117TH CONGRESS
2D SESSION

S. 3699

To provide guidance for and investment in the research and development activities of the Department of Energy Office of Science, and for other purposes.

IN THE SENATE OF THE UNITED STATES

FEBRUARY 17, 2022

Mr. MANCHIN (for himself, Mr. BARRASSO, Mr. DURBIN, and Mrs. BLACKBURN) introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources

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A BILL

To provide guidance for and investment in the research and development activities of the Department of Energy Office of Science, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the ''Department of Energy Science for the Future Act of 2022''.

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, including the transfer of knowledge, capabilities, and relevant technologies from basic research programs of the Department to applied research and development programs of the Department for the purpose of enabling development of mission-relevant technologies;

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

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

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

''(2) OFFICE OF SCIENCE.—The Director—

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

''(B) shall direct all programs which have not recently completed a future planning roadmap consistent with the funding of such programs authorized under the Department of Energy Science for the Future Act of 2022 to complete such a roadmap.''.

SEC. 3. BASIC ENERGY SCIENCES PROGRAM.

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

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

(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), as so redesignated—

(A) in paragraph (3)—

(i) in subparagraph (C), by striking ''and'' at the end;

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

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

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

(B) 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) UPGRADE.—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, entitled 'Report on Facility Upgrades', including the development of a multibend achromat lattice to produce a high flux of coherent x-rays within the hard x-ray energy region and a suite of beamlines optimized for this source.

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

''(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there is authorized to be appropriated to the Secretary to carry out the upgrade under this paragraph $101,000,000 for fiscal year 2022 and $56,000,000 for fiscal year 2023.

''(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.—In this paragraph, the term 'proton power upgrade' means the Spallation Neutron Source power upgrade described in—

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

"(ii) the publication entitled '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 in August, 2007; and

"(iii) the publication approved by the Basic Energy Sciences Advisory Committee on June 9, 2016, entitled '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 July 30, 2028, with the option for early operation in 2025.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there is authorized to be appropriated 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.—In this paragraph, the term 'second target station' means the Spallation Neutron Source second target station described in—

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

"(ii) the publication entitled, '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 in August, 2007; and

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

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

ations of the second target station under this paragraph occurs before December 31, 2033, with the option for early operation in 2029.

"(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there are authorized to be appropriated 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) UPGRADE.—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, entitled '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 are authorized to be appropriated 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) $26,400,000 for fiscal year 2026.

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

"(A) DEFINITIONS.—In this paragraph:

"(i) HIGH ENERGY.—The term 'high energy', with respect to an 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 1,000,000 pulses per second.

"(iii) ULTRA-SHORT PULSE.—The term 'ultra-short pulse', with respect to an x-ray, means that the x-ray has bursts capable of durations of less than 100 femtoseconds.

"(B) UPGRADE.—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, entitled 'Report on Facil-

ity Upgrades', including the development of experimental capabilities for high energy x-rays to reveal fundamental scientific discoveries; and

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

"(C) START OF OPERATIONS.—The Secretary shall, 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 are authorized to be appropriated 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 subsequent upgrades.

"(B) CONSULTATION REQUIRED.—The Secretary shall consult with the private sector, institutions of higher education, National Laboratories, and relevant Federal agencies to ensure that the facility described in subparagraph (A) has the capability to maintain, repair, and test superconducting radio frequency accelerator components.

"(C) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there are authorized to be appropriated 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 of 2022, 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 are authorized to be appropriated 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.

"(11) NATIONAL SYNCHROTRON LIGHT SOURCE II BEAMLINE BUILDOUT.—

"(A) IN GENERAL.—The Secretary shall provide for the development and construction of beamlines to provide significant additional capacity, complement the existing portfolio of beamlines, and complete the buildout of the National Synchrotron Light Source II.

"(B) START OF OPERATIONS.—Subject to the availability of appropriations, the Secretary—

"(i) shall begin carrying out subparagraph (A) not later than September 30, 2036; and

"(ii) may begin carrying out subparagraph (A)—

"(I) in calendar year 2033; or

"(II) after the construction of individual beamlines is complete.

"(C) FUNDING.—Of the funds authorized to be appropriated under subsection (j), there are authorized to be appropriated to the Sec-

retary such sums as are necessary to carry out this paragraph.''; and

(4) 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) codesign 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 dy-

namics 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 6 computational materials and chemical sciences centers to—

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

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

''(B) SELECTION.—The Director shall select centers under subparagraph (A) on a competitive, merit-reviewed basis. The Director shall consider applications from the National

Laboratories, institutes of higher education, multi-institutional collaborations, and other appropriate entities.

"(C) DURATION.—

"(i) NEW CENTERS.—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) EXISTING CENTERS.—A center already in existence on the date of enactment of the Department of Energy Science for the Future Act of 2022 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) FUNDING.—Of the funds authorized to be appropriated under subsection (j), there are authorized to be appropriated to the Sec-

retary such sums as are necessary to carry out this paragraph.

''(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 among National Laboratories, 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 is authorized to be appropriated to the Secretary to carry out activities under this subsection $10,000,000 for each of 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) $2,877,705,000 for fiscal year 2022;

"(2) $2,978,896,600 for fiscal year 2023;

"(3) $3,169,489,612 for fiscal year 2024;

"(4) $3,311,698,885 for fiscal year 2025; and

"(5) $3,441,651,600 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 the following:

"(4) FUNDS.—Of the funds authorized to be appropriated for basic energy sciences in a fiscal year, there is authorized to be appropriated to the Secretary to carry out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026."; and

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

"(4) FUNDS.—Of the funds authorized to be appropriated for basic energy sciences in a fiscal year, there is authorized to be appropriated to the Secretary to carry 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 (a)—

(A) in paragraph (1)—

(i) in subparagraph (A)(ii), by striking ''and'' after the semicolon at the end;

(ii) in subparagraph (B), by striking the period at the end and inserting ''; and''; and

(iii) by adding at the end the following:

''(C) to ensure the competitiveness of the United States in energy storage by fostering an ecosystem linking fundamental research and development to deployment of storage solutions while minimizing the environmental impacts of energy storage technologies.''; and

(B) in paragraph (2)—

(i) in subparagraph (A), by striking ''and'' after the semicolon at the end;

(ii) in subparagraph (B), by striking the period at the end and inserting ''; and''; and

(iii) by adding at the end the following:

''(C) any other relevant office of the Department.'';

(2) in subsection (b), by striking paragraph (4) and inserting the following:

''(4) FUNDING.—Of the funds authorized to be appropriated for basic energy sciences in a fiscal year, there is authorized to be appropriated to the Secretary to carry out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.'';

(3) in subsection (c), by striking paragraph (4) and inserting the following:

''(4) FUNDING.—Of the funds authorized to be appropriated for basic energy sciences in a fiscal year, there is authorized to be appropriated to the Secretary to carry out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.''; and

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

''(4) FUNDING.—Of the funds authorized to be appropriated for basic energy sciences in a fiscal year, there is authorized to be appropriated to the Secretary to carry out activities under this subsection $20,000,000 for each of fiscal years 2022 through 2026.''.

(d) FOUNDATIONAL NUCLEAR SCIENCE.—

(1) IN GENERAL.—The Director of the Office of Science shall support a program of research and de-

velopment to bridge scientific barriers to, and expand theoretical and fundamental knowledge relevant to, nuclear matter for the benefit of commerce, medicine, and national security.

(2) ACTIVITIES.—As part of the program described in paragraph (1)—

(A) the Director of the Office of Science shall support basic research to pursue distinct lines of scientific inquiry, including—

(i) nuclear materials science, including the application of advanced computing practices to foundational and emerging research problems in nuclear materials science and discovery;

(ii) the use of large data sets to model materials phenomena, including through—

(I) advanced characterization of materials;

(II) materials synthesis;

(III) processing; and

(IV) innovative use of experimental and theoretical data;

(iii) electrochemistry and associated techniques for processing nuclear materials;

(iv) advanced instrumentation and nuclear data collection to inform the activities described in clauses (i) through (iii); and

(v) any other line of scientific inquiry, as determined by the Director of the Office of Science; and

(B) the Assistant Secretary for Nuclear Energy shall consult with the Director of the Office of Science to support the direction of translational research, development, and validation of physical concepts developed under the program.

(3) FUNDING.—Of the funds authorized to be appropriated for basic energy sciences in a fiscal year, there is authorized to be appropriated to the Secretary of Energy to carry out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.

(e) CARBON MATERIALS SCIENCE INITIATIVE.—

(1) INITIATIVE.—

(A) IN GENERAL.—The Secretary of Energy (referred to in this subsection as the ''Secretary'') shall establish a research initiative, to be known as the ''Carbon Materials Science Initiative'' (referred to in this subsection as the

"Initiative"), to expand the fundamental knowledge of coal and carbon ore chemistry useful for understanding the conversion of carbon to material products.

(B) COORDINATION.—In carrying out programs and activities under the Initiative, the Secretary shall leverage expertise and resources from the Office of Fossil Energy and Carbon Management and the United States Geological Survey.

(C) TEAMS.—

(i) IN GENERAL.—In carrying out the Initiative, the Secretary shall establish and organize activities among multidisciplinary teams to leverage, to the maximum extent practicable, expertise from the National Laboratories, institutions of higher education, and the private sector.

(ii) GOALS.—The multidisciplinary teams described in clause (i) shall pursue aggressive, milestone-driven basic research goals established by the Secretary.

(2) RESEARCH PROGRAM.—

(A) IN GENERAL.—The Secretary shall carry out under the Initiative a program to sup-

port, and discover knowledge relevant to, carbon materials research.

(B) ACTIVITIES.—As part of the program described in subparagraph (A)—

(i) the Director of the Office of Science shall support basic research to pursue distinct lines of scientific inquiry, including methods of extraction and utilization of the materials and valuable minerals contained in raw coal; and

(ii) the Director of the Office of Science and the Assistant Secretary of Energy for Fossil Energy and Carbon Management shall support basic research to pursue distinct lines of scientific inquiry, including methods of improving materials for use as carbon oxide membranes for use in carbon capture systems.

(C) REVIEW.—The Secretary shall periodically review activities carried out under the program described in subparagraph (A) to evaluate the achievement of technical milestones.

(D) COORDINATION WITH EXISTING PROGRAMS AND CENTERS.—In carrying out the

program described in subparagraph (A), the Secretary shall—

(i) ensure coordination with—

(I) the United States Geological Survey; and

(II) the programs and the Carbon Utilization Research Center established under section 969A of the Energy Policy Act of 2005 (42 U.S.C. 16298a); and

(ii) avoid duplication of efforts to the maximum extent practicable.

(3) CARBON MATERIALS RESEARCH CENTERS.—

(A) IN GENERAL.—In carrying out the activities authorized under paragraph (2), the Secretary shall establish 1 center in each of the 2 major coal-producing regions of the United States, each of which shall—

(i) be known as a ''Carbon Materials Research Center'' (referred to in this paragraph as a ''Center''); and

(ii) focus on early stage research and development activities, including—

(I) developing and advancing methods of extracting carbon or other valuable materials from raw coal, or other solid carbon materials, for the development of other carbon-based materials;

(II) improving methods of improving the structural, physical, and chemical properties of carbon materials or other valuable materials from raw coal or other solid carbon materials and their recyclability; and

(III) focusing on overcoming the challenges and maximizing the benefits of coal-derived carbon.

(B) SELECTION.—The Secretary shall—

(i) select Centers under subparagraph (A) on a competitive, merit-reviewed basis; and

(ii) consider applications from the National Laboratories, institutions of higher education, multi-institutional collaborations, and other appropriate entities.

(C) DURATION.—A Center 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.

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

(4) FUNDING.—Of the funds authorized to be appropriated for basic energy sciences in a fiscal year, there is authorized to be appropriated to the Secretary to carry out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.

(f) CARBON OXIDE SEQUESTRATION RESEARCH AND GEOLOGIC COMPUTING INITIATIVE.—

(1) INITIATIVE.—

(A) IN GENERAL.—The Secretary of Energy (referred to in this subsection as the ''Secretary'') shall establish a research initiative, to be known as the ''Carbon Oxide Sequestration Research and Geologic Computing Initiative'' (referred to in this subsection as the ''Initiative''), to expand the fundamental knowledge, data collection, data analysis, and modeling of

subsurface geology for the purpose of advancing carbon oxide sequestration in geologic formations.

(B) LEVERAGING.—In carrying out programs and activities under the Initiative, the Secretary shall leverage expertise and resources from the Office of Fossil Energy and Carbon Management and the United States Geological Survey.

(C) TEAMS.—

(i) IN GENERAL.—In carrying out the Initiative, the Secretary shall establish and organize activities among multidisciplinary teams to leverage, to the maximum extent practicable, expertise from the National Laboratories, institutions of higher education, and the private sector.

(ii) GOALS.—The multidisciplinary teams described in clause (i) shall pursue aggressive, milestone-driven basic research goals established by the Secretary.

(D) ADDITIONAL ACTIVITIES.—The Secretary may organize additional activities under this subsection through other organizational structures.

(2) RESEARCH PROGRAM.—

(A) IN GENERAL.—The Secretary shall carry out under the Initiative a program to support research needed for, and discover knowledge relevant to, the sequestration of carbon oxides in geologic formations.

(B) ACTIVITIES.—As part of the program described in subparagraph (A), the Director of the Office of Science shall support basic research to pursue distinct lines of scientific inquiry, including—

(i) methods of gathering geologic data for pore space characterization, including improvements to geologic seismic imaging;

(ii) methods of evaluating pore space quality, including evaluation of geologic samples, to determine appropriate sequestration zones for carbon oxides;

(iii) methods of testing carbon oxide sequestration;

(iv) methods of monitoring carbon oxide migration in geologic formations; and

(v) advancements in data analytics, including the analysis of seismic data, and computing to improve the advanced com-

puting, visualization, and imaging of geologic formations for the sequestration of carbon oxides.

(C) REVIEW.—The Secretary shall periodically review activities carried out under the program described in subparagraph (A) to evaluate achievement of technical milestones.

(3) CARBON OXIDE STORAGE RESEARCH AND GEOLOGIC COMPUTING CENTERS.—

(A) IN GENERAL.—In carrying out the activities authorized under paragraph (2), the Director of the Office of Science shall select and establish not more than 2 carbon oxide storage research and geologic computing centers (referred to in this paragraph as a ''Center'') to develop and advance improvements to data collection, analysis, and modeling of subsurface geology for the purpose of advancing carbon oxide sequestration in geologic formations.

(B) SELECTION.—

(i) IN GENERAL.—The Director of the Office of Science shall—

(I) select Centers under subparagraph (A) on a competitive, merit-reviewed basis; and

(II) to the maximum extent practicable, locate each Center in a region with established and ongoing geologic carbon oxide sequestration research and demonstration.

(ii) APPLICATIONS.—In selecting Centers under subparagraph (A), the Director of the Office of Science shall consider applications from institutions of higher education, multi-institutional collaborations, and other appropriate entities.

(C) DURATION.—

(i) NEW CENTERS.—A Center established after the date of enactment of this Act 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) EXISTING CENTERS.—A Center already in existence on the date of enactment of this Act may continue to receive support for a period of not more than 5 years beginning on that date of enactment.

(iii) RENEWAL.—On expiration of a period of support described in clause (i) or

(ii), the Director of the Office of Science may renew support for the Center, on a merit-reviewed basis, for a period of not more than 5 years.

(4) COORDINATION WITH EXISTING PROGRAMS AND CENTERS.—In carrying out this subsection, the Secretary shall—

(A) ensure coordination with—

(i) the United States Geological Survey; and

(ii) the programs established under section 963 of the Energy Policy Act of 2005 (42 U.S.C. 16293); and

(B) avoid duplication of efforts to the maximum extent practicable.

(5) FUNDING.—Of the funds authorized to be appropriated for basic energy sciences in a fiscal year, there is authorized to be appropriated to the Secretary to carry out activities under this subsection $50,000,000 for each of fiscal years 2022 through 2026.

SEC. 4. BIOLOGICAL AND ENVIRONMENTAL RESEARCH.

(a) PROGRAM; BIOLOGICAL SYSTEMS; BIOMOLECULAR CHARACTERIZATION AND IMAGING SCIENCE.—Sec-

tion 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) is amended—

(1) in subsection (c), by redesignating paragraphs (6) through (8) as paragraphs (5) through (7), respectively;

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

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

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

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

''(1) to provide a fundamental understanding of the biology of plants, fungi, and microbes as a basis for developing innovative processes for bioenergy and bioproducts and accelerate breakthroughs and new knowledge that would enable the cost-effective, sustainable production of—

''(A) advanced biofuels;

''(B) bioenergy; and

''(C) biobased materials;

''(2) to conduct foundational functional biology research—

''(A) to support expanded biosystems design research; and

''(B) to understand—

''(i) fundamental genome structure; and

''(ii) phenomes, including functional genomics of gene products at genome scale;

''(3) to develop biosystems designs and synthetic biology approaches for new nonfood plant-derived and microbially derived bioproducts as a basis for new bioeconomy and biotechnology applications in bioproducts production, resource recovery, recycling, and upcycling ventures;

''(4) to conduct research to better understand environmentally relevant microbiomes and the interdependencies between plants and microbes in a sustainable ecosystem;

''(5) to 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, storage, and utilization;

''(6) to understand the microbiome mechanisms and microbiota used to transform, immobilize, or remove contaminants from subsurface environments and that affect the cycling and disposition of carbon, nutrients, and contaminants in the environment;

''(7) to develop the computational approaches and integrated platforms for open access collaborative science;

''(8) to 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—

''(A) to advance fungal, microbial, and plant 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) to deepen genome-enabled knowledge of the roles of microbes and microbial communities, including fungi, in—

"(i) supporting plant and tree productivity, performance, adaptation, and resilience in changing environmental conditions; and

"(ii) optimizing end uses of biomass;

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

"(D) to increase the scale and pace of characterizing the functions and physical characteristics of microbes and microbial communities to improve biosystems design;

"(9) to conduct research focused on developing analysis techniques and simulation capabilities, including artificial intelligence and machine learning, on high-performance computing platforms to accelerate collaborative and reproducible systems biology research;

''(10) to develop new technologies for bioimaging, measurement, and characterization purposes—

''(A) through the Biomolecular Characterization and Imaging Science program of the Department; and

''(B) to understand the structural, spatial, and temporal relationships of metabolic processes governing phenotypic expression in plants and microbes;

''(11) to conduct research focused on genotype-to-phenotype translations to develop a predictive understanding of cellular function under a variety of relevant environmental and bioenergy-related conditions;

''(12) to conduct metagenomic and metadata assembly research sequencing and analysis; and

''(13) to 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.''; and

(4) by adding at the end the following:

''(l) DEFINITIONS.—In this section:

''(1) ADVANCED BIOFUEL.—The term 'advanced biofuel' has the meaning given the term in section 9001 of the Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8101).

''(2) BIOENERGY.—The term 'bioenergy' means energy derived from biofuels.

''(3) BIOMASS.—The term 'biomass' has the meaning given the term in section 203(b) of the Energy Policy Act of 2005 (42 U.S.C. 15852(b)).

''(4) BIOPRODUCT.—The term 'bioproduct' has the meaning given the term 'biobased product' in section 9001 of the Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8101).''.

(b) LOW-DOSE RADIATION RESEARCH PROGRAM.—Paragraph (8) of subsection (e) of section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644), as redesignated by subsection (a)(2), 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) $50,000,000 for fiscal year 2025; and

"(F) $60,000,000 for fiscal year 2026.".

(c) LOW-DOSE RADIATION AND SPACE RADIATION RESEARCH PROGRAM.—Subsection (f) of section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644), as redesignated by subsection (a)(2), is amended to read as follows:

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

"(1) IN GENERAL.—The Secretary, 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 the program described in paragraph (1) is to accelerate breakthroughs in low-dose and low dose-rate radiation research and development as described in subsection (e) and to inform the advancement of new tools,

technologies, and advanced materials needed to facilitate long-duration space exploration.''.

(d) CLIMATE, ENVIRONMENTAL SCIENCE, AND OTHER ACTIVITIES.—Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) (as amended by subsection (a)) is amended by inserting after subsection (f) 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—

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

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

''(D) to 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) to understand and predict interactions among natural and human systems to inform potential mitigation and adaptation options for increased concentrations of greenhouse gas emissions and any associated changes in climate.

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

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

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

"(3) ENVIRONMENTAL SYSTEMS SCIENCE RESEARCH.—

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

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

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

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

''(ii) consult with the Interagency Research, Development, and Demonstration Coordination Committee on the Nexus of Energy and Water for Sustainability established under section 1010 of the Energy Act of 2020 (Public Law 116–260) on energy-water nexus research activities; and

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

''(C) COORDINATION.—

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

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

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

"(A) integrated capabilities for modeling multisectoral interactions, including the impacts of climate policies on human systems 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) MIDSCALE FUNDING MECHANISM.—

"(A) IN GENERAL.—Any of the activities authorized in this subsection may be carried out by competitively selected midscale, 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).

"(6) ATMOSPHERIC SCIENCES RESEARCH SUBPROGRAM.—

"(A) IN GENERAL.—The Secretary shall establish a subprogram as part of the activities carried out under paragraph (1), to be known as the 'Atmospheric Sciences Research Subpro-

gram', under which the Secretary shall conduct research relating to—

''(i) better understanding the atmosphere and the interaction of the atmosphere with the surface of the Earth;

''(ii) understanding sources of uncertainty in Earth system models, including with respect to the interdependence of clouds (including contrails), atmospheric aerosols (including natural aerosol loading events), and precipitation;

''(iii) understanding the radiative balance and hydrological cycle of Earth; and

''(iv) demonstrating the improved predictability of regional and global atmospheric models due to improved process-level understanding.

''(B) ACTIVITIES.—In carrying out the Atmospheric Sciences Research Subprogram, the Secretary shall—

''(i) collect data and conduct research to advance atmospheric and Earth system modeling capabilities;

''(ii) develop integrated, scalable testbeds that—

''(I) incorporate process-level understanding of the life cycles of aerosols, clouds, and precipitation; and

''(II) can be incorporated into other models;

''(iii) improve data, analysis, and prediction systems in marine, littoral, terrestrial, and arctic environments, including those environments sensitive to changes in the climate; and

''(iv) support the development of technologies relating to—

''(I) more accurate cloud, aerosol, and other atmospheric sensors;

''(II) observing sensor networks; and

''(III) computational predictive modeling.

''(C) USE OF ATMOSPHERIC RADIATION MEASUREMENT PROGRAM FACILITIES AND INFRASTRUCTURE.—To support the Atmospheric Sciences Research Subprogram and improve fundamental understanding of the physical and chemical processes that impact the formation,

life cycle, and radiative impacts of cloud and aerosol particles, the Secretary shall use the facilities and infrastructure of the Atmospheric Radiation Measurement User Facility—

"(i) to provide support to environmental scientists by collecting high-quality and well-characterized in-situ and aircraft observations of—

"(I) the microphysical properties of clouds and atmospheric aerosols;

"(II) the coincident and highly detailed dynamical and thermodynamic properties of the atmospheric environment that contains those clouds and aerosols;

"(III) the properties of precipitation; and

"(IV) the properties of radiation and the background environment; and

"(ii) to carry out laboratory studies and ground-based and airborne field campaigns to target specific atmospheric processes in different locations and across a range of environments, including by devel-

oping technologies to assist in advancing predictive capabilities.

''(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) SELECTION.—

''(A) IN GENERAL.—The Director shall select user facilities under paragraph (1) on a competitive, merit-reviewed basis.

''(B) APPLICANTS.—In selecting user facilities under paragraph (1), the Director shall consider applications from the National Laboratories, institutes of higher education, multi-institutional collaborations, and other appropriate entities.

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

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

"(B) analytical techniques, instruments, and modeling resources, including high-throughput molecular phenotyping, for understanding and predicting the functional 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).

"(4) 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.

"(5) MICROBIAL MOLECULAR PHENOTYPING CAPABILITY PROJECT.—

''(A) IN GENERAL.—The Secretary shall provide for the creation of a high-throughput microbial molecular phenotyping capability to accelerate discovery of new protein functions and metabolic pathways in microbial systems.

''(B) CAPABILITIES.—In carrying out subparagraph (A), the Secretary shall ensure the following capabilities:

''(i) Coupled high-throughput autonomous experimental and multimodal analytical capabilities.

''(ii) Direct integration of automated multiomics analyses, biomolecular and cellular imaging, and functional biological assays with high-throughput microbial culturing and cultivation capabilities at timescales relevant to biological processes under natural and perturbed environmental conditions.

''(C) DATA COORDINATION.—In carrying out subparagraph (A), the Secretary shall ensure integration and coordination with existing data platforms of the Department.

''(D) START OF OPERATIONS.—Subject to the availability of appropriations, the Secretary

shall begin carrying out subparagraph (A) not later than September 29, 2027.

''(E) FUNDING.—Of the funds authorized to be appropriated under subsection (k) for a fiscal year, there are authorized to be appropriated to the Secretary to carry out this paragraph—

''(i) $550,000 for fiscal year 2022;

''(ii) $29,000,000 for fiscal year 2023;

''(iii) $32,000,000 for fiscal year 2024;

''(iv) $30,500,000 for fiscal year 2025; and

''(v) $27,500,000 for fiscal year 2026.

''(6) USER FACILITIES INTEGRATION AND COLLABORATION PROGRAM.—

''(A) IN GENERAL.—The Director shall support a program of collaboration between user facilities 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 subsection (d) of section 209 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.

''(7) COORDINATION.—In carrying out the program authorized under paragraph (1), the Director shall ensure that the Office of Science—

''(A) consults and coordinates with the National Oceanic and 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 avail-

able 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 and other relevant Federal agencies, 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, physical, and human processes that interact in coastal zones.

''(2) COASTAL DATA COLLECTION SYSTEM.—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 scientific understanding and predictability of 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;

''(E) the Gulf coast; and

''(F) the coasts of United States territories and freely associated States.

''(3) EXISTING INFRASTRUCTURE.—In carrying out the programs and establishing the field research sites under paragraphs (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 paragraphs (1) and (2), the Secretary may enter into agreements with Federal Departments and agencies with complementary capabilities.

''(j) ENGINEERED ECOSYSTEMS INITIATIVE.—

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

''(2) INTERAGENCY COORDINATION.—The Secretary shall coordinate with the Director of the Na-

tional Science Foundation, the Administrator of the National Oceanic and Atmospheric Administration, the Director of the U.S. Geological Survey, the Secretary of Agriculture, and other relevant officials to avoid duplication of research and observational activities and to ensure that activities carried out under the initiative established under paragraph (1) are complimentary to activities being undertaken by other agencies.

''(3) REPORT.—Not later than 180 days after the date of enactment of the Department of Energy Science for the Future Act of 2022, 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 activity authorized under this subsection.

''(k) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, there are authorized to be appropriated to the Secretary to carry out the activities described in this section—

''(1) $880,360,000 for fiscal year 2022;

''(2) $946,385,200 for fiscal year 2023;

''(3) $1,016,332,164 for fiscal year 2024;

"(4) $1,090,475,415 for fiscal year 2025; and

"(5) $1,169,108,695 for fiscal year 2026.".

(e) BIOENERGY RESEARCH CENTERS.—Section 977 of the Energy Policy Act of 2005 (42 U.S.C. 16317) is amended by striking subsection (f) and inserting the following:

"(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 6 bioenergy research centers, or make an equivalent investment in other center-scale funding modalities, to conduct fundamental research in plant and microbial systems biology, biological imaging and analysis, and genomics, and to accelerate advanced research and development of advanced biofuels, 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 advanced biofuels and bioproducts from lignocellulosic biomass; 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 advanced 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 of 2022 may continue to receive support for a period of not more than 5 years beginning on the date of establishment of that center.

"(D) NEW CENTERS.—At least 1 new center established under paragraph (1) shall be led by an institution of higher education (as defined in section 101 of the Higher Education Act of 1965 (20 U.S.C. 1001)) that is located in an eligible jurisdiction (as defined in section 2203(b)(3)(A) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3)(A))).

"(3) RENEWAL.—After the end of the applicable period described in paragraph (2), the Director may renew support for a 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) ACTIVITIES.—Centers shall undertake research activities to accelerate the production of advanced biofuels and bioproducts from 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 advanced biofuels and bioproducts production; and

''(iii) utilizing multiscale modeling to advance predictive understanding of advanced 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 advanced biofuels and bioproducts and high-throughput methods for experimental validation of gene function;

"(iii) developing techniques to enhance microbial robustness for tolerating toxins to improve advanced biofuel and bioproduct yields and to gain a better under-

standing 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, and 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 biofuels and bioproducts.

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

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

''(7) FUNDING.—Of the funds authorized to be appropriated under subsection (k) of section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) for a fiscal year, there is authorized to be appropriated to the Secretary to carry

out this subsection $30,000,000 per center established under paragraph (1) for each of fiscal years 2022 through 2026.

''(8) DEFINITIONS.—In this subsection:

''(A) ADVANCED BIOFUEL.—The term 'advanced biofuel' has the meaning given the term in section 9001 of the Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8101).

''(B) BIOENERGY.—The term 'bioenergy' means energy derived from biofuels.

''(C) BIOMASS.—The term 'biomass' has the meaning given the term in section 203(b) of the Energy Policy Act of 2005 (42 U.S.C. 15852(b)).

''(D) BIOPRODUCT.—The term 'bioproduct' has the meaning given the term 'biobased product' in section 9001 of the Farm Security and Rural Investment Act of 2002 (7 U.S.C. 8101).''.

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;

(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—

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

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

''(3) to advance computing and networking capabilities for data-driven discovery; and

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

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

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

''(1) DIRECTOR.—The Director''; and

(B) by adding at the end the following:

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

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

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

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

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

"(B) tools, languages, programming environments, and operations for high-end computing systems (as defined in section 2 of the American Super Computing Leadership Act of 2017 (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 Com-

puting 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) SUSTAINMENT.—The Secretary shall seek to sustain and evolve the ecosystem described 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 adding at the end the following:

''(e) ADVANCED 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, including potential quantum accelerators, and distributed high-performance computing;

"(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 1 year after the date of enactment of the Department of Energy Science for the Future Act of 2022, 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 described in paragraph (1).

''(f) GUIDANCE ON MITIGATION OF BIAS IN HIGH-PERFORMANCE COMPUTING CAPABILITIES.—In leveraging high-performance computing systems for research purposes, including through the use of machine learning algorithms for data analysis and artificial intelligence, the Secretary shall issue guidance for the Department, the National Laboratories, and users as to how those capabilities should be employed in a manner that mitigates and, to the maximum extent practicable, avoids harmful algorithmic bias.

''(g) 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 mission challenges. That program 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 the program described in paragraph (1), 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 Office of Science.

''(h) 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, tech-

nology, software, and applications across all applicable program offices of the Department, and provide access to energy efficient computing resources to such partners;

''(ii) develop hardware and software technologies that decrease the energy needs of advanced computing practices, including through data center codesign;

''(iii) consider multiple heterogeneous computing architectures in collaboration with the program established under subsection (g), 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 1 year after the date of enactment of the Department of Energy Science for the Future Act of 2022, 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.

''(i) 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 cyberattacks.

''(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.

''(j) 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 all areas of computational

science relevant to the mission of the Department, including quantum computing.

''(2) FUNDING.—Of the funds authorized to be appropriated for the Advanced Scientific Computing Research Program, there are authorized to be appropriated to the Secretary for carrying out activities under this subsection—

''(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.

''(k) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, there are authorized to be appropriated to the Secretary to carry out the activities described in this section—

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

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

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

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

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

(b) QUANTUM SCIENCE NETWORK.—

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

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

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

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

(2) DEPARTMENT OF ENERGY QUANTUM NETWORK INFRASTRUCTURE RESEARCH AND DEVELOPMENT PROGRAM.—

(A) IN GENERAL.—Title IV of the National Quantum Initiative Act (15 U.S.C. 8851 et seq.) is amended by adding at the end the following:

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

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

accelerate innovation in quantum network infrastructure in order to—

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

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

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

"(4) demonstrate quantum networking utilizing the Department of Energy's Energy Sciences Network User Facility; and

"(5) advance the relevant domestic supply chains and manufacturing capabilities of the United States.

"(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 wavelength regimes, including 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, allowing entanglement-based protocols between small- and large-scale quantum processors, at the terrestrial and space-based level using quantum repeaters and optical or laser communications;

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

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

''(3) engage with the Quantum Economic Development Consortium and other organizations, as applicable, to transition component technologies to help facilitate as appropriate the development of a quantum supply chain for quantum network technologies;

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

''(5) develop experimental tools and testbeds in collaboration with the Energy Sciences Network User Facility necessary to support cross-cutting fundamental research and development activities with diverse stakeholders from industry, National Laboratories, and institutions of higher education; and

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

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

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

''(2) the National Science Foundation;

''(3) the National Aeronautics and Space Administration;

''(4) other relevant Federal agencies;

''(5) the National Laboratories;

''(6) industry stakeholders;

''(7) institutions of higher education; and

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

''(d) RESEARCH PLAN.—Not later than 180 days after the date of enactment of the Department of Energy Science for the Future Act of 2022, 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.—Of the funds authorized to be appropriated for the Department of Energy's Office of Science, there is authorized to be appropriated 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—

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

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

"(3) to accelerate the advancement of United States quantum computing capabilities; and

"(4) to advance the relevant domestic supply chains and manufacturing processes of the United States.

"(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) 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;

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

''(5) balance user access to commercial prototypes available for use for a broad class of applications and Federal research prototypes that enable benchmarking a wider variety of early-stage devices.

''(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.—Of the funds authorized to be appropriated for the Department of Energy's Office of Science, there are authorized to be appropriated 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.''.

(B) CLERICAL AMENDMENT.—The table of contents in section 1(b) of the National Quantum Initiative Act (Public Law 115–368; 132 Stat. 5092) is amended by inserting after the item relating to section 402 the following:

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

SEC. 6. FUSION ENERGY RESEARCH.

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

(1) in subsection (b)—

(A) in paragraph (2), by redesignating subparagraphs (A) and (B) as clauses (i) and (ii), respectively, and indenting appropriately;

(B) by redesignating paragraphs (1) and (2) as subparagraphs (A) and (B), respectively, and indenting appropriately;

(C) in the matter preceding subparagraph (A) (as so redesignated), by striking ''As part of'' and inserting the following:

''(1) IN GENERAL.—As part of''; and

(D) by adding at the end the following:

''(2) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated under subsection (q), there is 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 ''(o)'' and inserting ''(q)'';

(B) by striking ''subsection (d)'' and inserting ''this subsection''; and

(C) by striking ''2025'' and inserting ''2026'';

(3) in subsection (e)(4)—

(A) by striking ''(o)'' and inserting ''(q)'';

(B) by striking ''subsection (e)'' and inserting ''this subsection''; and

(C) by striking ''2025'' and inserting ''2026'';

(4) in subsection (i)(10)—

(A) in the matter preceding subparagraph (A)—

(i) by striking ''(o)'' and inserting ''(q)''; and

(ii) by striking ''subsection (i)'' and inserting ''this subsection'';

(B) in subparagraph (D), by striking ''and'' at the end;

(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) by redesignating subsection (o) as subsection (q);

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

''(o) 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 entitled 'Powering the Future: Fusion and Plasmas'.

The Secretary shall consult with the private sector, institutions of higher education, National Laboratories, and relevant Federal agencies to ensure that the 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 paragraph (1) 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/m^2.

''(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 described in paragraph (1) occurs before December 31, 2027.

''(4) FUNDING.—Of the funds authorized to be appropriated for Fusion Energy Sciences, there are authorized to be appropriated to the Secretary for

the Office of Fusion Energy Sciences to complete construction of the facility described in paragraph (1)—

"(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.

"(p) 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 entitled 'Powering the Future: Fusion and Plasmas'. The Secretary shall consult with the private sector, institutions of higher education, 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 described in paragraph (1) occurs before December 31, 2028.''; and

(7) in subsection (q) (as so redesignated)—

(A) in paragraph (4), by striking ''and'' at the end;

(B) in paragraph (5), by striking the period at the end and inserting ''; and''; and

(C) by adding at the end the following:

''(6) $1,000,000,000 for fiscal year 2026.''.

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

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

(2) in subparagraph (B), by striking the period at the end and inserting ''; and''; and

(3) by adding at the end the following:

''(C) $281,000,000 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 after subsection (a) the following:

''(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 (b), 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 of the Department of Energy Research and Innovation Act (42 U.S.C. 18643) is amended by striking subsection (d) (as redesignated by subsection (a)(1)) and inserting the following:

''(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 of the Department of Energy Research and Innovation Act (42 U.S.C. 18645) is amended by striking subsection (f) (as redesignated by subsection (a)(1)) and inserting the following:

''(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 by subsection (c)), is 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, by incorporating the findings and recommendations of the

2014 Particle Physics Project Prioritization Panel (P5) report entitled 'Building for Discovery', 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;

"(F) the Cosmic Microwave Background Stage 4 project; and

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

"(2) LONG-BASELINE NEUTRINO FACILITY.—

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

and better clarify the existence and nature of antimatter.

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

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

''(ii) 3 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 described in subparagraph (A) occurs before December 31, 2031.

''(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there are authorized to be appropriated to the Secretary to carry out construction of the project described in subparagraph (A)—

"(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 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 entitled 'Building for Discovery', to provide the world's most intense beam of neutrinos to the international Long Baseline Neutrino Facility and to carry out a broad range of future high energy physics experiments. The Secretary shall work with international partners to enable further significant contributions to the capabilities of that project.

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

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

''(ii) Proton beam power of 1.2 megawatts at the start of LBNF/DUNE, upgradeable to 2.4 megawatts 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 described in subparagraph (A) occurs before December 31, 2028.

''(D) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there are authorized to be appropriated to the Sec-

retary to carry out construction of the facility described in subparagraph (A)—

"(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, 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 entitled 'Building for Discovery: Strategic Plan for U.S. Particle Physics in the Global Context.'.

"(B) CONSULTATION.—The Secretary shall consult with the private sector, institutions of higher education, National Laboratories, and relevant Federal agencies to ensure that the project described in subparagraph (A) 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 subparagraph (A) will provide, at a minimum, 500,000 superconducting detectors deployed on an array of millimeter-wave telescopes with the required range in frequency, sensitivity, and survey speed that 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 oper-

ations of the facility described in subparagraph (A) occurs before December 31, 2030.

''(E) FUNDING.—Out of funds authorized to be appropriated under subsection (k), there are authorized to be appropriated to the Secretary to carry out construction of the facility described in subparagraph (A)—

''(i) $37,000,000 for fiscal year 2022;

''(ii) $50,000,000 for fiscal year 2023;

''(iii) $90,000,000 for fiscal year 2024;

''(iv) $80,000,000 for fiscal year 2025; and

''(v) $70,000,000 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 (b), 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 under section 310.

''(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;

''(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; and

''(3) submit to the Committee on Energy and Natural Resources of the Senate and the Committee on Science, Space, and Technology of the House of

Representatives a report on the inventory of underground mines in the United States that may be suitable for future development of underground science and engineering facilities.

''(k) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, 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.

Section 308 of the Department of Energy Research and Innovation Act (Public Law 115–246; 132 Stat. 3150) is amended to read as follows:

''SEC. 308. NUCLEAR PHYSICS.

''(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 is authorized to be appropriated to the Secretary to carry out construction of the facility under this paragraph $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 paragraph 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 of Science, Engineering, and Medicine entitled '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 described in subparagraph (A) meets the requirements in the 2015 Long Range Plan described in that subparagraph, 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 1 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 paragraph occurs before December 31, 2030.

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

"(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.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, 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. SCIENCE LABORATORIES INFRASTRUCTURE 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 the program under subsection (a), the Director shall use all available approaches and mechanisms, as the Secretary determines to be appropriate, including—

''(1) capital line items;

''(2) minor construction projects;

''(3) energy savings performance contracts;

''(4) utility energy service contracts;

''(5) alternative financing; and

''(6) expense funding.

''(d) RESTORATION AND MODERNIZATION PROJECTS.—

''(1) IN GENERAL.—The Secretary shall fund projects described in paragraph (2) as needed to address the deferred maintenance, critical infrastructure needs, and modernization of Office of Science National Laboratories.

''(2) PROJECTS DESCRIBED.—The projects referred to in paragraph (1) are, as determined by the Secretary—

"(A) priority deferred maintenance projects at Office of Science National Laboratories, including facilities sustainment for, upgrade of, and construction of research laboratories, administrative and support buildings, utilities, roads, power plants, and any other critical infrastructure; and

"(B) lab modernization projects at Office of Science National Laboratories, including projects relating to core infrastructure needed—

"(i) to support existing and emerging science missions with new and specialized requirements for world-leading scientific user facilities and computing capabilities; and

"(ii) to maintain safe, efficient, reliable, and environmentally responsible operations, including pilot projects to demonstrate net zero emissions with resilient operations.

"(e) SUBMISSION TO CONGRESS.—For each fiscal year through fiscal year 2026, at the same time as the annual budget submission of the President, the Secretary shall submit to the Committee on Appropriations and the

Committee on Energy and Natural Resources of the Senate and the Committee on Appropriations and the Committee on Science, Space, and Technology of the House of Representatives a list of projects for which the Secretary will provide funding under this section, including a description of each project and the funding profile for the project.

''(f) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, there is authorized to be appropriated to the Secretary to carry out the activities described in this section $600,000,000 for each of fiscal years 2022 through 2026.''.

SEC. 10. ACCELERATOR RESEARCH AND DEVELOPMENT.

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. 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—

''(1) to advance accelerator science and technology relevant to the Department, other Federal agencies, and United States industry;

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

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

''(4) to 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 under 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 institutions of higher education, industry, and other Federal agencies to enable the commercial application of advanced accelerator technologies.

''(e) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, 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. 11. ISOTOPE RESEARCH, DEVELOPMENT, AND PRODUCTION.

(a) IN GENERAL.—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 section 10) the following:

"SEC. 311. ISOTOPE RESEARCH, DEVELOPMENT, AND PRODUCTION.

''(a) DEFINITION OF CRITICAL RADIOACTIVE AND STABLE ISOTOPE.—

''(1) IN GENERAL.—In this section, the term 'critical radioactive and stable isotope' means a radioactive and stable isotope—

''(A) the domestic commercial production of which is unavailable or inadequate to satisfy the demand of research, medical, industrial, or related industries in the United States; and

''(B) the supply of which is augmented through—

''(i) Department production; or

''(ii) foreign suppliers.

''(2) EXCLUSION.—In this section, the term 'critical radioactive and stable isotope' does not include the medical isotope molybdenum-99, the production and supply of which is addressed in the American Medical Isotopes Production Act of 2012

(Public Law 112–239; 126 Stat. 2211) (including the amendments made by that Act).

''(b) PROGRAM.—The Director shall—

''(1) carry out, in coordination with other relevant programs across the Department, a program—

''(A) for the production of critical radioactive and stable isotopes, including the development of techniques to produce isotopes, that the Secretary determines are needed and of sufficient quality for research, medical, industrial, or related purposes;

''(B) for the production of critical radioactive and stable isotopes that are in short supply, including byproducts, surplus materials, and related isotope services;

''(C) to maintain and enhance the infrastructure required to produce and supply critical radioactive and stable isotope products and related services;

''(D) to conduct research and development on new and improved isotope production and processing techniques that can make critical radioactive and stable isotopes available for re-

search and application while assisting in workforce development;

''(E) to reduce domestic dependency on the foreign supply of critical radioactive and stable isotopes to ensure national preparedness; and

''(F)(i) to the maximum extent practicable, in accordance with—

''(I) evidence-based reports, including the 2015 report of the Nuclear Science Advisory Committee entitled 'Meeting Isotope Needs and Capturing Opportunities for the Future'; and

''(II) assessments of isotope supply chains, including current and future assessments; or

''(ii) as the Director otherwise determines necessary to ensure the availability of sufficient quantities of critical radioactive and stable isotopes to address existing and future needs;

''(2) ensure that isotope production activities carried out under this subsection are consistent with the statement of policy entitled 'Policies and Procedures for Transfer of Commercial Radioisotope Production and Distribution to Private Industry' (30 Fed. Reg. 3247 (March 9, 1965));

''(3) assess the domestic requirements of current and emerging critical radioactive and stable isotopes and associated applications to identify areas that may require Federal investment for the development of domestic production capacity for those isotopes, including through public-private partnerships, as appropriate;

''(4) ensure that isotope production activities are consistent with the needs of associated end-users, are of the quality needed by the end-users, and appropriately address the growing need for novel isotopes;

''(5) ensure that actions taken by the Department do not interfere with, delay, or otherwise adversely affect efforts by the private sector to make available or otherwise facilitate the supply of critical radioactive and stable isotopes, including efforts under existing agreements between the Department or contractors of the Department and the private sector; and

''(6) in coordination with the Assistant Secretary for Nuclear Energy, assess options for demonstrating the production of critical radioactive and stable isotopes in commercial nuclear reactors.

''(c) ADVISORY COMMITTEE.—

''(1) IN GENERAL.—Not later than 90 days after the date of enactment of this section, the Secretary shall establish an advisory committee (referred to in this subsection as the 'committee') in alignment with the Isotope Program of the Department—

''(A) to carry out the activities previously executed as part of the Isotope Subcommittee of the Nuclear Science Advisory Committee; and

''(B) to provide expert advice and assistance to the Director in carrying out subsection (a).

''(2) REPORT.—

''(A) IN GENERAL.—Not later than 1 year after the committee is established, the committee shall—

''(i) update the 2015 Nuclear Science Advisory Committee Isotope Committee Report entitled 'Meeting Isotope Needs and Capturing Opportunities for the Future'; and

''(ii) periodically update that report thereafter as needed.

"(B) INCLUSIONS.—An updated report under subparagraph (A) shall include an assessment of—

"(i) current demand in the United States for critical radioactive and stable isotopes;

"(ii) the impact of continued reliance on foreign supply of critical radioactive and stable isotopes;

"(iii) proposed mitigation strategies, including increasing domestic production sources for critical radioactive and stable isotopes, that—

"(I) are not commercially available; or

"(II) are commercially produced in quantities that are not sufficient—

"(aa) to satisfy domestic demand; and

"(bb) to minimize production constraints and supply disruptions to the United States healthcare and industrial isotope industries;

"(iv) current facilities, including upgrades to those facilities, and new facilities needed to meet domestic critical isotope needs; and

"(v) workforce development needs.

"(3) NONDUPLICATION.—The committee shall work in alignment with, and shall not duplicate the efforts of, preexisting advisory committees that are advising the Isotope Program of the Department.

"(4) FACA.—The committee shall be subject to the Federal Advisory Committee Act (5 U.S.C. App.).

"(d) REPORT.—

"(1) IN GENERAL.—Not later than the end of the first fiscal year beginning after the date of enactment of this section, and biennially thereafter, the Secretary shall submit to the Committees on Energy and Natural Resources and Environment and Public Works of the Senate and the Committee on Energy and Commerce of the House of Representatives a report describing the progress made under the program established under subsection (a) during the preceding 2 fiscal years.

"(2) INCLUSIONS.—Each report under paragraph (1) shall include—

"(A) an updated assessment of any critical radioactive and stable isotope shortages in the United States;

"(B) a description of—

"(i) any disruptions in the international supply of critical radioactive and stable isotopes during the preceding 2 fiscal years; and

"(ii) the impact of those disruptions on related activities; and

"(C)(i) a projection of anticipated disruptions in the international supply, or supply constraints, of critical radioactive and stable isotopes during the next 2 fiscal years; and

"(ii) the anticipated impact of those disruptions or constraints, as applicable, on related domestic activities.

"(e) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, there are authorized to be appropriated to the Secretary to carry out this section—

"(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.".

(b) DEMONSTRATION OF ISOTOPE PRODUCTION.—Section 952(a) of the Energy Policy Act of 2005 (42 U.S.C. 16272(a)) is amended—

(1) by redesignating paragraph (2) as paragraph (4) and moving the paragraph so as to appear after paragraph (3); and

(2) by inserting after paragraph (1) the following:

"(2) ISOTOPE DEMONSTRATION SUBPROGRAM.—

"(A) IN GENERAL.—The Secretary, acting through the Assistant Secretary for Nuclear Energy, shall establish a subprogram of the program established under paragraph (1), to be known as the 'isotope demonstration subprogram', to support the development and commercial demonstration of critical radioactive and stable isotope production in existing commercial nuclear power plants.

"(B) CONSULTATION.—In considering options for demonstrating the production of critical radioactive and stable isotopes in commercial nuclear reactors under the subprogram established under subparagraph (A), the Sec-

retary, acting through the Assistant Secretary for Nuclear Energy, shall consult with the Director of the Office of Science.

''(C) AUTHORIZATION OF APPROPRIATIONS.—In addition to any amounts made available to the Secretary under paragraph (4), there are authorized to be appropriated to the Secretary for each fiscal year described in that paragraph such sums as are necessary to carry out not more than 3 demonstration projects under the subprogram established under subparagraph (A).''.

(c) RADIOISOTOPE PROCESSING FACILITY.—

(1) IN GENERAL.—The Secretary of Energy (referred to in this subsection as ''the Secretary'') shall construct a radioisotope processing facility to provide for the growing radiochemical processing capability needs associated with the production of critical radioactive isotopes authorized under section 311 of the Department of Energy Research and Innovation Act.

(2) FUNDING.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, there is authorized to be appropriated to the

Secretary to carry out this subsection $375,000,000 for the period of fiscal years 2022 through 2026.

(d) STABLE ISOTOPE PRODUCTION AND RESEARCH CENTER.—

(1) IN GENERAL.—The Secretary of Energy (referred to in this subsection as ''the Secretary'') shall establish a stable isotope production and research center—

(A) to expand the ability of the United States to perform multiple stable isotope production campaigns at large-scale production, as authorized under section 311 of the Department of Energy Research and Innovation Act;

(B) to mitigate the dependence of the United States on foreign-produced stable isotopes; and

(C) to promote economic resilience.

(2) FUNDING.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, there is authorized to be appropriated to the Secretary to carry out this subsection $250,000,000 for the period 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 section 11), the following:

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

''The Director shall support the development of a scientific workforce through programs that facilitate collaboration between and among teachers at elementary schools and secondary schools, students at institutions of higher education, early-career researchers, faculty at institutions of higher education, 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 mission of the Office of Science.''.

(b) AUTHORIZATION OF APPROPRIATIONS.—Section 3169 of the Department of Energy Science Education Enhancement Act (42 U.S.C. 7381e) is amended by striking ''fiscal year 1991'' and inserting ''each of fiscal years 2022 through 2026''.

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

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

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

''(a) IN GENERAL.—The Secretary shall—

''(1) expand opportunities to increase the number of highly skilled science, technology, engineering, and mathematics (STEM) professionals working in disciplines relevant to the mission of the Department; and

''(2) broaden the recruitment pool to increase participation from Historically Black Colleges or Universities (as defined in section 3167B(f)), Hispanic-serving institutions (as defined in that section), Tribal Colleges or Universities (as defined in that section), minority-serving institutions (as defined in that section), institutions in eligible jurisdictions (as defined in that section), emerging research institutions, community colleges, and scientific societies in those disciplines.

''(b) PLAN.—Not later than 1 year after the date of enactment of the Department of Energy Science for the Future Act of 2022, the Secretary shall submit to the

Committee on Science, Space, and Technology of the House of Representatives and the Committees on Energy and Natural Resources and 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, including—

''(1) a plan for supporting relevant Federal research award grantees and leveraging partnerships, including partnerships maintained by other Federal research agencies;

''(2) metrics for assessing the participation of underrepresented groups in programs supported by the Department;

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

''(4) any other activities the Secretary determines appropriate.

''(c) AUTHORIZATION OF APPROPRIATIONS.—Of the amounts authorized to be appropriated under section 3169, not less than $2,000,000 is authorized to be appro-

priated each fiscal year for the activities described in this section.

"SEC. 3167B. EXPANDING OPPORTUNITIES FOR HIGHLY SKILLED SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) PROFESSIONALS.

''(a) IN GENERAL.—The Secretary shall—

''(1) expand opportunities for highly skilled science, technology, engineering, and mathematics (STEM) professionals working in disciplines relevant to the mission of the Department; and

''(2) broaden the recruitment pool to increase participation from Historically Black Colleges or Universities, Hispanic serving institutions, Tribal Colleges or Universities, minority-serving institutions, institutions in eligible jurisdictions, emerging research institutions, community colleges, and scientific societies in those disciplines.

''(b) PLAN AND OUTREACH STRATEGY.—

''(1) PLAN.—

''(A) IN GENERAL.—Not later than 180 days after the date of enactment of the Department of Energy Science for the Future Act of 2022, 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 user facilities to expand educational and workforce opportunities for underrepresented individuals, including—

''(i) high school, undergraduate, and graduate students; and

''(ii) recent graduates, teachers, and faculty in STEM fields.

''(B) CONTENTS.—The plan under subparagraph (A) 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 or Universities, Hispanic-serving institutions, Tribal Colleges or Universities, minority-serv-

ing institutions, institutions in eligible jurisdictions, and emerging research institutions.

''(c) BUILDING RESEARCH CAPACITY.—

''(1) IN GENERAL.—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 or Universities, Historically Black Colleges or Universities, institutions in eligible jurisdictions (as defined in section 2203(b)(3)(A) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3)(A))), institutions in communities with dislocated workers who were previously employed in manufacturing, coal power plants, and coal mining, and other institutions of higher education.

''(2) INCLUSIONS.—The programs developed under paragraph (1) may include—

''(A) enabling mutually beneficial and jointly managed partnerships between research-intensive institutions and emerging research institutions; and

''(B) soliciting research proposals, fellowships, training programs, and research support directly from emerging research institutions.

''(d) TRAINEESHIPS.—

''(1) IN GENERAL.—The Secretary shall establish a university-led Traineeship Program to address workforce training needs in STEM fields relevant to the Department.

''(2) FOCUS.—The focus of the Traineeship Program established under paragraph (1) shall be on—

''(A) supporting training and research experiences for underrepresented undergraduate and graduate students; and

''(B) increasing participation from underrepresented populations.

''(3) INCLUSION.—The traineeships under the Traineeship Program established under paragraph (1) shall include opportunities to build the next-generation workforce in research areas critical to maintaining core competencies across the programs of the Office of Science.

''(e) EVALUATION.—

''(1) IN GENERAL.—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.

''(2) REPORT.—Not later than 2 years after the date of enactment of the Department of Energy Science for the Future Act of 2022, and every 2 years thereafter, 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 summarizing progress toward meeting the key performance indicators established under paragraph (1).

''(f) DEFINITIONS.—In this section:

''(1) HISPANIC-SERVING INSTITUTION.—The term 'Hispanic-serving institution' has the meaning given the term in section 502(a) of the Higher Education Act of 1965 (20 U.S.C. 1101a(a)).

''(2) HISTORICALLY BLACK COLLEGE OR UNIVERSITY.—The term 'Historically Black College or University' has the meaning given the term 'part B institution' in section 322 of the Higher Education Act of 1965 (20 U.S.C. 1061).

''(3) INSTITUTION IN AN ELIGIBLE JURISDICTION.—The term 'institution in an eligible jurisdiction' means an institution of higher education (as defined in section 101 of the Higher Education Act of 1965 (20 U.S.C. 1001)) that is located in an eli-

gible jurisdiction (as defined in section 2203(b)(3)(A) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3)(A))).

''(4) 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)).

''(5) STEM.—The term 'STEM' means the subjects listed in section 2 of the STEM Education Act of 2015 (42 U.S.C. 6621 note; Public Law 114–59).

''(6) TRIBAL COLLEGE OR UNIVERSITY.—The term 'Tribal College or University' has the meaning given the term in section 316(b) of the Higher Education Act of 1965 (20 U.S.C. 1059c(b)).''.

(2) CLERICAL AMENDMENT.—The table of contents in section 2(b) of the National Defense Authorization Act for Fiscal Year 1991 (Public Law 101–510; 104 Stat. 1497) is amended by striking the items relating to sections 3167 and 3168 and inserting the following:

''Sec. 3167. Partnerships with historically Black colleges and universities, Hispanic-serving institutions, and tribal colleges.
''Sec. 3167A. Broadening participation for teachers and scientists.
''Sec. 3167B. Expanding opportunities for highly skilled science, technology, engineering, and mathematics (STEM) professionals.
''Sec. 3168. Definitions.
''Sec. 3169. Authorization of appropriations.''.

SEC. 13. HIGH INTENSITY LASER RESEARCH INITIATIVE; HELIUM CONSERVATION PROGRAM; OFFICE OF SCIENCE EMERGING BIOLOGICAL THREAT PREPAREDNESS RESEARCH INITIATIVE; MIDSCALE INSTRUMENTATION AND RESEARCH EQUIPMENT PROGRAM; AUTHORIZATION OF APPROPRIATIONS.

(a) IN GENERAL.—The Department of Energy Research and Innovation Act (42 U.S.C. 18601 et seq.) (as amended by section 12(a)) 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 entitled 'Opportunities in Intense Ultrafast Lasers: Reaching for the Brightest Light' and the report from the Brightest Light Initiative workshop entitled 'The Future of Intense Ultrafast Lasers in the U.S.'. The 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 leverage new laser technologies for more compact, less complex, and

low-cost accelerator systems needed for science applications.

''(c) COORDINATION.—

''(1) DIRECTOR.—The Director shall coordinate the initiative established under subsection (a) among all relevant programs within the Office of Science.

''(2) UNDER SECRETARY.—The Under Secretary for Science shall coordinate the initiative established under subsection (a) with other relevant programs within the Department and other Federal agencies.

''(d) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, there are authorized to be appropriated to the Secretary to carry out the activities described in this section—

''(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.—Not later than 2 years after the date of enactment of the Department of Energy Science for the Future Act of 2022, and every 3 years thereafter, the Director 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 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) expected or experienced impacts of helium supply shortages or prices on the research projects and facilities supported by the Department; and

''(4) 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 BIOLOGICAL THREAT PREPAREDNESS RESEARCH INITIATIVE.

''(a) IN GENERAL.—The Secretary shall establish within the Office of Science a cross-cutting research initiative, to be known as the 'Emerging Biological Threat Preparedness Research Initiative', to leverage the innovative analytical resources and tools, user facilities, and advanced computational and networking capabilities of the Department in order to aid efforts to prevent, prepare for, predict, and respond to emerging natural and anthropogenic biological threats to national security.

''(b) COMPETITIVE, MERIT-REVIEWED PROCESS.—The Secretary shall carry out the initiative established under subsection (a) 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.

''(c) ACTIVITIES.—In carrying out the initiative established under subsection (a), the Secretary shall—

''(1) determine a comprehensive set of technical milestones for the research activities described in that subsection; and

''(2) prioritize the objectives of—

''(A) supporting fundamental research and development in advanced analytics, experimental studies, materials synthesis, and high-performance computing technologies needed to characterize, model, simulate, and predict complex natural phenomena and biological materials related to emerging biological threats;

''(B)(i) supporting epidemiological modeling, including data management, curation, analysis, and modeling; and

"(ii) applying artificial intelligence, machine learning, and other computing tools to the processes described in clause (i);

"(C) understanding and modeling the transport of pathogens in indoor and outdoor air and water environments;

"(D) researching and developing advances in cost-effective and rapid pathogen detection, monitoring, testing, and diagnostic technologies and protocols, including for physiological and environmental samples;

"(E) supporting the research and development of materials and manufacturing of critical supplies needed for the prevention of and response to biological threats;

"(F) advancing molecular design for medical therapeutics;

"(G) ensuring that new experimental and computational tools are accessible to relevant research communities, including private sector entities and other Federal research institutions; and

"(H) supporting activities and projects that combine computational modeling and sim-

ulation with experimental research facilities and studies.

''(d) COORDINATION.—In carrying out the initiative established under subsection (a), the Secretary shall coordinate activities with—

''(1) other relevant offices of the Department;

''(2) the National Nuclear Security Administration;

''(3) the National Laboratories;

''(4) the Director of the National Science Foundation;

''(5) the Director of the Centers for Disease Control and Prevention;

''(6) the Director of the National Institutes of Health;

''(7) the heads of other relevant Federal agencies;

''(8) institutions of higher education; and

''(9) the private sector.

''(e) 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'), to support the initiative established under subsection (a) by providing, to the extent practicable, a centralized entity for multidisciplinary, collaborative, emerging infectious disease and biosecurity research and development through high performance computing and advanced data analytics technologies and processes, in conjunction with the experimental research facilities and studies supported by the Department.

''(2) MEMBERSHIP.—The members of the Consortium may include representatives from relevant Federal agencies, the National Laboratories, the private sector, and 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) provide access to the high-performance computing capabilities, expertise, and user facilities of the Department and the National Laboratories; and

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

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

"(ii) detailing organizational expenditures; and

"(iii) evaluating contributions 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, other Federal research institutions, institutions of higher education, and the private sector.

"(f) REPORT.—Not later than 2 years after the date of enactment of the Department of Energy Science for the

Future Act of 2022, 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 a report detailing the effectiveness of—

''(1) the interagency coordination among each Federal agency involved in the initiative established under subsection (a);

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

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

''(g) FUNDING.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, there are authorized to be appropriated to the Secretary to carry out the activities under this section—

''(1) $50,000,000 for each of fiscal years 2022 and 2023; and

''(2) such sums as are necessary for each of fiscal years 2024 through 2026.

''(h) PROHIBITION.—

''(1) IN GENERAL.—In carrying out this section, the Secretary may not carry out gain-of-function research.

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

''(3) OVERSIGHT AND GUIDANCE.—The Director of the Office of Science and Technology Policy shall provide guidance to the Department, the National Laboratories, and users regarding the establishment and promulgation of policies to implement the prohibition under paragraph (1).

"SEC. 316. MIDSCALE INSTRUMENTATION AND RESEARCH EQUIPMENT PROGRAM.

''(a) IN GENERAL.—The Director shall establish a midscale instrumentation and research equipment program to develop, acquire, and commercialize research instrumentation and equipment needed to meet the missions of the Department and to provide platform technologies for the broader scientific community.

''(b) ACTIVITIES.—Under the program established under subsection (a), the Director shall—

''(1) enable the development and acquisition of novel, state-of-the-art instruments that—

''(A) range in cost from $1,000,000 to $20,000,000 each; and

''(B) would significantly accelerate scientific breakthroughs at user facilities; and

''(2) strongly encourage partnerships among—

''(A) National Laboratories;

''(B) user facilities; and

''(C)(i) institutions in a State receiving funding under the Established Program to Stimulate Competitive Research established under section 2203(b)(3) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3));

''(ii) historically Black colleges or universities;

''(iii) minority-serving institutions of higher education; or

''(iv) institutions of higher education in a rural area.

''(3) COORDINATION WITH OTHER PROGRAMS.—The Director shall coordinate the program established under paragraph (1) with all other programs carried out by the Office of Science of the Department.

''(c) RESEARCH EQUIPMENT AND TECHNOLOGY DEVELOPMENT COORDINATION.—The Director shall encourage coordination among the Office of Science, the National Laboratories, the Office of Technology Transitions, and relevant academic and private sector entities to promote the dissemination or commercialization of research equipment and related technologies developed to aid basic science research discoveries.

''(d) AUTHORIZATION OF APPROPRIATIONS.—Out of funds authorized to be appropriated for the Office of Science in a fiscal year, there is authorized to be appropriated to carry out this section $150,000,000 for each of fiscals years 2022 through 2026.

''SEC. 317. AUTHORIZATION OF APPROPRIATIONS.

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

''(1) $8,451,905,000 for fiscal year 2022;

''(2) $9,035,354,600 for fiscal year 2023;

''(3) $9,705,470,672 for fiscal year 2024;

''(4) $10,259,703,569 for fiscal year 2025; and

''(5) $12,049,702,411 for fiscal year 2026.''.

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

''Sec. 310. Accelerator research and development.

''Sec. 311. Isotope research, development, and production.
''Sec. 312. Increased collaboration with teachers and scientists.
''Sec. 313. High intensity laser research initiative.
''Sec. 314. Helium conservation program.
''Sec. 315. Office of Science Emerging Biological Threat Preparedness Research Initiative.
''Sec. 316. Midscale instrumentation and research equipment program.
''Sec. 317. Authorization of appropriations.''.

SEC. 14. ESTABLISHED PROGRAM TO STIMULATE COMPETITIVE RESEARCH.

(a) RESEARCH AREAS.—Section 2203(b)(3)(E) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3)(E)) is amended—

(1) in the subparagraph heading, by striking ''IN AREAS OF APPLIED ENERGY RESEARCH, ENVIRONMENTAL MANAGEMENT, AND BASIC SCIENCE'';

(2) in clause (i)—

(A) in subclause (I), by inserting ''nuclear energy,'' before ''and''; and

(B) by striking subclause (V) and inserting the following:

''(V) basic science research, including—

''(aa) advanced scientific computing research;

''(bb) basic energy sciences;

''(cc) biological and environmental research;

''(dd) fusion energy sciences;

''(ee) high energy physics;

''(ff) nuclear physics;

''(gg) isotope research, development, and production;

''(hh) accelerator research, development, and production; and

''(ii) other areas of research funded by the Office of Science, as determined by the Secretary.''; and

(3) in clause (ii)—

(A) in subclause (II), by striking ''graduate'' and inserting ''undergraduate scholarships, graduate fellowships, and'';

(B) in subclause (III), by striking ''; and'' and inserting ''and staff;'';

(C) in subclause (IV)—

(i) by striking ''biennial'' and inserting ''annual''; and

(ii) by striking the period at the end and inserting a semicolon; and

(D) by adding at the end the following:

''(V) to develop research clusters for particular areas of expertise; and

"(VI) to diversify the future workforce.".

(b) RESEARCH CAPABILITY ENHANCEMENT.—Section 2203(b)(3) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3)) is amended by striking subparagraph (F) and inserting the following:

"(F) RESEARCH CAPABILITY ENHANCEMENT.—

"(i) SCHOLARSHIPS AND FELLOWSHIPS.—

"(I) IN GENERAL.—Pursuant to subparagraph (E)(ii), the Secretary shall award grants to institutions of higher education in eligible jurisdictions for those institutions of higher education to provide scholarships and fellowships.

"(II) GRANT.—A scholarship or fellowship awarded by an institution of higher education in an eligible jurisdiction using a grant provided under subclause (I)—

"(aa) in the case of an undergraduate scholarship—

"(AA) shall be for a period of 1 year; and

"(BB) may be competitively renewable on an annual basis; and

"(bb) in the case of a graduate level fellowship, shall be for a period of not more than 5 years.

"(ii) EARLY CAREER CAPACITY DEVELOPMENT.—

"(I) IN GENERAL.—Pursuant to subparagraph (E)(ii), the Secretary shall award grants to early career faculty and staff at institutions of higher education in eligible jurisdictions—

"(aa) to support investigator-initiated research, including associated research equipment and instrumentation;

"(bb) to support activities associated with identifying and responding to funding opportunities;

"(cc) to secure technical assistance for the pursuit of funding opportunities; and

"(dd) to develop and enhance collaboration among National Laboratories, Department of Energy programs, the private sector, and other relevant entities.

"(II) GRANTS.—A grant awarded under subclause (I) shall be—

"(aa) for a period of not more than 5 years; and

"(bb) competitively renewable for an additional 5-year period.

"(iii) RESEARCH CAPACITY DEVELOPMENT.—

"(I) IN GENERAL.—Pursuant to subparagraph (E)(ii), the Secretary shall award competitive grants to institutions of higher education in eligible jurisdictions for research capacity development and implementation, including—

"(aa) developing expertise in key technology areas, including associated equipment and instrumentation;

"(bb) developing and acquiring novel, state-of-the-art instruments and equipment that range in cost from $500,000 to $20,000,000;

"(cc) enhancing collaboration with National Laboratories, the Department of Energy, and the private sector through faculty or staff placement programs; and

"(dd) supporting formal partnership programs with institutions of higher education and National Laboratories.

"(II) GRANTS.—A grant awarded under subclause (I) shall be—

"(aa) for a period of not more than 5 years; and

"(bb) renewable for an additional 5-year period.

"(III) EQUIPMENT AND INSTRUMENTATION.—To the maximum extent practicable, the Secretary shall ensure that research equipment and instrumentation developed or acquired pursuant to a grant awarded under subclause (I) may sustain continued operation and be maintained without the need for additional or subsequent funding under this section.".

(c) PROGRAM IMPLEMENTATION UPDATE.—Section 2203(b)(3)(G) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3)(G)) is amended by adding at the end the following:

"(iii) UPDATE.—Not later than 270 days after the date of enactment of the Department of Energy Science for the Future Act of 2022, the Secretary shall—

"(I) update the plan submitted under clause (i); and

"(II) submit the updated plan to the committees described in that clause.".

(d) PROGRAM EVALUATION REPORT.—Section 2203(b)(3)(H) of the Energy Policy Act of 1992 (42

U.S.C. 13503(b)(3)(H)) is amended by adding at the end the following:

"(iv) ANNUAL REPORT.—At the end of each fiscal year, the Secretary shall submit to the Committee on Energy and Natural Resources and the Committee on Appropriations of the Senate and the Committee on Energy and Commerce and the Committee on Appropriations of the House of Representatives a report that includes—

"(I) the total amount of expenditures made by the Department to carry out EPSCoR in each eligible jurisdiction for each of the 3 most recent fiscal years for which such information is available;

"(II)(aa) the number of EPSCoR awards made to institutions of higher education located in eligible jurisdictions; and

"(bb) the amount and type of each award;

"(III) the number of awards that are not EPSCoR awards made by the Secretary to institutions of higher

education located in eligible jurisdictions;

''(IV)(aa) the number of representatives of institutions of higher education in eligible jurisdictions serving on each Office of Science advisory committee; and

''(bb) for each such advisory committee, the percentage of committee membership that those individuals constitute; and

''(V) the number of individuals from institutions of higher education in eligible jurisdictions serving on peer review committees.''.

(e) FUNDING.—Section 2203(b)(3) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3)) is amended by adding at the end the following:

''(I) FUNDING.—

''(i) AUTHORIZATION OF APPROPRIATIONS.—There are authorized to be appropriated to the Secretary to carry out EPSCoR, to remain available until expended—

"(I) $75,000,000 for fiscal year 2022;

"(II) $75,000,000 for fiscal year 2023;

"(III) $100,000,000 for fiscal year 2024;

"(IV) $100,000,000 for fiscal year 2025; and

"(V) $150,000,000 for fiscal year 2026.

"(ii) GRANTS TO CONSORTIA.—In the case of an EPSCoR grant awarded to a consortium that contains institutions of higher education that are not located in eligible jurisdictions, the Secretary may count—

"(I) the full amount of funds expended to provide the grant towards meeting the funding requirement in clause (iii) if the lead entity of the consortium is an institution of higher education located in an eligible jurisdiction; and

"(II) only the funds provided to institutions of higher education lo-

cated in eligible jurisdictions towards meeting the funding requirement in clause (iii) if the lead entity of the consortium is an institution of higher education that is not located in an eligible jurisdiction.

''(iii) ADDITIONAL FUNDS FOR ELIGIBLE JURISDICTIONS.—In addition to funds authorized to be appropriated under clause (i), the Secretary, to the maximum extent practicable, shall ensure that, of the research and development funds of the Office of Science that are awarded by the Secretary each year to institutions of higher education, not less than 10 percent is awarded to institutions of higher education in eligible jurisdictions pursuant to the evaluation and selection criteria in section 605.10 of title 10, Code of Federal Regulations (or successor regulations).

''(iv) ADDITIONAL FUNDS FOR EQUIPMENT AND INSTRUMENTATION.—In addition to funds authorized to be appropriated under clause (i), there is authorized to be appropriated to the Secretary to award

grants under subparagraph (F)(iii)(I) for the purpose described in item (bb) of that subparagraph $50,000,000 for each of fiscal years 2022 through 2026, to remain available until expended.''.

(f) ADVISORY COMMITTEES TO THE OFFICE OF SCIENCE.—In order to improve the advice and guidance provided to the Office of Science, the Undersecretary for Science shall seek to ensure, to the maximum extent practicable, the robust participation of institutions of higher education (as defined in section 101 of the Higher Education Act of 1965 (20 U.S.C. 1001)) located in eligible jurisdictions (as defined in section 2203(b)(3)(A) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3)(A))) on the Office of Science Federal Advisory Committee.

(g) TECHNICAL AMENDMENTS.—Section 2203(b) of the Energy Policy Act of 1992 (42 U.S.C. 13503(b)) is amended—

(1) in paragraph (1), by striking ''(1) The Secretary'' and inserting the following:

''(1) UNIVERSITY RESEARCH REACTORS.—The Secretary''; and

(2) in paragraph (2), by striking ''(2) The Secretary'' and inserting the following:

''(2) METHOD TO EVALUATE EFFECTIVENESS OF EDUCATION PROGRAMS.—The Secretary''.

SEC. 15. RESEARCH SECURITY.

(a) DEFINITIONS.—In this section:

(1) COUNTRY OF RISK.—

(A) IN GENERAL.—The term ''country of risk'' means a foreign country determined by the Secretary, in accordance with subparagraph (B), to present a risk of theft of United States intellectual property or a threat to the national security of the United States if nationals of the country, or entities owned or controlled by the country or nationals of the country, participate in any research, development, demonstration, or deployment activity authorized under this Act or an amendment made by this Act.

(B) DETERMINATION.—In making a determination under subparagraph (A), the Secretary, in coordination with the Director of the Office of Intelligence and Counterintelligence, shall take into consideration—

(i) the most recent World Wide Threat Assessment of the United States Intelligence Community, prepared by the Director of National Intelligence; and

(ii) the most recent National Counterintelligence Strategy of the United States.

(2) COVERED SUPPORT.—The term ''covered support'' means any grant, contract, subcontract, award, loan, program, support, or other activity authorized under this Act or an amendment made by this Act.

(3) ENTITY OF CONCERN.—The term ''entity of concern'' means any entity, including a national, that is—

(A) identified under section 1237(b) of the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999 (50 U.S.C. 1701 note; Public Law 105–261);

(B) identified under section 1260H of the William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021 (10 U.S.C. 113 note; Public Law 116–283);

(C) on the Entity List maintained by the Bureau of Industry and Security of the Department of Commerce and set forth in Supplement No. 4 to part 744 of title 15, Code of Federal Regulations;

(D) included in the list required by section 9(b)(3) of the Uyghur Human Rights Policy

Act of 2020 (Public Law 116–145; 134 Stat. 656); or

(E) identified by the Secretary, in coordination with the Director of the Office of Intelligence and Counterintelligence and the applicable office that would provide, or is providing, covered support, as posing an unmanageable threat—

(i) to the national security of the United States; or

(ii) of theft or loss of United States intellectual property.

(4) NATIONAL.—The term ''national'' has the meaning given the term in section 101 of the Immigration and Nationality Act (8 U.S.C. 1101).

(5) SECRETARY.—The term ''Secretary'' means the Secretary of Energy.

(b) SCIENCE AND TECHNOLOGY RISK ASSESSMENT.—

(1) IN GENERAL.—The Secretary shall develop and maintain tools and processes to manage and mitigate research security risks, such as a science and technology risk matrix, informed by threats identified by the Director of the Office of Intelligence and Counterintelligence, to facilitate deter-

minations of the risk of loss of United States intellectual property or threat to the national security of the United States posed by activities carried out under any covered support.

(2) CONTENT AND IMPLEMENTATION.—In developing and using the tools and processes developed under paragraph (1), the Secretary shall—

(A) deploy risk-based approaches to evaluating, awarding, and managing certain research, development, demonstration, and deployment activities, including designations that will indicate the relative risk of activities;

(B) assess, to the extent practicable, ongoing high-risk activities;

(C) designate an officer or employee of the Department of Energy to be responsible for tracking and notifying recipients of any covered support of unmanageable threats to United States national security or of theft or loss of United States intellectual property posed by an entity of concern;

(D) consider requiring recipients of covered support to implement additional research security mitigations for higher-risk activities if appropriate; and

(E) support the development of research security training for recipients of covered support on the risks posed by entities of concern.

(3) ANNUAL UPDATES.—The tools and processes developed under paragraph (1) shall be evaluated annually and updated as needed, with threat-informed input from the Office of Intelligence and Counterintelligence, to reflect changes in the risk designation under paragraph (2)(A) of research, development, demonstration, and deployment activities conducted by the Department.

(c) ENTITY OF CONCERN.—

(1) PROHIBITION.—Except as provided in paragraph (2), no entity of concern, or individual that owns or controls, is owned or controlled by, or is under common ownership or control with an entity of concern, may receive, or perform work under, any covered support.

(2) WAIVER OF PROHIBITION.—

(A) IN GENERAL.—The Secretary may waive the prohibition under paragraph (1) if determined by the Secretary to be in the national interest.

(B) NOTIFICATION TO CONGRESS.—Not less than 2 weeks prior to issuing a waiver

under subparagraph (A), the Secretary shall notify the Committee on Energy and Natural Resources of the Senate and the Committee on Science, Space, and Technology of the House of Representatives of the intent to issue the waiver, including a justification for the waiver.

(3) PENALTY.—

(A) TERMINATION OF SUPPORT.—On finding that any entity of concern or individual described in paragraph (1) has received covered support and has not received a waiver under paragraph (2), the Secretary shall terminate all covered support to that entity of concern or individual, as applicable.

(B) PENALTIES.—An entity of concern or individual identified under subparagraph (A) shall be—

(i) prohibited from receiving or participating in covered support for a period of not less than 1 year but not more than 10 years, as determined by the Secretary; or

(ii) instead of the penalty described in clause (i), subject to any other penalties authorized under applicable law or regula-

tions that the Secretary determines to be in the national interest.

(C) NOTIFICATION TO CONGRESS.—Prior to imposing a penalty under subparagraph (B), the Secretary shall notify the Committee on Energy and Natural Resources of the Senate and the Committee on Science, Space, and Technology of the House of Representatives of the intent to impose the penalty, including a description of and justification for the penalty.

(4) COORDINATION.—The Secretary shall—

(A) share information about the unmanageable threats described in subsection (a)(3)(E) with other Federal agencies; and

(B) develop consistent approaches to identifying entities of concern.

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

(e) REPORT REQUIRED.—Not later than 240 days after the date of enactment of this Act, the Secretary shall submit to Congress a report that—

(1) describes—

(A) the tools and processes developed under subsection (b)(1) and any updates to those tools and processes; and

(B) if applicable, the science and technology risk matrix developed under that subsection and how that matrix has been applied;

(2) includes a mitigation plan for managing risks posed by countries of risk with respect to future or ongoing research and development activities of the Department of Energy; and

(3) defines critical research areas, designated by risk, as determined by the Secretary.

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