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 socio-economic 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: