams, including public-private partnerships, that will develop conceptual pilot plant designs and technology roadmaps and lead to an engineering design of a pilot plant that will bring fusion to commercial viability.

"(B) COMPOSITION.—The national teams shall be composed of developers, manufacturers, universities, national laboratories, and engineering, procurement, and construction industries."; and

(B) by adding at the end the following:

"(2) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out activities described in paragraph (1)—

"(A) $20,000,000 for fiscal year 2022;

"(B) $35,000,000 for fiscal year 2023;

"(C) $50,000,000 for fiscal year 2024;

"(D) $65,000,000 for fiscal year 2025; and

"(E) $80,000,000 for fiscal year 2026.";

(6) in subsection (l)—

(A) by striking "sense of Congress that the United States should support" and inserting "sense of Congress that—";

"(1) the United States should support";

(B) in paragraph (1) (as so designated by subparagraph (A) of this paragraph), by striking the period at the end and inserting "; and"; and

(C) by adding at the end the following:

"(2) the Director shall incorporate the findings and recommendations of the report of the Fusion Energy Sciences Advisory Committee entitled 'Powering the Future: Fusion and Plasmas' and the report of the National Academies entitled "Bringing Fusion to the U.S. Grid" into the planning process of the Department, including the development of future budget requests to Congress.";

(7) by redesignating subsection (o) as subsection (r);

(8) by inserting after subsection (n) the following:

"(o) HIGH-PERFORMANCE COMPUTATION COLLABORATIVE RESEARCH PROGRAM.—

"(1) IN GENERAL.—The Secretary shall carry out a program to conduct and support collaborative research, development, and demonstration of fusion energy technologies, through high-performance computation modeling and simulation techniques, in order to—

"(A) support fundamental research in plasmas and matter at very high temperatures and densities;

"(B) inform the development of a broad range of fusion energy systems; and

"(C) facilitate the translation of research results in fusion energy science to industry.

"(2) COORDINATION.—In carrying out the program under paragraph (1), the Secretary shall coordinate with relevant Federal agencies, and prioritize the following objectives:

"(A) Using expertise from the private sector, institutions of higher education, and the National Laboratories to leverage existing, and develop new, computational software and capabilities that prospective users may use to accelerate research and development of fusion energy systems.

"(B) Developing computational tools to simulate and predict fusion energy science phenomena that may be validated through physical experimentation.

"(C) Increasing the utility of the research infrastructure of the Department by coordinating with the Advanced Scientific Computing Research program within the Office of Science.

"(D) Leveraging experience from existing modeling and simulation entities sponsored by the Department.

"(E) Ensuring that new experimental and computational tools are accessible to relevant research communities, including private sector entities engaged in fusion energy technology development.

"(F) Ensuring that newly developed computational tools are compatible with modern virtual engineering and visualization capabilities to accelerate the realization of fusion energy technologies and systems.

"(3) DUPLICATION.—The Secretary shall ensure the coordination of, and avoid unnecessary duplication of, the activities of this program with the activities of—

"(A) other research entities of the Department, including the National Laboratories, the Advanced Research Projects Agency–Energy, the Advanced Scientific Computing Research program; and

"(B) industry.

"(4) HIGH-PERFORMANCE COMPUTING FOR FUSION INNOVATION CENTER.—In carrying out the program under paragraph (1), the Secretary shall, in coordination with the Innovation Network for Fusion Energy, establish and operate a national High-Performance Computing for Fusion Innovation Center (referred to in this section as the 'Center'), in order to support the program under paragraph (1) by providing, to the extent practicable, a centralized entity for multi-

disciplinary, collaborative, fusion energy research and development through high performance computing and advanced data analytics technologies and processes.

"(5) SELECTION.—The Secretary shall select the Center under this subsection on a competitive, merit-reviewed basis. The Secretary shall consider applications from National Laboratories, institutions of higher education, multi-institutional collaborations, and other appropriate entities.

"(6) EXISTING ACTIVITIES.—The Center may incorporate existing research activities that are consistent with the program described in paragraph (1).

"(7) DURATION.—The Center established under this subsection shall receive support for a period of not more than 5 years, subject to the availability of appropriations.

"(8) RENEWAL.—Upon the expiration of any period of support of the Center, the Secretary may renew support for the Center, on a merit-reviewed basis, for a period of not more than 5 years.

"(9) TERMINATION.—Consistent with the existing authorities of the Department, the Secretary may terminate the Center for cause during the performance period.

"(p) MATERIAL PLASMA EXPOSURE EXPERIMENT.—

"(1) IN GENERAL.—The Secretary shall construct a Material Plasma Exposure Experiment facility as described in the 2020 publication approved by the Fusion Energy Sciences Advisory Committee titled 'Powering the Future: Fusion and Plasmas'. The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility is capable of meeting Federal research needs for steady state, high-heat-flux and plasma-material interaction testing of fusion materials over a range of fusion energy relevant parameters.

"(2) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in subsection (a) will provide the following capabilities:

"(A) A magnetic field at the target of 1 Tesla.

"(B) An energy flux at the target of 10 MW/m2.

"(C) The ability to expose previously irradiated plasma facing material samples to plasma.

"(3) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2027.

"(4) FUNDING.—Out of funds authorized to be appropriated for Fusion Energy Sciences, there are funds authorized to be appropriated to the Secretary for the Office of Fusion Energy Sciences to carry out to completion the construction of the facility under this section:

"(A) $32,800,000 for fiscal year 2022;

"(B) $13,400,000 for fiscal year 2023;

"(C) $12,600,000 for fiscal year 2024; and

"(D) $400,000 for fiscal year 2025.

"(q) MATTER IN EXTREME CONDITIONS INSTRUMENT UPGRADE.—

"(1) IN GENERAL.—The Secretary shall provide for the upgrade to the Matter in Extreme Conditions endstation at the Linac Coherent Light Source as described in the 2020 publication approved by the Fusion Energy Sciences Advisory Committee titled 'Powering the Future: Fusion and Plasmas'. The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility is capable of meeting Federal research needs for understanding physical and chemical changes to plasmas at fundamental timescales, and explore new regimes of dense material physics, astrophysics, planetary physics, and short-pulse laser-plasma interactions.

"(2) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2028."; and

(9) in subsection (r), as so redesignated, by striking paragraphs (2) through (5) and inserting the following:

"(2) $1,002,900,000 for fiscal year 2022;

"(3) $1,095,707,000 for fiscal year 2023;

"(4) $1,129,368,490 for fiscal year 2024;

"(5) $1,149,042,284 for fiscal year 2025; and

"(6) $1,243,097,244 for fiscal year 2026.".

(b) ITER CONSTRUCTION.—Section 972 of the Energy Policy Act of 2005 (42 U.S.C. 16312) is amended in subsection (c)(3)—

(1) in subparagraph (A), by striking "and" at the end; and

(2) by striking subparagraph (B) and inserting the following:

"(B) $300,000,000 for fiscal year 2022;
"(C) $325,000,000 for fiscal year 2023;
"(D) $350,000,000 for fiscal year 2024;
"(E) $350,000,000 for fiscal year 2025; and
"(F) $350,000,000 for fiscal year 2026.".

SEC. 7. HIGH ENERGY PHYSICS PROGRAM.

(a) PROGRAM.—Section 305 of the Department of Energy Research and Innovation Act (42 U.S.C. 18643) is amended—

(1) by redesignating subsections (b) through (d) as subsections (d) through (f), respectively; and

(2) by inserting the following after subsection (a):

"(b) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program in elementary particle physics and advanced technology research and development to improve the understanding of the fundamental properties of the universe, including constituents of matter and energy and the nature of space and time.

"(c) HIGH ENERGY FRONTIER RESEARCH.—As part of the program described in subsection (a), the Director shall carry out research using high energy accelerators and advanced detectors, including accelerators and detectors that will function as national user facilities, to create and study interactions of elementary particles and investigate fundamental forces.".

(b) INTERNATIONAL COLLABORATION.—Section 305(d) of the Department of Energy Research and Innovation Act (42 U.S.C. 18643(d)), as redesignated under subsection (a), is amended to read as follows:

"(d) INTERNATIONAL COLLABORATION.—The Director shall—

"(1) as practicable and in coordination with other appropriate Federal agencies as necessary, ensure the access of United States researchers to the most advanced accelerator facilities and research capabilities in the world, including the Large Hadron Collider;

"(2) to the maximum extent practicable, continue to leverage United States participation in the Large Hadron Collider, and prioritize expanding international partnerships and investments in the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment; and

"(3) to the maximum extent practicable, prioritize engagement in collaborative efforts in support of future international facilities that would provide access to the most advanced accelerator facilities in the world to United States researchers.".

(c) COSMIC FRONTIER RESEARCH.—Section 305(f) of the Department of Energy Research and Innovation Act (42 U.S.C. 18645(f)), as redesignated by subsection (a), is amended to read as follows:

"(f) COSMIC FRONTIER RESEARCH.—The Director shall carry out research activities on the nature of the primary contents of the universe, including the nature of dark energy and dark matter. These activities shall, to the maximum extent practicable, be consistent with the research priorities identified by the High Energy Physics Advisory Panel or the National Academy of Sciences, and may include—

"(1) collaborations with the National Aeronautics and Space Administration, the National Science Foundation, or international partners on relevant projects; and

"(2) the development of space-based, land-based, water-based, and underground facilities and experiments.".

(d) FURTHER ACTIVITIES.—Section 305 of the Department of Energy Research and Innovation Act (42 U.S.C. 18645), as amended, is further amended by adding at the end the following:

"(g) FACILITY CONSTRUCTION AND MAJOR ITEMS OF EQUIPMENT.—

"(1) PROJECTS.—Consistent with the Office of Science's project management practices, the Director shall, to the maximum extent practicable, incorporate the findings and recommendations of the 2014 Particle Physics Project Prioritization Panel (P5) report titled 'Building for Discovery', and support construction or fabrication of—

"(A) an international Long-Baseline Neutrino Facility based in the United States;

"(B) the Proton Improvement Plan II;

"(C) Second Generation Dark Matter experiments;

"(D) the Legacy Survey of Space and Time camera;

"(E) upgrades to detectors and other components of the Large Hadron Collider; and

"(F) other high priority projects recommended in the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel.

"(2) LONG-BASELINE NEUTRINO FACILITY.—

"(A) IN GENERAL.—The Secretary shall support construction of a Long-Baseline Neutrino Facility to facilitate the international Deep Underground Neutrino Experiment to examine the fundamental properties of neutrinos, explore physics beyond the Standard Model, and better clarify the existence and nature of antimatter.

"(B) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in subparagraph (A) will provide, at a minimum, the following capabilities:

"(i) A neutrino beam with wideband capability of 1.2 megawatts (MW) of beam power and upgradable to 2.4 MW of beam power.

"(ii) Three caverns excavated for a 70 kiloton fiducial detector mass and supporting surface buildings and utilities.

"(iii) Cryogenic systems to support neutrino detectors.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this subsection occurs before December 31, 2031.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $200,000,000 for fiscal year 2022;

"(ii) $325,000,000 for fiscal year 2023;

"(iii) $400,000,000 for fiscal year 2024;

"(iv) $375,000,000 for fiscal year 2025; and

"(v) $250,000,000 for fiscal year 2026.

"(3) PROTON IMPROVEMENT PLAN–II ACCELERATOR UPGRADE PROJECT.—

"(A) IN GENERAL.—The Secretary of Energy shall support construction of the Proton Improvement Plan II, an upgrade to the Fermilab accelerator complex identified in the 2014 Particle Physics Project Prioritization Panel (P5) report titled 'Building for Discovery', to provide the world's most intense beam of neutrinos to the international Long Baseline Neutrino Facility as well as abroad range of future high energy physics experiments. The Secretary of Energy shall work with international partners to enable further significant contributions to the capabilities of this project.

"(B) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in paragraph (1) will provide, at a minimum, the following capabilities:

"(i) A state-of-the-art 800 megaelectron volt (MeV) superconducting linear accelerator.

"(ii) Proton beam power of 1.2 MW at the start of LBNF/DUNE, upgradeable to 2.4 MW of beam power.

"(iii) A flexible design to enable high power beam delivery to multiple users simultaneously and customized beams tailored to specific scientific needs.

"(iv) Sustained high reliability operation of the Fermilab accelerator complex.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2028.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $191,000,000 for fiscal year 2022;

"(ii) $150,000,000 for fiscal year 2023;

"(iii) $120,000,000 for fiscal year 2024;

"(iv) $120,000,000 for fiscal year 2025; and

"(v) $100,000,000 for fiscal year 2026.

"(4) COSMIC MICROWAVE BACKGROUND STAGE 4.—

"(A) IN GENERAL.—The Secretary of Energy, in partnership with the Director of the National Science Foundation, shall support construction of the Cosmic Microwave Background Stage 4 project to survey the cosmic microwave background to test theories of cosmic inflation as described in the 2014 Particle Physics Prioritization Panel (P5) report titled 'Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context.'.

"(B) CONSULTATION.—The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure

that this experiment is capable of meeting Federal research needs in accessing the ultra-high energy physics of inflation and important neutrino properties.

"(C) EXPERIMENTAL CAPABILITIES.—The Secretary shall ensure to the maximum extent practicable that the facility described in subsection (a) will provide at minimum, 500,000 superconducting detectors deployed on an array of mm wave telescopes with the required range in frequency, sensitivity, and survey speed which will provide sufficient capability to enable an order of magnitude advance in observations of the Cosmic Microwave Background, delivering transformative discoveries in fundamental physics, cosmology, and astrophysics.

"(D) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2030.

"(E) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $37,000,000 for fiscal year 2022;
"(ii) $50,000,000 for fiscal year 2023;
"(iii) $70,000,000 for fiscal year 2024;
"(iv) $80,000,000 for fiscal year 2025; and
"(v) $90,000,000 for fiscal year 2026.

"(h) ACCELERATOR AND DETECTOR UPGRADES.—The Director shall upgrade accelerator facilities and detectors, as necessary and appropriate, to increase beam power, sustain high reliability, and improve precision measurement to advance the highest priority particle physics research programs. In carrying out facility upgrades, the Director shall continue to work with international partners, when appropriate and in the United States' interest, to leverage investments and expertise in critical technologies to help build and upgrade accelerator and detector facilities in the United States.

"(i) ACCELERATOR AND DETECTOR RESEARCH AND DEVELOPMENT.—As part of the program described in subsection (a), the Director shall carry out research and development in particle beam physics, accelerator science and technology, and particle and radiation detection with relevance to the specific needs of the High Energy Physics program, in coordination with the Accelerator Research and Development program authorized in section 311.

"(j) UNDERGROUND SCIENCE.—The Director shall—

"(1) support an underground science program consistent with the missions of the Department and the scientific needs of the High Energy Physics program, including those articulated in the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel, that leverages the capabilities of relevant underground science and engineering facilities; and

"(2) carry out a competitive grant program to award scientists and engineers at institutions of higher education, nonprofit institutions, and national laboratories to conduct research in underground science and engineering.

"(k) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $1,355,690,000 for fiscal year 2022;
"(2) $1,517,628,300 for fiscal year 2023;
"(3) $1,652,112,281 for fiscal year 2024;
"(4) $1,711,460,141 for fiscal year 2025; and
"(5) $1,656,012,351 for fiscal year 2026.".

SEC. 8. NUCLEAR PHYSICS PROGRAM.

(a) PROGRAM.—Section 308 of the Department of Energy Research and Innovation Act (42 U.S.C. 18646) is amended—

(1) by striking subsection (a);
(2) by redesignating subsection (b) as subsection (d); and
(3) by inserting the following before subsection (d), as so redesignated:

"(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program, and support relevant facilities, to discover and understand various forms of nuclear matter.

"(b) USER FACILITIES.—

"(1) FACILITY FOR RARE ISOTOPE BEAMS.—

"(A) IN GENERAL.—The Secretary shall support construction of a Facility for Rare Isotope Beams to advance the understanding of rare nuclear isotopes and the evolution of the cosmos.

"(B) FUNDING.—Out of funds authorized to be appropriated under subsection (c), there shall be made available to the Secretary to carry out construction of the facility under this subsection $2,000,000 for fiscal year 2022.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before March 1, 2022.

"(2) ELECTRON-ION COLLIDER.—

"(A) IN GENERAL.—The Secretary shall support construction of an Electron Ion Collider as described in the 2015 Long Range Plan of the Nuclear Science Advisory Committee and the report from the National Academies titled 'An Assessment of U.S.-Based Electron-Ion Collider Science', in order to measure the internal structure of the proton and the nucleus and answer fundamental questions about the nature of visible matter.

"(B) FACILITY CAPABILITY.—The Secretary shall ensure that the facility meets the requirements in the 2015 Long Range Plan, including—

"(i) at least 70 percent polarized beams of electrons and light ions;

"(ii) ion beams from deuterium to the heaviest stable nuclei;

"(iii) variable center of mass energy from 20 to 140 GeV;

"(iv) high collision luminosity of $10^{33-34}cm^{-2}s^{-1}$; and

"(v) the possibility of more than one interaction region.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2030.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (c), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $101,000,000 for fiscal year 2022;

"(ii) $155,000,000 for fiscal year 2023;

"(iii) $250,000,000 for fiscal year 2024;

"(iv) $300,000,000 for fiscal year 2025; and

"(v) $305,000,000 for fiscal year 2026.

"(c) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $780,000,000 for fiscal year 2022;

"(2) $879,390,000 for fiscal year 2023;

"(3) $1,025,097,300 for fiscal year 2024;

"(4) $1,129,354,111 for fiscal year 2025; and

"(5) $1,192,408,899 for fiscal year 2026.".

SEC. 9. ACCELERATOR RESEARCH AND DEVELOPMENT.

The Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) is amended by adding after section 309 the following:

"SEC. 310. ACCELERATOR RESEARCH AND DEVELOPMENT.

"(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program to—

"(1) advance accelerator science and technology relevant to the Department, other Federal agencies, and U.S. industry;

"(2) foster partnerships to develop, demonstrate, and enable the commercial application of accelerator technologies;

"(3) support the development of a skilled, diverse, and inclusive accelerator workforce; and

"(4) provide access to accelerator design and engineering resources.

"(b) ACCELERATOR RESEARCH.—In carrying out the program authorized under subsection (a), the Director shall support—

"(1) research activities in cross-cutting accelerator technologies including superconducting magnets and accelerators, beam physics, data analytics-based accelerator controls, simulation software, new particle sources, advanced laser technology, and transformative research; and

"(2) optimal operation of the Accelerator Test Facility.

"(c) ACCELERATOR DEVELOPMENT.—In carrying out the program authorized under subsection (a), the Director shall support partnerships to foster the development, demonstration, and commercial application of accelerator technologies including, advanced superconducting wire and cable, superconducting RF cavities, and high efficiency radiofrequency power sources for accelerators.

"(d) RESEARCH COLLABORATIONS.—In developing accelerator technologies under the program authorized in subsection (a), the Director shall—

"(1) consider the requirements necessary to support translational research and development for medical, industrial, security, and defense applications; and

"(2) leverage investments in accelerator technologies and fundamental research in particle physics by partnering with institutes of higher education, industry, and other Federal agencies to enable the commercial application of advanced accelerator technologies.

"(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $24,000,000 for fiscal year 2022;
"(2) $25,680,000 for fiscal year 2023;
"(3) $27,477,600 for fiscal year 2024;
"(4) $29,401,032 for fiscal year 2025; and
"(5) $31,459,104 for fiscal year 2026.".

SEC. 10. ISOTOPE DEVELOPMENT AND PRODUCTION FOR RESEARCH APPLICATIONS.

The Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) is amended by adding after section 310 as added by this Act the following:

"SEC. 311. ISOTOPE DEVELOPMENT AND PRODUCTION FOR RESEARCH APPLICATIONS.

"(a) IN GENERAL.—The Director—

"(1) shall carry out a program in coordination with other relevant programs across the Department of Energy for the production of isotopes, including the development of techniques to produce isotopes, that the Secretary determines are needed for research, medical, industrial, or related purposes, to the maximum extent practicable, in accordance with the 2015 NSAC 'Meeting Isotope Needs and Capturing Opportunities For The Future' report; and

"(2) shall ensure that isotope production activities carried out under the program under this paragraph do not compete with private industry unless the Director determines that critical national interests require the involvement of the Federal Government.

"(b) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out the program under this subsection—

"(1) $90,000,000 for fiscal year 2022;
"(2) $96,300,000 for fiscal year 2023;
"(3) $103,041,000 for fiscal year 2024;
"(4) $110,253,870 for fiscal year 2025; and
"(5) $117,971,641 for fiscal year 2026.".

SEC. 11. SCIENCE LABORATORIES INFRASTRUCTURE PROGRAM.

(a) PROGRAM.—Section 309 of the Department of Energy Research and Innovation Act (42 U.S.C. 18647) is amended by adding at the end the following:

"(c) APPROACH.—In carrying out this section, the Director shall utilize all available approaches and mechanisms, including capital line items, minor construction projects, energy savings performance contracts, utility energy service contracts, alternative financing and expense funding, as appropriate.

"(d) ALTERNATIVE FINANCING OF RESEARCH FACILITIES AND INFRASTRUCTURE.—

"(1) IN GENERAL.—Consistent with section 161(g) of the Atomic Energy Act of 1954 (42 U.S.C. 2201(g)), the Management and Operating contractors of the Department may enter into the lease-purchase of research facilities and infrastructure under the scope of their contract with the Department with the approval of the Secretary or their designee.

"(2) LIMITATIONS.—To carry out lease-purchases approved by the Secretary under subsection (a), the Department shall only be required to have budget authority in an amount sufficient to cover the minimum required lease payments through the period required to exercise a termination provision in the lease agreement, plus any associated lease termination penalties, regardless of whether such leased facility and infrastructure is on or off Government land, and if—

"(A) the Department has established a mission need for the facility or infrastructure to be leased;

"(B) the facility or infrastructure is general purpose, including offices, laboratories, cafeterias, utilities, and data centers;

"(C) the Department is not a party to and has no financial obligations under the lease-purchase transaction entered into by the Management and Operating contractor, other than allowability of the lease cost and conveyance of Government land, if needed;

"(D) the lease-purchase has an advance notice termination provision with reasonable pre-defined penalties that the Management and Operating contractor may exercise, at the direction of the Department, if funding for the lease is no longer available or the mission need ceases to exist;

"(E) there is an option for a no cost transfer of ownership to the Government once the underlying financing is retired, but neither the Management and Operating contractor nor the Department are obligated to purchase the facility or infrastructure at any time during or after the lease term;

"(F) the lease-purchase transaction, assuming exercise of the ownership option, is demonstrated to be the lowest lifecycle cost alternative for the Government; and

"(G) the cumulative annual base rent for all lease-purchases of facilities and infrastructure, inclusive of any transactions under consideration, does not exceed 2 percent of the Management and Operating contract operating budget for the year the commitment is made for the lease.

"(3) REPORTING.—Not later than one year after the date of the enactment of the Department of Energy Science for the Future Act, and biennially thereafter, the Department shall submit to the Committee on Science, Space, and Technology and the Committee on Appropriations of the House of Representatives, and the Committee on Energy and Natural Resources and the Committee on Appropriations of the Senate, a report on the lease-purchase transactions that the Management and Operating contractors of the Department entered into under subsection (a) that includes—

"(A) a list of the lease-purchase transactions entered into by each Management and Operating contractor and their respective costs;

"(B) the annual percentage of each Management and Operating contract operating budget that is used for lease-purchase transactions for the year the commitments were made; and

"(C) any other information the Secretary finds appropriate.

"(d) MID-SCALE INSTRUMENTATION PROGRAM.—The Director, in coordination with each of the programs carried out by the Office of Science, shall establish a mid-scale instrumentation program to enable the development and acquisition of novel, state-of-the-art instruments ranging in cost from $1 million to $20 million each that would significantly accelerate scientific breakthroughs at user facilities.

"(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section $500,000,000 for each of fiscal years 2022 through 2026.".

SEC. 12. INCREASED COLLABORATION WITH TEACHERS AND SCIENTISTS.

(a) IN GENERAL.—The Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) is amended by adding after section 311 as added by this Act the following:

"SEC. 312. INCREASED COLLABORATION WITH TEACHERS AND SCIENTISTS.

"(a) IN GENERAL.—The Director shall support the development of a scientific workforce through programs that facilitate collaboration between K–12, university students, early-career researchers, faculty, and the National Laboratories, including through the use of proven techniques to expand the number of individuals from underrepresented groups pursuing and attaining skills or undergraduate and graduate degrees relevant to the Office's mission.

"(b) AUTHORIZATION OF APPROPRIATIONS.—Section 3169 of the Department of Energy Science Education Enhancement Act (42 U.S.C. 7381e) is amended—

"(1) by striking, 'programs', and inserting 'programs, including the NSF INCLUDES National Network,'; and

"(2) by striking, 'year 1991', and inserting 'years 2022 through 2026'.".

(b) BROADENING PARTICIPATION IN WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS.—

(1) IN GENERAL.—The Department of Energy Science Education Enhancement Act (42 U.S.C. 7381 note) is amended by inserting the following sections after section 3167 (42 U.S.C. 7381c–1):

"SEC. 3167A. BROADENING PARTICIPATION FOR TEACHERS AND SCIENTISTS.

"(a) IN GENERAL.—The Secretary shall expand opportunities to increase the number and the diversity, equity, and inclusion of highly skilled science, technology, engineering, and mathematics (STEM) professionals working in Department of Energy mission-relevant disciplines and broaden the recruitment pool to increase diversity, including expanded partnerships with Historically Black Colleges, Tribal Colleges, Minority Serving Institutions, emerging research institutions, and scientific societies.

"(b) PLAN.—Not later than 1 year after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources and the Committee on Commerce, Science, and Transportation of the Senate and make available to the public a plan for broad-

ening participation of underrepresented groups in science, technology, engineering, and mathematics in programs supported by the Department programs, including—

"(1) a plan for supporting and leveraging the National Science Foundation INCLUDES National Network;

"(2) metrics for assessing the participation of underrepresented groups in Department programs;

"(3) experienced and potential barriers to broadening participation of underrepresented groups in Department programs, including recommended solutions; and

"(4) any other activities the Secretary finds appropriate.

"(c) AUTHORIZATION OF APPROPRIATIONS.—Of the amounts authorized to be appropriated in section 3169 (42 U.S.C. 7381e), at least $2,000,000 shall be made available each fiscal year for the activities described under this subsection.

"SEC. 3167B. EXPANDING OPPORTUNITIES TO INCREASE THE DIVERSITY, EQUITY, AND INCLUSION OF HIGHLY SKILLED SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) PROFESSIONALS.

"(a) IN GENERAL.—The Secretary shall expand opportunities to increase the number and the diversity, equity, and inclusion of highly skilled science, technology, engineering, and mathematics (STEM) professionals working in Department of Energy mission-relevant disciplines and broaden the recruitment pool to increase diversity, including expanded partnerships with minority-serving institutions, non-Research I universities, and scientific societies.

"(b) PLAN AND OUTREACH STRATEGY.—

"(1) PLAN.—Not later than 6 months after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate a 10-year educational plan to fund and expand new or existing programs administered by the Office of Science and sited at the national laboratories and Department of Energy user facilities to expand educational and workforce opportunities for underrepresented high school, undergraduate, and graduate students as well as recent graduates, teachers and faculty in STEM fields. This may include paid internships, fellowships, temporary employment, training programs, visiting student and faculty programs, sabbaticals, and research support.

"(2) OUTREACH CAPACITY.—The Secretary shall include in the plan under paragraph (1) an outreach strategy to improve the advertising, recruitment, and promotion of educational and workforce programs to community colleges, Historically Black Colleges and Universities, Tribal Colleges, Minority Serving Institutions, and emerging research institutions.

"(c) BUILDING RESEARCH CAPACITY.—The Secretary shall develop programs that strengthen the research capacity relevant to Office of Science disciplines at emerging research institutions, including minority-serving institutions, tribal colleges and universities, Historically Black Colleges and Universities, and colleges and universities. This may include enabling mutually beneficial and jointly managed partnerships between research-intensive institutions and emerging research institutions, and soliciting research proposals, fellowships, training programs, and research support directly from emerging research institutions.

"(d) TRAINEESHIPS.—The Secretary shall establish a university-led Traineeship Program to address workforce training needs in STEM fields relevant to the Department. The focus should be on supporting training and research experiences for underrepresented undergraduate and graduate students and increasing participation from underrepresented populations. The traineeships should include opportunities to build the next-generation workforce in research areas critical to maintaining core competencies across the Office of Science's programs.

"(e) EVALUATION.—The Secretary shall establish key performance indicators to measure and monitor progress of education and workforce programs and expand Departmental activities for data collection and analysis. The Secretary shall submit a report 2 years after the date of enactment of the Department of Energy Science for the Future Act, and every 2 years thereafter, to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate summarizing progress toward meeting key performance indicators.

"(f) DEFINITIONS.—In this section:

"(1) MINORITY-SERVING INSTITUTION.—The term 'minority-serving institution' includes the entities described in any of paragraphs (1) through (7) of section 371(a) of the Higher Education Act of 1965 (20 U.S.C. 1067q(a)).

"(2) HISTORICALLY BLACK COLLEGE AND UNIVERSITIES.—The term 'Historically Black Colleges and Universities' has the meaning given in 'part B institution' in section 322 of the Higher Education Act of 1965 (20 U.S.C. 1061).

"(3) STEM.—The term 'STEM' has the meaning given the term in the STEM Education Act of 2015 (42 U.S.C. 1861 et seq.).

"(4) TRIBAL COLLEGES AND UNIVERSITIES.—The term 'Tribal College or University' has the meaning given in section 316 of the Higher Education Act of 1965 (20 U.S.C. 1059c).".

(2) Clerical amendment.—The table of contents in section 2(b) of the National Defense Authorization Act for Fiscal Year 1991 is amended by inserting after the item relating to section 3167 the following:

"Sec. 3167A. Broadening participation for teachers and scientists.
"Sec. 3167B. Expanding opportunities to increase the diversity, equity, and inclusion of highly skilled science, technology, engineering, and mathematics (STEM) professionals.".

SEC. 13. HIGH INTENSITY LASER RESEARCH INITIATIVE; OFFICE OF SCIENCE EMERGING INFECTIOUS DISEASE COMPUTING RESEARCH INITIATIVE; HELIUM CONSERVATION PROGRAM; AUTHORIZATION OF APPROPRIATIONS.

(a) IN GENERAL.—The Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) is amended by adding at the end the following:

"SEC. 313. HIGH INTENSITY LASER RESEARCH INITIATIVE.

"(a) IN GENERAL.—The Director shall establish a high intensity laser research initiative consistent with the recommendations of the National Academies report, 'Opportunities in Intense Ultrafast Lasers: Reaching for the Brightest Light', and the report from the Brightest Light Initiative workshop on 'The Future of Intense Ultrafast Lasers in the U.S.'. This initiative should include research and development of petawatt-scale and of high average power laser technologies necessary for future facility needs in discovery science and to advance energy technologies, as well as support for a user network of academic and national laboratory high intensity laser facilities.

"(b) LEVERAGE.—The Director shall also leverage new laser technologies for more compact, less complex, and low-cost accelerator systems needed for science applications.

"(c) COORDINATION.—The Director shall coordinate this initiative among all relevant programs within the Office of Science, and the Under Secretary for Science shall coordinate this initiative with other relevant programs within the Department as well as within other Federal agencies.

"(d) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science there are authorized to be appropriated to the Secretary to carry out the activities described in this subsection—

"(1) $50,000,000 for fiscal year 2022;
"(2) $100,000,000 for fiscal year 2023;
"(3) $150,000,000 for fiscal year 2024;
"(4) $200,000,000 for fiscal year 2025; and
"(5) $250,000,000 for fiscal year 2026.

"SEC. 314. HELIUM CONSERVATION PROGRAM.

"(a) IN GENERAL.—The Secretary shall establish a program to reduce the consumption of helium for Department grant recipients and facilities and encourage helium recycling and reuse. The program shall competitively award grants for—

"(1) the purchase of equipment to capture, reuse, and recycle helium;
"(2) the installation, maintenance, and repair of new and existing helium capture, reuse, and recycling equipment; and
"(3) helium alternatives research and development activities.

"(b) REPORT.—In carrying out the program under this section, the Director shall submit to the Committee on Science, Space, and Technology of House of Representatives and the Committee on Energy and Natural Resources of the Senate a report, not later than two years after the date of enactment of the Department of Energy Science for the Future Act, and every 3 years thereafter, on the purchase of helium as part of research projects and facilities supported by the Department. The report shall include—

"(1) the quantity of helium purchased for projects and facilities supported by Department grants;
"(2) a cost-analysis for such helium;
"(3) the predominant production sources for such helium;
"(4) expected or experienced impacts of helium supply shortages or prices on the research projects and facilities supported by the Department; and
"(5) recommendations for reducing Department grant recipients' exposure to volatile helium prices.

"(c) COORDINATION.—In carrying out the program under this section, the Director shall coordinate with the National Science Foundation and other relevant Federal agencies on helium conservation activities.

"(d) DURATION.—The program established under this section shall receive support for a period of not more than 5 years, subject to the availability of appropriations.

"(e) RENEWAL.—Upon expiration of any period of support of the program under this section, the Director may renew support for the program for a period of not more than 5 years.

"SEC. 315. OFFICE OF SCIENCE EMERGING INFECTIOUS DISEASE COMPUTING RESEARCH INITIATIVE.

"(a) IN GENERAL.—The Secretary, in coordination with the Director of the National Science Foundation and the Administrator of the National Aeronautics and Space Administration, shall establish within the Office of Science, a cross-cutting research initiative to leverage the Federal Government's innovative analytical resources and tools, user facilities, and advanced computational and networking capabilities in order to prevent, prepare for, and respond to emerging infectious diseases, including COVID–19. The Secretary shall carry out this initiative through a competitive, merit-reviewed process, and consider applications from National Laboratories, institutions of higher education, multi-institutional collaborations, industry partners and other appropriate entities.

"(b) ACTIVITIES.—In carrying out the initiative established under subsection (a), the Secretary shall coordinate with programs across the Office of Science and with relevant Federal agencies to determine a comprehensive set of technical milestones for these research activities and prioritize the following objectives—

"(1) supporting fundamental research and development in advanced analytics, experimental studies, materials synthesis, high-performance computing technologies needed to characterize, model, simulate, and predict complex phenomena and biological materials related to emerging infectious diseases, including COVID–19 challenges, including a focus on testing and diagnostics, experimental data acquisition, sharing and management, advanced manufacturing, and molecular design and modeling;

"(2) using expertise from the private sector, institutions of higher education, and the National Laboratories to develop computational software and capabilities that prospective users may accelerate emerging infectious diseases research and development;

"(3) leveraging the research infrastructure of the Department, including scientific computing user facilities, x-ray light sources, neutron scattering facilities, nanoscale science research centers, and sequencing and bio-characterization facilities by coordinating with the Advanced Scientific Computing Research, Basic Energy Sciences, and Biological and Environmental Research programs within the Office of Science;

"(4) leveraging experience from existing modeling and simulation research and work sponsored by the Department and promoting collaboration and data sharing between National Laboratories, research entities, and user facilities of the Department by providing the necessary access and secure data transfer capabilities; and

"(5) ensuring that new experimental and computational tools are accessible to relevant research communities, including private sector entities to address emerging infectious diseases, including COVID–19 challenges.

"(c) COORDINATION.—In carrying out this initiative, the Secretary shall ensure, to the maximum extent practicable, coordination of these activities with the Department of Energy National Laboratories, institutions of higher education, and the private sector.

"(d) EMERGING INFECTIOUS DISEASES HIGH PERFORMANCE COMPUTING RESEARCH CONSORTIUM.—

"(1) IN GENERAL.—The Secretary in coordination with the Director of the National Science Foundation and the Director of the Office of Science and Technology Policy shall establish and operate an Emerging Infectious Diseases High Performance Computing Research Consortium (referred to in this section as the 'Consortium'), in order to support the initiative under subsection (a) by providing, to the extent practicable, a centralized entity for multidisciplinary, collaborative, emerging infectious disease research and development through high performance computing and advanced data analytics technologies and processes.

"(2) MEMBERSHIP.—The members of such consortium may include representatives from relevant Federal agencies, the private sector, institutions of higher education, which can each contribute relevant compute time, capabilities, or other resources.

"(3) ACTIVITIES.—The Consortium shall—

"(A) match applicants with available Federal and private sector computing resources;

"(B) consider supplemental awards for computing partnerships with Consortium members to qualifying entities on a competitive merit-review basis;

"(C) encourage collaboration and communication among member representatives of the consortium and awardees;

"(D) make available the high-performance computing capabilities, expertise, and user facilities of the Department and the National Laboratories; and

"(E) submit an annual report to the Secretary summarizing the activities of the Consortium, including—

"(i) describing each project undertaken by the Consortium;

"(ii) detailing organizational expenditures; and

"(iii) evaluating contribution to the achievement of technical milestones as determined in subsection (a).

"(4) COORDINATION.—The Secretary shall ensure the coordination of, and avoid unnecessary duplication of, the activities of the Consortium with the activities of other research entities of the Department, institutions of higher education and the private sector.

"(e) REPORT.—Not later than 2 years after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House, and the Committee on Energy and Natural Resources of the Senate, and the Committee on Commerce, Science, and Transportation of the Senate a report detailing the effectiveness of—

"(1) the interagency coordination between each Federal agency involved in the research initiative carried out under this section;

"(2) the collaborative research achievements of the initiative, including the achievement of the technical milestones determined under subsection (a); and

"(3) potential opportunities to expand the technical capabilities of the Department.

"(f) FUNDING.—From within funds authorized to be appropriated for the Department's Office of Science, there shall be made available to the Secretary to carry out the activities under this subsection, $50,000,000 for fiscal years 2022 and 2023.

"(g) PROHIBITION ON USE OF FUNDS.—

"(1) IN GENERAL.—No funds allocated to the initiative described in subsection (a) may be obligated or expended for gain-of-function research of concern.

"(2) GAIN-OF-FUNCTION RESEARCH DEFINED.—For the purposes of this subsection, 'gain-of-function research of concern' means research activities with the potential to generate pathogens with high transmissibility and high virulence in humans.

"SEC. 316. AUTHORIZATION OF APPROPRIATIONS.

"There are authorized to be appropriated to the Secretary to carry out the activities described in this title—

"(1) $8,801,915,000 for fiscal year 2022;

"(2) $9,451,015,300 for fiscal year 2023;

"(3) $10,160,677,621 for fiscal year 2024;

"(4) $10,693,625,004 for fiscal year 2025; and

"(5) $11,145,798,345 for fiscal year 2026.".

(b) TABLE OF CONTENTS.—Section 1(b) of the Department of Energy Research and Innovation Act is amended in the table of contents by inserting after the item relating to section 309 the following:

"Sec. 310. Accelerator research and development.
"Sec. 311. Isotope Development and Production for Research Applications.
"Sec. 312. Increased collaboration with teachers and scientists.
"Sec. 313. High intensity laser research initiative.
"Sec. 314. Helium conservation program.
"Sec. 315. Office of Science Emerging Infectious Disease Computing Research Initiative.
"Sec. 316. Authorization of appropriations.".

SEC. 14. STATE-OWNED ENTERPRISES PROHIBITION.

(a) INNOVATE IN AMERICA.—None of the funds authorized or made available by this Act, or the amendments made by this Act, may be used in awarding a contract, subcontract, grant, or loan to an entity that—

(1) is owned or controlled by, is a subsidiary of, or is otherwise related legally or financially to a corporation based in a country that—

(A) is identified as a nonmarket economy country (as defined in section 771(18) of the Tariff Act of 1930 (19 U.S.C. 1677(18))) as of the date of enactment of this Act;

(B) was identified by the United States Trade Representative in the most recent report required by section 182 of the Trade Act of 1974 (19 U.S.C. 2242) as a priority foreign country under subsection (a)(2) of that section; and

(C) is subject to monitoring by the Trade Representative under section 306 of the Trade Act of 1974 (19 U.S.C. 2416); or

(2) is listed pursuant to section 9(b)(3) of the Uyghur Human Rights Policy Act of 2020 (Public Law 116–145).

(b) EXCEPTION.—For purposes of subsection (a), the Secretary may issue a waiver, to be made publicly available, to an entity in which the legal or financial connection to a corporation is a minority relationship or investment.

(c) INTERNATIONAL AGREEMENTS.—This section shall be applied in a manner consistent with the obligations of the United States under international agreements.

II. PURPOSE OF THE BILL

The purpose of the bill is to amend the Department of Energy Organization Act, the Energy Policy Act of 2005, the Department of Energy Research and Innovation Act, the National Quantum Initiative Act, and the Department of Energy Science Education Enhancement Act to provide guidance for and investment in the research and development activities of the Department of Energy Office of Science, and for other purposes. H.R. 3593 is sponsored by Ms. Johnson and co-sponsored by Mr. Lucas, Mr. Bowman, and Mr. Weber.

III. BACKGROUND AND NEED FOR THE LEGISLATION

The Department of Energy Science for the Future Act authorizes the Department of Energy's Office of Science, which accounts for over half of DOE's non-defense R&D budget and supports a wide range of research facilities and activities.

Comprehensive policy and funding authorization for the Office has never been enacted, and many construction projects supported by the Office are at risk of schedule delays and total cost increases if they are not fully supported. The bill authorizes appropriations for the Office of Science of $8.8 billion for fiscal year 2022 with annual 7% increases for the office's core research programs, reaching $11.1 billion for fiscal year 2026. In addition to authorizing appropriations for core research programs, the bill authorizes Office of Science construction projects and upgrades of major scientific user facilities at levels required for them to be completed on time and on budget, while incorporating COVID–19 related impacts. Authorization levels for construction activities and total program funding is designed to ensure that support for core research can grow annually, independent of each project schedule.

IV. COMMITTEE HEARINGS

Pursuant to House Rule XIII, clause 3(c)(6), the Committee designates the following hearings as having been used to develop or consider the legislation:

On January 15th, 2020, in a hearing entitled *The Department of Energy's Office of Science: Exploring the Next Frontiers in Energy Research and Scientific Discovery*, the Subcommittee examined the Office of Science as a whole and analyzed the research and development activities and facilities supported by the office, considering potential directions for its various programs.

Witnesses

- Dr. Chris Fall, Director, Office of Science, U.S. Department of Energy

On September 11th, 2020, the Subcommittee on Energy held a legislative hearing entitled *Biological Research at the Department of Energy: Leveraging DOE's Unique Capabilities to Respond to the*

COVID–19 Pandemic. The hearing examined the biological research and development activities within the Office of Science's Biological and Environmental Research (BER) program. It analyzed historic reasons for the Department's bioscience research capabilities; how BER's research tools were leveraged to respond to the COVID–19 pandemic; and future directions for the Department's biological research activities.

Witnesses

- Dr. Mary Maxon, Associate Laboratory Director for Biosciences, Department of Energy, Lawrence Berkeley National Laboratory
- Dr. Debra Mohnen, Professor, Department of Biochemistry and Molecular Biology, University of Georgia
- Dr. Glenn C. Randall, Chair, Committee on Microbiology, The University of Chicago
- Dr. Kelly C. Wrighton, Associate Professor, Department of Soil and Crop Science, Colorado State University

On May 4th, 2021, the Subcommittee on Energy held a hearing entitled *Climate and Energy Science Research at the Department of Energy* that examined the Basic Energy Sciences (BES) program as a whole and the Earth and Environmental Systems Sciences Division within the Office of Science's BER program. The hearing analyzed climate and environmental systems research and its importance to understanding and reducing the threat of climate change. Within BES, the hearing focused on initiatives to advance material and chemical sciences research for a broad range of energy applications.

Witnesses

- Dr. Kristin Persson, Director, Molecular Foundry, Lawrence Berkeley National Laboratory
- Dr. Fikile Brushett, Associate Professor of Chemical Engineering, Massachusetts Institute of Technology
- Dr. Esther Takeuchi, Chair, Interdisciplinary Science Department, Brookhaven National Laboratory
- Dr. Xubin Zeng, Professor, Hydrology and Atmospheric Sciences, The University of Arizona
- Dr. Narasimha Rao, Associate Professor of Energy Systems, Yale School of the Environment

On May 19th, 2021, in a hearing entitled *Accelerating Discovery: The Future of Scientific Computing at the Department of Energy*, the Subcommittee on Energy held a legislative hearing that examined the scientific computing capabilities stewarded by the Office of Science's Advanced Scientific Computing Research (ASCR) program, including its forthcoming exascale systems, and the implications of these capabilities for other scientific disciplines and their relevance to pressing societal challenges.

Witnesses

- Dr. J. Stephen Binkley, Acting Director, Office of Science, Department of Energy
- Dr. Georgia Tourassi, Director, National Center for Computational Sciences at Oak Ridge National Laboratory
- Dr. Karen Willcox, Director, Oden Institute for Computational Engineering and Sciences at The University of Texas at Austin

• Dr. Christopher Monroe, Co-Founder and Chief Scientist, IonQ, Inc.

• Dr. Seny Kamara, Associate Professor, Brown University

The full Committee held a legislative hearing on May 27th, 2021 *entitled Overview of the Science and Energy Research Enterprise of the U.S. Department of Energy*, that examined the research, development, demonstration, and commercialization programs and activities carried out by DOE. It also considered the goals and impacts of the Department's Fiscal Year 2022 discretionary budget request, including funding levels and overall support for the Office of Science, facility construction, and fusion research.

Witnesses

• The Honorable Jennifer Granholm, Secretary of Energy, U.S. Department of Energy

V. Committee Consideration and Votes

The Committee on Science, Space, and Technology met to consider H.R. 3593 on June 15, 2021.

Chairwoman Johnson offered an amendment in the nature of a substitute to make technical corrections and conforming changes. *The amendment was agreed to by a voice vote.*

Mr. Foster offered an amendment to direct programs to update their roadmaps with the assumption of a budget doubling over 10 years. *The amendment was agreed to by a voice vote.*

Ms. Moore offered an amendment to authorize clean water and watershed research efforts. *The amendment was agreed to by a voice vote.*

Mr. Meijer and Mr. McNerney offered an amendment that requires the DOE Secretary to establish an initiative focused on the development of engineered ecosystems through artificial intelligence, novel sensing capabilities, and other emerging technologies. *The amendment was agreed to by a voice vote.*

Ms. Lofgren offered an amendment that establishes the Supercomputing for Safer Chemicals (SUPERSAFE) Consortium to leverage supercomputing capabilities at the National Laboratories for large scale identification of toxic substances and development of safer alternatives. *The amendment was withdrawn.*

Mr. McNerney offered an amendment that establishes the Energy Sciences Network user facility as platform for developing and testing quantum networking infrastructure technologies. *The amendment was agreed to by a voice vote.*

Mr. Beyer offered an amendment that establishes national teams for conceptual fusion pilot plant designs and technology roadmaps. *The amendment was agreed to by a voice vote.*

Mr. Foster offered an amendment that is a Sense of Congress and ensures that Office of Science Authorizations are adjusted for inflation. *The amendment was withdrawn.*

Mr. Waltz offered an amendment that prohibits gain-of-function research of concern. *The amendment was agreed to by a voice vote.*

Mr. Posey offered an amendment that prohibits funds going to state-owned enterprises. *The amendment was agreed to by a voice vote.*

Chairwoman Johnson moved that the Committee favorably report the bill, H.R. 3593, as amended, to the House of Representa-

tives with the recommendation that the bill be approved. *The motion was agreed to by a voice vote.*

VI. SUMMARY OF MAJOR PROVISIONS OF THE BILL

H.R. 3593 supports research relevant to advancing the next generation of energy storage, solar, hydrogen, critical materials, fusion energy, manufacturing, carbon removal, and bioenergy technologies, among other areas. It would support the modernization of the Office's nanoscience centers, and support and guide research in emerging areas, including quantum information science and artificial intelligence. The bill directs the Office to expand opportunities to increase the number and the diversity, equity, and inclusion of highly skilled STEM professionals working in DOE mission-relevant disciplines. And it requires the Office to coordinate and collaborate with other relevant programs supported by DOE as well as with other relevant federal agencies.

The six major research programs authorized in this bill are Advanced Scientific Computing Research, Basic Energy Sciences, Biological and Environmental Research, Fusion Energy Sciences, High Energy Physics, and Nuclear Physics. It also supports education initiatives through its Workforce Development for Teachers and Scientists program and general infrastructure projects for research facilities.

VII. SECTION-BY-SECTION ANALYSIS (BY TITLE AND SECTION)

Sec. 1. Short title

Section 1 establishes that H.R. 3593 may be cited as the "Department of Energy Science for the Future Act".

Sec. 2. Mission of the Office of Science

Section 2 amends the Department of Energy Organization Act (42 U.S.C. 7139) by authorizing the Director of the Office of Science to steward scientific user facilities and coordinate programs and activities of the Office of Science. This section also authorizes the Secretary of Energy to coordinate the activities of the Office of Science with other offices of the Department of Energy and other Federal Agencies.

Sec. 3. Basic energy sciences program

Subsection (a) amends the Department of Energy Research and Innovation Act (42 U.S.C. 18641) by authorizing a research and development program in basic energy sciences, including materials science and engineering, chemical sciences, physical biosciences, geosciences, and other disciplines; prioritizing research and development in sustainable chemistry to enable clean, safe, and economic alternatives and methodologies to traditional chemical products and processes; and authorizing annual appropriations and providing other guidance for major construction projects.

Subsection (b) amends Section 973 of the Energy Policy Act of 2005 (42 U.S.C. 16313) by authorizing various research and development activities related to artificial photosynthesis and authorizing annual appropriations.

Subsection (c) amends Section 975 of the Energy Policy Act of 2005 (42 U.S.C. 16315) by authorizing various research and devel-

opment activities related to electricity storage and authorizing annual appropriations.

Sec. 4. Biological and environmental research

Subsection (a) amends Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) by authorizing research and development program in biological systems science and climate and environment science relevant to the development of new energy technologies and to support the energy, environment, and national security missions of the Department.

Subsection (b) amends Section 977(f) of the Energy Policy Act of 2005 (42 U.S.C. 16317(f)) by authorizing up to six bioenergy research centers focused on fundamental research in plant and microbial systems biology, biological imaging and analysis, and genomics to accelerate the research, development, and commercial application of bioenergy sources and biobased products. It also provides guidance on the research thrusts, duration, selection, partnership efforts, and other activities and characteristics of these centers.

Subsection (c) amends Section 306(e)(8) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(e)(8)) by authorizing annual appropriations for a Low-Dose Radiation Research Program.

Subsection (d) amends Section 306(f) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(d)) by directing the Secretary of Energy, in consultation with the Administrator of the National Aeronautics and Space Administration, to carry out a basic research program on the similarities and differences between low-dose radiation exposure on Earth, in low-Earth orbit, and in the space environment.

Subsection (e) amends Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) by: authorizing research in Earth and environment systems science, including in clean water and watersheds and climate and Earth modeling, and through a new mid-scale funding mechanism; providing guidance on the stewardship of biological and environmental research user facilities; and establishing new initiatives in coastal zone research and engineered ecosystems.

Sec. 5. Advanced scientific computing research

Subsection (a) amends Section 304 0f the Department of Energy Research and Innovation Act (42 U.S.C. 18642) by authorizing: a program to steward applied mathematics, computational science, and computer science research relevant to the mission of the Department; support research to accelerate the development of advanced computing and networking technologies; and expansion of funding for the Computational Science Graduate Fellowship. Subsection (a) also: provides guidance on activities necessary for the long-term sustainment of the Exascale computing ecosystem; establishes new initiatives in next-generation computing, heterogeneous computing architectures, and energy efficient computing; and provides guidance on the future of the Energy Sciences Network. Finally, Subsection (a) establishes programs to support quantum network infrastructure research and development and broaden access to quantum computing resources, and directs the Secretary of En-

ergy of ensure the equitable use of the Department's high-performance computing resources.

Sec. 6. Fusion energy research

Subsection (a) amends Section 307 of the Department of Energy Research and Innovation Act (42 U.S.C. 18645) by authorizing: appropriations for research and development of fusion materials, inertial fusion concepts for energy applications, and a milestone-based development program; the establishment of national teams to develop conceptual designs and technology roadmaps for a pilot fusion plant; the establishment of a high-performance computation collaborative research program and an associated innovation center in high-performance computing for fusion; and construction of the Material Plasma Exposure Experiment and the Matter in Extreme Conditions Instrument Upgrade project.

Subsection (b) amends Section 972 of the Energy Policy Act of 2005 (42 U.S.C. 16312) by authorizing annual appropriations for the construction of the ITER international fusion project.

Sec. 7. High energy physics program

Subsection (a) amends Section 305 of the Department of Energy Research and Innovation Act (42 U.S.C. 18643) by authorizing a research program in elementary particle physics and associated advanced technology research and development, including activities that leverage high energy accelerators and advanced detectors to create and study the interaction of elementary particles and to investigate the fundamental forces of physics.

Subsection (b) amends Section 305(d) of the Department of Energy Research and Innovation Act (42 U.S.C. 18634(d)) by authorizing the Director to ensure the participation of the United States in international efforts related to the Large Hadron Collider, encourage international participation in the Long Baseline Neutrino Facility and Deep Underground Neutrino Experiment, and prioritize engagement in future international facilities.

Subsection (c) amends Section 305(f) of the Department of Energy Research and Innovation Act (42 U.S.C. 18645(f)) by authorizing research in fundamental cosmic phenomena and collaboration with other Federal Agencies and international partners on associated facilities and experiments.

Subsection (d) amends Section 305 of the Department of Energy Research and Innovation Act (42 U.S.C. 18645) by authorizing the construction of major facilities and items of equipment recommended by the 2014 Particle Physics Project Prioritization Panel report entitled "Building for Discovery"; upgrades to existing accelerators and detectors; accelerator and detector research and development; and a program in underground science.

Sec. 8. Nuclear physics

Subsection (a) amends Section 308 of the Department of Energy Research and Innovation Act (42 U.S.C. 18646) by authorizing a research program in nuclear matter and providing guidance and authorization levels for the construction of the Facility for Rare Isotope Beams and the Electron-Ion Collider.

Sec. 9. Accelerator research and development

Section 9 amends the Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) by authorizing a program to advance accelerator science and technology of relevance to the mission of the Department; foster partnerships to develop, demonstrate, and enable the commercial application of such technologies; support associated workforce development activities; and provide access to accelerator design and engineering resources.

Sec. 10. Isotope development and production for research applications

Section 10 amends the Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) by authorizing a program to produce isotopes for use in research, medical, industrial, and related purposes and to advance isotope production methods and techniques. Section 10 also directs the Secretary to ensure that any activities carried out under this program do not compete with private industry unless such activities are warranted by national security concerns.

Sec. 11. Science laboratories infrastructure program

Subsection (a) amends Section 309 of the Department of Energy Research and Innovation Act (42 U.S.C. 18647) by authorizing the Director of the Office of Science to employ all available approaches and funding mechanisms to address science laboratory infrastructure needs; specifying limitations for pursuing alternative financing means; and mandating a biennial report on the Department's lease-purchase transactions. Subsection (a) also establishes a mid-scale instrumentation program to enable the acquisition and development of instruments ranging in cost between $1 million and $20 million.

Sec. 12. Increased collaboration with teachers and scientists

Subsection (a) amends the Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) by authorizing the Director of the Office of Science to support the development of a scientific workforce through programs that foster collaboration between K–12 students, university students, early-career researchers, faculty, and national laboratories, including through proven mechanisms for engaging individuals from underrepresented groups.

Subsection (b) amends the Department of Energy Science Education Enhancement Act (42 U.S.C. 7381) by directing the Secretary of Energy to expand opportunities to increase the number and the diversity, equity, and inclusion of highly skilled STEM professionals working in the Department's mission-relevant disciplines and broaden the recruitment pool to increase diversity, including expanded partnerships with minority-serving institutions, emerging research institutions, and scientific societies. Subsection (b) also directs the Office of Science to collaborate with the National Science Foundation to support and leverage the National Science Foundation Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES) National Network to expand the number of students, early-career researchers, and faculty from underrepresented groups pursuing and attaining skills or undergraduate and grad-

uate degrees in science, technology, engineering, and mathematics fields relevant to the Department's mission.

Sec. 13. High intensity laser research initiative; office of science emerging infectious disease initiative; helium conservation program; authorization of appropriations

Subsection (a) amends the Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) by authorizing the establishment of a high intensity laser research initiative to advance laser technologies relevant to future facility needs in discovery science as well as to support a user network of academic and national laboratory high intensity laser facilities; and establishes a program to reduce the use of helium among the Department's grantees and facilities by encouraging recycling and reuse. This subsection also authorizes the Secretary of Energy, in coordination with the Administrator of the National Aeronautics and Space Administration and the Director of the National Science Foundation, to carry out a crosscutting initiative that leverages the Federal Government's relevant analytical resources and tools, user facilities, and advanced computational and networking capabilities to prevent, prepare for, and respond to emerging infectious diseases, including COVID–19. Finally, subsection (a) also authorizes annual appropriations for the Office of Science.

Subsection (b) amends Section 1(b) of the Department of Energy Research and Innovation Act by inserting a Table of Contents that reflects the amendatory language included in H.R. 3593.

Sec. 14. State owned enterprises prohibition

Subsection (a) stipulates that none of the funds authorized under H.R. 3593 may be used in awarding a contract, subcontract, grant, or loan to any entity that is legally or financially related to a corporation based in a country that is identified as a nonmarket economy country pursuant to Section 771(18) of the Tariff Act of 1930 (19 U.S.C. 1677(18)); was identified by the U.S. Trade Representative as a priority foreign country pursuant to Section 182(a)(2) of the Trade Act of 1974 (19 U.S.C. 2242); or is subject to monitoring by the U.S. Trade Representative under Section 306 of the Trade Act of 1974 (19 U.S.C. 2416). This subsection also prohibits the use of funds authorized under H.R. 3593 from being awarded to any entity that is legally or financially related to a corporation based in a country that is listed pursuant to Section 9(b)(3) of the Uyghur Human Rights Policy Act of 2020 (Public Law 116 145).

Subsection (b) authorizes the Secretary of Energy to grant a publicly available waiver to a an entity that might qualify under Subsection (a) if such an entity possesses a minority relationship or investment.

Subsection (c) stipulates that Section 14 shall be applied in a manner that is consistent with U.S. obligations under international agreements.

VIII. COMMITTEE VIEWS

In carrying out the activities authorized in the Act, it is the view of the Committee that the Department should ensure that future budget requests include the resources required to maintain the previously approved schedule of construction activities supported by

the Department and minimize the total costs for such projects. It is also the view of the Committee that the Department should maintain and, as authorized, grow its support for non-construction research activities in promising scientific fields even as it invests in building the next generation of scientific facilities and tools.

IX. Cost Estimate

The committee establishes cost estimates based on CBO scores but, at the time of the filing of this report, there was no CBO estimate upon which to base the committee's cost estimate.

X. Congressional Budget Office Cost Estimate

No Congressional Budget Office Cost Estimate at the time of filing.

XI. Federal Mandates Statement

H.R. 3593 contains no unfunded mandates.

XII. Committee Oversight Findings and Recommendations

The Committee's oversight findings and recommendations are reflected in the body of this report.

XIII. Statement on General Performance Goals and Objectives

Pursuant to House Rule XIII clause (3)(c)(4), the goals of H.R. 3593 are to provide guidance for and investment in the research and development activities of the Department of Energy Office of Science, and to fully fund construction projects that are planned or underway stewarded by the Office of Science.

XIV. Federal Advisory Committee Statement

No Federal Advisory Committees are created in H.R. 3593.

XV. Duplication of Federal Programs

Pursuant to House Rule XIII 3(c)(5), the Committee finds that no provision of H.R. 3593 establishes or reauthorizes a program of the federal government known to be duplicative of another federal program, including any program that was included in a report to Congress pursuant to section 21 of Public Law 111–139 or the most recent Catalog of Federal Domestic Assistance.

XVI. Earmark Identification

Pursuant to clause 9(e), 9(f), and 9(g) of House Rule XXI, the Committee finds that H.R. 3593 contains no earmarks, limited tax benefits, or limited tariff benefits.

XVII. Applicability to the Legislative Branch

The Committee finds that H.R. 3593 does not relate to the terms and conditions of employment or access to public services or accommodations within the meaning of section 102(b)(3) of the Congressional Accountability Act (Public Law 104–1).

XVIII. Statement on Preemption of State, Local, or Tribal Law

This bill is not intended to preempt any state, local, or tribal law.

XIX. Changes in Existing Law Made by the Bill, as Reported

In compliance with clause 3(e) of rule XIII of the Rules of the House of Representatives, changes in existing law made by the bill, as reported, are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new matter is printed in italics, and existing law in which no change is proposed is shown in roman):

DEPARTMENT OF ENERGY ORGANIZATION ACT

* * * * * * *

TITLE II—ESTABLISHMENT OF THE DEPARTMENT

* * * * * * *

OFFICE OF SCIENCE

SEC. 209. (a) There shall be within the Department an Office of Science to be headed by a Director, who shall be appointed by the President, by and with the advice and consent of the Senate, and who shall be compensated at the rate provided for level IV of the Executive Schedule under section 5315 of title 5, United States Code.

(b) It shall be the duty and responsibility of the Director—

(1) to advise the Secretary with respect to the physical research program transferred to the Department from the Energy Research and Development Administration;

(2) to monitor the Department's energy research and development programs in order to advise the Secretary with respect to any undesirable duplication or gaps in such programs;

(3) to advise the Secretary with respect to the well-being and management of the multipurpose laboratories under the jurisdiction of the Department, excluding laboratories that constitute part of the nuclear weapons complex;

(4) to advise the Secretary with respect to education and training activities required for effective short- and long-term basic and applied research activities of the Department;

(5) to advise the Secretary with respect to grants and other forms of financial assistance required for effective short- and long-term basic and applied research activities of the Department; and

(6) to carry out such additional duties assigned to the Office by the Secretary.

(c) MISSION.—The mission of the Office of Science shall be the delivery of scientific discoveries, capabilities, and major scientific tools to transform the understanding of nature and to advance the energy, economic, and national security of the United States.

(d) USER FACILITIES.—The Director shall carry out the construction, operation, and maintenance of user facilities to support the mission described in subsection (c). As practicable, these facilities shall serve the needs of the Department, industry, the academic

community, and other relevant entities for the purposes of advancing the missions of the Department, improving the competitiveness of the United States, protecting public health and safety, and addressing other national priorities including emergencies.

(e) COORDINATION.—

(1) IN GENERAL.—The Secretary—

(A) shall ensure the coordination of the Office of Science with the other activities of the Department;

(B) shall support joint activities among the programs of the Department;

(C) shall coordinate with other relevant Federal agencies in supporting advancements in related research areas as appropriate; and

(D) may form partnerships to enhance the utilization of and ensure access to user facilities by other Federal agencies.

(2) OFFICE OF SCIENCE.—The Director—

(A) shall ensure the coordination of programs and activities carried out by the Office of Science; and

(B) shall direct all programs which have not recently completed a future planning roadmap consistent with the funding of such programs authorized under the Department of Energy Science for the Future Act to complete such a roadmap.

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DEPARTMENT OF ENERGY RESEARCH AND INNOVATION ACT

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "Department of Energy Research and Innovation Act".

(b) TABLE OF CONTENTS.—The table of contents of this Act is as follows:

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TITLE III—DEPARTMENT OF ENERGY OFFICE OF SCIENCE POLICY

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SEC. 303. BASIC ENERGY SCIENCES.

(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research and development program in basic energy sciences, including materials sciences and engineering, chemical sciences, physical biosciences, geosciences, and other disciplines, to understand, model, and control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies, address scientific grand challenges, and support the energy, environment, and national security missions of the Department.

(b) SUSTAINABLE CHEMISTRY.—In carrying out chemistry-related research and development activities under this section, the Director shall prioritize research and development of sustainable chemistry to support clean, safe, and economic alternatives and methodologies to traditional chemical products and processes.

[(a)] *(c)* ENERGY FRONTIER RESEARCH CENTERS.—

(1) IN GENERAL.—The Director shall carry out a program to provide awards, on a competitive, merit-reviewed basis, to multi-institutional collaborations or other appropriate entities to conduct fundamental and use-inspired energy research to accelerate scientific breakthroughs.

(2) COLLABORATIONS.—A collaboration receiving an award under this subsection may include multiple types of institutions and private sector entities.

(3) SELECTION AND DURATION.—

(A) IN GENERAL.—A collaboration under this subsection shall be selected for a period of 4 years.

(B) EXISTING CENTERS.—An Energy Frontier Research Center in existence and supported by the Director on the date of enactment of this Act may continue to receive support for a period of 4 years beginning on the date of establishment of that center.

(C) REAPPLICATION.—After the end of the period described in subparagraph (A) or (B), as applicable, a recipient of an award may reapply for selection on a competitive, merit-reviewed basis.

(D) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming center for cause during the performance period.

(4) NO FUNDING FOR CONSTRUCTION.—No funding provided pursuant to this subsection may be used for the construction of new buildings or facilities.

[(b)] *(d)* BASIC ENERGY SCIENCES USER FACILITIES.—

(1) IN GENERAL.—The Director shall carry out a program for the development, construction, operation, and maintenance of national user facilities.

(2) REQUIREMENTS.—To the maximum extent practicable, the national user facilities developed, constructed, operated, or maintained under paragraph (1) shall serve the needs of the Department, industry, the academic community, and other relevant entities to create and examine materials and chemical processes for the purpose of improving the competitiveness of the United States.

(3) INCLUDED FACILITIES.—The national user facilities developed, constructed, operated, or maintained under paragraph (1) shall include—

(A) x-ray light sources;

(B) neutron sources;

(C) nanoscale science research centers; [and]

(D) autonomous chemistry and materials synthesis and characterization facilities that leverage advances in artificial intelligence; and

[(D)] *(E)* such other facilities as the Director considers appropriate, consistent with section 209 of the Department of Energy Organization Act (42 U.S.C. 7139).

(4) ADVANCED PHOTON SOURCE UPGRADE.—

(A) DEFINITIONS.—In this paragraph:

(i) FLUX.—The term "flux" means the rate of flow of photons.

(ii) HARD X-RAY.—The term "hard x-ray" means a photon with energy greater than 20 kiloelectron volts.

(B) IN GENERAL.—The Secretary shall provide for the upgrade to the Advanced Photon Source described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled "Report on Facility Upgrades", including the development of a multi-bend achromat lattice to produce a high flux of coherent x-rays within the hard x-ray energy region and a suite of beamlines optimized for this source.

(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the upgrade under this paragraph occurs before March 31, 2026.

(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph $157,000,000 for fiscal year 2022.

(5) SPALLATION NEUTRON SOURCE PROTON POWER UPGRADE.—

(A) IN GENERAL.—The Secretary shall provide for the proton power upgrade to the Spallation Neutron Source.

(B) PROTON POWER UPGRADE DEFINED.—For the purposes of this paragraph, the term "proton power upgrade" means the Spallation Neutron Source power upgrade described in—

(i) the publication titled "Facilities for the Future of Science: A Twenty-Year Outlook", published by the Office of Science of the Department of Energy in December, 2003;

(ii) the publication titled "Four Years Later: An Interim Report on Facilities for the Future of Science: A Twenty-Year Outlook", published by the Office of Science of the Department of Energy in August, 2007; and

(iii) the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled "Report on Facility Upgrades".

(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start

of full operations of the upgrade under this paragraph occurs before December 31, 2028.

(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph $49,800,000 for fiscal year 2022.

(6) SPALLATION NEUTRON SOURCE SECOND TARGET STATION.—

(A) IN GENERAL.—The Secretary shall provide for a second target station for the Spallation Neutron Source.

(B) SECOND TARGET STATION DEFINED.—For the purposes of this paragraph, the term "second target station" means the Spallation Neutron Source second target station described in—

(i) the publication titled, "Facilities for the Future of Science: A Twenty-Year Outlook", published by the Office of Science of the Department of Energy in December, 2003;

(ii) the publication titled, "Four Years Later: An Interim Report on Facilities for the Future of Science: A Twenty-Year Outlook", published by the Office of Science of the Department of Energy in August, 2007; and

(iii) the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled "Report on Facility Upgrades".

(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the second target station under this paragraph occurs before December 31, 2030, with the option for early operation in 2029.

(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the activities under this paragraph, including construction—

(i) $70,000,000 for fiscal year 2022;

(ii) $127,000,000 for fiscal year 2023;

(iii) $204,000,000 for fiscal year 2024;

(iv) $279,000,000 for fiscal year 2025; and

(v) $300,000,000 for fiscal year 2026.

(7) ADVANCED LIGHT SOURCE UPGRADE.—

(A) DEFINITIONS.—In this paragraph:

(i) FLUX.—The term "flux" means the rate of flow of photons.

(ii) SOFT X-RAY.—The term "soft x-ray" means a photon with energy in the range from 50 to 2,000 electron volts.

(B) IN GENERAL.—The Secretary shall provide for the upgrade to the Advanced Light Source described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled "Report on Facility Upgrades", including the development of a multibend achromat lattice to produce a high flux of coherent x-rays within the soft x-ray energy region.

(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start

of full operations of the upgrade under this paragraph occurs before September 30, 2029.

(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph—

(i) $75,100,000 for fiscal year 2022;
(ii) $135,000,000 for fiscal year 2023;
(iii) $102,500,000 for fiscal year 2024;
(iv) $25,000,000 for fiscal year 2025; and
(v) $25,000,000 for fiscal year 2026.

(8) LINAC COHERENT LIGHT SOURCE II HIGH ENERGY UPGRADE.—

(A) DEFINITIONS.—In this paragraph:

(i) HIGH ENERGY X-RAY.—The term "high energy x-ray" means a photon with an energy in the 5 to 13 kiloelectron volt range.

(ii) HIGH REPETITION RATE.—The term "high repetition rate" means the delivery of x-ray pulses up to 1 million pulses per second.

(iii) ULTRA-SHORT PULSE X-RAYS.—The term "ultra-short pulse x-rays" means x-ray bursts capable of durations of less than 100 femtoseconds.

(B) IN GENERAL.—The Secretary shall—

(i) provide for the upgrade to the Linac Coherent Light Source II facility described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled "Report on Facility Upgrades", including the development of experimental capabilities for high energy x-rays to reveal fundamental scientific discoveries; and

(ii) ensure such upgrade enables the production and use of high energy, ultra-short pulse x-rays delivered at a high repetition rate.

(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the upgrade under this paragraph occurs before December 31, 2026.

(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph—

(i) $106,925,000 for fiscal year 2022;
(ii) $125,925,000 for fiscal year 2023;
(iii) $115,000,000 for fiscal year 2024;
(iv) $89,000,000 for fiscal year 2025; and
(v) $49,344,000 for fiscal year 2026.

(9) CRYOMODULE REPAIR AND MAINTENANCE FACILITY.—

(A) IN GENERAL.—The Secretary shall provide for the construction of a cryomodule repair and maintenance facility to service the Linac Coherent Light Source II and upgrades to the facility. The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility has the

capability to maintain, repair, and test superconducting radiofrequency accelerator components.

(B) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the activities under this paragraph—

(i) $19,000,000 for fiscal year 2022;
(ii) $25,000,000 for fiscal year 2023;
(iii) $25,000,000 for fiscal year 2024; and
(iv) $17,000,000 for fiscal year 2025.

(10) NANOSCALE SCIENCE RESEARCH CENTER RECAPITALIZATION PROJECT.—

(A) IN GENERAL.—The Secretary shall provide for the recapitalization of the Nanoscale Science Research Centers, to include the upgrade of equipment at each Center supported by the Office of Science on the date of enactment of the Department of Energy Science for the Future Act, to accelerate advances in the various fields of science including nanoscience, materials, chemistry, biology, and quantum information science.

(B) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the recapitalization under this paragraph—

(i) $20,000,000 for fiscal year 2022;
(ii) $30,000,000 for fiscal year 2023;
(iii) $20,000,000 for fiscal year 2024; and
(iv) $20,000,000 for fiscal year 2025.

[(c)**]** *(e)* ACCELERATOR RESEARCH AND DEVELOPMENT.—The Director shall carry out research and development on advanced accelerator and storage ring technologies relevant to the development of basic energy sciences user facilities, in consultation with the High Energy Physics and Nuclear Physics programs of the Office of Science.

[(d)**]** *(f)* SOLAR FUELS RESEARCH INITIATIVE.—

(1) IN GENERAL.—Section 973 of the Energy Policy Act of 2005 (42 U.S.C. 16313) is amended to read as follows:

"SEC. SEC. 973. SOLAR FUELS RESEARCH INITIATIVE.

"(a) INITIATIVE.—

"(1) IN GENERAL.—The Secretary shall carry out a research initiative, to be known as the 'Solar Fuels Research Initiative' (referred to in this section as the 'Initiative') to expand theoretical and fundamental knowledge of photochemistry, electrochemistry, biochemistry, and materials science useful for the practical development of experimental systems to convert solar energy to chemical energy.

"(2) LEVERAGING.—In carrying out programs and activities under the Initiative, the Secretary shall leverage expertise and resources from—

"(A) the Basic Energy Sciences Program and the Biological and Environmental Research Program of the Office of Science; and

"(B) the Office of Energy Efficiency and Renewable Energy.

"(3) TEAMS.—

"(A) IN GENERAL.—In carrying out the Initiative, the Secretary shall organize activities among multidisciplinary teams to leverage, to the maximum extent practicable, expertise from the National Laboratories, institutions of higher education, and the private sector.

"(B) GOALS.—The multidisciplinary teams described in subparagraph (A) shall pursue aggressive, milestone-driven, basic research goals.

"(C) RESOURCES.—The Secretary shall provide sufficient resources to the multidisciplinary teams described in subparagraph (A) to achieve the goals described in subparagraph (B) over a period of time to be determined by the Secretary.

"(4) ADDITIONAL ACTIVITIES.—The Secretary may organize additional activities under this subsection through Energy Frontier Research Centers, Energy Innovation Hubs, or other organizational structures.

"(b) ARTIFICIAL PHOTOSYNTHESIS.—

"(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research needed to bridge scientific barriers to, and discover knowledge relevant to, artificial photosynthetic systems.

"(2) ACTIVITIES.—As part of the program described in paragraph (1)—

"(A) the Director of the Office of Basic Energy Sciences shall support basic research to pursue distinct lines of scientific inquiry, including—

"(i) photoinduced production of hydrogen and oxygen from water; and

"(ii) the sustainable photoinduced reduction of carbon dioxide to fuel products including hydrocarbons, alcohols, carbon monoxide, and natural gas; and

"(B) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

"(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

"(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.

"(c) BIOCHEMISTRY, REPLICATION OF NATURAL PHOTOSYNTHESIS, AND RELATED PROCESSES.—

"(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research needed to replicate natural photosynthetic processes by use of artificial photosynthetic components and materials.

"(2) ACTIVITIES.—As part of the program described in paragraph (1)—

"(A) the Director of the Office of Basic Energy Sciences shall support basic research to expand fundamental knowledge to replicate natural synthesis processes, including—

"(i) the photoinduced reduction of dinitrogen to ammonia;

"(ii) the absorption of carbon dioxide from ambient air;

"(iii) molecular-based charge separation and storage;

"(iv) photoinitiated electron transfer; and

"(v) catalysis in biological or biomimetic systems;

"(B) the Associate Director of Biological and Environmental Research shall support systems biology and genomics approaches to understand genetic and physiological pathways connected to photosynthetic mechanisms; and

"(C) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

"(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

"(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.".

(2) CONFORMING AMENDMENT.—The table of contents for the Energy Policy Act of 2005 is amended by striking the item relating to section 973 and inserting the following:

""Sec. 973. Solar fuels research initiative."."

[(e)] *(g)* ELECTRICITY STORAGE RESEARCH INITIATIVE.—

(1) IN GENERAL.—Section 975 of the Energy Policy Act of 2005 (42 U.S.C. 16315) is amended to read as follows:

"SEC. SEC. 975. ELECTRICITY STORAGE RESEARCH INITIATIVE.

"(a) INITIATIVE.—

"(1) IN GENERAL.—The Secretary shall carry out a research initiative, to be known as the 'Electricity Storage Research Initiative' (referred to in this section as the 'Initiative')—

"(A) to expand theoretical and fundamental knowledge to control, store, and convert—

"(i) electrical energy to chemical energy; and

"(ii) chemical energy to electrical energy; and

"(B) to support scientific inquiry into the practical understanding of chemical and physical processes that occur within systems involving crystalline and amorphous solids, polymers, and organic and aqueous liquids.

"(2) LEVERAGING.—In carrying out programs and activities under the Initiative, the Secretary shall leverage expertise and resources from—

"(A) the Basic Energy Sciences Program, the Advanced Scientific Computing Research Program, and the Biological and Environmental Research Program of the Office of Science; and

"(B) the Office of Energy Efficiency and Renewable Energy.

"(3) TEAMS.—

"(A) IN GENERAL.—In carrying out the Initiative, the Secretary shall organize activities among multidisciplinary teams to leverage, to the maximum extent practicable, ex-

pertise from the National Laboratories, institutions of higher education, and the private sector.

"(B) GOALS.—The multidisciplinary teams described in subparagraph (A) shall pursue aggressive, milestone-driven, basic research goals.

"(C) RESOURCES.—The Secretary shall provide sufficient resources to the multidisciplinary teams described in subparagraph (A) to achieve the goals described in subparagraph (B) over a period of time to be determined by the Secretary.

"(4) ADDITIONAL ACTIVITIES.—The Secretary may organize additional activities under this subsection through Energy Frontier Research Centers, Energy Innovation Hubs, or other organizational structures.

"(b) MULTIVALENT SYSTEMS.—

"(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research needed to bridge scientific barriers to, and discover knowledge relevant to, multivalent ion materials in electric energy storage systems.

"(2) ACTIVITIES.—As part of the program described in paragraph (1)—

"(A) the Director of the Office of Basic Energy Sciences shall investigate electrochemical properties and the dynamics of materials, including charge transfer phenomena and mass transport in materials; and

"(B) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

"(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

"(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.

"(c) ELECTROCHEMISTRY MODELING AND SIMULATION.—

"(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research to model and simulate organic electrolytes, including the static and dynamic electrochemical behavior and phenomena of organic electrolytes at the molecular and atomic level in monovalent and multivalent systems.

"(2) ACTIVITIES.—As part of the program described in paragraph (1)—

"(A) the Director of the Office of Basic Energy Sciences, in coordination with the Associate Director of Advanced Scientific Computing Research, shall support the development of high performance computational tools through a joint development process to maximize the effectiveness of current and projected high performance computing systems; and

"(B) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

"(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

"(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.

"(d) MESOSCALE ELECTROCHEMISTRY.—

"(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research needed to reveal electrochemistry in confined mesoscale spaces, including scientific discoveries relevant to—

"(A) bio-electrochemistry and electrochemical energy conversion and storage in confined spaces; and

"(B) the dynamics of the phenomena described in subparagraph (A).

"(2) ACTIVITIES.—As part of the program described in paragraph (1)—

"(A) the Director of the Office of Basic Energy Sciences and the Associate Director of Biological and Environmental Research shall investigate phenomena of mesoscale electrochemical confinement for the purpose of replicating and controlling new electrochemical behavior; and

"(B) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

"(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

"(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.".

(2) CONFORMING AMENDMENT.—The table of contents for the Energy Policy Act of 2005 is amended by striking the item relating to section 975 and inserting the following:

""Sec. 975. Electricity storage research initiative."."

(h) COMPUTATIONAL MATERIALS AND CHEMICAL SCIENCES.—

(1) IN GENERAL.—The Director shall support a program of research and development for the application of advanced computing practices to foundational and emerging research problems in chemistry and materials science. Research activities shall include—

(A) chemical catalysis research and development;

(B) the use of large data sets to model materials phenomena, including through advanced characterization of materials, materials synthesis, processing, and innovative use of experimental and theoretical data;

(C) co-design of chemical system and chemistry modeling software with advanced computing systems and hardware technologies; and

(D) modeling of chemical processes, assemblies, and reactions such as molecular dynamics and quantum chemistry, including through novel computing methods.

(2) COMPUTATIONAL MATERIALS AND CHEMICAL SCIENCES CENTERS.—

(A) IN GENERAL.—In carrying out the activities authorized under paragraph (1), the Director shall select and establish up to six computational materials and chemical sciences centers to—

(i) develop open-source, robust, and validated computational codes and user-friendly software, coupled with innovative use of experimental and theoretical data, to enable the design, discovery, and development of new materials and chemical systems; and

(ii) focus on overcoming challenges and maximizing the benefits of exascale and other high performance computing underpinned by accelerated node technologies.

(B) SELECTION.—The Director shall select centers under subparagraph (A) on a competitive, merit-reviewed basis. The Director shall consider applications from the National Laboratories, institutes of higher education, multi-institutional collaborations, and other appropriate entities.

(C) DURATION.—

(i) A center selected under subparagraph (A) shall receive support for a period of not more than 5 years beginning on the date of establishment of that center, subject to the availability of appropriations.

(ii) A center already in existence on the date of enactment of the Department of Energy Science for the Future Act may continue to receive support for a period of not more than 5 years beginning on the date of establishment of that center.

(D) RENEWAL.—Upon the expiration of any period of support of a center under this subsection, the Director may renew support for the center, on a merit-reviewed basis, for a period of not more than 5 years.

(E) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming center for cause during the performance period.

(i) MATERIALS RESEARCH DATABASE.—

(1) IN GENERAL.—The Director shall support the development of a web-based platform to develop and provide access to a database of computed information on known and predicted materials properties and computational tools to accelerate breakthroughs in materials discovery and design.

(2) PROGRAM.—In carrying out this subsection, the Director shall—

(A) conduct cooperative research with industry, academia, and other research institutions to advance understanding, prediction, and manipulation of materials and facilitate the design of novel materials;

(B) develop and maintain data infrastructure at user facilities that generate data to collect, analyze, label, and otherwise prepare the data for inclusion in the database;

(C) leverage existing high performance computing systems to conduct high throughput calculations, and develop computational and data mining algorithms for the prediction of material properties;

(D) strengthen the foundation for new technologies and advanced manufacturing; and

(E) drive the development of advanced materials for applications that span the Department's missions in energy, environment, and national security.

(3) COORDINATION.—In carrying out this subsection, the Director shall leverage programs and activities across the Department, including computational materials and chemical sciences centers established under subsection (h).

(4) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out activities under this subsection $10,000,000 for each of the fiscal years 2022 through 2026.

(j) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

(1) $2,727,705,000 for fiscal year 2022;
(2) $2,828,896,600 for fiscal year 2023;
(3) $3,019,489,612 for fiscal year 2024;
(4) $3,161,698,885 for fiscal year 2025; and
(5) $3,291,651,600 for fiscal year 2026.

SEC. 304. ADVANCED SCIENTIFIC COMPUTING RESEARCH.

(a) IN GENERAL.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out, in coordination with academia and relevant public and private sector entities, a research, development, and demonstration program to—

(1) steward applied mathematics, computational science, and computer science research relevant to the missions of the Department and the competitiveness of the United States;

(2) develop modeling, simulation, and other computational tools relevant to other scientific disciplines and to the development of new energy technologies and other technologies;

(3) advance computating and networking capabilities for data-driven discovery; and

(4) develop advanced scientific computing hardware and software tools for science and engineering.

[(a)] *(b)* AMERICAN SUPER COMPUTING LEADERSHIP.—

(1) RENAMING OF ACT.—

(A) IN GENERAL.—Section 1 of the Department of Energy High-End Computing Revitalization Act of 2004 (15 U.S.C. 5501 note; Public Law 108-423) is amended by striking "Department of Energy High-End Computing Revitalization Act of 2004" and inserting "American Super Computing Leadership Act of 2017".

(B) CONFORMING AMENDMENT.—Section 976(a)(1) of the Energy Policy Act of 2005 (42 U.S.C. 16316(1)) is amended by striking "Department of Energy High-End Computing Revitalization Act of 2004" and inserting "American Super Computing Leadership Act of 2017".

(2) DEFINITIONS.—Section 2 of the American Super Computing Leadership Act of 2017 (15 U.S.C. 5541) is amended—

(A) by redesignating paragraphs (2) through (5) as paragraphs (3) through (6), respectively;

(B) by striking paragraph (1) and inserting the following:

"(1) DEPARTMENT.—The term 'Department' means the Department of Energy.

"(2) EXASCALE COMPUTING.—The term 'exascale computing' means computing through the use of a computing machine that performs near or above 10 to the 18th power operations per second."; and

(C) in paragraph (6) (as redesignated by subparagraph (A)), by striking ", acting through the Director of the Office of Science of the Department of Energy".

(3) DEPARTMENT OF ENERGY HIGH-END COMPUTING RESEARCH AND DEVELOPMENT PROGRAM.—Section 3 of the American Super Computing Leadership Act of 2017 (15 U.S.C. 5542) is amended—

(A) in subsection (a)(1), by striking "program" and inserting "coordinated program across the Department";

(B) in subsection (b)(2), by striking ", which may" and all that follows through "architectures"; and

(C) by striking subsection (d) and inserting the following:

"(d) EXASCALE COMPUTING PROGRAM.—

"(1) IN GENERAL.—The Secretary shall conduct a research program (referred to in this subsection as the 'Program') for exascale computing, including the development of two or more exascale computing machine architectures, to promote the missions of the Department.

"(2) EXECUTION.—

"(A) IN GENERAL.—In carrying out the Program, the Secretary shall—

"(i) establish two or more National Laboratory partnerships with industry partners and institutions of higher education for the research and development of two or more exascale computing architectures across all applicable organizations of the Department;

"(ii) conduct mission-related codesign activities in developing the exascale computing architectures under clause (i);

"(iii) develop such advancements in hardware and software technology as are required to fully realize the potential of an exascale production system in addressing Department target applications and solving scientific problems involving predictive modeling and simulation and large scale data analytics and management;

"(iv) explore the use of exascale computing technologies to advance a broad range of science and engineering; and

"(v) provide, as appropriate, on a competitive, merit-reviewed basis, access for researchers in industries in the United States, institutions of higher education, National Laboratories, and other Federal agencies to the exascale computing systems developed pursuant to clause (i).

"(B) SELECTION OF PARTNERS.—The Secretary shall select the partnerships with the computing facilities of the Department under subparagraph (A) through a competitive, peer-review process.

"(3) CODESIGN AND APPLICATION DEVELOPMENT.—

"(A) IN GENERAL.—The Secretary shall—

"(i) carry out the Program through an integration of applications, computer science, applied mathematics, and computer hardware architecture using the partnerships established pursuant to paragraph (2) to ensure that, to the maximum extent practicable, two or more exascale computing machine architectures are capable of solving Department target applications and broader scientific problems, including predictive modeling and simulation and large scale data analytics and management; and

"(ii) conduct outreach programs to increase the readiness for the use of such platforms by domestic industries, including manufacturers.

"(B) REPORT.—The Secretary shall submit to Congress a report describing—

"(i) how the integration under subparagraph (A) is furthering application science data and computational workloads across application interests, including national security, material science, physical science, cybersecurity, biological science, the Materials Genome and BRAIN Initiatives of the President, advanced manufacturing, and the national electric grid; and

"(ii) the roles and responsibilities of National Laboratories and industry, including the definition of the roles and responsibilities within the Department to ensure an integrated program across the Department.

"(4) PROJECT REVIEW.—

"(A) IN GENERAL.—The exascale architectures developed pursuant to partnerships established pursuant to paragraph (2) shall be reviewed through a project review process.

"(B) REPORT.—Not later than 90 days after the date of enactment of this subsection, the Secretary shall submit to Congress a report on—

"(i) the results of the review conducted under subparagraph (A); and

"(ii) the coordination and management of the Program to ensure an integrated research program across the Department.

"(5) ANNUAL REPORTS.—At the time of the budget submission of the Department for each fiscal year, the Secretary, in consultation with the members of the partnerships established pursuant to paragraph (2), shall submit to Congress a report that describes funding for the Program as a whole by functional element of the Department and critical milestones.".

[(b)] *(c)* HIGH-PERFORMANCE COMPUTING AND NETWORKING RESEARCH.—

(1) DIRECTOR.—The Director shall support research in high-performance computing and networking relevant to energy applications, including modeling, simulation, and advanced data analytics for basic and applied energy research programs carried out by the Secretary.

(2) COORDINATION.—The Under Secretary for Science shall ensure the coordination of the activities of the Department, including activities under this section, to determine and meet the computational and networking research and facility needs of the Office of Science and all other relevant energy technology and energy efficiency programs within the Department and with other Federal agencies as appropriate.

[(c) APPLIED MATHEMATICS AND SOFTWARE DEVELOPMENT FOR HIGH-END COMPUTING SYSTEMS.—The Director shall carry out activities to develop, test, and support—

[(1) mathematics, models, and algorithms for complex systems and programming environments; and

[(2) tools, languages, and operating systems for high-end computing systems (as defined in section 2 of the American Super Computing Leadership Act of 2017 (15 U.S.C. 5541)).]

(d) APPLIED MATHEMATICS AND SOFTWARE DEVELOPMENT FOR HIGH-END COMPUTING SYSTEMS AND COMPUTER SCIENCES RESEARCH.—

(1) IN GENERAL.—The Director shall carry out activities to develop, test, and support—

(A) mathematics, statistics, and algorithms for modeling complex systems relevant to the missions of the Department, including on advanced computing architectures; and

(B) tools, languages, programming environments, and operations for high-end computing systems (as defined in section 2 of the American Super Computing Leadership Act (15 U.S.C. 5541).

(2) PORTFOLIO BALANCE.—

(A) IN GENERAL.—The Director shall maintain a balanced portfolio within the advanced scientific computing research and development program established under section 976 of the Energy Policy Act of 2005 (42 U.S.C. 16316) that supports robust investment in—

(i) applied mathematical, computational, and computer sciences research needs relevant to the mission of the Department, including foundational areas that are critical to the advancement of energy sciences and technologies and new and emerging computing technologies; and

(ii) associated high-performance computing hardware and facilities.

(B) EXASCALE ECOSYSTEM SUSTAINMENT.—

(i) SENSE OF CONGRESS.—It is the sense of Congress that the Exascale Computing Project has successfully created a broad ecosystem that provides shared software packages, novel evaluation systems, and applications relevant to the science and engineering requirements of the Department, and that such products must be maintained and improved in order that the full potential of the deployed systems can be continuously realized.

(ii) IN GENERAL.—The Secretary shall seek to sustain and evolve the ecosystem referenced in clause (i) to ensure that the exascale software stack and other research software will continue to be maintained, hard-

ened, and otherwise optimized for long-term use on exascale systems and beyond and reliable availability to the user community.

(e) NEXT GENERATION COMPUTING PROGRAM.—

(1) IN GENERAL.—The Secretary shall establish a program to develop and implement a strategy for achieving computing systems with capabilities beyond exascale computing systems. In establishing this program, the Secretary shall—

(A) maintain foundational research programs in mathematical, computational, and computer sciences focused on new and emerging computing needs within the mission of the Department, including post-Moore's law computing architectures, novel approaches to modeling and simulation, artificial intelligence and scientific machine learning, quantum computing, edge computing, extreme heterogeneity, and distributed high-performance computing; and

(B) retain best practices and maintain support for essential hardware, applications, and software elements of the Exascale Computing Program that are necessary for sustaining the vitality of a long-term capable software ecosystem for exascale and beyond; and

(C) develop a Department-wide strategy for balancing on-premises and cloud-based computing and scientific data management.

(2) REPORT.—Not later than one year after the date of the enactment of this Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives, and the Committee on Energy and Natural Resources of the Senate, a report on the development and implementation of the strategy outlined in paragraph (1).

(f) ARCHITECTURAL RESEARCH IN HETEROGENEOUS COMPUTING SYSTEMS.—

(1) IN GENERAL.—The Secretary shall carry out a program of research and development in heterogeneous and reconfigurable computing systems to expand understanding of the potential for heterogeneous and reconfigurable computing systems to deliver high performance, high efficiency computing for Department of Energy mission challenges. This shall include research and development that explores the convergence of big data analytics, simulations, and artificial intelligence to drive the design of heterogenous computing system architectures.

(2) COORDINATION.—In carrying out this program, the Secretary shall ensure coordination between research activities undertaken by the Advanced Scientific Computing Research program and materials research supported by the Basic Energy Sciences program within the Department of Energy Office of Science.

(g) ENERGY EFFICIENT COMPUTING PROGRAM.—

(1) IN GENERAL.—The Secretary shall support a program of fundamental research, development, and demonstration of energy efficient computing and data center technologies relevant to advanced computing applications, including high performance computing, artificial intelligence, and scientific machine learning.

(2) EXECUTION.—

(A) PROGRAM.—In carrying out the program under paragraph (1), the Secretary shall—

(i) establish a partnership for National Laboratories, industry partners, and institutions of higher education for codesign of energy efficient hardware, technology, software, and applications across all applicable program offices of the Department, and provide access to energy efficient computing resources to such partners;

(ii) develop hardware and software technologies that decrease the energy needs of advanced computing practices, including through data center co-design; and

(iii) consider multiple heterogeneous computing architectures in collaboration with the program established under subsection (f) including neuromorphic computing, persistent computing, and ultrafast networking; and

(iv) provide, as appropriate, on a competitive, merit-reviewed basis, access for researchers from institutions of higher education, National Laboratories, industry, and other Federal agencies to the energy efficient computing technologies developed pursuant to clause (i).

(B) SELECTION OF PARTNERS.—In selecting participants for the partnership established under subparagraph (A)(i), the Secretary shall select participants through a competitive, merit review process.

(C) REPORT.—Not later than one year after the date of the enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives, and the Committee on Energy and Natural Resources of the Senate, a report on—

(i) the activities conducted under subparagraph (A); and

(ii) the coordination and management of the program under subparagraph (A) to ensure an integrated research program across the Department.

(h) ENERGY SCIENCES NETWORK.—

(1) IN GENERAL.—The Secretary shall provide for upgrades to the Energy Sciences Network user facility in order to meet the research needs of the Department for highly reliable data transport capabilities optimized for the requirements of large-scale science.

(2) CAPABILITIES.—In carrying out paragraph (1), the Secretary shall ensure the following capabilities:

(A) To provide high bandwidth scientific networking across the continental United States and the Atlantic Ocean.

(B) To ensure network reliability.

(C) To protect the network infrastructure from cyber-attacks.

(D) To manage transport of exponentially increasing levels of data from the Department's National Laboratories and sites, user facilities, experiments, and sensors.

(E) To contribute to the integration of heterogeneous computing frameworks and systems.

(i) COMPUTATIONAL SCIENCE GRADUATE FELLOWSHIP.—

(1) IN GENERAL.—The Secretary shall support the Computational Science Graduate Fellowship program in order to facilitate collaboration between graduate students and researchers at the National Laboratories, and contribute to the development of a diverse and inclusive computational workforce to help advance research in areas relevant to the mission of the Department.

(2) FUNDING.—From within funds authorized to be appropriated for Advanced Scientific Computing Research Program, the Secretary shall make available for carrying out the activities under this section—

(A) $21,000,000 for fiscal year 2022;
(B) $22,050,000 for fiscal year 2023;
(C) $23,152,500 for fiscal year 2024;
(D) $24,310,125 for fiscal year 2025; and
(E) $25,525,631 for fiscal year 2026.

(j) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

(1) $1,126,350,000 for fiscal year 2022;
(2) $1,222,674,500 for fiscal year 2023;
(3) $1,324,320,715 for fiscal year 2024;
(4) $1,431,660,115 for fiscal year 2025; and
(5) $1,535,090,121 for fiscal year 2026.

SEC. 305. HIGH-ENERGY PHYSICS.

(a) SENSE OF CONGRESS.—It is the sense of Congress that—

(1) the Director should incorporate the findings and recommendations of the report of the Particle Physics Project Prioritization Panel entitled "Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context" into the planning process of the Department; and

(2) the nations that lead in particle physics by hosting international teams dedicated to a common scientific goal attract the world's best talent and inspire future generations of physicists and technologists.

(b) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program in elementary particle physics and advanced technology research and development to improve the understanding of the fundamental properties of the universe, including constituents of matter and energy and the nature of space and time.

(c) HIGH ENERGY FRONTIER RESEARCH.—As part of the program described in subsection (a), the Director shall carry out research using high energy accelerators and advanced detectors, including accelerators and detectors that will function as national user facilities, to create and study interactions of elementary particles and investigate fundamental forces.

[(b) INTERNATIONAL COLLABORATION.—The Director, as practicable and in coordination with other appropriate Federal agencies as necessary, shall ensure the access of United States researchers to the most advanced accelerator facilities and research capabilities in the world, including the Large Hadron Collider.**]**

(d) INTERNATIONAL COLLABORATION.—The Director shall—

(1) as practicable and in coordination with other appropriate Federal agencies as necessary, ensure the access of United States researchers to the most advanced accelerator facilities and research capabilities in the world, including the Large Hadron Collider;

(2) to the maximum extent practicable, continue to leverage United States participation in the Large Hadron Collider, and prioritize expanding international partnerships and investments in the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment; and

(3) to the maximum extent practicable, prioritize engagement in collaborative efforts in support of future international facilities that would provide access to the most advanced accelerator facilities in the world to United States researchers.

[(c)] *(e)* NEUTRINO RESEARCH.—The Director shall carry out research activities on rare decay processes and the nature of the neutrino, which may include collaborations with the National Science Foundation or international collaborations.

[(d) DARK ENERGY AND DARK MATTER RESEARCH.—The Director shall carry out research activities on the nature of dark energy and dark matter, which may include collaborations with the National Aeronautics and Space Administration or the National Science Foundation; or international collaborations.]

(f) COSMIC FRONTIER RESEARCH.—The Director shall carry out research activities on the nature of the primary contents of the universe, including the nature of dark energy and dark matter. These activities shall, to the maximum extent practicable, be consistent with the research priorities identified by the High Energy Physics Advisory Panel or the National Academy of Sciences, and may include—

(1) collaborations with the National Aeronautics and Space Administration, the National Science Foundation, or international partners on relevant projects; and

(2) the development of space-based, land-based, water-based, and underground facilities and experiments.

(g) FACILITY CONSTRUCTION AND MAJOR ITEMS OF EQUIPMENT.—

(1) PROJECTS.—Consistent with the Office of Science's project management practices, the Director shall, to the maximum extent practicable, incorporate the findings and recommendations of the 2014 Particle Physics Project Prioritization Panel (P5) report titled "Building for Discovery", and support construction or fabrication of—

(A) an international Long-Baseline Neutrino Facility based in the United States;

(B) the Proton Improvement Plan II;

(C) Second Generation Dark Matter experiments;

(D) the Legacy Survey of Space and Time camera;

(E) upgrades to detectors and other components of the Large Hadron Collider; and

(F) other high priority projects recommended in the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel.

(2) LONG-BASELINE NEUTRINO FACILITY.—

(A) IN GENERAL.—The Secretary shall support construction of a Long-Baseline Neutrino Facility to facilitate the

international Deep Underground Neutrino Experiment to examine the fundamental properties of neutrinos, explore physics beyond the Standard Model, and better clarify the existence and nature of antimatter.

(B) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in subparagraph (A) will provide, at a minimum, the following capabilities:

(i) A neutrino beam with wideband capability of 1.2 megawatts (MW) of beam power and upgradable to 2.4 MW of beam power.

(ii) Three caverns excavated for a 70 kiloton fiducial detector mass and supporting surface buildings and utilities.

(iii) Cryogenic systems to support neutrino detectors.

(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this subsection occurs before December 31, 2031.

(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

(i) $200,000,000 for fiscal year 2022;

(ii) $325,000,000 for fiscal year 2023;

(iii) $400,000,000 for fiscal year 2024;

(iv) $375,000,000 for fiscal year 2025; and

(v) $250,000,000 for fiscal year 2026.

(3) PROTON IMPROVEMENT PLAN–II ACCELERATOR UPGRADE PROJECT.—

(A) IN GENERAL.—The Secretary of Energy shall support construction of the Proton Improvement Plan II, an upgrade to the Fermilab accelerator complex identified in the 2014 Particle Physics Project Prioritization Panel (P5) report titled "Building for Discovery", to provide the world's most intense beam of neutrinos to the international Long Baseline Neutrino Facility as well as abroad range of future high energy physics experiments. The Secretary of Energy shall work with international partners to enable further significant contributions to the capabilities of this project.

(B) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in paragraph (1) will provide, at a minimum, the following capabilities:

(i) A state-of-the-art 800 megaelectron volt (MeV) superconducting linear accelerator.

(ii) Proton beam power of 1.2 MW at the start of LBNF/DUNE, upgradeable to 2.4 MW of beam power.

(iii) A flexible design to enable high power beam delivery to multiple users simultaneously and customized beams tailored to specific scientific needs.

(iv) Sustained high reliability operation of the Fermilab accelerator complex.

(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start

of full operations of the facility under this section occurs before December 31, 2028.

(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

(i) $191,000,000 for fiscal year 2022;
(ii) $150,000,000 for fiscal year 2023;
(iii) $120,000,000 for fiscal year 2024;
(iv) $120,000,000 for fiscal year 2025; and
(v) $100,000,000 for fiscal year 2026.

(4) COSMIC MICROWAVE BACKGROUND STAGE 4.—

(A) IN GENERAL.—The Secretary of Energy, in partnership with the Director of the National Science Foundation, shall support construction of the Cosmic Microwave Background Stage 4 project to survey the cosmic microwave background to test theories of cosmic inflation as described in the 2014 Particle Physics Prioritization Panel (P5) report titled "Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context.".

(B) CONSULTATION.—The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this experiment is capable of meeting Federal research needs in accessing the ultra-high energy physics of inflation and important neutrino properties.

(C) EXPERIMENTAL CAPABILITIES.—The Secretary shall ensure to the maximum extent practicable that the facility described in subsection (a) will provide at minimum, 500,000 superconducting detectors deployed on an array of mm wave telescopes with the required range in frequency, sensitivity, and survey speed which will provide sufficient capability to enable an order of magnitude advance in observations of the Cosmic Microwave Background, delivering transformative discoveries in fundamental physics, cosmology, and astrophysics.

(D) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2030.

(E) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

(i) $37,000,000 for fiscal year 2022;
(ii) $50,000,000 for fiscal year 2023;
(iii) $70,000,000 for fiscal year 2024;
(iv) $80,000,000 for fiscal year 2025; and
(v) $90,000,000 for fiscal year 2026.

(h) ACCELERATOR AND DETECTOR UPGRADES.—The Director shall upgrade accelerator facilities and detectors, as necessary and appropriate, to increase beam power, sustain high reliability, and improve precision measurement to advance the highest priority particle physics research programs. In carrying out facility upgrades, the Director shall continue to work with international partners, when ap-

propriate and in the United States' interest, to leverage investments and expertise in critical technologies to help build and upgrade accelerator and detector facilities in the United States.

(i) ACCELERATOR AND DETECTOR RESEARCH AND DEVELOPMENT.—As part of the program described in subsection (a), the Director shall carry out research and development in particle beam physics, accelerator science and technology, and particle and radiation detection with relevance to the specific needs of the High Energy Physics program, in coordination with the Accelerator Research and Development program authorized in section 311.

(j) UNDERGROUND SCIENCE.—The Director shall—

(1) support an underground science program consistent with the missions of the Department and the scientific needs of the High Energy Physics program, including those articulated in the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel, that leverages the capabilities of relevant underground science and engineering facilities; and

(2) carry out a competitive grant program to award scientists and engineers at institutions of higher education, nonprofit institutions, and national laboratories to conduct research in underground science and engineering.

(k) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

(1) $1,355,690,000 for fiscal year 2022;
(2) $1,517,628,300 for fiscal year 2023;
(3) $1,652,112,281 for fiscal year 2024;
(4) $1,711,460,141 for fiscal year 2025; and
(5) $1,656,012,351 for fiscal year 2026.

SEC. 306. BIOLOGICAL AND ENVIRONMENTAL RESEARCH.

[(a) BIOLOGICAL SYSTEMS.—The Director shall carry out research and development activities in fundamental, structural, computational, and systems biology to increase systems-level understanding of the complex biological systems, which may include activities—

[(1) to accelerate breakthroughs and new knowledge that would enable the cost-effective, sustainable production of—

[(A) biomass-based liquid transportation fuels;

[(B) bioenergy; and

[(C) biobased materials;

[(2) to improve understanding of the global carbon cycle, including processes for removing carbon dioxide from the atmosphere, through photosynthesis and other biological processes, for sequestration and storage; and

[(3) to understand the biological mechanisms used to transform, immobilize, or remove contaminants from subsurface environments.]

(a) PROGRAM.—As part of the duties of the Director authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), and coordinated with the activities authorized under sections 303 and 304 of this Act, the Director shall carry out a program of research and development in the areas of biological systems science and climate and environmental science, including subsurface science, relevant to the development of new energy tech-

nologies and to support the energy, environmental, and national security missions of the Department.

(b) BIOLOGICAL SYSTEMS.—The Director shall carry out research and development activities in genomic science including fundamental research on plants and microbes to increase systems-level understanding of the complex biological systems, which may include activities to—

(1) accelerate breakthroughs and new knowledge that would enable the cost-effective, sustainable production of—

(A) biomass-based liquid transportation fuels;

(B) bioenergy; and

(C) biobased materials from renewable biomass;

(2) improve fundamental understanding of plant and microbial processes impacting the global carbon cycle, including processes for removing carbon dioxide from the atmosphere, through photosynthesis and other biological processes, for sequestration and storage;

(3) understand the microbiome mechanisms used to transform, immobilize, or remove contaminants from subsurface environments;

(4) develop the computational approaches and integrated platforms for open access collaborative science;

(5) leverage tools and approaches across the Office of Science to expand research to include novel processes, methods, and science to develop bio-based chemicals, polymers, inorganic materials, including research to—

(A) advance biosystems design research to advance the understanding of how CRISPR tools and other gene editing tools and technologies work in nature, in the laboratory, and in practice;

(B) deepen genome-enabled knowledge of root architecture and growth in crops, including trees; and

(C) develop biosystems design methods and tools to increase the efficiency of photosynthesis in plants; and

(6) develop other relevant methods and processes as determined by the Director.

(c) BIOMOLECULAR CHARACTERIZATION AND IMAGING SCIENCE.—The Director shall carry out research and development activities in biomolecular characterization and imaging science, including development of integrative imaging and analysis platforms and biosensors to understand the expression, structure, and function of genome information encoded within cells and for real-time measurements in ecosystems and field sites of relevance to the mission of the Department of Energy.

[(b)**]** *(d)* LIMITATION FOR RESEARCH FUNDS.—The Director shall not approve new climate science-related initiatives without making a determination that such work is well-coordinated with any relevant work carried out by other Federal agencies.

[(c)**]** *(e)* LOW-DOSE RADIATION RESEARCH PROGRAM.—

(1) IN GENERAL.—The Secretary shall carry out a research program on low-dose and low dose-rate radiation to—

(A) enhance the scientific understanding of, and reduce uncertainties associated with, the effects of exposure to low-dose and low dose-rate radiation; and

(B) inform improved risk-assessment and risk-management methods with respect to such radiation.

(2) PROGRAM COMPONENTS.—In carrying out the program required under paragraph (1), the Secretary shall—

(A) support and carry out the directives under section 106(b) of the American Innovation and Competitiveness Act (42 U.S.C. 6601 note), except that such section shall be treated for purposes of this subsection as applying to low dose and low-dose rate radiation research, in coordination with the Physical Science Subcommittee of the National Science and Technology Council;

(B) identify and, to the extent possible, quantify, potential monetary and health-related impacts to Federal agencies, the general public, industry, research communities, and other users of information produced by such research program;

(C) leverage the collective body of knowledge from existing low-dose and low dose-rate radiation research;

(D) engage with other Federal agencies, research communities, and potential users of information produced under this section, including institutions performing or utilizing radiation research, medical physics, radiology, health physics, and emergency response measures; and

(E) support education and outreach activities to disseminate information and promote public understanding of low-dose radiation, with a focus on non-emergency situations such as medical physics, space exploration, and naturally occurring radiation.

(3) RESEARCH PLAN.—

(A) Not later than 90 days after the date of enactment of the Energy Act of 2020, the Secretary shall enter into an agreement with the National Academy of Sciences to develop a long-term strategic and prioritized research agenda for the program described in paragraph (2);

(B) Not later than one year after the date of enactment of the Energy Act of 2020, the Secretary shall transmit this research plan developed in subparagraph (A) to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate.

(4) GAO STUDY.—Not later than 3 years after the date of enactment of the Energy Act of 2020, the Comptroller General shall transmit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate, a report on:

(A) an evaluation of the program activities carried out under this section;

(B) the effectiveness of the coordination and management of the program; and

(C) the implementation of the research plan outlined in paragraph (3).

(6) DEFINITIONS.—In this subsection:

(A) LOW-DOSE RADIATION.—The term "low-dose radiation" means a radiation dose of less than 100 millisieverts.

(B) LOW DOSE-RATE RADIATION.—The term "low dose-rate radiation" means a radiation dose rate of less than 5 millisieverts per hour.

(7) RULE OF CONSTRUCTION.—Nothing in this subsection shall be construed to subject any research carried out by the Secretary for the program under this subsection to any limitations described in section 977(e) of the Energy Policy Act of 2005 (42 U.S.C. 16317(e)).

(8) FUNDING.—For purposes of carrying out this subsection, the Secretary is authorized to make available from funds provided to the Biological and Environmental Research Program—

(A) $20,000,000 for fiscal year 2021;

(B) $20,000,000 for fiscal year 2022;

(C) $30,000,000 for fiscal year 2023; [and]

(D) $40,000,000 for fiscal year 2024[.]*;*

(E) $40,000,000 for fiscal year 2025; and

(F) $50,000,000 for fiscal year 2026.

[(d) SPACE RADIATION RESEARCH.—The Secretary of Energy, shall continue and strengthen collaboration with the Administrator of the National Aeronautics and Space Administration on basic research to understand the effects and risks of human exposure to ionizing radiation in low Earth orbit, and in the space environment.]

(f) LOW-DOSE RADIATION AND SPACE RADIATION RESEARCH PROGRAM.—

(1) IN GENERAL.—The Secretary of Energy, in consultation with the Administrator of the National Aeronautics and Space Administration shall carry out a basic research program on the similarities and differences between the effects of exposure to low-dose radiation on Earth, in low Earth orbit, and in the space environment.

(2) PURPOSE.—The purpose of this program is to accelerate breakthroughs in low-dose and low dose-rate radiation research and development as described in subsection (d) and to inform the advancement of new tools, technologies, and advanced materials needed to facilitate long-duration space exploration.

(g) EARTH AND ENVIRONMENTAL SYSTEMS SCIENCES ACTIVITIES.—

(1) IN GENERAL.—As part of the activities authorized under subsection (a), and in coordination with activities carried out under subsection (b), the Director shall carry out earth and environmental systems science research, in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, which may include activities to—

(A) understand, observe, and model the response of Earth's atmosphere and biosphere to increased concentrations of greenhouse gas emissions and any associated changes in climate, including frequency and intensity of extreme weather events;

(B) understand the coupled physical, chemical, and biological processes to transform, immobilize, remove, or move carbon, nitrogen, and other energy production-derived contaminants such as radionuclides and heavy metals, and understand the process of sequestration and transformation

of these, carbon dioxide, and other relevant molecules in subsurface environments;

(C) understand, observe, and model the cycling of water, carbon, and nutrients in terrestrial systems and at scales relevant to resources management;

(D) understand the biological, biogeochemical, and physical processes across the multiple scales that control the flux of environmentally relevant compounds between the terrestrial surface and the atmosphere; and

(E) inform potential natural mitigation and adaptation options for increased concentrations of greenhouse gas emissions and any associated changes in climate.

(2) PRIORITIZATION.—In carrying out the program authorized under paragraph (1), the Director shall prioritize—

(A) the development of software and algorithms to enable the productive application of environmental systems and extreme weather in climate and Earth system prediction models in high-performance computing systems; and

(B) capabilities that support the Department's mission needs for energy and infrastructure security, resilience, and reliability.

(3) ENVIRONMENTAL SYSTEMS SCIENCE RESEARCH.—

(A) IN GENERAL.—As part of the activities described in paragraph (1), the Director shall carry out research to advance an integrated, robust, and scale-aware predictive understanding of environmental systems, including the role of hydrobiogeochemistry, from the subsurface to the top of the vegetative canopy that considers effects of seasonal to interannual variability and change.

(B) CLEAN WATER AND WATERSHED RESEARCH.—As part of the activities described in subparagraph (A), the Director shall—

(i) support interdisciplinary research to significantly advance our understanding of water availability, quality, and the impact of human activity and a changing climate on urban and rural watershed systems, including in freshwater environments;

(ii) consult with the Interagency Research, Development, and Demonstration Coordination Committee on the Nexus of Energy and Water for Sustainability established under section 1010 of the Energy Act of 2020 (division Z of the Consolidated Appropriations Act, 2021) on energy-water nexus research activities; and

(iii) engage with representatives of research and academic institutions, nonprofit organizations, State, local, and tribal governments, and industry, who have expertise in technologies, technological innovations, or practices relating to the energy-water nexus, as applicable.

(C) COORDINATION.—

(i) DIRECTOR.—The Director shall carry out activities under this paragraph in accordance with priorities established by the Secretary to support and accelerate the decontamination of relevant facilities managed by the Department.

(ii) SECRETARY.—The Secretary shall ensure the coordination of activities of the Department, including activities under this paragraph, to support and accelerate the decontamination of relevant facilities managed by the Department.

(4) CLIMATE AND EARTH MODELING.—As part of the activities described in paragraph (1), the Director, in collaboration with the Advanced Scientific Computing Research program described in section 304 and other programs carried out by the Department, as applicable, and in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, shall carry out research to develop, evaluate, and use high-resolution regional climate, global climate, Earth system, and other relevant models to inform decisions on reducing greenhouse gas emissions and the resulting impacts of a changing global climate. Such modeling shall include—

(A) integrated capabilities for modeling multisectoral interactions, including socioeconomic factors as appropriate, which may include the impacts of climate policies on social and regional equity and well-being, and the interdependencies and risks at the energy-water-land nexus;

(B) greenhouse gas emissions, air quality, energy supply and demand, and other critical elements; and

(C) interaction among human and Earth systems informed by interdisciplinary research, including the economic and social sciences.

(5) MID-SCALE FUNDING MECHANISM.—

(A) IN GENERAL.—Any of the activities authorized in this subsection may be carried out by competitively selected mid-scale, multi-institutional research centers in lieu of individual research grants, or large-scale experiments or user facilities.

(B) CONSIDERATION.—The Biological and Environmental Research Advisory Committee shall provide recommendations to the Director on projects most suitable for the research centers described in subparagraph (A).

(h) BIOLOGICAL AND ENVIRONMENTAL RESEARCH USER FACILITIES.—

(1) IN GENERAL.—The Director shall carry out a program for the development, construction, operation, and maintenance of user facilities to enhance the collection and analysis of observational data related to complex biological, climate, and environmental systems.

(2) FACILITY REQUIREMENTS.—To the maximum extent practicable, the user facilities developed, constructed, operated, or maintained under paragraph (1) shall include—

(A) distributed field research and observation platforms for understanding earth system processes;

(B) analytical techniques, instruments, and modeling resources for understanding the physical, chemical, and cellular processes of biological and environmental systems;

(C) integrated high-throughput sequencing, advanced bioanalytic techniques, DNA design and synthesis, metabolomics, and computational analysis; and

(D) such other facilities as the Director considers appropriate, consistent with section 209 of the Department of Energy Organization Act (42 U.S.C. 7139).

(3) EXISTING FACILITIES.—In carrying out the program established in paragraph (1), the Director is encouraged to evaluate the capabilities of existing user facilities and, to the maximum extent practicable, invest in modernization of those capabilities to address emerging research priorities.

(4) USER FACILITIES INTEGRATION AND COLLABORATION PROGRAM.—

(A) IN GENERAL.—The Director shall support a program of collaboration between user facilities as defined under this subsection to encourage and enable researchers to more readily integrate the tools, expertise, resources, and capabilities of multiple Office of Science user facilities (as described in section 209(d) of the Department of Energy Organization Act (42 U.S.C. 7139)) to further research and advance emerging technologies.

(B) ACTIVITIES.—The program shall advance the integration of automation, robotics, computational biology, bioinformatics, biosensing, cellular platforms and other relevant emerging technologies as determined by the Director to enhance productivity and scientific impact of user facilities.

(5) EARTH AND ENVIRONMENTAL SYSTEMS SCIENCES USER FACILITIES.—

(A) IN GENERAL.—In carrying out the activities authorized under paragraph (1), the Director shall establish and operate user facilities to advance the collection, validation, and analysis of atmospheric data, including activities to advance knowledge and improve model representations and measure the impact of atmospheric gases, aerosols, and clouds on earth and environmental systems.

(B) SELECTION.—The Director shall select user facilities under paragraph (1) on a competitive, merit-reviewed basis. The Director shall consider applications from the National Laboratories, institutes of higher education, multi-institutional collaborations, and other appropriate entities.

(C) EXISTING FACILITIES.—To the maximum extent practicable, the Director shall utilize existing facilities to carry out this subsection.

(6) COORDINATION.—In carrying out the program authorized in paragraph (1), the Director shall ensure that the Office of Science—

(A) consults and coordinates with the National Oceanic Atmospheric Administration, the Environmental Protection Agency, the National Aeronautics and Space Administration, the Department of Agriculture, the Department of the Interior, and any other relevant Federal agency on the collection, validation, and analysis of atmospheric data; and

(B) coordinates with relevant stakeholders, including institutes of higher education, nonprofit research institutions, industry, State, local, and tribal governments, and other appropriate entities to ensure access to the best available relevant atmospheric and historical weather data.

(i) COASTAL ZONE RESEARCH INITIATIVE.—

(1) IN GENERAL.—The Director shall carry out a research program, in consultation with the National Oceanic and Atmospheric Administration, to enhance the understanding of coastal ecosystems. In carrying out this program, the Director shall prioritize efforts to enhance the collection of observational data, and shall develop models to analyze the ecological, biogeochemical, hydrological and physical processes that interact in coastal zones.

(2) NATIONAL SYSTEM FOR COASTAL DATA COLLECTION.—The Director shall establish, in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, an integrated system of geographically diverse field research sites in order to improve the quantity and quality of observational data, and that encompass the major land water interfaces of the United States, including—

(A) the Great Lakes region;

(B) the Pacific coast;

(C) the Atlantic coast;

(D) the Arctic; and

(E) the Gulf coast.

(3) EXISTING INFRASTRUCTURE.—In carrying out the programs and establishing the field research sites under paragraph (1) and (2), the Secretary shall leverage existing research and development infrastructure supported by the Department, including the Department's existing marine and coastal research lab.

(4) COORDINATION.—For the purposes of carrying out the programs and establishing the field research sites under the Initiative, the Secretary may enter into agreements with Federal Departments and agencies with complementary capabilities.

(5) REPORT.—Not less than 2 years after the date of the enactment of the Department of Energy Science for the Future Act, the Director shall provide to the Committee on Science, Space, and Technology and the Committee on Appropriations of the House of Representatives and the Committee on Energy and Natural Resources and the Committee on Appropriations of the Senate a report examining whether the system described in this section should be established as a National User Facility.

(j) TECHNOLOGY DEVELOPMENT.—The Director shall support a technology research program for the development of instrumentation and other research tools required to meet the missions of the Department and to provide platform technologies for the broader scientific community. Technologies shall include but are not limited to—

(1) cryo-electron microscopy;

(2) fabricated ecosystems;

(3) next generation sensors including quantum sensors for biological integration and bioproduction;

(4) technologies to accelerate data analysis; and

(5) plant and microbial phenotyping for gene discovery.

(k) EMERGING TECHNOLOGIES.—

(1) IN GENERAL.—The Secretary shall establish within the Biological and Environmental Research program an initiative focused on the development of engineered ecosystems through the

application of artificial intelligence, novel sensing capabilities, and other emerging technologies.

(2) INTERAGENCY COORDINATION.—The Secretary shall coordinate with the Director of the National Science Foundation, the Administrator of the National Oceanic and Atmospheric Administration, the Director of the U.S. Geological Survey, and other relevant officials to avoid duplication of research and observational activities and to ensure that activities carried out under this initiative are complimentary to those currently being undertaken by other agencies.

(3) REPORT.—Not later than 180 days after the enactment of this Act, the Secretary shall provide a report to the Committee on Science, Space, and Technology of the House, and the Committee on Energy and Natural Resources of the Senate, on the activity mandated in subsection (k).

(l) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

(1) $820,360,000 for fiscal year 2022;
(2) $886,385,200 for fiscal year 2023;
(3) $956,332,164 for fiscal year 2024;
(4) $1,020,475,415 for fiscal year 2025; and
(5) $1,099,108,695 for fiscal year 2026.

SEC. 307. FUSION ENERGY.

(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139) and section 972 of the Energy Policy Act of 2005 (42 U.S.C. 16312), the Director shall carry out a fusion energy sciences research and enabling technology development program to effectively address the scientific and engineering challenges to building a cost competitive fusion power plant and to support the development of a competitive fusion power industry in the United States. As part of this program, the Director shall carry out research activities to expand the fundamental understandings of plasma and matter at very high temperatures and densities for fusion applications and for other engineering and plasma science applications.

(b) FUSION MATERIALS RESEARCH AND DEVELOPMENT.—**[**As part of**]**

(1) IN GENERAL.—As part of the activities authorized in section 978 of the Energy Policy Act of 2005 (42 U.S.C. 16318)—

[(1)**]** *(A)* the Director, in coordination with the Assistant Secretary for Nuclear Energy of the Department, shall carry out research and development activities to identify, characterize, and demonstrate materials that can endure the neutron, plasma, and heat fluxes expected in a fusion power system; and

[(2)**]** *(B)* the Director shall provide an assessment of—

[(A)**]** *(i)* the need for one or more facilities that can examine and test potential fusion and next generation fission materials and other enabling technologies relevant to the development of fusion power; and

[(B)**]** *(ii)* whether a single new facility that substantially addresses magnetic fusion and next generation fission materials research needs is feasible, in conjunc-

tion with the expected capabilities of facilities operational as of the date of enactment of this Act.

(2) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated under subsection (r), there are authorized to be appropriated to the Secretary to carry out activities described in paragraph (1) $50,000,000 for each of fiscal years 2022 through 2026.

(c) TOKAMAK RESEARCH AND DEVELOPMENT.—The Director shall support research and development activities and facility operations to optimize the tokamak approach to fusion energy.

(d) INERTIAL FUSION RESEARCH AND DEVELOPMENT.—

(1) IN GENERAL.—The Director shall carry out a program of research and technology development in inertial fusion for energy applications, including ion beam, laser, and pulsed power fusion systems.

(2) ACTIVITIES.—As part of the program described in paragraph (1), the Director shall support activities at and partnerships with universities and the National Laboratories to—

(A) develop novel target designs;

(B) support modeling of various inertial fusion energy concepts and systems;

(C) develop diagnostic tools; and

(D) improve inertial fusion energy driver technologies.

(3) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated under subsection ~~[~~(o)~~]~~ *(r)*, there are authorized to be appropriated to the Secretary to carry out the activities described in subsection (d) $25,000,000 for each of fiscal years 2021 through 2025~~[~~.~~]~~ *and $40,000,000 for fiscal year 2026.*

(e) ALTERNATIVE AND ENABLING CONCEPTS.—

(1) IN GENERAL.—The Director shall support research and development activities and facility operations at institutions of higher education, National Laboratories, and private facilities in the United States for a portfolio of alternative and enabling fusion energy concepts that may provide solutions to significant challenges to the establishment of a commercial magnetic fusion power plant, prioritized based on the ability of the United States to play a leadership role in the international fusion research community.

(2) ACTIVITIES.—Fusion energy concepts and activities explored under paragraph (1) may include—

(A) alternative fusion energy concepts, including—

(i) advanced stellarator concepts;

(ii) non-tokamak confinement configurations operating at low magnetic fields;

(iii) magnetized target fusion energy concepts; or

(iv) other promising fusion energy concepts identified by the Director;

(B) enabling fusion technology development activities, including—

(i) high magnetic field approaches facilitated by high temperature superconductors;

(ii) liquid metals to address issues associated with fusion plasma interactions with the inner wall of the encasing device; and

(iii) advanced blankets for heat management and fuel breeding; and

(C) advanced scientific computing activities.

(3) INNOVATION NETWORK FOR FUSION ENERGY.—

(A) IN GENERAL.—The Secretary, acting through the Office of Science, shall support a program to provide fusion energy researchers with access to scientific and technical resources and expertise at facilities supported by the Department, including such facilities at National Laboratories and universities, to advance innovative fusion energy technologies toward commercial application.

(B) AWARDS.—Financial assistance under the program established in subsection (a)—

(i) shall be awarded on a competitive, merit-reviewed basis; and

(ii) may be in the form of grants, vouchers, equipment loans, or contracts to private entities.

(4) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated under subsection [(o)] *(r)*, there are authorized to be appropriated to the Secretary to carry out the activities described in subsection (e) $50,000,000 for each of fiscal years 2021 through 2025[.] *and $75,000,000 for fiscal year 2026.*

(f) COORDINATION WITH ARPA-E.—The Director shall coordinate with the Director of the Advanced Research Projects Agency-Energy (referred to in this subsection as "ARPA-E") to—

(1) assess the potential for any fusion energy project supported by ARPA-E to represent a promising approach to a commercially viable fusion power plant;

(2) determine whether the results of any fusion energy project supported by ARPA-E merit the support of follow-on research activities carried out by the Office of Science; and

(3) avoid the unintentional duplication of activities.

(g) FAIRNESS IN COMPETITION FOR SOLICITATIONS FOR INTERNATIONAL PROJECT ACTIVITIES.—Section 33 of the Atomic Energy Act of 1954 (42 U.S.C. 2053) is amended by inserting before the first sentence the following: "In this section, with respect to international research projects, the term 'private facilities or laboratories' means facilities or laboratories located in the United States.".

(h) IDENTIFICATION OF PRIORITIES.—

(1) REPORT.—

(A) IN GENERAL.—Not later than 2 years after the date of enactment of this Act, the Secretary shall submit to Congress a report on the fusion energy research and development activities that the Department proposes to carry out over the 10-year period following the date of the report under not fewer than 3 realistic budget scenarios, including a scenario based on 3-percent annual growth in the non-ITER portion of the budget for fusion energy research and development activities.

(B) INCLUSIONS.—The report required under subparagraph (A) shall—

(i) identify specific areas of fusion energy research and enabling technology development in which the

United States can and should establish or solidify a lead in the global fusion energy development effort;

(ii) identify priorities for initiation of facility construction and facility decommissioning under each of the three budget scenarios described in subparagraph (A); and

(iii) assess the ability of the fusion workforce of the United States to carry out the activities identified under clauses (i) and (ii), including the adequacy of programs at institutions of higher education in the United States to train the leaders and workers of the next generation of fusion energy researchers.

(2) PROCESS.—In order to develop the report required under paragraph (1)(A), the Secretary shall leverage best practices and lessons learned from the process used to develop the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel.

(3) REQUIREMENT.—No member of the Fusion Energy Sciences Advisory Committee shall be excluded from participating in developing or voting on final approval of the report required under paragraph (1)(A).

(i) MILESTONE-BASED DEVELOPMENT PROGRAM.—

(1) IN GENERAL.—Using the authority of the Secretary under section 646(g) of the Department of Energy Organization Act (42 U.S.C. 7256(g)), notwithstanding paragraph (10) of such section, the Secretary shall establish, not later than 6 months after the date of enactment of this section, a milestone-based fusion energy development program that requires projects to meet particular technical milestones before a participant is awarded funds by the Department.

(2) PURPOSE.—The purpose of the program established by paragraph (1) shall be to support the development of a U.S.-based fusion power industry through the research and development of technologies that will enable the construction of new full-scale fusion systems capable of demonstrating significant improvements in the performance of such systems, as defined by the Secretary, within 10 years of the enactment of this section.

(3) ELIGIBILITY.—Any entity is eligible to participate in the program provided that the Secretary has deemed it as having the necessary resources and expertise.

(4) REQUIREMENTS.—In carrying out the milestone-based program under paragraph (1), the Secretary shall, for each relevant project—

(A) request proposals from eligible entities, as determined by the Secretary, that include proposed technical milestones, including estimated project timelines and total costs;

(B) set milestones based on a rigorous technical review process;

(C) award funding of a predetermined amount to projects that successfully meet proposed milestones under paragraph (1), or for expenses deemed reimbursable by the Secretary, in accordance with terms negotiated for an individual award; and

(D) communicate regularly with selected eligible entities and, if the Secretary deems appropriate, exercise small amounts of flexibility for technical milestones as projects mature.

(5) AWARDS.—For the program established under paragraph (1)—

(A) an award recipient shall be responsible for all costs until milestones are achieved, or reimbursable expenses are reviewed and verified by the Department;

(B) should an awardee not meet the milestones described in paragraph (4), the Secretary may end the partnership with an award recipient and use the remaining funds in the ended agreement for new or existing projects carried out under this section; and

(C) consistent with the existing authorities of the Department, the Secretary may end the partnership with an award recipient for cause during the performance period.

(6) APPLICATIONS.—Any project proposal submitted to the program under paragraph (1) shall be evaluated based upon its scientific, technical, and business merits through a peer-review process, which shall include reviewers with appropriate expertise from the private sector, the investment community, and experts in the science and engineering of fusion and plasma physics.

(7) PROJECT MANAGEMENT.—In carrying out projects under this program and assessing the completion of their milestones in accordance with paragraph (4), the Secretary shall consult with experts that represent diverse perspectives and professional experiences, including those from the private sector, to ensure a complete and thorough review.

(8) PROGRAMMATIC REVIEW.—Not later than 4 years after the Secretary has established 3 milestones under this program, the Secretary shall enter into a contractual arrangement with the National Academy of Sciences to review and provide a report describing the findings of this review to the House Committee on Science, Space, and Technology and the Senate Committee on Energy and Natural Resources on the program established under this paragraph (1) that assesses—

(A) the benefits and drawbacks of a milestone-based fusion program as compared to traditional program structure funding models at the Department;

(B) lessons-learned from program operations; and

(C) any other matters the Secretary determines regarding the program.

(9) ANNUAL REPORT.—As part of the annual budget request submitted for each fiscal year, the Secretary shall provide the House Committee on Science, Space, and Technology and the Senate Committee on Energy and Natural Resources a report describing partnerships supported by the program established under paragraph (1) during the previous fiscal year.

(10) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated under subsection ⟦(o)⟧ *(r)*, there are authorized to be appropriated to the Secretary to carry out the activities described in subsection (i), to remain available until expended—

(A) $45,000,000 for fiscal year 2021;
(B) $65,000,000 for fiscal year 2022;
(C) $105,000,000 for fiscal year 2023;
(D) $65,000,000 for fiscal year 2024[; and];
(E) $45,000,000 for fiscal year 2025[.]; *and*
(F) $45,000,000 for fiscal year 2026.

(j) FUSION REACTOR SYSTEM DESIGN.—[The Director shall support research and development activities to design future fusion reactor systems and examine and address the technical drivers for the cost of these systems.]

(1) IN GENERAL.—

(A) ESTABLISHMENT.—Within 180 days of enactment of the Department of Energy Science for the Future Act, the Director shall establish at least 2 national teams, including public-private partnerships, that will develop conceptual pilot plant designs and technology roadmaps and lead to an engineering design of a pilot plant that will bring fusion to commercial viability.

(B) COMPOSITION.—The national teams shall be composed of developers, manufacturers, universities, national laboratories, and engineering, procurement, and construction industries.

(2) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out activities described in paragraph (1)—

(A) $20,000,000 for fiscal year 2022;
(B) $35,000,000 for fiscal year 2023;
(C) $50,000,000 for fiscal year 2024;
(D) $65,000,000 for fiscal year 2025; and
(E) $80,000,000 for fiscal year 2026.

(k) GENERAL PLASMA SCIENCE AND APPLICATIONS.—The Director shall support research in general plasma science and high energy density physics that advance the understanding of the scientific community of fundamental properties and complex behavior of matter to control and manipulate plasmas for a broad range of applications, including support for research relevant to advancements in chip manufacturing and microelectronics.

(l) SENSE OF CONGRESS.—It is the [sense of Congress that the United States should support] *sense of Congress that—*

(1)the United States should support a robust, diverse program in addition to providing sufficient support to, at a minimum, meet its commitments to ITER and maintain the schedule of the project as determined by the Secretary in coordination with the ITER Organization at the time of the enactment of this section. It is further the sense of Congress that developing the scientific basis for fusion, providing research results key to the success of ITER, and training the next generation of fusion scientists are of critical importance to the United States and should in no way be diminished by participation of the United States in the ITER project[.]*; and*

(2) the Director shall incorporate the findings and recommendations of the report of the Fusion Energy Sciences Advisory Committee entitled "Powering the Future: Fusion and Plasmas" and the report of the National Academies entitled "Bringing Fusion to the U.S. Grid" into the planning process of the

Department, including the development of future budget requests to Congress.

(m) INTERNATIONAL COLLABORATION.—The Director shall—

(1) as practicable and in coordination with other appropriate Federal agencies as necessary, ensure the access of United States researchers to the most advanced fusion research facilities and research capabilities in the world, including ITER;

(2) to the maximum extent practicable, continue to leverage United States participation ITER, and prioritize expanding international partnerships and investments in current and future fusion research facilities within the United States; and

(3) to the maximum extent practicable, prioritize engagement in collaborative efforts in support of future international facilities that would provide access to the most advanced fusion research facilities in the world to United States researchers.

(n) FISSION AND FUSION RESEARCH COORDINATION REPORT.—

(1) IN GENERAL.—Not later than 6 months after the date of enactment of this section, the Secretary shall transmit to Congress a report addressing opportunities for coordinating fusion energy research and development activities between the Office of Nuclear Energy, the Office of Science, and the Advanced Research Projects Agency—Energy.

(2) COMPONENTS.—The report shall assess opportunities for collaboration on research and development of—

(A) liquid metals to address issues associated with fusion plasma interactions with the inner wall of the encasing device and other components within the reactor;

(B) immersion blankets for heat management and fuel breeding;

(C) technologies and methods for instrumentation and control;

(D) computational methods and codes for system operation and maintenance;

(E) codes and standard development;

(F) radioactive waste handling;

(G) radiological safety;

(H) potential for non-electricity generation applications; and

(I) any other overlapping priority as identified by the Director of the Office of Science or the Assistant Secretary of Energy for Nuclear Energy.

(o) HIGH-PERFORMANCE COMPUTATION COLLABORATIVE RESEARCH PROGRAM.—

(1) IN GENERAL.—The Secretary shall carry out a program to conduct and support collaborative research, development, and demonstration of fusion energy technologies, through high-performance computation modeling and simulation techniques, in order to—

(A) support fundamental research in plasmas and matter at very high temperatures and densities;

(B) inform the development of a broad range of fusion energy systems; and

(C) facilitate the translation of research results in fusion energy science to industry.

(2) COORDINATION.—In carrying out the program under paragraph (1), the Secretary shall coordinate with relevant Federal agencies, and prioritize the following objectives:

(A) Using expertise from the private sector, institutions of higher education, and the National Laboratories to leverage existing, and develop new, computational software and capabilities that prospective users may use to accelerate research and development of fusion energy systems.

(B) Developing computational tools to simulate and predict fusion energy science phenomena that may be validated through physical experimentation.

(C) Increasing the utility of the research infrastructure of the Department by coordinating with the Advanced Scientific Computing Research program within the Office of Science.

(D) Leveraging experience from existing modeling and simulation entities sponsored by the Department.

(E) Ensuring that new experimental and computational tools are accessible to relevant research communities, including private sector entities engaged in fusion energy technology development.

(F) Ensuring that newly developed computational tools are compatible with modern virtual engineering and visualization capabilities to accelerate the realization of fusion energy technologies and systems.

(3) DUPLICATION.—The Secretary shall ensure the coordination of, and avoid unnecessary duplication of, the activities of this program with the activities of—

(A) other research entities of the Department, including the National Laboratories, the Advanced Research Projects Agency–Energy, the Advanced Scientific Computing Research program; and

(B) industry.

(4) HIGH-PERFORMANCE COMPUTING FOR FUSION INNOVATION CENTER.—In carrying out the program under paragraph (1), the Secretary shall, in coordination with the Innovation Network for Fusion Energy, establish and operate a national High-Performance Computing for Fusion Innovation Center (referred to in this section as the 'Center'), in order to support the program under paragraph (1) by providing, to the extent practicable, a centralized entity for multidisciplinary, collaborative, fusion energy research and development through high performance computing and advanced data analytics technologies and processes.

(5) SELECTION.—The Secretary shall select the Center under this subsection on a competitive, merit-reviewed basis. The Secretary shall consider applications from National Laboratories, institutions of higher education, multi-institutional collaborations, and other appropriate entities.

(6) EXISTING ACTIVITIES.—The Center may incorporate existing research activities that are consistent with the program described in paragraph (1).

(7) DURATION.—The Center established under this subsection shall receive support for a period of not more than 5 years, subject to the availability of appropriations.

(8) RENEWAL.—Upon the expiration of any period of support of the Center, the Secretary may renew support for the Center, on a merit-reviewed basis, for a period of not more than 5 years.

(9) TERMINATION.—Consistent with the existing authorities of the Department, the Secretary may terminate the Center for cause during the performance period.

(p) MATERIAL PLASMA EXPOSURE EXPERIMENT.—

(1) IN GENERAL.—The Secretary shall construct a Material Plasma Exposure Experiment facility as described in the 2020 publication approved by the Fusion Energy Sciences Advisory Committee titled "Powering the Future: Fusion and Plasmas". The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility is capable of meeting Federal research needs for steady state, high-heat-flux and plasma-material interaction testing of fusion materials over a range of fusion energy relevant parameters.

(2) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in subsection (a) will provide the following capabilities:

(A) A magnetic field at the target of 1 Tesla.

(B) An energy flux at the target of 10 MW/m2.

(C) The ability to expose previously irradiated plasma facing material samples to plasma.

(3) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2027.

(4) FUNDING.—Out of funds authorized to be appropriated for Fusion Energy Sciences, there are funds authorized to be appropriated to the Secretary for the Office of Fusion Energy Sciences to carry out to completion the construction of the facility under this section:

(A) $32,800,000 for fiscal year 2022;

(B) $13,400,000 for fiscal year 2023;

(C) $12,600,000 for fiscal year 2024; and

(D) $400,000 for fiscal year 2025.

(q) MATTER IN EXTREME CONDITIONS INSTRUMENT UPGRADE.—

(1) IN GENERAL.—The Secretary shall provide for the upgrade to the Matter in Extreme Conditions endstation at the Linac Coherent Light Source as described in the 2020 publication approved by the Fusion Energy Sciences Advisory Committee titled "Powering the Future: Fusion and Plasmas". The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility is capable of meeting Federal research needs for understanding physical and chemical changes to plasmas at fundamental timescales, and explore new regimes of dense material physics, astrophysics, planetary physics, and short-pulse laser-plasma interactions.

(2) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2028.

[(o)] *(r)* AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

(1) $996,000,000 for fiscal year 2021;
[(2) $921,000,000 for fiscal year 2022;
[(3) $961,000,000 for fiscal year 2023;
[(4) $921,000,000 for fiscal year 2024; and
[(5) $901,000,000 for fiscal year 2025.]
(2) $1,002,900,000 for fiscal year 2022;
(3) $1,095,707,000 for fiscal year 2023;
(4) $1,129,368,490 for fiscal year 2024;
(5) $1,149,042,284 for fiscal year 2025; and
(6) $1,243,097,244 for fiscal year 2026.

SEC. 308. NUCLEAR PHYSICS.

[(a) ISOTOPE DEVELOPMENT AND PRODUCTION FOR RESEARCH APPLICATIONS.—The Director—

[(1) may carry out a program for the production of isotopes, including the development of techniques to produce isotopes, that the Secretary determines are needed for research, medical, industrial, or related purposes; and

[(2) shall ensure that isotope production activities carried out under the program under this paragraph do not compete with private industry unless the Director determines that critical national interests require the involvement of the Federal Government.]

(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program, and support relevant facilities, to discover and understand various forms of nuclear matter.

(b) USER FACILITIES.—

(1) FACILITY FOR RARE ISOTOPE BEAMS.—

(A) IN GENERAL.—The Secretary shall support construction of a Facility for Rare Isotope Beams to advance the understanding of rare nuclear isotopes and the evolution of the cosmos.

(B) FUNDING.—Out of funds authorized to be appropriated under subsection (c), there shall be made available to the Secretary to carry out construction of the facility under this subsection $2,000,000 for fiscal year 2022.

(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before March 1, 2022.

(2) ELECTRON-ION COLLIDER.—

(A) IN GENERAL.—The Secretary shall support construction of an Electron Ion Collider as described in the 2015 Long Range Plan of the Nuclear Science Advisory Committee and the report from the National Academies titled "An Assessment of U.S.-Based Electron-Ion Collider Science", in order to measure the internal structure of the proton and the nucleus and answer fundamental questions about the nature of visible matter.

(B) FACILITY CAPABILITY.—The Secretary shall ensure that the facility meets the requirements in the 2015 Long Range Plan, including—

(i) at least 70 percent polarized beams of electrons and light ions;

(ii) ion beams from deuterium to the heaviest stable nuclei;

(iii) variable center of mass energy from 20 to 140 GeV;

(iv) high collision luminosity of 10~~33–34~~*cm-*~~2~~*s-*~~1~~*; and*

(v) the possibility of more than one interaction region.

(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2030.

(D) FUNDING.—Out of funds authorized to be appropriated under subsection (c), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

(i) $101,000,000 for fiscal year 2022;

(ii) $155,000,000 for fiscal year 2023;

(iii) $250,000,000 for fiscal year 2024;

(iv) $300,000,000 for fiscal year 2025; and

(v) $305,000,000 for fiscal year 2026.

(c) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

(1) $780,000,000 for fiscal year 2022;

(2) $879,390,000 for fiscal year 2023;

(3) $1,025,097,300 for fiscal year 2024;

(4) $1,129,354,111 for fiscal year 2025; and

(5) $1,192,408,899 for fiscal year 2026.

[(b)] *(d)* RENAMING OF THE RARE ISOTOPE ACCELERATOR.—Section 981 of the Energy Policy Act of 2005 (42 U.S.C. 16321) is amended—

(1) in the section heading, by striking "rare isotope accelerator" and inserting "facility for rare isotope beams"; and

(2) by striking "Rare Isotope Accelerator" each place it appears and inserting "Facility for Rare Isotope Beams".

SEC. 309. SCIENCE LABORATORIES INFRASTRUCTURE PROGRAM.

(a) IN GENERAL.—The Director shall carry out a program to improve the safety, efficiency, and mission readiness of infrastructure at laboratories of the Office of Science.

(b) INCLUSIONS.—The program under subsection (a) shall include projects—

(1) to renovate or replace space that does not meet research needs;

(2) to replace facilities that are no longer cost effective to renovate or operate;

(3) to modernize utility systems to prevent failures and ensure efficiency;

(4) to remove excess facilities to allow safe and efficient operations; and

(5) to construct modern facilities to conduct advanced research in controlled environmental conditions.

(c) APPROACH.—In carrying out this section, the Director shall utilize all available approaches and mechanisms, including capital line items, minor construction projects, energy savings performance contracts, utility energy service contracts, alternative financing and expense funding, as appropriate.

(d) ALTERNATIVE FINANCING OF RESEARCH FACILITIES AND INFRASTRUCTURE.—

(1) IN GENERAL.—Consistent with section 161(g) of the Atomic Energy Act of 1954 (42 U.S.C. 2201(g)), the Management and Operating contractors of the Department may enter into the lease-purchase of research facilities and infrastructure under the scope of their contract with the Department with the approval of the Secretary or their designee.

(2) LIMITATIONS.—To carry out lease-purchases approved by the Secretary under subsection (a), the Department shall only be required to have budget authority in an amount sufficient to cover the minimum required lease payments through the period required to exercise a termination provision in the lease agreement, plus any associated lease termination penalties, regardless of whether such leased facility and infrastructure is on or off Government land, and if—

(A) the Department has established a mission need for the facility or infrastructure to be leased;

(B) the facility or infrastructure is general purpose, including offices, laboratories, cafeterias, utilities, and data centers;

(C) the Department is not a party to and has no financial obligations under the lease-purchase transaction entered into by the Management and Operating contractor, other than allowability of the lease cost and conveyance of Government land, if needed;

(D) the lease-purchase has an advance notice termination provision with reasonable pre-defined penalties that the Management and Operating contractor may exercise, at the direction of the Department, if funding for the lease is no longer available or the mission need ceases to exist;

(E) there is an option for a no cost transfer of ownership to the Government once the underlying financing is retired, but neither the Management and Operating contractor nor the Department are obligated to purchase the facility or infrastructure at any time during or after the lease term;

(F) the lease-purchase transaction, assuming exercise of the ownership option, is demonstrated to be the lowest lifecycle cost alternative for the Government; and

(G) the cumulative annual base rent for all lease-purchases of facilities and infrastructure, inclusive of any transactions under consideration, does not exceed 2 percent of the Management and Operating contract operating budget for the year the commitment is made for the lease.

(3) REPORTING.—Not later than one year after the date of the enactment of the Department of Energy Science for the Future Act, and biennially thereafter, the Department shall submit to the Committee on Science, Space, and Technology and the Com-

mittee on Appropriations of the House of Representatives, and the Committee on Energy and Natural Resources and the Committee on Appropriations of the Senate, a report on the lease-purchase transactions that the Management and Operating contractors of the Department entered into under subsection (a) that includes—

(A) a list of the lease-purchase transactions entered into by each Management and Operating contractor and their respective costs;

(B) the annual percentage of each Management and Operating contract operating budget that is used for lease-purchase transactions for the year the commitments were made; and

(C) any other information the Secretary finds appropriate.

(d) MID-SCALE INSTRUMENTATION PROGRAM.—The Director, in coordination with each of the programs carried out by the Office of Science, shall establish a mid-scale instrumentation program to enable the development and acquisition of novel, state-of-the-art instruments ranging in cost from $1 million to $20 million each that would significantly accelerate scientific breakthroughs at user facilities.

(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section $500,000,000 for each of fiscal years 2022 through 2026.

SEC. 310. ACCELERATOR RESEARCH AND DEVELOPMENT.

(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program to—

(1) advance accelerator science and technology relevant to the Department, other Federal agencies, and U.S. industry;

(2) foster partnerships to develop, demonstrate, and enable the commercial application of accelerator technologies;

(3) support the development of a skilled, diverse, and inclusive accelerator workforce; and

(4) provide access to accelerator design and engineering resources.

(b) ACCELERATOR RESEARCH.—In carrying out the program authorized under subsection (a), the Director shall support—

(1) research activities in cross-cutting accelerator technologies including superconducting magnets and accelerators, beam physics, data analytics-based accelerator controls, simulation software, new particle sources, advanced laser technology, and transformative research; and

(2) optimal operation of the Accelerator Test Facility.

(c) ACCELERATOR DEVELOPMENT.—In carrying out the program authorized under subsection (a), the Director shall support partnerships to foster the development, demonstration, and commercial application of accelerator technologies including, advanced superconducting wire and cable, superconducting RF cavities, and high efficiency radiofrequency power sources for accelerators.

(d) RESEARCH COLLABORATIONS.—In developing accelerator technologies under the program authorized in subsection (a), the Director shall—

(1) consider the requirements necessary to support translational research and development for medical, industrial, security, and defense applications; and

(2) leverage investments in accelerator technologies and fundamental research in particle physics by partnering with institutes of higher education, industry, and other Federal agencies to enable the commercial application of advanced accelerator technologies.

(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

(1) $24,000,000 for fiscal year 2022;
(2) $25,680,000 for fiscal year 2023;
(3) $27,477,600 for fiscal year 2024;
(4) $29,401,032 for fiscal year 2025; and
(5) $31,459,104 for fiscal year 2026.

SEC. 311. ISOTOPE DEVELOPMENT AND PRODUCTION FOR RESEARCH APPLICATIONS.

(a) IN GENERAL.—The Director—

(1) shall carry out a program in coordination with other relevant programs across the Department of Energy for the production of isotopes, including the development of techniques to produce isotopes, that the Secretary determines are needed for research, medical, industrial, or related purposes, to the maximum extent practicable, in accordance with the 2015 NSAC 'Meeting Isotope Needs and Capturing Opportunities For The Future' report; and

(2) shall ensure that isotope production activities carried out under the program under this paragraph do not compete with private industry unless the Director determines that critical national interests require the involvement of the Federal Government.

(b) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out the program under this subsection—

(1) $90,000,000 for fiscal year 2022;
(2) $96,300,000 for fiscal year 2023;
(3) $103,041,000 for fiscal year 2024;
(4) $110,253,870 for fiscal year 2025; and
(5) $117,971,641 for fiscal year 2026.

SEC. 312. INCREASED COLLABORATION WITH TEACHERS AND SCIENTISTS.

(a) IN GENERAL.—The Director shall support the development of a scientific workforce through programs that facilitate collaboration between K–12, university students, early-career researchers, faculty, and the National Laboratories, including through the use of proven techniques to expand the number of individuals from underrepresented groups pursuing and attaining skills or undergraduate and graduate degrees relevant to the Office's mission.

(b) AUTHORIZATION OF APPROPRIATIONS.—Section 3169 of the Department of Energy Science Education Enhancement Act (42 U.S.C. 7381e) is amended—

(1) by striking, "programs", and inserting "programs, including the NSF INCLUDES National Network,"; and

(2) by striking, "year 1991", and inserting "years 2022 through 2026".

SEC. 313. HIGH INTENSITY LASER RESEARCH INITIATIVE.

(a) IN GENERAL.—The Director shall establish a high intensity laser research initiative consistent with the recommendations of the National Academies report, "Opportunities in Intense Ultrafast Lasers: Reaching for the Brightest Light", and the report from the Brightest Light Initiative workshop on "The Future of Intense Ultrafast Lasers in the U.S.". This initiative should include research and development of petawatt-scale and of high average power laser technologies necessary for future facility needs in discovery science and to advance energy technologies, as well as support for a user network of academic and national laboratory high intensity laser facilities.

(b) LEVERAGE.—The Director shall also leverage new laser technologies for more compact, less complex, and low-cost accelerator systems needed for science applications.

(c) COORDINATION.—The Director shall coordinate this initiative among all relevant programs within the Office of Science, and the Under Secretary for Science shall coordinate this initiative with other relevant programs within the Department as well as within other Federal agencies.

(d) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science there are authorized to be appropriated to the Secretary to carry out the activities described in this subsection—

(1) $50,000,000 for fiscal year 2022;
(2) $100,000,000 for fiscal year 2023;
(3) $150,000,000 for fiscal year 2024;
(4) $200,000,000 for fiscal year 2025; and
(5) $250,000,000 for fiscal year 2026.

SEC. 314. HELIUM CONSERVATION PROGRAM.

(a) IN GENERAL.—The Secretary shall establish a program to reduce the consumption of helium for Department grant recipients and facilities and encourage helium recycling and reuse. The program shall competitively award grants for—

(1) the purchase of equipment to capture, reuse, and recycle helium;

(2) the installation, maintenance, and repair of new and existing helium capture, reuse, and recycling equipment; and

(3) helium alternatives research and development activities.

(b) REPORT.—In carrying out the program under this section, the Director shall submit to the Committee on Science, Space, and Technology of House of Representatives and the Committee on Energy and Natural Resources of the Senate a report, not later than two years after the date of enactment of the Department of Energy Science for the Future Act, and every 3 years thereafter, on the purchase of helium as part of research projects and facilities supported by the Department. The report shall include—

(1) the quantity of helium purchased for projects and facilities supported by Department grants;

(2) a cost-analysis for such helium;

(3) the predominant production sources for such helium;

(4) expected or experienced impacts of helium supply shortages or prices on the research projects and facilities supported by the Department; and

(5) recommendations for reducing Department grant recipients' exposure to volatile helium prices.

(c) COORDINATION.—In carrying out the program under this section, the Director shall coordinate with the National Science Foundation and other relevant Federal agencies on helium conservation activities.

(d) DURATION.—The program established under this section shall receive support for a period of not more than 5 years, subject to the availability of appropriations.

(e) RENEWAL.—Upon expiration of any period of support of the program under this section, the Director may renew support for the program for a period of not more than 5 years.

SEC. 315. OFFICE OF SCIENCE EMERGING INFECTIOUS DISEASE COMPUTING RESEARCH INITIATIVE.

(a) IN GENERAL.—The Secretary, in coordination with the Director of the National Science Foundation and the Administrator of the National Aeronautics and Space Administration, shall establish within the Office of Science, a cross-cutting research initiative to leverage the Federal Government's innovative analytical resources and tools, user facilities, and advanced computational and networking capabilities in order to prevent, prepare for, and respond to emerging infectious diseases, including COVID–19. The Secretary shall carry out this initiative through a competitive, merit-reviewed process, and consider applications from National Laboratories, institutions of higher education, multi-institutional collaborations, industry partners and other appropriate entities.

(b) ACTIVITIES.—In carrying out the initiative established under subsection (a), the Secretary shall coordinate with programs across the Office of Science and with relevant Federal agencies to determine a comprehensive set of technical milestones for these research activities and prioritize the following objectives—

(1) supporting fundamental research and development in advanced analytics, experimental studies, materials synthesis, high-performance computing technologies needed to characterize, model, simulate, and predict complex phenomena and biological materials related to emerging infectious diseases, including COVID–19 challenges, including a focus on testing and diagnostics, experimental data acquisition, sharing and management, advanced manufacturing, and molecular design and modeling;

(2) using expertise from the private sector, institutions of higher education, and the National Laboratories to develop computational software and capabilities that prospective users may accelerate emerging infectious diseases research and development;

(3) leveraging the research infrastructure of the Department, including scientific computing user facilities, x-ray light sources, neutron scattering facilities, nanoscale science research centers, and sequencing and bio-characterization facilities by coordinating with the Advanced Scientific Computing Research, Basic Energy Sciences, and Biological and Environmental Research programs within the Office of Science;

(4) leveraging experience from existing modeling and simulation research and work sponsored by the Department and promoting collaboration and data sharing between National Lab-

oratories, research entities, and user facilities of the Department by providing the necessary access and secure data transfer capabilities; and

(5) ensuring that new experimental and computational tools are accessible to relevant research communities, including private sector entities to address emerging infectious diseases, including COVID–19 challenges.

(c) COORDINATION.—In carrying out this initiative, the Secretary shall ensure, to the maximum extent practicable, coordination of these activities with the Department of Energy National Laboratories, institutions of higher education, and the private sector.

(d) EMERGING INFECTIOUS DISEASES HIGH PERFORMANCE COMPUTING RESEARCH CONSORTIUM.—

(1) IN GENERAL.—The Secretary in coordination with the Director of the National Science Foundation and the Director of the Office of Science and Technology Policy shall establish and operate an Emerging Infectious Diseases High Performance Computing Research Consortium (referred to in this section as the 'Consortium'), in order to support the initiative under subsection (a) by providing, to the extent practicable, a centralized entity for multidisciplinary, collaborative, emerging infectious disease research and development through high performance computing and advanced data analytics technologies and processes.

(2) MEMBERSHIP.—The members of such consortium may include representatives from relevant Federal agencies, the private sector, institutions of higher education, which can each contribute relevant compute time, capabilities, or other resources.

(3) ACTIVITIES.—The Consortium shall—

(A) match applicants with available Federal and private sector computing resources;

(B) consider supplemental awards for computing partnerships with Consortium members to qualifying entities on a competitive merit-review basis;

(C) encourage collaboration and communication among member representatives of the consortium and awardees;

(D) make available the high-performance computing capabilities, expertise, and user facilities of the Department and the National Laboratories; and

(E) submit an annual report to the Secretary summarizing the activities of the Consortium, including—

(i) describing each project undertaken by the Consortium;

(ii) detailing organizational expenditures; and

(iii) evaluating contribution to the achievement of technical milestones as determined in subsection (a).

(4) COORDINATION.—The Secretary shall ensure the coordination of, and avoid unnecessary duplication of, the activities of the Consortium with the activities of other research entities of the Department, institutions of higher education and the private sector.

(e) REPORT.—Not later than 2 years after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House, and the Committee on Energy and Natural Re-

sources of the Senate, and the Committee on Commerce, Science, and Transportation of the Senate a report detailing the effectiveness of—

(1) the interagency coordination between each Federal agency involved in the research initiative carried out under this section;

(2) the collaborative research achievements of the initiative, including the achievement of the technical milestones determined under subsection (a); and

(3) potential opportunities to expand the technical capabilities of the Department.

(f) FUNDING.—From within funds authorized to be appropriated for the Department's Office of Science, there shall be made available to the Secretary to carry out the activities under this subsection, $50,000,000 for fiscal years 2022 and 2023.

(g) PROHIBITION ON USE OF FUNDS.—

(1) IN GENERAL.—No funds allocated to the initiative described in subsection (a) may be obligated or expended for gain-of-function research of concern.

(2) GAIN-OF-FUNCTION RESEARCH DEFINED.—For the purposes of this subsection, "gain-of-function research of concern" means research activities with the potential to generate pathogens with high transmissibility and high virulence in humans.

SEC. 316. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated to the Secretary to carry out the activities described in this title—

(1) $8,801,915,000 for fiscal year 2022;
(2) $9,451,015,300 for fiscal year 2023;
(3) $10,160,677,621 for fiscal year 2024;
(4) $10,693,625,004 for fiscal year 2025; and
(5) $11,145,798,345 for fiscal year 2026.

ENERGY POLICY ACT OF 2005

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TITLE IX—RESEARCH AND DEVELOPMENT

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Subtitle G—Science

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SEC. 972. FUSION ENERGY SCIENCES PROGRAM.

(a) DECLARATION OF POLICY.—It shall be the policy of the United States to conduct research, development, demonstration, and commercial applications to provide for the scientific, engineering, and commercial infrastructure necessary to ensure that the United States is competitive with other countries in providing fusion energy for its own needs and the needs of other countries, including

by demonstrating electric power or hydrogen production for the United States energy grid using fusion energy at the earliest date.

(b) PLANNING.—

(1) IN GENERAL.—Not later than 180 days after the date of enactment of this Act, the Secretary shall submit to Congress a plan (with proposed cost estimates, budgets, and lists of potential international partners) for the implementation of the policy described in subsection (a) in a manner that ensures that—

(A) existing fusion research facilities are more fully used;

(B) fusion science, technology, theory, advanced computation, modeling, and simulation are strengthened;

(C) new magnetic and inertial fusion research and development facilities are selected based on scientific innovation and cost effectiveness, and the potential of the facilities to advance the goal of practical fusion energy at the earliest date practicable;

(D) facilities that are selected are funded at a cost-effective rate;

(E) communication of scientific results and methods between the fusion energy science community and the broader scientific and technology communities is improved;

(F) inertial confinement fusion facilities are used to the extent practicable for the purpose of inertial fusion energy research and development;

(G) attractive alternative inertial and magnetic fusion energy approaches are more fully explored; and

(H) to the extent practicable, the recommendations of the Fusion Energy Sciences Advisory Committee in the report on workforce planning, dated March 2004, are carried out, including periodic reassessment of program needs.

(2) COSTS AND SCHEDULES.—The plan shall also address the status of and, to the extent practicable, costs and schedules for—

(A) the design and implementation of international or national facilities for the testing of fusion materials; and

(B) the design and implementation of international or national facilities for the testing and development of key fusion technologies.

(c) UNITED STATES PARTICIPATION IN ITER.—

(1) IN GENERAL.—There is authorized United States participation in the construction and operations of the ITER project, as agreed to under the April 25, 2007 "Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project". The Director shall coordinate and carry out the responsibilities of the United States with respect to this Agreement.

(2) REPORT.—Not later than 1 year after the date of enactment of this section, the Secretary shall submit to Congress a report providing an assessment of the most recent schedule for ITER that has been approved by the ITER Council.

(3) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated under section 307(o) of the Department of Energy Research and Innovation Act (42 U.S.C.

18645), there shall be made available to the Secretary to carry out the construction of ITER—

(A) $374,000,000 for fiscal year 2021; [and]

[(B) $281,000,000 for each of fiscal years 2022 through 2025.]

(B) $300,000,000 for fiscal year 2022;

(C) $325,000,000 for fiscal year 2023;

(D) $350,000,000 for fiscal year 2024;

(E) $350,000,000 for fiscal year 2025; and

(F) $350,000,000 for fiscal year 2026.

SEC. 973. SOLAR FUELS RESEARCH INITIATIVE.

(a) INITIATIVE.—

(1) IN GENERAL.—The Secretary shall carry out a research initiative, to be known as the "Solar Fuels Research Initiative" (referred to in this section as the "Initiative") to expand theoretical and fundamental knowledge of photochemistry, electrochemistry, biochemistry, and materials science useful for the practical development of experimental systems to convert solar energy to chemical energy.

(2) LEVERAGING.—In carrying out programs and activities under the Initiative, the Secretary shall leverage expertise and resources from—

(A) the Basic Energy Sciences Program and the Biological and Environmental Research Program of the Office of Science; and

(B) the Office of Energy Efficiency and Renewable Energy.

(3) TEAMS.—

(A) IN GENERAL.—In carrying out the Initiative, the Secretary shall organize activities among multidisciplinary teams to leverage, to the maximum extent practicable, expertise from the National Laboratories, institutions of higher education, and the private sector.

(B) GOALS.—The multidisciplinary teams described in subparagraph (A) shall pursue aggressive, milestone-driven, basic research goals.

(C) RESOURCES.—The Secretary shall provide sufficient resources to the multidisciplinary teams described in subparagraph (A) to achieve the goals described in subparagraph (B) over a period of time to be determined by the Secretary.

(4) ADDITIONAL ACTIVITIES.—The Secretary may organize additional activities under this subsection through Energy Frontier Research Centers, Energy Innovation Hubs, or other organizational structures.

(b) ARTIFICIAL PHOTOSYNTHESIS.—

(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research needed to bridge scientific barriers to, and discover knowledge relevant to, artificial photosynthetic systems.

(2) ACTIVITIES.—As part of the program described in paragraph (1)—

(A) the Director of the Office of Basic Energy Sciences shall support basic research to pursue distinct lines of scientific inquiry, including—

(i) photoinduced production of hydrogen and oxygen from water; and

(ii) the sustainable photoinduced reduction of carbon dioxide to fuel products including hydrocarbons, alcohols, carbon monoxide, and natural gas; and

(B) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

[(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.]

(4) FUNDING.—From within funds authorized to be appropriated for Basic Energy Sciences, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2031.

(c) BIOCHEMISTRY, REPLICATION OF NATURAL PHOTOSYNTHESIS, AND RELATED PROCESSES.—

(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research needed to replicate natural photosynthetic processes by use of artificial photosynthetic components and materials.

(2) ACTIVITIES.—As part of the program described in paragraph (1)—

(A) the Director of the Office of Basic Energy Sciences shall support basic research to expand fundamental knowledge to replicate natural synthesis processes, including—

(i) the photoinduced reduction of dinitrogen to ammonia;

(ii) the absorption of carbon dioxide from ambient air;

(iii) molecular-based charge separation and storage;

(iv) photoinitiated electron transfer; and

(v) catalysis in biological or biomimetic systems;

(B) the Associate Director of Biological and Environmental Research shall support systems biology and genomics approaches to understand genetic and physiological pathways connected to photosynthetic mechanisms; and

(C) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

[(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.]

(4) FUNDING.—From within funds authorized to be appropriated in section 316 of the Department of Energy Research and Innovation Act, the Secretary shall make available for car-

rying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.

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SEC. 975. ELECTRICITY STORAGE RESEARCH INITIATIVE.

(a) INITIATIVE.—

(1) IN GENERAL.—The Secretary shall carry out a research initiative, to be known as the "Electricity Storage Research Initiative" (referred to in this section as the "Initiative")—

(A) to expand theoretical and fundamental knowledge to control, store, and convert—

(i) electrical energy to chemical energy; and

(ii) chemical energy to electrical energy; and

(B) to support scientific inquiry into the practical understanding of chemical and physical processes that occur within systems involving crystalline and amorphous solids, polymers, and organic and aqueous liquids.

(2) LEVERAGING.—In carrying out programs and activities under the Initiative, the Secretary shall leverage expertise and resources from—

(A) the Basic Energy Sciences Program, the Advanced Scientific Computing Research Program, and the Biological and Environmental Research Program of the Office of Science; and

(B) the Office of Energy Efficiency and Renewable Energy.

(3) TEAMS.—

(A) IN GENERAL.—In carrying out the Initiative, the Secretary shall organize activities among multidisciplinary teams to leverage, to the maximum extent practicable, expertise from the National Laboratories, institutions of higher education, and the private sector.

(B) GOALS.—The multidisciplinary teams described in subparagraph (A) shall pursue aggressive, milestone-driven, basic research goals.

(C) RESOURCES.—The Secretary shall provide sufficient resources to the multidisciplinary teams described in subparagraph (A) to achieve the goals described in subparagraph (B) over a period of time to be determined by the Secretary.

(4) ADDITIONAL ACTIVITIES.—The Secretary may organize additional activities under this subsection through Energy Frontier Research Centers, Energy Innovation Hubs, or other organizational structures.

(b) MULTIVALENT SYSTEMS.—

(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research needed to bridge scientific barriers to, and discover knowledge relevant to, multivalent ion materials in electric energy storage systems.

(2) ACTIVITIES.—As part of the program described in paragraph (1)—

(A) the Director of the Office of Basic Energy Sciences shall investigate electrochemical properties and the dynamics of materials, including charge transfer phenomena and mass transport in materials; and

(B) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

[(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.]

(4) FUNDING.—From within funds authorized to be appropriated for Basic Energy Sciences, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.

(c) ELECTROCHEMISTRY MODELING AND SIMULATION.—

(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research to model and simulate organic electrolytes, including the static and dynamic electrochemical behavior and phenomena of organic electrolytes at the molecular and atomic level in monovalent and multivalent systems.

(2) ACTIVITIES.—As part of the program described in paragraph (1)—

(A) the Director of the Office of Basic Energy Sciences, in coordination with the Associate Director of Advanced Scientific Computing Research, shall support the development of high performance computational tools through a joint development process to maximize the effectiveness of current and projected high performance computing systems; and

(B) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

[(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.]

(4) FUNDING.—From within funds authorized to be appropriated in section 316 of the Department of Energy Research and Innovation Act, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.

(d) MESOSCALE ELECTROCHEMISTRY.—

(1) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research needed to reveal electrochemistry in confined mesoscale spaces, including scientific discoveries relevant to—

(A) bio-electrochemistry and electrochemical energy conversion and storage in confined spaces; and

(B) the dynamics of the phenomena described in subparagraph (A).

(2) ACTIVITIES.—As part of the program described in paragraph (1)—

(A) the Director of the Office of Basic Energy Sciences and the Associate Director of Biological and Environmental Research shall investigate phenomena of mesoscale electrochemical confinement for the purpose of replicating and controlling new electrochemical behavior; and

(B) the Assistant Secretary for Energy Efficiency and Renewable Energy shall support translational research, development, and validation of physical concepts developed under the program.

(3) STANDARD OF REVIEW.—The Secretary shall review activities carried out under the program described in paragraph (1) to determine the achievement of technical milestones.

[(4) PROHIBITION.—No funds allocated to the program described in paragraph (1) may be obligated or expended for commercial application of energy technology.**]**

(4) FUNDING.—From within funds authorized to be appropriated in section 316 of the Department of Energy Research and Innovation Act, the Secretary shall make available for carrying out activities under this subsection $20,000,000 for each of fiscal years 2022 through 2026.

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SEC. 977. SYSTEMS BIOLOGY PROGRAM.

(a) PROGRAM.—

(1) ESTABLISHMENT.—The Secretary shall establish a research, development, and demonstration program in microbial and plant systems biology, protein science, computational biology, and environmental science to support the energy, national security, and environmental missions of the Department.

(2) GRANTS.—The program shall support individual researchers and multidisciplinary teams of researchers through competitive, merit-reviewed grants.

(3) CONSULTATION.—In carrying out the program, the Secretary shall consult with other Federal agencies that conduct genetic and protein research.

(b) GOALS.—The program shall have the goal of developing technologies and methods based on the biological functions of genomes, microbes, and plants that—

(1) can facilitate the production of fuels, including hydrogen in sustainable production systems that reduce greenhouse gas emissions;

(2) convert carbon dioxide to organic carbon;

(3) detoxify soils and water, including at facilities of the Department, contaminated with heavy metals and radiological materials;

(4) develop cellulosic and other feedstocks that are less resource and land intensive and that promote sustainable use of resources, including soil, water, energy, forests, and land, and ensure protection of air, water, and soil quality; and

(5) address other Department missions as identified by the Secretary.

(c) PLAN.—

(1) DEVELOPMENT OF PLAN.—Not later than 1 year after the date of enactment of this Act, the Secretary shall prepare and transmit to Congress a research plan describing how the program authorized pursuant to this section will be undertaken to accomplish the program goals established in subsection (b).

(2) REVIEW OF PLAN.—The Secretary shall contract with the National Academy of Sciences to review the research plan developed under this subsection. The Secretary shall transmit the review to Congress not later than 18 months after transmittal of the research plan under paragraph (1), along with the Secretary's response to the recommendations contained in the review.

(d) USER FACILITIES AND ANCILLARY EQUIPMENT.—Within the funds authorized to be appropriated pursuant to this subtitle, amounts shall be available for projects to develop, plan, construct, acquire, or operate special equipment, instrumentation, or facilities, including user facilities at National Laboratories, for researchers conducting research, development, demonstration, and commercial application in systems biology and proteomics and associated biological disciplines.

(e) PROHIBITION ON BIOMEDICAL AND HUMAN CELL AND HUMAN SUBJECT RESEARCH.—

(1) NO BIOMEDICAL RESEARCH.—In carrying out the program under this section, the Secretary shall not conduct biomedical research.

(2) LIMITATIONS.—Nothing in this section shall authorize the Secretary to conduct any research or demonstrations—

(A) on human cells or human subjects; or

(B) designed to have direct application with respect to human cells or human subjects.

[(f) BIOENERGY RESEARCH CENTERS.—

[(1) ESTABLISHMENT OF CENTERS.—In carrying out the program under subsection (a), the Secretary shall establish at least 7 bioenergy research centers, which may be of varying size.

[(2) GEOGRAPHIC DISTRIBUTION.—The Secretary shall establish at least 1 bioenergy research center in each Petroleum Administration for Defense District or Subdistrict of a Petroleum Administration for Defense District.

[(3) GOALS.—The goals of the centers established under this subsection shall be to accelerate basic transformational research and development of biofuels, including biological processes.

[(4) SELECTION AND DURATION.—

[(A) IN GENERAL.—A center under this subsection shall be selected on a competitive basis for a period of 5 years.

[(B) REAPPLICATION.—After the end of the period described in subparagraph (A), a grantee may reapply for selection on a competitive basis.

[(5) INCLUSION.—A center that is in existence on the date of enactment of this subsection—

[(A) shall be counted towards the requirement for establishment of at least 7 bioenergy research centers; and

[(B) may continue to receive support for a period of 5 years beginning on the date of establishment of the center.]

(f) BIOENERGY RESEARCH CENTERS.—

(1) IN GENERAL.—In carrying out the program under section 306(a) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(a)), the Director shall support up to six bioenergy research centers to conduct fundamental research in plant and microbial systems biology, biological imaging and analysis, and genomics, and to accelerate advanced research and development of biomass-based liquid transportation fuels, bioenergy, or biobased materials, chemicals, and products that are produced from a variety of regionally diverse feedstocks, and to facilitate the translation of research results to industry. The activities of the centers authorized under this subsection may include—

(A) accelerating the domestication of bioenergy-relevant plants, microbes, and associated microbial communities to enable high-impact, value-added coproduct development at multiple points in the bioenergy supply chain;

(B) developing the science and technological advances to ensure process sustainability is considered in the creation of biofuels and bioproducts from lignocellulose; and

(C) using the latest tools in genomics, molecular biology, catalysis science, chemical engineering, systems biology, and computational and robotics technologies to sustainably produce and transform biomass into biofuels and bioproducts.

(2) SELECTION AND DURATION.—

(A) IN GENERAL.—A center established under paragraph (1) shall be selected on a competitive, merit-reviewed basis for a period of not more than 5 years, subject to the availability of appropriations, beginning on the date of establishment of that center.

(B) APPLICATIONS.—The Director shall consider applications from National Laboratories, multi-institutional collaborations, and other appropriate entities.

(C) EXISTING CENTERS.—A center already in existence on the date of enactment of the Department of Energy Science for the Future Act may continue to receive support for a period of not more than 5 years beginning on the date of establishment of that center.

(3) RENEWAL.—After the end of either period described in paragraph (2), the Director may renew support for the center for a period of not more than 5 years on a merit-reviewed basis. For a center in operation for 10 years after its previous selection on a competitive, merit-reviewed basis, the Director may renew support for the center on a competitive, merit-reviewed basis for a period of not more than 5 years, and may subsequently provide an additional renewal on a merit-reviewed basis for a period of not more than 5 years.

(4) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming center for cause during the performance period.

(5) ACTIVITIES.—Centers shall undertake research activities to accelerate the production of biofuels and bioproducts from advanced biomass resources by identifying the most suitable species of plants for use as energy crops; and improving methods of breeding, propagation, planting, producing, harvesting, storage and processing. Activities may include the following:

(A) Research activities to increase sustainability, including—

(i) advancing knowledge of how bioenergy crop interactions with biotic and abiotic environmental factors influence crop growth, yield, and quality;

(ii) identifying the most impactful research areas that address the economics of biofuels and bioproducts production; and

(iii) utilizing multiscale modeling to advance predictive understanding of biofuel cropping ecosystems.

(B) Research activities to further feedstock development, including lignocellulosic, algal, gaseous wastes including carbon oxides and methane, and direct air capture of single carbon gases via plants and microbes, including—

(i) developing genetic and genomic tools, high-throughput analytical tools, and biosystems design approaches to enhance bioenergy feedstocks and their associated microbiomes;

(ii) conducting field testing of new potential bioenergy feedstock crops under environmentally benign and geographically diverse conditions to assess viability and robustness; and

(iii) developing quantitative models informed by experimentation to predict how bioenergy feedstocks perform under diverse conditions.

(C) Research activities to improve lignocellulosic deconstruction and separation methods, including—

(i) developing feedstock-agnostic deconstruction processes capable of efficiently fractionating biomass into targeted output streams;

(ii) gaining a detailed understanding of plant cell wall biosynthesis, composition, structure, and properties during deconstruction; and

(iii) improving enzymes and approaches for biomass breakdown and cellulose, hemicellulose, and lignin processing.

(D) Research activities to improve the feedstock conversion process for advanced biofuels and bioproducts, including—

(i) developing high-throughput methods to screen or select high-performance microbial strains and communities to improve product formation rates, yields, and selectivity;

(ii) establishing a broad set of platform microorganisms and microbial communities suitable for metabolic engineering to produce biofuels and bioproducts, as well as high-throughput methods for experimental validation of gene function;

(iii) developing techniques to enhance microbial robustness for tolerating toxins to improve biofuel and bioproduct yields and to gain a better understanding of the cellular and molecular bases of tolerance for major chemical classes of inhibitors found in these processes;

(iv) advancing technologies for the use of batch, continuous, as well as consolidated bioprocessing;

(v) identifying, creating, and optimizing microbial and chemical pathways to produce promising, atom-economical intermediates and final bioproducts from biomass with considerations given to environmentally benign processes;

(vi) developing high-throughput, real-time, in situ analytical techniques to understand and characterize the pre- and post-bioproduct separation streams in detail;

(vii) creating methodologies for efficiently identifying viable target molecules, identifying high-value bioproducts in existing biomass streams, and utilizing current byproduct streams;

(viii) identifying and improving plant feedstocks with enhanced extractable levels of desired bioproducts or bioproduct precursors, including lignin streams; and

(ix) developing integrated biological and chemical catalytic approaches to valorize and produce a diverse portfolio of advanced fuels and bioproducts.

(6) INDUSTRY PARTNERSHIPS.—Centers shall establish industry partnerships to translate research results to commercial applications.

(7) COORDINATION.—In coordination with the Bioenergy Technologies Office of the Department, the Director shall support interdisciplinary research activities to improve the capacity, efficiency, resilience, security, reliability, and affordability, of the production and use of biofuels and bioproducts, as well as activities to enable positive impacts and avoid the potential negative impacts that the production and use of biofuels and bioproducts may have on ecosystems, people, and historically marginalized communities.

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NATIONAL QUANTUM INITIATIVE ACT

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "National Quantum Initiative Act".

(b) TABLE OF CONTENTS.—The table of contents of this Act is as follows:

SEC. 2. DEFINITIONS.

In this Act:

(1) ADVISORY COMMITTEE.—The term "Advisory Committee" means the National Quantum Initiative Advisory Committee established under section 104(a).

(2) APPROPRIATE COMMITTEES OF CONGRESS.—The term "appropriate committees of Congress" means—

(A) the Committee on Commerce, Science, and Transportation of the Senate;

(B) the Committee on Energy and Natural Resources of the Senate; and

(C) the Committee on Science, Space, and Technology of the House of Representatives.

(3) COORDINATION OFFICE.—The term "Coordination Office" means the National Quantum Coordination Office established under section 102(a).

(4) INSTITUTION OF HIGHER EDUCATION.—The term "institution of higher education" has the meaning given the term in section 101(a) of the Higher Education Act of 1965 (20 U.S.C. 1001(a)).

(5) PROGRAM.—The term "Program" means the National Quantum Initiative Program implemented under section 101(a).

(6) QUANTUM INFORMATION SCIENCE.—The term "quantum information science" means the use of the laws of quantum physics for the storage, transmission, manipulation, computing, or measurement of information.

(7) QUANTUM NETWORK INFRASTRUCTURE.—The term "quantum network infrastructure" means any facility, expertise, or capability that is necessary to enable the development and deployment of scalable and diverse quantum network technologies.

[(7)**]** *(8)* SUBCOMMITTEE.—The term "Subcommittee" means the Subcommittee on Quantum Information Science of the National Science and Technology Council established under section 103(a).

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TITLE IV—DEPARTMENT OF ENERGY QUANTUM ACTIVITIES

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SEC. 403. DEPARTMENT OF ENERGY QUANTUM NETWORK INFRASTRUCTURE RESEARCH AND DEVELOPMENT PROGRAM.

(a) IN GENERAL.—The Secretary of Energy (referred to in this section as the "Secretary") shall carry out a research, development, and demonstration program to accelerate innovation in quantum network infrastructure in order to—

(1) facilitate the advancement of distributed quantum computing systems through the internet and intranet;

(2) improve the precision of measurements of scientific phenomena and physical imaging technologies;

(3) develop secure national quantum communications technologies and strategies; and

(4) demonstrate these capabilities utilizing the Department's Energy Sciences Network User Facility.

(b) PROGRAM.—In carrying out this section, the Secretary shall—

(1) coordinate with—

(A) the Director of the National Science Foundation;

(B) the Director of the National Institute of Standards and Technology;

(C) the Chair of the subcommittee on Quantum Information Science of the National Science and Technology Council established under section 103(a); and

(D) the Chair of the subcommittee on the Economic and Security Implications of Quantum Science;

(2) conduct cooperative research with industry, National Laboratories, institutions of higher education, and other research institutions to facilitate new quantum infrastructure methods and technologies, including—

(A) quantum-limited detectors, ultra-low loss optical channels, space-to-ground connections, and classical networking and cybersecurity protocols;

(B) entanglement and hyper-entangled state sources and transmission, control, and measurement of quantum states;

(C) quantum interconnects that allow short range local connections between quantum processors;

(D) transducers for quantum sources and signals between optical and telecommunications regimes and quantum computer-relevant domains, including microwaves;

(E) development of quantum memory buffers and small-scale quantum computers that are compatible with photon-based quantum bits in the optical or telecommunications wavelengths;

(F) long-range entanglement distribution at both the terrestrial and space-based level using quantum repeaters, allowing entanglement-based protocols between small- and large scale quantum processors;

(G) quantum routers, multiplexers, repeaters, and related technologies necessary to create secure long-distance quantum communication; and

(H) integration of systems across the quantum technology stack into traditional computing networks, including the development of remote controlled, high performance, and reliable implementations of key quantum network components by leveraging the expertise, infrastructure and supplemental investments in the Energy Sciences Network User Facility;

(3) engage with the Quantum Economic Development Consortium (QED–C) to transition component technologies to help facilitate as appropriate the development of a quantum supply chain for quantum network technologies;

(4) advance basic research in advanced scientific computing, particle and nuclear physics, and material science to enhance the understanding, prediction, and manipulation of materials, processes, and physical phenomena relevant to quantum network infrastructure;

(5) develop experimental tools and testbeds in collaboration with the Department's Energy Sciences Network User Facility necessary to support cross-cutting fundamental research and development activities with diverse stakeholders from industry, National Laboratories, and institutions of higher education; and

(6) consider quantum network infrastructure applications that span the Department of Energy's missions in energy, environment, and national security.

(c) LEVERAGING.—In carrying out this section, the Secretary shall leverage resources, infrastructure, and expertise across the Department of Energy and from—

(1) the National Institute of Standards and Technology;

(2) the National Science Foundation;

(3) the National Aeronautics and Space Administration;

(4) other relevant Federal agencies;

(5) the National Laboratories;

(6) industry stakeholders;

(7) institutions of higher education; and

(8) the National Quantum Information Science Research Centers.

(d) RESEARCH PLAN.—Not later than 180 days after the date of the enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate, a 4-year research plan that identifies and prioritizes basic research needs relating to quantum network infrastructure.

(e) STANDARD OF REVIEW.—The Secretary shall review activities carried out under this section to determine the achievement of technical milestones.

(f) FUNDING.—Out of funds authorized to be appropriated for the Department of Energy's Office of Science, there shall be made available to the Secretary to carry out the activities under this section, $100,000,000 for each of fiscal years 2022 through 2026.

SEC. 404. DEPARTMENT OF ENERGY QUANTUM USER EXPANSION FOR SCIENCE AND TECHNOLOGY PROGRAM.

(a) IN GENERAL.—The Secretary of Energy (referred to in this section as the "Secretary") shall establish and carry out a program (to be known as the "Quantum User Expansion for Science and Technology program" or "QUEST program") to encourage and facilitate access to United States quantum computing hardware and quantum computing clouds for research purposes in order to—

(1) enhance the United States quantum research enterprise;

(2) educate the future quantum computing workforce; and

(3) accelerate the advancement of United States quantum computing capabilities.

(b) PROGRAM.—In carrying out this section, the Secretary shall—

(1) coordinate with—

(A) the Director of the National Science Foundation;

(B) the Director of the National Institute of Standards and Technology;

(C) the Chair of the Quantum Information Science of the National Science and Technology Council established under section 103(a); and

(D) the Chair of the subcommittee on the Economic and Security Implications of Quantum Science;

(2) provide researchers based within the United States with access to, and use of, United States quantum computing resources through a competitive, merit-reviewed process;

(3) consider applications from the National Laboratories, multi-institutional collaborations, institutions of higher education, industry stakeholders, and any other entities that the Secretary determines are appropriate to provide national leadership on quantum computing related issues; and

(4) consult and coordinate with private sector stakeholders, the user community, and interagency partners on program development and best management practices.

(c) LEVERAGING.—In carrying out this section, the Secretary shall leverage resources and expertise across the Department of Energy and from—

(1) the National Institute of Standards and Technology;

(2) the National Science Foundation;

(3) the National Aeronautics and Space Administration;

(4) other relevant Federal agencies;

(5) the National Laboratories;

(6) industry stakeholders;

(7) institutions of higher education; and

(8) the National Quantum Information Science Research Centers.

(d) SECURITY.—In carrying out the activities authorized by this section, the Secretary, in consultation with the Director of the National Science Foundation and the Director of the National Institute of Standards and Technology, shall ensure proper security controls are in place to protect sensitive information, as appropriate.

(e) FUNDING.—Out of funds authorized to be appropriated for the Department of Energy's Office of Science, there shall be made available to the Secretary to carry out the activities under this section—

(1) $30,000,000 for fiscal year 2022;

(2) $50,000,000 for fiscal year 2023;

(3) $70,000,000 for fiscal year 2024;

(4) $90,000,000 for fiscal year 2025; and

(5) $100,000,000 for fiscal year 2026.

(f) EQUITABLE USE OF HIGH-PERFORMANCE COMPUTING CAPABILITIES.—

(1) SENSE OF CONGRESS.—It is the sense of Congress that machine learning algorithms can exhibit biases that cause harm to historically marginalized communities.

(2) POLICY.—In leveraging high-performance computing systems for research purposes, including through the use of machine learning algorithms for data analysis, the Secretary shall ensure that such capabilities are employed in a manner that mitigates and, to the maximum extent practicable, avoids harmful algorithmic bias and equitably addresses challenges impacting different populations, including historically marginalized communities.

NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 1991

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SEC. 2. ORGANIZATION OF ACT INTO DIVISIONS; TABLE OF CONTENTS

(a) * * *

(b) TABLE OF CONTENTS.—The table of contents for this Act is as follows:

* * * * * * *

DIVISION C—OTHER NATIONAL DEFENSE AUTHORIZATIONS

TITLE XXXI—DEPARTMENT OF ENERGY NATIONAL SECURITY PROGRAMS

* * * * * * *

PART E—DEPARTMENT OF ENERGY SCIENCE EDUCATION PROGRAMS

SEC. 3161. SHORT TITLE

This part may be cited as the "Department of Energy Science Education Enhancement Act".

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Subpart A—Science Education Enhancement

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SEC. 3167. PARTNERSHIPS WITH HISTORICALLY BLACK COLLEGES AND UNIVERSITIES, HISPANIC-SERVING INSTITUTIONS, AND TRIBAL COLLEGES.

(a) DEFINITIONS.—In this section:

(1) HISPANIC-SERVING INSTITUTION.—The term "Hispanic-serving institution" has the meaning given the term in section 502(a) of the Higher Education Act of 1965 (20 U.S.C. 1101a(a)).

(2) HISTORICALLY BLACK COLLEGE OR UNIVERSITY.—The term "historically Black college or university" has the meaning given the term "part B institution" in section 322 of the Higher Education Act of 1965 (20 U.S.C. 1061).

(3) NATIONAL LABORATORY.—The term "National Laboratory" has the meaning given the term in section 2 of the Energy Policy Act of 2005.

(4) SCIENCE FACILITY.—The term "science facility" has the meaning given the term "single-purpose research facility" in section 903 of the Energy Policy Act of 2005.

(5) TRIBAL COLLEGE.—The term "tribal college" has the meaning given the term "tribally controlled college or university" in section 2(a) of the Tribally Controlled Colleges and Universities Assistance Act of 1978 (25 U.S.C. 1801(a)).

(b) EDUCATION PARTNERSHIP.—The Secretary shall require the director of each National Laboratory, and may require the head of any science facility, to increase the participation of historically Black colleges or universities, Hispanic-serving institutions, or tribal colleges in any activity that increases the capacity of the historically Black colleges or universities, Hispanic-serving institutions, or tribal colleges to train personnel in science or engineering.

(c) ACTIVITIES.—An activity described in subsection (b) includes—

(1) collaborative research;

(2) equipment transfer;

(3) training activities carried out at a National Laboratory or science facility; and

(4) mentoring activities carried out at a National Laboratory or science facility.

(d) REPORT.—Not later than 2 years after the date of enactment of this subsection, the Secretary shall submit to Congress a report describing the activities carried out under this section.

SEC. 3167A. BROADENING PARTICIPATION FOR TEACHERS AND SCIENTISTS.

(a) IN GENERAL.—The Secretary shall expand opportunities to increase the number and the diversity, equity, and inclusion of highly skilled science, technology, engineering, and mathematics (STEM) professionals working in Department of Energy mission-relevant disciplines and broaden the recruitment pool to increase diversity, including expanded partnerships with Historically Black Colleges, Tribal Colleges, Minority Serving Institutions, emerging research institutions, and scientific societies.

(b) PLAN.—Not later than 1 year after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources and the Committee on Commerce, Science, and Transportation of the Senate and make available to the public a plan for broadening participation of underrepresented groups in science, technology, engineering, and mathematics in programs supported by the Department programs, including—

(1) a plan for supporting and leveraging the National Science Foundation INCLUDES National Network;

(2) metrics for assessing the participation of underrepresented groups in Department programs;

(3) experienced and potential barriers to broadening participation of underrepresented groups in Department programs, including recommended solutions; and

(4) any other activities the Secretary finds appropriate.

(c) AUTHORIZATION OF APPROPRIATIONS.—Of the amounts authorized to be appropriated in section 3169 (42 U.S.C. 7381e), at least $2,000,000 shall be made available each fiscal year for the activities described under this subsection.

SEC. 3167B. EXPANDING OPPORTUNITIES TO INCREASE THE DIVERSITY, EQUITY, AND INCLUSION OF HIGHLY SKILLED SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) PROFESSIONALS.

(a) IN GENERAL.—The Secretary shall expand opportunities to increase the number and the diversity, equity, and inclusion of highly skilled science, technology, engineering, and mathematics (STEM) professionals working in Department of Energy mission-relevant disciplines and broaden the recruitment pool to increase diversity, including expanded partnerships with minority-serving institutions, non-Research I universities, and scientific societies.

(b) PLAN AND OUTREACH STRATEGY.—

(1) PLAN.—Not later than 6 months after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate a 10-year educational plan to fund and expand new or existing programs administered by the Office of Science and sited at the national laboratories and Department of Energy user facilities to expand educational and workforce opportunities for underrepresented high school, undergraduate, and graduate students as well as recent graduates, teachers and faculty in STEM fields. This may include paid internships, fellowships, temporary employment, training programs, visiting student and faculty programs, sabbaticals, and research support.

(2) OUTREACH CAPACITY.—The Secretary shall include in the plan under paragraph (1) an outreach strategy to improve the advertising, recruitment, and promotion of educational and workforce programs to community colleges, Historically Black Colleges and Universities, Tribal Colleges, Minority Serving Institutions, and emerging research institutions.

(c) BUILDING RESEARCH CAPACITY.—The Secretary shall develop programs that strengthen the research capacity relevant to Office of Science disciplines at emerging research institutions, including minority-serving institutions, tribal colleges and universities, Historically Black Colleges and Universities, and colleges and universities. This may include enabling mutually beneficial and jointly managed partnerships between research-intensive institutions and emerging research institutions, and soliciting research proposals, fellowships, training programs, and research support directly from emerging research institutions.

(d) TRAINEESHIPS.—The Secretary shall establish a university-led Traineeship Program to address workforce training needs in STEM fields relevant to the Department. The focus should be on supporting training and research experiences for underrepresented undergraduate and graduate students and increasing participation from underrepresented populations. The traineeships should include opportunities to build the next-generation workforce in research areas critical to maintaining core competencies across the Office of Science's programs.

(e) EVALUATION.—The Secretary shall establish key performance indicators to measure and monitor progress of education and workforce programs and expand Departmental activities for data collection and analysis. The Secretary shall submit a report 2 years after the date of enactment of the Department of Energy Science for the

Future Act, and every 2 years thereafter, to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate summarizing progress toward meeting key performance indicators.

(f) DEFINITIONS.—In this section:

(1) MINORITY-SERVING INSTITUTION.—The term "minority-serving institution" includes the entities described in any of paragraphs (1) through (7) of section 371(a) of the Higher Education Act of 1965 (20 U.S.C. 1067q(a)).

(2) HISTORICALLY BLACK COLLEGE AND UNIVERSITIES.—The term "Historically Black Colleges and Universities" has the meaning given in "part B institution" in section 322 of the Higher Education Act of 1965 (20 U.S.C. 1061).

(3) STEM.—The term "STEM" has the meaning given the term in the STEM Education Act of 2015 (42 U.S.C. 1861 et seq.).

(4) TRIBAL COLLEGES AND UNIVERSITIES.—The term "Tribal College or University" has the meaning given in section 316 of the Higher Education Act of 1965 (20 U.S.C. 1059c).

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XX. PROCEEDINGS OF THE FULL COMMITTEE MARKUP

MARKUPS:
H.R. 2225, NATIONAL SCIENCE FOUNDATION FOR THE FUTURE ACT
H.R. 3593, DEPARTMENT OF ENERGY SCIENCE FOR THE FUTURE ACT

MARKUPS

BEFORE THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED SEVENTEENTH CONGRESS

FIRST SESSION

JUNE 15, 2021

Serial No. CP: 117–6

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MARKUPS: H.R. 2225, NATIONAL SCIENCE FOUNDATION FOR THE FUTURE ACT H.R. 3593, DEPARTMENT OF ENERGY SCIENCE FOR THE FUTURE ACT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

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MARKUP ON H.R. 2225, NATIONAL SCIENCE FOUNDATION FOR THE FUTURE ACT

MARKUP ON H.R. 3593, DEPARTMENT OF ENERGY SCIENCE FOR THE FUTURE ACT

TUESDAY, JUNE 15, 2021

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Committee met, pursuant to notice, at 10:05 a.m., via Zoom, Hon. Eddie Bernice Johnson [Chairwoman of the Committee] presiding.

Chairwoman JOHNSON. Good morning. The Committee will come to order. Without objection, the Chair is authorized to declare recess at any time. Pursuant to Committee rule 2(e) and House rule XI, the Committee announces that she may postpone rollcall votes.

Pursuant to *House Resolution 8*, today, the Committee is meeting virtually. I want to announce a couple of reminders to the Members about the conduct of this remote meeting. First, Members should keep their video feed on as long as they are present in the meeting. Members are responsible for their own microphones. And please also keep your microphones muted unless you are speaking. Finally, if Members have documents they wish to submit to the record, please email them to Committee Clerk, whose email address was circulated prior to the meeting.

Pursuant to the Committee—to the—pursuant to notice, the Committee meets to consider the following measures: H.R. 2225, the *National Science Foundation for the Future Act*; and H.R. 3593, the *Department of Energy Sciences for the Future Act*.

Good morning and welcome to today's markup of H.R. 2225, the *National Science Foundation for the Future Act*; and H.R. 3593, the *Department of Energy Science for the Future Act*.

America has always been a driving force for innovation, and that innovation has been the most important engine of our economic growth for at least 100 years. However, our international competitors have taken note of our success, and those competitors are making huge bets on science and technology (S&T) investments in the hopes that they will see the same fruits of innovation that we have seen. If we are to remain the world's leader in science and technology, we need to act now. But we shouldn't act rashly. Instead of trying to copy the efforts of our emerging competitors, we should be doubling down on the proven innovation engines we have

at the National Science Foundation (NSF) and the Department of Energy (DOE).

The bills before us today do just that. The race to be the best at science and technology is a race to have good high-paying jobs. And I want to be clear. I'm not just talking about scientists and computer programmers. I'm also talking about the electricians and pipefitters who help to build our research and computing centers. And I'm talking about the technicians and custodial staff that help maintain these facilities. I'm talking about the factory workers manufacturing the next generation of green technologies right here in America. That's what is at stake when we consider these bills today.

The first bill we will be considering today is *NSF for the Future Act*. It is the first comprehensive reauthorization of NSF in more than 10 years. The legislation puts NSF on a sustainable 5-year doubling path. It strategically builds an NSF existing—on NSF existing strengths while also pushing the agency in bold new directions. It represents a significant step forward in building more regional and institutional diversity in our academic research enterprise, and it addresses our STEM (science, technology, engineering, and mathematics) pipeline at all levels.

I am very proud of where this bill is today. It includes many good ideas from Members on both sides of the aisle. It also reflects input from the most diverse group of stakeholders this Committee has ever consulted. We have dozens of letters of support from organizations representing all fields of science and engineering. Thousands of individual scientists have publicly voiced their support. Countless thought leaders, universities, and former government leaders have told us how much they support this bill. This is reflected in the strongly worded endorsements we have received from groups like the Association of American Universities and the American Chemical Society.

We will also consider the *DOE Science for the Future Act*. The Department of Energy's Office of Science is the Nation's premier Federal agency that supports research in the physical sciences for energy applications. And the bill we are considering today will ensure that the Office of Science remains the world leader in these pursuits for years to come.

Consideration of this bill could not come at a more critical juncture as the world forges a clean energy future so that America can reap the rewards of that transition. This bipartisan bill would be the first comprehensive authorization for this crucial office that supports over half of DOE's non-defense R&D (research and development) budget. H.R. 3593 authorizes significant, steady, and sustainable growth for the Office of Science. The bill ensures that the office's construction projects and upgrades to its user facilities have the resources they need to be completed on time and on budget. That's why the bill has been endorsed by stakeholders in the business community like the U.S. Chamber of Commerce, the academic community like the University of Texas, and the scientific community like the American Physical Society.

Without objection, I will place into the record the full list of endorsing organizations for both bills.

[The information referred at end of transcript:]

Chairwoman JOHNSON. The bills before us today are the result of a collaborative bipartisan approach.

Before I yield back, I want to recognize the efforts of Ranking Member Lucas and his staff in helping us to get where we are today. I feel strongly that the legislation we are considering today represents the best of this Committee, and it would not have been possible without the strong collaboration by Ranking Member Lucas. I look forward to a productive markup and to getting these bills to the floor so we can send them to the Senate.

[The prepared statement of Chairwoman Johnson follows:]

Good morning, and welcome to today's markup of H.R. 2225, the *National Science Foundation for the Future Act* and HR 3593, the *Department of Energy Science for the Future Act*.

America has always been a driving force of innovation. And that innovation has been the most important engine of our economic growth for at least the past 100 years. However, our international competitors have taken note of our success. And those competitors are making huge bets on science and technology investments in the hopes that they will see the same fruits of innovation that we have seen. If we are to remain the world leader in science and technology, we need to act now.

But we shouldn't act rashly. Instead of trying to copy the efforts of our emerging competitors, we should be doubling down on the proven innovation engines we have at the National Science Foundation and the Department of Energy. The bills before us today do just that.

The race to be the best at science and technology is a race to have good high-paying jobs. And I want to be clear—I'm not just talking about scientists and computer programmers. I'm also talking about the electricians and pipefitters who help to build our research and computing centers. I'm talking about the technicians and custodial staff that help maintain these facilities. I'm talking about the factory workers manufacturing the next generation of green technologies right here in America. That's what is at stake when we consider these bills today.

The first bill we will be considering today is the *NSF for the Future Act*. It is the first comprehensive reauthorization of NSF in more than 10 years. This legislation puts NSF on a sustainable, 5-year doubling path. It strategically builds on NSF's existing strengths, while also pushing the agency in bold new directions. It represents a significant step forward in building more regional and institutional diversity in our academic research enterprise. And it addresses our STEM pipeline at all levels.

I am very proud of where this bill is today. It includes many good ideas from Members on both sides of the aisle. It also reflects input from the most diverse group of stakeholders this Committee has ever consulted. We have dozens of letters of support from organizations representing all fields of science and engineering. Thousands of individual scientists have publicly voiced their support. Countless thought leaders, universities, and former government leaders have told us how much they support this bill. This is reflected in the strongly worded endorsements we have received from groups like the Association of American Universities and the American Chemical Society.

We will also consider the *DOE Science for the Future Act*. The Department of Energy's Office of Science is the nation's premier federal agency that supports research in the physical sciences for energy applications. And the bill we are considering today will ensure that the Office of Science remains the world leader in these pursuits for years to come.

Consideration of this bill could not come at a more critical juncture as the world forges a clean energy future, so that America can reap the rewards of that transition. This bipartisan bill would be the first comprehensive authorization of this crucial office that supports over half of DOE's non-defense R&D budget. H.R. 3593 authorizes significant, steady, and sustainable growth for the Office of Science. The bill ensures the Office's construction projects and upgrades to its user facilities have the resources they need to be completed on-time and on-budget. That's why the bill has been endorsed by stakeholders in the business community, like the U.S. Chamber of Commerce: the academic community, like the University of Texas; and the scientific community, like the American Physical Society. Without objection, I'll place into the record the full list of endorsing organizations for both bills.

The bills before us today are the result of a collaborative bipartisan approach. Before I yield back, I want to recognize the efforts of Ranking Member Lucas and his

staff in helping us to get to where we are today. I feel strongly that the legislation we are considering today represents the best of this Committee, and it would not have been possible without the strong collaboration by Ranking Member Lucas.

I look forward to a productive markup, and to getting these bills to the floor so we can send them to the Senate.

Chairwoman JOHNSON. I now recognize our Ranking Member Mr. Lucas for his opening remarks.

Mr. LUCAS. Thank you, Chairwoman Johnson, for holding today's markup of the *NSF for the Future Act* and the *DOE Science for the Future Act*. These comprehensive reauthorization bills of the National Science Foundation and the Department of Energy Office of Science are the accumulation of years of work by this Committee to consider the best path forward for two of the most important pieces of America's Federal research enterprise.

America's scientific and technological competitiveness has been our highest priority. I should say ours and my highest priority as Ranking Member of this Committee. It's gratifying to see the amount of momentum on both sides of the aisle in the House and the Senate for legislation to secure our global scientific and technological leadership.

The need to act now to redouble our research investment is best captured by two data points. First, as much as 85 percent of America's long-term economic growth is due to advances in science and technology. There's a direct connection between investment in research and development and job growth here at home.

Second, China increased public R&D by 56 percent between 2011 and 2016, but the U.S. investment in the same period fell by 12 percent in absolute terms. China has likely surpassed the United States in total R&D spending and though—through both investment and theft is working to overtake us as the global leader in science and technology. Our international competitiveness is at stake.

America's continued scientific leadership requires comprehensive and strategic approach to research and development that provides long-term increased investment and stability across the research ecosystem. It also requires interagency collaboration and public-private partnerships. And it must focus on evolving technologies that are crucial to our national and economic security like AI (artificial intelligence), semiconductors, quantum sciences.

I believe we have achieved that with these two bills. In the *NSF for the Future Act* we put a great deal of care into crafting a new directorate that provides NSF's ability—improves it might be the best way to describe their ability to advance fundamental research without duplicating or seeking to replace the missions of other Federal research agencies. Our proposed Directorate for Science and Engineering Solutions takes the basic research funded by NSF and helps supply those discoveries to solve national challenges from cybersecurity to climate change.

We also propose a funding profile for the new directorate that is practical, sustainable, and in balance with the rest of the Foundation. Although most of the public attention has been on the new directorate, our bill also provides updated policy direction to the rest of the Foundation. It has been 4 years since NSF received a comprehensive policy update and 11 years since the last reauthorization, so these provisions are important.

I will share a few highlights of the bill. NSF is the largest Federal funder of STEM education, and our bill directs new mechanisms to improve the Foundation's investment in STEM at all levels. The bill also includes provisions to improve the availability of research data to more rapidly advance innovation and to improve transparency and reproducibility of taxpayer-funded research. Additionally, the bill includes important measures to protect American research from foreign influence and theft. These policies were developed after months of input from stakeholders and bipartisan discussions. It's smart legislation, and I'll discuss some other provisions in the bill when we consider the bipartisan amendment in the nature of a substitute (ANS).

Next, we'll consider the *DOE Science for the Future Act*. This bill reauthorizes the Office of Science to increase our investment and provide a roadmap for DOE's research and development work. If it becomes law, it will be the first comprehensive authorization of the Office of Science, and it could not come at a better time. The bill provides nearly $50 billion over 5 years, giving the Office of Science and our national labs the resources they need to continue to excel. We need cutting-edge facilities for our Federal scientists and researchers from academia and industry to conduct big science, research that can't be done in individual labs and requires massive equipment that industry cannot provide like advanced light sources and neutron sources.

Our Nation's national laboratories, hosted by DOE's Office of Science, are experts in conducting this type of complex, large-scale research. Our bill authorizes funding timelines for DOE research facilities and equipment that will bring them online as quickly as possible and at the lowest possible project cost. I'll discuss more provisions of this bill when we consider the bipartisan amendment in the nature of a substitute.

Chairwoman Johnson and I have taken a deliberative and bipartisan approach to revitalizing American research. Together, the *NSF for the Future Act* and the *DOE Science for the Future Act* are a sustainable strategy for American progress. It comprehensively scales up our research enterprise. Today, we'll consider many amendments that I think will improve these bills. I hope that through the process we can maintain the bipartisan spirit that created these two groundbreaking pieces of legislation.

Thank you, Chairwoman, for your partnership in this process. Your leadership should serve as a model for all of how the Committee legislative process should work, and I say that with the greatest of sincerity.

And I yield back the balance of my time. Thank you, Madam Chair.

[The prepared statement of Mr. Lucas follows:]

Thank you, Chairwoman Johnson, for holding today's markup of the *NSF for the Future Act* and the *DOE Science for the Future Act*. These comprehensive reauthorization bills of the National Science Foundation and the Department of Energy Office of Science are the culmination of years of work by this Committee to consider the best path forward for two of the most important pieces of America's federal research enterprise.

America's scientific and technological competitiveness has been my highest priority as Ranking Member of this Committee. It's gratifying to see that there is now momentum on both sides of the aisle in the House and Senate for legislation to secure our global science and technology leadership.

The need to act now to redouble our research investment is best captured by two data points. First, as much as 85% of America's long-term economic growth is due to advances in science and technology. There's a direct connection between investment in research and development and job growth here at home. Second, China increased public R&D by 56% between 2011 and 2016, but U.S. investment in the same period fell by 12% in absolute terms. China has likely surpassed the U.S. in total R&D spending and-through both investment and theft-is working to overtake us as the global leader in science and technology. Our international competitiveness is at stake.

America's continued scientific leadership requires a comprehensive and strategic approach to research and development that provides long-term increased investment and stability across the research ecosystem. It also requires inter-agency collaboration and public-private partnerships. And it must focus on evolving technologies that are crucial to our national and economic security, like AI, semiconductors, and quantum sciences. I believe we have achieved that with these two bills.

In the *NSF for the Future Act*, we put a great deal of care into crafting a new directorate that improves NSF's ability to advance fundamental research, without duplicating or seeking to replace the missions of other federal research agencies. Our proposed Directorate for Science and Engineering Solutions takes the basic research funded by NSF and helps apply those discoveries to solving national challenges from cybersecurity to climate change. We also propose a funding profile for the new directorate that is practical, sustainable, and in balance with the rest of the Foundation. Although most of the public attention has been on the new directorate, our bill also provides updated policy direction to the rest of the Foundation.

It has been four years since NSF received a comprehensive policy update, and 11 years since the last reauthorization, so these provisions are important. I will share a few highlights of the bill. NSF is the largest federal funder of STEM education, and our bill directs new mechanisms to improve the Foundation's investments in STEM at all levels.

The bill also includes provisions to improve the availability of research data, to more rapidly advance innovation, and to improve transparency and reproducibility of taxpayer funded research. Additionally, the bill includes important measures to protect American research from foreign influence and theft.

These policies were developed after months of input from stakeholders and bipartisan discussions. It's smart legislation, and I will discuss some other provisions in the bill when we consider the bipartisan Amendment in the Nature of a Substitute.

Next we will consider the *DOE Science for the Future Act*. The bill reauthorizes the Office of Science to increase our investments and provide a roadmap for DOE's research and development work. If it becomes law, it will be the first comprehensive authorization of the Office of Science, and it could not come at a better time.

The bill proposes nearly $50 billion over 5 years, giving the Office of Science and our National Labs the resources they need to continue to excel.

We need cutting-edge facilities for our federal scientists and researchers from academia and industry to conduct big science-research that can't be done in individual labs and requires massive equipment that industry cannot provide, like advanced light sources and neutron sources. Our Nation's National Laboratories, hosted by DOE's Office of Science, are experts in conducting this type of complex, large-scale research.

Our bill authorizes funding timelines for DOE research facilities and equipment that will bring them online as quickly as possible, at the lowest possible total project cost.

I will discuss more provisions of this bill when we consider the bipartisan Amendment in the Nature of a Substitute.

Chairwoman Johnson and I have taken a deliberative and bipartisan approach to revitalizing American research. Together, the *NSF for the Future Act* and the *DOE Science for the Future Act* together are a sustainable strategy for American progress that comprehensively scales up our research enterprise.

Today we will consider many amendments that I think will improve these bills. I hope through the process we can maintain the bipartisan spirit that created these two groundbreaking pieces of legislation.

Thank you, Chairwoman, for your partnership in this

Chairwoman JOHNSON. OK. Thank you very much, Mr. Lucas.

Chairwoman JOHNSON. We will now consider House Bill 3593, the *Department of Energy Science for the Future Act*. The Clerk will report the bill.

The CLERK. H.R. 3593, the *Department of Energy Science for the Future Act*.

[The bill follows:]

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303

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(Original Signature of Member)

117TH CONGRESS
1ST SESSION

H. R. 3593

To provide guidance for and investment in the research and development activities of the Department of Energy Office of Science, and for other purposes.

IN THE HOUSE OF REPRESENTATIVES

Ms. JOHNSON of Texas introduced the following bill; which was referred to the Committee on Science, Space, and Technology

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A BILL

To provide guidance for and investment in the research and development activities of the Department of Energy Office of Science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Department of Energy Science for the Future Act".

SEC. 2. MISSION OF THE OFFICE OF SCIENCE.

Section 209 of the Department of Energy Organization Act (42 U.S.C. 7139) is amended by adding at the end the following:

"(d) USER FACILITIES.—The Director shall carry out the construction, operation, and maintenance of user facilities to support the mission described in subsection (c). As practicable, these facilities shall serve the needs of the Department, industry, the academic community, and other relevant entities for the purposes of advancing the missions of the Department, improving the competitiveness of the United States, protecting public health and safety, and addressing other national priorities including emergencies.

"(e) COORDINATION.—

"(1) IN GENERAL.—The Secretary—

"(A) shall ensure the coordination of the Office of Science with the other activities of the Department;

"(B) shall support joint activities among the programs of the Department;

"(C) shall coordinate with other relevant Federal agencies in supporting advancements in related research areas as appropriate; and

"(D) may form partnerships to enhance the utilization of and ensure access to user facilities by other Federal agencies.

"(2) WITHIN THE OFFICE OF SCIENCE.—The Director shall ensure the coordination of programs and activities carried out by the Office of Science.".

SEC. 3. BASIC ENERGY SCIENCES PROGRAM.

(a) DEPARTMENT OF ENERGY RESEARCH AND INNOVATION ACT.—Section 303 of the Department of Energy Research and Innovation Act (42 U.S.C. 18641) is amended—

(1) by redesignating subsections (a) through (e) as subsections (c) through (g), respectively; and

(2) by inserting before subsection (d), as so redesignated, the following:

"(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research and development program in basic energy sciences, including materials sciences and engineering, chemistry, physical biosciences, geosciences, and other disciplines, to understand, model, and control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies, address scientific grand challenges, and support

the energy, environment, and national security missions of the Department.

"(b) SUSTAINABLE CHEMISTRY.—In carrying out chemistry-related research and development activities under this section, the Director shall prioritize research and development sustainable chemistry to support clean, safe, and economic alternatives and methodologies to traditional chemical products and processes.";

(3) in subsection (c)(3), as so redesignated—

(A) in subparagraph (C), by striking "and" at the end;

(B) by redesignating subparagraph (D) as subparagraph (E); and

(C) by inserting after subparagraph (C) the following:

"(D) autonomous chemistry and materials synthesis facilities that leverage advances in artificial intelligence; and";

(4) in subsection (d), as so redesignated, by adding at the end the following:

"(4) ADVANCED PHOTON SOURCE UPGRADE.—

"(A) DEFINITIONS.—In this paragraph:

"(i) FLUX.—The term 'flux' means the rate of flow of photons.

"(ii) HARD X-RAY.—The term 'hard x-ray' means a photon with energy greater than 20 kiloelectron volts.

"(B) IN GENERAL.—The Secretary shall provide for the upgrade to the Advanced Photon Source described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades', including the development of a multi-bend achromat lattice to produce a high flux of coherent x-rays within the hard x-ray energy region and a suite of beamlines optimized for this source.

"(C) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the upgrade under this paragraph occurs before March 31, 2026.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph $157,000,000 for fiscal year 2022.

"(5) SPALLATION NEUTRON SOURCE PROTON POWER UPGRADE.—

"(A) IN GENERAL.—The Secretary shall provide for the proton power upgrade to the Spallation Neutron Source.

"(B) PROTON POWER UPGRADE DEFINED.—For the purposes of this paragraph, the term 'proton power upgrade' means the Spallation Neutron Source power upgrade described in—

"(i) the publication titled 'Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in December, 2003;

"(ii) the publication titled 'Four Years Later: An Interim Report on Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in August, 2007; and

"(iii) the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades'.

"(C) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable,

ensure that the start of full operations of the upgrade under this paragraph occurs before December 31, 2025.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph $49,800,000 for fiscal year 2022.

"(6) SPALLATION NEUTRON SOURCE SECOND TARGET STATION.—

"(A) IN GENERAL.—The Secretary shall provide for a second target station for the Spallation Neutron Source.

"(B) SECOND TARGET STATION DEFINED.—For the purposes of this paragraph, the term 'second target station' means the Spallation Neutron Source second target station described in—

"(i) the publication titled, 'Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in December, 2003;

"(ii) the publication titled, 'Four Years Later: An Interim Report on Facili-

ties for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in August, 2007; and

"(iii) the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades'.

"(C) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the second target station under this paragraph occurs before December 31, 2030, with the option for early operation in 2028.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the activities under this paragraph, including construction—

"(i) $70,000,000 for fiscal year 2022;

"(ii) $127,000,000 for fiscal year 2023;

"(iii) $204,000,000 for fiscal year 2024;

"(iv) $279,000,000 for fiscal year 2025; and

"(v) $300,000,000 for fiscal year 2026.

"(7) ADVANCED LIGHT SOURCE UPGRADE.—

"(A) DEFINITIONS.—In this paragraph:

"(i) FLUX.—The term 'flux' means the rate of flow of photons.

"(ii) SOFT X-RAY.—The term 'soft x-ray' means a photon with energy in the range from 50 to 2,000 electron volts.

"(B) IN GENERAL.—The Secretary shall provide for the upgrade to the Advanced Light Source described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades', including the development of a multibend achromat lattice to produce a high flux of coherent x-rays within the soft x-ray energy region.

"(C) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the upgrade under this paragraph occurs before December 31, 2026.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph—

"(i) $75,100,000 for fiscal year 2022;

"(ii) $135,000,000 for fiscal year 2023;

"(iii) $102,500,000 for fiscal year 2024;

"(iv) $25,000,000 for fiscal year 2025; and

"(v) $25,000,000 for fiscal year 2026.

"(8) LINAC COHERENT LIGHT SOURCE II HIGH ENERGY UPGRADE.—

"(A) DEFINITIONS.—In this paragraph:

"(i) HIGH ENERGY X-RAY.—The term 'high energy x-ray' means a photon with an energy in the 5 to 13 kiloelectron volt range.

"(ii) HIGH REPETITION RATE.—The term 'high repetition rate' means the delivery of x-ray pulses up to 1 million pulses per second.

"(iii) ULTRA-SHORT PULSE X-RAYS.—The term 'ultra-short pulse x-rays' means

x-ray bursts capable of durations of less than 100 femtoseconds.

"(B) IN GENERAL.—The Secretary shall—

"(i) provide for the upgrade to the Linac Coherent Light Source II facility described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades', including the development of experimental capabilities for high energy x-rays to reveal fundamental scientific discoveries; and

"(ii) ensure such upgrade enables the production and use of high energy, ultrashort pulse x-rays delivered at a high repetition rate.

"(C) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the upgrade under this paragraph occurs before December 31, 2026.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph—

"(i) $106,925,000 for fiscal year 2022;

"(ii) $125,925,000 for fiscal year 2023;

"(iii) $115,000,000 for fiscal year 2024;

"(iv) $89,000,000 for fiscal year 2025; and

"(v) $49,344,000 for fiscal year 2026.

"(9) CRYOMODULE REPAIR AND MAINTENANCE FACILITY.—

"(A) IN GENERAL.—The Secretary shall provide for the construction of a cryomodule repair and maintenance facility to service the Linac Coherent Light Source II and upgrades to the facility. The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility has the capability to maintain, repair, and test superconducting radiofrequency accelerator components.

"(B) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the activities under this paragraph—

"(i) $19,000,000 for fiscal year 2022;

"(ii) $25,000,000 for fiscal year 2023;

"(iii) $25,000,000 for fiscal year 2024; and

"(iv) $17,000,000 for fiscal year 2025.

"(10) NANOSCALE SCIENCE RESEARCH CENTER RECAPITALIZATION PROJECT.—

"(A) IN GENERAL.—The Secretary shall provide for the recapitalization of the Nanoscale Science Research Centers, to include the upgrade of equipment at each Center supported by the Office of Science on the date of enactment of the Department of Energy Science for the Future Act, to accelerate advances in the various fields of science including nanoscience, materials, chemistry, biology, and quantum information science.

"(B) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the recapitalization under this paragraph—

"(i) $20,000,000 for fiscal year 2022;

"(ii) $30,000,000 for fiscal year 2023;

"(iii) $20,000,000 for fiscal year 2024; and

"(iv) $20,000,000 for fiscal year 2025.";

(5) by adding at the end the following:

"(h) COMPUTATIONAL MATERIALS AND CHEMISTRY SCIENCE CENTERS.—

"(1) IN GENERAL.—The Director shall support a program of research and development for the application of advanced computing practices to foundational and emerging research problems in chemistry and materials science. Research activities shall include—

"(A) chemical catalysis research and development;

"(B) the use of large data sets to model materials phenomena, including through advanced characterization of materials, materials synthesis, processing, and innovative use of experimental and theoretical data;

"(C) adaptation of chemical system and chemistry modeling software to advanced computing systems and hardware; and

"(D) modeling of chemical processes, assemblies, and reactions such as molecular dy-

namics and quantum chemistry, including through novel computing methods.

"(2) COMPUTATIONAL MATERIALS AND CHEMISTRY SCIENCE CENTERS.—

"(A) IN GENERAL.—In carrying out the activities authorized under paragraph (1), the Director shall select and establish up to six computational materials and chemistry science centers to—

"(i) develop open-source, robust, and validated computational codes and user-friendly software, coupled with innovative use of experimental and theoretical data, to enable the design, discovery, and development of new materials and chemical systems, including chemical catalysis research and development; and

"(ii) focus on overcoming challenges and maximizing the benefits of exascale and other high performance computing.

"(B) SELECTION.—The Director shall select centers under subparagraph (A) on a competitive, merit-reviewed basis. The Director shall consider applications from the National Laboratories, institutes of higher education,

multi-institutional collaborations, and other appropriate entities.

"(C) DURATION.—

"(i) A center selected under subparagraph (A) shall receive support for a period of not more than 5 years beginning on the date of establishment of that center, subject to the availability of appropriations.

"(ii) A center already in existence on the date of enactment of the Department of Energy Science for the Future Act may continue to receive support for a period of not more than 5 years beginning on the date of establishment of that center.

"(D) RENEWAL.—Upon the expiration of any period of support of a center under this subsection, the Director may renew support for the center, on a merit-reviewed basis, for a period of not more than 5 years.

"(E) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming center for cause during the performance period.

"(i) MATERIALS RESEARCH DATABASE.—

"(1) IN GENERAL.—The Director shall support the development of a web-based platform to develop and provide access to a database of computed information on known and predicted materials properties and computational tools to accelerate breakthroughs in materials discovery and design.

"(2) PROGRAM.—In carrying out this subsection, the Director shall—

"(A) conduct cooperative research with industry, academia, and other research institutions to advance understanding, prediction, and manipulation of materials and facilitate the design of novel materials;

"(B) develop and maintain data infrastructure at user facilities that generate data to collect, analyze, label, and otherwise prepare the data for inclusion in the database;

"(C) leverage existing high performance computing systems to conduct high throughput calculations, and develop computational and data mining algorithms for the prediction of material properties;

"(D) strengthen the foundation for new technologies and advanced manufacturing; and

"(E) drive the development of advanced materials for applications that span the Department's missions in energy, environment, and national security.

"(3) COORDINATION.—In carrying out this subsection, the Director shall leverage and activities across the Department, including computational materials and chemistry science centers established under subsection (h).

"(4) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out activities under this subsection $10,000,000 for each of the fiscal years 2022 through 2026.

"(j) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $2,757,705,000 for fiscal year 2022;

"(2) $2,828,896,600 for fiscal year 2023;

"(3) $3,019,489,612 for fiscal year 2024;

"(4) $3,161,698,885 for fiscal year 2025; and

"(5) $3,291,651,600 for fiscal year 2026.".

(b) ARTIFICIAL PHOTOSYNTHESIS.—Subtitle G of title IX of the Energy Policy Act of 2005 (42 U.S.C. 16311 et seq.) is amended—

(1) in section 973(b), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated for Basic Energy Sciences, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2031."; and

(2) in section 975(c), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated in section 313 of this Act, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal 5 years 2022 through 2026.".

(c) ELECTRICITY STORAGE RESEARCH INITIATIVE.—Section 975 of the Energy Policy Act of 2005 (42 U.S.C.16315) is amended—

(1) in subsection (b), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated for Basic Energy Sciences, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.";

(2) in subsection (c), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated in section 313 of this Act, the Secretary shall make available for carrying out activities under this subsection $30,000,000 for each of fiscal years 2022 through 2026."; and

(3) in subsection (d), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated in section 313 of this Act, the Secretary shall make available for carrying out activities under this subsection $20,000,000 for each of fiscal years 2022 through 2026.".

SEC. 4. BIOLOGICAL AND ENVIRONMENTAL RESEARCH.

(a) PROGRAM.—Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) is amended—

(1) by redesignating subsections (a) through (c) as subsections (b) through (d), respectively; and

(2) by inserting before subsection (b), as so redesignated, the following:

"(a) PROGRAM.—As part of the duties of the Director authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), and coordinated

with the activities authorized under sections 303 and 304 of this Act, the Director shall carry out a program of research and development in the areas of biological systems science and climate and environmental science, including subsurface science, relevant to the development of new energy technologies and to support the energy, environmental, and national security missions of the Department.".

(b) BIOENERGY RESEARCH CENTERS.—Section 977(f) of the Energy Policy Act of 2005 (42 U.S.C. 16317(f)) is amended to read as follows:

"(f) BIOENERGY RESEARCH CENTERS.—

"(1) IN GENERAL.—In carrying out the program under section 306(a) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(a)), the Director shall support up to six bioenergy research centers to conduct fundamental research in plant and microbial systems biology, biological imaging and analysis, and genomics, and to accelerate advanced research and development of biomass-based liquid transportation fuels, bioenergy, or biobased materials, chemicals, and products that are produced from a variety of regionally diverse feedstocks, and to facilitate the translation of re-

search results to industry. The activities of the centers authorized under this subsection may include—

"(A) accelerating the domestication of bioenergy-relevant plants and microbes to enable high-impact, value-added coproduct development at multiple points in the bioenergy supply chain;

"(B) developing the science and technological advances to ensure process sustainability is considered in the creation of biofuels and bioproducts from lignocellulose; and

"(C) using the latest tools in genomics, molecular biology, catalysis science, chemical engineering, systems biology, and computational and robotics technologies to sustainably produce and transform biomass into biofuels and bioproducts.

"(2) SELECTION AND DURATION.—

"(A) IN GENERAL.—A center established under paragraph (1) shall be selected on a competitive, merit-reviewed basis for a period of not more than 5 years, subject to the availability of appropriations, beginning on the date of establishment of that center.

"(B) APPLICATIONS.—The Director shall consider applications from National Laboratories, multi-institutional collaborations, and other appropriate entities.

"(C) EXISTING CENTERS.—A center already in existence on the date of enactment of the Department of Energy Science for the Future Act may continue to receive support for a period of not more than 5 years beginning on the date of establishment of that center.

"(3) RENEWAL.—After the end of either period described in paragraph (2), the Director may renew support for the center for a period of not more than 5 years on a merit-reviewed basis. For a center in operation for 10 years after its previous selection on a competitive, merit-reviewed basis, the Director may renew support for the center on a competitive, merit-reviewed basis for a period of not more than 5 years, and may subsequently provide an additional renewal on a merit-reviewed basis for a period of not more than 5 years.

"(4) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming center for cause during the performance period.

"(5) ACTIVITIES.—Centers shall undertake research activities to accelerate the production of biofuels and bioproducts from advanced biomass resources by identifying the most suitable species of plants for use as energy crops; and improving methods of breeding, propagation, planting, producing, harvesting, storage and processing. Activities may include the following:

"(A) Research activities to increase sustainability, including—

"(i) advancing knowledge of how bioenergy crop interactions with biotic and abiotic environmental factors influence crop growth, yield, and quality;

"(ii) identifying the most impactful research areas that address the economics of biofuels and bioproducts production; and

"(iii) utilizing multiscale modeling to advance predictive understanding of biofuel cropping ecosystems.

"(B) Research activities to further feedstock development, including lignocellulosic, algal, gaseous wastes including carbon oxides and methane, and direct air capture of single

carbon gases via plants and microbes, including—

"(i) developing genetic and genomic tools, high-throughput analytical tools, and biosystems design approaches to enhance bioenergy feedstocks;

"(ii) conducting field testing of new potential bioenergy feedstock crops under environmentally benign and geographically diverse conditions to assess viability and robustness; and

"(iii) developing quantitative models informed by experimentation to predict how bioenergy feedstocks perform under diverse conditions.

"(C) Research activities to improve lignocellulosic deconstruction and separation methods, including—

"(i) developing feedstock-agnostic deconstruction processes capable of efficiently fractionating biomass into targeted output streams;

"(ii) gaining a detailed understanding of plant cell wall biosynthesis, composition,

structure, and properties during deconstruction; and

"(iii) improving enzymes and approaches for biomass breakdown and cellulose, hemicellulose, and lignin processing.

"(D) Research activities to improve the feedstock conversion process for advanced biofuels and bioproducts, including—

"(i) developing high-throughput methods to screen or select high-performance microbial strains to improve product formation rates, yields, and selectivity;

"(ii) establishing a broad set of platform microorganisms suitable for metabolic engineering to produce biofuels and bioproducts, as well as high-throughput methods for experimental validation of gene function;

"(iii) developing techniques to enhance microbial robustness for tolerating toxins to improve biofuel and bioproduct yields and to gain a better understanding of the cellular and molecular bases of tolerance for major chemical classes of inhibitors found in these processes;

"(iv) advancing technologies for the use of batch, continuous, as well as consolidated bioprocessing;

"(v) identifying, creating, and optimizing microbial and chemical pathways to produce promising, atom-economical intermediates and final bioproducts from biomass with considerations given to environmentally benign processes;

"(vi) developing high-throughput, real-time, in situ analytical techniques to understand and characterize the pre- and post-bioproduct separation streams in detail;

"(vii) creating methodologies for efficiently identifying viable target molecules, identifying high-value bioproducts in existing biomass streams, and utilizing current byproduct streams;

"(viii) identifying and improving plant feedstocks with enhanced extractable levels of desired bioproducts or bioproduct precursors, including lignin streams; and

"(ix) developing integrated biological and chemical catalytic approaches to

valorize and produce a diverse portfolio of advanced fuels and bioproducts.

"(6) INDUSTRY PARTNERSHIPS.—Centers shall establish industry partnerships to translate research results to commercial applications.".

(c) LOW-DOSE RADIATION RESEARCH PROGRAM.—Section 306(d)(7) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(c)), as redesignated under subsection (a), is amended to read as follows:

"(7) FUNDING.—For purposes of carrying out this subsection, the Secretary is authorized to make available from funds provided to the Biological and Environmental Research Program $40,000,000 for fiscal year 2025 and $50,000,000 for fiscal year 2026.".

(d) BIOLOGICAL SCIENCES RESEARCH ACTIVITIES.—Section 306(b) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644), as redesignated under subsection (a), is amended as follows:

"(b) BIOLOGICAL SYSTEMS.—The Director shall carry out research and development activities in fundamental, structural, computational, and systems biology to increase systems-level understanding of the complex biological systems, which may include activities to—

"(1) accelerate breakthroughs and new knowledge that would enable the cost-effective, sustainable production of—

"(A) biomass-based liquid transportation fuels;

"(B) bioenergy; and

"(C) biobased materials;

"(2) improve understanding of the global carbon cycle, including processes for removing carbon dioxide from the atmosphere, through photosynthesis and other biological processes, for sequestration and storage;

"(3) understand the biological mechanisms used to transform, immobilize, or remove contaminants from subsurface environments;

"(4) leverage tools and approaches across the Office of Science to expand research to include novel processes, methods, and science to develop bio-based chemicals, polymers, inorganic materials, including research to—

"(A) advance the understanding of how CRISPR tools and other gene editing tools and technologies work in nature, in the laboratory, and in practice;

"(B) deepen knowledge of the genetics of root architecture and growth in crops, including trees; and

"(C) develop methods and tools to increase the efficiency of photosynthesis in plants; and

"(5) develop other relevant methods and processes as determined by the Director.".

(e) CLIMATE, ENVIRONMENTAL SCIENCE, AND OTHER ACTIVITIES.—Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) is further amended by adding at the end the following:

"(e) EARTH AND ENVIRONMENTAL SYSTEMS SCIENCES ACTIVITIES.—

"(1) IN GENERAL.—As part of the activities authorized under subsection (a), and in coordination with activities carried out under subsection (b), the Director shall carry out earth and environmental systems science research, which may include activities to—

"(A) understand, observe, and model the response of Earth's atmosphere and biosphere to increased concentrations of greenhouse gas emissions and any associated changes in climate, including frequency and intensity of extreme weather events;

"(B) understand the coupled physical, chemical, and biological processes to transform, immobilize, remove, or move carbon, nitrogen, and other energy production-derived contaminants such as radionuclides and heavy metals, and understand the process of sequestration and transformation of these, carbon dioxide, and other relevant molecules in subsurface environments;

"(C) understand, observe, and model the cycling of water, carbon, and nutrients in terrestrial systems and at scales relevant to resources management;

"(D) understand the biological, biogeochemical, and physical processes across the multiple scales that control the flux of environmentally relevant compounds between the terrestrial surface and the atmosphere; and

"(E) inform potential natural mitigation and adaptation options for increased concentrations of greenhouse gas emissions and any associated changes in climate.

"(2) PRIORITIZATION.—In carrying out the program authorized under paragraph (1), the Director shall prioritize—

"(A) the development of software and algorithms to enable the productive application of environmental systems and extreme weather prediction models in high-performance computing systems; and

"(B) capabilities that support the Department's mission needs for energy and infrastructure security, resilience, and reliability.

"(3) SUBSURFACE BIOGEOCHEMICAL RESEARCH.—

"(A) IN GENERAL.—As part of the activities described in paragraph (1), the Director shall carry out research to advance a fundamental understanding of coupled physical, chemical, and biological processes for controlling the movement of sequestered carbon, nitrogen, and other subsurface environmental contaminants, including how hydrology drives biogeochemistry across molecular to watershed scales, and how coupling between physical, chemical, and biological processes influence flows of water, carbon, nutrients, and contaminants.

"(B) COORDINATION.—

"(i) DIRECTOR.—The Director shall carry out activities under this paragraph in accordance with priorities established by the Secretary to support and accelerate the decontamination of relevant facilities managed by the Department.

"(ii) SECRETARY.—The Secretary shall ensure the coordination of activities of the Department, including activities under this paragraph, to support and accelerate the decontamination of relevant facilities managed by the Department.

"(4) CLIMATE AND EARTH MODELING.—As part of the activities described in paragraph (1), the Director, in collaboration with the Advanced Scientific Computing Research program described in section 304, and in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, shall carry out research to develop, evaluate, and use high-resolution regional climate, global climate, and Earth system models to inform decisions on reducing greenhouse gas emissions and the resulting impacts of a changing global climate. Such modeling shall include, among other critical elements, greenhouse gas emissions, land use,

watershed responses, and interaction among human and Earth systems.

"(5) MID-SCALE FUNDING MECHANISM.—

"(A) IN GENERAL.—Any of the activities authorized in this subsection may be carried out by competitively selected mid-scale, multi-institutional research centers in lieu of individual research grants, or large-scale experiments or user facilities.

"(B) CONSIDERATION.—The Biological and Environmental Research Advisory Committee shall provide recommendations to the Director on projects most suitable for the research centers described in subparagraph (A).

"(f) BIOLOGICAL AND ENVIRONMENTAL RESEARCH USER FACILITIES.—

"(1) IN GENERAL.—The Director shall carry out a program for the development, construction, operation, and maintenance of user facilities to enhance the collection and analysis of observational data related to complex biological, climate, and environmental systems.

"(2) FACILITY REQUIREMENTS.—To the maximum extent practicable, the user facilities devel-

oped, constructed, operated, or maintained under paragraph (1) shall include—

"(A) distributed field research and observation platforms for understanding earth system processes;

"(B) instruments and modeling resources for understanding the physical, chemical, and cellular processes of biological and environmental systems;

"(C) integrated high-throughput sequencing, advanced bioanalytic techniques, DNA design and synthesis, metabolomics, and computational analysis; and

"(D) such other facilities as the Director considers appropriate, consistent with section 209 of the Department of Energy Organization Act (42 U.S.C. 7139).

"(3) EXISTING FACILITIES.—In carrying out the program established in paragraph (1), the Director is encouraged to evaluate the capabilities of existing user facilities and, to the maximum extent practicable, invest in modernization of those capabilities to address emerging research priorities.

"(4) USER FACILITIES INTEGRATION AND COLLABORATION PROGRAM.—

"(A) IN GENERAL.—The Director shall support a program of collaboration between user facilities as defined under this subsection to encourage and enable researchers to more readily integrate the tools, expertise, resources, and capabilities of multiple user facilities to further research and advance emerging technologies.

"(B) ACTIVITIES.—The program shall advance the integration of automation, robotics, computational biology, bioinformatics, biosensing, cellular platforms and other relevant emerging technologies as determined by the Director to enhance productivity and scientific impact of user facilities.

"(5) EARTH AND ENVIRONMENTAL SYSTEMS SCIENCES USER FACILITIES.—In carrying out the activities authorized under paragraph (1), the Director shall establish and operate user facilities to advance the collection, validation, and analysis of atmospheric data, including activities to advance knowledge and improve model representations and measure the impact of atmospheric gases, aerosols, and clouds on earth and environmental systems.

"(A) SELECTION.—The Director shall select user facilities under paragraph (1) on a competitive, merit-reviewed basis. The Director shall consider applications from the National Laboratories, institutes of higher education, multi-institutional collaborations, and other appropriate entities.

"(B) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming user facility for cause during the performance period.

"(C) EXISTING FACILITIES.—To the maximum extent practicable, the Director shall utilize existing facilities to carry out this subsection.

"(6) COORDINATION.—In carrying out the program authorized in paragraph (1), the Director shall ensure that the Office of Science—

"(A) consults and coordinates with the National Oceanic Atmospheric Administration, the Environmental Protection Agency, the National Aeronautics and Space Administration, the Department of Agriculture, the Department of the Interior, and any other relevant Federal agency

on the collection, validation, and analysis of atmospheric data; and

"(B) coordinates with relevant stakeholders, including institutes of higher education, nonprofit research institutions, industry, State, local, and tribal governments, and other appropriate entities to ensure access to the best available relevant atmospheric and historical weather data.

"(g) COASTAL ZONE RESEARCH INITIATIVE.—

"(1) IN GENERAL.—The Director shall carry out a research program to enhance the understanding of coastal ecosystems. In carrying out this program, the Director shall prioritize efforts to enhance the collection of observational data, and shall develop models to analyze the ecological, biogeochemical, hydrological and physical processes that interact in coastal zones.

"(2) NATIONAL SYSTEM FOR COASTAL DATA COLLECTION.—The Director shall establish an integrated system of geographically diverse field research sites in order to improve the quantity and quality of observational data, and that encompass the major land water interfaces of the United States, including—

"(A) the Great Lakes region;

"(B) the Pacific coast;

"(C) the Atlantic coast;

"(D) the Arctic; and

"(E) the Gulf coast.

"(3) EXISTING INFRASTRUCTURE.—In carrying out the programs and establishing the field research sites under paragraph (1) and (2), the Secretary shall leverage existing research and development infrastructure supported by the Department, including the Department's existing marine and coastal research lab.

"(4) COORDINATION.—For the purposes of carrying out the programs and establishing the field research sites under the Initiative, the Secretary may enter into agreements with Federal Departments and agencies with complementary capabilities.

"(5) REPORT.—Not less than 2 years after the date of the enactment of the Department of Energy Science for the Future Act, the Director shall provide to the Committee on Science, Space, and Technology and the Committee on Appropriations of the House of Representatives and the Committee on Energy and Natural Resources and the Committee on Appropriations of the Senate a report examining

whether the system described in this section should be established as a National User Facility.

"(h) TECHNOLOGY DEVELOPMENT.—The Director shall support a technology research program for the development of instrumentation and other research tools required to meet the missions of the Department and to provide platform technologies for the broader scientific community. Technologies shall include but are not limited to—

"(1) cryo-electron microscopy;

"(2) fabricated ecosystems; and

"(3) next generation sensors including quantum sensors for biological integration and bioproduction.

"(i) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $820,360,000 for fiscal year 2022;

"(2) $886,385,200 for fiscal year 2023;

"(3) $956,332,164 for fiscal year 2024;

"(4) $1,020,475,415 for fiscal year 2025; and

"(5) $1,099,108,695 for fiscal year 2026.".

SEC. 5. ADVANCED SCIENTIFIC COMPUTING RESEARCH PROGRAM.

(a) ADVANCED SCIENTIFIC COMPUTING RESEARCH.—Section 304 of the Department of Energy Re-

search and Innovation Act (42 U.S.C. 18642) is amended—

(1) by redesignating subsections (a) through (c) as subsections (b) through (d), respectively; and

(2) by inserting before subsection (b), as so redesignated, the following:

"(a) IN GENERAL.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out, in coordination with academia and relevant public and private sector entities, a research, development, and demonstration program to—

"(1) advance computational and networking capabilities for data-driven discovery;

"(2) analyze, model, simulate, and predict complex phenomena relevant to the development of new energy technologies and other technologies; and

"(3) to steward applied mathematics, computational science, and computer science; and other science disciplines relevant to the missions of the Department and the competitiveness of the United States.";

(3) in subsection (b) (as redesignated under paragraph (1))—

(A) by striking "the Director" and inserting "(1) DIRECTOR.—The Director"; and

(B) by adding at the end the following:

"(2) COORDINATION.—The Under Secretary for Science shall ensure the coordination of the activities of the Department, including activities under this section, to determine and meet the computational and networking research and facility needs of the Office of Science and all other relevant energy technology and energy efficiency programs within the Department, and across the Federal Government.";

(4) by amending subsection (d), as so redesignated, to read as follows:

"(d) APPLIED MATHEMATICS AND SOFTWARE DEVELOPMENT FOR HIGH-END COMPUTING SYSTEMS AND COMPUTER SCIENCES RESEARCH.—

"(1) IN GENERAL.—The Director shall carry out activities to develop, test, and support—

"(A) mathematics, statistics, and algorithms for modeling complex systems relevant to the missions of the Department, including on advanced computing architectures; and

"(B) tools, languages, programming environments, and operations for high-end computing systems (as defined in section 2 of the

American Super Computing Leadership Act (15 U.S.C. 5541).

"(2) PORTFOLIO BALANCE.—

"(A) IN GENERAL.—The Director shall maintain a balanced portfolio within the advanced scientific computing research and development program established under section 976 of the Energy Policy Act of 2005 (42 U.S.C. 16316) that supports robust investment in—

"(i) applied mathematical, computational, and computer sciences research needs relevant to the mission of the Department, including foundational areas that are critical to the advancement of energy sciences and technologies and new and emerging computing technologies; and

"(ii) associated high-performance computing hardware and facilities.

"(B) EXASCALE ECOSYSTEM SUSTAINMENT.—

"(i) SENSE OF CONGRESS.—It is the sense of Congress that the Exascale Computing Project has successfully created a broad ecosystem that provides shared software packages, novel evaluation systems,

and applications for exascale users, and that such products must be maintained and improved in order that the full potential of the deployed systems can be continuously realized.

"(ii) IN GENERAL.—The Secretary shall seek to sustain the ecosystem referenced in clause (i) to ensure that the exascale software stack and other research software will continue to be maintained, hardened, and otherwise optimized for long-term use on exascale systems and reliable availability to the user community."; and

(5) by inserting after subsection (d) the following:

"(e) NEXT GENERATION COMPUTING PROGRAM.—

"(1) IN GENERAL.—The Secretary shall establish a program to develop and implement a strategy for achieving computing systems with capabilities beyond exascale computing systems. In establishing this program, the Secretary shall—

"(A) maintain foundational research programs in mathematical, computational, and computer sciences focused on new and emerging

computing needs within the mission of the Department, including post-Moore's law computing architectures, novel approaches to modeling and simulation, artificial intelligence and scientific machine learning, quantum computing, edge computing, extreme heterogeneity, and distributed high-performance computing; and

"(B) retain best practices and maintain support for essential hardware, applications, and software elements of the Exascale Computing Program that are necessary for sustaining the vitality of a long-term exascale ecosystem.

"(2) REPORT.—Not later than one year after the date of the enactment of this Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives, and the Committee on Energy and Natural Resources of the Senate, a report on the development and implementation of the strategy outlined in paragraph (1).

"(f) ARCHITECTURAL RESEARCH IN HETEROGENEOUS COMPUTING SYSTEMS.—

"(1) IN GENERAL.—The Secretary shall carry out a program of research and development in het-

erogeneous computing systems to address extreme heterogeneity and to expand understanding of the potential for heterogeneous computing systems to deliver high performance, high efficiency computing for Department of Energy mission challenges. This shall include research and development that explores the convergence of big data analytics, simulations, and artificial intelligence.

"(2) COORDINATION.—In carrying out this program, the Secretary shall ensure coordination between research activities undertaken by the Advanced Scientific Computing Research program and materials research supported by the Basic Energy Sciences program within the Department of Energy Office of Science.

"(g) ENERGY EFFICIENT COMPUTING PROGRAM.—

"(1) IN GENERAL.—The Secretary shall support a program of fundamental research, development, and demonstration of energy efficient computing and data center technologies relevant to advanced computing applications, including high performance computing, artificial intelligence, and scientific machine learning.

"(2) EXECUTION.—

"(A) PROGRAM.—In carrying out the program under paragraph (1), the Secretary shall—

"(i) establish a partnership for National Laboratories, industry partners, and institutions of higher education for co-design of energy efficient hardware, technology, software, and applications across all applicable program offices of the Department, and provide access to energy efficient computing resources to such partners;

"(ii) develop hardware and software technologies that decrease the energy needs of advanced computing practices, including through data center co-design; and

"(iii) consider multiple heterogeneous computing architectures in collaboration with the program established under subsection (f) including neuromorphic computing, persistent computing, and ultrafast networking; and

"(iv) provide, as appropriate, on a competitive, merit-reviewed basis, access for researchers from institutions of higher

education, National Laboratories, industry, and other Federal agencies to the energy efficient computing technologies developed pursuant to clause (i).

"(B) SELECTION OF PARTNERS.—In selecting participants for the partnership established under subparagraph (A)(i), the Secretary shall select participants through a competitive, merit review process.

"(C) REPORT.—Not later than one year after the date of the enactment of this Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives, and the Committee on Energy and Natural Resources of the Senate, a report on—

"(i) the activities conducted under subparagraph (A); and

"(ii) the coordination and management of the program under subparagraph (A) to ensure an integrated research program across the Department.

"(h) ENERGY SCIENCES NETWORK.—

"(1) IN GENERAL.—The Secretary shall provide for an upgrade to the Energy Sciences Network user

facility in order to meet Federal research needs for highly reliable data transport capabilities optimized for the requirements of large-scale science.

"(2) CAPABILITIES.—In carrying out paragraph (1), the Secretary shall ensure the following capabilities:

"(A) To provide high bandwidth scientific networking across the continental United States and the Atlantic Ocean.

"(B) To maximize network reliability.

"(C) To protect the network and data from cyber-attacks.

"(D) To support exponentially increasing levels of data from the Department's scientific user facilities, experiments, and sensors.

"(E) To integrate heterogeneous computing frameworks and systems.

"(i) COMPUTATIONAL SCIENCE GRADUATE FELLOWSHIP.—

"(1) IN GENERAL.—The Secretary shall support the Computational Science Graduate Fellowship program in order to facilitate collaboration between graduate students and researchers at the National Laboratories, and contribute to the development of a diverse and inclusive computational workforce to

help advance research in areas relevant to the mission of the Department.

"(2) FUNDING.—From within funds authorized to be appropriated for Advanced Scientific Computing Research Program, the Secretary shall make available for carrying out the activities under this section—

"(A) $21,000,000 for fiscal year 2022;

"(B) $22,050,000 for fiscal year 2023;

"(C) $23,152,500 for fiscal year 2024;

"(D) $24,310,125 for fiscal year 2025; and

"(E) $25,525,631 for fiscal year 2026.

"(j) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $1,086,050,000 for fiscal year 2022;

"(2) $1,162,073,500 for fiscal year 2023;

"(3) $1,243,418,645 for fiscal year 2024;

"(4) $1,330,457,950 for fiscal year 2025; and

"(5) $1,423,590,007 for fiscal year 2026.".

(b) QUANTUM SCIENCE NETWORK.—

(1) DEFINITIONS.—Section 2 of the National Quantum Initiative Act (15 U.S.C. 8801) is amended—

(A) by redesignating paragraph (7) as paragraph (8); and

(B) by inserting after paragraph (6) the following:

"(7) QUANTUM NETWORK INFRASTRUCTURE.—The term 'quantum network infrastructure' means any facility, expertise, or capability that is necessary to enable the development and deployment of scalable and diverse quantum network technologies.".

(2) DEPARTMENT OF ENERGY QUANTUM NETWORK INFRASTRUCTURE RESEARCH AND DEVELOPMENT PROGRAM.—Title IV of the National Quantum Initiative Act (15 U.S.C. 8851 et seq.) is amended by adding at the end the following:

"SEC. 403. DEPARTMENT OF ENERGY QUANTUM NETWORK INFRASTRUCTURE RESEARCH AND DEVELOPMENT PROGRAM.

"(a) IN GENERAL.—The Secretary of Energy (referred to in this section as the 'Secretary') shall carry out a research, development, and demonstration program to accelerate innovation in quantum network infrastructure in order to—

"(1) facilitate the advancement of distributed quantum computing systems through the internet and intranet;

"(2) improve the precision of measurements of scientific phenomena and physical imaging technologies; and

"(3) develop secure national quantum communications technologies and strategies.

"(b) PROGRAM.—In carrying out this section, the Secretary shall—

"(1) coordinate with—

"(A) the Director of the National Science Foundation;

"(B) the Director of the National Institute of Standards and Technology;

"(C) the Chair of the subcommittee on Quantum Information Science of the National Science and Technology Council established under section 103(a); and

"(D) the Chair of the subcommittee on the Economic and Security Implications of Quantum Science;

"(2) conduct cooperative research with industry, National Laboratories, institutions of higher education, and other research institutions to facilitate new quantum infrastructure methods and technologies, including—

"(A) quantum-limited detectors, ultra-low loss optical channels, space-to-ground connections, and classical networking and cybersecurity protocols;

"(B) entanglement and hyper-entangled state sources and transmission, control, and measurement of quantum states;

"(C) quantum interconnects that allow short range local connections between quantum processors;

"(D) transducers for quantum sources and signals between optical and telecommunications regimes and quantum computer-relevant domains, including microwaves;

"(E) development of quantum memory buffers and small-scale quantum computers that are compatible with photon-based quantum bits in the optical or telecommunications wavelengths;

"(F) long-range entanglement distribution at both the terrestrial and space-based level using quantum repeaters, allowing entanglement-based protocols between small- and large scale quantum processors;

"(G) quantum routers, multiplexers, repeaters, and related technologies necessary to create secure long-distance quantum communication; and

"(H) integration of systems across the quantum technology stack into traditional computing networks, including the development of remote controlled, high performance, and reliable implementations of key quantum network components;

"(3) engage with the Quantum Economic Development Consortium (QED–C) to transition component technologies to help facilitate as appropriate the development of a quantum supply chain for quantum network technologies;

"(4) advance basic research in advanced scientific computing, particle physics, and material science to enhance the understanding, prediction, and manipulation of materials, processes, and physical phenomena relevant to quantum network infrastructure;

"(5) develop experimental tools and testbeds necessary to support cross-cutting fundamental research and development activities with diverse stake-

holders from industry and institutions of higher education; and

"(6) consider quantum network infrastructure applications that span the Department of Energy's missions in energy, environment, and national security.

"(c) LEVERAGING.—In carrying out this section, the Secretary shall leverage resources, infrastructure, and expertise across the Department of Energy and from—

"(1) the National Institute of Standards and Technology;

"(2) the National Science Foundation;

"(3) the National Aeronautics and Space Administration;

"(4) other relevant Federal agencies;

"(5) the National Laboratories;

"(6) industry stakeholders;

"(7) institutions of higher education; and

"(8) the National Quantum Information Science Research Centers.

"(d) RESEARCH PLAN.—Not later than 180 days after the date of the enactment of this Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate,

a 4-year research plan that identifies and prioritizes basic research needs relating to quantum network infrastructure.

"(e) STANDARD OF REVIEW.—The Secretary shall review activities carried out under this section to determine the achievement of technical milestones.

"(f) FUNDING.—Out of funds authorized to be appropriated for the Department of Energy's Office of Science, there shall be made available to the Secretary to carry out the activities under this section, $100,000,000 for each of fiscal years 2022 through 2026.

"SEC. 404. DEPARTMENT OF ENERGY QUANTUM USER EXPANSION FOR SCIENCE AND TECHNOLOGY PROGRAM.

"(a) IN GENERAL.—The Secretary of Energy (referred to in this section as the 'Secretary') shall, establish and carry out a program (to be known as the 'Quantum User Expansion for Science and Technology program' or 'QUEST program') to encourage and facilitate access to United States quantum computing hardware and quantum computing clouds for research purposes in order to—

"(1) enhance the United States quantum research enterprise;

"(2) educate the future quantum computing workforce; and

"(3) accelerate the advancement of United States quantum computing capabilities.

"(b) PROGRAM.—In carrying out this section, the Secretary shall—

"(1) coordinate with—

"(A) the Director of the National Science Foundation;

"(B) the Director of the National Institute of Standards and Technology;

"(C) the Chair of the Quantum Information Science of the National Science and Technology Council established under section 103(a); and

"(D) the Chair of the subcommittee on the Economic and Security Implications of Quantum Science;

"(2) provide researchers based within the United States with access to, and use of, United States quantum computing resources through a competitive, merit-reviewed process;

"(3) consider applications from the National Laboratories, multi-institutional collaborations, institutions of higher education, industry stakeholders, and any other entities that the Secretary determines

are appropriate to provide national leadership on quantum computing related issues; and

"(4) consult and coordinate with private sector stakeholders, the user community, and interagency partners on program development and best management practices.

"(c) LEVERAGING.—In carrying out this section, the Secretary shall leverage resources and expertise across the Department of Energy and from—

"(1) the National Institute of Standards and Technology;

"(2) the National Science Foundation;

"(3) the National Aeronautics and Space Administration;

"(4) other relevant Federal agencies;

"(5) the National Laboratories;

"(6) industry stakeholders;

"(7) institutions of higher education; and

"(8) the National Quantum Information Science Research Centers.

"(d) SECURITY.—In carrying out the activities authorized by this section, the Secretary, in consultation with the Director of the National Science Foundation and the Director of the National Institute of Standards and

Technology, shall ensure proper security controls are in place to protect sensitive information, as appropriate.".

SEC. 6. FUSION ENERGY RESEARCH.

(a) FUSION ENERGY RESEARCH.—Section 307 of the Department of Energy Research and Innovation Act (42 U.S.C. 18645) is amended—

(1) in subsection (b)—

(A) in the matter preceding paragraph (1), by striking "As part of" and inserting "(1) IN GENERAL.—As part of";

(B) by redesignating—

(i) paragraphs (1) and (2) as subparagraphs (A) and (B), respectively; and

(ii) in subparagraph (B) (as redesignated by clause (i)), subparagraphs (A) and (B) as clauses (i) and (ii), respectively; and

(C) by adding at the end the following:

"(2) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated under subsection (o), there are authorized to be appropriated to the Secretary to carry out activities described in paragraph (1) $50,000,000 for each of fiscal years 2022 through 2026.";

(2) in subsection (d)(3), by striking the period at the end and inserting "and $40,000,000 for fiscal year 2026.";

(3) in subsection (e)(4), by striking the period at the end and inserting "and $75,000,000 for fiscal year 2026.";

(4) in subsection (i)(10)—

(A) in subparagraph (D), by striking "; and" and inserting a semicolon;

(B) in subparagraph (E), by striking the period at the end and inserting "; and"; and

(C) by adding at the end the following:

"(F) $45,000,000 for fiscal year 2026.";

(5) in subsection (j)—

(A) by striking "The Director" and inserting "(1) IN GENERAL.—The Director"; and

(B) by adding at the end the following:

"(2) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out activities described in paragraph (1)—

"(A) $20,000,000 for fiscal year 2022;

"(B) $35,000,000 for fiscal year 2023;

"(C) $50,000,000 for fiscal year 2024;

"(D) $65,000,000 for fiscal year 2025; and

"(E) $80,000,000 for fiscal year 2026.";

(6) in subsection (l)—

(A) by striking "sense of Congress that" and inserting "sense of Congress that—";

(B) by striking "United States should support" and inserting "(1) United States should support"; and

(C) by adding at the end the following:

"(2) the Director shall incorporate the findings and recommendations of the report of the Fusion Energy Sciences Advisory Committee entitled 'Powering the Future: Fusion and Plasmas' and the report of the National Academies entitled "Bringing Fusion to the U.S. Grid" into the planning process of the Department, including the development of future budget requests to Congress.";

(7) by redesignating subsection (o) as subsection (r);

(8) by adding at the end the following:

"(o) HIGH-PERFORMANCE COMPUTATION COLLABORATIVE RESEARCH PROGRAM.—

"(1) IN GENERAL.—The Secretary shall carry out a program to conduct and support collaborative research, development, and demonstration of fusion energy technologies, through high-performance com-

putation modeling and simulation techniques, in order to—

"(A) support fundamental research in plasmas and matter at very high temperatures and densities;

"(B) inform the development of a broad range of fusion energy systems; and

"(C) facilitate the translation of research results in fusion energy science to industry.

"(2) COORDINATION.—In carrying out the program under paragraph (1), the Secretary shall coordinate with relevant Federal agencies, and prioritize the following objectives:

"(A) Using expertise from the private sector, institutions of higher education, and the National Laboratories to leverage existing, and develop new, computational software and capabilities that prospective users may use to accelerate research and development of fusion energy systems.

"(B) Developing computational tools to simulate and predict fusion energy science phenomena that may be validated through physical experimentation.

"(C) Increasing the utility of the research infrastructure of the Department by coordinating with the Advanced Scientific Computing Research program within the Office of Science.

"(D) Leveraging experience from existing modeling and simulation entities sponsored by the Department.

"(E) Ensuring that new experimental and computational tools are accessible to relevant research communities, including private sector entities engaged in fusion energy technology development.

"(F) Ensuring that newly developed computational tools are compatible with modern virtual engineering and visualization capabilities to accelerate the realization of fusion energy technologies and systems.

"(3) DUPLICATION.—The Secretary shall ensure the coordination of, and avoid unnecessary duplication of, the activities of this program with the activities of—

"(A) other research entities of the Department, including the National Laboratories, the Advanced Research Projects Agency–Energy,

the Advanced Scientific Computing Research program; and

"(B) industry.

"(4) HIGH-PERFORMANCE COMPUTING FOR FUSION INNOVATION CENTER.—In carrying out the program under paragraph (1), the Secretary shall establish and operate a national High-Performance Computing for Fusion Innovation Center (referred to in this section as the 'Center'), which shall focus on the early stage research and development activities described under paragraph (1).

"(5) SELECTION.—The Secretary shall select the Center under this subsection on a competitive, merit-reviewed basis. The Secretary shall consider applications from National Laboratories, institutions of higher education, multi-institutional collaborations, and other appropriate entities.

"(6) DURATION.—The Center established under this subsection shall receive support for a period of not more than 5 years, subject to the availability of appropriations.

"(7) RENEWAL.—Upon the expiration of any period of support of the Center, the Secretary may renew support for the Center, on a merit-reviewed basis, for a period of not more than 5 years.

"(8) TERMINATION.—Consistent with the existing authorities of the Department, the Secretary may terminate the Center for cause during the performance period.

"(p) MATERIAL PLASMA EXPOSURE EXPERIMENT.—

"(1) IN GENERAL.—The Secretary shall construct a Material Plasma Exposure Experiment facility as described in the 2020 publication approved by the Fusion Energy Sciences Advisory Committee titled 'Powering the Future: Fusion and Plasmas'. The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility is capable of meeting Federal research needs for steady state, high-heat-flux and plasma-material interaction testing of fusion materials over a range of fusion energy relevant parameters.

"(2) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in subsection (a) will provide the following capabilities:

"(A) A magnetic field at the target of 1 Tesla.

"(B) An energy flux at the target of 10 MW/m2.

"(C) The ability to expose previously irradiated plasma facing material samples to plasma.

"(3) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the facility under this section occurs before December 31, 2027.

"(4) FUNDING.—Out of funds authorized to be appropriated for Fusion Energy Sciences, there are funds authorized to be appropriated to the Secretary for the Office of Fusion Energy Sciences to carry out to completion the construction of the facility under this section:

"(A) $32,800,000 for fiscal year 2022;

"(B) $13,400,000 for fiscal year 2023;

"(C) $12,600,000 for fiscal year 2024; and

"(D) $400,000 for fiscal year 2025.

"(q) MATTER IN EXTREME CONDITIONS INSTRUMENT UPGRADE.—

"(1) IN GENERAL.—The Secretary shall provide for the upgrade to the Matter in Extreme Conditions endstation at the Linac Coherent Light Source as described in the 2020 publication approved by the Fusion Energy Sciences Advisory Committee titled 'Powering the Future: Fusion and Plasmas'. The

Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility is capable of meeting Federal research needs for understanding physical and chemical changes to plasmas at fundamental timescales, and explore new regimes of dense material physics, astrophysics, planetary physics, and short-pulse laser-plasma interactions.

"(2) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the facility under this section occurs before December 31, 2028."; and

(9) in subsection (r), as so redesignated, by striking paragraphs (2) through (5) and inserting the following:

"(2) $1,002,900,000 for fiscal year 2022;

"(3) $1,095,707,000 for fiscal year 2023;

"(4) $1,129,368,490 for fiscal year 2024;

"(5) $1,149,042,284 for fiscal year 2025; and

"(6) $1,243,097,244 for fiscal year 2026.".

(b) ITER CONSTRUCTION.—Section 972 of the Energy Policy Act of 2005 (42 U.S.C. 16312) is amended in subsection (c)(3)—

(1) in subparagraph (A), by striking "and" at the end; and

(2) by striking subparagraph (B) and inserting the following:

"(B) $300,000,000 for fiscal year 2022;

"(C) $325,000,000 for fiscal year 2023;

"(D) $350,000,000 for fiscal year 2024;

"(E) $350,000,000 for fiscal year 2025; and

"(F) $350,000,000 for fiscal year 2026.".

SEC. 7. HIGH ENERGY PHYSICS PROGRAM.

(a) PROGRAM.—Section 305 of the Department of Energy Research and Innovation Act (42 U.S.C. 18643) is amended—

(1) by redesignating subsections (b) through (d) as subsections (d) through (f), respectively; and

(2) by inserting the following after subsection (a):

"(b) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program on the fundamental constituents of matter and energy and the nature of space and time in order to support theoretical and experimental research in both elementary particle physics and fundamental accelerator science and technology and understand fundamental properties of the universe.

"(e) HIGH ENERGY FRONTIER RESEARCH.—As part of the program described in subsection (a), the Director shall carry out research using high energy accelerators and advanced detectors, including accelerators and detectors that will function as national user facilities, to create and study interactions of elementary particles and investigate fundamental forces.".

(b) INTERNATIONAL COLLABORATION.—Section 305(d) of the Department of Energy Research and Innovation Act (42 U.S.C. 18643(d)), as redesignated under subsection (a), is amended to read as follows:

"(d) INTERNATIONAL COLLABORATION.—The Director shall—

"(1) as practicable and in coordination with other appropriate Federal agencies as necessary, ensure the access of United States researchers to the most advanced accelerator facilities and research capabilities in the world, including the Large Hadron Collider;

"(2) to the maximum extent practicable, continue to leverage United States participation in the Large Hadron Collider, and prioritize expanding international partnerships and investments in the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment; and

"(3) to the maximum extent practicable, prioritize engagement in collaborative efforts in support of future international facilities that would provide access to the most advanced accelerator facilities in the world to United States researchers.".

(c) COSMIC FRONTIER RESEARCH.—Section 305(f) of the Department of Energy Research and Innovation Act (42 U.S.C. 18645(f)), as redesignated by subsection (a), is amended to read as follows:

"(f) COSMIC FRONTIER RESEARCH.—The Director shall carry out research activities on the nature of the primary contents of the universe, including the nature of dark energy and dark matter, which may include collaboration with the National Aeronautics and Space Administration or the National Science Foundation, or international collaboration. These activities shall, to the maximum extent practicable, be consistent with the research priorities identified by the High Energy Physics Advisory Panel or the National Academy of Sciences, and may include—

"(1) collaborations with the National Aeronautics and Space Administration, the National Science Foundation, or international partners on relevant projects; and

"(2) the development of space-based, land-based, water-based, and underground facilities and experiments.".

(d) SECTION.—Section 305 of the Department of Energy Research and Innovation Act (42 U.S.C. 18645), as amended, is further amended by adding at the end the following:

"(g) FACILITY CONSTRUCTION AND MAJOR ITEMS OF EQUIPMENT.—

"(1) PROJECTS.—Consistent with the Office of Science's project management practices, the Director shall, to the maximum extent practicable, incorporate the findings and recommendations of the 2014 Particle Physics Project Prioritization Panel (P5) report titled 'Building for Discovery', and support construction or fabrication of—

"(A) an international Long-Baseline Neutrino Facility based in the United States;

"(B) the Proton Improvement Plan II;

"(C) Second Generation Dark Matter experiments;

"(D) the Dark Energy Spectroscopic Instrument;

"(E) the Vera Rubin Observatory camera;

"(F) upgrades to components of the Large Hadron Collider; and

"(G) other high priority projects recommended in the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel.

"(2) LONG-BASELINE NEUTRINO FACILITY.—

"(A) IN GENERAL.—The Secretary shall support construction of a Long-Baseline Neutrino Facility to facilitate the international Deep Underground Neutrino Experiment to examine the fundamental properties of neutrinos, explore physics beyond the Standard Model, and better clarify the existence and nature of antimatter.

"(B) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in subparagraph (A) will provide, at a minimum, the following capabilities:

"(i) A neutrino beam with wideband capability of 1.2 megawatts (MW) of beam power and upgradable to 2.4 MW of beam power.

"(ii) Three caverns excavated for a 70 kiloton fiducial detector mass and supporting surface buildings and utilities.

"(iii) Cryogenic systems to support neutrino detectors.

"(C) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the facility under this subsection occurs before December 31, 2031.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $200,000,000 for fiscal year 2022;

"(ii) $325,000,000 for fiscal year 2023;

"(iii) $400,000,000 for fiscal year 2024;

"(iv) $375,000,000 for fiscal year 2025; and

"(v) $250,000,000 for fiscal year 2026.

"(3) PROTON IMPROVEMENT PLAN–II ACCELERATOR UPGRADE PROJECT.—

"(A) IN GENERAL.—The Secretary of Energy shall support construction of the Proton Improvement Plan II, an upgrade to the Fermilab accelerator complex identified in the 2014 Particle Physics Project Prioritization Panel (P5) report titled 'Building for Discovery', to provide the world's most intense beam of neutrinos to the international Long Baseline Neutrino Facility as well as abroad range of future high energy physics experiments. The Secretary of Energy shall work with international partners to enable further significant contributions to the capabilities of this project.

"(B) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in paragraph (1) will provide, at a minimum, the following capabilities:

"(i) A state-of-the-art 800 megaelectron volt (MeV) superconducting linear accelerator.

"(ii) Proton beam power of 1.2 MW at the start of LBNF/DUNE, upgradeable to 2.4 MW of beam power.

"(iii) A flexible design to enable high power beam delivery to multiple users simultaneously and customized beams tailored to specific scientific needs.

"(iv) Sustained high reliability operation of the Fermilab accelerator complex.

"(C) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the facility under this section occurs before December 31, 2028.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $191,000,000 for fiscal year 2022;

"(ii) $150,000,000 for fiscal year 2023;

"(iii) $120,000,000 for fiscal year 2024;

"(iv) $120,000,000 for fiscal year 2025; and

"(v) $100,000,000 for fiscal year 2026.

"(4) COSMIC MICROWAVE BACKGROUND STAGE 4.—

"(A) IN GENERAL.—The Secretary of Energy, in partnership with the Director of the National Science Foundation, shall support construction of the Cosmic Microwave Background Stage 4 project to survey the cosmic microwave background to test theories of cosmic inflation as described in the 2014 Particle Physics Prioritization Panel (P5) report titled 'Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context.'.

"(B) CONSULTATION.—The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this experiment is capable of meeting Federal research needs in accessing the ultra-high energy physics of inflation and important neutrino properties.

"(C) EXPERIMENTAL CAPABILITIES.—The Secretary shall ensure that the facility de-

scribed in subsection (a) will provide at minimum, 500,000 superconducting detectors deployed on an array of mm wave telescopes with the required range in frequency, sensitivity, and survey speed to enable an order of magnitude advance in observations of the Cosmic Microwave Background, delivering transformative discoveries in fundamental physics, cosmology, and astrophysics.

"(D) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the facility under this section occurs before December 31, 2030.

"(E) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $37,000,000 for fiscal year 2022;

"(ii) $45,000,000 for fiscal year 2023;

"(iii) $71,400,000 for fiscal year 2024;

"(iv) $49,800,000 for fiscal year 2025; and

"(v) $84,800,000 for fiscal year 2026.

"(h) ACCELERATOR AND DETECTOR UPGRADES.—The Director shall upgrade accelerator facilities and detectors, as necessary and appropriate, to increase beam power, sustain high reliability, and improve precision measurement to advance the highest priority particle physics research programs. In carrying out facility upgrades, the Director shall continue to work with international partners, when appropriate and in the United States interest, to leverage investments and expertise in critical technologies to help build and upgrade accelerator and detector facilities in the United States.

"(i) ACCELERATOR AND DETECTOR RESEARCH AND DEVELOPMENT.—As part of the program described in subsection (a), the Director shall carry out research and development in advanced accelerator and detector concepts and technologies, including laser technologies, in order to develop and deploy next generation technologies to support discovery science in particle physics and to reduce the necessary size and cost for the next generation of particle accelerators, in coordination with the Office of Science's Basic Energy Sciences and Nuclear Physics programs as well as other relevant Federal agencies.

"(j) RESEARCH COLLABORATIONS.—In developing accelerator technologies under the program authorized in subsection (e), the Director shall—

"(1) consider the requirements necessary to support translational research and development for medical, industrial, security, and defense applications; and

"(2) leverage investments in accelerator technologies and fundamental research in particle physics by partnering with institutes of higher education, industry, and other Federal agencies to help commercialize technologies with promising applications.

"(k) UNDERGROUND SCIENCE.—The Director shall—

"(1) support an underground science program consistent with the missions of the Department and the scientific needs of the High Energy Physics program, including those articulated in the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel, that leverages the capabilities of relevant underground science and engineering facilities; and

"(2) carry out a competitive grant program to award scientists and engineers at institutions of higher education, nonprofit institutions, and national

laboratories to conduct research in underground science and engineering.

"(l) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $1,355,690,000 for fiscal year 2022;

"(2) $1,512,628,300 for fiscal year 2023;

"(3) $1,653,512,281 for fiscal year 2024;

"(4) $1,681,260,141 for fiscal year 2025; and

"(5) $1,650,812,351 for fiscal year 2026.".

SEC. 8. NUCLEAR PHYSICS PROGRAM.

(a) PROGRAM.—Section 308 of the Department of Energy Research and Innovation Act (42 U.S.C. 18646) is amended—

(1) by redesignating subsections (a) and (b) as subsections (b) and (c), respectively; and

(2) by inserting the following before subsection (b), as so redesignated:

"(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program, and support relevant facilities, to discover and understand various forms of nuclear matter.".

(b) ISOTOPE DEVELOPMENT AND PRODUCTION FOR RESEARCH APPLICATIONS.—Section 308(b)(1) of the De-

partment of Energy Research and Innovation Act (42 U.S.C. 18646(a)(1)), as redesignated under subsection (a), is amended to read as follows:

"(1) shall carry out a program in coordination with other relevant programs across the Department of Energy for the production of isotopes, including the development of techniques to produce isotopes, that the Secretary determines are needed for research, medical, industrial, or related purposes, to the maximum extent practicable, in accordance with the 2015 NSAC 'Meeting Isotope Needs and Capturing Opportunities For The Future' report; and".

(c) PROGRAM ADMINISTRATION.—Section 308 of the Department of Energy Research and Innovation Act (42 U.S.C. 18646) is amended by adding at the end the following:

"(d) USER FACILITIES.—

"(1) FACILITY FOR RARE ISOTOPE BEAMS.—

"(A) IN GENERAL.—The Secretary shall support construction of a Facility for Rare Isotope Beams to advance the understanding of rare nuclear isotopes and the evolution of the cosmos.

"(B) FUNDING.—Out of funds authorized to be appropriated under subsection (f), there

shall be made available to the Secretary to carry out construction of the facility under this subsection $2,000,000 for fiscal year 2022.

"(2) ELECTRON-ION COLLIDER.—

"(A) IN GENERAL.—The Secretary shall support construction of an Electron Ion Collider as described in the 2015 Long Range Plan of the Nuclear Science Advisory Committee and the report from the National Academies titled 'An Assessment of U.S.-Based Electron-Ion Collider Science', in order to measure the internal structure of the proton and the nucleus and answer fundamental questions about the nature of visible matter.

"(B) FACILITY CAPABILITY.—The Secretary shall ensure that the facility meets the requirements in the 2015 Long Range Plan, including—

"(i) at least 70 percent polarized beams of electrons and light ions;

"(ii) ion beams from deuterium to the heaviest stable nuclei;

"(iii) variable center of mass energy from 20 to 140 GeV;

"(iv) high collision luminosity of $10^{33-34}cm^{-2}s^{-1}$; and

"(v) the possibility of more than one interaction region.

"(C) START OF OPERATIONS.—The Secretary shall, to the maximum extent practicable, ensure that the start of full operations of the facility under this section occurs before December 31, 2030.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (e), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $101,000,000 for fiscal year 2022;

"(ii) $155,000,000 for fiscal year 2023;

"(iii) $250,000,000 for fiscal year 2024;

"(iv) $300,000,000 for fiscal year 2025; and

"(v) $305,000,000 for fiscal year 2026.

"(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $861,000,000 for fiscal year 2022;

"(2) $960,390,000 for fiscal year 2023;

"(3) $1,106,097,300 for fiscal year 2024;

"(4) $1,210,354,111 for fiscal year 2025; and

"(5) $1,273,408,899 for fiscal year 2026.".

SEC. 9. SCIENCE LABORATORIES INFRASTRUCTURE PROGRAM.

(a) PROGRAM.—Section 309 of the Department of Energy Research and Innovation Act (42 U.S.C. 18647) is amended by adding at the end the following:

"(e) APPROACH.—In carrying out this section, the Director shall utilize all available approaches and mechanisms, including capital line items, minor construction projects, energy savings performance contracts, utility energy service contracts, alternative financing and expense funding, as appropriate.

"(d) ALTERNATIVE FINANCING OF RESEARCH FACILITIES AND INFRASTRUCTURE.—

"(1) IN GENERAL.—Consistent with section 161(g) of the Atomic Energy Act of 1954 (42 U.S.C. 2201(g)), the Management and Operating contractors of the Department may enter into the

lease-purchase of research facilities and infrastructure under the scope of their contract with the Department with the approval of the Secretary or their designee.

"(2) LIMITATIONS.—To carry out lease-purchases approved by the Secretary under subsection (a), the Department shall only be required to have budget authority in an amount sufficient to cover the minimum required lease payments through the period required to exercise a termination provision in the lease agreement, plus any associated lease termination penalties, regardless of whether such leased facility and infrastructure is on or off Government land, and if—

"(A) the Department has established a mission need for the facility or infrastructure to be leased;

"(B) the facility or infrastructure is general purpose, including offices, laboratories, cafeterias, utilities, and data centers;

"(C) the Department is not a party to and has no financial obligations under the lease-purchase transaction entered into by the Management and Operating contractor, other than al-

lowability of the lease cost and conveyance of Government land, if needed;

"(D) the lease-purchase has an advance notice termination provision with reasonable pre-defined penalties that the Management and Operating contractor may exercise, at the direction of the Department, if funding for the lease is no longer available or the mission need ceases to exist;

"(E) there is an option for a no cost transfer of ownership to the Government once the underlying financing is retired, but neither the Management and Operating contractor nor the Department are obligated to purchase the facility or infrastructure at any time during or after the lease term;

"(F) the lease-purchase transaction, assuming exercise of the ownership option, is demonstrated to be the lowest lifecycle cost alternative for the Government; and

"(G) the cumulative annual base rent for all lease-purchases of facilities and infrastructure, inclusive of any transactions under consideration, does not exceed 2 percent of the Management and Operating contract operating

budget for the year the commitment is made for the lease.

"(3) REPORTING.—Not later than one year after the date of the enactment of the Department of Energy Science for the Future Act, and biennially thereafter, the Department shall submit to the Committee on Science, Space, and Technology and the Committee on Appropriations of the House of Representatives, and the Committee on Energy and Natural Resources and the Committee on Appropriations of the Senate, a report on the lease-purchase transactions that the Management and Operating contractors of the Department entered into under subsection (a) that includes—

"(A) a list of the lease-purchase transactions entered into by each Management and Operating contractor and their respective costs;

"(B) the annual percentage of each Management and Operating contract operating budget that is used for lease-purchase transactions for the year the commitments were made; and

"(C) any other information the Secretary finds appropriate.

"(d) MID-SCALE INSTRUMENTATION PROGRAM.—The Director, in coordination with each of the programs carried out by the Office of Science, shall establish a mid-scale instrumentation program to enable the development and acquisition of novel, state-of-the-art instruments ranging in cost from $1 million to $20 million each that would significantly accelerate scientific breakthroughs at user facilities.

"(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section $500,000,000 for each of fiscal years 2022 through 2026.".

SEC. 10. INCREASED COLLABORATION WITH TEACHERS AND SCIENTISTS.

(a) IN GENERAL.—The Department of Energy Research and Innovation Act (42 U.S.C. 18601 note) is amended by adding at the end the following:

"SEC. 310. INCREASED COLLABORATION WITH TEACHERS AND SCIENTISTS.

"(a) IN GENERAL.—The Director shall support the development of a scientific workforce through programs that facilitate collaboration between K–12, university students, early-career researchers, faculty, and the National Laboratories, including through the use of proven techniques to expand the number of individuals from under-

represented groups pursuing and attaining skills or undergraduate and graduate degrees relevant to the Office's mission.

"(b) AUTHORIZATION OF APPROPRIATIONS.—Section 3169 of the Department of Energy Science Education Enhancement Act (42 U.S.C. 7381e) is amended—

"(1) by striking, 'programs', and inserting 'programs, including the NSF INCLUDES National Network,'; and

"(2) by striking, 'year 1991', and inserting 'years 2022 through 2026'.".

(b) BROADENING PARTICIPATION IN WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS.—The Department of Energy Science Education Enhancement Act (42 U.S.C. 7381 note) is amended by inserting the following sections after section 3167 (42 U.S.C. 7381c–1):

"SEC. 3167A. BROADENING PARTICIPATION FOR TEACHERS AND SCIENTISTS.

"(a) IN GENERAL.—The Secretary, in collaboration with the Director of the National Science Foundation, shall support and leverage the National Science Foundation Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science National Network, hereafter referred to as the

NSF INCLUDES National Network, to expand the number of students, early-career researchers, and faculty from underrepresented groups pursuing and attaining skills or undergraduate and graduate degrees in science, technology, engineering, and mathematics fields relevant to the Department's mission.

"(b) PLAN.—Not later than 1 year after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources and the Committee on Commerce, Science, and Transportation of the Senate and make available to the public a plan for broadening participation of underrepresented groups in science, technology, engineering, and mathematics in programs supported by the Department programs, including—

"(1) a plan for supporting and leveraging the National Science Foundation INCLUDES National Network;

"(2) metrics for assessing the participation of underrepresented groups in Department programs;

"(3) experienced and potential barriers to broadening participation of underrepresented groups

in Department programs, including recommended solutions; and

"(4) any other activities the Secretary finds appropriate.

"(c) AUTHORIZATION OF APPROPRIATIONS.—Of the amounts authorized to be appropriated in section 3169 (42 U.S.C. 7381e), at least $2,000,000 shall be made available each fiscal year for the activities described under this subsection.

"SEC. 3167B. EXPANDING OPPORTUNITIES TO INCREASE THE DIVERSITY, EQUITY, AND INCLUSION OF HIGHLY SKILLED SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) PROFESSIONALS.

"(a) IN GENERAL.—The Secretary shall expand opportunities to increase the number and the diversity, equity, and inclusion of highly skilled science, technology, engineering, and mathematics (STEM) professionals working in Department of Energy mission-relevant disciplines and broaden the recruitment pool to increase diversity, including expanded partnerships with minority-serving institutions, non-Research I universities, and scientific societies.

"(b) PLAN AND OUTREACH STRATEGY.—

"(1) IN GENERAL.—Not later than 6 months after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate a 10-year educational plan in accordance with paragraph (2) and an outreach strategy in accordance with paragraph (3).

"(2) PLAN.—The plan under paragraph (1) shall fund and expand new or existing programs administered by the Office of Science and sited at the National Laboratories and Department of Energy user facilities to expand educational and workforce opportunities for underrepresented high school, undergraduate, and graduate students as well as recent graduates, teachers and faculty in STEM fields. Such programs may include paid internships, fellowships, temporary employment, training programs, visiting student and faculty programs, sabbaticals, and research support.

"(3) OUTREACH STRATEGY.—The outreach strategy under paragraph (1) shall include a plan to improve the advertising, recruitment, and promotion of educational and workforce programs to commu-

nity colleges, minority-serving institutions, and non-Research I universities.

"(c) BUILDING RESEARCH CAPACITY.—The Secretary shall develop programs that strengthen the research capacity relevant to Office of Science disciplines at emerging research institutions, including minority-serving institutions, colleges, and universities. This may include enabling meaningful partnerships between research-intensive institutions and emerging research institutions, and soliciting research proposals, fellowships, training programs, and research support directly from emerging research institutions.

"(d) TRAINEESHIPS.—The Secretary shall establish a university-led Traineeship Program to address workforce training needs in DOE-relevant STEM fields. The focus should be on supporting training and research experiences for underrepresented undergraduate and graduate students and increasing participation from underrepresented populations. The traineeships should include opportunities to build the next-generation workforce in research areas critical to maintaining core competencies across the Office of Science's programs.

"(e) EVALUATION.—The Secretary shall establish key performance indicators to measure and monitor progress

of education and workforce programs and expand Departmental activities for data collection and analysis.

"(f) REPORT.—The Secretary shall submit a report every 2 years to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate summarizing progress toward meeting key performance indicators under subsection (e).

"(g) MINORITY-SERVING INSTITUTION DEFINED.—The term 'minority-serving institution' includes the entities described in any of paragraphs (1) through (7) of section 371(a) of the Higher Education Act of 1965 (20 U.S.C. 1067q(a));".

SEC. 11. HIGH INTENSITY LASER RESEARCH INITIATIVE; HELIUM CONSERVATION PROGRAM; AUTHORIZATION OF APPROPRIATIONS.

(a) IN GENERAL.—The Department of Energy Research and Innovation Act (42 U.S.C. 18601 note) is amended by adding at the end the following:

"SEC. 311. HIGH INTENSITY LASER RESEARCH INITIATIVE.

"(a) IN GENERAL.—The Director shall establish a high intensity laser research initiative consistent with the recommendations of the National Academies report, 'Opportunities in Intense Ultrafast Lasers: Reaching for the Brightest Light', and the report from the Brightest Light

Initiative workshop on 'The Future of Intense Ultrafast Lasers in the U.S.'. This initiative should include research and development of petawatt-scale and of high average power laser technologies necessary for future facility needs in discovery science and to advance energy technologies, as well as support for a user network of academic and national laboratory high intensity laser facilities.

"(b) LEVERAGE.—The Director shall also leverage new laser technologies for more compact, less complex, and low-cost accelerator systems needed for science applications.

"(c) COORDINATION.—The Director shall coordinate this initiative among all relevant programs within the Office of Science, and the Under Secretary for Science shall coordinate this initiative with other relevant programs within the Department as well as within other Federal agencies.

"(d) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science there are authorized to be appropriated to the Secretary to carry out the activities described in this subsection—

"(1) $50,000,000 for fiscal year 2022;

"(2) $100,000,000 for fiscal year 2023;

"(3) $150,000,000 for fiscal year 2024;

"(4) $200,000,000 for fiscal year 2025; and

"(5) $250,000,000 for fiscal year 2026.

"SEC. 312. HELIUM CONSERVATION PROGRAM.

"(a) IN GENERAL.—The Secretary shall establish a program to reduce the consumption of helium for Department grant recipients and facilities and encourage helium recycling and reuse. The program shall competitively award grants for—

"(1) the purchase of equipment to capture, reuse, and recycle helium;

"(2) the installation, maintenance, and repair of new and existing helium capture, reuse, and recycling equipment; and

"(3) helium alternatives research and development activities.

"(b) REPORT.—In carrying out the program under this section, the Director shall submit to the Committee on Science, Space, and Technology of House of Representatives and the Committee on Energy and Natural Resources of the Senate a report, not later than two years after the date of enactment of the Department of Energy Science for the Future Act, and every 3 years thereafter, on the purchase of helium as part of research projects and facilities supported by the Department. The report shall include—

"(1) the quantity of helium purchased for projects and facilities supported by Department grants;

"(2) a cost-analysis for such helium;

"(3) the predominant production sources for such helium;

"(4) expected or experienced impacts of helium supply shortages or prices on the research projects and facilities supported by the Department; and

"(5) recommendations for reducing Department grant recipients' exposure to volatile helium prices.

"(c) COORDINATION.—In carrying out the program under this section, the Director shall coordinate with the National Science Foundation and other relevant Federal agencies on helium conversation activities.

"(d) DURATION.—The program established under this section shall receive support for a period of not more than 5 years, subject to the availability of appropriations.

"(e) RENEWAL.—Upon expiration of any period of support of the program under this section, the Director may renew support for the program for a period of not more than 5 years.

"SEC. 313. AUTHORIZATION OF APPROPRIATIONS.

"There are authorized to be appropriated to the Secretary to carry out the activities described in this title—

"(1) $8,728,615,000 for fiscal year 2022;

"(2) $9,344,434,300 for fiscal year 2023;

"(3) $10,031,656,951 for fiscal year 2024;

"(4) $10,503,567,938 for fiscal year 2025; and

"(5) $10,960,667,486 for fiscal year 2026.".

(b) TABLE OF CONTENTS.—Section 1(b) of the Department of Energy Research and Innovation Act is amended in the table of contents by inserting after the item relating to section 309 the following:

"Sec. 310. Increased collaboration with teachers and scientists.
"Sec. 311. High intensity laser research initiative.
"Sec. 312. Helium conservation program.
"Sec. 313. Authorization of appropriations.".

Chairwoman JOHNSON. Without objection, the bill is considered as read and open to amendment at any point.

Does anyone wish to be recognized to speak on this underlying bill?

No? OK. Then we will proceed with the amendments in the order on the roster. So our first amendment on the roster is an amendment offered by myself. The Clerk will report the amendment.

The CLERK. Amendment No. 1, amendment in the nature of a substitute to H.R. 3593 offered by Mr.—Ms. Johnson of Texas.

[The amendment of Chairwoman Johnson follows:]

AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593 OFFERED BY MS. JOHNSON OF TEXAS

Strike all after the enacting clause and insert the following:

SECTION 1. SHORT TITLE.

This Act may be cited as the "Department of Energy Science for the Future Act".

SEC. 2. MISSION OF THE OFFICE OF SCIENCE.

Section 209 of the Department of Energy Organization Act (42 U.S.C. 7139) is amended by adding at the end the following:

"(d) USER FACILITIES.—The Director shall carry out the construction, operation, and maintenance of user facilities to support the mission described in subsection (c). As practicable, these facilities shall serve the needs of the Department, industry, the academic community, and other relevant entities for the purposes of advancing the missions of the Department, improving the competitiveness of the United States, protecting public health and safety, and addressing other national priorities including emergencies.

"(e) COORDINATION.—

"(1) IN GENERAL.—The Secretary—

"(A) shall ensure the coordination of the Office of Science with the other activities of the Department;

"(B) shall support joint activities among the programs of the Department;

"(C) shall coordinate with other relevant Federal agencies in supporting advancements in related research areas as appropriate; and

"(D) may form partnerships to enhance the utilization of and ensure access to user facilities by other Federal agencies.

"(2) WITHIN THE OFFICE OF SCIENCE.—The Director shall ensure the coordination of programs and activities carried out by the Office of Science.".

SEC. 3. BASIC ENERGY SCIENCES PROGRAM.

(a) DEPARTMENT OF ENERGY RESEARCH AND INNOVATION ACT.—Section 303 of the Department of Energy Research and Innovation Act (42 U.S.C. 18641) is amended—

(1) by redesignating subsections (a) through (e) as subsections (c) through (g), respectively; and

(2) by inserting before subsection (c), as so redesignated, the following:

"(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research and development program in basic energy sciences, including materials sciences and engineering, chemical sciences, physical biosciences, geosciences, and other disciplines, to understand, model, and control matter and energy at the electronic, atomic, and molecular levels in order to provide the foundations for new energy technologies, address scientific grand challenges, and support the energy, environment, and national security missions of the Department.

"(b) SUSTAINABLE CHEMISTRY.—In carrying out chemistry-related research and development activities under this section, the Director shall prioritize research and development of sustainable chemistry to support clean, safe, and economic alternatives and methodologies to traditional chemical products and processes.";

(3) in subsection (d)(3), as so redesignated—

(A) in subparagraph (C), by striking "and" at the end;

(B) by redesignating subparagraph (D) as subparagraph (E); and

(C) by inserting after subparagraph (C) the following:

"(D) autonomous chemistry and materials synthesis and characterization facilities that leverage advances in artificial intelligence; and";

(4) in subsection (d), as so redesignated, by adding at the end the following:

"(4) ADVANCED PHOTON SOURCE UPGRADE.—

"(A) DEFINITIONS.—In this paragraph:

"(i) FLUX.—The term 'flux' means the rate of flow of photons.

"(ii) HARD X-RAY.—The term 'hard x-ray' means a photon with energy greater than 20 kiloelectron volts.

"(B) IN GENERAL.—The Secretary shall provide for the upgrade to the Advanced Photon Source described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades', including the development of a multi-bend achromat lattice to produce a high flux of coherent x-rays within the hard x-ray energy region and a suite of beamlines optimized for this source.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full oper-

ations of the upgrade under this paragraph occurs before March 31, 2026.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph $157,000,000 for fiscal year 2022.

"(5) SPALLATION NEUTRON SOURCE PROTON POWER UPGRADE.—

"(A) IN GENERAL.—The Secretary shall provide for the proton power upgrade to the Spallation Neutron Source.

"(B) PROTON POWER UPGRADE DEFINED.—For the purposes of this paragraph, the term 'proton power upgrade' means the Spallation Neutron Source power upgrade described in—

"(i) the publication titled 'Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in December, 2003;

"(ii) the publication titled 'Four Years Later: An Interim Report on Facilities for the Future of Science: A Twenty-Year

Outlook', published by the Office of Science of the Department of Energy in August, 2007; and

"(iii) the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades'.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the upgrade under this paragraph occurs before December 31, 2028.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph $49,800,000 for fiscal year 2022.

"(6) SPALLATION NEUTRON SOURCE SECOND TARGET STATION.—

"(A) IN GENERAL.—The Secretary shall provide for a second target station for the Spallation Neutron Source.

"(B) SECOND TARGET STATION DEFINED.—For the purposes of this paragraph, the term 'second target station' means the

Spallation Neutron Source second target station described in—

"(i) the publication titled, 'Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in December, 2003;

"(ii) the publication titled, 'Four Years Later: An Interim Report on Facilities for the Future of Science: A Twenty-Year Outlook', published by the Office of Science of the Department of Energy in August, 2007; and

"(iii) the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades'.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the second target station under this paragraph occurs before December 31, 2030, with the option for early operation in 2029.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there

shall be made available to the Secretary to carry out the activities under this paragraph, including construction—

"(i) $70,000,000 for fiscal year 2022;

"(ii) $127,000,000 for fiscal year 2023;

"(iii) $204,000,000 for fiscal year 2024;

"(iv) $279,000,000 for fiscal year 2025; and

"(v) $300,000,000 for fiscal year 2026.

"(7) ADVANCED LIGHT SOURCE UPGRADE.—

"(A) DEFINITIONS.—In this paragraph:

"(i) FLUX.—The term 'flux' means the rate of flow of photons.

"(ii) SOFT X-RAY.—The term 'soft x-ray' means a photon with energy in the range from 50 to 2,000 electron volts.

"(B) IN GENERAL.—The Secretary shall provide for the upgrade to the Advanced Light Source described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades', including the development of a

multibend achromat lattice to produce a high flux of coherent x-rays within the soft x-ray energy region.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the upgrade under this paragraph occurs before September 30, 2029.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph—

"(i) $75,100,000 for fiscal year 2022;

"(ii) $135,000,000 for fiscal year 2023;

"(iii) $102,500,000 for fiscal year 2024;

"(iv) $25,000,000 for fiscal year 2025; and

"(v) $25,000,000 for fiscal year 2026.

"(8) LINAC COHERENT LIGHT SOURCE II HIGH ENERGY UPGRADE.—

"(A) DEFINITIONS.—In this paragraph:

"(i) HIGH ENERGY X-RAY.—The term 'high energy x-ray' means a photon with

an energy in the 5 to 13 kiloelectron volt range.

"(ii) HIGH REPETITION RATE.—The term 'high repetition rate' means the delivery of x-ray pulses up to 1 million pulses per second.

"(iii) ULTRA-SHORT PULSE X-RAYS.—The term 'ultra-short pulse x-rays' means x-ray bursts capable of durations of less than 100 femtoseconds.

"(B) IN GENERAL.—The Secretary shall—

"(i) provide for the upgrade to the Linac Coherent Light Source II facility described in the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, titled 'Report on Facility Upgrades', including the development of experimental capabilities for high energy x-rays to reveal fundamental scientific discoveries; and

"(ii) ensure such upgrade enables the production and use of high energy, ultra-short pulse x-rays delivered at a high repetition rate.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the upgrade under this paragraph occurs before December 31, 2026.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the upgrade under this paragraph—

"(i) $106,925,000 for fiscal year 2022;

"(ii) $125,925,000 for fiscal year 2023;

"(iii) $115,000,000 for fiscal year 2024;

"(iv) $89,000,000 for fiscal year 2025; and

"(v) $49,344,000 for fiscal year 2026.

"(9) CRYOMODULE REPAIR AND MAINTENANCE FACILITY.—

"(A) IN GENERAL.—The Secretary shall provide for the construction of a cryomodule repair and maintenance facility to service the Linac Coherent Light Source II and upgrades to the facility. The Secretary shall consult with

the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility has the capability to maintain, repair, and test superconducting radiofrequency accelerator components.

"(B) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the activities under this paragraph—

"(i) $19,000,000 for fiscal year 2022;

"(ii) $25,000,000 for fiscal year 2023;

"(iii) $25,000,000 for fiscal year 2024; and

"(iv) $17,000,000 for fiscal year 2025.

"(10) NANOSCALE SCIENCE RESEARCH CENTER RECAPITALIZATION PROJECT.—

"(A) IN GENERAL.—The Secretary shall provide for the recapitalization of the Nanoscale Science Research Centers, to include the upgrade of equipment at each Center supported by the Office of Science on the date of enactment of the Department of Energy Science for the Future Act, to accelerate advances in the various fields of science including nanoscience,

materials, chemistry, biology, and quantum information science.

"(B) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out the recapitalization under this paragraph—

"(i) $20,000,000 for fiscal year 2022;

"(ii) $30,000,000 for fiscal year 2023;

"(iii) $20,000,000 for fiscal year 2024; and

"(iv) $20,000,000 for fiscal year 2025.";

(5) by adding at the end the following:

"(h) COMPUTATIONAL MATERIALS AND CHEMICAL SCIENCES.—

"(1) IN GENERAL.—The Director shall support a program of research and development for the application of advanced computing practices to foundational and emerging research problems in chemistry and materials science. Research activities shall include—

"(A) chemical catalysis research and development;

"(B) the use of large data sets to model materials phenomena, including through advanced characterization of materials, materials synthesis, processing, and innovative use of experimental and theoretical data;

"(C) co-design of chemical system and chemistry modeling software with advanced computing systems and hardware technologies; and

"(D) modeling of chemical processes, assemblies, and reactions such as molecular dynamics and quantum chemistry, including through novel computing methods.

"(2) COMPUTATIONAL MATERIALS AND CHEMICAL SCIENCES CENTERS.—

"(A) IN GENERAL.—In carrying out the activities authorized under paragraph (1), the Director shall select and establish up to six computational materials and chemical sciences centers to—

"(i) develop open-source, robust, and validated computational codes and user-friendly software, coupled with innovative use of experimental and theoretical data, to enable the design, discovery, and devel-

opment of new materials and chemical systems; and

"(ii) focus on overcoming challenges and maximizing the benefits of exascale and other high performance computing underpinned by accelerated node technologies.

"(B) SELECTION.—The Director shall select centers under subparagraph (A) on a competitive, merit-reviewed basis. The Director shall consider applications from the National Laboratories, institutes of higher education, multi-institutional collaborations, and other appropriate entities.

"(C) DURATION.—

"(i) A center selected under subparagraph (A) shall receive support for a period of not more than 5 years beginning on the date of establishment of that center, subject to the availability of appropriations.

"(ii) A center already in existence on the date of enactment of the Department of Energy Science for the Future Act may continue to receive support for a period of

not more than 5 years beginning on the date of establishment of that center.

"(D) RENEWAL.—Upon the expiration of any period of support of a center under this subsection, the Director may renew support for the center, on a merit-reviewed basis, for a period of not more than 5 years.

"(E) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming center for cause during the performance period.

"(i) MATERIALS RESEARCH DATABASE.—

"(1) IN GENERAL.—The Director shall support the development of a web-based platform to develop and provide access to a database of computed information on known and predicted materials properties and computational tools to accelerate breakthroughs in materials discovery and design.

"(2) PROGRAM.—In carrying out this subsection, the Director shall—

"(A) conduct cooperative research with industry, academia, and other research institutions to advance understanding, prediction, and manipulation of materials and facilitate the design of novel materials;

"(B) develop and maintain data infrastructure at user facilities that generate data to collect, analyze, label, and otherwise prepare the data for inclusion in the database;

"(C) leverage existing high performance computing systems to conduct high throughput calculations, and develop computational and data mining algorithms for the prediction of material properties;

"(D) strengthen the foundation for new technologies and advanced manufacturing; and

"(E) drive the development of advanced materials for applications that span the Department's missions in energy, environment, and national security.

"(3) COORDINATION.—In carrying out this subsection, the Director shall leverage programs and activities across the Department, including computational materials and chemical sciences centers established under subsection (h).

"(4) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there shall be made available to the Secretary to carry out activities under this subsection $10,000,000 for each of the fiscal years 2022 through 2026.

"(j) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $2,727,705,000 for fiscal year 2022;

"(2) $2,828,896,600 for fiscal year 2023;

"(3) $3,019,489,612 for fiscal year 2024;

"(4) $3,161,698,885 for fiscal year 2025; and

"(5) $3,291,651,600 for fiscal year 2026.".

(b) ARTIFICIAL PHOTOSYNTHESIS.—Section 973 of the Energy Policy Act of 2005 (42 U.S.C. 16313) is amended—

(1) in subsection (b), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated for Basic Energy Sciences, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2031."; and

(2) in subsection (c), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated in section 316 of the Department of Energy Research and Innovation Act, the Secretary shall make available for carrying out activities

under this subsection $50,000,000 for each of fiscal years 2022 through 2026.".

(c) ELECTRICITY STORAGE RESEARCH INITIATIVE.—Section 975 of the Energy Policy Act of 2005 (42 U.S.C.16315) is amended—

(1) in subsection (b), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated for Basic Energy Sciences, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.";

(2) in subsection (c), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated in section 316 of the Department of Energy Research and Innovation Act, the Secretary shall make available for carrying out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026."; and

(3) in subsection (d), by striking paragraph (4) and inserting:

"(4) FUNDING.—From within funds authorized to be appropriated in section 316 of the Department of Energy Research and Innovation Act, the Sec-

retary shall make available for carrying out activities under this subsection $20,000,000 for each of fiscal years 2022 through 2026.".

SEC. 4. BIOLOGICAL AND ENVIRONMENTAL RESEARCH.

(a) PROGRAM; BIOLOGICAL SYSTEMS; BIOMOLECULAR CHARACTERIZATION AND IMAGING SCIENCE.—Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) is amended—

(1) by redesignating subsection (a) as subsection (b);

(2) by inserting before subsection (b), as redesignated under paragraph (1), the following:

"(a) PROGRAM.—As part of the duties of the Director authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), and coordinated with the activities authorized under sections 303 and 304 of this Act, the Director shall carry out a program of research and development in the areas of biological systems science and climate and environmental science, including subsurface science, relevant to the development of new energy technologies and to support the energy, environmental, and national security missions of the Department.

"(b) BIOLOGICAL SYSTEMS.—The Director shall carry out research and development activities in genomic science including fundamental research on plants and mi-

crobes to increase systems-level understanding of the complex biological systems, which may include activities to—

"(1) accelerate breakthroughs and new knowledge that would enable the cost-effective, sustainable production of—

"(A) biomass-based liquid transportation fuels;

"(B) bioenergy; and

"(C) biobased materials from renewable biomass;

"(2) improve fundamental understanding of plant and microbial processes impacting the global carbon cycle, including processes for removing carbon dioxide from the atmosphere, through photosynthesis and other biological processes, for sequestration and storage;

"(3) understand the microbiome mechanisms used to transform, immobilize, or remove contaminants from subsurface environments;

"(4) develop the computational approaches and integrated platforms for open access collaborative science;

"(5) leverage tools and approaches across the Office of Science to expand research to include novel processes, methods, and science to develop bio-based

chemicals, polymers, inorganic materials, including research to—

"(A) advance biosystems design research to advance the understanding of how CRISPR tools and other gene editing tools and technologies work in nature, in the laboratory, and in practice;

"(B) deepen genome-enabled knowledge of root architecture and growth in crops, including trees; and

"(C) develop biosystems design methods and tools to increase the efficiency of photosynthesis in plants; and

"(6) develop other relevant methods and processes as determined by the Director.

"(c) BIOMOLECULAR CHARACTERIZATION AND IMAGING SCIENCE.—The Director shall carry out research and development activities in biomolecular characterization and imaging science, including development of integrative imaging and analysis platforms and biosensors to understand the expression, structure, and function of genome information encoded within cells and for real-time measurements in ecosystems and field sites of relevance to the mission of the Department of Energy.";

(3) by striking subsection (b) as redesignated under paragraph (1); and

(4) by redesignating subsections (b) through (d) as subsections (d) through (f), respectively.

(b) BIOENERGY RESEARCH CENTERS.—Section 977(f) of the Energy Policy Act of 2005 (42 U.S.C. 16317(f)) is amended to read as follows:

"(f) BIOENERGY RESEARCH CENTERS.—

"(1) IN GENERAL.—In carrying out the program under section 306(a) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(a)), the Director shall support up to six bioenergy research centers to conduct fundamental research in plant and microbial systems biology, biological imaging and analysis, and genomics, and to accelerate advanced research and development of biomass-based liquid transportation fuels, bioenergy, or biobased materials, chemicals, and products that are produced from a variety of regionally diverse feedstocks, and to facilitate the translation of research results to industry. The activities of the centers authorized under this subsection may include—

"(A) accelerating the domestication of bioenergy-relevant plants, microbes, and associated microbial communities to enable high-impact,

value-added coproduct development at multiple points in the bioenergy supply chain;

"(B) developing the science and technological advances to ensure process sustainability is considered in the creation of biofuels and bioproducts from lignocellulose; and

"(C) using the latest tools in genomics, molecular biology, catalysis science, chemical engineering, systems biology, and computational and robotics technologies to sustainably produce and transform biomass into biofuels and bioproducts.

"(2) SELECTION AND DURATION.—

"(A) IN GENERAL.—A center established under paragraph (1) shall be selected on a competitive, merit-reviewed basis for a period of not more than 5 years, subject to the availability of appropriations, beginning on the date of establishment of that center.

"(B) APPLICATIONS.—The Director shall consider applications from National Laboratories, multi-institutional collaborations, and other appropriate entities.

"(C) EXISTING CENTERS.—A center already in existence on the date of enactment of

the Department of Energy Science for the Future Act may continue to receive support for a period of not more than 5 years beginning on the date of establishment of that center.

"(3) RENEWAL.—After the end of either period described in paragraph (2), the Director may renew support for the center for a period of not more than 5 years on a merit-reviewed basis. For a center in operation for 10 years after its previous selection on a competitive, merit-reviewed basis, the Director may renew support for the center on a competitive, merit-reviewed basis for a period of not more than 5 years, and may subsequently provide an additional renewal on a merit-reviewed basis for a period of not more than 5 years.

"(4) TERMINATION.—Consistent with the existing authorities of the Department, the Director may terminate an underperforming center for cause during the performance period.

"(5) ACTIVITIES.—Centers shall undertake research activities to accelerate the production of biofuels and bioproducts from advanced biomass resources by identifying the most suitable species of plants for use as energy crops; and improving methods of breeding, propagation, planting, producing,

harvesting, storage and processing. Activities may include the following:

"(A) Research activities to increase sustainability, including—

"(i) advancing knowledge of how bioenergy crop interactions with biotic and abiotic environmental factors influence crop growth, yield, and quality;

"(ii) identifying the most impactful research areas that address the economics of biofuels and bioproducts production; and

"(iii) utilizing multiscale modeling to advance predictive understanding of biofuel cropping ecosystems.

"(B) Research activities to further feedstock development, including lignocellulosic, algal, gaseous wastes including carbon oxides and methane, and direct air capture of single carbon gases via plants and microbes, including—

"(i) developing genetic and genomic tools, high-throughput analytical tools, and biosystems design approaches to enhance bioenergy feedstocks and their associated microbiomes;

"(ii) conducting field testing of new potential bioenergy feedstock crops under environmentally benign and geographically diverse conditions to assess viability and robustness; and

"(iii) developing quantitative models informed by experimentation to predict how bioenergy feedstocks perform under diverse conditions.

"(C) Research activities to improve lignocellulosic deconstruction and separation methods, including—

"(i) developing feedstock-agnostic deconstruction processes capable of efficiently fractionating biomass into targeted output streams;

"(ii) gaining a detailed understanding of plant cell wall biosynthesis, composition, structure, and properties during deconstruction; and

"(iii) improving enzymes and approaches for biomass breakdown and cellulose, hemicellulose, and lignin processing.

"(D) Research activities to improve the feedstock conversion process for advanced biofuels and bioproducts, including—

"(i) developing high-throughput methods to screen or select high-performance microbial strains and communities to improve product formation rates, yields, and selectivity;

"(ii) establishing a broad set of platform microorganisms and microbial communities suitable for metabolic engineering to produce biofuels and bioproducts, as well as high-throughput methods for experimental validation of gene function;

"(iii) developing techniques to enhance microbial robustness for tolerating toxins to improve biofuel and bioproduct yields and to gain a better understanding of the cellular and molecular bases of tolerance for major chemical classes of inhibitors found in these processes;

"(iv) advancing technologies for the use of batch, continuous, as well as consolidated bioprocessing;

"(v) identifying, creating, and optimizing microbial and chemical pathways to produce promising, atom-economical intermediates and final bioproducts from biomass with considerations given to environmentally benign processes;

"(vi) developing high-throughput, real-time, in situ analytical techniques to understand and characterize the pre- and post-bioproduct separation streams in detail;

"(vii) creating methodologies for efficiently identifying viable target molecules, identifying high-value bioproducts in existing biomass streams, and utilizing current byproduct streams;

"(viii) identifying and improving plant feedstocks with enhanced extractable levels of desired bioproducts or bioproduct precursors, including lignin streams; and

"(ix) developing integrated biological and chemical catalytic approaches to valorize and produce a diverse portfolio of advanced fuels and bioproducts.

"(6) INDUSTRY PARTNERSHIPS.—Centers shall establish industry partnerships to translate research results to commercial applications.

"(7) COORDINATION.—In coordination with the Bioenergy Technologies Office of the Department, the Director shall support interdisciplinary research activities to improve the capacity, efficiency, resilience, security, reliability, and affordability, of the production and use of biofuels and bioproducts, as well as activities to enable positive impacts and avoid the potential negative impacts that the production and use of biofuels and bioproducts may have on ecosystems, people, and historically marginalized communities.".

(c) LOW-DOSE RADIATION RESEARCH PROGRAM.—Section 306(e)(8) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(c)(8)), as redesignated under subsection (a), is amended—

(1) in subparagraph (C), by striking "and";

(2) in subparagraph (D), by striking the period at the end and inserting a semicolon; and

(3) by adding at the end the following:

"(E) $40,000,000 for fiscal year 2025; and

"(F) $50,000,000 for fiscal year 2026.".

(d) LOW-DOSE RADIATION AND SPACE RADIATION RESEARCH PROGRAM.—Section 306(f) of the Department of Energy Research and Innovation Act (42 U.S.C. 18644(d)), as redesignated under subsection (a), is amended to read as follows:

"(f) LOW-DOSE RADIATION AND SPACE RADIATION RESEARCH PROGRAM.—

"(1) IN GENERAL.—The Secretary of Energy, in consultation with the Administrator of the National Aeronautics and Space Administration shall carry out a basic research program on the similarities and differences between the effects of exposure to low-dose radiation on Earth, in low Earth orbit, and in the space environment.

"(2) PURPOSE.—The purpose of this program is to accelerate breakthroughs in low-dose and low dose-rate radiation research and development as described in subsection (d) and to inform the advancement of new tools, technologies, and advanced materials needed to facilitate long-duration space exploration.".

(e) CLIMATE, ENVIRONMENTAL SCIENCE, AND OTHER ACTIVITIES.—Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) is further amended by adding at the end the following:

"(g) EARTH AND ENVIRONMENTAL SYSTEMS SCIENCES ACTIVITIES.—

"(1) IN GENERAL.—As part of the activities authorized under subsection (a), and in coordination with activities carried out under subsection (b), the Director shall carry out earth and environmental systems science research, in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, which may include activities to—

"(A) understand, observe, and model the response of Earth's atmosphere and biosphere to increased concentrations of greenhouse gas emissions and any associated changes in climate, including frequency and intensity of extreme weather events;

"(B) understand the coupled physical, chemical, and biological processes to transform, immobilize, remove, or move carbon, nitrogen, and other energy production-derived contaminants such as radionuclides and heavy metals, and understand the process of sequestration and transformation of these, carbon dioxide, and other relevant molecules in subsurface environments;

"(C) understand, observe, and model the cycling of water, carbon, and nutrients in terrestrial systems and at scales relevant to resources management;

"(D) understand the biological, biogeochemical, and physical processes across the multiple scales that control the flux of environmentally relevant compounds between the terrestrial surface and the atmosphere; and

"(E) inform potential natural mitigation and adaptation options for increased concentrations of greenhouse gas emissions and any associated changes in climate.

"(2) PRIORITIZATION.—In carrying out the program authorized under paragraph (1), the Director shall prioritize—

"(A) the development of software and algorithms to enable the productive application of environmental systems and extreme weather in climate and Earth system prediction models in high-performance computing systems; and

"(B) capabilities that support the Department's mission needs for energy and infrastructure security, resilience, and reliability.

"(3) ENVIRONMENTAL SYSTEMS SCIENCE RESEARCH.—

"(A) IN GENERAL.—As part of the activities described in paragraph (1), the Director shall carry out research to advance an integrated, robust, and scale-aware predictive understanding of environmental systems, including the role of hydrobiogeochemistry, from the subsurface to the top of the vegetative canopy that considers effects of seasonal to interannual variability and change.

"(B) COORDINATION.—

"(i) DIRECTOR.—The Director shall carry out activities under this paragraph in accordance with priorities established by the Secretary to support and accelerate the decontamination of relevant facilities managed by the Department.

"(ii) SECRETARY.—The Secretary shall ensure the coordination of activities of the Department, including activities under this paragraph, to support and accelerate the decontamination of relevant facilities managed by the Department.

"(4) CLIMATE AND EARTH MODELING.—As part of the activities described in paragraph (1), the Director, in collaboration with the Advanced Scientific Computing Research program described in section 304 and other programs carried out by the Department, as applicable, and in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, shall carry out research to develop, evaluate, and use high-resolution regional climate, global climate, Earth system, and other relevant models to inform decisions on reducing greenhouse gas emissions and the resulting impacts of a changing global climate. Such modeling shall include—

"(A) integrated capabilities for modeling multisectoral interactions, including socioeconomic factors as appropriate, which may include the impacts of climate policies on social and regional equity and well-being, and the interdependencies and risks at the energy-water-land nexus;

"(B) greenhouse gas emissions, air quality, energy supply and demand, and other critical elements; and

"(C) interaction among human and Earth systems informed by interdisciplinary research, including the economic and social sciences.

"(5) MID-SCALE FUNDING MECHANISM.—

"(A) IN GENERAL.—Any of the activities authorized in this subsection may be carried out by competitively selected mid-scale, multi-institutional research centers in lieu of individual research grants, or large-scale experiments or user facilities.

"(B) CONSIDERATION.—The Biological and Environmental Research Advisory Committee shall provide recommendations to the Director on projects most suitable for the research centers described in subparagraph (A).

"(h) BIOLOGICAL AND ENVIRONMENTAL RESEARCH USER FACILITIES.—

"(1) IN GENERAL.—The Director shall carry out a program for the development, construction, operation, and maintenance of user facilities to enhance the collection and analysis of observational data related to complex biological, climate, and environmental systems.

"(2) FACILITY REQUIREMENTS.—To the maximum extent practicable, the user facilities devel-

oped, constructed, operated, or maintained under paragraph (1) shall include—

"(A) distributed field research and observation platforms for understanding earth system processes;

"(B) analytical techniques, instruments, and modeling resources for understanding the physical, chemical, and cellular processes of biological and environmental systems;

"(C) integrated high-throughput sequencing, advanced bioanalytic techniques, DNA design and synthesis, metabolomics, and computational analysis; and

"(D) such other facilities as the Director considers appropriate, consistent with section 209 of the Department of Energy Organization Act (42 U.S.C. 7139).

"(3) EXISTING FACILITIES.—In carrying out the program established in paragraph (1), the Director is encouraged to evaluate the capabilities of existing user facilities and, to the maximum extent practicable, invest in modernization of those capabilities to address emerging research priorities.

"(4) USER FACILITIES INTEGRATION AND COLLABORATION PROGRAM.—

"(A) IN GENERAL.—The Director shall support a program of collaboration between user facilities as defined under this subsection to encourage and enable researchers to more readily integrate the tools, expertise, resources, and capabilities of multiple Office of Science user facilities (as described in section 209(d) of the Department of Energy Organization Act (42 U.S.C. 7139)) to further research and advance emerging technologies.

"(B) ACTIVITIES.—The program shall advance the integration of automation, robotics, computational biology, bioinformatics, biosensing, cellular platforms and other relevant emerging technologies as determined by the Director to enhance productivity and scientific impact of user facilities.

"(5) EARTH AND ENVIRONMENTAL SYSTEMS SCIENCES USER FACILITIES.—

"(A) IN GENERAL.—In carrying out the activities authorized under paragraph (1), the Director shall establish and operate user facilities to advance the collection, validation, and analysis of atmospheric data, including activities to advance knowledge and improve model

representations and measure the impact of atmospheric gases, aerosols, and clouds on earth and environmental systems.

"(B) SELECTION.—The Director shall select user facilities under paragraph (1) on a competitive, merit-reviewed basis. The Director shall consider applications from the National Laboratories, institutes of higher education, multi-institutional collaborations, and other appropriate entities.

"(C) EXISTING FACILITIES.—To the maximum extent practicable, the Director shall utilize existing facilities to carry out this subsection.

"(6) COORDINATION.—In carrying out the program authorized in paragraph (1), the Director shall ensure that the Office of Science—

"(A) consults and coordinates with the National Oceanic Atmospheric Administration, the Environmental Protection Agency, the National Aeronautics and Space Administration, the Department of Agriculture, the Department of the Interior, and any other relevant Federal agency on the collection, validation, and analysis of atmospheric data; and

"(B) coordinates with relevant stakeholders, including institutes of higher education, nonprofit research institutions, industry, State, local, and tribal governments, and other appropriate entities to ensure access to the best available relevant atmospheric and historical weather data.

"(i) COASTAL ZONE RESEARCH INITIATIVE.—

"(1) IN GENERAL.—The Director shall carry out a research program, in consultation with the National Oceanic and Atmospheric Administration, to enhance the understanding of coastal ecosystems. In carrying out this program, the Director shall prioritize efforts to enhance the collection of observational data, and shall develop models to analyze the ecological, biogeochemical, hydrological and physical processes that interact in coastal zones.

"(2) NATIONAL SYSTEM FOR COASTAL DATA COLLECTION.—The Director shall establish, in consultation with the National Oceanic and Atmospheric Administration and other relevant agencies, an integrated system of geographically diverse field research sites in order to improve the quantity and quality of observational data, and that encompass

the major land water interfaces of the United States, including—

"(A) the Great Lakes region;

"(B) the Pacific coast;

"(C) the Atlantic coast;

"(D) the Arctic; and

"(E) the Gulf coast.

"(3) EXISTING INFRASTRUCTURE.—In carrying out the programs and establishing the field research sites under paragraph (1) and (2), the Secretary shall leverage existing research and development infrastructure supported by the Department, including the Department's existing marine and coastal research lab.

"(4) COORDINATION.—For the purposes of carrying out the programs and establishing the field research sites under the Initiative, the Secretary may enter into agreements with Federal Departments and agencies with complementary capabilities.

"(5) REPORT.—Not less than 2 years after the date of the enactment of the Department of Energy Science for the Future Act, the Director shall provide to the Committee on Science, Space, and Technology and the Committee on Appropriations of the House of Representatives and the Committee on En-

ergy and Natural Resources and the Committee on Appropriations of the Senate a report examining whether the system described in this section should be established as a National User Facility.

"(j) TECHNOLOGY DEVELOPMENT.—The Director shall support a technology research program for the development of instrumentation and other research tools required to meet the missions of the Department and to provide platform technologies for the broader scientific community. Technologies shall include but are not limited to—

"(1) cryo-electron microscopy;

"(2) fabricated ecosystems;

"(3) next generation sensors including quantum sensors for biological integration and bioproduction;

"(4) technologies to accelerate data analysis; and

"(5) plant and microbial phenotyping for gene discovery.

"(k) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $820,360,000 for fiscal year 2022;

"(2) $886,385,200 for fiscal year 2023;

"(3) $956,332,164 for fiscal year 2024;

"(4) $1,020,475,415 for fiscal year 2025; and

"(5) $1,099,108,695 for fiscal year 2026.".

SEC. 5. ADVANCED SCIENTIFIC COMPUTING RESEARCH PROGRAM.

(a) ADVANCED SCIENTIFIC COMPUTING RESEARCH.—Section 304 of the Department of Energy Research and Innovation Act (42 U.S.C. 18642) is amended—

(1) by redesignating subsections (a) through (c) as subsections (b) through (d), respectively; and

(2) by inserting before subsection (b), as so redesignated, the following:

"(a) IN GENERAL.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out, in coordination with academia and relevant public and private sector entities, a research, development, and demonstration program to—

"(1) steward applied mathematics, computational science, and computer science research relevant to the missions of the Department and the competitiveness of the United States;

"(2) develop modeling, simulation, and other computational tools relevant to other scientific disciplines and to the development of new energy technologies and other technologies;

"(3) advance computating and networking capabilities for data-driven discovery; and

"(4) develop advanced scientific computing hardware and software tools for science and engineering.";

(3) in subsection (b) (as redesignated under paragraph (1))—

(A) by striking "the Director" and inserting "(1) DIRECTOR.—The Director"; and

(B) by adding at the end the following:

"(2) COORDINATION.—The Under Secretary for Science shall ensure the coordination of the activities of the Department, including activities under this section, to determine and meet the computational and networking research and facility needs of the Office of Science and all other relevant energy technology and energy efficiency programs within the Department and with other Federal agencies as appropriate.";

(4) by amending subsection (d), as so redesignated, to read as follows:

"(d) APPLIED MATHEMATICS AND SOFTWARE DEVELOPMENT FOR HIGH-END COMPUTING SYSTEMS AND COMPUTER SCIENCES RESEARCH.—

"(1) IN GENERAL.—The Director shall carry out activities to develop, test, and support—

"(A) mathematics, statistics, and algorithms for modeling complex systems relevant to the missions of the Department, including on advanced computing architectures; and

"(B) tools, languages, programming environments, and operations for high-end computing systems (as defined in section 2 of the American Super Computing Leadership Act (15 U.S.C. 5541).

"(2) PORTFOLIO BALANCE.—

"(A) IN GENERAL.—The Director shall maintain a balanced portfolio within the advanced scientific computing research and development program established under section 976 of the Energy Policy Act of 2005 (42 U.S.C. 16316) that supports robust investment in—

"(i) applied mathematical, computational, and computer sciences research needs relevant to the mission of the Department, including foundational areas that are critical to the advancement of energy sciences and technologies and new and emerging computing technologies; and

"(ii) associated high-performance computing hardware and facilities.

"(B) EXASCALE ECOSYSTEM SUSTAINMENT.—

"(i) SENSE OF CONGRESS.—It is the sense of Congress that the Exascale Computing Project has successfully created a broad ecosystem that provides shared software packages, novel evaluation systems, and applications relevant to the science and engineering requirements of the Department, and that such products must be maintained and improved in order that the full potential of the deployed systems can be continuously realized.

"(ii) IN GENERAL.—The Secretary shall seek to sustain and evolve the ecosystem referenced in clause (i) to ensure that the exascale software stack and other research software will continue to be maintained, hardened, and otherwise optimized for long-term use on exascale systems and beyond and reliable availability to the user community."; and

(5) by inserting after subsection (d) the following:

"(e) NEXT GENERATION COMPUTING PROGRAM.—

"(1) IN GENERAL.—The Secretary shall establish a program to develop and implement a strategy for achieving computing systems with capabilities beyond exascale computing systems. In establishing this program, the Secretary shall—

"(A) maintain foundational research programs in mathematical, computational, and computer sciences focused on new and emerging computing needs within the mission of the Department, including post-Moore's law computing architectures, novel approaches to modeling and simulation, artificial intelligence and scientific machine learning, quantum computing, edge computing, extreme heterogeneity, and distributed high-performance computing; and

"(B) retain best practices and maintain support for essential hardware, applications, and software elements of the Exascale Computing Program that are necessary for sustaining the vitality of a long-term capable software ecosystem for exascale and beyond; and

"(C) develop a Department-wide strategy for balancing on-premises and cloud-based computing and scientific data management.

"(2) REPORT.—Not later than one year after the date of the enactment of this Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives, and the Committee on Energy and Natural Resources of the Senate, a report on the development and implementation of the strategy outlined in paragraph (1).

"(f) ARCHITECTURAL RESEARCH IN HETEROGENEOUS COMPUTING SYSTEMS.—

"(1) IN GENERAL.—The Secretary shall carry out a program of research and development in heterogeneous and reconfigurable computing systems to expand understanding of the potential for heterogeneous and reconfigurable computing systems to deliver high performance, high efficiency computing for Department of Energy mission challenges. This shall include research and development that explores the convergence of big data analytics, simulations, and artificial intelligence to drive the design of heterogenous computing system architectures.

"(2) COORDINATION.—In carrying out this program, the Secretary shall ensure coordination between research activities undertaken by the Advanced Scientific Computing Research program and materials research supported by the Basic Energy Sciences program within the Department of Energy Office of Science.

"(g) ENERGY EFFICIENT COMPUTING PROGRAM.—

"(1) IN GENERAL.—The Secretary shall support a program of fundamental research, development, and demonstration of energy efficient computing and data center technologies relevant to advanced computing applications, including high performance computing, artificial intelligence, and scientific machine learning.

"(2) EXECUTION.—

"(A) PROGRAM.—In carrying out the program under paragraph (1), the Secretary shall—

"(i) establish a partnership for National Laboratories, industry partners, and institutions of higher education for co-design of energy efficient hardware, technology, software, and applications across all applicable program offices of the De-

partment, and provide access to energy efficient computing resources to such partners;

"(ii) develop hardware and software technologies that decrease the energy needs of advanced computing practices, including through data center co-design; and

"(iii) consider multiple heterogeneous computing architectures in collaboration with the program established under subsection (f) including neuromorphic computing, persistent computing, and ultrafast networking; and

"(iv) provide, as appropriate, on a competitive, merit-reviewed basis, access for researchers from institutions of higher education, National Laboratories, industry, and other Federal agencies to the energy efficient computing technologies developed pursuant to clause (i).

"(B) SELECTION OF PARTNERS.—In selecting participants for the partnership established under subparagraph (A)(i), the Secretary shall select participants through a competitive, merit review process.

"(C) REPORT.—Not later than one year after the date of the enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives, and the Committee on Energy and Natural Resources of the Senate, a report on—

"(i) the activities conducted under subparagraph (A); and

"(ii) the coordination and management of the program under subparagraph (A) to ensure an integrated research program across the Department.

"(h) ENERGY SCIENCES NETWORK.—

"(1) IN GENERAL.—The Secretary shall provide for upgrades to the Energy Sciences Network user facility in order to meet the research needs of the Department for highly reliable data transport capabilities optimized for the requirements of large-scale science.

"(2) CAPABILITIES.—In carrying out paragraph (1), the Secretary shall ensure the following capabilities:

"(A) To provide high bandwidth scientific networking across the continental United States and the Atlantic Ocean.

"(B) To ensure network reliability.

"(C) To protect the network infrastructure from cyber-attacks.

"(D) To manage transport of exponentially increasing levels of data from the Department's National Laboratories and sites, user facilities, experiments, and sensors.

"(E) To contribute to the integration of heterogeneous computing frameworks and systems.

"(i) COMPUTATIONAL SCIENCE GRADUATE FELLOWSHIP.—

"(1) IN GENERAL.—The Secretary shall support the Computational Science Graduate Fellowship program in order to facilitate collaboration between graduate students and researchers at the National Laboratories, and contribute to the development of a diverse and inclusive computational workforce to help advance research in areas relevant to the mission of the Department.

"(2) FUNDING.—From within funds authorized to be appropriated for Advanced Scientific Com-

puting Research Program, the Secretary shall make available for carrying out the activities under this section—

"(A) $21,000,000 for fiscal year 2022;

"(B) $22,050,000 for fiscal year 2023;

"(C) $23,152,500 for fiscal year 2024;

"(D) $24,310,125 for fiscal year 2025; and

"(E) $25,525,631 for fiscal year 2026.

"(j) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $1,126,350,000 for fiscal year 2022;

"(2) $1,222,674,500 for fiscal year 2023;

"(3) $1,324,320,715 for fiscal year 2024;

"(4) $1,431,660,115 for fiscal year 2025; and

"(5) $1,535,090,121 for fiscal year 2026.".

(b) QUANTUM SCIENCE NETWORK.—

(1) DEFINITIONS.—Section 2 of the National Quantum Initiative Act (15 U.S.C. 8801) is amended—

(A) by redesignating paragraph (7) as paragraph (8); and

(B) by inserting after paragraph (6) the following:

"(7) QUANTUM NETWORK INFRASTRUCTURE.—The term 'quantum network infrastructure' means any facility, expertise, or capability that is necessary to enable the development and deployment of scalable and diverse quantum network technologies.".

(2) DEPARTMENT OF ENERGY QUANTUM NETWORK INFRASTRUCTURE RESEARCH AND DEVELOPMENT PROGRAM.—Title IV of the National Quantum Initiative Act (15 U.S.C. 8851 et seq.) is amended by adding at the end the following:

"SEC. 403. DEPARTMENT OF ENERGY QUANTUM NETWORK INFRASTRUCTURE RESEARCH AND DEVELOPMENT PROGRAM.

"(a) IN GENERAL.—The Secretary of Energy (referred to in this section as the 'Secretary') shall carry out a research, development, and demonstration program to accelerate innovation in quantum network infrastructure in order to—

"(1) facilitate the advancement of distributed quantum computing systems through the internet and intranet;

"(2) improve the precision of measurements of scientific phenomena and physical imaging technologies; and

"(3) develop secure national quantum communications technologies and strategies.

"(b) PROGRAM.—In carrying out this section, the Secretary shall—

"(1) coordinate with—

"(A) the Director of the National Science Foundation;

"(B) the Director of the National Institute of Standards and Technology;

"(C) the Chair of the subcommittee on Quantum Information Science of the National Science and Technology Council established under section 103(a); and

"(D) the Chair of the subcommittee on the Economic and Security Implications of Quantum Science;

"(2) conduct cooperative research with industry, National Laboratories, institutions of higher education, and other research institutions to facilitate new quantum infrastructure methods and technologies, including—

"(A) quantum-limited detectors, ultra-low loss optical channels, space-to-ground connections, and classical networking and cybersecurity protocols;

"(B) entanglement and hyper-entangled state sources and transmission, control, and measurement of quantum states;

"(C) quantum interconnects that allow short range local connections between quantum processors;

"(D) transducers for quantum sources and signals between optical and telecommunications regimes and quantum computer-relevant domains, including microwaves;

"(E) development of quantum memory buffers and small-scale quantum computers that are compatible with photon-based quantum bits in the optical or telecommunications wavelengths;

"(F) long-range entanglement distribution at both the terrestrial and space-based level using quantum repeaters, allowing entanglement-based protocols between small- and large scale quantum processors;

"(G) quantum routers, multiplexers, repeaters, and related technologies necessary to create secure long-distance quantum communication; and

"(H) integration of systems across the quantum technology stack into traditional computing networks, including the development of remote controlled, high performance, and reliable implementations of key quantum network components;

"(3) engage with the Quantum Economic Development Consortium (QED–C) to transition component technologies to help facilitate as appropriate the development of a quantum supply chain for quantum network technologies;

"(4) advance basic research in advanced scientific computing, particle and nuclear physics, and material science to enhance the understanding, prediction, and manipulation of materials, processes, and physical phenomena relevant to quantum network infrastructure;

"(5) develop experimental tools and testbeds necessary to support cross-cutting fundamental research and development activities with diverse stakeholders from industry and institutions of higher education; and

"(6) consider quantum network infrastructure applications that span the Department of Energy's

missions in energy, environment, and national security.

"(c) LEVERAGING.—In carrying out this section, the Secretary shall leverage resources, infrastructure, and expertise across the Department of Energy and from—

"(1) the National Institute of Standards and Technology;

"(2) the National Science Foundation;

"(3) the National Aeronautics and Space Administration;

"(4) other relevant Federal agencies;

"(5) the National Laboratories;

"(6) industry stakeholders;

"(7) institutions of higher education; and

"(8) the National Quantum Information Science Research Centers.

"(d) RESEARCH PLAN.—Not later than 180 days after the date of the enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate, a 4-year research plan that identifies and prioritizes basic research needs relating to quantum network infrastructure.

"(e) STANDARD OF REVIEW.—The Secretary shall review activities carried out under this section to determine the achievement of technical milestones.

"(f) FUNDING.—Out of funds authorized to be appropriated for the Department of Energy's Office of Science, there shall be made available to the Secretary to carry out the activities under this section, $100,000,000 for each of fiscal years 2022 through 2026.

"SEC. 404. DEPARTMENT OF ENERGY QUANTUM USER EXPANSION FOR SCIENCE AND TECHNOLOGY PROGRAM.

"(a) IN GENERAL.—The Secretary of Energy (referred to in this section as the 'Secretary') shall establish and carry out a program (to be known as the 'Quantum User Expansion for Science and Technology program' or 'QUEST program') to encourage and facilitate access to United States quantum computing hardware and quantum computing clouds for research purposes in order to—

"(1) enhance the United States quantum research enterprise;

"(2) educate the future quantum computing workforce; and

"(3) accelerate the advancement of United States quantum computing capabilities.

"(b) PROGRAM.—In carrying out this section, the Secretary shall—

"(1) coordinate with—

"(A) the Director of the National Science Foundation;

"(B) the Director of the National Institute of Standards and Technology;

"(C) the Chair of the Quantum Information Science of the National Science and Technology Council established under section 103(a); and

"(D) the Chair of the subcommittee on the Economic and Security Implications of Quantum Science;

"(2) provide researchers based within the United States with access to, and use of, United States quantum computing resources through a competitive, merit-reviewed process;

"(3) consider applications from the National Laboratories, multi-institutional collaborations, institutions of higher education, industry stakeholders, and any other entities that the Secretary determines are appropriate to provide national leadership on quantum computing related issues; and

"(4) consult and coordinate with private sector stakeholders, the user community, and interagency partners on program development and best management practices.

"(c) LEVERAGING.—In carrying out this section, the Secretary shall leverage resources and expertise across the Department of Energy and from—

"(1) the National Institute of Standards and Technology;

"(2) the National Science Foundation;

"(3) the National Aeronautics and Space Administration;

"(4) other relevant Federal agencies;

"(5) the National Laboratories;

"(6) industry stakeholders;

"(7) institutions of higher education; and

"(8) the National Quantum Information Science Research Centers.

"(d) SECURITY.—In carrying out the activities authorized by this section, the Secretary, in consultation with the Director of the National Science Foundation and the Director of the National Institute of Standards and Technology, shall ensure proper security controls are in place to protect sensitive information, as appropriate.

"(e) FUNDING.—Out of funds authorized to be appropriated for the Department of Energy's Office of Science, there shall be made available to the Secretary to carry out the activities under this section—

"(1) $30,000,000 for fiscal year 2022;

"(2) $50,000,000 for fiscal year 2023;

"(3) $70,000,000 for fiscal year 2024;

"(4) $90,000,000 for fiscal year 2025; and

"(5) $100,000,000 for fiscal year 2026.

"(f) EQUITABLE USE OF HIGH-PERFORMANCE COMPUTING CAPABILITIES.—

"(1) SENSE OF CONGRESS.—It is the sense of Congress that machine learning algorithms can exhibit biases that cause harm to historically marginalized communities.

"(2) POLICY.—In leveraging high-performance computing systems for research purposes, including through the use of machine learning algorithms for data analysis, the Secretary shall ensure that such capabilities are employed in a manner that mitigates and, to the maximum extent practicable, avoids harmful algorithmic bias and equitably addresses challenges impacting different populations, including historically marginalized communities.".

SEC. 6. FUSION ENERGY RESEARCH.

(a) FUSION ENERGY RESEARCH.—Section 307 of the Department of Energy Research and Innovation Act (42 U.S.C. 18645) is amended—

(1) in subsection (b)—

(A) in the matter preceding paragraph (1), by striking "As part of" and inserting "(1) IN GENERAL.—As part of";

(B) by redesignating—

(i) paragraphs (1) and (2) as subparagraphs (A) and (B), respectively; and

(ii) in subparagraph (B) (as redesignated by clause (i)), subparagraphs (A) and (B) as clauses (i) and (ii), respectively; and

(C) by adding at the end the following:

"(2) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated under subsection (r), there are authorized to be appropriated to the Secretary to carry out activities described in paragraph (1) $50,000,000 for each of fiscal years 2022 through 2026.";

(2) in subsection (d)(3)—

(A) by striking the period at the end and inserting "and $40,000,000 for fiscal year 2026."; and

(B) by striking "(o)" and inserting "(r)"; and

(3) in subsection (e)(4)—

(A) by striking the period at the end and inserting "and $75,000,000 for fiscal year 2026."; and

(B) by striking "(o)" and inserting "(r)";

(4) in subsection (i)(10)—

(A) In the matter preceding subparagraph (A), by striking "(o)" and inserting "(r)";

(B) in subparagraph (D), by striking "; and" and inserting a semicolon;

(C) in subparagraph (E), by striking the period at the end and inserting "; and"; and

(D) by adding at the end the following:

"(F) $45,000,000 for fiscal year 2026.";

(5) in subsection (j)—

(A) by striking "The Director" and inserting "(1) IN GENERAL.—The Director"; and

(B) by adding at the end the following:

"(2) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out activities described in paragraph (1)—

"(A) $20,000,000 for fiscal year 2022;

"(B) $35,000,000 for fiscal year 2023;

"(C) $50,000,000 for fiscal year 2024;

"(D) $65,000,000 for fiscal year 2025; and

"(E) $80,000,000 for fiscal year 2026.";

(6) in subsection (l)—

(A) by striking "sense of Congress that" and inserting "sense of Congress that—";

(B) by striking "United States should support" and inserting "(1) United States should support"; and

(C) by adding at the end the following:

"(2) the Director shall incorporate the findings and recommendations of the report of the Fusion Energy Sciences Advisory Committee entitled 'Powering the Future: Fusion and Plasmas' and the report of the National Academies entitled "Bringing Fusion to the U.S. Grid" into the planning process of the Department, including the development of future budget requests to Congress.";

(7) by redesignating subsection (o) as subsection (r);

(8) by inserting after subsection (n) the following:

"(o) HIGH-PERFORMANCE COMPUTATION COLLABORATIVE RESEARCH PROGRAM.—

"(1) IN GENERAL.—The Secretary shall carry out a program to conduct and support collaborative research, development, and demonstration of fusion energy technologies, through high-performance computation modeling and simulation techniques, in order to—

"(A) support fundamental research in plasmas and matter at very high temperatures and densities;

"(B) inform the development of a broad range of fusion energy systems; and

"(C) facilitate the translation of research results in fusion energy science to industry.

"(2) COORDINATION.—In carrying out the program under paragraph (1), the Secretary shall coordinate with relevant Federal agencies, and prioritize the following objectives:

"(A) Using expertise from the private sector, institutions of higher education, and the National Laboratories to leverage existing, and develop new, computational software and capabilities that prospective users may use to accelerate research and development of fusion energy systems.

"(B) Developing computational tools to simulate and predict fusion energy science phenomena that may be validated through physical experimentation.

"(C) Increasing the utility of the research infrastructure of the Department by coordinating with the Advanced Scientific Computing Research program within the Office of Science.

"(D) Leveraging experience from existing modeling and simulation entities sponsored by the Department.

"(E) Ensuring that new experimental and computational tools are accessible to relevant research communities, including private sector entities engaged in fusion energy technology development.

"(F) Ensuring that newly developed computational tools are compatible with modern virtual engineering and visualization capabilities to accelerate the realization of fusion energy technologies and systems.

"(3) DUPLICATION.—The Secretary shall ensure the coordination of, and avoid unnecessary duplication of, the activities of this program with the activities of—

"(A) other research entities of the Department, including the National Laboratories, the Advanced Research Projects Agency–Energy, the Advanced Scientific Computing Research program; and

"(B) industry.

"(4) HIGH-PERFORMANCE COMPUTING FOR FUSION INNOVATION CENTER.—In carrying out the program under paragraph (1), the Secretary shall, in coordination with the Innovation Network for Fusion Energy, establish and operate a national High-Performance Computing for Fusion Innovation Center (referred to in this section as the 'Center'), in order to support the program under paragraph (1) by providing, to the extent practicable, a centralized entity for multidisciplinary, collaborative, fusion energy research and development through high performance computing and advanced data analytics technologies and processes.

"(5) SELECTION.—The Secretary shall select the Center under this subsection on a competitive, merit-reviewed basis. The Secretary shall consider applications from National Laboratories, institutions of higher education, multi-institutional collaborations, and other appropriate entities.

"(6) EXISTING ACTIVITIES.—The Center may incorporate existing research activities that are consistent with the program described in paragraph (1).

"(7) DURATION.—The Center established under this subsection shall receive support for a period of not more than 5 years, subject to the availability of appropriations.

"(8) RENEWAL.—Upon the expiration of any period of support of the Center, the Secretary may renew support for the Center, on a merit-reviewed basis, for a period of not more than 5 years.

"(9) TERMINATION.—Consistent with the existing authorities of the Department, the Secretary may terminate the Center for cause during the performance period.

"(p) MATERIAL PLASMA EXPOSURE EXPERIMENT.—

"(1) IN GENERAL.—The Secretary shall construct a Material Plasma Exposure Experiment facility as described in the 2020 publication approved by the Fusion Energy Sciences Advisory Committee titled 'Powering the Future: Fusion and Plasmas'. The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility is capable of meeting Federal research needs for steady

state, high-heat-flux and plasma-material interaction testing of fusion materials over a range of fusion energy relevant parameters.

"(2) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in subsection (a) will provide the following capabilities:

"(A) A magnetic field at the target of 1 Tesla.

"(B) An energy flux at the target of 10 MW/m2.

"(C) The ability to expose previously irradiated plasma facing material samples to plasma.

"(3) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2027.

"(4) FUNDING.—Out of funds authorized to be appropriated for Fusion Energy Sciences, there are funds authorized to be appropriated to the Secretary for the Office of Fusion Energy Sciences to carry out to completion the construction of the facility under this section:

"(A) $32,800,000 for fiscal year 2022;

"(B) $13,400,000 for fiscal year 2023;

"(C) $12,600,000 for fiscal year 2024; and

"(D) $400,000 for fiscal year 2025.

"(q) MATTER IN EXTREME CONDITIONS INSTRUMENT UPGRADE.—

"(1) IN GENERAL.—The Secretary shall provide for the upgrade to the Matter in Extreme Conditions endstation at the Linac Coherent Light Source as described in the 2020 publication approved by the Fusion Energy Sciences Advisory Committee titled 'Powering the Future: Fusion and Plasmas'. The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Federal agencies to ensure that this facility is capable of meeting Federal research needs for understanding physical and chemical changes to plasmas at fundamental timescales, and explore new regimes of dense material physics, astrophysics, planetary physics, and short-pulse laser-plasma interactions.

"(2) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2028."; and

(9) in subsection (r), as so redesignated, by striking paragraphs (2) through (5) and inserting the following:

"(2) $1,002,900,000 for fiscal year 2022;

"(3) $1,095,707,000 for fiscal year 2023;

"(4) $1,129,368,490 for fiscal year 2024;

"(5) $1,149,042,284 for fiscal year 2025; and

"(6) $1,243,097,244 for fiscal year 2026.".

(b) ITER CONSTRUCTION.—Section 972 of the Energy Policy Act of 2005 (42 U.S.C. 16312) is amended in subsection (c)(3)—

(1) in subparagraph (A), by striking "and" at the end; and

(2) by striking subparagraph (B) and inserting the following:

"(B) $300,000,000 for fiscal year 2022;

"(C) $325,000,000 for fiscal year 2023;

"(D) $350,000,000 for fiscal year 2024;

"(E) $350,000,000 for fiscal year 2025; and

"(F) $350,000,000 for fiscal year 2026.".

SEC. 7. HIGH ENERGY PHYSICS PROGRAM.

(a) PROGRAM.—Section 305 of the Department of Energy Research and Innovation Act (42 U.S.C. 18643) is amended—

(1) by redesignating subsections (b) through (d) as subsections (d) through (f), respectively; and

(2) by inserting the following after subsection (a):

"(b) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program in elementary particle physics and advanced technology research and development to improve the understanding of the fundamental properties of the universe, including constituents of matter and energy and the nature of space and time.

"(c) HIGH ENERGY FRONTIER RESEARCH.—As part of the program described in subsection (a), the Director shall carry out research using high energy accelerators and advanced detectors, including accelerators and detectors that will function as national user facilities, to create and study interactions of elementary particles and investigate fundamental forces.".

(b) INTERNATIONAL COLLABORATION.—Section 305(d) of the Department of Energy Research and Innovation Act (42 U.S.C. 18643(d)), as redesignated under subsection (a), is amended to read as follows:

"(d) INTERNATIONAL COLLABORATION.—The Director shall—

"(1) as practicable and in coordination with other appropriate Federal agencies as necessary, ensure the access of United States researchers to the most advanced accelerator facilities and research capabilities in the world, including the Large Hadron Collider;

"(2) to the maximum extent practicable, continue to leverage United States participation in the Large Hadron Collider, and prioritize expanding international partnerships and investments in the Long-Baseline Neutrino Facility and Deep Underground Neutrino Experiment; and

"(3) to the maximum extent practicable, prioritize engagement in collaborative efforts in support of future international facilities that would provide access to the most advanced accelerator facilities in the world to United States researchers.".

(c) COSMIC FRONTIER RESEARCH.—Section 305(f) of the Department of Energy Research and Innovation Act (42 U.S.C. 18645(f)), as redesignated by subsection (a), is amended to read as follows:

"(f) COSMIC FRONTIER RESEARCH.—The Director shall carry out research activities on the nature of the primary contents of the universe, including the nature of dark energy and dark matter. These activities shall, to the

maximum extent practicable, be consistent with the research priorities identified by the High Energy Physics Advisory Panel or the National Academy of Sciences, and may include—

"(1) collaborations with the National Aeronautics and Space Administration, the National Science Foundation, or international partners on relevant projects; and

"(2) the development of space-based, land-based, water-based, and underground facilities and experiments.".

(d) FURTHER ACTIVITIES.—Section 305 of the Department of Energy Research and Innovation Act (42 U.S.C. 18645), as amended, is further amended by adding at the end the following:

"(g) FACILITY CONSTRUCTION AND MAJOR ITEMS OF EQUIPMENT.—

"(1) PROJECTS.—Consistent with the Office of Science's project management practices, the Director shall, to the maximum extent practicable, incorporate the findings and recommendations of the 2014 Particle Physics Project Prioritization Panel (P5) report titled 'Building for Discovery', and support construction or fabrication of—

"(A) an international Long-Baseline Neutrino Facility based in the United States;

"(B) the Proton Improvement Plan II;

"(C) Second Generation Dark Matter experiments;

"(D) the Legacy Survey of Space and Time camera;

"(E) upgrades to detectors and other components of the Large Hadron Collider; and

"(F) other high priority projects recommended in the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel.

"(2) LONG-BASELINE NEUTRINO FACILITY.—

"(A) IN GENERAL.—The Secretary shall support construction of a Long-Baseline Neutrino Facility to facilitate the international Deep Underground Neutrino Experiment to examine the fundamental properties of neutrinos, explore physics beyond the Standard Model, and better clarify the existence and nature of antimatter.

"(B) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in

subparagraph (A) will provide, at a minimum, the following capabilities:

"(i) A neutrino beam with wideband capability of 1.2 megawatts (MW) of beam power and upgradable to 2.4 MW of beam power.

"(ii) Three caverns excavated for a 70 kiloton fiducial detector mass and supporting surface buildings and utilities.

"(iii) Cryogenic systems to support neutrino detectors.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this subsection occurs before December 31, 2031.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $200,000,000 for fiscal year 2022;

"(ii) $325,000,000 for fiscal year 2023;

"(iii) $400,000,000 for fiscal year 2024;

"(iv) $375,000,000 for fiscal year 2025; and

"(v) $250,000,000 for fiscal year 2026.

"(3) PROTON IMPROVEMENT PLAN–II ACCELERATOR UPGRADE PROJECT.—

"(A) IN GENERAL.—The Secretary of Energy shall support construction of the Proton Improvement Plan II, an upgrade to the Fermilab accelerator complex identified in the 2014 Particle Physics Project Prioritization Panel (P5) report titled 'Building for Discovery', to provide the world's most intense beam of neutrinos to the international Long Baseline Neutrino Facility as well as abroad range of future high energy physics experiments. The Secretary of Energy shall work with international partners to enable further significant contributions to the capabilities of this project.

"(B) FACILITY CAPABILITIES.—The Secretary shall ensure that the facility described in

paragraph (1) will provide, at a minimum, the following capabilities:

"(i) A state-of-the-art 800 megaelectron volt (MeV) superconducting linear accelerator.

"(ii) Proton beam power of 1.2 MW at the start of LBNF/DUNE, upgradeable to 2.4 MW of beam power.

"(iii) A flexible design to enable high power beam delivery to multiple users simultaneously and customized beams tailored to specific scientific needs.

"(iv) Sustained high reliability operation of the Fermilab accelerator complex.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2028.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $191,000,000 for fiscal year 2022;

"(ii) $150,000,000 for fiscal year 2023;

"(iii) $120,000,000 for fiscal year 2024;

"(iv) $120,000,000 for fiscal year 2025; and

"(v) $100,000,000 for fiscal year 2026.

"(4) COSMIC MICROWAVE BACKGROUND STAGE 4.—

"(A) IN GENERAL.—The Secretary of Energy, in partnership with the Director of the National Science Foundation, shall support construction of the Cosmic Microwave Background Stage 4 project to survey the cosmic microwave background to test theories of cosmic inflation as described in the 2014 Particle Physics Prioritization Panel (P5) report titled 'Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context.'.

"(B) CONSULTATION.—The Secretary shall consult with the private sector, universities, National Laboratories, and relevant Fed-

eral agencies to ensure that this experiment is capable of meeting Federal research needs in accessing the ultra-high energy physics of inflation and important neutrino properties.

"(C) EXPERIMENTAL CAPABILITIES.—The Secretary shall ensure to the maximum extent practicable that the facility described in subsection (a) will provide at minimum, 500,000 superconducting detectors deployed on an array of mm wave telescopes with the required range in frequency, sensitivity, and survey speed which will provide sufficient capability to enable an order of magnitude advance in observations of the Cosmic Microwave Background, delivering transformative discoveries in fundamental physics, cosmology, and astrophysics.

"(D) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2030.

"(E) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there shall be made available to the Secretary to

carry out construction of the facility under this subsection—

"(i) $37,000,000 for fiscal year 2022;

"(ii) $50,000,000 for fiscal year 2023;

"(iii) $70,000,000 for fiscal year 2024;

"(iv) $80,000,000 for fiscal year 2025; and

"(v) $90,000,000 for fiscal year 2026.

"(h) ACCELERATOR AND DETECTOR UPGRADES.—The Director shall upgrade accelerator facilities and detectors, as necessary and appropriate, to increase beam power, sustain high reliability, and improve precision measurement to advance the highest priority particle physics research programs. In carrying out facility upgrades, the Director shall continue to work with international partners, when appropriate and in the United States' interest, to leverage investments and expertise in critical technologies to help build and upgrade accelerator and detector facilities in the United States.

"(i) ACCELERATOR AND DETECTOR RESEARCH AND DEVELOPMENT.—As part of the program described in subsection (a), the Director shall carry out research and development in particle beam physics, accelerator science and technology, and particle and radiation detection with

relevance to the specific needs of the High Energy Physics program, in coordination with the Accelerator Research and Development program authorized in section 311.

"(j) UNDERGROUND SCIENCE.—The Director shall—

"(1) support an underground science program consistent with the missions of the Department and the scientific needs of the High Energy Physics program, including those articulated in the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel, that leverages the capabilities of relevant underground science and engineering facilities; and

"(2) carry out a competitive grant program to award scientists and engineers at institutions of higher education, nonprofit institutions, and national laboratories to conduct research in underground science and engineering.

"(k) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $1,355,690,000 for fiscal year 2022;

"(2) $1,517,628,300 for fiscal year 2023;

"(3) $1,652,112,281 for fiscal year 2024;

"(4) $1,711,460,141 for fiscal year 2025; and

"(5) $1,656,012,351 for fiscal year 2026.".

SEC. 8. NUCLEAR PHYSICS PROGRAM.

(a) PROGRAM.—Section 308 of the Department of Energy Research and Innovation Act (42 U.S.C. 18646) is amended—

(1) by striking subsection (a);

(2) by redesignating subsection (b) as subsection (d); and

(3) by inserting the following before subsection (d), as so redesignated:

"(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program, and support relevant facilities, to discover and understand various forms of nuclear matter.

"(b) USER FACILITIES.—

"(1) FACILITY FOR RARE ISOTOPE BEAMS.—

"(A) IN GENERAL.—The Secretary shall support construction of a Facility for Rare Isotope Beams to advance the understanding of rare nuclear isotopes and the evolution of the cosmos.

"(B) FUNDING.—Out of funds authorized to be appropriated under subsection (c), there shall be made available to the Secretary to carry out construction of the facility under this subsection $2,000,000 for fiscal year 2022.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before March 1, 2022.

"(2) ELECTRON-ION COLLIDER.—

"(A) IN GENERAL.—The Secretary shall support construction of an Electron Ion Collider as described in the 2015 Long Range Plan of the Nuclear Science Advisory Committee and the report from the National Academies titled 'An Assessment of U.S.-Based Electron-Ion Collider Science', in order to measure the internal structure of the proton and the nucleus and answer fundamental questions about the nature of visible matter.

"(B) FACILITY CAPABILITY.—The Secretary shall ensure that the facility meets the requirements in the 2015 Long Range Plan, including—

"(i) at least 70 percent polarized beams of electrons and light ions;

"(ii) ion beams from deuterium to the heaviest stable nuclei;

"(iii) variable center of mass energy from 20 to 140 GeV;

"(iv) high collision luminosity of $10^{33-34}cm^{-2}s^{-1}$; and

"(v) the possibility of more than one interaction region.

"(C) START OF OPERATIONS.—The Secretary shall, subject to the availability of appropriations, ensure that the start of full operations of the facility under this section occurs before December 31, 2030.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (c), there shall be made available to the Secretary to carry out construction of the facility under this subsection—

"(i) $101,000,000 for fiscal year 2022;

"(ii) $155,000,000 for fiscal year 2023;

"(iii) $250,000,000 for fiscal year 2024;

"(iv) $300,000,000 for fiscal year 2025; and

"(v) $305,000,000 for fiscal year 2026.

"(c) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $780,000,000 for fiscal year 2022;

"(2) $879,390,000 for fiscal year 2023;

"(3) $1,025,097,300 for fiscal year 2024;

"(4) $1,129,354,111 for fiscal year 2025; and

"(5) $1,192,408,899 for fiscal year 2026.".

SEC. 9. ACCELERATOR RESEARCH AND DEVELOPMENT.

The Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) is amended by adding after section 309 the following:

"SEC. 310. ACCELERATOR RESEARCH AND DEVELOPMENT.

"(a) PROGRAM.—As part of the activities authorized under section 209 of the Department of Energy Organization Act (42 U.S.C. 7139), the Director shall carry out a research program to—

"(1) advance accelerator science and technology relevant to the Department, other Federal agencies, and U.S. industry;

"(2) foster partnerships to develop, demonstrate, and enable the commercial application of accelerator technologies;

"(3) support the development of a skilled, diverse, and inclusive accelerator workforce; and

"(4) provide access to accelerator design and engineering resources.

"(b) ACCELERATOR RESEARCH.—In carrying out the program authorized under subsection (a), the Director shall support—

"(1) research activities in cross-cutting accelerator technologies including superconducting magnets and accelerators, beam physics,, data analytics-based accelerator controls, simulation software, new particle sources, advanced laser technology, and transformative research; and

"(2) optimal operation of the Accelerator Test Facility.

"(c) ACCELERATOR DEVELOPMENT.—In carrying out the program authorized under subsection (a), the Director shall support partnerships to foster the development, demonstration, and commercial application of accelerator technologies including, advanced superconducting wire and cable, superconducting RF cavities, and high efficiency radiofrequency power sources for accelerators.

"(d) RESEARCH COLLABORATIONS.—In developing accelerator technologies under the program authorized in subsection (a), the Director shall—

"(1) consider the requirements necessary to support translational research and development for medical, industrial, security, and defense applications; and

"(2) leverage investments in accelerator technologies and fundamental research in particle physics by partnering with institutes of higher education, industry, and other Federal agencies to enable the commercial application of advanced accelerator technologies.

"(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

"(1) $24,000,000 for fiscal year 2022;

"(2) $25,680,000 for fiscal year 2023;

"(3) $27,477,600 for fiscal year 2024;

"(4) $29,401,032 for fiscal year 2025; and

"(5) $31,459,104 for fiscal year 2026.".

SEC. 10. ISOTOPE DEVELOPMENT AND PRODUCTION FOR RESEARCH APPLICATIONS.

The Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) is amended by adding after section 310 as added by this Act the following:

"SEC. 311. ISOTOPE DEVELOPMENT AND PRODUCTION FOR RESEARCH APPLICATIONS.

"(a) IN GENERAL.—The Director—

"(1) shall carry out a program in coordination with other relevant programs across the Department of Energy for the production of isotopes, including the development of techniques to produce isotopes, that the Secretary determines are needed for research, medical, industrial, or related purposes, to the maximum extent practicable, in accordance with the 2015 NSAC 'Meeting Isotope Needs and Capturing Opportunities For The Future' report; and

"(2) shall ensure that isotope production activities carried out under the program under this paragraph do not compete with private industry unless the Director determines that critical national interests require the involvement of the Federal Government.

"(b) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to carry out the program under this subsection—

"(1) $90,000,000 for fiscal year 2022;

"(2) $96,300,000 for fiscal year 2023;

"(3) $103,041,000 for fiscal year 2024;

"(4) $110,253,870 for fiscal year 2025; and

"(5) $117,971,641 for fiscal year 2026.".

SEC. 11. SCIENCE LABORATORIES INFRASTRUCTURE PROGRAM.

(a) PROGRAM.—Section 309 of the Department of Energy Research and Innovation Act (42 U.S.C. 18647) is amended by adding at the end the following:

"(c) APPROACH.—In carrying out this section, the Director shall utilize all available approaches and mechanisms, including capital line items, minor construction projects, energy savings performance contracts, utility energy service contracts, alternative financing and expense funding, as appropriate.

"(d) ALTERNATIVE FINANCING OF RESEARCH FACILITIES AND INFRASTRUCTURE.—

"(1) IN GENERAL.—Consistent with section 161(g) of the Atomic Energy Act of 1954 (42 U.S.C. 2201(g)), the Management and Operating contractors of the Department may enter into the lease-purchase of research facilities and infrastructure under the scope of their contract with the Department with the approval of the Secretary or their designee.

"(2) LIMITATIONS.—To carry out lease-purchases approved by the Secretary under subsection (a), the Department shall only be required to have budget authority in an amount sufficient to cover the minimum required lease payments through the

period required to exercise a termination provision in the lease agreement, plus any associated lease termination penalties, regardless of whether such leased facility and infrastructure is on or off Government land, and if—

"(A) the Department has established a mission need for the facility or infrastructure to be leased;

"(B) the facility or infrastructure is general purpose, including offices, laboratories, cafeterias, utilities, and data centers;

"(C) the Department is not a party to and has no financial obligations under the lease-purchase transaction entered into by the Management and Operating contractor, other than allowability of the lease cost and conveyance of Government land, if needed;

"(D) the lease-purchase has an advance notice termination provision with reasonable pre-defined penalties that the Management and Operating contractor may exercise, at the direction of the Department, if funding for the lease is no longer available or the mission need ceases to exist;

"(E) there is an option for a no cost transfer of ownership to the Government once the underlying financing is retired, but neither the Management and Operating contractor nor the Department are obligated to purchase the facility or infrastructure at any time during or after the lease term;

"(F) the lease-purchase transaction, assuming exercise of the ownership option, is demonstrated to be the lowest lifecycle cost alternative for the Government; and

"(G) the cumulative annual base rent for all lease-purchases of facilities and infrastructure, inclusive of any transactions under consideration, does not exceed 2 percent of the Management and Operating contract operating budget for the year the commitment is made for the lease.

"(3) REPORTING.—Not later than one year after the date of the enactment of the Department of Energy Science for the Future Act, and biennially thereafter, the Department shall submit to the Committee on Science, Space, and Technology and the Committee on Appropriations of the House of Representatives, and the Committee on Energy and Nat-

ural Resources and the Committee on Appropriations of the Senate, a report on the lease-purchase transactions that the Management and Operating contractors of the Department entered into under subsection (a) that includes—

"(A) a list of the lease-purchase transactions entered into by each Management and Operating contractor and their respective costs;

"(B) the annual percentage of each Management and Operating contract operating budget that is used for lease-purchase transactions for the year the commitments were made; and

"(C) any other information the Secretary finds appropriate.

"(d) MID-SCALE INSTRUMENTATION PROGRAM.—The Director, in coordination with each of the programs carried out by the Office of Science, shall establish a mid-scale instrumentation program to enable the development and acquisition of novel, state-of-the-art instruments ranging in cost from $1 million to $20 million each that would significantly accelerate scientific breakthroughs at user facilities.

"(e) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry

out the activities described in this section $500,000,000 for each of fiscal years 2022 through 2026.".

SEC. 12. INCREASED COLLABORATION WITH TEACHERS AND SCIENTISTS.

(a) IN GENERAL.—The Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) is amended by adding after section 311 as added by the Act the following:

"SEC. 312. INCREASED COLLABORATION WITH TEACHERS AND SCIENTISTS.

"(a) IN GENERAL.—The Director shall support the development of a scientific workforce through programs that facilitate collaboration between K–12, university students, early-career researchers, faculty, and the National Laboratories, including through the use of proven techniques to expand the number of individuals from underrepresented groups pursuing and attaining skills or undergraduate and graduate degrees relevant to the Office's mission.

"(b) AUTHORIZATION OF APPROPRIATIONS.—Section 3169 of the Department of Energy Science Education Enhancement Act (42 U.S.C. 7381e) is amended—

"(1) by striking, 'programs', and inserting 'programs, including the NSF INCLUDES National Network,'; and

"(2) by striking, 'year 1991', and inserting 'years 2022 through 2026'.".

(b) BROADENING PARTICIPATION IN WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS.—The Department of Energy Science Education Enhancement Act (42 U.S.C. 7381 note) is amended by inserting the following sections after section 3167 (42 U.S.C. 7381c–1):

"SEC. 3167A. BROADENING PARTICIPATION FOR TEACHERS AND SCIENTISTS.

"(a) IN GENERAL.—The Secretary shall expand opportunities to increase the number and the diversity, equity, and inclusion of highly skilled science, technology, engineering, and mathematics (STEM) professionals working in Department of Energy mission-relevant disciplines and broaden the recruitment pool to increase diversity, including expanded partnerships with Historically Black Colleges, Tribal Colleges, Minority Serving Institutions, emerging research institutions, and scientific societies.

"(b) PLAN.—Not later than 1 year after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources and the Committee on Commerce, Science, and

Transportation of the Senate and make available to the public a plan for broadening participation of underrepresented groups in science, technology, engineering, and mathematics in programs supported by the Department programs, including—

"(1) a plan for supporting and leveraging the National Science Foundation INCLUDES National Network;

"(2) metrics for assessing the participation of underrepresented groups in Department programs;

"(3) experienced and potential barriers to broadening participation of underrepresented groups in Department programs, including recommended solutions; and

"(4) any other activities the Secretary finds appropriate.

"(c) AUTHORIZATION OF APPROPRIATIONS.—Of the amounts authorized to be appropriated in section 3169 (42 U.S.C. 7381e), at least $2,000,000 shall be made available each fiscal year for the activities described under this subsection.

"SEC. 3167B. EXPANDING OPPORTUNITIES TO INCREASE THE DIVERSITY, EQUITY, AND INCLUSION OF HIGHLY SKILLED SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) PROFESSIONALS.

"(a) IN GENERAL.—The Secretary shall expand opportunities to increase the number and the diversity, equity, and inclusion of highly skilled science, technology, engineering, and mathematics (STEM) professionals working in Department of Energy mission-relevant disciplines and broaden the recruitment pool to increase diversity, including expanded partnerships with minority-serving institutions, non-Research I universities, and scientific societies.

"(b) PLAN AND OUTREACH STRATEGY.—

"(1) PLAN.—Not later than 6 months after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate a 10-year educational plan to fund and expand new or existing programs administered by the Office of Science and sited at the national laboratories and Department of Energy user facilities to expand educational and workforce opportunities for

underrepresented high school, undergraduate, and graduate students as well as recent graduates, teachers and faculty in STEM fields. This may include paid internships, fellowships, temporary employment, training programs, visiting student and faculty programs, sabbaticals, and research support.

"(2) OUTREACH CAPACITY.—The Secretary shall include in the plan under paragraph (1) an outreach strategy to improve the advertising, recruitment, and promotion of educational and workforce programs to community colleges, Historically Black Colleges and Universities, Tribal Colleges, Minority Serving Institutions, and emerging research institutions.

"(c) BUILDING RESEARCH CAPACITY.—The Secretary shall develop programs that strengthen the research capacity relevant to Office of Science disciplines at emerging research institutions, including minority-serving institutions, tribal colleges and universities, Historically Black Colleges and Universities, and colleges and universities. This may include enabling mutually beneficial and jointly managed partnerships between research-intensive institutions and emerging research institutions, and soliciting research proposals, fellowships, training programs, and re-

search support directly from emerging research institutions.

"(d) TRAINEESHIPS.—The Secretary shall establish a university-led Traineeship Program to address workforce training needs in STEM fields relevant to the Department. The focus should be on supporting training and research experiences for underrepresented undergraduate and graduate students and increasing participation from underrepresented populations. The traineeships should include opportunities to build the next-generation workforce in research areas critical to maintaining core competencies across the Office of Science's programs.

"(e) EVALUATION.—The Secretary shall establish key performance indicators to measure and monitor progress of education and workforce programs and expand Departmental activities for data collection and analysis. The Secretary shall submit a report 2 years after the date of enactment of the Department of Energy Science for the Future Act, and every 2 years thereafter, to the Committee on Science, Space, and Technology of the House of Representatives and the Committee on Energy and Natural Resources of the Senate summarizing progress toward meeting key performance indicators.

"(f) DEFINITIONS.—In this section:

"(1) MINORITY-SERVING INSTITUTION.—The term 'minority-serving institution' includes the entities described in any of paragraphs (1) through (7) of section 371(a) of the Higher Education Act of 1965 (20 U.S.C. 1067q(a)).

"(2) HISTORICALLY BLACK COLLEGE AND UNIVERSITIES.—The term 'Historically Black Colleges and Universities' has the meaning given in 'part B institution' in section 322 of the Higher Education Act of 1965 (20 U.S.C. 1061).

"(3) STEM.—The term 'STEM' has the meaning given the term in the STEM Education Act of 2015 (42 U.S.C. 1861 et seq.).

"(4) TRIBAL COLLEGES AND UNIVERSITIES.—The term 'Tribal College or University' has the meaning given in section 316 of the Higher Education Act of 1965 (20 U.S.C. 1059c).".

SEC. 13. HIGH INTENSITY LASER RESEARCH INITIATIVE; OFFICE OF SCIENCE EMERGING INFECTIOUS DISEASE COMPUTING RESEARCH INITIATIVE; HELIUM CONSERVATION PROGRAM; AUTHORIZATION OF APPROPRIATIONS.

(a) IN GENERAL.—The Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) is amended by adding at the end the following:

"SEC. 313. HIGH INTENSITY LASER RESEARCH INITIATIVE.

"(a) IN GENERAL.—The Director shall establish a high intensity laser research initiative consistent with the recommendations of the National Academies report, 'Opportunities in Intense Ultrafast Lasers: Reaching for the Brightest Light', and the report from the Brightest Light Initiative workshop on 'The Future of Intense Ultrafast Lasers in the U.S.'. This initiative should include research and development of petawatt-scale and of high average power laser technologies necessary for future facility needs in discovery science and to advance energy technologies, as well as support for a user network of academic and national laboratory high intensity laser facilities.

"(b) LEVERAGE.—The Director shall also leverage new laser technologies for more compact, less complex, and low-cost accelerator systems needed for science applications.

"(c) COORDINATION.—The Director shall coordinate this initiative among all relevant programs within the Office of Science, and the Under Secretary for Science shall coordinate this initiative with other relevant programs within the Department as well as within other Federal agencies.

"(d) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science there are authorized to be appropriated to the Sec-

retary to carry out the activities described in this subsection—

"(1) $50,000,000 for fiscal year 2022;

"(2) $100,000,000 for fiscal year 2023;

"(3) $150,000,000 for fiscal year 2024;

"(4) $200,000,000 for fiscal year 2025; and

"(5) $250,000,000 for fiscal year 2026.

"SEC. 314. HELIUM CONSERVATION PROGRAM.

"(a) IN GENERAL.—The Secretary shall establish a program to reduce the consumption of helium for Department grant recipients and facilities and encourage helium recycling and reuse. The program shall competitively award grants for—

"(1) the purchase of equipment to capture, reuse, and recycle helium;

"(2) the installation, maintenance, and repair of new and existing helium capture, reuse, and recycling equipment; and

"(3) helium alternatives research and development activities.

"(b) REPORT.—In carrying out the program under this section, the Director shall submit to the Committee on Science, Space, and Technology of House of Representatives and the Committee on Energy and Natural Resources of the Senate a report, not later than two years

after the date of enactment of the Department of Energy Science for the Future Act, and every 3 years thereafter, on the purchase of helium as part of research projects and facilities supported by the Department. The report shall include—

"(1) the quantity of helium purchased for projects and facilities supported by Department grants;

"(2) a cost-analysis for such helium;

"(3) the predominant production sources for such helium;

"(4) expected or experienced impacts of helium supply shortages or prices on the research projects and facilities supported by the Department; and

"(5) recommendations for reducing Department grant recipients' exposure to volatile helium prices.

"(c) COORDINATION.—In carrying out the program under this section, the Director shall coordinate with the National Science Foundation and other relevant Federal agencies on helium conservation activities.

"(d) DURATION.—The program established under this section shall receive support for a period of not more than 5 years, subject to the availability of appropriations.

"(e) RENEWAL.—Upon expiration of any period of support of the program under this section, the Director

may renew support for the program for a period of not more than 5 years.

"SEC. 315. OFFICE OF SCIENCE EMERGING INFECTIOUS DISEASE COMPUTING RESEARCH INITIATIVE.

"(a) IN GENERAL.—The Secretary, in coordination with the Director of the National Science Foundation and the Administrator of the National Aeronautics and Space Administration, shall establish within the Office of Science, a cross-cutting research initiative to leverage the Federal Government's innovative analytical resources and tools, user facilities, and advanced computational and networking capabilities in order to prevent, prepare for, and respond to emerging infectious diseases, including COVID–19. The Secretary shall carry out this initiative through a competitive, merit-reviewed process, and consider applications from National Laboratories, institutions of higher education, multi-institutional collaborations, industry partners and other appropriate entities.

"(b) ACTIVITIES.—In carrying out the initiative established under subsection (a), the Secretary shall coordinate with programs across the Office of Science and with relevant Federal agencies to determine a comprehensive set of technical milestones for these research activities and prioritize the following objectives—

"(1) supporting fundamental research and development in advanced analytics, experimental studies, materials synthesis, high-performance computing technologies needed to characterize, model, simulate, and predict complex phenomena and biological materials related to emerging infectious diseases, including COVID–19 challenges, including a focus on testing and diagnostics, experimental data acquisition, sharing and management, advanced manufacturing, and molecular design and modeling;

"(2) using expertise from the private sector, institutions of higher education, and the National Laboratories to develop computational software and capabilities that prospective users may accelerate emerging infectious diseases research and development;

"(3) leveraging the research infrastructure of the Department, including scientific computing user facilities, x-ray light sources, neutron scattering facilities, nanoscale science research centers, and sequencing and bio-characterization facilities by coordinating with the Advanced Scientific Computing Research, Basic Energy Sciences, and Biological and Environmental Research programs within the Office of Science;

"(4) leveraging experience from existing modeling and simulation research and work sponsored by the Department and promoting collaboration and data sharing between National Laboratories, research entities, and user facilities of the Department by providing the necessary access and secure data transfer capabilities; and

"(5) ensuring that new experimental and computational tools are accessible to relevant research communities, including private sector entities to address emerging infectious diseases, including COVID–19 challenges.

"(c) COORDINATION.—In carrying out this initiative, the Secretary shall ensure, to the maximum extent practicable, coordination of these activities with the Department of Energy National Laboratories, institutions of higher education, and the private sector.

"(d) EMERGING INFECTIOUS DISEASES HIGH PERFORMANCE COMPUTING RESEARCH CONSORTIUM.—

"(1) IN GENERAL.—The Secretary in coordination with the Director of the National Science Foundation and the Director of the Office of Science and Technology Policy shall establish and operate an Emerging Infectious Diseases High Performance Computing Research Consortium (referred to in this

section as the 'Consortium'), in order to support the initiative under subsection (a) by providing, to the extent practicable, a centralized entity for multidisciplinary, collaborative, emerging infectious disease research and development through high performance computing and advanced data analytics technologies and processes.

"(2) MEMBERSHIP.—The members of such consortium may include representatives from relevant Federal agencies, the private sector, institutions of higher education, which can each contribute relevant compute time, capabilities, or other resources.

"(3) ACTIVITIES.—The Consortium shall—

"(A) match applicants with available Federal and private sector computing resources;

"(B) consider supplemental awards for computing partnerships with Consortium members to qualifying entities on a competitive merit-review basis;

"(C) encourage collaboration and communication among member representatives of the consortium and awardees;

"(D) make available the high-performance computing capabilities, expertise, and user fa-

cilities of the Department and the National Laboratories; and

"(E) submit an annual report to the Secretary summarizing the activities of the Consortium, including—

"(i) describing each project undertaken by the Consortium;

"(ii) detailing organizational expenditures; and

"(iii) evaluating contribution to the achievement of technical milestones as determined in subsection (a).

"(4) COORDINATION.—The Secretary shall ensure the coordination of, and avoid unnecessary duplication of, the activities of the Consortium with the activities of other research entities of the Department, institutions of higher education and the private sector.

"(e) REPORT.—Not later than 2 years after the date of enactment of the Department of Energy Science for the Future Act, the Secretary shall submit to the Committee on Science, Space, and Technology of the House, and the Committee on Energy and Natural Resources of the Senate, and the Committee on Commerce, Science, and

Transportation of the Senate a report detailing the effectiveness of—

"(1) the interagency coordination between each Federal agency involved in the research initiative carried out under this section;

"(2) the collaborative research achievements of the initiative, including the achievement of the technical milestones determined under subsection (a); and

"(3) potential opportunities to expand the technical capabilities of the Department.

"(f) FUNDING.—From within funds authorized to be appropriated for the Department's Office of Science, there shall be made available to the Secretary to carry out the activities under this subsection, $50,000,000 for fiscal years 2022 and 2023.

"SEC. 316. AUTHORIZATION OF APPROPRIATIONS.

"There are authorized to be appropriated to the Secretary to carry out the activities described in this title—

"(1) $8,801,915,000 for fiscal year 2022;

"(2) $9,451,015,300 for fiscal year 2023;

"(3) $10,160,677,621 for fiscal year 2024;

"(4) $10,693,625,004 for fiscal year 2025; and

"(5) $11,145,798,345 for fiscal year 2026.".

(b) TABLE OF CONTENTS.—Section 1(b) of the Department of Energy Research and Innovation Act is amended in the table of contents by inserting after the item relating to section 309 the following:

Chairwoman JOHNSON. I ask unanimous consent to dispense with the reading, and without objection, so ordered.

I recognize myself for 5 minutes to explain this amendment.

I'm very pleased to offer this amendment in the nature of a substitute for the *Department of Energy's Science for the Future Act*, alongside Ranking Member Lucas. I'm going to speak briefly and place my extended remarks in the record.

[The prepared statement of Chairwoman Johnson follows:]

I am very pleased to offer this amendment in the nature of a substitute for the *Department of Energy Science for the Future Act* alongside Ranking Member Lucas.

The Department of Energy's Office of Science oversees ten of DOE's seventeen national labs, manages 29 scientific user facilities, and houses six program offices focused on a broad range of activities spanning from advanced computing to materials and chemical science, particle physics, biological science, and fusion energy research.

The substitute amendment for *DOE Science for the Future Act*, like the introduced bill, provides for a comprehensive authorization of the Office of Science. It authorizes appropriations for the Office of Science of $8.8 billion for fiscal year 2022 with annual 7% increases for the office's core research programs, reaching $11.1 billion for fiscal year 2026. This ensures that the ten national laboratories stewarded by the Office have the resources they need to modernize their infrastructure after, in many cases, decades of neglect.

The amendment ensures we keep our commitments to multi-national projects at home and abroad, including the ITER international fusion project and the Long Baseline Neutrino Facility that is examining the frontiers of fundamental physics.

This amendment is a substantial investment in the fight against climate change. Through its support of research to advance the next generation of energy storage, solar, hydrogen, critical materials, fusion energy, manufacturing, carbon removal, and bioenergy technologies, among many other areas, the Office of Science is uniquely positioned to help us reach our shared goals of developing energy that is clean, sustainable, reliable, and affordable. In doing so, this amendment helps us guarantee that the next generation of clean energy researchers, scientists, and professionals come from all backgrounds.

The amendment directs the Office of Science to collaborate with NSF to leverage the Foundation's INCLUDES National Network to expand the number of students, early-career researchers, and faculty from underrepresented groups pursuing degrees in science, technology, engineering, and mathematics.

What the world has endured during this pandemic must not be in vain, and we must learn from it. That is why this amendment leverages the Department's analytical resources, user facilities, and advanced computational capabilities to prevent, prepare for, and respond to emerging infectious diseases, including COVID-19.

We all know that the United States faces increased international competition in science and technology. The only way we will be able to face that challenge is if we all work together. I truly appreciate the collaboration on this amendment by Ranking Member Lucas and all Members of this Committee, Democrats and Republicans. I think this bill will be better for that collaboration, and in turn, our nation will be better off.

Chairwoman JOHNSON. We all know that the United States face increased international competition in science and technology. The only way we will be able to face that challenge is if we are all willing to work together. I truly appreciate the collaboration on this amendment by Ranking Member Lucas and all the Members of the Committee, Democrats and Republicans. I think this bill will be better for their collaboration, and in return, our Nation will be better off.

Is there any further discussion on this amendment?

Mr. Lucas.

Mr. LUCAS. Thank you, Chairwoman Johnson.

This amendment strikes and replaces the text of H.R. 3593, the *DOE Science for the Future Act*, to incorporate stakeholder feedback of the underlying bill and make technical changes to the text. I'd like to thank the Chairwoman and her staff for working with

us in a bipartisan and cooperative manner to get these necessary changes finalized.

Among these changes, this amendment includes several important provisions from my bill, H.R. 5685, the *Securing American Leadership in Science and Technology Act*, including a DOE infectious disease R&D initiative and full funding for the Quantum User Expansion for Science and Technologies program. This past year, the Department of Energy and its national labs have demonstrated the value of using high-performance supercomputing, advance research facilities to model COVID–19, understand its effects on human cells, and predict its spread. DOE and the U.S. research community have done incredible work in using the Department's world-leading resources to fight this pandemic and address the many challenges it has presented.

DOE and its Office of Science should continue to play a key role in emerging infectious disease research for many years to come. That's why my *SALSTA* includes a comprehensive authorization for this work by establishing a crosscutting emerging infectious disease research initiative and a high-performance computing research consortium, we can ensure the continuation of these life-saving R&D activities. I'm pleased to see this amendment included these high-priority provisions.

I'm also glad to see that this amendment updates the original bill to include full support for the QUEST program and another *SALSTA* priority, which expands public-private partnerships in quantum resource use. Quantum information science will revolutionize our relationship with technology and our capacity for scientific advances. In order to remain competitive in this critical industry of the future, we need to take the long-term and big-picture approach and get serious about our investments in quantum computing and in the U.S. quantum industry. By giving U.S. researchers access to quantum computing hardware and quantum computing clouds, the QUEST program encourages greater participation in the development of quantum information sciences, thereby facilitating a larger and more diverse range of research into these evolving technologies.

I also once again would like to thank Chairman—Chairwoman Johnson for working with me to get these critical provisions added to this amendment. And as always, I'm grateful for the opportunity to work alongside my Science Committee colleagues to prioritize fundamental research that will support U.S. innovation, keep our country safe, independent, and globally competitive. This bipartisan Office of Science reauthorization has been a long time coming for the Science Committee. This is a product we should all be proud of. And today's amendment brings us one step closer to its enactment. I encourage my colleagues to support this amendment, and I yield back, Madam Chair. Thank you.

[The prepared statement of Mr. Lucas follows:]

Thank you, Chairwoman Johnson. This amendment strikes and replaces the text ofH.R. 3593, the *DOE Science for the Future Act*, to incorporate stakeholder feedback to the underlying bill and make technical changes to the text. I'd like to thank the Chairwoman and her staff for working with us in a bipartisan and cooperative manner to get these necessary changes finalized.

Among these changes, this amendment includes several important provisions from my bill, H.R.5685, the *Securing American Leadership in Science and Technology Act*

(SALSTA), including a DOE infectious disease R&D initiative and full funding for the Quantum User Expansion for Science and Technology or (QUEST) Program.

This past year, the Department of Energy and its National Laboratories have demonstrated the value of using high-performance supercomputing and advanced research facilities to model COVID-19, understand its effects on human cells, and predict its spread. DOE and the U.S. research community have done incredible work in using the Department's world-leading resources to fight this pandemic and address the many challenges it has presented.

DOE and its Office of Science should continue to play a key role in emerging infectious disease research for many years to come. That's why SALSTA includes a comprehensive authorization of this work. By establishing a cross-cutting Emerging Infectious Disease Research Initiative and a high-performance computing research consortium, we can ensure the continuation of these life-saving R&D activities. I'm pleased to see this amendment includes these high-priority provisions.

I'm also glad to see that this amendment updates the original bill to include full support for the QUEST program, another SALSTA priority which expands public-private partnerships for quantum resource use. Quantum information science will revolutionize our relationship with technology and our capacity for scientific advancement. In order to remain competitive in this critical industry of the future, we need to take the long-term and big picture approach and get serious about our investments in quantum computing and in the U.S. quantum industry. By giving U.S. researchers access to quantum computing hardware and quantum computing clouds, the QUEST program encourages greater participation in the development of quantum information sciences, thereby facilitating a larger and more diverse range of research into these evolving technologies.

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This bipartisan Office of Science authorization has been a long-time coming for the Science Committee. This is a product we should all be proud of, and today's amendment brings us one step closer to its enactment. I encourage my colleagues to support this amendment.

Chairwoman JOHNSON. Thank you very much. I now recognize Ms. Moore. You're muted.

Ms. MOORE. OK. I got it now. Oh, my goodness, thank you so much, Chairwoman Johnson and Ranking Member Lucas, for your just impeccable work on this amendment in the nature of a substitute to H.R. 3593. I—before I get into my remarks, I absolutely want to lift up the names of the Subcommittee Chair Bowman and Ranking Member Weber for really putting in such a robust effort to advance our research into energy biology and climate science.

You know, access to clean drinking water rests at the nexus of both our Nation's infrastructure debate and our climate crisis. And as a native of Wisconsin, I'm vested in, acculturated, committed, and [inaudible] to the value of clean air and water as inspired by the late, great Wisconsin Governor and Wisconsin United States Senator Gaylord Nelson, the father of Earth Day, celebrated annually on April 22nd globally by billions of people in 193 countries. That's my culture that I bring to this Committee.

And in the great region—Great Lakes region proper, we're seeing warmer, wetter summers. The increased runoff into lake systems are bringing more contaminants to both the lakes and our groundwater. And of course the illnesses that occur from greenhouse gases are really devastating to people like me and my daughter who have asthma and other underlying respiratory conditions. And as I've said before, you know, making clean water accessible and sustainable for future generations requires investments in new ideas. And while we're reauthorizing the DOE's science portfolio, I believe it's important that some of this research be directed toward further un-

derstanding the complex Earth cycles that affect our drinking water.

My amendment does just that. By requiring DOE's Office of Science to support interdisciplinary clean water and watershed research into the activities, both human and natural, that affect water availability and quality across our country, including in freshwater environments like our Great Lakes. This is so needed not only for city dwellers but for our farmers as well who suffer from some contaminated runoffs.

Additionally, my amendment requires DOE carrying out that to do it in partnership with representatives from State, local, and tribal governments, research and academic institutions, and nonprofit organizations like the Milwaukee Water Council. This amendment ensures that this will be a priority at the DOE Office of Science, and I look forward to seeing some of the new research and innovative technology that springs from such research to help protect our Nation's water.

An old African proverb says water has no enemies, and we got to make that true by treating it for the trustworthiness that it deserves. And we must and can do as much as possible to prevent the impacts of climate crisis from worsening over the course of the next 50 years. It is also important that we get a jump on the research we need now to better provide to our vulnerable communities in the wake of the climate shifts we are already seeing.

And, again, I commend the Chair and Ranking Member for their great work in putting together this bill and working to address critical research. I urge my colleagues to support this. I'll shut up before I start losing votes, and I yield back.

Chairwoman JOHNSON. Thank you very much. Mr. Weber.

Mr. WEBER. Well, thank you, Chairwoman Johnson. And thank you, Chairman Bowman and Ranking Member Lucas, as well for all your hard work to get us here today. I'll try not to repeat the many praises we've heard thus far for the legislation even though many of those praises are certainly worth repeating.

I do want to say thank you, as Congresswoman Moore, the gentlelady from Wisconsin, for her kind words. I appreciate that.

Let me start by also expressing my gratitude to everyone involved on this Committee for just how far we've come. Since I was first appointed Chairman of the Energy Subcommittee in 2015, I worked on the America COMPETES reauthorization process, which provided important program direction for the Office of Science. Since then, we've had a number of landmark successes in updating this guidance first through the enactment of the *Department of Energy Research and Innovation Act in 2018* and, most recently, we were able to authorize pieces of the office last Congress in the *Energy Act of 2020*.

Yet after all these years and all this incredible bipartisan work, we've never had a comprehensive Office of Science reauthorization like the *DOE Science for the Future Act*. Over this time period we've seen the tune of the White House change twice, countless Members come and go, and even the controlling majority of this body change. Darn. But through it all, Ranking Member Lucas, Chairwoman Johnson, and many others, including myself, have re-

mained committed to keeping America's scientific enterprise at the absolute forefront of global competition.

My colleagues have heard me repeatedly stress the importance of basic research. You've also heard me grumble and complain when I thought we were focusing too much on applied energy and increasing its already significant portion of DOE's budget. I might sound like a broken record, but it's because I believe so strongly in this.

I'd like to thank my—I'd like to think that my friends across the aisle and across the political spectrum really took note when within a year of Ranking Member Lucas's leadership the Republican side of this Committee put forth our benchmark legislation, the *Securing American Leadership in Science and Technology Act.* or *SALSTA*. We put forth *SALSTA* as a signal that even in the minority we are serious about the DOE Office of Science and its role in developing climate change solutions and advancing American competitiveness. And because of the competitive nature of *SALSTA* and its clear focus on basic Federal research, I fully believe my Democratic colleagues recognized our effort as the start of a very tremendous and good and well-deserved bipartisan opportunity because that is what the legislative process entails, isn't it? It's giving and taking, hearing many opinions inside, outside of these walls, disagreeing over some things but yet finding common ground on more things.

As a result, today marks the culmination of more than a decade of hard work. The legislation before us today is the first-ever comprehensive reauthorization of the DOE Office of Science, and I couldn't be more thrilled about that. Some of the main pillars of this bill are funding construction and upgrades to major scientific user facilities, providing guidance in emerging research areas like quantum, and responsibly increasing the annual budget for each of the Office's core research programs. All of it is meant to put our full muscle behind the Office of Science. That is because time and time again this office has demonstrated that basic science research is the most effective way to encourage the development of new technologies. If we want to maintain our technological edge and combat the threat countries like China are making toward our global leadership and innovation, this bill isn't just a recommendation or a message, it's an absolute necessity.

Through the*DOE Science of the Future Act*, we are prioritizing critical research areas and investing in the science and technology that will drive the development of cleaner, more efficient, and more affordable energy. It wasn't the most direct path, I get it, and it certainly wasn't easy, but we're finally approaching the finish line.

I look forward to continuing to work with my colleagues as we take this bill to the floor and onto the President's desk. Thank you, Madam Chairman, thank you, Ranking Member Lucas, and I yield back the balance of my time.

Chairwoman JOHNSON. Thank you very much. Ms. Bonamici.

Ms. BONAMICI. Thank you, Chairwoman Johnson. I move to strike the last word.

Chairwoman JOHNSON. You're recognized for 5 minutes.

Ms. BONAMICI. Thank you so much. I'm very grateful to Chairwoman Johnson and Ranking Member Lucas for their work

crafting this bipartisan bill to reauthorize the Office of Science, and I'm pleased to support it.

The Department of Energy's Office of Science is helping to address the climate crisis and to accelerate our transition to a clean energy economy. As a Member of the Energy Subcommittee, I have appreciated Chair Bowman's leadership to explore different facets of the research programs within the scope of the Office of Science. DOE's work contributes to important discoveries to decarbonizing the electricity sector, strengthen our quantum computing, support high-energy physics, and more. At a hearing on the Basic Energy Sciences program we heard from witnesses about the Office's work to advance battery technology development. Our hearing focused on high-performance computing and highlighted how future exascale capabilities will strengthen our understanding and response to the climate crisis.

And as we recently heard during our budget hearing with Secretary Granholm, the Department of Energy has been woefully underfunded in light of the scope of its work in accelerating our clean energy transition. This bill takes the important steps to leverage Federal investment and advance the next generation of energy storage, solar, critical materials, and manufacturing technologies and more.

I again want to thank Chairwoman Johnson and Ranking Member Lucas for their bipartisan leadership. I urge my colleagues to support the amendment in the nature of a substitute, and I yield back the balance of my time.

Chairwoman JOHNSON. Thank you very much. Mr. Posey.

Mr. POSEY. I move to strike the last word.

Chairwoman JOHNSON. The gentleman is recognized for 5 minutes.

Mr. POSEY. Thank you, Chairwoman Johnson. And I again want to echo the comments of the Ranking Member concerning your leadership. I'm grateful and want to thank you and the Ranking Member that this amendment includes additional language that directs the Department of Energy to, in consultation with NASA, carry out basic research programs to compare the effects of exposure to low-dose radiation on earth and low-Earth orbit and in the space environment. The ultimate goal of such research would be to inform low-dose radiation guidance here on Earth and to help facilitate long-duration spaceflights.

These provisions build on the success of my bill, the *Low-Dose Radiation Research Act*, which was signed into law last Congress as part of the *Energy Act of 2020*. The bill authorized a low-dose radiation research program within the Department of Energy's Office of Science that we may continue to advance our understanding of the effects of low-dose radiation on human health, allowing us to make more risk-informed approaches to management decisions regarding radiation exposure.

NASA and the Department of Energy both exhibit great expertise in this area of research, and we know that the best science can occur when agencies work together. And it's great that this Committee is able to make those connections. This is especially true in science and it's critical to our mission to push the limits of human exploration.

That's why I'm glad this amendment will further encourage and strengthen our collaboration between NASA and the Department of Energy in its necessary work. It's the kind of legislative initiative that helps our government avoid duplication of efforts while making the most of taxpayer money.

I look forward to finding other opportunities to support DOE and NASA [inaudible] this Congress and again want to thank you for working with us to get this language added, and I encourage my colleagues to support the amendment. Thank you. I yield back.

Chairwoman JOHNSON. Thank you very much.

If there are no additional comments, we will move then to the next amendment and vote on the substitute later.

The first amendment up is from Mr. Foster, the gentleman from Illinois. You're recognized to offer your amendment.

Mr. FOSTER. Thank you. I have an amendment at the desk.

Chairwoman JOHNSON. The Clerk will report the amendment.

The CLERK. Amendment No. 2, amendment to the amendment in the nature of the substitute to H.R. 3593 offered by Mr. Foster of Illinois.

[The amendment of Mr. Foster follows:]

AMENDMENT TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593

OFFERED BY MR. FOSTER OF ILLINOIS

Page 2, strike lines 13 through 15 and insert the following:

"(2) OFFICE OF SCIENCE.—The Director—

"(A) shall ensure the coordination of programs and activities carried out by the Office of Science; and

"(B) shall direct all programs which have not recently completed a future planning roadmap consistent with the funding of such programs authorized under the Department of Energy Science for the Future Act to complete such a roadmap.".

Chairwoman JOHNSON. I ask unanimous consent to dispense with the reading, and without objection, so ordered.

I recognize the gentleman now for 5 minutes to explain his amendment.

Mr. FOSTER. Thank you, Madam Chairwoman.

The Department of Energy's Office of Science has a particularly important role to play in our understanding of basic science and technology. As the Co-Chair of the National Laboratories Caucus, I look forward to resuming our bipartisan congressional delegation visits to all 17 of the DOE national laboratories, which are truly the crown jewels of our scientific enterprise.

With the new funding envisaged in this act, the programs that fall under the Office of Science and related agencies can begin to plan for big next-generation projects that will lay the groundwork for the advances of the future. In order to capitalize on this, these programs need to begin planning now on how they will utilize this expanded funding.

The programs under the Office of Science undergo periodic interagency planning activities where they prioritize the projects that will shape the future of each program. These planning activities will frequently result in a roadmap or similar forward-looking document that incorporates the funding profile that the program expects to receive.

Unfortunately, many of the planning activities undertaken in the last 10 years were taken under budgetary assumptions that we now hope were pessimistic. Now, for example, in the case of fusion, the recent roadmap was told to consider three scenarios: first, a flat budget that barely kept up with inflation; second, a hopeful budget that was up only 2 percent per year after inflation, which is significantly less than we are hoping for now; and third, an unconstrained budget where potential new projects were listed and prioritized. But because this scenario was not then viewed as a realistic possibility, insufficient effort was put into generating detailed project cost estimates that will be needed to design the more robust programs that we're authorizing with this legislation.

My amendment simply directs the DOE programs to create necessary roadmaps which assume a DOE funding profile compatible with the legislation that we're proposing here today and, as in my words to Secretary Granholm in her recent appearance before our Committee, to throw deep. This more aggressive planning will allow these programs to really maximize the impact of these funds. Thank you, and I urge my colleagues to support this amendment and yield back.

Chairwoman JOHNSON. Thank you very much. I have no requests for discussion, additional time, so the vote occurs on the amendment.

All those in favor, say aye.

Those opposed, nay.

The ayes have it, and the amendment is agreed to.

The next amendment is offered by Ms. Moore, the lady from Wisconsin. You're recognized for your amendment.

Ms. MOORE. Thank you so much, Madam Chair, and I have had the opportunity to get into——

Chairwoman JOHNSON. The Clerk will report the amendment. OK.

Ms. MOORE. Oh, I'm so sorry.

The CLERK. Amendment No. 3, amendment to the amendment in the nature of a substitute to H.R. 3593 offered by Ms. Moore of Wisconsin.

[The amendment of Ms. Moore follows:]

AMENDMENT TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593 OFFERED BY MS. MOORE OF WISCONSIN

Page 34, after line 11, insert the following (and redesignate the subsequent subparagraph accordingly):

(B) CLEAN WATER AND WATERSHED RESEARCH.—As part of the activities described in subparagraph (A), the Director shall—

(i) support interdisciplinary research to significantly advance our understanding of water availability, quality, and the impact of human activity and a changing climate on urban and rural watershed systems, including in freshwater environments;

(ii) consult with the Interagency Research, Development, and Demonstration Coordination Committee on the Nexus of Energy and Water for Sustainability established under section 1010 of the Energy Act of 2020 (division Z of the Consolidated Appropriations Act, 2021) on energy-water nexus research activities; and

(iii) engage with representatives of research and academic institutions, nonprofit organizations, State, local, and tribal governments, and industry, who have expertise in technologies, technological innovations, or practices relating to the energy-water nexus, as applicable.

☒

Chairwoman JOHNSON. The Clerk will dispense with the reading with unanimous consent, and Ms. Moore is recognized for 5 minutes to explain her amendment.

Ms. MOORE. Thank you, Madam Chair. My amendment requires the Department of Energy's Office of Science to report interdisciplinary clean water and watershed research into the activities, both human and natural, that affect water availability and quality across our country, including in the freshwater environments like our Great Lakes.

I would hope that the Committee would adopt this very worthy amendment, and I yield back.

Chairwoman JOHNSON. Thank you very much. Any further discussion on this amendment?

If there's no further discussion, the vote occurs on the amendment.

All those in favor, say aye.

Those opposed, say nay.

The ayes have it, and the amendment is agreed to.

The next amendment is offered by—what is——

STAFF. Mr. Meijer.

Chairwoman JOHNSON. Meijer?

STAFF. Meijer.

Chairwoman JOHNSON. Meijer. The gentleman is recognized for his amendment.

Mr. MEIJER. Madam Chair, I have an amendment at the desk.

Chairwoman JOHNSON. The Clerk will report the amendment.

The CLERK. Amendment No. 4, amendment to the amendment in the nature of a substitute to H.R. 3593 offered by Mr. Meijer of Michigan——

Chairwoman JOHNSON. I ask——

The CLERK [continuing]. And Mr. McNerney.

[The amendment of Mr. Meijer and Mr. McNerney follows:]

AMENDMENT TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593 And
OFFERED BY MR. MEIJER OF MICHIGAN MR. McNERNEY

Page 42, after line 18, insert the following:

"(k) EMERGING TECHNOLOGIES.—

"(1) IN GENERAL.—The Secretary shall establish within the Biological and Environmental Research program an initiative focused on the development of engineered ecosystems through the application of artificial intelligence, novel sensing capabilities, and other emerging technologies.

"(2) INTERAGENCY COORDINATION.—The Secretary shall coordinate with the Director of the National Science Foundation, the Administrator of the National Oceanic and Atmospheric Administration, the Director of the U.S. Geological Survey, and other relevant officials to avoid duplication of research and observational activities and to ensure that activities carried out under this initiative are complimentary to those currently being undertaken by other agencies.

"(3) REPORT.—Not later than 180 days after the enactment of this Act, the Secretary shall pro-

vide a report to the Committee on Science, Space, and Technology of the House, and the Committee on Energy and Natural Resources of the Senate, on the activity mandated in subsection (k).".

Page 42, line 19, strike "(k)" and insert "(l)".

☒

Chairwoman JOHNSON. Thank you. I ask unanimous consent to dispense with the reading. Without objection, so ordered.

I recognize the gentleman for 5 minutes to explain his amendment.

Mr. MEIJER. Thank you, Chairwoman Johnson.

This amendment establishes a research initiative within the Department of Energy's Biological and Environmental Research or BER program that is focused on using sophisticated next-generation technologies to advance engineered ecosystems. Simply put, engineered ecosystems are natural environments with human-made elements incorporated into them. We live in these in our daily lives. Our cities, farms, and parks, and even our interstate highway systems are all examples of engineered ecosystems. But the purpose of this amendment is to arm the Office of Science's BER program with the ability to use emerging technologies to better improve these environmental outcomes, leveraging innovative technologies like artificial intelligence and advanced-sensing capabilities to solve complex environmental challenges can help us lead the fight against climate change.

For example, AI can improve climate modeling and predict our most complex future environmental scenarios, informing potential for geo-engineering in order to reduce the amount of radiation entering and residing in the Earth's atmosphere. New sensors can also detect the presence of pollutants down to minuscule quantities, advancing bioremediation methods that use microbes to remove pollutants from water.

It is not my intent to endorse a single technology or a single solution pathway because to solve the complex problems associated with climate change we must utilize any and all technologies at our disposal. That's why I'm offering this amendment. These are very early stage technologies that require more research to fully understand both their potential and their impact. If it helps our planet, it's worth our focus. And the process to find the best solutions can only be benefited by exploring technologies that seemed like science fiction just a decade ago. Engineered ecosystems and the adapting relationship between humans and nature will continue to play a critical role in our conversations around climate.

Through technology, cities and buildings that are more efficient, farms have precision agriculture methods in order to reduce emissions. But through this amendment we can seek to build off those success stories and create more with the utilization of these emerging technologies.

I'll be the first to admit there is no silver bullet, but I'm willing to invest in DOE's path toward every technology that could play a role in an environmentally sound future. I urge my colleagues to support this amendment and reserve the balance of my time.

Chairwoman JOHNSON. Thank you very much. Any further discussion on the amendment?

Mr. MCNERNEY. Yes, Madam Speaker, I'd like to be recognized. This is Mr. McNerney from California.

Chairwoman JOHNSON. Mr. McNerney is recognized.

Mr. MCNERNEY. Well, I thank the Chair for recognizing me. And I want to thank my colleague from Michigan, Mr. Meijer, for his leadership here on this issue.

The United States has the highest level of investment in climate research and the greatest concentration of expertise of any individual nation. Because of this, we are uniquely positioned to research and assess atmospheric climate intervention through the application of these emerging technologies.

Unfortunately, we're falling short when it comes to exploring all the possibilities despite possessing the highest concentration of capabilities to do so. I'm proud to cosponsor this amendment offered by my colleague Mr. Meijer to establish within the biological and environmental research program an initiative aimed at bridging the gap. A simple authorization for the Office of Science to perform basic research on climate intervention would help put us at least on par with several countries and international bodies already taking these approaches seriously.

China posts one of the largest atmospheric climate intervention research programs in the world, and the United Nations' Scientific Assessment Panel voted to include the assessment of interventions to increase the reflectivity of the—in the stratosphere—of the stratosphere in their ozone assessment report. Competitors and allies alike recognize the value of atmospheric climate intervention research. We must authorize the Department of Energy Office of Science to make the most out of research they already do on atmospheric systems. Applying these artificial—this artificial intelligence technology, novel sensing capabilities, and other emerging technologies in such a program is a crucial step to ensure that the United States continues to be on the forefront of biological and environmental research. I yield back.

Chairwoman JOHNSON. Thank you very much. Any further requests for time?

If there's no further discussion, the vote occurs on the amendment.

All those in favor, say aye.

Those opposed, say no.

The ayes have it, and the amendment is agreed to.

The next amendment on the roster is an amendment offered by the gentlelady from California, Ms. Lofgren. I think she's back.

Ms. LOFGREN. I am, Madam Chairwoman.

Chairwoman JOHNSON. You're recognized.

Ms. LOFGREN. Thank you. As you know, I do have an amendment at the desk.

Chairwoman JOHNSON. The Clerk will report the amendment.

Ms. LOFGREN. I ask unanimous consent that the reading be dispensed with.

[The amendment of Ms. Lofgren follows:]

AMENDMENT TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593

OFFERED BY MS. LOFGREN OF CALIFORNIA

Page 43, after line 1, insert the following (and redesignate subsequent sections accordingly):

SEC. 5. SUPERCOMPUTING FOR SAFER CHEMICALS (SUPERSAFE) CONSORTIUM.

(a) ESTABLISHMENT.—

(1) IN GENERAL.—The Administrator of the Environmental Protection Agency, in collaboration with the Secretary of Energy, the Secretary of Labor, the Secretary of Health and Human Services, the Director of the National Toxicology Program, and the heads of any other relevant Federal agencies, shall form a consortium, to be known as the "Supercomputing for Safer Chemicals (SUPERSAFE) Consortium" (referred to in this section as the "Consortium").

(2) INCLUSION OF STATE AGENCIES.—The Secretary shall allow the head of a relevant State agency to join the Consortium on request of the State agency.

(b) CONSORTIUM ACTIVITIES.—

(1) IN GENERAL.—The Consortium, working through the National Laboratories and public research institutions, shall use supercomputing and other similar capabilities—

(A) to establish rapid approaches for large-scale identification of toxic substances and the development of safer alternatives to toxic substances by developing and validating computational toxicology methods based on unique high-performance computing, artificial intelligence, machine learning, and precision measurements;

(B) to transition to a more circular economy and cleaner energy by expanding knowledge to shift the market for toxic substances and products toward safe-by-design alternatives; and

(C) to address the burdens of—

(i) environmental toxic substance exposures in disadvantaged communities;

(ii) greater toxic substance use in products targeted towards those communities; and

(iii) exposure to toxic substances at Department of Energy facilities.

(2) MODELS.—In carrying out paragraph (1), the Consortium shall use supercomputers to develop, validate, and run models to predict adverse health effects caused by toxic substances.

(c) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated to the Secretary to carry out this section—

(1) for fiscal year 2022, $20,000,000;

(2) for fiscal year 2023, $30,000,000; and

(3) for each fiscal years 2024 through 2026, $35,000,000.

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Ms. LOFGREN. And, Madam Chair, I would like to note this amendment is really a wonderful suggestion. It would allow for the safer use of chemicals, industrial chemicals that would not be at odds with market needs. And we all know that we have a commitment to combating climate change. We have a concern for public health and responsible consumer behavior, and all of that is pushing us toward safer and more sustainable use of chemicals in manufacturing and consumer products.

The use of supercomputing and artificial intelligence has the potential to transform our understanding of the adverse human and environmental effects associated with industrial chemical use. These technologies can be developed and applied to rapidly provide information to evaluate chemical safety to avoid the chronic diseases and environmental harm caused by toxic chemicals that could also be used to develop alternatives to substances that would pose a threat.

This proposal would establish a Supercomputing for Safer Chemicals or SUPERSAFE Consortium that would allow EPA (Environmental Protection Agency) to leverage the computational assets at our national labs to expand on an existing work in this space and increased stakeholder participation by incorporating relevant State agencies. It would also work to address the inequitable burdens of environmental chemical exposures in disadvantaged communities and potentially creating more hazardous chemical use in products targeted toward those communities.

Now, I mentioned that this was a wonderful amendment, but unfortunately, it is not pertinent to this section of the bill because there is an existing Center on Computational Toxicology and Exposure, and this should be an amendment in the EPA authorization. So I'd like to ask unanimous consent to withdraw this amendment. I wanted to raise it because of its importance and hope that we can pursue it in the appropriate space.

Chairwoman JOHNSON. Thank you very much. The next amendment is by Mr. McNerney. Mr. McNerney, you're recognized.

Mr. MCNERNEY. I have an amendment at the desk.

Chairwoman JOHNSON. The Clerk will report the amendment.

The CLERK. Amendment No. 6, amendment to the amendment in the nature of a substitute to H.R. 3593 offered by Mr. McNerney of California.

[The amendment of Mr. McNerney follows:]

AMENDMENT TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593 OFFERED BY MR. MCNERNEY OF CALIFORNIA

Page 54, line 24, strike "and.".

Page 55, line 2, strike the period and insert "; and".

Page 55, after line 2, insert the following:

(4) demonstrate these capabilities utilizing the Department's Energy Sciences Network User Facility.

Page 57, line 6, strike the semicolon and insert "by leveraging the expertise, infrastructure and supplemental investments in the Energy Sciences Network User Facility;"

Page 57, line 18, insert "in collaboration with the Department's Energy Sciences Network User Facility" after "testbeds".

Page 57, line 21, insert ", National Laboratories," after "industry".

Chairwoman JOHNSON. Sorry. We can dispense with the reading of the amendment. The Chair now recognizes the sponsor.

Mr. MCNERNEY. Well, I thank the Chair for recognizing me and for bringing this amendment up for this consideration.

Quantum research is one of those fields that will define which country leads in the scientific enterprise. This amendment would establish the Energy Sciences Network, ESnet, as a platform for the development and testing of quantum networking infrastructure.

ESnet is a high-performance computer network that provides highly reliable data transport capabilities of DOE researchers and external collaborators, which essentially makes it a system that circulates data between the involved parties and helps enable the DOE Office of Science mission. In addition to its operational functions, ESnet serves as a testbed for the development of new network technologies and has a skilled workforce of network scientists and engineers.

As DOE's center of expertise and network operations and management, ESnet will serve as a critical component in the Department's initiative in quantum networking R&D by serving as a platform for testing and ultimately delivering quantum networking to the national laboratories and other DOE sites. I'll yield back.

Chairwoman JOHNSON. Thank you very much. Any further discussion? Any requests for time?

If there's no further discussion, the vote occurs on the amendment.

All those in favor, say aye.

Those opposed, say no.

The ayes have it, and the amendment is agreed to.

The next amendment on the roster is an amendment offered by the gentleman from Virginia, Mr. Beyer. You're recognized to offer your amendment.

Mr. BEYER. Thank you, Madam Chair, very much. I have an amendment with the Clerk.

Chairwoman JOHNSON. The Clerk will report the amendment.

The CLERK. Amendment No. 7, amendment to the amendment in the nature of a substitute to H.R. 3593 offered by Mr. Beyer of Virginia.

[The amendment of Mr. Beyer follows:]

AMENDMENT TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593

OFFERED BY M__. _____

Page 64, strike lines 18 and 19 and insert the following:

(A) by striking "The Director" and all that follows through the period and inserting the following:

"(1) IN GENERAL.—

"(A) ESTABLISHMENT.—Within 180 days of enactment of the Department of Energy Science for the Future Act, the Director shall establish at least 2 national teams, including public-private partnerships, that will develop conceptual pilot plant designs and technology roadmaps and lead to an engineering design of a pilot plant that will bring fusion to commercial viability.

"(B) COMPOSITION.—The national teams shall be composed of developers, manufacturers, universities, national laboratories, and engineering, procurement, and construction industries.".

Chairwoman JOHNSON. I ask unanimous consent to dispense with the reading. Without objection, so ordered.

I recognize the gentleman for 5 minutes to explain his amendment.

Mr. BEYER. Thank you, Chairwoman Johnson.

I'm introducing this amendment because it recognizes some significant recommendations in the recent National Academies report entitled "Bringing Fusion to the U.S. Grid." This amendment replaces language we enacted in the *Energy Act of 2020* to direct the DOE to carry out fusion reactor system design activities with language more specific to the Academies' recommendations, and it establishes national teams to develop conceptual fusion pilot plan designs and technology roadmaps.

And we all know that fusion energy has been 25 years away every year of our lives. Now it could be much, much closer, but there are specific technological objectives that have to be overcome, and the National Academies says set up two teams to do this, and we can make great progress. So this is a really important step in the effort to commercialize fusion energy, and I urge my colleagues to support this amendment. Madam Chair, thank you, and I yield back.

Chairwoman JOHNSON. Thank you. I think Mr. Lucas——

Mr. LUCAS. Thank you, Chairwoman Johnson.

Chairwoman JOHNSON [continuing]. Do you have a request for time?

Mr. LUCAS. Yes, ma'am. I move to strike the last word.

Chairwoman JOHNSON. You are recognized.

Mr. LUCAS. Thank you, Chairwoman Johnson.

I would like to thank Representative Beyer for offering this amendment, which incorporates stakeholder feedback to expand upon the fusion energy sciences language in this legislation. The system design activities authorized in this amendment will strengthen the U.S. fusion industry and help prepare our energy sector for the day when commercial fusion power becomes a reality. This is a key piece of the puzzle in our mission to realize the full potential of fusion energy. I encourage my colleagues to support this amendment, and I yield back.

Chairwoman JOHNSON. Thank you very much. Any other requests for time?

Mr. MCNERNEY. Madam Chair, I would request time. Mr. McNerney.

Chairwoman JOHNSON. Mr. McNerney.

Mr. MCNERNEY. I thank the Chairwoman for recognizing me. I just want to say thanks for Don Beyer on this issue. He's led on fusion. We have a Fusion Caucus. This is an important issue. As we look to the future of energy in our nation and our world, fusion is going to have to be a big part of that. We need to pull out all the stops and move forward aggressively on that. So thank you again, Don, for your leadership. I urge all of my colleagues to be enthusiastic about fusion and about this amendment, and I yield back.

Chairwoman JOHNSON. Thank you very much. Any further requests for time?

If not, the vote on—the vote occurs on the amendment.

All those in favor, say aye.

Those opposed, say no.

The ayes have it, and the amendment is approved.

Next—the next amendment on the roster is an amendment offered by the gentleman from Illinois, Mr. Foster, and you're recognized to offer your amendment.

Mr. FOSTER. Thank you, Madam Chair. I have an amendment at the desk.

Chairwoman JOHNSON. The Clerk will report the amendment.

The CLERK. Amendment No. 8, amendment to the amendment in the nature of a substitute to H.R. 3593 offered by Mr. Foster of Illinois.

[The amendment of Mr. Foster follows:]

AMENDMENT TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593

OFFERED BY MR. FOSTER OF ILLINOIS

Page 110, line 18, strike "There are" and insert "(a) There are".

Page 110, insert after line 24 the following:

"(b) SENSE OF CONGRESS.—It is the sense of Congress that if, during the years for which there are authorizations under subsection (a), if actual inflation rates exceed the inflation rates projected by the Office of Management and Budget, on which such authorizations were based, Congress should modify such authorizations to reflect the actual rate of inflation.".

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Chairwoman JOHNSON. I ask unanimous consent to dispense with the reading. Without objection, so offered—ordered.

And I recognize the gentleman for 5 minutes to explain his amendment.

Mr. FOSTER. Thank you, Madam Chairwoman.

This amendment is similar to one that I offered and withdrew for the NSF earlier in this markup.

The research performed at the DOE Office of Science often involves large scientific projects with multiyear construction and operating budgets. And as such, they are particularly vulnerable to unanticipated increases in inflation. When Congress authorizes a large construction project, that commitment should be made in real inflation-corrected terms, and our Federal agencies should have some assurance that if inflation unexpectedly affects their planned budgeting, that they're not going to be hauled back in front of Congress for complaints that have more to do with macroeconomic conditions than their failure to produce.

So I understand that this is not allowed under our current authorization appropriation procedures, so I withdraw my amendment and yield back.

Chairwoman JOHNSON. Thank you very much, Mr. Foster.

The next amendment on the roster is an amendment offered by the gentleman from Florida, Mr. Waltz. You're recognized to offer the amendment.

Mr. WALTZ. Thank you. Thank you, Madam Chairwoman. My amendment seeks to clarify the scope of research——

Chairwoman JOHNSON. The amendment—the Clerk will report the amendment.

Mr. WALTZ. Oh, excuse me. I have an amendment at the desk.

The CLERK. Amendment No. 9, amendment to the amendment in the nature of a substitute to H.R. 3593 offered by Mr. Waltz of Florida.

[The amendment of Mr. Waltz follows:]

AMENDMENT TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593

OFFERED BY MR. WALTZ OF FLORIDA

Page 110, line 16, insert the following:

"(g) PROHIBITION ON USE OF FUNDS.—

"(1) IN GENERAL.—No funds allocated to the initiative described in subsection (a) may be obligated or expended for gain-of-function research of concern.

"(2) GAIN-OF-FUNCTION RESEARCH DEFINED.—For the purposes of this subsection, 'gain-of-function research of concern' means research activities with the potential to generate pathogens with high transmissibility and high virulence in humans.".

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Chairwoman JOHNSON. Without objection, the—we ask unanimous consent to dispense with the reading. And I now recognize the gentleman for 5 minutes to explain his amendment.

Mr. WALTZ. Thank you, Madam Chairwoman.

My amendment seeks to clarify the scope of research within the Department of Energy's new emerging infectious disease program without eliminating possible benefits of pathogen research. The amendment prohibits DOE's infectious disease program from conducting gain-of-function research with the potential to generate pathogens in humans. Domestic gain-of-function research in humans is not intended for the Department of Energy and must be very closely monitored by health professionals. Gain-of-function research——

Chairwoman JOHNSON. You're muted.

STAFF. Will you tell him he's muted?

Chairwoman JOHNSON. Somehow, you are muted.

Mr. WALTZ. Excuse me. Gain-of-function research, Madam Chairwoman, is a topic of interest in the Federal Government's 90-day review of the origins of COVID–19. In fact, this Committee has jurisdiction over the Office of Science and Technology Policy (OSTP), which historically has provided guidance to the Federal research agencies on gain-of-function research. In 2014, this office, OSTP, announced a governmentwide pause and a risk assessment of gain-of-function research and then subsequently in January of 2017 OSTP and the White House provided guidance on the use of gain-of-function research.

Considering this history, Ranking Member Lucas and myself sent a letter on June 3rd seeking information about the White House Office of Science and Technology Policy's role, which is a cabinet-level office, in the 90-day origins of COVID–19 investigation. It is essential for OSTP and the research agencies to provide their expertise and conduct full diligence during this review period.

With this amendment, we are still enabling—this is important for my colleagues to understand. We are still enabling DOE's computing power to be applied to research on spread and severity of diseases that could be the cause of the next pandemic. However, it maintains thoughtful biosafety and biosecurity safeguards. I consider this a clarifying amendment by nature, and I urge my colleagues to support it. I yield back the balance of my time.

Chairwoman JOHNSON. Thank you very much. I yield myself 5 minutes.

I support Mr. Waltz's amendment and thank him for working together on an appropriate definition for this limitation on DOE funding. Gain-of-function and loss-of-function studies are common in molecular microbiology and virology. The vast majority of gain-of-function research is performed to help understand how diseases work for the sake of protecting public health. The potential benefits of gain-of-function research are significant, but some of the specific types of studies also are at risk. Representative Waltz has touched on an important issue in the national security and ethical implications of modern science. This Committee should be a part of a larger conversation about how to balance the opportunities and the risks of the genomic engineering and how to ensure laboratory biosafety around the world.

I look forward to working with Representative Waltz and my colleagues on these important issues, and I yield back.

Any further——

Mr. LUCAS. Madam Chair?

Chairwoman JOHNSON. Mr. Lucas.

Mr. LUCAS. Thank you, Madam Chair. I'd like to thank Ranking Member Waltz for offering this amendment, which provides a critical safeguard for DOE's emerging infectious disease research activities authorized in this legislation. Gain-of-function research that can increase the contagiousness or strength of a virus must be closely monitored. Until the American people have a better understanding of this work and its implications for national and global biosecurity, we have a responsibility to limit it here at home. I encourage my colleagues to support this amendment, and I yield back. Thank you, Madam Chair.

Chairwoman JOHNSON. Thank you very much.

Any further request for time? Did I hear someone? OK. The vote occurs on the amendment.

All those in favor, say aye.

Those opposed, say no.

The ayes have it, and the amendment is agreed to.

The next amendment on the roster is an amendment offered by the gentleman from Florida, Mr. Posey. You're recognized to offer your amendment.

Mr. POSEY. Thank you, Madam Chair. I have an amendment at the desk.

Chairwoman JOHNSON. The Clerk will report the amendment.

The CLERK. Amendment number 10, amendment to the amendment in the nature of a substitute to H.R. 3593 offered by Mr. Posey of Florida.

[The amendment of Mr. Posey follows:]

AMENDMENT TO THE AMENDMENT IN THE NATURE OF A SUBSTITUTE TO H.R. 3593 OFFERED BY MR. POSEY OF FLORIDA

At the end, add the following:

SEC. 14. STATE-OWNED ENTERPRISES PROHIBITION.

(a) INNOVATE IN AMERICA.—None of the funds authorized or made available by this Act, or the amendments made by this Act, may be used in awarding a contract, subcontract, grant, or loan to an entity that—

(1) is owned or controlled by, is a subsidiary of, or is otherwise related legally or financially to a corporation based in a country that—

(A) is identified as a nonmarket economy country (as defined in section 771(18) of the Tariff Act of 1930 (19 U.S.C. 1677(18))) as of the date of enactment of this Act;

(B) was identified by the United States Trade Representative in the most recent report required by section 182 of the Trade Act of 1974 (19 U.S.C. 2242) as a priority foreign country under subsection (a)(2) of that section; and

(C) is subject to monitoring by the Trade Representative under section 306 of the Trade Act of 1974 (19 U.S.C. 2416); or

(2) is listed pursuant to section 9(b)(3) of the Uyghur Human Rights Policy Act of 2020 (Public Law 116–145).

(b) EXCEPTION.—For purposes of subsection (a), the Secretary may issue a waiver, to be made publicly available, to an entity in which the legal or financial connection to a corporation is a minority relationship or investment.

(c) INTERNATIONAL AGREEMENTS.—This section shall be applied in a manner consistent with the obligations of the United States under international agreements.

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Chairwoman JOHNSON. I ask unanimous consent to dispense with the reading. Without objection, so ordered.

I recognize now the gentleman for 5 minutes to explain his amendment.

Mr. POSEY. Thank you, Chairwoman Johnson.

This amendment will ensure that none of the taxpayer funds authorized in H.R. 3593 will be used to buildup foreign countries' competitiveness in science and technology at the expense of our own. Specifically, this amendment states that none of the funds authorized here can be used to award Federal contracts, grants, loans to entities owned, controlled, or otherwise tied to a corporation based in a nonmarket-economy country or foreign country of concern.

The Chinese Communist Party has made it an explicit goal to surpass the United States as a global frontrunner in science and technologies. It's Made in 2025 initiative outlines a clear strategy to get ahead of us in critical technologies and industries of the future. Simply put, we can't afford to spend the time, money, and effort to sow the seeds of new technologies here at home while other countries like China get the same reward for no cost to them at all. We must do more to work together to protect American research while maintaining the spirit of open science that has fueled generations of discoveries.

This amendment would also prohibit funds from going to entities listed under the *Uyghur Human Rights Policy Act of 2020*. We have a moral obligation to ensure that none of the funds in this act benefit State-sponsored companies associated with human rights violations.

The amendment provides commonsense protections for taxpayer-funded research to ensure that we are not spending billions of dollars on research that China will then use to outcompete us. I urge my colleagues to support this amendment. Thank you. I yield back.

Chairwoman JOHNSON. Thank you very much. I recognize myself to speak on this amendment.

I want to thank Mr.—Representative Posey for this amendment, which aims to ensure the responsible use of our limited research dollars at home and abroad. I am supporting this amendment today but with the caveat that we may need to revisit this language after the Department of Energy has had sufficient time to review its potential impacts on current and expected research activities. I look forward to continuing to work with Mr. Posey and my colleagues on both sides of the aisle to make sure we strike the appropriate balance when we engage in well-intentioned collaborations with researchers and nations that are not always our friends. I thank you and yield back.

Any further request for time?

Mr. LUCAS. Madam Chair?

Chairwoman JOHNSON. Mr. Lucas.

Mr. LUCAS. Thank you, Chairwoman Johnson, and thank you, Mr. Posey, for offering this amendment.

As Mr. Posey stated, the Chinese Communist Party has made no secret of their intention to do whatever they can to dominate the development of critical technologies. They're not above espionage, hacking, or illegal methods to acquire the knowledge and informa-

tion they need. But we shouldn't make it easy for bad actors to reap the rewards of the United States' investment.

The underlying bill will result in significant investment in research and multiple projects in the most competitive science fields. This amendment would prevent companies owned or controlled by the Chinese Communist Party from receiving that information and opening the door to theft of information.

Additionally, this amendment takes a step further and makes sure that no company or entity has participated in atrocities against Uyghur people receives funds from this bill. No company, group, or individual who benefits from State-sponsored forced labor should benefit from the taxpayers of this country. I urge my colleagues to support this amendment and the underlying bill and yield back the balance of my time, Madam Chair.

Chairwoman JOHNSON. Thank you very much.

Is there any further request for time?

Hearing none, all those in favor, say aye.

Those opposed, say no.

The ayes have it, and the amendment is agreed to.

We will now vote on the amendment in the nature of a substitute, as amended. The vote occurs on the amendment.

All those in favor, say aye.

All those opposed, say no.

Further proceedings on this amendment then will—I'm sorry. Well, believe it or not, we're ready to report the amendment. A reporting quorum being present, I move that the Committee on Science, Space, and Technology report H.R. 3593, as amended, to the House with the recommendation that the bill be approved.

Those in favor of the motion will signify by saying aye.

Those opposed, say no.

The ayes have it. The bill is favorably reported.

Without objection, the motion to reconsider is laid on the table, and I ask unanimous consent that the staff be authorized to make any necessary technical and conforming changes to the bill. Without objection, so ordered.

Members will have 2 subsequent calendar days in which to submit supplementary minority or additional views on the measure.

I want to thank the Members for coming to work this morning and getting this done. This concludes our markup, and the meeting is adjourned.

[Whereupon, at 12:57 p.m., the Committee was adjourned.]

○

H.R. 3593 Endorsements

American Association for the Advancement of Science

American Association of Physicists in Medicine

American Association of Physics Teachers

American Astronomical Society

American Chemical Society

American Crystallographic Association

American Geophysical Union

American Geosciences Institute

American Institute of Physics

American Mathematical Society

American Nuclear Society

American Physical Society

Applied Physics Laboratory, University of Washington

American Society for Engineering Education

American Society of Agronomy

Acoustical Society of America (ASA)

American Society of Mechanical Engineers

American Society for Microbiology

American Society of Plant Biologists

American Vacuum Society

Arizona State University

Association of American Universities

Association of Public and Land-grant Universities

AVS – The Society for Science and Technology of Materials, Interfaces, and Processing

Battelle

Binghamton University

Biophysical Society

Bipartisan Policy Center

Boston University

Case Western Reserve University

Citizens for Responsible Energy Solutions (CRES)

City College of CUNY

ClearPath Action

Clemson University

Coalition for Academic Scientific Computation (CASC)

Consortium for Ocean Leadership

Columbia University

Computing Research Association

Council of Scientific Society Presidents

Cornell University

Cray Inc.

Crop Science Society of America

Duke University

The Ecological Society of America

Florida State University

Energy Sciences Coalition

Environmental Defense Fund

Fusion Industry Association

Fusion Power Associates

General Atomics

Geological Society of America

George Mason University

Georgia Institute of Technology

Harvard University

Health Physics Society

IBM

IEEE-USA

Iowa State University

Jefferson Science Associates, LLC

Krell Institute

Lehigh University

Long Island University

Massachusetts Institute of Technology

Materials Research Society

Michigan State University

Michigan Technological University

New York University

Northeastern University

Northern Illinois University

Northwestern University

Oak Ridge Associated Universities (ORAU)

OSA—The Optical Society

Pace University

Penn State University

Princeton University

Purdue University

Rensselaer Polytechnic Institute

Rutgers, The State University of New Jersey

Semiconductor Industry Association

Society for Industrial and Applied Mathematics

Soil Science Society of America

South Dakota School of Mines

Southeastern Universities Research Association

SPIE

Stanford University

Stony Brook University

Tech-X Corporation

The Honorable Paul M. Dabbar, Former Under Secretary for Science, U.S. Department of Energy

South Dakota Science and Technology Authority

The Ohio State University

University of California System

University of Chicago

University of Colorado Boulder

University of Delaware

University of Illinois System

University of Iowa

University of Maryland, College Park

University of Michigan

University of Missouri System

University of Nebraska

University of North Texas

University of Oklahoma

University of Pennsylvania

University of Rochester

University of Southern California

University of Tennessee

University of Texas at Austin

University of Virginia

University of Wisconsin-Madison

U.S. Chamber of Commerce

Vanderbilt University

Washington State University

West Virginia University

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