

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

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.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*

3 **SECTION 1. SHORT TITLE.**

4 This Act may be cited as the “Department of Energy
5 Science for the Future Act of 2022”.

6 **SEC. 2. MISSION OF THE OFFICE OF SCIENCE.**

7 Section 209 of the Department of Energy Organiza-
8 tion Act (42 U.S.C. 7139) is amended by adding at the
9 end the following:

1 “(d) USER FACILITIES.—The Director shall carry
2 out the construction, operation, and maintenance of user
3 facilities to support the mission described in subsection
4 (c). As practicable, these facilities shall serve the needs
5 of the Department, industry, the academic community,
6 and other relevant entities for the purposes of advancing
7 the missions of the Department, improving the competi-
8 tiveness of the United States, protecting public health and
9 safety, and addressing other national priorities including
10 emergencies.

11 “(e) COORDINATION.—

12 “(1) IN GENERAL.—The Secretary—

13 “(A) shall ensure the coordination of the
14 Office of Science with the other activities of the
15 Department, including the transfer of knowl-
16 edge, capabilities, and relevant technologies
17 from basic research programs of the Depart-
18 ment to applied research and development pro-
19 grams of the Department for the purpose of en-
20 abling development of mission-relevant tech-
21 nologies;

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

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

4 “(D) may form partnerships to enhance
 5 the utilization of and ensure access to user fa-
 6 cilities by other Federal agencies.

7 “(2) OFFICE OF SCIENCE.—The Director—

8 “(A) shall ensure the coordination of pro-
 9 grams and activities carried out by the Office of
 10 Science; and

11 “(B) shall direct all programs which have
 12 not recently completed a future planning road-
 13 map consistent with the funding of such pro-
 14 grams authorized under the Department of En-
 15 ergy Science for the Future Act of 2022 to
 16 complete such a roadmap.”.

17 **SEC. 3. BASIC ENERGY SCIENCES PROGRAM.**

18 (a) DEPARTMENT OF ENERGY RESEARCH AND INNO-
 19 VATION ACT.—Section 303 of the Department of Energy
 20 Research and Innovation Act (42 U.S.C. 18641) is amend-
 21 ed—

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

24 (2) by inserting before subsection (c), as so re-
 25 designated, the following:

1 “(a) PROGRAM.—As part of the activities authorized
 2 under section 209 of the Department of Energy Organiza-
 3 tion Act (42 U.S.C. 7139), the Director shall carry out
 4 a research and development program in basic energy
 5 sciences, including materials sciences and engineering,
 6 chemical sciences, physical biosciences, geosciences, and
 7 other disciplines, to understand, model, and control matter
 8 and energy at the electronic, atomic, and molecular levels
 9 in order to provide the foundations for new energy tech-
 10 nologies, address scientific grand challenges, and support
 11 the energy, environment, and national security missions
 12 of the Department.

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

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

20 (A) in paragraph (3)—

21 (i) in subparagraph (C), by striking

22 “and” at the end;

23 (ii) by redesignating subparagraph

24 (D) as subparagraph (E); and

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

3 “(D) autonomous chemistry and materials
 4 synthesis and characterization facilities that le-
 5 verage advances in artificial intelligence; and”;
 6 and

7 (B) by adding at the end the following:

8 “(4) ADVANCED PHOTON SOURCE UPGRADE.—

9 “(A) DEFINITIONS.—In this paragraph:

10 “(i) FLUX.—The term ‘flux’ means
 11 the rate of flow of photons.

12 “(ii) HARD X-RAY.—The term ‘hard
 13 x-ray’ means a photon with energy greater
 14 than 20 kiloelectron volts.

15 “(B) UPGRADE.—The Secretary shall pro-
 16 vide for the upgrade to the Advanced Photon
 17 Source described in the publication approved by
 18 the Basic Energy Sciences Advisory Committee
 19 on June 9, 2016, entitled ‘Report on Facility
 20 Upgrades’, including the development of a
 21 multibend achromat lattice to produce a high
 22 flux of coherent x-rays within the hard x-ray
 23 energy region and a suite of beamlines opti-
 24 mized 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;

1 “(ii) the publication entitled ‘Four
2 Years Later: An Interim Report on Facili-
3 ties for the Future of Science: A Twenty-
4 Year Outlook’, published by the Office of
5 Science of the Department in August,
6 2007; and

7 “(iii) the publication approved by the
8 Basic Energy Sciences Advisory Committee
9 on June 9, 2016, entitled ‘Report on Facil-
10 ity Upgrades’.

11 “(C) START OF OPERATIONS.—The Sec-
12 retary shall, subject to the availability of appro-
13 priations, ensure that the start of full oper-
14 ations of the upgrade under this paragraph oc-
15 curs before July 30, 2028, with the option for
16 early operation in 2025.

17 “(D) FUNDING.—Out of funds authorized
18 to be appropriated under subsection (j), there is
19 authorized to be appropriated to the Secretary
20 to carry out the upgrade under this paragraph
21 \$49,800,000 for fiscal year 2022.

22 “(6) SPALLATION NEUTRON SOURCE SECOND
23 TARGET STATION.—

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

4 “(B) SECOND TARGET STATION DE-
5 FINED.—In this paragraph, the term ‘second
6 target station’ means the Spallation Neutron
7 Source second target station described in—

8 “(i) the publication entitled, ‘Facilities
9 for the Future of Science: A Twenty-Year
10 Outlook’, published by the Office of
11 Science of the Department in December,
12 2003;

13 “(ii) the publication entitled, ‘Four
14 Years Later: An Interim Report on Facili-
15 ties for the Future of Science: A Twenty-
16 Year Outlook’, published by the Office of
17 Science of the Department in August,
18 2007; and

19 “(iii) the publication approved by the
20 Basic Energy Sciences Advisory Committee
21 on June 9, 2016, entitled ‘Report on Facil-
22 ity Upgrades’.

23 “(C) START OF OPERATIONS.—The Sec-
24 retary shall, subject to the availability of appro-
25 priations, 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.

1 “(B) UPGRADE.—The Secretary shall pro-
2 vide for the upgrade to the Advanced Light
3 Source described in the publication approved by
4 the Basic Energy Sciences Advisory Committee
5 on June 9, 2016, entitled ‘Report on Facility
6 Upgrades’, including the development of a
7 multibend achromat lattice to produce a high
8 flux of coherent x-rays within the soft x-ray en-
9 ergy region.

10 “(C) START OF OPERATIONS.—The Sec-
11 retary shall, subject to the availability of appro-
12 priations, ensure that the start of full oper-
13 ations of the upgrade under this paragraph oc-
14 curs before September 30, 2029.

15 “(D) FUNDING.—Out of funds authorized
16 to be appropriated under subsection (j), there
17 are authorized to be appropriated to the Sec-
18 retary to carry out the upgrade under this
19 paragraph—

20 “(i) \$75,100,000 for fiscal year 2022;

21 “(ii) \$135,000,000 for fiscal year
22 2023;

23 “(iii) \$102,500,000 for fiscal year
24 2024;

1 “(iv) \$25,000,000 for fiscal year
2 2025; and

3 “(v) \$26,400,000 for fiscal year 2026.

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

6 “(A) DEFINITIONS.—In this paragraph:

7 “(i) HIGH ENERGY.—The term ‘high
8 energy’, with respect to an x-ray, means a
9 photon with an energy in the 5 to 13
10 kiloelectron volt range.

11 “(ii) HIGH REPETITION RATE.—The
12 term ‘high repetition rate’ means the deliv-
13 ery of x-ray pulses up to 1,000,000 pulses
14 per second.

15 “(iii) ULTRA-SHORT PULSE.—The
16 term ‘ultra-short pulse’, with respect to an
17 x-ray, means that the x-ray has bursts ca-
18 pable of durations of less than 100
19 femtoseconds.

20 “(B) UPGRADE.—The Secretary shall—

21 “(i) provide for the upgrade to the
22 Linac Coherent Light Source II facility de-
23 scribed in the publication approved by the
24 Basic Energy Sciences Advisory Committee
25 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, ultra-short pulse x-rays delivered at a high repetition rate.

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

“(D) FUNDING.—Out of funds authorized to be appropriated under subsection (j), there 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;

1 “(iv) \$89,000,000 for fiscal year
2 2025; and

3 “(v) \$49,344,000 for fiscal year 2026.

4 “(9) CRYOMODULE REPAIR AND MAINTENANCE
5 FACILITY.—

6 “(A) IN GENERAL.—The Secretary shall
7 provide for the construction of a cryomodule re-
8 pair and maintenance facility to service the
9 Linac Coherent Light Source II and subsequent
10 upgrades.

11 “(B) CONSULTATION REQUIRED.—The
12 Secretary shall consult with the private sector,
13 institutions of higher education, National Lab-
14 oratories, and relevant Federal agencies to en-
15 sure that the facility described in subparagraph
16 (A) has the capability to maintain, repair, and
17 test superconducting radio frequency accel-
18 erator components.

19 “(C) FUNDING.—Out of funds authorized
20 to be appropriated under subsection (j), there
21 are authorized to be appropriated to the Sec-
22 retary to carry out the activities under this
23 paragraph—

24 “(i) \$19,000,000 for fiscal year 2022;

25 “(ii) \$25,000,000 for fiscal year 2023;

1 “(iii) \$25,000,000 for fiscal year
2 2024; and

3 “(iv) \$17,000,000 for fiscal year
4 2025.

5 “(10) NANOSCALE SCIENCE RESEARCH CENTER
6 RECAPITALIZATION PROJECT.—

7 “(A) IN GENERAL.—The Secretary shall
8 provide for the recapitalization of the Nanoscale
9 Science Research Centers, to include the up-
10 grade of equipment at each Center supported
11 by the Office of Science on the date of enact-
12 ment of the Department of Energy Science for
13 the Future Act of 2022, to accelerate advances
14 in the various fields of science including nano-
15 science, materials, chemistry, biology, and
16 quantum information science.

17 “(B) FUNDING.—Out of funds authorized
18 to be appropriated under subsection (j), there
19 are authorized to be appropriated to the Sec-
20 retary to carry out the recapitalization under
21 this paragraph—

22 “(i) \$20,000,000 for fiscal year 2022;

23 “(ii) \$30,000,000 for fiscal year 2023;

24 “(iii) \$20,000,000 for fiscal year
25 2024; and

1 “(iv) \$20,000,000 for fiscal year
2 2025.

3 “(11) NATIONAL SYNCHROTRON LIGHT SOURCE
4 II BEAMLINE BUILDOUT.—

5 “(A) IN GENERAL.—The Secretary shall
6 provide for the development and construction of
7 beamlines to provide significant additional ca-
8 pacity, complement the existing portfolio of
9 beamlines, and complete the buildout of the Na-
10 tional Synchrotron Light Source II.

11 “(B) START OF OPERATIONS.—Subject to
12 the availability of appropriations, the Sec-
13 retary—

14 “(i) shall begin carrying out subpara-
15 graph (A) not later than September 30,
16 2036; and

17 “(ii) may begin carrying out subpara-
18 graph (A)—

19 “(I) in calendar year 2033; or

20 “(II) after the construction of in-
21 dividual beamlines is complete.

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

1 retary such sums as are necessary to carry out
2 this paragraph.”; and

3 (4) by adding at the end the following:

4 “(h) COMPUTATIONAL MATERIALS AND CHEMICAL
5 SCIENCES.—

6 “(1) IN GENERAL.—The Director shall support
7 a program of research and development for the ap-
8 plication of advanced computing practices to
9 foundational and emerging research problems in
10 chemistry and materials science. Research activities
11 shall include—

12 “(A) chemical catalysis research and devel-
13 opment;

14 “(B) the use of large data sets to model
15 materials phenomena, including through ad-
16 vanced characterization of materials, materials
17 synthesis, processing, and innovative use of ex-
18 perimental and theoretical data;

19 “(C) codesign of chemical system and
20 chemistry modeling software with advanced
21 computing systems and hardware technologies;
22 and

23 “(D) modeling of chemical processes, as-
24 semblies, 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

1 Laboratories, institutes of higher education,
2 multi-institutional collaborations, and other ap-
3 propriate entities.

4 “(C) DURATION.—

5 “(i) NEW CENTERS.—A center se-
6 lected under subparagraph (A) shall re-
7 ceive support for a period of not more than
8 5 years beginning on the date of establish-
9 ment of that center, subject to the avail-
10 ability of appropriations.

11 “(ii) EXISTING CENTERS.—A center
12 already in existence on the date of enact-
13 ment of the Department of Energy Science
14 for the Future Act of 2022 may continue
15 to receive support for a period of not more
16 than 5 years beginning on the date of es-
17 tablishment of that center.

18 “(D) RENEWAL.—Upon the expiration of
19 any period of support of a center under this
20 subsection, the Director may renew support for
21 the center, on a merit-reviewed basis, for a pe-
22 riod of not more than 5 years.

23 “(E) FUNDING.—Of the funds authorized
24 to be appropriated under subsection (j), there
25 are authorized to be appropriated to the Sec-

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

3 “(i) MATERIALS RESEARCH DATABASE.—

4 “(1) IN GENERAL.—The Director shall support
5 the development of a web-based platform to develop
6 and provide access to a database of computed infor-
7 mation on known and predicted materials properties
8 and computational tools to accelerate breakthroughs
9 in materials discovery and design.

10 “(2) PROGRAM.—In carrying out this sub-
11 section, the Director shall—

12 “(A) conduct cooperative research among
13 National Laboratories, industry, academia, and
14 other research institutions to advance under-
15 standing, prediction, and manipulation of mate-
16 rials and facilitate the design of novel materials;

17 “(B) develop and maintain data infrastruc-
18 ture at user facilities that generate data to col-
19 lect, analyze, label, and otherwise prepare the
20 data for inclusion in the database;

21 “(C) leverage existing high performance
22 computing systems to conduct high throughput
23 calculations, and develop computational and
24 data mining algorithms for the prediction of
25 material properties;

1 “(D) strengthen the foundation for new
2 technologies and advanced manufacturing; and

3 “(E) drive the development of advanced
4 materials for applications that span the Depart-
5 ment’s missions in energy, environment, and
6 national security.

7 “(3) COORDINATION.—In carrying out this sub-
8 section, the Director shall leverage programs and ac-
9 tivities across the Department, including computa-
10 tional materials and chemical sciences centers estab-
11 lished under subsection (h).

12 “(4) FUNDING.—Out of funds authorized to be
13 appropriated under subsection (j), there is author-
14 ized to be appropriated to the Secretary to carry out
15 activities under this subsection \$10,000,000 for each
16 of fiscal years 2022 through 2026.

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

20 “(1) \$2,877,705,000 for fiscal year 2022;

21 “(2) \$2,978,896,600 for fiscal year 2023;

22 “(3) \$3,169,489,612 for fiscal year 2024;

23 “(4) \$3,311,698,885 for fiscal year 2025; and

24 “(5) \$3,441,651,600 for fiscal year 2026.”.

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

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

6 “(4) FUNDS.—Of the funds authorized to be
7 appropriated for basic energy sciences in a fiscal
8 year, there is authorized to be appropriated to the
9 Secretary to carry out activities under this sub-
10 section \$50,000,000 for each of fiscal years 2022
11 through 2026.”; and

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

14 “(4) FUNDS.—Of the funds authorized to be
15 appropriated for basic energy sciences in a fiscal
16 year, there is authorized to be appropriated to the
17 Secretary to carry out activities under this sub-
18 section \$50,000,000 for each of fiscal years 2022
19 through 2026.”.

20 (c) ELECTRICITY STORAGE RESEARCH INITIATIVE.—
21 Section 975 of the Energy Policy Act of 2005 (42 U.S.C.
22 16315) is amended—

23 (1) in subsection (a)—

24 (A) in paragraph (1)—

1 (i) in subparagraph (A)(ii), by strik-
2 ing “and” after the semicolon at the end;

3 (ii) in subparagraph (B), by striking
4 the period at the end and inserting “;
5 and”; and

6 (iii) by adding at the end the fol-
7 lowing:

8 “(C) to ensure the competitiveness of the
9 United States in energy storage by fostering an
10 ecosystem linking fundamental research and de-
11 velopment to deployment of storage solutions
12 while minimizing the environmental impacts of
13 energy storage technologies.”; and

14 (B) in paragraph (2)—

15 (i) in subparagraph (A), by striking
16 “and” after the semicolon at the end;

17 (ii) in subparagraph (B), by striking
18 the period at the end and inserting “;
19 and”; and

20 (iii) by adding at the end the fol-
21 lowing:

22 “(C) any other relevant office of the De-
23 partment.”;

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

1 “(4) FUNDING.—Of the funds authorized to be
2 appropriated for basic energy sciences in a fiscal
3 year, there is authorized to be appropriated to the
4 Secretary to carry out activities under this sub-
5 section \$50,000,000 for each of fiscal years 2022
6 through 2026.”;

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

9 “(4) FUNDING.—Of the funds authorized to be
10 appropriated for basic energy sciences in a fiscal
11 year, there is authorized to be appropriated to the
12 Secretary to carry out activities under this sub-
13 section \$50,000,000 for each of fiscal years 2022
14 through 2026.”; and

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

17 “(4) FUNDING.—Of the funds authorized to be
18 appropriated for basic energy sciences in a fiscal
19 year, there is authorized to be appropriated to the
20 Secretary to carry out activities under this sub-
21 section \$20,000,000 for each of fiscal years 2022
22 through 2026.”.

23 (d) FOUNDATIONAL NUCLEAR SCIENCE.—

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

1 velopment to bridge scientific barriers to, and ex-
2 pand theoretical and fundamental knowledge rel-
3 evant to, nuclear matter for the benefit of commerce,
4 medicine, and national security.

5 (2) ACTIVITIES.—As part of the program de-
6 scribed in paragraph (1)—

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

10 (i) nuclear materials science, including
11 the application of advanced computing
12 practices to foundational and emerging re-
13 search problems in nuclear materials
14 science and discovery;

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

17 (I) advanced characterization of
18 materials;

19 (II) materials synthesis;

20 (III) processing; and

21 (IV) innovative use of experi-
22 mental and theoretical data;

23 (iii) electrochemistry and associated
24 techniques for processing nuclear mate-
25 rials;

1 (iv) advanced instrumentation and nu-
 2 clear data collection to inform the activities
 3 described in clauses (i) through (iii); and

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

7 (B) the Assistant Secretary for Nuclear
 8 Energy shall consult with the Director of the
 9 Office of Science to support the direction of
 10 translational research, development, and valida-
 11 tion of physical concepts developed under the
 12 program.

13 (3) FUNDING.—Of the funds authorized to be
 14 appropriated for basic energy sciences in a fiscal
 15 year, there is authorized to be appropriated to the
 16 Secretary of Energy to carry out activities under
 17 this subsection \$50,000,000 for each of fiscal years
 18 2022 through 2026.

19 (e) CARBON MATERIALS SCIENCE INITIATIVE.—

20 (1) INITIATIVE.—

21 (A) IN GENERAL.—The Secretary of En-
 22 ergy (referred to in this subsection as the “Sec-
 23 retary”) shall establish a research initiative, to
 24 be known as the “Carbon Materials Science Ini-
 25 tiative” (referred to in this subsection as the

1 “Initiative”), to expand the fundamental knowl-
2 edge of coal and carbon ore chemistry useful for
3 understanding the conversion of carbon to ma-
4 terial products.

5 (B) COORDINATION.—In carrying out pro-
6 grams and activities under the Initiative, the
7 Secretary shall leverage expertise and resources
8 from the Office of Fossil Energy and Carbon
9 Management and the United States Geological
10 Survey.

11 (C) TEAMS.—

12 (i) IN GENERAL.—In carrying out the
13 Initiative, the Secretary shall establish and
14 organize activities among multidisciplinary
15 teams to leverage, to the maximum extent
16 practicable, expertise from the National
17 Laboratories, institutions of higher edu-
18 cation, and the private sector.

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

23 (2) RESEARCH PROGRAM.—

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

1 port, and discover knowledge relevant to, car-
2 bon materials research.

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

5 (i) the Director of the Office of
6 Science shall support basic research to
7 pursue distinct lines of scientific inquiry,
8 including methods of extraction and utili-
9 zation of the materials and valuable min-
10 erals contained in raw coal; and

11 (ii) the Director of the Office of
12 Science and the Assistant Secretary of En-
13 ergy for Fossil Energy and Carbon Man-
14 agement shall support basic research to
15 pursue distinct lines of scientific inquiry,
16 including methods of improving materials
17 for use as carbon oxide membranes for use
18 in carbon capture systems.

19 (C) REVIEW.—The Secretary shall periodi-
20 cally review activities carried out under the pro-
21 gram described in subparagraph (A) to evaluate
22 the achievement of technical milestones.

23 (D) COORDINATION WITH EXISTING PRO-
24 GRAMS AND CENTERS.—In carrying out the

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

3 (i) ensure coordination with—

4 (I) the United States Geological
5 Survey; and

6 (II) the programs and the Car-
7 bon Utilization Research Center es-
8 tablished under section 969A of the
9 Energy Policy Act of 2005 (42 U.S.C.
10 16298a); and

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

13 (3) CARBON MATERIALS RESEARCH CEN-
14 TERS.—

15 (A) IN GENERAL.—In carrying out the ac-
16 tivities authorized under paragraph (2), the
17 Secretary shall establish 1 center in each of the
18 2 major coal-producing regions of the United
19 States, each of which shall—

20 (i) be known as a “Carbon Materials
21 Research Center” (referred to in this para-
22 graph as a “Center”); and

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

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

7 (II) improving methods of im-
8 proving the structural, physical, and
9 chemical properties of carbon mate-
10 rials or other valuable materials from
11 raw coal or other solid carbon mate-
12 rials and their recyclability; and

13 (III) focusing on overcoming the
14 challenges and maximizing the bene-
15 fits of coal-derived carbon.

16 (B) SELECTION.—The Secretary shall—

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

20 (ii) consider applications from the Na-
21 tional Laboratories, institutions of higher
22 education, multi-institutional collabora-
23 tions, and other appropriate entities.

24 (C) DURATION.—A Center shall receive
25 support for a period of not more than 5 years

1 beginning on the date of establishment of that
 2 Center, subject to the availability of appropria-
 3 tions.

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

9 (4) FUNDING.—Of the funds authorized to be
 10 appropriated for basic energy sciences in a fiscal
 11 year, there is authorized to be appropriated to the
 12 Secretary to carry out activities under this sub-
 13 section \$50,000,000 for each of fiscal years 2022
 14 through 2026.

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

17 (1) INITIATIVE.—

18 (A) IN GENERAL.—The Secretary of En-
 19 ergy (referred to in this subsection as the “Sec-
 20 retary”) shall establish a research initiative, to
 21 be known as the “Carbon Oxide Sequestration
 22 Research and Geologic Computing Initiative”
 23 (referred to in this subsection as the “Initia-
 24 tive”), to expand the fundamental knowledge,
 25 data collection, data analysis, and modeling of

1 subsurface geology for the purpose of advancing
2 carbon oxide sequestration in geologic forma-
3 tions.

4 (B) LEVERAGING.—In carrying out pro-
5 grams and activities under the Initiative, the
6 Secretary shall leverage expertise and resources
7 from the Office of Fossil Energy and Carbon
8 Management and the United States Geological
9 Survey.

10 (C) TEAMS.—

11 (i) IN GENERAL.—In carrying out the
12 Initiative, the Secretary shall establish and
13 organize activities among multidisciplinary
14 teams to leverage, to the maximum extent
15 practicable, expertise from the National
16 Laboratories, institutions of higher edu-
17 cation, and the private sector.

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

22 (D) ADDITIONAL ACTIVITIES.—The Sec-
23 retary may organize additional activities under
24 this subsection through other organizational
25 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-

1 puting, visualization, and imaging of geo-
2 logic formations for the sequestration of
3 carbon oxides.

4 (C) REVIEW.—The Secretary shall periodi-
5 cally review activities carried out under the pro-
6 gram described in subparagraph (A) to evaluate
7 achievement of technical milestones.

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

10 (A) IN GENERAL.—In carrying out the ac-
11 tivities authorized under paragraph (2), the Di-
12 rector of the Office of Science shall select and
13 establish not more than 2 carbon oxide storage
14 research and geologic computing centers (re-
15 ferred to in this paragraph as a “Center”) to
16 develop and advance improvements to data col-
17 lection, analysis, and modeling of subsurface ge-
18 ology for the purpose of advancing carbon oxide
19 sequestration in geologic formations.

20 (B) SELECTION.—

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

23 (I) select Centers under subpara-
24 graph (A) on a competitive, merit-re-
25 viewed basis; and

1 (II) to the maximum extent prac-
2 ticable, locate each Center in a region
3 with established and ongoing geologic
4 carbon oxide sequestration research
5 and demonstration.

6 (ii) APPLICATIONS.—In selecting Cen-
7 ters under subparagraph (A), the Director
8 of the Office of Science shall consider ap-
9 plications from institutions of higher edu-
10 cation, multi-institutional collaborations,
11 and other appropriate entities.

12 (C) DURATION.—

13 (i) NEW CENTERS.—A Center estab-
14 lished after the date of enactment of this
15 Act shall receive support for a period of
16 not more than 5 years beginning on the
17 date of establishment of that Center, sub-
18 ject to the availability of appropriations.

19 (ii) EXISTING CENTERS.—A Center
20 already in existence on the date of enact-
21 ment of this Act may continue to receive
22 support for a period of not more than 5
23 years beginning on that date of enactment.

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

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

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

8 (A) ensure coordination with—

9 (i) the United States Geological Sur-
 10 vey; and

11 (ii) the programs established under
 12 section 963 of the Energy Policy Act of
 13 2005 (42 U.S.C. 16293); and

14 (B) avoid duplication of efforts to the max-
 15 imum extent practicable.

16 (5) FUNDING.—Of the funds authorized to be
 17 appropriated for basic energy sciences in a fiscal
 18 year, there is authorized to be appropriated to the
 19 Secretary to carry out activities under this sub-
 20 section \$50,000,000 for each of fiscal years 2022
 21 through 2026.

22 **SEC. 4. BIOLOGICAL AND ENVIRONMENTAL RESEARCH.**

23 (a) PROGRAM; BIOLOGICAL SYSTEMS; BIOMOLEC-
 24 ULAR 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 “(1) to provide a fundamental understanding of
2 the biology of plants, fungi, and microbes as a basis
3 for developing innovative processes for bioenergy and
4 bioproducts and accelerate breakthroughs and new
5 knowledge that would enable the cost-effective, sus-
6 tainable production of—

7 “(A) advanced biofuels;

8 “(B) bioenergy; and

9 “(C) biobased materials;

10 “(2) to conduct foundational functional biology
11 research—

12 “(A) to support expanded biosystems de-
13 sign research; and

14 “(B) to understand—

15 “(i) fundamental genome structure;

16 and

17 “(ii) phenomes, including functional
18 genomics of gene products at genome
19 scale;

20 “(3) to develop biosystems designs and syn-
21 thetic biology approaches for new nonfood plant-de-
22 rived and microbially derived bioproducts as a basis
23 for new bioeconomy and biotechnology applications
24 in bioproducts production, resource recovery, recy-
25 cling, and upcycling ventures;

1 “(4) to conduct research to better understand
2 environmentally relevant microbiomes and the inter-
3 dependencies between plants and microbes in a sus-
4 tainable ecosystem;

5 “(5) to improve fundamental understanding of
6 plant and microbial processes impacting the global
7 carbon cycle, including processes for removing car-
8 bon dioxide from the atmosphere, through photosyn-
9 thesis and other biological processes, for sequestra-
10 tion, storage, and utilization;

11 “(6) to understand the microbiome mechanisms
12 and microbiota used to transform, immobilize, or re-
13 move contaminants from subsurface environments
14 and that affect the cycling and disposition of carbon,
15 nutrients, and contaminants in the environment;

16 “(7) to develop the computational approaches
17 and integrated platforms for open access collabo-
18 rative science;

19 “(8) to leverage tools and approaches across the
20 Office of Science to expand research to include novel
21 processes, methods, and science to develop bio-based
22 chemicals, polymers, inorganic materials, including
23 research—

24 “(A) to advance fungal, microbial, and
25 plant biosystems design research to advance the

1 understanding of how CRISPR tools and other
 2 gene editing tools and technologies work in na-
 3 ture, in the laboratory, and in practice;

4 “(B) to deepen genome-enabled knowledge
 5 of the roles of microbes and microbial commu-
 6 nities, including fungi, in—

7 “(i) supporting plant and tree produc-
 8 tivity, performance, adaptation, and resil-
 9 ience in changing environmental condi-
 10 tions; and

11 “(ii) optimizing end uses of biomass;

12 “(C) to develop biosystems design methods
 13 and tools to increase the efficiency of photosyn-
 14 thesis in plants; and

15 “(D) to increase the scale and pace of
 16 characterizing the functions and physical char-
 17 acteristics of microbes and microbial commu-
 18 nities to improve biosystems design;

19 “(9) to conduct research focused on developing
 20 analysis techniques and simulation capabilities, in-
 21 cluding artificial intelligence and machine learning,
 22 on high-performance computing platforms to accel-
 23 erate collaborative and reproducible systems biology
 24 research;

1 “(10) to develop new technologies for bio-
2 imaging, measurement, and characterization pur-
3 poses—

4 “(A) through the Biomolecular Character-
5 ization and Imaging Science program of the
6 Department; and

7 “(B) to understand the structural, spatial,
8 and temporal relationships of metabolic proc-
9 esses governing phenotypic expression in plants
10 and microbes;

11 “(11) to conduct research focused on genotype-
12 to-phenotype translations to develop a predictive un-
13 derstanding of cellular function under a variety of
14 relevant environmental and bioenergy-related condi-
15 tions;

16 “(12) to conduct metagenomic and metadata
17 assembly research sequencing and analysis; and

18 “(13) to develop other relevant methods and
19 processes as determined by the Director.

20 “(c) BIOMOLECULAR CHARACTERIZATION AND IMAG-
21 ING SCIENCE.—The Director shall carry out research and
22 development activities in biomolecular characterization
23 and imaging science, including development of integrative
24 imaging and analysis platforms and biosensors to under-
25 stand the expression, structure, and function of genome

1 information encoded within cells and for real-time meas-
 2 urements in ecosystems and field sites of relevance to the
 3 mission of the Department.”; and

4 (4) by adding at the end the following:

5 “(1) DEFINITIONS.—In this section:

6 “(1) ADVANCED BIOFUEL.—The term ‘ad-
 7 vanced biofuel’ has the meaning given the term in
 8 section 9001 of the Farm Security and Rural Invest-
 9 ment Act of 2002 (7 U.S.C. 8101).

10 “(2) BIOENERGY.—The term ‘bioenergy’ means
 11 energy derived from biofuels.

12 “(3) BIOMASS.—The term ‘biomass’ has the
 13 meaning given the term in section 203(b) of the En-
 14 ergy Policy Act of 2005 (42 U.S.C. 15852(b)).

15 “(4) BIOPRODUCT.—The term ‘bioproduct’ has
 16 the meaning given the term ‘biobased product’ in
 17 section 9001 of the Farm Security and Rural Invest-
 18 ment Act of 2002 (7 U.S.C. 8101).”.

19 (b) LOW-DOSE RADIATION RESEARCH PROGRAM.—
 20 Paragraph (8) of subsection (e) of section 306 of the De-
 21 partment of Energy Research and Innovation Act (42
 22 U.S.C. 18644), as redesignated by subsection (a)(2), is
 23 amended—

24 (1) in subparagraph (C), by striking “and”;

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

3 (3) by adding at the end the following:

4 “(E) \$50,000,000 for fiscal year 2025; and

5 “(F) \$60,000,000 for fiscal year 2026.”.

6 (c) LOW-DOSE RADIATION AND SPACE RADIATION
7 RESEARCH PROGRAM.—Subsection (f) of section 306 of
8 the Department of Energy Research and Innovation Act
9 (42 U.S.C. 18644), as redesignated by subsection (a)(2),
10 is amended to read as follows:

11 “(f) LOW-DOSE RADIATION AND SPACE RADIATION
12 RESEARCH PROGRAM.—

13 “(1) IN GENERAL.—The Secretary, in consulta-
14 tion with the Administrator of the National Aero-
15 nautics and Space Administration, shall carry out a
16 basic research program on the similarities and dif-
17 ferences between the effects of exposure to low-dose
18 radiation on Earth, in low Earth orbit, and in the
19 space environment.

20 “(2) PURPOSE.—The purpose of the program
21 described in paragraph (1) is to accelerate break-
22 throughs in low-dose and low dose-rate radiation re-
23 search and development as described in subsection
24 (e) and to inform the advancement of new tools,

1 technologies, and advanced materials needed to fa-
 2 cilitate long-duration space exploration.”.

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

8 “(g) EARTH AND ENVIRONMENTAL SYSTEMS
 9 SCIENCES ACTIVITIES.—

10 “(1) IN GENERAL.—As part of the activities au-
 11 thorized under subsection (a), and in coordination
 12 with activities carried out under subsection (b), the
 13 Director shall carry out earth and environmental
 14 systems science research, in consultation with the
 15 National Oceanic and Atmospheric Administration
 16 and other relevant agencies, which may include ac-
 17 tivities—

18 “(A) to understand, observe, measure, and
 19 model the response of Earth’s atmosphere and
 20 biosphere to changing concentrations of green-
 21 house gas emissions and any associated changes
 22 in climate, including frequency and intensity of
 23 extreme weather events;

24 “(B) to understand the coupled physical,
 25 chemical, and biological processes to transform,

1 immobilize, remove, or move carbon, nitrogen,
2 and other energy production-derived contami-
3 nants such as radionuclides and heavy metals,
4 and understand the process of sequestration
5 and transformation of these, carbon dioxide,
6 and other relevant molecules in subsurface envi-
7 ronments;

8 “(C) to understand, observe, and model the
9 cycling of water, carbon, and nutrients in ter-
10 restrial systems and at scales relevant to re-
11 sources management;

12 “(D) to understand the biological, biogeo-
13 chemical, and physical processes across the
14 multiple scales that control the flux of environ-
15 mentally relevant compounds between the ter-
16 restrial surface and the atmosphere; and

17 “(E) to understand and predict inter-
18 actions among natural and human systems to
19 inform potential mitigation and adaptation op-
20 tions for increased concentrations of greenhouse
21 gas emissions and any associated changes in cli-
22 mate.

23 “(2) PRIORITIZATION.—In carrying out the
24 program authorized under paragraph (1), the Direc-
25 tor shall prioritize—

1 “(A) the development of software and algo-
 2 rithms to enable the productive application of
 3 environmental systems and extreme weather in
 4 climate and Earth system prediction models in
 5 high-performance computing systems; and

6 “(B) capabilities that support the Depart-
 7 ment’s mission needs for energy and infrastruc-
 8 ture security, resilience, and reliability.

9 “(3) ENVIRONMENTAL SYSTEMS SCIENCE RE-
 10 SEARCH.—

11 “(A) IN GENERAL.—As part of the activi-
 12 ties described in paragraph (1), the Director
 13 shall carry out research to advance an inte-
 14 grated, robust, and scale-aware predictive un-
 15 derstanding of environmental systems, including
 16 the role of hydrobiogeochemistry, from the sub-
 17 surface to the top of the vegetative canopy that
 18 considers effects of seasonal to interannual vari-
 19 ability and change.

20 “(B) CLEAN WATER AND WATERSHED RE-
 21 SEARCH.—As part of the activities described in
 22 subparagraph (A), the Director shall—

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

1 pact of human activity and a changing cli-
2 mate on urban and rural watershed sys-
3 tems, including in freshwater environ-
4 ments;

5 “(ii) consult with the Interagency Re-
6 search, Development, and Demonstration
7 Coordination Committee on the Nexus of
8 Energy and Water for Sustainability estab-
9 lished under section 1010 of the Energy
10 Act of 2020 (Public Law 116–260) on en-
11 ergy-water nexus research activities; and

12 “(iii) engage with representatives of
13 research and academic institutions, non-
14 profit organizations, State, local, and tribal
15 governments, and industry, who have ex-
16 pertise in technologies, technological inno-
17 vations, or practices relating to the energy-
18 water nexus, as applicable.

19 “(C) COORDINATION.—

20 “(i) DIRECTOR.—The Director shall
21 carry out activities under this paragraph in
22 accordance with priorities established by
23 the Secretary to support and accelerate the
24 decontamination of relevant facilities man-
25 aged by the Department.

1 “(ii) SECRETARY.—The Secretary
 2 shall ensure the coordination of activities
 3 of the Department, including activities
 4 under this paragraph, to support and ac-
 5 celerate the decontamination of relevant fa-
 6 cilities managed by the Department.

7 “(4) CLIMATE AND EARTH MODELING.—As
 8 part of the activities described in paragraph (1), the
 9 Director, in collaboration with the Advanced Sci-
 10 entific Computing Research program described in
 11 section 304 and other programs carried out by the
 12 Department, as applicable, and in consultation with
 13 the National Oceanic and Atmospheric Administra-
 14 tion and other relevant agencies, shall carry out re-
 15 search to develop, evaluate, and use high-resolution
 16 regional climate, global climate, Earth system, and
 17 other relevant models to inform decisions on reduc-
 18 ing greenhouse gas emissions and the resulting im-
 19 pacts of a changing global climate. Such modeling
 20 shall include—

21 “(A) integrated capabilities for modeling
 22 multisectoral interactions, including the impacts
 23 of climate policies on human systems and the
 24 interdependencies and risks at the energy-
 25 water-land nexus;

1 “(B) greenhouse gas emissions, air quality,
2 energy supply and demand, and other critical
3 elements; and

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

7 “(5) MIDSACLE FUNDING MECHANISM.—

8 “(A) IN GENERAL.—Any of the activities
9 authorized in this subsection may be carried out
10 by competitively selected midscale, multi-institu-
11 tional research centers in lieu of individual re-
12 search grants, or large-scale experiments or
13 user facilities.

14 “(B) CONSIDERATION.—The Biological
15 and Environmental Research Advisory Com-
16 mittee shall provide recommendations to the Di-
17 rector on projects most suitable for the research
18 centers described in subparagraph (A).

19 “(6) ATMOSPHERIC SCIENCES RESEARCH SUB-
20 PROGRAM.—

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

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

3 “(i) better understanding the atmos-
4 phere and the interaction of the atmos-
5 phere with the surface of the Earth;

6 “(ii) understanding sources of uncer-
7 tainty in Earth system models, including
8 with respect to the interdependence of
9 clouds (including contrails), atmospheric
10 aerosols (including natural aerosol loading
11 events), and precipitation;

12 “(iii) understanding the radiative bal-
13 ance and hydrological cycle of Earth; and

14 “(iv) demonstrating the improved pre-
15 dictability of regional and global atmos-
16 pheric models due to improved process-
17 level understanding.

18 “(B) ACTIVITIES.—In carrying out the At-
19 mospheric Sciences Research Subprogram, the
20 Secretary shall—

21 “(i) collect data and conduct research
22 to advance atmospheric and Earth system
23 modeling capabilities;

24 “(ii) develop integrated, scalable test-
25 beds that—

1 “(I) incorporate process-level un-
 2 derstanding of the life cycles of
 3 aerosols, clouds, and precipitation;
 4 and

5 “(II) can be incorporated into
 6 other models;

7 “(iii) improve data, analysis, and pre-
 8 diction systems in marine, littoral, terres-
 9 trial, and arctic environments, including
 10 those environments sensitive to changes in
 11 the climate; and

12 “(iv) support the development of tech-
 13 nologies relating to—

14 “(I) more accurate cloud, aerosol,
 15 and other atmospheric sensors;

16 “(II) observing sensor networks;
 17 and

18 “(III) computational predictive
 19 modeling.

20 “(C) USE OF ATMOSPHERIC RADIATION
 21 MEASUREMENT PROGRAM FACILITIES AND IN-
 22 FRASTRUCTURE.—To support the Atmospheric
 23 Sciences Research Subprogram and improve
 24 fundamental understanding of the physical and
 25 chemical processes that impact the formation,

1 life cycle, and radiative impacts of cloud and
 2 aerosol particles, the Secretary shall use the fa-
 3 cilities and infrastructure of the Atmospheric
 4 Radiation Measurement User Facility—

5 “(i) to provide support to environ-
 6 mental scientists by collecting high-quality
 7 and well-characterized in-situ and aircraft
 8 observations of—

9 “(I) the microphysical properties
 10 of clouds and atmospheric aerosols;

11 “(II) the coincident and highly
 12 detailed dynamical and thermo-
 13 dynamic properties of the atmospheric
 14 environment that contains those
 15 clouds and aerosols;

16 “(III) the properties of precipita-
 17 tion; and

18 “(IV) the properties of radiation
 19 and the background environment; and

20 “(ii) to carry out laboratory studies
 21 and ground-based and airborne field cam-
 22 paigns to target specific atmospheric proc-
 23 esses in different locations and across a
 24 range of environments, including by devel-

1 oping technologies to assist in advancing
2 predictive capabilities.

3 “(h) BIOLOGICAL AND ENVIRONMENTAL RESEARCH
4 USER FACILITIES.—

5 “(1) IN GENERAL.—The Director shall carry
6 out a program for the development, construction, op-
7 eration, and maintenance of user facilities to en-
8 hance the collection and analysis of observational
9 data related to complex biological, climate, and envi-
10 ronmental systems.

11 “(2) SELECTION.—

12 “(A) IN GENERAL.—The Director shall se-
13 lect user facilities under paragraph (1) on a
14 competitive, merit-reviewed basis.

15 “(B) APPLICANTS.—In selecting user fa-
16 cilities under paragraph (1), the Director shall
17 consider applications from the National Labora-
18 tories, institutes of higher education, multi-in-
19 stitutional collaborations, and other appropriate
20 entities.

21 “(3) FACILITY REQUIREMENTS.—To the max-
22 imum extent practicable, the user facilities devel-
23 oped, constructed, operated, or maintained under
24 paragraph (1) shall include—

1 “(A) distributed field research and obser-
2 vation platforms for understanding earth sys-
3 tem processes;

4 “(B) analytical techniques, instruments,
5 and modeling resources, including high-through-
6 put molecular phenotyping, for understanding
7 and predicting the functional processes of bio-
8 logical and environmental systems;

9 “(C) integrated high-throughput sequenc-
10 ing, advanced bioanalytic techniques, DNA de-
11 sign and synthesis, metabolomics, and computa-
12 tional analysis; and

13 “(D) such other facilities as the Director
14 considers appropriate, consistent with section
15 209 of the Department of Energy Organization
16 Act (42 U.S.C. 7139).

17 “(4) EXISTING FACILITIES.—In carrying out
18 the program established in paragraph (1), the Direc-
19 tor is encouraged to evaluate the capabilities of ex-
20 isting user facilities and, to the maximum extent
21 practicable, invest in modernization of those capa-
22 bilities to address emerging research priorities.

23 “(5) MICROBIAL MOLECULAR PHENOTYPING CA-
24 PABILITY PROJECT.—

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

6 “(B) CAPABILITIES.—In carrying out sub-
7 paragraph (A), the Secretary shall ensure the
8 following capabilities:

9 “(i) Coupled high-throughput autono-
10 mous experimental and multimodal analyt-
11 ical capabilities.

12 “(ii) Direct integration of automated
13 multiomics analyses, biomolecular and cel-
14 lular imaging, and functional biological as-
15 says with high-throughput microbial cul-
16 turing and cultivation capabilities at
17 timescales relevant to biological processes
18 under natural and perturbed environmental
19 conditions.

20 “(C) DATA COORDINATION.—In carrying
21 out subparagraph (A), the Secretary shall en-
22 sure integration and coordination with existing
23 data platforms of the Department.

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

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

3 “(E) FUNDING.—Of the funds authorized
 4 to be appropriated under subsection (k) for a
 5 fiscal year, there are authorized to be appro-
 6 priated to the Secretary to carry out this para-
 7 graph—

8 “(i) \$550,000 for fiscal year 2022;

9 “(ii) \$29,000,000 for fiscal year 2023;

10 “(iii) \$32,000,000 for fiscal year
 11 2024;

12 “(iv) \$30,500,000 for fiscal year
 13 2025; and

14 “(v) \$27,500,000 for fiscal year 2026.

15 “(6) USER FACILITIES INTEGRATION AND COL-
 16 LABORATION PROGRAM.—

17 “(A) IN GENERAL.—The Director shall
 18 support a program of collaboration between
 19 user facilities to encourage and enable research-
 20 ers to more readily integrate the tools, exper-
 21 tise, resources, and capabilities of multiple Of-
 22 fice of Science user facilities (as described in
 23 subsection (d) of section 209 of the Department
 24 of Energy Organization Act (42 U.S.C. 7139))

1 to further research and advance emerging tech-
2 nologies.

3 “(B) ACTIVITIES.—The program shall ad-
4 vance the integration of automation, robotics,
5 computational biology, bioinformatics, bio-
6 sensing, cellular platforms and other relevant
7 emerging technologies as determined by the Di-
8 rector to enhance productivity and scientific im-
9 pact of user facilities.

10 “(7) COORDINATION.—In carrying out the pro-
11 gram authorized under paragraph (1), the Director
12 shall ensure that the Office of Science—

13 “(A) consults and coordinates with the Na-
14 tional Oceanic and Atmospheric Administration,
15 the Environmental Protection Agency, the Na-
16 tional Aeronautics and Space Administration,
17 the Department of Agriculture, the Department
18 of the Interior, and any other relevant Federal
19 agency on the collection, validation, and anal-
20 ysis of atmospheric data; and

21 “(B) coordinates with relevant stake-
22 holders, including institutes of higher education,
23 nonprofit research institutions, industry, State,
24 local, and tribal governments, and other appro-
25 priate entities to ensure access to the best avail-

1 able relevant atmospheric and historical weath-
2 er data.

3 “(i) COASTAL ZONE RESEARCH INITIATIVE.—

4 “(1) IN GENERAL.—The Director shall carry
5 out a research program, in consultation with the Na-
6 tional Oceanic and Atmospheric Administration and
7 other relevant Federal agencies, to enhance the un-
8 derstanding of coastal ecosystems. In carrying out
9 this program, the Director shall prioritize efforts to
10 enhance the collection of observational data, and
11 shall develop models to analyze the ecological, bio-
12 geochemical, hydrological, physical, and human proc-
13 esses that interact in coastal zones.

14 “(2) COASTAL DATA COLLECTION SYSTEM.—

15 The Director shall establish, in consultation with the
16 National Oceanic and Atmospheric Administration
17 and other relevant agencies, an integrated system of
18 geographically diverse field research sites in order to
19 improve the scientific understanding and predict-
20 ability of the major land water interfaces of the
21 United States, including—

22 “(A) the Great Lakes region;

23 “(B) the Pacific coast;

24 “(C) the Atlantic coast;

25 “(D) the Arctic;

1 “(E) the Gulf coast; and

2 “(F) the coasts of United States territories
3 and freely associated States.

4 “(3) EXISTING INFRASTRUCTURE.—In carrying
5 out the programs and establishing the field research
6 sites under paragraphs (1) and (2), the Secretary
7 shall leverage existing research and development in-
8 frastructure supported by the Department, including
9 the Department’s existing marine and coastal re-
10 search lab.

11 “(4) COORDINATION.—For the purposes of car-
12 rying out the programs and establishing the field re-
13 search sites under paragraphs (1) and (2), the Sec-
14 retary may enter into agreements with Federal De-
15 partments and agencies with complementary capa-
16 bilities.

17 “(j) ENGINEERED ECOSYSTEMS INITIATIVE.—

18 “(1) IN GENERAL.—The Secretary shall estab-
19 lish within the Biological and Environmental Re-
20 search program an initiative focused on the develop-
21 ment of engineered ecosystems through the applica-
22 tion of artificial intelligence, novel sensing capabili-
23 ties, and other emerging technologies.

24 “(2) INTERAGENCY COORDINATION.—The Sec-
25 retary shall coordinate with the Director of the Na-

1 tional Science Foundation, the Administrator of the
2 National Oceanic and Atmospheric Administration,
3 the Director of the U.S. Geological Survey, the Sec-
4 retary of Agriculture, and other relevant officials to
5 avoid duplication of research and observational ac-
6 tivities and to ensure that activities carried out
7 under the initiative established under paragraph (1)
8 are complimentary to activities being undertaken by
9 other agencies.

10 “(3) REPORT.—Not later than 180 days after
11 the date of enactment of the Department of Energy
12 Science for the Future Act of 2022, the Secretary
13 shall submit to the Committee on Science, Space,
14 and Technology of the House of Representatives and
15 the Committee on Energy and Natural Resources of
16 the Senate a report on the activity authorized under
17 this subsection.

18 “(k) AUTHORIZATION OF APPROPRIATIONS.—Out of
19 funds authorized to be appropriated for the Office of
20 Science in a fiscal year, there are authorized to be appro-
21 priated to the Secretary to carry out the activities de-
22 scribed in this section—

23 “(1) \$880,360,000 for fiscal year 2022;

24 “(2) \$946,385,200 for fiscal year 2023;

25 “(3) \$1,016,332,164 for fiscal year 2024;

1 “(4) \$1,090,475,415 for fiscal year 2025; and
2 “(5) \$1,169,108,695 for fiscal year 2026.”.

3 (e) BIOENERGY RESEARCH CENTERS.—Section 977
4 of the Energy Policy Act of 2005 (42 U.S.C. 16317) is
5 amended by striking subsection (f) and inserting the fol-
6 lowing:

7 “(f) BIOENERGY RESEARCH CENTERS.—

8 “(1) IN GENERAL.—In carrying out the pro-
9 gram under section 306(a) of the Department of
10 Energy Research and Innovation Act (42 U.S.C.
11 18644(a)), the Director shall support up to 6 bio-
12 energy research centers, or make an equivalent in-
13 vestment in other center-scale funding modalities, to
14 conduct fundamental research in plant and microbial
15 systems biology, biological imaging and analysis, and
16 genomics, and to accelerate advanced research and
17 development of advanced biofuels, bioenergy or
18 biobased materials, chemicals, and products that are
19 produced from a variety of regionally diverse feed-
20 stocks, and to facilitate the translation of research
21 results to industry. The activities of the centers au-
22 thorized under this subsection may include—

23 “(A) accelerating the domestication of bio-
24 energy-relevant plants, microbes, and associated
25 microbial communities to enable high-impact,

1 value-added coproduct development at multiple
2 points in the bioenergy supply chain;

3 “(B) developing the science and techno-
4 logical advances to ensure process sustainability
5 is considered in the creation of advanced
6 biofuels and bioproducts from lignocellulosic
7 biomass; and

8 “(C) using the latest tools in genomics,
9 molecular biology, catalysis science, chemical
10 engineering, systems biology, and computational
11 and robotics technologies to sustainably produce
12 and transform biomass into advanced biofuels
13 and bioproducts.

14 “(2) SELECTION AND DURATION.—

15 “(A) IN GENERAL.—A center established
16 under paragraph (1) shall be selected on a com-
17 petitive, merit-reviewed basis for a period of not
18 more than 5 years, subject to the availability of
19 appropriations, beginning on the date of estab-
20 lishment of that center.

21 “(B) APPLICATIONS.—The Director shall
22 consider applications from National Labora-
23 tories, multi-institutional collaborations, and
24 other appropriate entities.

1 “(C) EXISTING CENTERS.—A center al-
2 ready in existence on the date of enactment of
3 the Department of Energy Science for the Fu-
4 ture Act of 2022 may continue to receive sup-
5 port for a period of not more than 5 years be-
6 ginning on the date of establishment of that
7 center.

8 “(D) NEW CENTERS.—At least 1 new cen-
9 ter established under paragraph (1) shall be led
10 by an institution of higher education (as de-
11 fined in section 101 of the Higher Education
12 Act of 1965 (20 U.S.C. 1001)) that is located
13 in an eligible jurisdiction (as defined in section
14 2203(b)(3)(A) of the Energy Policy Act of 1992
15 (42 U.S.C. 13503(b)(3)(A))).

16 “(3) RENEWAL.—After the end of the applica-
17 ble period described in paragraph (2), the Director
18 may renew support for a center for a period of not
19 more than 5 years on a merit-reviewed basis. For a
20 center in operation for 10 years after its previous se-
21 lection on a competitive, merit-reviewed basis, the
22 Director may renew support for the center on a com-
23 petitive, merit-reviewed basis for a period of not
24 more than 5 years, and may subsequently provide an

1 additional renewal on a merit-reviewed basis for a
2 period of not more than 5 years.

3 “(4) ACTIVITIES.—Centers shall undertake re-
4 search activities to accelerate the production of ad-
5 vanced biofuels and bioproducts from biomass re-
6 sources by identifying the most suitable species of
7 plants for use as energy crops; and improving meth-
8 ods of breeding, propagation, planting, producing,
9 harvesting, storage and processing. Activities may
10 include the following:

11 “(A) Research activities to increase sus-
12 tainability, including—

13 “(i) advancing knowledge of how bio-
14 energy crop interactions with biotic and
15 abiotic environmental factors influence
16 crop growth, yield, and quality;

17 “(ii) identifying the most impactful
18 research areas that address the economics
19 of advanced biofuels and bioproducts pro-
20 duction; and

21 “(iii) utilizing multiscale modeling to
22 advance predictive understanding of ad-
23 vanced biofuel cropping ecosystems.

24 “(B) Research activities to further feed-
25 stock development, including lignocellulosic,

1 algal, gaseous wastes including carbon oxides
2 and methane, and direct air capture of single
3 carbon gases via plants and microbes, includ-
4 ing—

5 “(i) developing genetic and genomic
6 tools, high-throughput analytical tools, and
7 biosystems design approaches to enhance
8 bioenergy feedstocks and their associated
9 microbiomes;

10 “(ii) conducting field testing of new
11 potential bioenergy feedstock crops under
12 environmentally benign and geographically
13 diverse conditions to assess viability and
14 robustness; and

15 “(iii) developing quantitative models
16 informed by experimentation to predict
17 how bioenergy feedstocks perform under
18 diverse conditions.

19 “(C) Research activities to improve
20 lignocellulosic deconstruction and separation
21 methods, including—

22 “(i) developing feedstock-agnostic
23 deconstruction processes capable of effi-
24 ciently fractionating biomass into targeted
25 output streams;

1 “(ii) gaining a detailed understanding
2 of plant cell wall biosynthesis, composition,
3 structure, and properties during
4 deconstruction; and

5 “(iii) improving enzymes and ap-
6 proaches for biomass breakdown and cel-
7 lulose, hemicellulose, and lignin processing.

8 “(D) Research activities to improve the
9 feedstock conversion process for advanced
10 biofuels and bioproducts, including—

11 “(i) developing high-throughput meth-
12 ods to screen or select high-performance
13 microbial strains and communities to im-
14 prove product formation rates, yields, and
15 selectivity;

16 “(ii) establishing a broad set of plat-
17 form microorganisms and microbial com-
18 munities suitable for metabolic engineering
19 to produce advanced biofuels and bioprod-
20 ucts and high-throughput methods for ex-
21 perimental validation of gene function;

22 “(iii) developing techniques to en-
23 hance microbial robustness for tolerating
24 toxins to improve advanced biofuel and bio-
25 product 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

1 of desired bioproducts or bioproduct pre-
2 cursors, including lignin streams; and

3 “(ix) developing integrated biological
4 and chemical catalytic approaches to
5 valorize and produce a diverse portfolio of
6 advanced biofuels and bioproducts.

7 “(5) INDUSTRY PARTNERSHIPS.—Centers shall
8 establish industry partnerships to translate research
9 results to commercial applications.

10 “(6) COORDINATION.—In coordination with the
11 Bioenergy Technologies Office of the Department,
12 the Secretary shall support interdisciplinary research
13 activities to improve the capacity, efficiency, resil-
14 ience, security, reliability, and affordability, of the
15 production and use of advanced biofuels and bio-
16 products, as well as activities to enable positive im-
17 pacts and avoid the potential negative impacts that
18 the production and use of advanced biofuels and bio-
19 products may have on ecosystems, people, and his-
20 torically marginalized communities.

21 “(7) FUNDING.—Of the funds authorized to be
22 appropriated under subsection (k) of section 306 of
23 the Department of Energy Research and Innovation
24 Act (42 U.S.C. 18644) for a fiscal year, there is au-
25 thorized to be appropriated to the Secretary to carry

1 out this subsection \$30,000,000 per center estab-
 2 lished under paragraph (1) for each of fiscal years
 3 2022 through 2026.

4 “(8) DEFINITIONS.—In this subsection:

5 “(A) ADVANCED BIOFUEL.—The term ‘ad-
 6 vanced biofuel’ has the meaning given the term
 7 in section 9001 of the Farm Security and Rural
 8 Investment Act of 2002 (7 U.S.C. 8101).

9 “(B) BIOENERGY.—The term ‘bioenergy’
 10 means energy derived from biofuels.

11 “(C) BIOMASS.—The term ‘biomass’ has
 12 the meaning given the term in section 203(b) of
 13 the Energy Policy Act of 2005 (42 U.S.C.
 14 15852(b)).

15 “(D) BIOPRODUCT.—The term ‘bio-
 16 product’ has the meaning given the term
 17 ‘biobased product’ in section 9001 of the Farm
 18 Security and Rural Investment Act of 2002 (7
 19 U.S.C. 8101).”.

20 **SEC. 5. ADVANCED SCIENTIFIC COMPUTING RESEARCH**
 21 **PROGRAM.**

22 (a) ADVANCED SCIENTIFIC COMPUTING RE-
 23 SEARCH.—Section 304 of the Department of Energy Re-
 24 search and Innovation Act (42 U.S.C. 18642) is amend-
 25 ed—

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

3 (2) by inserting before subsection (b), as so re-
4 designated, the following:

5 “(a) IN GENERAL.—As part of the activities author-
6 ized under section 209 of the Department of Energy Orga-
7 nization Act (42 U.S.C. 7139), the Director shall carry
8 out, in coordination with academia and relevant public and
9 private sector entities, a research, development, and dem-
10 onstration program—

11 “(1) to steward applied mathematics, computa-
12 tional science, and computer science research rel-
13 evant to the missions of the Department and the
14 competitiveness of the United States;

15 “(2) to develop modeling, simulation, and other
16 computational tools relevant to other scientific dis-
17 ciplines and to the development of new energy tech-
18 nologies and other technologies;

19 “(3) to advance computing and networking ca-
20 pabilities for data-driven discovery; and

21 “(4) to develop advanced scientific computing
22 hardware and software tools for science and engi-
23 neering.”;

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

1 (A) by striking “The Director” and insert-
2 ing the following:

3 “(1) DIRECTOR.—The Director”; and

4 (B) by adding at the end the following:

5 “(2) COORDINATION.—The Under Secretary for
6 Science shall ensure the coordination of the activities
7 of the Department, including activities under this
8 section, to determine and meet the computational
9 and networking research and facility needs of the
10 Office of Science and all other relevant energy tech-
11 nology and energy efficiency programs within the
12 Department and with other Federal agencies as ap-
13 propriate.”;

14 (4) by amending subsection (d), as so redesign-
15 nated, to read as follows:

16 “(d) APPLIED MATHEMATICS AND SOFTWARE DE-
17 VELOPMENT FOR HIGH-END COMPUTING SYSTEMS AND
18 COMPUTER SCIENCES RESEARCH.—

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

21 “(A) mathematics, statistics, and algo-
22 rithms for modeling complex systems relevant
23 to the missions of the Department, including on
24 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—

1 “(A) maintain foundational research pro-
2 grams in mathematical, computational, and
3 computer sciences focused on new and emerging
4 computing needs within the mission of the De-
5 partment, including post-Moore’s law computing
6 architectures, novel approaches to modeling and
7 simulation, artificial intelligence and scientific
8 machine learning, quantum computing, edge
9 computing, extreme heterogeneity, including po-
10 tential quantum accelerators, and distributed
11 high-performance computing;

12 “(B) retain best practices and maintain
13 support for essential hardware, applications,
14 and software elements of the Exascale Com-
15 puting Program that are necessary for sus-
16 taining the vitality of a long-term capable soft-
17 ware ecosystem for exascale and beyond; and

18 “(C) develop a Department-wide strategy
19 for balancing on-premises and cloud-based com-
20 puting and scientific data management.

21 “(2) REPORT.—Not later than 1 year after the
22 date of enactment of the Department of Energy
23 Science for the Future Act of 2022, the Secretary
24 shall submit to the Committee on Science, Space,
25 and Technology of the House of Representatives and

1 the Committee on Energy and Natural Resources of
2 the Senate a report on the development and imple-
3 mentation of the strategy described in paragraph
4 (1).

5 “(f) GUIDANCE ON MITIGATION OF BIAS IN HIGH-
6 PERFORMANCE COMPUTING CAPABILITIES.—In
7 leveraging high-performance computing systems for re-
8 search purposes, including through the use of machine
9 learning algorithms for data analysis and artificial intel-
10 ligence, the Secretary shall issue guidance for the Depart-
11 ment, the National Laboratories, and users as to how
12 those capabilities should be employed in a manner that
13 mitigates and, to the maximum extent practicable, avoids
14 harmful algorithmic bias.

15 “(g) ARCHITECTURAL RESEARCH IN HETERO-
16 GENEUS COMPUTING SYSTEMS.—

17 “(1) IN GENERAL.—The Secretary shall carry
18 out a program of research and development in het-
19 erogeneous and reconfigurable computing systems to
20 expand understanding of the potential for hetero-
21 geneous and reconfigurable computing systems to
22 deliver high-performance, high-efficiency computing
23 for Department mission challenges. That program
24 shall include research and development that explores
25 the convergence of big data analytics, simulations,

1 and artificial intelligence to drive the design of het-
 2 erogenous computing system architectures.

3 “(2) COORDINATION.—In carrying out the pro-
 4 gram described in paragraph (1), the Secretary shall
 5 ensure coordination between research activities un-
 6 dertaken by the Advanced Scientific Computing Re-
 7 search program and materials research supported by
 8 the Basic Energy Sciences program within the Office
 9 of Science.

10 “(h) ENERGY EFFICIENT COMPUTING PROGRAM.—

11 “(1) IN GENERAL.—The Secretary shall sup-
 12 port a program of fundamental research, develop-
 13 ment, and demonstration of energy efficient com-
 14 puting and data center technologies relevant to ad-
 15 vanced computing applications, including high-per-
 16 formance computing, artificial intelligence, and sci-
 17 entific machine learning.

18 “(2) EXECUTION.—

19 “(A) PROGRAM.—In carrying out the pro-
 20 gram under paragraph (1), the Secretary
 21 shall—

22 “(i) establish a partnership for Na-
 23 tional Laboratories, industry partners, and
 24 institutions of higher education for co-
 25 design of energy efficient hardware, tech-

1 nology, software, and applications across
2 all applicable program offices of the De-
3 partment, and provide access to energy ef-
4 ficient computing resources to such part-
5 ners;

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

10 “(iii) consider multiple heterogeneous
11 computing architectures in collaboration
12 with the program established under sub-
13 section (g), including neuromorphic com-
14 puting, persistent computing, and ultrafast
15 networking; and

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

23 “(B) SELECTION OF PARTNERS.—In se-
24 lecting participants for the partnership estab-
25 lished under subparagraph (A)(i), the Secretary

1 shall select participants through a competitive,
2 merit review process.

3 “(C) REPORT.—Not later than 1 year
4 after the date of enactment of the Department
5 of Energy Science for the Future Act of 2022,
6 the Secretary shall submit to the Committee on
7 Science, Space, and Technology of the House of
8 Representatives and the Committee on Energy
9 and Natural Resources of the Senate a report
10 on—

11 “(i) the activities conducted under
12 subparagraph (A); and

13 “(ii) the coordination and manage-
14 ment of the program under subparagraph
15 (A) to ensure an integrated research pro-
16 gram across the Department.

17 “(i) ENERGY SCIENCES NETWORK.—

18 “(1) IN GENERAL.—The Secretary shall provide
19 for upgrades to the Energy Sciences Network user
20 facility in order to meet the research needs of the
21 Department for highly reliable data transport capa-
22 bilities optimized for the requirements of large-scale
23 science.

1 “(2) CAPABILITIES.—In carrying out paragraph
2 (1), the Secretary shall ensure the following capabili-
3 ties:

4 “(A) To provide high bandwidth scientific
5 networking across the continental United States
6 and the Atlantic Ocean.

7 “(B) To ensure network reliability.

8 “(C) To protect the network infrastructure
9 from cyberattacks.

10 “(D) To manage transport of exponentially
11 increasing levels of data from the Department’s
12 National Laboratories and sites, user facilities,
13 experiments, and sensors.

14 “(E) To contribute to the integration of
15 heterogeneous computing frameworks and sys-
16 tems.

17 “(j) COMPUTATIONAL SCIENCE GRADUATE FELLOW-
18 SHIP.—

19 “(1) IN GENERAL.—The Secretary shall sup-
20 port the Computational Science Graduate Fellowship
21 program in order to facilitate collaboration between
22 graduate students and researchers at the National
23 Laboratories, and contribute to the development of
24 a diverse and inclusive computational workforce to
25 help advance research in all areas of computational

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

3 “(2) FUNDING.—Of the funds authorized to be
 4 appropriated for the Advanced Scientific Computing
 5 Research Program, there are authorized to be appro-
 6 priated to the Secretary for carrying out activities
 7 under this subsection—

8 “(A) \$21,000,000 for fiscal year 2022;

9 “(B) \$22,050,000 for fiscal year 2023;

10 “(C) \$23,152,500 for fiscal year 2024;

11 “(D) \$24,310,125 for fiscal year 2025;

12 and

13 “(E) \$25,525,631 for fiscal year 2026.

14 “(k) AUTHORIZATION OF APPROPRIATIONS.—Out of
 15 funds authorized to be appropriated for the Office of
 16 Science in a fiscal year, there are authorized to be appro-
 17 priated to the Secretary to carry out the activities de-
 18 scribed in this section—

19 “(1) \$1,126,350,000 for fiscal year 2022;

20 “(2) \$1,222,674,500 for fiscal year 2023;

21 “(3) \$1,324,320,715 for fiscal year 2024;

22 “(4) \$1,431,660,115 for fiscal year 2025; and

23 “(5) \$1,535,090,121 for fiscal year 2026.”.

24 (b) QUANTUM SCIENCE NETWORK.—

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

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

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

8 “(7) QUANTUM NETWORK INFRASTRUCTURE.—
 9 The term ‘quantum network infrastructure’ means
 10 any facility, expertise, or capability that is necessary
 11 to enable the development and deployment of scal-
 12 able and diverse quantum network technologies.”.

13 (2) DEPARTMENT OF ENERGY QUANTUM NET-
 14 WORK INFRASTRUCTURE RESEARCH AND DEVELOP-
 15 MENT PROGRAM.—

16 (A) IN GENERAL.—Title IV of the Na-
 17 tional Quantum Initiative Act (15 U.S.C. 8851
 18 et seq.) is amended by adding at the end the
 19 following:

20 **“SEC. 403. DEPARTMENT OF ENERGY QUANTUM NETWORK**
 21 **INFRASTRUCTURE RESEARCH AND DEVELOP-**
 22 **MENT PROGRAM.**

23 “(a) IN GENERAL.—The Secretary of Energy (re-
 24 ferred to in this section as the ‘Secretary’) shall carry out
 25 a research, development, and demonstration program to

1 accelerate innovation in quantum network infrastructure
2 in order to—

3 “(1) facilitate the advancement of distributed
4 quantum computing systems through the internet
5 and intranet;

6 “(2) improve the precision of measurements of
7 scientific phenomena and physical imaging tech-
8 nologies;

9 “(3) develop secure national quantum commu-
10 nications technologies and strategies;

11 “(4) demonstrate quantum networking utilizing
12 the Department of Energy’s Energy Sciences Net-
13 work User Facility; and

14 “(5) advance the relevant domestic supply
15 chains and manufacturing capabilities of the United
16 States.

17 “(b) PROGRAM.—In carrying out this section, the
18 Secretary shall—

19 “(1) coordinate with—

20 “(A) the Director of the National Science
21 Foundation;

22 “(B) the Director of the National Institute
23 of Standards and Technology;

24 “(C) the Chair of the Subcommittee on
25 Quantum Information Science of the National

1 Science and Technology Council established
2 under section 103(a); and

3 “(D) the Chair of the Subcommittee on the
4 Economic and Security Implications of Quan-
5 tum Science;

6 “(2) conduct cooperative research with indus-
7 try, National Laboratories, institutions of higher
8 education, and other research institutions to facili-
9 tate new quantum infrastructure methods and tech-
10 nologies, including—

11 “(A) quantum-limited detectors, ultra-low
12 loss optical channels, space-to-ground connec-
13 tions, and classical networking and cybersecu-
14 rity protocols;

15 “(B) entanglement and hyper-entangled
16 state sources and transmission, control, and
17 measurement of quantum states;

18 “(C) quantum interconnects that allow
19 short range local connections between quantum
20 processors;

21 “(D) transducers for quantum sources and
22 signals between optical wavelength regimes, in-
23 cluding telecommunications regimes and quan-
24 tum computer-relevant domains, including
25 microwaves;

1 “(E) development of quantum memory
2 buffers and small-scale quantum computers
3 that are compatible with photon-based quantum
4 bits in the optical or telecommunications wave-
5 lengths;

6 “(F) long-range entanglement distribution,
7 allowing entanglement-based protocols between
8 small- and large-scale quantum processors, at
9 the terrestrial and space-based level using quan-
10 tum repeaters and optical or laser communica-
11 tions;

12 “(G) quantum routers, multiplexers, re-
13 peaters, and related technologies necessary to
14 create secure long-distance quantum commu-
15 nication; and

16 “(H) integration of systems across the
17 quantum technology stack into traditional com-
18 puting networks, including the development of
19 remote controlled, high-performance, and reli-
20 able implementations of key quantum network
21 components by leveraging the expertise, infra-
22 structure and supplemental investments at the
23 National Laboratories in the Energy Sciences
24 Network User Facility;

1 “(3) engage with the Quantum Economic De-
2 velopment Consortium and other organizations, as
3 applicable, to transition component technologies to
4 help facilitate as appropriate the development of a
5 quantum supply chain for quantum network tech-
6 nologies;

7 “(4) advance basic research in advanced sci-
8 entific computing, particle and nuclear physics, and
9 material science to enhance the understanding, pre-
10 diction, and manipulation of materials, processes,
11 and physical phenomena relevant to quantum net-
12 work infrastructure;

13 “(5) develop experimental tools and testbeds in
14 collaboration with the Energy Sciences Network
15 User Facility necessary to support cross-cutting fun-
16 damental research and development activities with
17 diverse stakeholders from industry, National Labora-
18 tories, and institutions of higher education; and

19 “(6) consider quantum network infrastructure
20 applications that span the Department of Energy’s
21 missions in energy, environment, and national secu-
22 rity.

23 “(c) LEVERAGING.—In carrying out this section, the
24 Secretary shall leverage resources, infrastructure, and ex-
25 pertise across the Department of Energy and from—

1 “(1) the National Institute of Standards and
2 Technology;

3 “(2) the National Science Foundation;

4 “(3) the National Aeronautics and Space Ad-
5 ministration;

6 “(4) other relevant Federal agencies;

7 “(5) the National Laboratories;

8 “(6) industry stakeholders;

9 “(7) institutions of higher education; and

10 “(8) the National Quantum Information
11 Science Research Centers.

12 “(d) RESEARCH PLAN.—Not later than 180 days
13 after the date of enactment of the Department of Energy
14 Science for the Future Act of 2022, the Secretary shall
15 submit to the Committee on Science, Space, and Tech-
16 nology of the House of Representatives and the Committee
17 on Energy and Natural Resources of the Senate a 4-year
18 research plan that identifies and prioritizes basic research
19 needs relating to quantum network infrastructure.

20 “(e) STANDARD OF REVIEW.—The Secretary shall
21 review activities carried out under this section to deter-
22 mine the achievement of technical milestones.

23 “(f) FUNDING.—Of the funds authorized to be appro-
24 priated for the Department of Energy’s Office of Science,
25 there is authorized to be appropriated to the Secretary to

1 carry out the activities under this section \$100,000,000
2 for each of fiscal years 2022 through 2026.

3 **“SEC. 404. DEPARTMENT OF ENERGY QUANTUM USER EX-**
4 **PANSION FOR SCIENCE AND TECHNOLOGY**
5 **PROGRAM.**

6 “(a) IN GENERAL.—The Secretary of Energy (re-
7 ferred to in this section as the ‘Secretary’) shall establish
8 and carry out a program, to be known as the ‘Quantum
9 User Expansion for Science and Technology program’ or
10 ‘QUEST program’, to encourage and facilitate access to
11 United States quantum computing hardware and quantum
12 computing clouds for research purposes—

13 “(1) to enhance the United States quantum re-
14 search enterprise;

15 “(2) to educate the future quantum computing
16 workforce;

17 “(3) to accelerate the advancement of United
18 States quantum computing capabilities; and

19 “(4) to advance the relevant domestic supply
20 chains and manufacturing processes of the United
21 States.

22 “(b) PROGRAM.—In carrying out this section, the
23 Secretary shall—

24 “(1) coordinate with—

1 “(A) the Director of the National Science
2 Foundation;

3 “(B) the Director of the National Institute
4 of Standards and Technology;

5 “(C) the Chair of the Subcommittee on
6 Quantum Information Science of the National
7 Science and Technology Council established
8 under section 103(a); and

9 “(D) the Chair of the Subcommittee on the
10 Economic and Security Implications of Quan-
11 tum Science;

12 “(2) provide researchers based within the
13 United States with access to, and use of, United
14 States quantum computing resources through a com-
15 petitive, merit-reviewed process;

16 “(3) consider applications from the National
17 Laboratories, multi-institutional collaborations, insti-
18 tutions of higher education, industry stakeholders,
19 and any other entities that the Secretary determines
20 are appropriate to provide national leadership on
21 quantum computing related issues;

22 “(4) consult and coordinate with private sector
23 stakeholders, the user community, and interagency
24 partners on program development and best manage-
25 ment practices; and

1 “(5) balance user access to commercial proto-
2 types available for use for a broad class of applica-
3 tions and Federal research prototypes that enable
4 benchmarking a wider variety of early-stage devices.

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

8 “(1) the National Institute of Standards and
9 Technology;

10 “(2) the National Science Foundation;

11 “(3) the National Aeronautics and Space Ad-
12 ministration;

13 “(4) other relevant Federal agencies;

14 “(5) the National Laboratories;

15 “(6) industry stakeholders;

16 “(7) institutions of higher education; and

17 “(8) the National Quantum Information
18 Science Research Centers.

19 “(d) SECURITY.—In carrying out the activities au-
20 thorized by this section, the Secretary, in consultation
21 with the Director of the National Science Foundation and
22 the Director of the National Institute of Standards and
23 Technology, shall ensure proper security controls are in
24 place to protect sensitive information, as appropriate.

1 “(e) FUNDING.—Of the funds authorized to be ap-
 2 propriated for the Department of Energy’s Office of
 3 Science, there are authorized to be appropriated to the
 4 Secretary to carry out the activities under this section—

5 “(1) \$30,000,000 for fiscal year 2022;

6 “(2) \$50,000,000 for fiscal year 2023;

7 “(3) \$70,000,000 for fiscal year 2024;

8 “(4) \$90,000,000 for fiscal year 2025; and

9 “(5) \$100,000,000 for fiscal year 2026.”.

10 (B) CLERICAL AMENDMENT.—The table of
 11 contents in section 1(b) of the National Quan-
 12 tum Initiative Act (Public Law 115–368; 132
 13 Stat. 5092) is amended by inserting after the
 14 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.”.

15 **SEC. 6. FUSION ENERGY RESEARCH.**

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

19 (1) in subsection (b)—

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

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

4 (C) in the matter preceding subparagraph
 5 (A) (as so redesignated), by striking “As part
 6 of” and inserting the following:

7 “(1) IN GENERAL.—As part of”; and

8 (D) by adding at the end the following:

9 “(2) AUTHORIZATION OF APPROPRIATIONS.—
 10 Out of funds authorized to be appropriated under
 11 subsection (q), there is authorized to be appro-
 12 priated to the Secretary to carry out activities de-
 13 scribed in paragraph (1) \$50,000,000 for each of
 14 fiscal years 2022 through 2026.”;

15 (2) in subsection (d)(3)—

16 (A) by striking “(o)” and inserting “(q)”;

17 (B) by striking “subsection (d)” and in-
 18 serting “this subsection”; and

19 (C) by striking “2025” and inserting
 20 “2026”;

21 (3) in subsection (e)(4)—

22 (A) by striking “(o)” and inserting “(q)”;

23 (B) by striking “subsection (e)” and in-
 24 serting “this subsection”; and

1 (C) by striking “2025” and inserting
 2 “2026”;

3 (4) in subsection (i)(10)—

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

6 (i) by striking “(o)” and inserting
 7 “(q)”; and

8 (ii) by striking “subsection (i)” and
 9 inserting “this subsection”;

10 (B) in subparagraph (D), by striking
 11 “and” at the end;

12 (C) in subparagraph (E), by striking the
 13 period at the end and inserting “; and”; and

14 (D) by adding at the end the following:

15 “(F) \$45,000,000 for fiscal year 2026.”;

16 (5) by redesignating subsection (o) as sub-
 17 section (q);

18 (6) by inserting after subsection (n) the fol-
 19 lowing:

20 “(o) MATERIAL PLASMA EXPOSURE EXPERIMENT.—

21 “(1) IN GENERAL.—The Secretary shall con-
 22 struct a Material Plasma Exposure Experiment fa-
 23 cility as described in the 2020 publication approved
 24 by the Fusion Energy Sciences Advisory Committee
 25 entitled ‘Powering the Future: Fusion and Plasmas’.

1 The Secretary shall consult with the private sector,
2 institutions of higher education, National Labora-
3 tories, and relevant Federal agencies to ensure that
4 the facility is capable of meeting Federal research
5 needs for steady state, high-heat-flux, and plasma-
6 material interaction testing of fusion materials over
7 a range of fusion energy relevant parameters.

8 “(2) FACILITY CAPABILITIES.—The Secretary
9 shall ensure that the facility described in paragraph
10 (1) will provide the following capabilities:

11 “(A) A magnetic field at the target of 1
12 Tesla.

13 “(B) An energy flux at the target of 10
14 MW/m².

15 “(C) The ability to expose previously irra-
16 diated plasma facing material samples to plas-
17 ma.

18 “(3) START OF OPERATIONS.—The Secretary
19 shall, subject to the availability of appropriations,
20 ensure that the start of full operations of the facility
21 described in paragraph (1) occurs before December
22 31, 2027.

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

1 the Office of Fusion Energy Sciences to complete
2 construction of the facility described in paragraph
3 (1)—

4 “(A) \$32,800,000 for fiscal year 2022;

5 “(B) \$13,400,000 for fiscal year 2023;

6 “(C) \$12,600,000 for fiscal year 2024; and

7 “(D) \$400,000 for fiscal year 2025.

8 “(p) MATTER IN EXTREME CONDITIONS INSTRU-
9 MENT UPGRADE.—

10 “(1) IN GENERAL.—The Secretary shall provide
11 for the upgrade to the Matter in Extreme Conditions
12 endstation at the Linac Coherent Light Source as
13 described in the 2020 publication approved by the
14 Fusion Energy Sciences Advisory Committee entitled
15 ‘Powering the Future: Fusion and Plasmas’. The
16 Secretary shall consult with the private sector, insti-
17 tutions of higher education, National Laboratories,
18 and relevant Federal agencies to ensure that this fa-
19 cility is capable of meeting Federal research needs
20 for understanding physical and chemical changes to
21 plasmas at fundamental timescales, and explore new
22 regimes of dense material physics, astrophysics,
23 planetary physics, and short-pulse laser-plasma
24 interactions.

1 “(2) START OF OPERATIONS.—The Secretary
 2 shall, subject to the availability of appropriations,
 3 ensure that the start of full operations of the facility
 4 described in paragraph (1) occurs before December
 5 31, 2028.”; and

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

7 (A) in paragraph (4), by striking “and” at
 8 the end;

9 (B) in paragraph (5), by striking the pe-
 10 riod at the end and inserting “; and”; and

11 (C) by adding at the end the following:

12 “(6) \$1,000,000,000 for fiscal year 2026.”.

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

16 (1) in subparagraph (A), by striking “and” at
 17 the end;

18 (2) in subparagraph (B), by striking the period
 19 at the end and inserting “; and”; and

20 (3) by adding at the end the following:

21 “(C) \$281,000,000 for fiscal year 2026.”.

22 **SEC. 7. HIGH ENERGY PHYSICS PROGRAM.**

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

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

3 (2) by inserting after subsection (a) the fol-
4 lowing:

5 “(b) PROGRAM.—As part of the activities authorized
6 under section 209 of the Department of Energy Organiza-
7 tion Act (42 U.S.C. 7139), the Director shall carry out
8 a research program in elementary particle physics and ad-
9 vanced technology research and development to improve
10 the understanding of the fundamental properties of the
11 universe, including constituents of matter and energy and
12 the nature of space and time.

13 “(c) HIGH ENERGY FRONTIER RESEARCH.—As part
14 of the program described in subsection (b), the Director
15 shall carry out research using high energy accelerators
16 and advanced detectors, including accelerators and detec-
17 tors that will function as national user facilities, to create
18 and study interactions of elementary particles and inves-
19 tigate fundamental forces.”.

20 (b) INTERNATIONAL COLLABORATION.—Section 305
21 of the Department of Energy Research and Innovation Act
22 (42 U.S.C. 18643) is amended by striking subsection (d)
23 (as redesignated by subsection (a)(1)) and inserting the
24 following:

1 “(d) INTERNATIONAL COLLABORATION.—The Direc-
2 tor shall—

3 “(1) as practicable and in coordination with
4 other appropriate Federal agencies as necessary, en-
5 sure the access of United States researchers to the
6 most advanced accelerator facilities and research ca-
7 pabilities in the world, including the Large Hadron
8 Collider;

9 “(2) to the maximum extent practicable, con-
10 tinue to leverage United States participation in the
11 Large Hadron Collider, and prioritize expanding
12 international partnerships and investments in the
13 Long-Baseline Neutrino Facility and Deep Under-
14 ground Neutrino Experiment; and

15 “(3) to the maximum extent practicable,
16 prioritize engagement in collaborative efforts in sup-
17 port of future international facilities that would pro-
18 vide access to the most advanced accelerator facili-
19 ties in the world to United States researchers.”.

20 (c) COSMIC FRONTIER RESEARCH.—Section 305 of
21 the Department of Energy Research and Innovation Act
22 (42 U.S.C. 18645) is amended by striking subsection (f)
23 (as redesignated by subsection (a)(1)) and inserting the
24 following:

1 “(f) COSMIC FRONTIER RESEARCH.—The Director
 2 shall carry out research activities on the nature of the pri-
 3 mary contents of the universe, including the nature of
 4 dark energy and dark matter. These activities shall, to the
 5 maximum extent practicable, be consistent with the re-
 6 search priorities identified by the High Energy Physics
 7 Advisory Panel or the National Academy of Sciences, and
 8 may include—

9 “(1) collaborations with the National Aero-
 10 nautics and Space Administration, the National
 11 Science Foundation, or international partners on rel-
 12 evant projects; and

13 “(2) the development of space-based, land-
 14 based, water-based, and underground facilities and
 15 experiments.”.

16 (d) FURTHER ACTIVITIES.—Section 305 of the De-
 17 partment of Energy Research and Innovation Act (42
 18 U.S.C. 18645) (as amended by subsection (c)), is amended
 19 by adding at the end the following:

20 “(g) FACILITY CONSTRUCTION AND MAJOR ITEMS
 21 OF EQUIPMENT.—

22 “(1) PROJECTS.—Consistent with the Office of
 23 Science’s project management practices, the Director
 24 shall, to the maximum extent practicable, by incor-
 25 porating 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,

1 and better clarify the existence and nature of
2 antimatter.

3 “(B) FACILITY CAPABILITIES.—The Sec-
4 retary shall ensure that the facility described in
5 subparagraph (A) will provide, at a minimum,
6 the following capabilities:

7 “(i) A neutrino beam with wideband
8 capability of 1.2 megawatts of beam power
9 and upgradable to 2.4 megawatts of beam
10 power.

11 “(ii) 3 caverns excavated for a 70 kil-
12 oton fiducial detector mass and supporting
13 surface buildings and utilities.

14 “(iii) Cryogenic systems to support
15 neutrino detectors.

16 “(C) START OF OPERATIONS.—The Sec-
17 retary shall, subject to the availability of appro-
18 priations, ensure that the start of full oper-
19 ations of the facility described in subparagraph
20 (A) occurs before December 31, 2031.

21 “(D) FUNDING.—Out of funds authorized
22 to be appropriated under subsection (k), there
23 are authorized to be appropriated to the Sec-
24 retary to carry out construction of the project
25 described in subparagraph (A)—

1 “(i) \$200,000,000 for fiscal year
2 2022;

3 “(ii) \$325,000,000 for fiscal year
4 2023;

5 “(iii) \$400,000,000 for fiscal year
6 2024;

7 “(iv) \$375,000,000 for fiscal year
8 2025; and

9 “(v) \$250,000,000 for fiscal year
10 2026.

11 “(3) PROTON IMPROVEMENT PLAN II ACCEL-
12 ERATOR UPGRADE PROJECT.—

13 “(A) IN GENERAL.—The Secretary shall
14 support construction of the Proton Improve-
15 ment Plan II, an upgrade to the Fermilab ac-
16 celerator complex identified in the 2014 Particle
17 Physics Project Prioritization Panel (P5) report
18 entitled ‘Building for Discovery’, to provide the
19 world’s most intense beam of neutrinos to the
20 international Long Baseline Neutrino Facility
21 and to carry out a broad range of future high
22 energy physics experiments. The Secretary shall
23 work with international partners to enable fur-
24 ther significant contributions to the capabilities
25 of that project.

1 “(B) FACILITY CAPABILITIES.—The Sec-
2 retary shall ensure that the facility described in
3 subparagraph (A) will provide, at a minimum,
4 the following capabilities:

5 “(i) A state-of-the-art 800
6 megaelectron volt superconducting linear
7 accelerator.

8 “(ii) Proton beam power of 1.2
9 megawatts at the start of LBNF/DUNE,
10 upgradeable to 2.4 megawatts of beam
11 power.

12 “(iii) A flexible design to enable high
13 power beam delivery to multiple users si-
14 multaneously and customized beams tai-
15 lored to specific scientific needs.

16 “(iv) Sustained high reliability oper-
17 ation of the Fermilab accelerator complex.

18 “(C) START OF OPERATIONS.—The Sec-
19 retary shall, subject to the availability of appro-
20 priations, ensure that the start of full oper-
21 ations of the facility described in subparagraph
22 (A) occurs before December 31, 2028.

23 “(D) FUNDING.—Out of funds authorized
24 to be appropriated under subsection (k), there
25 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.’.

1 “(B) CONSULTATION.—The Secretary
2 shall consult with the private sector, institutions
3 of higher education, National Laboratories, and
4 relevant Federal agencies to ensure that the
5 project described in subparagraph (A) is capa-
6 ble of meeting Federal research needs in access-
7 ing the ultra-high energy physics of inflation
8 and important neutrino properties.

9 “(C) EXPERIMENTAL CAPABILITIES.—The
10 Secretary shall ensure to the maximum extent
11 practicable that the facility described in sub-
12 paragraph (A) will provide, at a minimum,
13 500,000 superconducting detectors deployed on
14 an array of millimeter-wave telescopes with the
15 required range in frequency, sensitivity, and
16 survey speed that will provide sufficient capa-
17 bility to enable an order of magnitude advance
18 in observations of the Cosmic Microwave Back-
19 ground, delivering transformative discoveries in
20 fundamental physics, cosmology, and astro-
21 physics.

22 “(D) START OF OPERATIONS.—The Sec-
23 retary shall, subject to the availability of appro-
24 priations, ensure that the start of full oper-

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

3 “(E) FUNDING.—Out of funds authorized
4 to be appropriated under subsection (k), there
5 are authorized to be appropriated to the Sec-
6 retary to carry out construction of the facility
7 described in subparagraph (A)—

8 “(i) \$37,000,000 for fiscal year 2022;

9 “(ii) \$50,000,000 for fiscal year 2023;

10 “(iii) \$90,000,000 for fiscal year
11 2024;

12 “(iv) \$80,000,000 for fiscal year
13 2025; and

14 “(v) \$70,000,000 for fiscal year 2026.

15 “(h) ACCELERATOR AND DETECTOR UPGRADES.—

16 The Director shall upgrade accelerator facilities and detec-
17 tors, as necessary and appropriate, to increase beam
18 power, sustain high reliability, and improve precision
19 measurement to advance the highest priority particle phys-
20 ics research programs. In carrying out facility upgrades,
21 the Director shall continue to work with international
22 partners, when appropriate and in the United States inter-
23 est, to leverage investments and expertise in critical tech-
24 nologies to help build and upgrade accelerator and detec-
25 tor facilities in the United States.

1 “(i) ACCELERATOR AND DETECTOR RESEARCH AND
2 DEVELOPMENT.—As part of the program described in
3 subsection (b), the Director shall carry out research and
4 development in particle beam physics, accelerator science
5 and technology, and particle and radiation detection with
6 relevance to the specific needs of the High Energy Physics
7 program, in coordination with the Accelerator Research
8 and Development program authorized under section 310.

9 “(j) UNDERGROUND SCIENCE.—The Director shall—

10 “(1) support an underground science program
11 consistent with the missions of the Department and
12 the scientific needs of the High Energy Physics pro-
13 gram, including those articulated in the most recent
14 report of the Particle Physics Project Prioritization
15 Panel of the High Energy Physics Advisory Panel,
16 that leverages the capabilities of relevant under-
17 ground science and engineering facilities;

18 “(2) carry out a competitive grant program to
19 award scientists and engineers at institutions of
20 higher education, nonprofit institutions, and Na-
21 tional Laboratories to conduct research in under-
22 ground science and engineering; and

23 “(3) submit to the Committee on Energy and
24 Natural Resources of the Senate and the Committee
25 on Science, Space, and Technology of the House of

1 Representatives a report on the inventory of under-
 2 ground mines in the United States that may be suit-
 3 able for future development of underground science
 4 and engineering facilities.

5 “(k) AUTHORIZATION OF APPROPRIATIONS.—Out of
 6 funds authorized to be appropriated for the Office of
 7 Science in a fiscal year, there are authorized to be appro-
 8 priated to the Secretary to carry out the activities de-
 9 scribed in this section—

10 “(1) \$1,355,690,000 for fiscal year 2022;

11 “(2) \$1,517,628,300 for fiscal year 2023;

12 “(3) \$1,652,112,281 for fiscal year 2024;

13 “(4) \$1,711,460,141 for fiscal year 2025; and

14 “(5) \$1,656,012,351 for fiscal year 2026.”.

15 **SEC. 8. NUCLEAR PHYSICS PROGRAM.**

16 Section 308 of the Department of Energy Research
 17 and Innovation Act (Public Law 115–246; 132 Stat.
 18 3150) is amended to read as follows:

19 **“SEC. 308. NUCLEAR PHYSICS.**

20 “(a) PROGRAM.—As part of the activities authorized
 21 under section 209 of the Department of Energy Organiza-
 22 tion Act (42 U.S.C. 7139), the Director shall carry out
 23 a research program, and support relevant facilities, to dis-
 24 cover and understand various forms of nuclear matter.

25 “(b) USER FACILITIES.—

1 “(1) FACILITY FOR RARE ISOTOPE BEAMS.—

2 “(A) IN GENERAL.—The Secretary shall
3 support construction of a Facility for Rare Iso-
4 tope Beams to advance the understanding of
5 rare nuclear isotopes and the evolution of the
6 cosmos.

7 “(B) FUNDING.—Out of funds authorized
8 to be appropriated under subsection (c), there
9 is authorized to be appropriated to the Sec-
10 retary to carry out construction of the facility
11 under this paragraph \$2,000,000 for fiscal year
12 2022.

13 “(C) START OF OPERATIONS.—The Sec-
14 retary shall, subject to the availability of appro-
15 priations, ensure that the start of full oper-
16 ations of the facility under this paragraph oc-
17 curs before March 1, 2022.

18 “(2) ELECTRON-ION COLLIDER.—

19 “(A) IN GENERAL.—The Secretary shall
20 support construction of an Electron Ion Collider
21 as described in the 2015 Long Range Plan of
22 the Nuclear Science Advisory Committee and
23 the report from the National Academies of
24 Science, Engineering, and Medicine entitled ‘An
25 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 $10^{33-34}\text{cm}^{-2}\text{s}^{-1}$; 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.

1 “(D) FUNDING.—Out of funds authorized
 2 to be appropriated under subsection (c), there
 3 are authorized to be appropriated to the Sec-
 4 retary to carry out construction of the facility
 5 under this paragraph—

6 “(i) \$101,000,000 for fiscal year
 7 2022;

8 “(ii) \$155,000,000 for fiscal year
 9 2023;

10 “(iii) \$250,000,000 for fiscal year
 11 2024;

12 “(iv) \$300,000,000 for fiscal year
 13 2025; and

14 “(v) \$305,000,000 for fiscal year
 15 2026.

16 “(c) AUTHORIZATION OF APPROPRIATIONS.—Out of
 17 funds authorized to be appropriated for the Office of
 18 Science in a fiscal year, there are authorized to be appro-
 19 priated to the Secretary to carry out the activities de-
 20 scribed in this section—

21 “(1) \$780,000,000 for fiscal year 2022;

22 “(2) \$879,390,000 for fiscal year 2023;

23 “(3) \$1,025,097,300 for fiscal year 2024;

24 “(4) \$1,129,354,111 for fiscal year 2025; and

25 “(5) \$1,192,408,899 for fiscal year 2026.”.

1 **SEC. 9. SCIENCE LABORATORIES INFRASTRUCTURE PRO-**
 2 **GRAM.**

3 Section 309 of the Department of Energy Research
 4 and Innovation Act (42 U.S.C. 18647) is amended by add-
 5 ing at the end the following:

6 “(c) **APPROACH.**—In carrying out the program under
 7 subsection (a), the Director shall use all available ap-
 8 proaches and mechanisms, as the Secretary determines to
 9 be appropriate, including—

- 10 “(1) capital line items;
- 11 “(2) minor construction projects;
- 12 “(3) energy savings performance contracts;
- 13 “(4) utility energy service contracts;
- 14 “(5) alternative financing; and
- 15 “(6) expense funding.

16 “(d) **RESTORATION AND MODERNIZATION**
 17 **PROJECTS.**—

18 “(1) **IN GENERAL.**—The Secretary shall fund
 19 projects described in paragraph (2) as needed to ad-
 20 dress the deferred maintenance, critical infrastruc-
 21 ture needs, and modernization of Office of Science
 22 National Laboratories.

23 “(2) **PROJECTS DESCRIBED.**—The projects re-
 24 ferred to in paragraph (1) are, as determined by the
 25 Secretary—

1 “(A) priority deferred maintenance
2 projects at Office of Science National Labora-
3 tories, including facilities sustainment for, up-
4 grade of, and construction of research labora-
5 tories, administrative and support buildings,
6 utilities, roads, power plants, and any other
7 critical infrastructure; and

8 “(B) lab modernization projects at Office
9 of Science National Laboratories, including
10 projects relating to core infrastructure need-
11 ed—

12 “(i) to support existing and emerging
13 science missions with new and specialized
14 requirements for world-leading scientific
15 user facilities and computing capabilities;
16 and

17 “(ii) to maintain safe, efficient, reli-
18 able, and environmentally responsible oper-
19 ations, including pilot projects to dem-
20 onstrate net zero emissions with resilient
21 operations.

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

1 Committee on Energy and Natural Resources of the Sen-
 2 ate and the Committee on Appropriations and the Com-
 3 mittee on Science, Space, and Technology of the House
 4 of Representatives a list of projects for which the Sec-
 5 retary will provide funding under this section, including
 6 a description of each project and the funding profile for
 7 the project.

8 “(f) AUTHORIZATION OF APPROPRIATIONS.—Out of
 9 funds authorized to be appropriated for the Office of
 10 Science in a fiscal year, there is authorized to be appro-
 11 priated to the Secretary to carry out the activities de-
 12 scribed in this section \$600,000,000 for each of fiscal
 13 years 2022 through 2026.”.

14 **SEC. 10. ACCELERATOR RESEARCH AND DEVELOPMENT.**

15 The Department of Energy Research and Innovation
 16 Act (42 U.S.C. 18601 et seq.) is amended by adding at
 17 the end the following:

18 **“SEC. 310. ACCELERATOR RESEARCH AND DEVELOPMENT.**

19 “(a) PROGRAM.—As part of the activities authorized
 20 under section 209 of the Department of Energy Organiza-
 21 tion Act (42 U.S.C. 7139), the Director shall carry out
 22 a research program—

23 “(1) to advance accelerator science and tech-
 24 nology relevant to the Department, other Federal
 25 agencies, and United States industry;

1 “(2) to foster partnerships to develop, dem-
2 onstrate, and enable the commercial application of
3 accelerator technologies;

4 “(3) to support the development of a skilled, di-
5 verse, and inclusive accelerator workforce; and

6 “(4) to provide access to accelerator design and
7 engineering resources.

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

11 “(1) research activities in cross-cutting accel-
12 erator technologies including superconducting
13 magnets and accelerators, beam physics, data ana-
14 lytics-based accelerator controls, simulation software,
15 new particle sources, advanced laser technology, and
16 transformative research; and

17 “(2) optimal operation of the Accelerator Test
18 Facility.

19 “(c) ACCELERATOR DEVELOPMENT.—In carrying out
20 the program authorized under subsection (a), the Director
21 shall support partnerships to foster the development, dem-
22 onstration, and commercial application of accelerator tech-
23 nologies, including advanced superconducting wire and
24 cable, superconducting RF cavities, and high efficiency ra-
25 diofrequency power sources for accelerators.

1 “(d) RESEARCH COLLABORATIONS.—In developing
2 accelerator technologies under the program authorized
3 under subsection (a), the Director shall—

4 “(1) consider the requirements necessary to
5 support translational research and development for
6 medical, industrial, security, and defense applica-
7 tions; and

8 “(2) leverage investments in accelerator tech-
9 nologies and fundamental research in particle phys-
10 ics by partnering with institutions of higher edu-
11 cation, industry, and other Federal agencies to en-
12 able the commercial application of advanced accel-
13 erator technologies.

14 “(e) AUTHORIZATION OF APPROPRIATIONS.—Out of
15 funds authorized to be appropriated for the Office of
16 Science in a fiscal year, there are authorized to be appro-
17 priated to the Secretary to carry out the activities de-
18 scribed in this section—

19 “(1) \$24,000,000 for fiscal year 2022;

20 “(2) \$25,680,000 for fiscal year 2023;

21 “(3) \$27,477,600 for fiscal year 2024;

22 “(4) \$29,401,032 for fiscal year 2025; and

23 “(5) \$31,459,104 for fiscal year 2026.”.

1 **SEC. 11. ISOTOPE RESEARCH, DEVELOPMENT, AND PRO-**
2 **DUCTION.**

3 (a) IN GENERAL.—The Department of Energy Re-
4 search and Innovation Act (42 U.S.C. 18601 et seq.) is
5 amended by adding after section 310 (as added by section
6 10) the following:

7 **“SEC. 311. ISOTOPE RESEARCH, DEVELOPMENT, AND PRO-**
8 **DUCTION.**

9 “(a) DEFINITION OF CRITICAL RADIOACTIVE AND
10 STABLE ISOTOPE.—

11 “(1) IN GENERAL.—In this section, the term
12 ‘critical radioactive and stable isotope’ means a ra-
13 dioactive and stable isotope—

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

18 “(B) the supply of which is augmented
19 through—

20 “(i) Department production; or

21 “(ii) foreign suppliers.

22 “(2) EXCLUSION.—In this section, the term
23 ‘critical radioactive and stable isotope’ does not in-
24 clude the medical isotope molybdenum-99, the pro-
25 duction and supply of which is addressed in the
26 American Medical Isotopes Production Act of 2012

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

3 “(b) PROGRAM.—The Director shall—

4 “(1) carry out, in coordination with other rel-
5 evant programs across the Department, a pro-
6 gram—

7 “(A) for the production of critical radio-
8 active and stable isotopes, including the devel-
9 opment of techniques to produce isotopes, that
10 the Secretary determines are needed and of suf-
11 ficient quality for research, medical, industrial,
12 or related purposes;

13 “(B) for the production of critical radio-
14 active and stable isotopes that are in short sup-
15 ply, including byproducts, surplus materials,
16 and related isotope services;

17 “(C) to maintain and enhance the infra-
18 structure required to produce and supply crit-
19 ical radioactive and stable isotope products and
20 related services;

21 “(D) to conduct research and development
22 on new and improved isotope production and
23 processing techniques that can make critical ra-
24 dioactive and stable isotopes available for re-

1 search and application while assisting in work-
2 force development;

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

6 “(F)(i) to the maximum extent practicable,
7 in accordance with—

8 “(I) evidence-based reports, including
9 the 2015 report of the Nuclear Science Ad-
10 visory Committee entitled ‘Meeting Isotope
11 Needs and Capturing Opportunities for the
12 Future’; and

13 “(II) assessments of isotope supply
14 chains, including current and future as-
15 sessments; or

16 “(ii) as the Director otherwise determines
17 necessary to ensure the availability of sufficient
18 quantities of critical radioactive and stable iso-
19 topes to address existing and future needs;

20 “(2) ensure that isotope production activities
21 carried out under this subsection are consistent with
22 the statement of policy entitled ‘Policies and Proce-
23 dures for Transfer of Commercial Radioisotope Pro-
24 duction and Distribution to Private Industry’ (30
25 Fed. Reg. 3247 (March 9, 1965));

1 “(3) assess the domestic requirements of cur-
2 rent and emerging critical radioactive and stable iso-
3 topes and associated applications to identify areas
4 that may require Federal investment for the develop-
5 ment of domestic production capacity for those iso-
6 topes, including through public-private partnerships,
7 as appropriate;

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

13 “(5) ensure that actions taken by the Depart-
14 ment do not interfere with, delay, or otherwise ad-
15 versely affect efforts by the private sector to make
16 available or otherwise facilitate the supply of critical
17 radioactive and stable isotopes, including efforts
18 under existing agreements between the Department
19 or contractors of the Department and the private
20 sector; and

21 “(6) in coordination with the Assistant Sec-
22 retary for Nuclear Energy, assess options for dem-
23 onstrating the production of critical radioactive and
24 stable isotopes in commercial nuclear reactors.

25 “(c) ADVISORY COMMITTEE.—

1 “(1) IN GENERAL.—Not later than 90 days
2 after the date of enactment of this section, the Sec-
3 retary shall establish an advisory committee (re-
4 ferred to in this subsection as the ‘committee’) in
5 alignment with the Isotope Program of the Depart-
6 ment—

7 “(A) to carry out the activities previously
8 executed as part of the Isotope Subcommittee
9 of the Nuclear Science Advisory Committee;
10 and

11 “(B) to provide expert advice and assist-
12 ance to the Director in carrying out subsection
13 (a).

14 “(2) REPORT.—

15 “(A) IN GENERAL.—Not later than 1 year
16 after the committee is established, the com-
17 mittee shall—

18 “(i) update the 2015 Nuclear Science
19 Advisory Committee Isotope Committee
20 Report entitled ‘Meeting Isotope Needs
21 and Capturing Opportunities for the Fu-
22 ture’; and

23 “(ii) periodically update that report
24 thereafter as needed.

1 “(B) INCLUSIONS.—An updated report
2 under subparagraph (A) shall include an assess-
3 ment of—

4 “(i) current demand in the United
5 States for critical radioactive and stable
6 isotopes;

7 “(ii) the impact of continued reliance
8 on foreign supply of critical radioactive
9 and stable isotopes;

10 “(iii) proposed mitigation strategies,
11 including increasing domestic production
12 sources for critical radioactive and stable
13 isotopes, that—

14 “(I) are not commercially avail-
15 able; or

16 “(II) are commercially produced
17 in quantities that are not sufficient—

18 “(aa) to satisfy domestic de-
19 mand; and

20 “(bb) to minimize produc-
21 tion constraints and supply dis-
22 ruptions to the United States
23 healthcare and industrial isotope
24 industries;

1 “(iv) current facilities, including up-
2 grades to those facilities, and new facilities
3 needed to meet domestic critical isotope
4 needs; and

5 “(v) workforce development needs.

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

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

13 “(d) REPORT.—

14 “(1) IN GENERAL.—Not later than the end of
15 the first fiscal year beginning after the date of en-
16 actment of this section, and biennially thereafter,
17 the Secretary shall submit to the Committees on En-
18 ergy and Natural Resources and Environment and
19 Public Works of the Senate and the Committee on
20 Energy and Commerce of the House of Representa-
21 tives a report describing the progress made under
22 the program established under subsection (a) during
23 the preceding 2 fiscal years.

24 “(2) INCLUSIONS.—Each report under para-
25 graph (1) shall include—

1 “(A) an updated assessment of any critical
 2 radioactive and stable isotope shortages in the
 3 United States;

4 “(B) a description of—

5 “(i) any disruptions in the inter-
 6 national supply of critical radioactive and
 7 stable isotopes during the preceding 2 fis-
 8 cal years; and

9 “(ii) the impact of those disruptions
 10 on related activities; and

11 “(C)(i) a projection of anticipated disrup-
 12 tions in the international supply, or supply con-
 13 straints, of critical radioactive and stable iso-
 14 topes during the next 2 fiscal years; and

15 “(ii) the anticipated impact of those dis-
 16 ruptions or constraints, as applicable, on re-
 17 lated domestic activities.

18 “(e) AUTHORIZATION OF APPROPRIATIONS.—Out of
 19 funds authorized to be appropriated for the Office of
 20 Science in a fiscal year, there are authorized to be appro-
 21 priated to the Secretary to carry out this section—

22 “(1) \$90,000,000 for fiscal year 2022;

23 “(2) \$96,300,000 for fiscal year 2023;

24 “(3) \$103,041,000 for fiscal year 2024;

25 “(4) \$110,253,870 for fiscal year 2025; and

1 “(5) \$117,971,641 for fiscal year 2026.”.

2 (b) DEMONSTRATION OF ISOTOPE PRODUCTION.—

3 Section 952(a) of the Energy Policy Act of 2005 (42

4 U.S.C. 16272(a)) is amended—

5 (1) by redesignating paragraph (2) as para-
6 graph (4) and moving the paragraph so as to appear
7 after paragraph (3); and

8 (2) by inserting after paragraph (1) the fol-
9 lowing:

10 “(2) ISOTOPE DEMONSTRATION SUBPRO-
11 GRAM.—

12 “(A) IN GENERAL.—The Secretary, acting
13 through the Assistant Secretary for Nuclear
14 Energy, shall establish a subprogram of the
15 program established under paragraph (1), to be
16 known as the ‘isotope demonstration subpro-
17 gram’, to support the development and commer-
18 cial demonstration of critical radioactive and
19 stable isotope production in existing commercial
20 nuclear power plants.

21 “(B) CONSULTATION.—In considering op-
22 tions for demonstrating the production of crit-
23 ical radioactive and stable isotopes in commer-
24 cial nuclear reactors under the subprogram es-
25 tablished 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

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

3 (d) STABLE ISOTOPE PRODUCTION AND RESEARCH
4 CENTER.—

5 (1) IN GENERAL.—The Secretary of Energy
6 (referred to in this subsection as “the Secretary”)
7 shall establish a stable isotope production and re-
8 search center—

9 (A) to expand the ability of the United
10 States to perform multiple stable isotope pro-
11 duction campaigns at large-scale production, as
12 authorized under section 311 of the Depart-
13 ment of Energy Research and Innovation Act;

14 (B) to mitigate the dependence of the
15 United States on foreign-produced stable iso-
16 topes; and

17 (C) to promote economic resilience.

18 (2) FUNDING.—Out of funds authorized to be
19 appropriated for the Office of Science in a fiscal
20 year, there is authorized to be appropriated to the
21 Secretary to carry out this subsection \$250,000,000
22 for the period of fiscal years 2022 through 2026.

1 **SEC. 12. INCREASED COLLABORATION WITH TEACHERS**
2 **AND SCIENTISTS.**

3 (a) IN GENERAL.—The Department of Energy Re-
4 search and Innovation Act (42 U.S.C. 18601 et seq.) is
5 amended by adding after section 311 (as added by section
6 11), the following:

7 **“SEC. 312. INCREASED COLLABORATION WITH TEACHERS**
8 **AND SCIENTISTS.**

9 “The Director shall support the development of a sci-
10 entific workforce through programs that facilitate collabo-
11 ration between and among teachers at elementary schools
12 and secondary schools, students at institutions of higher
13 education, early-career researchers, faculty at institutions
14 of higher education, and the National Laboratories, in-
15 cluding through the use of proven techniques to expand
16 the number of individuals from underrepresented groups
17 pursuing and attaining skills or undergraduate and grad-
18 uate degrees relevant to the mission of the Office of
19 Science.”.

20 (b) AUTHORIZATION OF APPROPRIATIONS.—Section
21 3169 of the Department of Energy Science Education En-
22 hancement Act (42 U.S.C. 7381e) is amended by striking
23 “fiscal year 1991” and inserting “each of fiscal years
24 2022 through 2026”.

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

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

5 **“SEC. 3167A. BROADENING PARTICIPATION FOR TEACHERS**
6 **AND SCIENTISTS.**

7 “(a) IN GENERAL.—The Secretary shall—

8 “(1) expand opportunities to increase the num-
9 ber of highly skilled science, technology, engineering,
10 and mathematics (STEM) professionals working in
11 disciplines relevant to the mission of the Depart-
12 ment; and

13 “(2) broaden the recruitment pool to increase
14 participation from Historically Black Colleges or
15 Universities (as defined in section 3167B(f)), His-
16 panic-serving institutions (as defined in that sec-
17 tion), Tribal Colleges or Universities (as defined in
18 that section), minority-serving institutions (as de-
19 fined in that section), institutions in eligible jurisdic-
20 tions (as defined in that section), emerging research
21 institutions, community colleges, and scientific soci-
22 eties in those disciplines.

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

1 Committee on Science, Space, and Technology of the
2 House of Representatives and the Committees on Energy
3 and Natural Resources and Commerce, Science, and
4 Transportation of the Senate and make available to the
5 public a plan for broadening participation of underrep-
6 resented groups in science, technology, engineering, and
7 mathematics in programs supported by the Department,
8 including—

9 “(1) a plan for supporting relevant Federal re-
10 search award grantees and leveraging partnerships,
11 including partnerships maintained by other Federal
12 research agencies;

13 “(2) metrics for assessing the participation of
14 underrepresented groups in programs supported by
15 the Department;

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

20 “(4) any other activities the Secretary deter-
21 mines appropriate.

22 “(c) AUTHORIZATION OF APPROPRIATIONS.—Of the
23 amounts authorized to be appropriated under section
24 3169, not less than \$2,000,000 is authorized to be appro-

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

3 **“SEC. 3167B. EXPANDING OPPORTUNITIES FOR HIGHLY**
 4 **SKILLED SCIENCE, TECHNOLOGY, ENGINEER-**
 5 **ING, AND MATHEMATICS (STEM) PROFES-**
 6 **SIONALS.**

7 “(a) IN GENERAL.—The Secretary shall—

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

12 “(2) broaden the recruitment pool to increase
 13 participation from Historically Black Colleges or
 14 Universities, Hispanic serving institutions, Tribal
 15 Colleges or Universities, minority-serving institu-
 16 tions, institutions in eligible jurisdictions, emerging
 17 research institutions, community colleges, and sci-
 18 entific societies in those disciplines.

19 “(b) PLAN AND OUTREACH STRATEGY.—

20 “(1) PLAN.—

21 “(A) IN GENERAL.—Not later than 180
 22 days after the date of enactment of the Depart-
 23 ment of Energy Science for the Future Act of
 24 2022, the Secretary shall submit to the Com-
 25 mittee on Science, Space, and Technology of

1 the House of Representatives and the Com-
2 mittee on Energy and Natural Resources of the
3 Senate a 10-year educational plan to fund and
4 expand new or existing programs administered
5 by the Office of Science and sited at the Na-
6 tional Laboratories and Department user facili-
7 ties to expand educational and workforce oppor-
8 tunities for underrepresented individuals, in-
9 cluding—

10 “(i) high school, undergraduate, and
11 graduate students; and

12 “(ii) recent graduates, teachers, and
13 faculty in STEM fields.

14 “(B) CONTENTS.—The plan under sub-
15 paragraph (A) may include paid internships,
16 fellowships, temporary employment, training
17 programs, visiting student and faculty pro-
18 grams, sabbaticals, and research support.

19 “(2) OUTREACH CAPACITY.—The Secretary
20 shall include in the plan under paragraph (1) an
21 outreach strategy to improve the advertising, recruit-
22 ment, and promotion of educational and workforce
23 programs to community colleges, Historically Black
24 Colleges or Universities, Hispanic-serving institu-
25 tions, 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 “(1) IN GENERAL.—The Secretary shall estab-
2 lish a university-led Traineeship Program to address
3 workforce training needs in STEM fields relevant to
4 the Department.

5 “(2) FOCUS.—The focus of the Traineeship
6 Program established under paragraph (1) shall be
7 on—

8 “(A) supporting training and research ex-
9 periences for underrepresented undergraduate
10 and graduate students; and

11 “(B) increasing participation from under-
12 represented populations.

13 “(3) INCLUSION.—The traineeships under the
14 Traineeship Program established under paragraph
15 (1) shall include opportunities to build the next-gen-
16 eration workforce in research areas critical to main-
17 taining core competencies across the programs of the
18 Office of Science.

19 “(e) EVALUATION.—

20 “(1) IN GENERAL.—The Secretary shall estab-
21 lish key performance indicators to measure and
22 monitor progress of education and workforce pro-
23 grams and expand Departmental activities for data
24 collection and analysis.

1 “(2) REPORT.—Not later than 2 years after the
 2 date of enactment of the Department of Energy
 3 Science for the Future Act of 2022, and every 2
 4 years thereafter, the Secretary shall submit to the
 5 Committee on Science, Space, and Technology of the
 6 House of Representatives and the Committee on En-
 7 ergy and Natural Resources of the Senate a report
 8 summarizing progress toward meeting the key per-
 9 formance indicators established under paragraph
 10 (1).

11 “(f) DEFINITIONS.—In this section:

12 “(1) HISPANIC-SERVING INSTITUTION.—The
 13 term ‘Hispanic-serving institution’ has the meaning
 14 given the term in section 502(a) of the Higher Edu-
 15 cation Act of 1965 (20 U.S.C. 1101a(a)).

16 “(2) HISTORICALLY BLACK COLLEGE OR UNI-
 17 VERSITY.—The term ‘Historically Black College or
 18 University’ has the meaning given the term ‘part B
 19 institution’ in section 322 of the Higher Education
 20 Act of 1965 (20 U.S.C. 1061).

21 “(3) INSTITUTION IN AN ELIGIBLE JURISDIC-
 22 TION.—The term ‘institution in an eligible jurisdic-
 23 tion’ means an institution of higher education (as
 24 defined in section 101 of the Higher Education Act
 25 of 1965 (20 U.S.C. 1001)) that is located in an eli-

1 gible jurisdiction (as defined in section
2 2203(b)(3)(A) of the Energy Policy Act of 1992 (42
3 U.S.C. 13503(b)(3)(A))).

4 “(4) MINORITY-SERVING INSTITUTION.—The
5 term ‘minority-serving institution’ includes the enti-
6 ties described in any of paragraphs (1) through (7)
7 of section 371(a) of the Higher Education Act of
8 1965 (20 U.S.C. 1067q(a)).

9 “(5) STEM.—The term ‘STEM’ means the
10 subjects listed in section 2 of the STEM Education
11 Act of 2015 (42 U.S.C. 6621 note; Public Law 114–
12 59).

13 “(6) TRIBAL COLLEGE OR UNIVERSITY.—The
14 term ‘Tribal College or University’ has the meaning
15 given the term in section 316(b) of the Higher Edu-
16 cation Act of 1965 (20 U.S.C. 1059c(b)).”.

17 (2) CLERICAL AMENDMENT.—The table of con-
18 tents in section 2(b) of the National Defense Au-
19 thorization Act for Fiscal Year 1991 (Public Law
20 101–510; 104 Stat. 1497) is amended by striking
21 the items relating to sections 3167 and 3168 and in-
22 serting the following:

“Sec. 3167. Partnerships with historically Black colleges and universities, His-
panic-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.”.

1 **SEC. 13. HIGH INTENSITY LASER RESEARCH INITIATIVE;**
 2 **HELIUM CONSERVATION PROGRAM; OFFICE**
 3 **OF SCIENCE EMERGING BIOLOGICAL THREAT**
 4 **PREPAREDNESS RESEARCH INITIATIVE;**
 5 **MIDSCALE INSTRUMENTATION AND RE-**
 6 **SEARCH EQUIPMENT PROGRAM; AUTHORIZA-**
 7 **TION OF APPROPRIATIONS.**

8 (a) IN GENERAL.—The Department of Energy Re-
 9 search and Innovation Act (42 U.S.C. 18601 et seq.) (as
 10 amended by section 12(a)) is amended by adding at the
 11 end the following:

12 **“SEC. 313. HIGH INTENSITY LASER RESEARCH INITIATIVE.**

13 “(a) IN GENERAL.—The Director shall establish a
 14 high intensity laser research initiative consistent with the
 15 recommendations of the National Academies report enti-
 16 tled ‘Opportunities in Intense Ultrafast Lasers: Reaching
 17 for the Brightest Light’ and the report from the Brightest
 18 Light Initiative workshop entitled ‘The Future of Intense
 19 Ultrafast Lasers in the U.S.’. The initiative should include
 20 research and development of petawatt-scale and of high
 21 average power laser technologies necessary for future facil-
 22 ity needs in discovery science and to advance energy tech-
 23 nologies, as well as support for a user network of academic
 24 and National Laboratory high intensity laser facilities.

25 “(b) LEVERAGE.—The Director shall leverage new
 26 laser technologies for more compact, less complex, and

1 low-cost accelerator systems needed for science applica-
 2 tions.

3 “(c) COORDINATION.—

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

7 “(2) UNDER SECRETARY.—The Under Sec-
 8 retary for Science shall coordinate the initiative es-
 9 tablished under subsection (a) with other relevant
 10 programs within the Department and other Federal
 11 agencies.

12 “(d) AUTHORIZATION OF APPROPRIATIONS.—Out of
 13 funds authorized to be appropriated for the Office of
 14 Science in a fiscal year, there are authorized to be appro-
 15 priated to the Secretary to carry out the activities de-
 16 scribed in this section—

17 “(1) \$50,000,000 for fiscal year 2022;

18 “(2) \$100,000,000 for fiscal year 2023;

19 “(3) \$150,000,000 for fiscal year 2024;

20 “(4) \$200,000,000 for fiscal year 2025; and

21 “(5) \$250,000,000 for fiscal year 2026.

22 **“SEC. 314. HELIUM CONSERVATION PROGRAM.**

23 “(a) IN GENERAL.—The Secretary shall establish a
 24 program to reduce the consumption of helium for Depart-
 25 ment grant recipients and facilities and encourage helium

1 recycling and reuse. The program shall competitively
2 award grants for—

3 “(1) the purchase of equipment to capture,
4 reuse, and recycle helium;

5 “(2) the installation, maintenance, and repair
6 of new and existing helium capture, reuse, and recy-
7 cling equipment; and

8 “(3) helium alternatives research and develop-
9 ment activities.

10 “(b) REPORT.—Not later than 2 years after the date
11 of enactment of the Department of Energy Science for the
12 Future Act of 2022, and every 3 years thereafter, the Di-
13 rector shall submit to the Committee on Science, Space,
14 and Technology of the House of Representatives and the
15 Committee on Energy and Natural Resources of the Sen-
16 ate a report on the purchase of helium as part of research
17 projects and facilities supported by the Department. The
18 report shall include—

19 “(1) the quantity of helium purchased for
20 projects and facilities supported by Department
21 grants;

22 “(2) a cost-analysis for such helium;

23 “(3) expected or experienced impacts of helium
24 supply shortages or prices on the research projects
25 and facilities supported by the Department; and

1 “(4) recommendations for reducing Department
2 grant recipients’ exposure to volatile helium prices.

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

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

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

14 **“SEC. 315. OFFICE OF SCIENCE EMERGING BIOLOGICAL**
15 **THREAT PREPAREDNESS RESEARCH INITIA-**
16 **TIVE.**

17 “(a) IN GENERAL.—The Secretary shall establish
18 within the Office of Science a cross-cutting research initia-
19 tive, to be known as the ‘Emerging Biological Threat Pre-
20 paredness Research Initiative’, to leverage the innovative
21 analytical resources and tools, user facilities, and ad-
22 vanced computational and networking capabilities of the
23 Department in order to aid efforts to prevent, prepare for,
24 predict, and respond to emerging natural and anthropo-
25 genic biological threats to national security.

1 “(b) COMPETITIVE, MERIT-REVIEWED PROCESS.—

2 The Secretary shall carry out the initiative established
3 under subsection (a) through a competitive, merit-re-
4 viewed process, and consider applications from National
5 Laboratories, institutions of higher education, multi-insti-
6 tutional collaborations, industry partners and other appro-
7 priate entities.

8 “(c) ACTIVITIES.—In carrying out the initiative es-
9 tablished under subsection (a), the Secretary shall—

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

13 “(2) prioritize the objectives of—

14 “(A) supporting fundamental research and
15 development in advanced analytics, experi-
16 mental studies, materials synthesis, and high-
17 performance computing technologies needed to
18 characterize, model, simulate, and predict com-
19 plex natural phenomena and biological mate-
20 rials related to emerging biological threats;

21 “(B)(i) supporting epidemiological mod-
22 eling, including data management, curation,
23 analysis, and modeling; and

1 “(ii) applying artificial intelligence, ma-
2 chine learning, and other computing tools to the
3 processes described in clause (i);

4 “(C) understanding and modeling the
5 transport of pathogens in indoor and outdoor
6 air and water environments;

7 “(D) researching and developing advances
8 in cost-effective and rapid pathogen detection,
9 monitoring, testing, and diagnostic technologies
10 and protocols, including for physiological and
11 environmental samples;

12 “(E) supporting the research and develop-
13 ment of materials and manufacturing of critical
14 supplies needed for the prevention of and re-
15 sponse to biological threats;

16 “(F) advancing molecular design for med-
17 ical therapeutics;

18 “(G) ensuring that new experimental and
19 computational tools are accessible to relevant
20 research communities, including private sector
21 entities and other Federal research institutions;
22 and

23 “(H) supporting activities and projects
24 that combine computational modeling and sim-

1 ulation with experimental research facilities and
2 studies.

3 “(d) COORDINATION.—In carrying out the initiative
4 established under subsection (a), the Secretary shall co-
5 ordinate activities with—

6 “(1) other relevant offices of the Department;

7 “(2) the National Nuclear Security Administra-
8 tion;

9 “(3) the National Laboratories;

10 “(4) the Director of the National Science Foun-
11 dation;

12 “(5) the Director of the Centers for Disease
13 Control and Prevention;

14 “(6) the Director of the National Institutes of
15 Health;

16 “(7) the heads of other relevant Federal agen-
17 cies;

18 “(8) institutions of higher education; and

19 “(9) the private sector.

20 “(e) EMERGING INFECTIOUS DISEASES HIGH PER-
21 FORMANCE COMPUTING RESEARCH CONSORTIUM.—

22 “(1) IN GENERAL.—The Secretary, in coordina-
23 tion with the Director of the National Science Foun-
24 dation and the Director of the Office of Science and
25 Technology Policy, shall establish and operate an

1 Emerging Infectious Diseases High Performance
2 Computing Research Consortium (referred to in this
3 section as the ‘Consortium’), to support the initiative
4 established under subsection (a) by providing, to the
5 extent practicable, a centralized entity for multidisci-
6 plinary, collaborative, emerging infectious disease
7 and biosecurity research and development through
8 high performance computing and advanced data
9 analytics technologies and processes, in conjunction
10 with the experimental research facilities and studies
11 supported by the Department.

12 “(2) MEMBERSHIP.—The members of the Con-
13 sortium may include representatives from relevant
14 Federal agencies, the National Laboratories, the pri-
15 vate sector, and institutions of higher education,
16 which can each contribute relevant compute time,
17 capabilities, or other resources.

18 “(3) ACTIVITIES.—The Consortium shall—

19 “(A) match applicants with available Fed-
20 eral and private sector computing resources;

21 “(B) consider supplemental awards for
22 computing partnerships with Consortium mem-
23 bers to qualifying entities on a competitive
24 merit-review basis;

1 “(C) encourage collaboration and commu-
2 nication among member representatives of the
3 Consortium and awardees;

4 “(D) provide access to the high-perform-
5 ance computing capabilities, expertise, and user
6 facilities of the Department and the National
7 Laboratories; and

8 “(E) submit an annual report to the Sec-
9 retary summarizing the activities of the Consor-
10 tium, including—

11 “(i) describing each project under-
12 taken by the Consortium;

13 “(ii) detailing organizational expendi-
14 tures; and

15 “(iii) evaluating contributions to the
16 achievement of technical milestones as de-
17 termined in subsection (a).

18 “(4) COORDINATION.—The Secretary shall en-
19 sure the coordination of, and avoid unnecessary du-
20 plication of, the activities of the Consortium with the
21 activities of other research entities of the Depart-
22 ment, other Federal research institutions, institu-
23 tions of higher education, and the private sector.

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

1 Future Act of 2022, the Secretary shall submit to the
2 Committee on Science, Space, and Technology of the
3 House of Representatives and the Committee on Energy
4 and Natural Resources and the Committee on Commerce,
5 Science, and Transportation of the Senate a report detail-
6 ing the effectiveness of—

7 “(1) the interagency coordination among each
8 Federal agency involved in the initiative established
9 under subsection (a);

10 “(2) the collaborative research achievements of
11 that initiative, including the achievement of the tech-
12 nical milestones determined under that subsection;
13 and

14 “(3) potential opportunities to expand the tech-
15 nical capabilities of the Department.

16 “(g) FUNDING.—Out of funds authorized to be ap-
17 propriated for the Office of Science in a fiscal year, there
18 are authorized to be appropriated to the Secretary to carry
19 out the activities under this section—

20 “(1) \$50,000,000 for each of fiscal years 2022
21 and 2023; and

22 “(2) such sums as are necessary for each of fis-
23 cal years 2024 through 2026.

24 “(h) PROHIBITION.—

1 “(1) IN GENERAL.—In carrying out this sec-
 2 tion, the Secretary may not carry out gain-of-func-
 3 tion research.

4 “(2) GAIN-OF-FUNCTION RESEARCH DE-
 5 FINED.—In this subsection, ‘gain-of-function re-
 6 search’ means research activities with the potential
 7 to generate pathogens with high transmissibility and
 8 high virulence in humans.

9 “(3) OVERSIGHT AND GUIDANCE.—The Direc-
 10 tor of the Office of Science and Technology Policy
 11 shall provide guidance to the Department, the Na-
 12 tional Laboratories, and users regarding the estab-
 13 lishment and promulgation of policies to implement
 14 the prohibition under paragraph (1).

15 **“SEC. 316. MIDSCALE INSTRUMENTATION AND RESEARCH**
 16 **EQUIPMENT PROGRAM.**

17 “(a) IN GENERAL.—The Director shall establish a
 18 midscale instrumentation and research equipment pro-
 19 gram to develop, acquire, and commercialize research in-
 20 strumentation and equipment needed to meet the missions
 21 of the Department and to provide platform technologies
 22 for the broader scientific community.

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

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

3 “(A) range in cost from \$1,000,000 to
4 \$20,000,000 each; and

5 “(B) would significantly accelerate sci-
6 entific breakthroughs at user facilities; and

7 “(2) strongly encourage partnerships among—

8 “(A) National Laboratories;

9 “(B) user facilities; and

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

15 “(ii) historically Black colleges or univer-
16 sities;

17 “(iii) minority-serving institutions of high-
18 er education; or

19 “(iv) institutions of higher education in a
20 rural area.

21 “(3) COORDINATION WITH OTHER PRO-
22 GRAMS.—The Director shall coordinate the program
23 established under paragraph (1) with all other pro-
24 grams carried out by the Office of Science of the
25 Department.

1 “(c) RESEARCH EQUIPMENT AND TECHNOLOGY DE-
 2 VELOPMENT COORDINATION.—The Director shall encour-
 3 age coordination among the Office of Science, the National
 4 Laboratories, the Office of Technology Transitions, and
 5 relevant academic and private sector entities to promote
 6 the dissemination or commercialization of research equip-
 7 ment and related technologies developed to aid basic
 8 science research discoveries.

9 “(d) AUTHORIZATION OF APPROPRIATIONS.—Out of
 10 funds authorized to be appropriated for the Office of
 11 Science in a fiscal year, there is authorized to be appro-
 12 priated to carry out this section \$150,000,000 for each
 13 of fiscals years 2022 through 2026.

14 **“SEC. 317. AUTHORIZATION OF APPROPRIATIONS.**

15 “There are authorized to be appropriated to the Sec-
 16 retary to carry out the activities described in this title—

17 “(1) \$8,451,905,000 for fiscal year 2022;

18 “(2) \$9,035,354,600 for fiscal year 2023;

19 “(3) \$9,705,470,672 for fiscal year 2024;

20 “(4) \$10,259,703,569 for fiscal year 2025; and

21 “(5) \$12,049,702,411 for fiscal year 2026.”.

22 (b) TABLE OF CONTENTS.—Section 1(b) of the De-
 23 partment of Energy Research and Innovation Act is
 24 amended in the table of contents by inserting after the
 25 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.”.

1 SEC. 14. ESTABLISHED PROGRAM TO STIMULATE COMPETITIVE RESEARCH.

2 (a) RESEARCH AREAS.—Section 2203(b)(3)(E) of
3 the Energy Policy Act of 1992 (42 U.S.C.
4 13503(b)(3)(E)) is amended—
5

6 (1) in the subparagraph heading, by striking
7 “IN AREAS OF APPLIED ENERGY RESEARCH, ENVI-
8 RONMENTAL MANAGEMENT, AND BASIC SCIENCE”;

9 (2) in clause (i)—

10 (A) in subclause (I), by inserting “nuclear
11 energy,” before “and”; and

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

14 “(V) basic science research, in-
15 cluding—

16 “(aa) advanced scientific
17 computing research;

18 “(bb) basic energy sciences;

19 “(cc) biological and environ-
20 mental research;

21 “(dd) fusion energy sciences;

1 “(ee) high energy physics;
 2 “(ff) nuclear physics;
 3 “(gg) isotope research, de-
 4 velopment, and production;
 5 “(hh) accelerator research,
 6 development, and production; and
 7 “(ii) other areas of research
 8 funded by the Office of Science,
 9 as determined by the Secretary.”;
 10 and

11 (3) in clause (ii)—

12 (A) in subclause (II), by striking “grad-
 13 uate” and inserting “undergraduate scholar-
 14 ships, graduate fellowships, and”;

15 (B) in subclause (III), by striking “; and”
 16 and inserting “and staff;”;

17 (C) in subclause (IV)—

18 (i) by striking “biennial” and insert-
 19 ing “annual”; and

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

22 (D) by adding at the end the following:

23 “(V) to develop research clusters
 24 for particular areas of expertise; and

1 “(VI) to diversify the future
2 workforce.”.

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

7 “(F) RESEARCH CAPABILITY ENHANCE-
8 MENT.—

9 “(i) SCHOLARSHIPS AND FELLOW-
10 SHIPS.—

11 “(I) IN GENERAL.—Pursuant to
12 subparagraph (E)(ii), the Secretary
13 shall award grants to institutions of
14 higher education in eligible jurisdic-
15 tions for those institutions of higher
16 education to provide scholarships and
17 fellowships.

18 “(II) GRANT.—A scholarship or
19 fellowship awarded by an institution
20 of higher education in an eligible ju-
21 risdiction using a grant provided
22 under subclause (I)—

23 “(aa) in the case of an un-
24 dergraduate scholarship—

1 “(AA) shall be for a pe-
 2 riod of 1 year; and

3 “(BB) may be competi-
 4 tively renewable on an an-
 5 nual basis; and

6 “(bb) in the case of a grad-
 7 uate level fellowship, shall be for
 8 a period of not more than 5
 9 years.

10 “(ii) EARLY CAREER CAPACITY DE-
 11 VELOPMENT.—

12 “(I) IN GENERAL.—Pursuant to
 13 subparagraph (E)(ii), the Secretary
 14 shall award grants to early career fac-
 15 ulty and staff at institutions of higher
 16 education in eligible jurisdictions—

17 “(aa) to support investi-
 18 gator-initiated research, including
 19 associated research equipment
 20 and instrumentation;

21 “(bb) to support activities
 22 associated with identifying and
 23 responding to funding opportuni-
 24 ties;

1 “(cc) to secure technical as-
 2 sistance for the pursuit of fund-
 3 ing opportunities; and

4 “(dd) to develop and en-
 5 hance collaboration among Na-
 6 tional Laboratories, Department
 7 of Energy programs, the private
 8 sector, and other relevant enti-
 9 ties.

10 “(II) GRANTS.—A grant awarded
 11 under subclause (I) shall be—

12 “(aa) for a period of not
 13 more than 5 years; and

14 “(bb) competitively renew-
 15 able for an additional 5-year pe-
 16 riod.

17 “(iii) RESEARCH CAPACITY DEVELOP-
 18 MENT.—

19 “(I) IN GENERAL.—Pursuant to
 20 subparagraph (E)(ii), the Secretary
 21 shall award competitive grants to in-
 22 stitutions of higher education in eligi-
 23 ble jurisdictions for research capacity
 24 development and implementation, in-
 25 cluding—

1 “(aa) developing expertise in
2 key technology areas, including
3 associated equipment and instru-
4 mentation;

5 “(bb) developing and acquir-
6 ing novel, state-of-the-art instru-
7 ments and equipment that range
8 in cost from \$500,000 to
9 \$20,000,000;

10 “(cc) enhancing collabora-
11 tion with National Laboratories,
12 the Department of Energy, and
13 the private sector through faculty
14 or staff placement programs; and

15 “(dd) supporting formal
16 partnership programs with insti-
17 tutions of higher education and
18 National Laboratories.

19 “(II) GRANTS.—A grant awarded
20 under subclause (I) shall be—

21 “(aa) for a period of not
22 more than 5 years; and

23 “(bb) renewable for an addi-
24 tional 5-year period.

1 “(III) EQUIPMENT AND INSTRU-
 2 MENTATION.—To the maximum ex-
 3 tent practicable, the Secretary shall
 4 ensure that research equipment and
 5 instrumentation developed or acquired
 6 pursuant to a grant awarded under
 7 subclause (I) may sustain continued
 8 operation and be maintained without
 9 the need for additional or subsequent
 10 funding under this section.”.

11 (c) PROGRAM IMPLEMENTATION UPDATE.—Section
 12 2203(b)(3)(G) of the Energy Policy Act of 1992 (42
 13 U.S.C. 13503(b)(3)(G)) is amended by adding at the end
 14 the following:

15 “(iii) UPDATE.—Not later than 270
 16 days after the date of enactment of the
 17 Department of Energy Science for the Fu-
 18 ture Act of 2022, the Secretary shall—

19 “(I) update the plan submitted
 20 under clause (i); and

21 “(II) submit the updated plan to
 22 the committees described in that
 23 clause.”.

24 (d) PROGRAM EVALUATION REPORT.—Section
 25 2203(b)(3)(H) of the Energy Policy Act of 1992 (42

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

3 “(iv) ANNUAL REPORT.—At the end
4 of each fiscal year, the Secretary shall sub-
5 mit to the Committee on Energy and Nat-
6 ural Resources and the Committee on Ap-
7 propriations of the Senate and the Com-
8 mittee on Energy and Commerce and the
9 Committee on Appropriations of the House
10 of Representatives a report that includes—

11 “(I) the total amount of expendi-
12 tures made by the Department to
13 carry out EPSCoR in each eligible ju-
14 risdiction for each of the 3 most re-
15 cent fiscal years for which such infor-
16 mation is available;

17 “(II)(aa) the number of EPSCoR
18 awards made to institutions of higher
19 education located in eligible jurisdic-
20 tions; and

21 “(bb) the amount and type of
22 each award;

23 “(III) the number of awards that
24 are not EPSCoR awards made by the
25 Secretary to institutions of higher

1 education located in eligible jurisdic-
 2 tions;

3 “(IV)(aa) the number of rep-
 4 resentatives of institutions of higher
 5 education in eligible jurisdictions serv-
 6 ing on each Office of Science advisory
 7 committee; and

8 “(bb) for each such advisory
 9 committee, the percentage of com-
 10 mittee membership that those individ-
 11 uals constitute; and

12 “(V) the number of individuals
 13 from institutions of higher education
 14 in eligible jurisdictions serving on peer
 15 review committees.”.

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

19 “(I) FUNDING.—

20 “(i) AUTHORIZATION OF APPROPRIA-
 21 TIONS.—There are authorized to be appro-
 22 priated to the Secretary to carry out
 23 EPSCoR, to remain available until ex-
 24 pended—

1 “(I) \$75,000,000 for fiscal year
2 2022;

3 “(II) \$75,000,000 for fiscal year
4 2023;

5 “(III) \$100,000,000 for fiscal
6 year 2024;

7 “(IV) \$100,000,000 for fiscal
8 year 2025; and

9 “(V) \$150,000,000 for fiscal year
10 2026.

11 “(ii) GRANTS TO CONSORTIA.—In the
12 case of an EPSCoR grant awarded to a
13 consortium that contains institutions of
14 higher education that are not located in el-
15 igible jurisdictions, the Secretary may
16 count—

17 “(I) the full amount of funds ex-
18 pended to provide the grant towards
19 meeting the funding requirement in
20 clause (iii) if the lead entity of the
21 consortium is an institution of higher
22 education located in an eligible juris-
23 diction; and

24 “(II) only the funds provided to
25 institutions of higher education lo-

1 cated in eligible jurisdictions towards
2 meeting the funding requirement in
3 clause (iii) if the lead entity of the
4 consortium is an institution of higher
5 education that is not located in an eli-
6 gible jurisdiction.

7 “(iii) ADDITIONAL FUNDS FOR ELIGI-
8 BLE JURISDICTIONS.—In addition to funds
9 authorized to be appropriated under clause
10 (i), the Secretary, to the maximum extent
11 practicable, shall ensure that, of the re-
12 search and development funds of the Office
13 of Science that are awarded by the Sec-
14 retary each year to institutions of higher
15 education, not less than 10 percent is
16 awarded to institutions of higher education
17 in eligible jurisdictions pursuant to the
18 evaluation and selection criteria in section
19 605.10 of title 10, Code of Federal Regula-
20 tions (or successor regulations).

21 “(iv) ADDITIONAL FUNDS FOR EQUIP-
22 MENT AND INSTRUMENTATION.—In addi-
23 tion to funds authorized to be appropriated
24 under clause (i), there is authorized to be
25 appropriated to the Secretary to award

1 grants under subparagraph (F)(iii)(I) for
 2 the purpose described in item (bb) of that
 3 subparagraph \$50,000,000 for each of fis-
 4 cal years 2022 through 2026, to remain
 5 available until expended.”.

6 (f) ADVISORY COMMITTEES TO THE OFFICE OF
 7 SCIENCE.—In order to improve the advice and guidance
 8 provided to the Office of Science, the Undersecretary for
 9 Science shall seek to ensure, to the maximum extent prac-
 10 ticable, the robust participation of institutions of higher
 11 education (as defined in section 101 of the Higher Edu-
 12 cation Act of 1965 (20 U.S.C. 1001)) located in eligible
 13 jurisdictions (as defined in section 2203(b)(3)(A) of the
 14 Energy Policy Act of 1992 (42 U.S.C. 13503(b)(3)(A)))
 15 on the Office of Science Federal Advisory Committee.

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

19 (1) in paragraph (1), by striking “(1) The Sec-
 20 retary” and inserting the following:

21 “(1) UNIVERSITY RESEARCH REACTORS.—The
 22 Secretary”; and

23 (2) in paragraph (2), by striking “(2) The Sec-
 24 retary” and inserting the following:

1 “(2) METHOD TO EVALUATE EFFECTIVENESS
2 OF EDUCATION PROGRAMS.—The Secretary”.

3 **SEC. 15. RESEARCH SECURITY.**

4 (a) DEFINITIONS.—In this section:

5 (1) COUNTRY OF RISK.—

6 (A) IN GENERAL.—The term “country of
7 risk” means a foreign country determined by
8 the Secretary, in accordance with subparagraph
9 (B), to present a risk of theft of United States
10 intellectual property or a threat to the national
11 security of the United States if nationals of the
12 country, or entities owned or controlled by the
13 country or nationals of the country, participate
14 in any research, development, demonstration, or
15 deployment activity authorized under this Act
16 or an amendment made by this Act.

17 (B) DETERMINATION.—In making a deter-
18 mination under subparagraph (A), the Sec-
19 retary, in coordination with the Director of the
20 Office of Intelligence and Counterintelligence,
21 shall take into consideration—

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

1 (ii) the most recent National Counter-
2 intelligence Strategy of the United States.

3 (2) COVERED SUPPORT.—The term “covered
4 support” means any grant, contract, subcontract,
5 award, loan, program, support, or other activity au-
6 thorized under this Act or an amendment made by
7 this Act.

8 (3) ENTITY OF CONCERN.—The term “entity of
9 concern” means any entity, including a national,
10 that is—

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

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

19 (C) on the Entity List maintained by the
20 Bureau of Industry and Security of the Depart-
21 ment of Commerce and set forth in Supplement
22 No. 4 to part 744 of title 15, Code of Federal
23 Regulations;

24 (D) included in the list required by section
25 9(b)(3) of the Uyghur Human Rights Policy

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

3 (E) identified by the Secretary, in coordi-
4 nation with the Director of the Office of Intel-
5 ligence and Counterintelligence and the applica-
6 ble office that would provide, or is providing,
7 covered support, as posing an unmanageable
8 threat—

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

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

13 (4) NATIONAL.—The term “national” has the
14 meaning given the term in section 101 of the Immi-
15 gration and Nationality Act (8 U.S.C. 1101).

16 (5) SECRETARY.—The term “Secretary” means
17 the Secretary of Energy.

18 (b) SCIENCE AND TECHNOLOGY RISK ASSESS-
19 MENT.—

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

1 minations of the risk of loss of United States intel-
2 lectual property or threat to the national security of
3 the United States posed by activities carried out
4 under any covered support.

5 (2) CONTENT AND IMPLEMENTATION.—In de-
6 veloping and using the tools and processes developed
7 under paragraph (1), the Secretary shall—

8 (A) deploy risk-based approaches to evalu-
9 ating, awarding, and managing certain re-
10 search, development, demonstration, and de-
11 ployment activities, including designations that
12 will indicate the relative risk of activities;

13 (B) assess, to the extent practicable, ongo-
14 ing high-risk activities;

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

22 (D) consider requiring recipients of covered
23 support to implement additional research secu-
24 rity mitigations for higher-risk activities if ap-
25 propriate; and

1 (E) support the development of research
2 security training for recipients of covered sup-
3 port on the risks posed by entities of concern.

4 (3) ANNUAL UPDATES.—The tools and proc-
5 esses developed under paragraph (1) shall be evalu-
6 ated annually and updated as needed, with threat-
7 informed input from the Office of Intelligence and
8 Counterintelligence, to reflect changes in the risk
9 designation under paragraph (2)(A) of research, de-
10 velopment, demonstration, and deployment activities
11 conducted by the Department.

12 (c) ENTITY OF CONCERN.—

13 (1) PROHIBITION.—Except as provided in para-
14 graph (2), no entity of concern, or individual that
15 owns or controls, is owned or controlled by, or is
16 under common ownership or control with an entity
17 of concern, may receive, or perform work under, any
18 covered support.

19 (2) WAIVER OF PROHIBITION.—

20 (A) IN GENERAL.—The Secretary may
21 waive the prohibition under paragraph (1) if de-
22 termined by the Secretary to be in the national
23 interest.

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

1 under subparagraph (A), the Secretary shall no-
2 tify the Committee on Energy and Natural Re-
3 sources of the Senate and the Committee on
4 Science, Space, and Technology of the House of
5 Representatives of the intent to issue the waiv-
6 er, including a justification for the waiver.

7 (3) PENALTY.—

8 (A) TERMINATION OF SUPPORT.—On find-
9 ing that any entity of concern or individual de-
10 scribed in paragraph (1) has received covered
11 support and has not received a waiver under
12 paragraph (2), the Secretary shall terminate all
13 covered support to that entity of concern or in-
14 dividual, as applicable.

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

18 (i) prohibited from receiving or par-
19 ticipating in covered support for a period
20 of not less than 1 year but not more than
21 10 years, as determined by the Secretary;
22 or

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

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

3 (C) NOTIFICATION TO CONGRESS.—Prior
4 to imposing a penalty under subparagraph (B),
5 the Secretary shall notify the Committee on En-
6 ergy and Natural Resources of the Senate and
7 the Committee on Science, Space, and Tech-
8 nology of the House of Representatives of the
9 intent to impose the penalty, including a de-
10 scription of and justification for the penalty.

11 (4) COORDINATION.—The Secretary shall—

12 (A) share information about the unman-
13 ageable threats described in subsection
14 (a)(3)(E) with other Federal agencies; and

15 (B) develop consistent approaches to iden-
16 tifying entities of concern.

17 (d) INTERNATIONAL AGREEMENTS.—This section
18 shall be applied in a manner consistent with the obliga-
19 tions of the United States under international agreements.

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

23 (1) describes—

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

4 (B) if applicable, the science and tech-
5 nology risk matrix developed under that sub-
6 section and how that matrix has been applied;

7 (2) includes a mitigation plan for managing
8 risks posed by countries of risk with respect to fu-
9 ture or ongoing research and development activities
10 of the Department of Energy; and

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

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