

117TH CONGRESS
1ST SESSION

H. R. 3593

AN ACT

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

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

1 **SECTION 1. SHORT TITLE.**

2 This Act may be cited as the “Department of Energy
3 Science for the Future Act”.

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

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

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

18 “(e) COORDINATION.—

19 “(1) IN GENERAL.—The Secretary—

20 “(A) shall ensure the coordination of the
21 Office of Science with the other activities of the
22 Department;

23 “(B) shall support joint activities among
24 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 to complete
16 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; and

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) 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) IN GENERAL.—The Secretary shall
16 provide for the upgrade to the Advanced Pho-
17 ton Source described in the publication ap-
18 proved by the Basic Energy Sciences Advisory
19 Committee on June 9, 2016, titled ‘Report on
20 Facility Upgrades’, including the development
21 of a multi-bend achromat lattice to produce a
22 high flux of coherent x-rays within the hard x-
23 ray energy region and a suite of beamlines opti-
24 mized for this source.

1 “(C) START OF OPERATIONS.—The Sec-
2 retary shall, subject to the availability of appro-
3 priations, ensure that the start of full oper-
4 ations of the upgrade under this paragraph oc-
5 curs before March 31, 2026.

6 “(D) FUNDING.—Out of funds authorized
7 to be appropriated under subsection (j), there
8 shall be made available to the Secretary to
9 carry out the upgrade under this paragraph
10 \$101,000,000 for fiscal year 2022 and
11 \$56,000,000 for fiscal year 2023.

12 “(5) SPALLATION NEUTRON SOURCE PROTON
13 POWER UPGRADE.—

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

17 “(B) PROTON POWER UPGRADE DE-
18 FINED.—For the purposes of this paragraph,
19 the term ‘proton power upgrade’ means the
20 Spallation Neutron Source power upgrade de-
21 scribed in—

22 “(i) the publication titled ‘Facilities
23 for the Future of Science: A Twenty-Year
24 Outlook’, published by the Office of

1 Science of the Department of Energy in
2 December, 2003;

3 “(ii) the publication titled ‘Four Years
4 Later: An Interim Report on Facilities for
5 the Future of Science: A Twenty-Year
6 Outlook’, published by the Office of
7 Science of the Department of Energy in
8 August, 2007; and

9 “(iii) the publication approved by the
10 Basic Energy Sciences Advisory Committee
11 on June 9, 2016, titled ‘Report on Facility
12 Upgrades’.

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 upgrade under this paragraph oc-
17 curs before July 30, 2028, with the option for
18 early operation in 2025.

19 “(D) FUNDING.—Out of funds authorized
20 to be appropriated under subsection (j), there
21 shall be made available to the Secretary to
22 carry out the upgrade under this paragraph
23 \$49,800,000 for fiscal year 2022.

24 “(6) SPALLATION NEUTRON SOURCE SECOND
25 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.—For the purposes of this paragraph,
6 the term ‘second target station’ means the
7 Spallation Neutron Source second target station
8 described in—

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

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

20 “(iii) the publication approved by the
21 Basic Energy Sciences Advisory Committee
22 on June 9, 2016, titled ‘Report on Facility
23 Upgrades’.

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

priations, ensure that the start of full operations 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 shall be made available to the Secretary to carry out the activities under this paragraph, including construction—

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

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

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

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

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

“(7) ADVANCED LIGHT SOURCE UPGRADE.—

“(A) DEFINITIONS.—In this paragraph:

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

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

1 “(B) IN GENERAL.—The Secretary shall
2 provide 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, titled ‘Report on Facility Up-
6 grades’, 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 shall be made available to the Secretary to
18 carry out the upgrade under this paragraph—

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

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

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

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

1 “(v) \$25,000,000 for fiscal year 2026.

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

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

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

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

13 “(iii) ULTRA-SHORT PULSE X-RAYS.—
14 The term ‘ultra-short pulse x-rays’ means
15 x-ray bursts capable of durations of less
16 than 100 femtoseconds.

17 “(B) IN GENERAL.—The Secretary shall—

18 “(i) provide for the upgrade to the
19 Linac Coherent Light Source II facility de-
20 scribed in the publication approved by the
21 Basic Energy Sciences Advisory Committee
22 on June 9, 2016, titled ‘Report on Facility
23 Upgrades’, including the development of
24 experimental capabilities for high energy x-

1 rays to reveal fundamental scientific dis-
2 coveries; and

3 “(ii) ensure such upgrade enables the
4 production and use of high energy, ultra-
5 short pulse x-rays delivered at a high rep-
6 etition rate.

7 “(C) START OF OPERATIONS.—The Sec-
8 retary shall, subject to the availability of appro-
9 priations, ensure that the start of full oper-
10 ations of the upgrade under this paragraph oc-
11 curs before December 31, 2026.

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

16 “(i) \$106,925,000 for fiscal year
17 2022;

18 “(ii) \$125,925,000 for fiscal year
19 2023;

20 “(iii) \$115,000,000 for fiscal year
21 2024;

22 “(iv) \$89,000,000 for fiscal year
23 2025; and

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

1 “(9) CRYOMODULE REPAIR AND MAINTENANCE
2 FACILITY.—

3 “(A) IN GENERAL.—The Secretary shall
4 provide for the construction of a cryomodule re-
5 pair and maintenance facility to service the
6 Linac Coherent Light Source II and upgrades
7 to the facility. The Secretary shall consult with
8 the private sector, universities, National Lab-
9 oratories, and relevant Federal agencies to en-
10 sure that this facility has the capability to
11 maintain, repair, and test superconducting ra-
12 diofrequency accelerator components.

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

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

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

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

21 “(iv) \$17,000,000 for fiscal year
22 2025.

23 “(10) NANOSCALE SCIENCE RESEARCH CENTER
24 RECAPITALIZATION PROJECT.—

1 “(A) IN GENERAL.—The Secretary shall
2 provide for the recapitalization of the Nanoscale
3 Science Research Centers, to include the up-
4 grade of equipment at each Center supported
5 by the Office of Science on the date of enact-
6 ment of the Department of Energy Science for
7 the Future Act, to accelerate advances in the
8 various fields of science including nanoscience,
9 materials, chemistry, biology, and quantum in-
10 formation science.

11 “(B) FUNDING.—Out of funds authorized
12 to be appropriated under subsection (j), there
13 shall be made available to the Secretary to
14 carry out the recapitalization under this para-
15 graph—

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

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

18 “(iii) \$20,000,000 for fiscal year

19 2024; and

20 “(iv) \$20,000,000 for fiscal year

21 2025.”; and

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

23 “(h) COMPUTATIONAL MATERIALS AND CHEMICAL
24 SCIENCES.—

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

7 “(A) chemical catalysis research and devel-
8 opment;

9 “(B) the use of large data sets to model
10 materials phenomena, including through ad-
11 vanced characterization of materials, materials
12 synthesis, processing, and innovative use of ex-
13 perimental and theoretical data;

14 “(C) co-design of chemical system and
15 chemistry modeling software with advanced
16 computing systems and hardware technologies;
17 and

18 “(D) modeling of chemical processes, as-
19 semblies, and reactions such as molecular dy-
20 namics and quantum chemistry, including
21 through novel computing methods.

22 “(2) COMPUTATIONAL MATERIALS AND CHEM-
23 ICAL SCIENCES CENTERS.—

24 “(A) IN GENERAL.—In carrying out the
25 activities authorized under paragraph (1), the

1 Director shall select and establish up to six
2 computational materials and chemical sciences
3 centers to—

4 “(i) develop open-source, robust, and
5 validated computational codes and user-
6 friendly software, coupled with innovative
7 use of experimental and theoretical data,
8 to enable the design, discovery, and devel-
9 opment of new materials and chemical sys-
10 tems; and

11 “(ii) focus on overcoming challenges
12 and maximizing the benefits of exascale
13 and other high performance computing
14 underpinned by accelerated node tech-
15 nologies.

16 “(B) SELECTION.—The Director shall se-
17 lect centers under subparagraph (A) on a com-
18 petitive, merit-reviewed basis. The Director
19 shall consider applications from the National
20 Laboratories, institutes of higher education,
21 multi-institutional collaborations, and other ap-
22 propriate entities.

23 “(C) DURATION.—

24 “(i) A center selected under subpara-
25 graph (A) shall receive support for a pe-

1 riod of not more than 5 years beginning on
2 the date of establishment of that center,
3 subject to the availability of appropria-
4 tions.

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

11 “(D) RENEWAL.—Upon the expiration of
12 any period of support of a center under this
13 subsection, the Director may renew support for
14 the center, on a merit-reviewed basis, for a pe-
15 riod of not more than 5 years.

16 “(E) TERMINATION.—Consistent with the
17 existing authorities of the Department, the Di-
18 rector may terminate an underperforming cen-
19 ter for cause during the performance period.

20 “(i) MATERIALS RESEARCH DATABASE.—

21 “(1) IN GENERAL.—The Director shall support
22 the development of a web-based platform to develop
23 and provide access to a database of computed infor-
24 mation on known and predicted materials properties

1 and computational tools to accelerate breakthroughs
2 in materials discovery and design.

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

5 “(A) conduct cooperative research with in-
6 dustry, academia, and other research institu-
7 tions to advance understanding, prediction, and
8 manipulation of materials and facilitate the de-
9 sign of novel materials;

10 “(B) develop and maintain data infrastruc-
11 ture at user facilities that generate data to col-
12 lect, analyze, label, and otherwise prepare the
13 data for inclusion in the database;

14 “(C) leverage existing high performance
15 computing systems to conduct high throughput
16 calculations, and develop computational and
17 data mining algorithms for the prediction of
18 material properties;

19 “(D) strengthen the foundation for new
20 technologies and advanced manufacturing; and

21 “(E) drive the development of advanced
22 materials for applications that span the Depart-
23 ment’s missions in energy, environment, and
24 national security.

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

6 “(4) FUNDING.—Out of funds authorized to be
 7 appropriated under subsection (j), there shall be
 8 made available to the Secretary to carry out activi-
 9 ties under this subsection \$10,000,000 for each of
 10 the fiscal years 2022 through 2026.

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

14 “(1) \$2,727,705,000 for fiscal year 2022;

15 “(2) \$2,828,896,600 for fiscal year 2023;

16 “(3) \$3,019,489,612 for fiscal year 2024;

17 “(4) \$3,161,698,885 for fiscal year 2025; and

18 “(5) \$3,291,651,600 for fiscal year 2026.”.

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

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

24 “(4) FUNDING.—From within funds authorized
 25 to be appropriated for Basic Energy Sciences, the

1 Secretary shall make available for carrying out ac-
2 tivities under this subsection \$50,000,000 for each
3 of fiscal years 2022 through 2026.”; and

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

6 “(4) FUNDING.—From within funds authorized
7 to be appropriated in section 316 of the Department
8 of Energy Research and Innovation Act, the Sec-
9 retary shall make available for carrying out activities
10 under this subsection \$50,000,000 for each of fiscal
11 years 2022 through 2026.”.

12 (c) ELECTRICITY STORAGE RESEARCH INITIATIVE.—
13 Section 975 of the Energy Policy Act of 2005 (42 U.S.C.
14 16315) is amended—

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

17 “(4) FUNDING.—From within funds authorized
18 to be appropriated for Basic Energy Sciences, the
19 Secretary shall make available for carrying out ac-
20 tivities under this subsection \$50,000,000 for each
21 of fiscal years 2022 through 2026.”;

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

24 “(4) FUNDING.—From within funds authorized
25 to be appropriated in section 316 of the Department

1 of Energy Research and Innovation Act, the Sec-
2 retary shall make available for carrying out activities
3 under this subsection \$50,000,000 for each of fiscal
4 years 2022 through 2026.”; and

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

7 “(4) FUNDING.—From within funds authorized
8 to be appropriated in section 316 of the Department
9 of Energy Research and Innovation Act, the Sec-
10 retary shall make available for carrying out activities
11 under this subsection \$20,000,000 for each of fiscal
12 years 2022 through 2026.”.

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

14 (a) PROGRAM; BIOLOGICAL SYSTEMS; BIOMOLEC-
15 ULAR CHARACTERIZATION AND IMAGING SCIENCE.—Sec-
16 tion 306 of the Department of Energy Research and Inno-
17 vation Act (42 U.S.C. 18644) is amended—

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

20 “(a) PROGRAM.—As part of the duties of the Director
21 authorized under section 209 of the Department of En-
22 ergy Organization Act (42 U.S.C. 7139), and coordinated
23 with the activities authorized under sections 303 and 304
24 of this Act, the Director shall carry out a program of re-
25 search and development in the areas of biological systems

1 science and climate and environmental science, including
2 subsurface science, relevant to the development of new en-
3 ergy technologies and to support the energy, environ-
4 mental, and national security missions of the Department.

5 “(b) BIOLOGICAL SYSTEMS.—The Director shall
6 carry out research and development activities in genomic
7 science including fundamental research on plants and mi-
8 crobes to increase systems-level understanding of the com-
9 plex biological systems, which may include activities to—

10 “(1) accelerate breakthroughs and new knowl-
11 edge that would enable the cost-effective, sustainable
12 production of—

13 “(A) biomass-based liquid transportation
14 fuels;

15 “(B) bioenergy; and

16 “(C) biobased materials from renewable
17 biomass;

18 “(2) improve fundamental understanding of
19 plant and microbial processes impacting the global
20 carbon cycle, including processes for removing car-
21 bon dioxide from the atmosphere, through photosyn-
22 thesis and other biological processes, for sequestra-
23 tion and storage;

1 “(3) understand the microbiome mechanisms
2 used to transform, immobilize, or remove contami-
3 nants from subsurface environments;

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

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

12 “(A) advance biosystems design research
13 to advance the understanding of how CRISPR
14 tools and other gene editing tools and tech-
15 nologies work in nature, in the laboratory, and
16 in practice;

17 “(B) deepen genome-enabled knowledge of
18 root architecture and growth in crops, including
19 trees; and

20 “(C) develop biosystems design methods
21 and tools to increase the efficiency of photosyn-
22 thesis in plants; and

23 “(6) develop other relevant methods and proc-
24 esses as determined by the Director.

1 “(c) BIOMOLECULAR CHARACTERIZATION AND IMAG-
2 ING SCIENCE.—The Director shall carry out research and
3 development activities in biomolecular characterization
4 and imaging science, including development of integrative
5 imaging and analysis platforms and biosensors to under-
6 stand the expression, structure, and function of genome
7 information encoded within cells and for real-time meas-
8 urements in ecosystems and field sites of relevance to the
9 mission of the Department of Energy.”; and

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

12 (b) BIOENERGY RESEARCH CENTERS.—Section
13 977(f) of the Energy Policy Act of 2005 (42 U.S.C.
14 16317(f)) is amended to read as follows:

15 “(f) BIOENERGY RESEARCH CENTERS.—

16 “(1) IN GENERAL.—In carrying out the pro-
17 gram under section 306(a) of the Department of
18 Energy Research and Innovation Act (42 U.S.C.
19 18644(a)), the Director shall support up to six bio-
20 energy research centers to conduct fundamental re-
21 search in plant and microbial systems biology, bio-
22 logical imaging and analysis, and genomics, and to
23 accelerate advanced research and development of
24 biomass-based liquid transportation fuels, bioenergy,
25 or biobased materials, chemicals, and products that

1 are produced from a variety of regionally diverse
2 feedstocks, and to facilitate the translation of re-
3 search results to industry. The activities of the cen-
4 ters authorized under this subsection may include—

5 “(A) accelerating the domestication of bio-
6 energy-relevant plants, microbes, and associated
7 microbial communities to enable high-impact,
8 value-added coproduct development at multiple
9 points in the bioenergy supply chain;

10 “(B) developing the science and techno-
11 logical advances to ensure process sustainability
12 is considered in the creation of biofuels and bio-
13 products from lignocellulose; and

14 “(C) using the latest tools in genomics,
15 molecular biology, catalysis science, chemical
16 engineering, systems biology, and computational
17 and robotics technologies to sustainably produce
18 and transform biomass into biofuels and bio-
19 products.

20 “(2) SELECTION AND DURATION.—

21 “(A) IN GENERAL.—A center established
22 under paragraph (1) shall be selected on a com-
23 petitive, merit-reviewed basis for a period of not
24 more than 5 years, subject to the availability of

1 appropriations, beginning on the date of estab-
2 lishment of that center.

3 “(B) APPLICATIONS.—The Director shall
4 consider applications from National Labora-
5 tories, multi-institutional collaborations, and
6 other appropriate entities.

7 “(C) EXISTING CENTERS.—A center al-
8 ready in existence on the date of enactment of
9 the Department of Energy Science for the Fu-
10 ture Act may continue to receive support for a
11 period of not more than 5 years beginning on
12 the date of establishment of that center.

13 “(3) RENEWAL.—After the end of either period
14 described in paragraph (2), the Director may renew
15 support for the center for a period of not more than
16 5 years on a merit-reviewed basis. For a center in
17 operation for 10 years after its previous selection on
18 a competitive, merit-reviewed basis, the Director
19 may renew support for the center on a competitive,
20 merit-reviewed basis for a period of not more than
21 5 years, and may subsequently provide an additional
22 renewal on a merit-reviewed basis for a period of not
23 more than 5 years.

24 “(4) TERMINATION.—Consistent with the exist-
25 ing authorities of the Department, the Director may

1 terminate an underperforming center for cause dur-
2 ing the performance period.

3 “(5) ACTIVITIES.—Centers shall undertake re-
4 search activities to accelerate the production of
5 biofuels and bioproducts from advanced 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 biofuels and bioproducts production; and

20 “(iii) utilizing multiscale modeling to
21 advance predictive understanding of biofuel
22 cropping ecosystems.

23 “(B) Research activities to further feed-
24 stock development, including lignocellulosic,
25 algal, gaseous wastes including carbon oxides

1 and methane, and direct air capture of single
2 carbon gases via plants and microbes, includ-
3 ing—

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

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

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

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

21 “(i) developing feedstock-agnostic
22 deconstruction processes capable of effi-
23 ciently fractionating biomass into targeted
24 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 biofuels and bioproducts, as
20 well as high-throughput methods for exper-
21 imental validation of gene function;

22 “(iii) developing techniques to en-
23 hance microbial robustness for tolerating
24 toxins to improve biofuel and bioproduct
25 yields and to gain a better understanding

1 of the cellular and molecular bases of toler-
2 ance for major chemical classes of inhibi-
3 tors found in these processes;

4 “(iv) advancing technologies for the
5 use of batch, continuous, as well as con-
6 solidated bioprocessing;

7 “(v) identifying, creating, and opti-
8 mizing microbial and chemical pathways to
9 produce promising, atom-economical inter-
10 mediates and final bioproducts from bio-
11 mass with considerations given to environ-
12 mentally benign processes;

13 “(vi) developing high-throughput,
14 real-time, in situ analytical techniques to
15 understand and characterize the pre- and
16 post-bioproduct separation streams in de-
17 tail;

18 “(vii) creating methodologies for effi-
19 ciently identifying viable target molecules,
20 identifying high-value bioproducts in exist-
21 ing biomass streams, and utilizing current
22 byproduct streams;

23 “(viii) identifying and improving plant
24 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 fuels and bioproducts.

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

10 “(7) COORDINATION.—In coordination with the
11 Bioenergy Technologies Office of the Department,
12 the Director 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 biofuels and bioproducts, as
16 well as activities to enable positive impacts and avoid
17 the potential negative impacts that the production
18 and use of biofuels and bioproducts may have on
19 ecosystems, people, and historically marginalized
20 communities.”.

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

25 (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) \$40,000,000 for fiscal year 2025; and

5 “(F) \$50,000,000 for fiscal year 2026.”.

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

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

13 “(1) IN GENERAL.—The Secretary of Energy,
14 in consultation with the Administrator of the Na-
15 tional Aeronautics and Space Administration, shall
16 carry out a basic research program on the similar-
17 ities and differences between the effects of exposure
18 to low-dose radiation on Earth, in low Earth orbit,
19 and in the space environment.

20 “(2) PURPOSE.—The purpose of this program
21 is to accelerate breakthroughs in low-dose and low
22 dose-rate radiation research and development as de-
23 scribed in subsection (e) and to inform the advance-
24 ment of new tools, technologies, and advanced mate-

1 rials needed to facilitate long-duration space explo-
2 ration.”.

3 (e) 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 is further amended by adding at the end the following:

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

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

17 “(A) understand, observe, and model the
18 response of Earth’s atmosphere and biosphere
19 to increased concentrations of greenhouse gas
20 emissions and any associated changes in cli-
21 mate, including frequency and intensity of ex-
22 treme weather events;

23 “(B) understand the coupled physical,
24 chemical, and biological processes to transform,
25 immobilize, remove, or move carbon, nitrogen,

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

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

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

16 “(E) inform potential natural mitigation
17 and adaptation options for increased concentra-
18 tions of greenhouse gas emissions and any asso-
19 ciated changes in climate.

20 “(2) PRIORITIZATION.—In carrying out the
21 program authorized under paragraph (1), the Direc-
22 tor shall prioritize—

23 “(A) the development of software and algo-
24 rithms to enable the productive application of
25 environmental systems and extreme weather in

1 climate and Earth system prediction models in
2 high-performance computing systems; and

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

6 “(3) ENVIRONMENTAL SYSTEMS SCIENCE RE-
7 SEARCH.—

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

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

20 “(i) support interdisciplinary research
21 to significantly advance our understanding
22 of water availability, quality, and the im-
23 pact of human activity and a changing cli-
24 mate on urban and rural watershed sys-

1 tems, including in freshwater environ-
2 ments;

3 “(ii) consult with the Interagency Re-
4 search, Development, and Demonstration
5 Coordination Committee on the Nexus of
6 Energy and Water for Sustainability estab-
7 lished under section 1010 of the Energy
8 Act of 2020 (division Z of the Consolidated
9 Appropriations Act, 2021 (Public Law
10 116–260)) on energy-water nexus research
11 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 socio-
23 economic factors as appropriate, which may in-
24 clude the impacts of climate policies on social
25 and regional equity and well-being, and the

1 interdependencies and risks at the energy-
2 water-land nexus;

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

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

9 “(5) MID-SCALE FUNDING MECHANISM.—

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

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

21 “(h) BIOLOGICAL AND ENVIRONMENTAL RESEARCH
22 USER FACILITIES.—

23 “(1) IN GENERAL.—The Director shall carry
24 out a program for the development, construction, op-
25 eration, and maintenance of user facilities to en-

1 hance the collection and analysis of observational
2 data related to complex biological, climate, and envi-
3 ronmental systems.

4 “(2) FACILITY REQUIREMENTS.—To the max-
5 imum extent practicable, the user facilities devel-
6 oped, constructed, operated, or maintained under
7 paragraph (1) shall include—

8 “(A) distributed field research and obser-
9 vation platforms for understanding earth sys-
10 tem processes;

11 “(B) analytical techniques, instruments,
12 and modeling resources for understanding the
13 physical, chemical, and cellular processes of bio-
14 logical and environmental systems;

15 “(C) integrated high-throughput sequenc-
16 ing, advanced bioanalytic techniques, DNA de-
17 sign and synthesis, metabolomics, and computa-
18 tional analysis; and

19 “(D) such other facilities as the Director
20 considers appropriate, consistent with section
21 209 of the Department of Energy Organization
22 Act (42 U.S.C. 7139).

23 “(3) EXISTING FACILITIES.—In carrying out
24 the program established in paragraph (1), the Direc-
25 tor is encouraged to evaluate the capabilities of ex-

1 isting user facilities and, to the maximum extent
2 practicable, invest in modernization of those capa-
3 bilities to address emerging research priorities.

4 “(4) USER FACILITIES INTEGRATION AND COL-
5 LABORATION PROGRAM.—

6 “(A) IN GENERAL.—The Director shall
7 support a program of collaboration between
8 user facilities as defined under this subsection
9 to encourage and enable researchers to more
10 readily integrate the tools, expertise, resources,
11 and capabilities of multiple Office of Science
12 user facilities (as described in section 209(d) of
13 the Department of Energy Organization Act
14 (42 U.S.C. 7139)) to further research and ad-
15 vance emerging technologies.

16 “(B) ACTIVITIES.—The program shall ad-
17 vance the integration of automation, robotics,
18 computational biology, bioinformatics, bio-
19 sensing, cellular platforms and other relevant
20 emerging technologies as determined by the Di-
21 rector to enhance productivity and scientific im-
22 pact of user facilities.

23 “(5) EARTH AND ENVIRONMENTAL SYSTEMS
24 SCIENCES USER FACILITIES.—

1 “(A) IN GENERAL.—In carrying out the
2 activities authorized under paragraph (1), the
3 Director shall establish and operate user facili-
4 ties to advance the collection, validation, and
5 analysis of atmospheric data, including activi-
6 ties to advance knowledge and improve model
7 representations and measure the impact of at-
8 mospheric gases, aerosols, and clouds on earth
9 and environmental systems.

10 “(B) SELECTION.—The Director shall se-
11 lect user facilities under paragraph (1) on a
12 competitive, merit-reviewed basis. The Director
13 shall consider applications from the National
14 Laboratories, institutes of higher education,
15 multi-institutional collaborations, and other ap-
16 propriate entities.

17 “(C) EXISTING FACILITIES.—To the max-
18 imum extent practicable, the Director shall uti-
19 lize existing facilities to carry out this sub-
20 section.

21 “(6) COORDINATION.—In carrying out the pro-
22 gram authorized in paragraph (1), the Director shall
23 ensure that the Office of Science—

24 “(A) consults and coordinates with the Na-
25 tional Oceanic Atmospheric Administration, the

1 Environmental Protection Agency, the National
2 Aeronautics and Space Administration, the De-
3 partment of Agriculture, the Department of the
4 Interior, and any other relevant Federal agency
5 on the collection, validation, and analysis of at-
6 mospheric data; and

7 “(B) coordinates with relevant stake-
8 holders, including institutes of higher education,
9 nonprofit research institutions, industry, State,
10 local, and tribal governments, and other appro-
11 priate entities to ensure access to the best avail-
12 able relevant atmospheric and historical weath-
13 er data.

14 “(i) COASTAL ZONE RESEARCH INITIATIVE.—

15 “(1) IN GENERAL.—The Director shall carry
16 out a research program, in consultation with the Na-
17 tional Oceanic and Atmospheric Administration, to
18 enhance the understanding of coastal ecosystems. In
19 carrying out this program, the Director shall
20 prioritize efforts to enhance the collection of obser-
21 vational data, and shall develop models to analyze
22 the ecological, biogeochemical, hydrological and
23 physical processes that interact in coastal zones.

24 “(2) NATIONAL SYSTEM FOR COASTAL DATA
25 COLLECTION.—The Director shall establish, in con-

1 sultation with the National Oceanic and Atmospheric
2 Administration and other relevant agencies, an inte-
3 grated system of geographically diverse field re-
4 search sites in order to improve the quantity and
5 quality of observational data, and that encompass
6 the major land water interfaces of the United
7 States, including—

8 “(A) the Great Lakes region;

9 “(B) the Pacific coast;

10 “(C) the Atlantic coast;

11 “(D) the Arctic; and

12 “(E) the Gulf coast.

13 “(3) EXISTING INFRASTRUCTURE.—In carrying
14 out the programs and establishing the field research
15 sites under paragraph (1) and (2), the Secretary
16 shall leverage existing research and development in-
17 frastructure supported by the Department, including
18 the Department’s existing marine and coastal re-
19 search lab.

20 “(4) COORDINATION.—For the purposes of car-
21 rying out the programs and establishing the field re-
22 search sites under the Initiative, the Secretary may
23 enter into agreements with Federal Departments
24 and agencies with complementary capabilities.

1 “(5) REPORT.—Not less than 2 years after the
2 date of the enactment of the Department of Energy
3 Science for the Future Act, the Director shall pro-
4 vide to the Committee on Science, Space, and Tech-
5 nology and the Committee on Appropriations of the
6 House of Representatives and the Committee on En-
7 ergy and Natural Resources and the Committee on
8 Appropriations of the Senate a report examining
9 whether the system described in this section should
10 be established as a National User Facility.

11 “(j) TECHNOLOGY DEVELOPMENT.—The Director
12 shall support a technology research program for the devel-
13 opment of instrumentation and other research tools re-
14 quired to meet the missions of the Department and to pro-
15 vide platform technologies for the broader scientific com-
16 munity. Technologies shall include but are not limited to—

17 “(1) cryo-electron microscopy;

18 “(2) fabricated ecosystems;

19 “(3) next generation sensors including quantum
20 sensors for biological integration and bioproduction;

21 “(4) technologies to accelerate data analysis;

22 and

23 “(5) plant and microbial phenotyping for gene
24 discovery.

25 “(k) EMERGING TECHNOLOGIES.—

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

7 “(2) INTERAGENCY COORDINATION.—The Sec-
8 retary shall coordinate with the Director of the Na-
9 tional Science Foundation, the Administrator of the
10 National Oceanic and Atmospheric Administration,
11 the Director of the U.S. Geological Survey, and
12 other relevant officials to avoid duplication of re-
13 search and observational activities and to ensure
14 that activities carried out under this initiative are
15 complimentary to those currently being undertaken
16 by other agencies.

17 “(3) REPORT.—Not later than 180 days after
18 the enactment of this Act, the Secretary shall pro-
19 vide a report to the Committee on Science, Space,
20 and Technology of the House, and the Committee on
21 Energy and Natural Resources of the Senate, on the
22 activity mandated in subsection (k).

23 “(1) AUTHORIZATION OF APPROPRIATIONS.—There
24 are authorized to be appropriated to the Secretary to carry
25 out the activities described in this section—

- 1 “(1) \$820,360,000 for fiscal year 2022;
 2 “(2) \$886,385,200 for fiscal year 2023;
 3 “(3) \$956,332,164 for fiscal year 2024;
 4 “(4) \$1,020,475,415 for fiscal year 2025; and
 5 “(5) \$1,099,108,695 for fiscal year 2026.”.

6 **SEC. 5. ADVANCED SCIENTIFIC COMPUTING RESEARCH**
 7 **PROGRAM.**

8 (a) ADVANCED SCIENTIFIC COMPUTING RE-
 9 SEARCH.—Section 304 of the Department of Energy Re-
 10 search and Innovation Act (42 U.S.C. 18642) is amend-
 11 ed—

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

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

16 “(a) IN GENERAL.—As part of the activities author-
 17 ized under section 209 of the Department of Energy Orga-
 18 nization Act (42 U.S.C. 7139), the Director shall carry
 19 out, in coordination with academia and relevant public and
 20 private sector entities, a research, development, and dem-
 21 onstration program to—

22 “(1) steward applied mathematics, computa-
 23 tional science, and computer science research rel-
 24 evant to the missions of the Department and the
 25 competitiveness of the United States;

1 “(2) develop modeling, simulation, and other
2 computational tools relevant to other scientific dis-
3 ciplines and to the development of new energy tech-
4 nologies and other technologies;

5 “(3) advance computing and networking capa-
6 bilities for data-driven discovery; and

7 “(4) develop advanced scientific computing
8 hardware and software tools for science and engi-
9 neering.”;

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

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

14 “(1) DIRECTOR.—The Director”; and

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

16 “(2) COORDINATION.—The Under Secretary for
17 Science shall ensure the coordination of the activities
18 of the Department, including activities under this
19 section, to determine and meet the computational
20 and networking research and facility needs of the
21 Office of Science and all other relevant energy tech-
22 nology and energy efficiency programs within the
23 Department and with other Federal agencies as ap-
24 propriate.”;

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

3 “(d) APPLIED MATHEMATICS AND SOFTWARE DE-
4 VELOPMENT FOR HIGH-END COMPUTING SYSTEMS AND
5 COMPUTER SCIENCES RESEARCH.—

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

8 “(A) mathematics, statistics, and algo-
9 rithms for modeling complex systems relevant
10 to the missions of the Department, including on
11 advanced computing architectures; and

12 “(B) tools, languages, programming envi-
13 ronments, and operations for high-end com-
14 puting systems (as defined in section 2 of the
15 American Super Computing Leadership Act (15
16 U.S.C. 5541).

17 “(2) PORTFOLIO BALANCE.—

18 “(A) IN GENERAL.—The Director shall
19 maintain a balanced portfolio within the ad-
20 vanced scientific computing research and devel-
21 opment program established under section 976
22 of the Energy Policy Act of 2005 (42 U.S.C.
23 16316) that supports robust investment in—

24 “(i) applied mathematical, computa-
25 tional, and computer sciences research

1 needs relevant to the mission of the De-
2 partment, including foundational areas
3 that are critical to the advancement of en-
4 ergy sciences and technologies and new
5 and emerging computing technologies; and

6 “(ii) associated high-performance
7 computing hardware and facilities.

8 “(B) EXASCALE ECOSYSTEM
9 SUSTAINMENT.—

10 “(i) SENSE OF CONGRESS.—It is the
11 sense of Congress that the Exascale Com-
12 puting Project has successfully created a
13 broad ecosystem that provides shared soft-
14 ware packages, novel evaluation systems,
15 and applications relevant to the science
16 and engineering requirements of the De-
17 partment, and that such products must be
18 maintained and improved in order that the
19 full potential of the deployed systems can
20 be continuously realized.

21 “(ii) IN GENERAL.—The Secretary
22 shall seek to sustain and evolve the eco-
23 system referenced in clause (i) to ensure
24 that the exascale software stack and other
25 research software will continue to be main-

1 tained, hardened, and otherwise optimized
2 for long-term use on exascale systems and
3 beyond and reliable availability to the user
4 community.”; and

5 (5) by inserting after subsection (d) the fol-
6 lowing:

7 “(e) NEXT GENERATION COMPUTING PROGRAM.—

8 “(1) IN GENERAL.—The Secretary shall estab-
9 lish a program to develop and implement a strategy
10 for achieving computing systems with capabilities be-
11 yond exascale computing systems. In establishing
12 this program, the Secretary shall—

13 “(A) maintain foundational research pro-
14 grams in mathematical, computational, and
15 computer sciences focused on new and emerging
16 computing needs within the mission of the De-
17 partment, including post-Moore’s law computing
18 architectures, novel approaches to modeling and
19 simulation, artificial intelligence and scientific
20 machine learning, quantum computing, edge
21 computing, extreme heterogeneity, and distrib-
22 uted high-performance computing;

23 “(B) retain best practices and maintain
24 support for essential hardware, applications,
25 and software elements of the Exascale Com-

1 puting Program that are necessary for sus-
2 taining the vitality of a long-term capable soft-
3 ware ecosystem for exascale and beyond; and

4 “(C) develop a Department-wide strategy
5 for balancing on-premises and cloud-based com-
6 puting and scientific data management.

7 “(2) REPORT.—Not later than one year after
8 the date of the enactment of the Department of En-
9 ergy Science for the Future Act, the Secretary shall
10 submit to the Committee on Science, Space, and
11 Technology of the House of Representatives, and the
12 Committee on Energy and Natural Resources of the
13 Senate, a report on the development and implemen-
14 tation of the strategy outlined in paragraph (1).

15 “(f) ARCHITECTURAL RESEARCH IN HETERO-
16 GENEOUS 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 of Energy mission challenges. This
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 this pro-
4 gram, the Secretary shall ensure coordination be-
5 tween research activities undertaken by the Ad-
6 vanced Scientific Computing Research program and
7 materials research supported by the Basic Energy
8 Sciences program within the Department of Energy
9 Office of Science.

10 “(g) 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 co-design;

10 “(iii) consider multiple heterogeneous
11 computing architectures in collaboration
12 with the program established under sub-
13 section (f) 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 one year
4 after the date of the enactment of the Depart-
5 ment of Energy Science for the Future Act, the
6 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 “(h) 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 cyber-attacks.

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 “(i) 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

1 help advance research in areas relevant to the mis-
 2 sion of the Department.

3 “(2) FUNDING.—From within funds authorized
 4 to be appropriated for Advanced Scientific Com-
 5 puting Research Program, the Secretary shall make
 6 available for carrying out the activities under this
 7 section—

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

17 “(1) \$1,126,350,000 for fiscal year 2022;

18 “(2) \$1,222,674,500 for fiscal year 2023;

19 “(3) \$1,324,320,715 for fiscal year 2024;

20 “(4) \$1,431,660,115 for fiscal year 2025; and

21 “(5) \$1,535,090,121 for fiscal year 2026.”.

22 (b) QUANTUM SCIENCE NETWORK.—

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

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

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

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

10 (2) DEPARTMENT OF ENERGY QUANTUM NET-
11 WORK INFRASTRUCTURE RESEARCH AND DEVELOP-
12 MENT PROGRAM.—(A) Title IV of the National
13 Quantum Initiative Act (15 U.S.C. 8851 et seq.) is
14 amended by adding at the end the following:

15 **“SEC. 403. DEPARTMENT OF ENERGY QUANTUM NETWORK**
16 **INFRASTRUCTURE RESEARCH AND DEVELOP-**
17 **MENT PROGRAM.**

18 “(a) IN GENERAL.—The Secretary of Energy (re-
19 ferred to in this section as the ‘Secretary’) shall carry out
20 a research, development, and demonstration program to
21 accelerate innovation in quantum network infrastructure
22 in order to—

23 “(1) facilitate the advancement of distributed
24 quantum computing systems through the internet
25 and intranet;

1 “(2) improve the precision of measurements of
2 scientific phenomena and physical imaging tech-
3 nologies;

4 “(3) develop secure national quantum commu-
5 nications technologies and strategies; and

6 “(4) demonstrate these capabilities utilizing the
7 Department of Energy’s Energy Sciences Network
8 User Facility.

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

11 “(1) coordinate with—

12 “(A) the Director of the National Science
13 Foundation;

14 “(B) the Director of the National Institute
15 of Standards and Technology;

16 “(C) the Chair of the Subcommittee on
17 Quantum Information Science of the National
18 Science and Technology Council established
19 under section 103(a); and

20 “(D) the Chair of the Subcommittee on the
21 Economic and Security Implications of Quan-
22 tum Science;

23 “(2) conduct cooperative research with indus-
24 try, National Laboratories, institutions of higher
25 education, and other research institutions to facili-

1 tate new quantum infrastructure methods and tech-
2 nologies, including—

3 “(A) quantum-limited detectors, ultra-low
4 loss optical channels, space-to-ground connec-
5 tions, and classical networking and cybersecu-
6 rity protocols;

7 “(B) entanglement and hyper-entangled
8 state sources and transmission, control, and
9 measurement of quantum states;

10 “(C) quantum interconnects that allow
11 short range local connections between quantum
12 processors;

13 “(D) transducers for quantum sources and
14 signals between optical and telecommunications
15 regimes and quantum computer-relevant do-
16 mains, including microwaves;

17 “(E) development of quantum memory
18 buffers and small-scale quantum computers
19 that are compatible with photon-based quantum
20 bits in the optical or telecommunications wave-
21 lengths;

22 “(F) long-range entanglement distribution
23 at both the terrestrial and space-based level
24 using quantum repeaters, allowing entangle-

1 ment-based protocols between small- and large
2 scale quantum processors;

3 “(G) quantum routers, multiplexers, re-
4 peaters, and related technologies necessary to
5 create secure long-distance quantum commu-
6 nication; and

7 “(H) integration of systems across the
8 quantum technology stack into traditional com-
9 puting networks, including the development of
10 remote controlled, high performance, and reli-
11 able implementations of key quantum network
12 components by leveraging the expertise, infra-
13 structure and supplemental investments in the
14 Energy Sciences Network User Facility;

15 “(3) engage with the Quantum Economic De-
16 velopment Consortium (QED-C) to transition com-
17 ponent technologies to help facilitate as appropriate
18 the development of a quantum supply chain for
19 quantum network technologies;

20 “(4) advance basic research in advanced sci-
21 entific computing, particle and nuclear physics, and
22 material science to enhance the understanding, pre-
23 diction, and manipulation of materials, processes,
24 and physical phenomena relevant to quantum net-
25 work infrastructure;

1 “(5) develop experimental tools and testbeds in
2 collaboration with the Department of Energy’s En-
3 ergy Sciences Network User Facility necessary to
4 support cross-cutting fundamental research and de-
5 velopment activities with diverse stakeholders from
6 industry, National Laboratories, and institutions of
7 higher education; and

8 “(6) consider quantum network infrastructure
9 applications that span the Department of Energy’s
10 missions in energy, environment, and national secu-
11 rity.

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

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

17 “(2) the National Science Foundation;

18 “(3) the National Aeronautics and Space Ad-
19 ministration;

20 “(4) other relevant Federal agencies;

21 “(5) the National Laboratories;

22 “(6) industry stakeholders;

23 “(7) institutions of higher education; and

24 “(8) the National Quantum Information
25 Science Research Centers.

1 “(d) RESEARCH PLAN.—Not later than 180 days
2 after the date of the enactment of the Department of En-
3 ergy Science for the Future Act, the Secretary shall sub-
4 mit to the Committee on Science, Space, and Technology
5 of the House of Representatives and the Committee on
6 Energy and Natural Resources of the Senate, a 4-year re-
7 search plan that identifies and prioritizes basic research
8 needs relating to quantum network infrastructure.

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

12 “(f) FUNDING.—Out of funds authorized to be appro-
13 priated for the Department of Energy’s Office of Science,
14 there shall be made available to the Secretary to carry out
15 the activities under this section, \$100,000,000 for each
16 of fiscal years 2022 through 2026.

17 **“SEC. 404. DEPARTMENT OF ENERGY QUANTUM USER EX-**
18 **PANSION FOR SCIENCE AND TECHNOLOGY**
19 **PROGRAM.**

20 “(a) IN GENERAL.—The Secretary of Energy (re-
21 ferred to in this section as the ‘Secretary’) shall establish
22 and carry out a program (to be known as the ‘Quantum
23 User Expansion for Science and Technology program’ or
24 ‘QUEST program’) to encourage and facilitate access to

1 United States quantum computing hardware and quantum
2 computing clouds for research purposes to—

3 “(1) enhance the United States quantum re-
4 search enterprise;

5 “(2) educate the future quantum computing
6 workforce; and

7 “(3) accelerate the advancement of United
8 States quantum computing capabilities.

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

11 “(1) coordinate with—

12 “(A) the Director of the National Science
13 Foundation;

14 “(B) the Director of the National Institute
15 of Standards and Technology;

16 “(C) the Chair of the Subcommittee on
17 Quantum Information Science of the National
18 Science and Technology Council established
19 under section 103(a); and

20 “(D) the Chair of the Subcommittee on the
21 Economic and Security Implications of Quan-
22 tum Science;

23 “(2) provide researchers based within the
24 United States with access to, and use of, United

1 States quantum computing resources through a com-
2 petitive, merit-reviewed process;

3 “(3) consider applications from the National
4 Laboratories, multi-institutional collaborations, insti-
5 tutions of higher education, industry stakeholders,
6 and any other entities that the Secretary determines
7 are appropriate to provide national leadership on
8 quantum computing related issues; and

9 “(4) consult and coordinate with private sector
10 stakeholders, the user community, and interagency
11 partners on program development and best manage-
12 ment practices.

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

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

18 “(2) the National Science Foundation;

19 “(3) the National Aeronautics and Space Ad-
20 ministration;

21 “(4) other relevant Federal agencies;

22 “(5) the National Laboratories;

23 “(6) industry stakeholders;

24 “(7) institutions of higher education; and

1 “(8) the National Quantum Information
2 Science Research Centers.

3 “(d) SECURITY.—In carrying out the activities au-
4 thorized by this section, the Secretary, in consultation
5 with the Director of the National Science Foundation and
6 the Director of the National Institute of Standards and
7 Technology, shall ensure proper security controls are in
8 place to protect sensitive information, as appropriate.

9 “(e) FUNDING.—Out of funds authorized to be ap-
10 propriated for the Department of Energy’s Office of
11 Science, there shall be made available to the Secretary to
12 carry out the activities under this section—

13 “(1) \$30,000,000 for fiscal year 2022;

14 “(2) \$50,000,000 for fiscal year 2023;

15 “(3) \$70,000,000 for fiscal year 2024;

16 “(4) \$90,000,000 for fiscal year 2025; and

17 “(5) \$100,000,000 for fiscal year 2026.

18 “(f) EQUITABLE USE OF HIGH-PERFORMANCE COM-
19 PUTING CAPABILITIES.—

20 “(1) SENSE OF CONGRESS.—It is the sense of
21 Congress that machine learning algorithms can ex-
22 hibit biases that cause harm to historically
23 marginalized communities.

24 “(2) POLICY.—In leveraging high-performance
25 computing systems for research purposes, including

1 through the use of machine learning algorithms for
 2 data analysis, the Secretary shall ensure that such
 3 capabilities are employed in a manner that mitigates
 4 and, to the maximum extent practicable, avoids
 5 harmful algorithmic bias and equitably addresses
 6 challenges impacting different populations, including
 7 historically marginalized communities.”.

8 (B) The table of contents in section 1(b) of the
 9 National Quantum Initiative Act is amended by in-
 10 serting after the item relating to section 402 the fol-
 11 lowing items:

“Sec. 403. Department of energy quantum network infrastructure research and
 development program.

“Sec. 404. Department of energy quantum user expansion for science and tech-
 nology program.”.

12 **SEC. 6. FUSION ENERGY RESEARCH.**

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

16 (1) in subsection (b)—

17 (A) in the matter preceding paragraph (1),
 18 by striking “As part of” and inserting the fol-
 19 lowing:

20 “(1) IN GENERAL.—As part of”;

21 (B) by redesignating—

22 (i) paragraphs (1) and (2) as sub-
 23 paragraphs (A) and (B), respectively (and

1 by adjusting the margins of such subpara-
2 graphs accordingly); and

3 (ii) in subparagraph (B) (as redesign-
4 nated by clause (i)), subparagraphs (A)
5 and (B) as clauses (i) and (ii), respectively
6 (and by adjusting the margins of such
7 clauses accordingly); and

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

9 “(2) AUTHORIZATION OF APPROPRIATIONS.—

10 Out of funds authorized to be appropriated under
11 subsection (r), there are 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 the period at the end and
17 inserting “and \$40,000,000 for fiscal year
18 2026.”; and

19 (B) by striking “(o)” and inserting “(r)”;
20 and

21 (3) in subsection (e)(4)—

22 (A) by striking the period at the end and
23 inserting “and \$75,000,000 for fiscal year
24 2026.”; and

25 (B) by striking “(o)” and inserting “(r)”;

1 (4) in subsection (i)(10)—

2 (A) In the matter preceding subparagraph

3 (A), by striking “(o)” and inserting “(r)”;

4 (B) in subparagraph (D), by striking “;
5 and” and inserting a semicolon;

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

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

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

10 (5) in subsection (j)—

11 (A) by striking “The Director” and all
12 that follows through the period and inserting
13 the following:

14 “(1) IN GENERAL.—

15 “(A) ESTABLISHMENT.—Within 180 days
16 of enactment of the Department of Energy
17 Science for the Future Act, the Director shall
18 establish at least 2 national teams, including
19 public-private partnerships, that will develop
20 conceptual pilot plant designs and technology
21 roadmaps and lead to an engineering design of
22 a pilot plant that will bring fusion to commer-
23 cial viability.

24 “(B) COMPOSITION.—The national teams
25 shall be composed of developers, manufacturers,

1 universities, national laboratories, and engineer-
 2 ing, procurement, and construction industries.”;
 3 and

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

5 “(2) AUTHORIZATION OF APPROPRIATIONS.—

6 There are authorized to be appropriated to carry out
 7 activities described in paragraph (1)—

8 “(A) \$20,000,000 for fiscal year 2022;

9 “(B) \$35,000,000 for fiscal year 2023;

10 “(C) \$50,000,000 for fiscal year 2024;

11 “(D) \$65,000,000 for fiscal year 2025;

12 and

13 “(E) \$80,000,000 for fiscal year 2026.”;

14 (6) in subsection (l)—

15 (A) by striking “sense of Congress that the
 16 United States should support” and inserting
 17 “sense of Congress that—”;

18 “(1) the United States should support”;

19 (B) in paragraph (1) (as so designated by
 20 subparagraph (A) of this paragraph), by strik-
 21 ing the period at the end and inserting “; and”;
 22 and

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

24 “(2) the Director shall incorporate the findings
 25 and recommendations of the report of the Fusion

1 Energy Sciences Advisory Committee entitled
2 ‘Powering the Future: Fusion and Plasmas’ and the
3 report of the National Academies of Science, Engi-
4 neering, and Medicine entitled “Bringing Fusion to
5 the U.S. Grid” into the planning process of the De-
6 partment, including the development of future budg-
7 et requests to Congress.”;

8 (7) by redesignating subsection (o) as sub-
9 section (r);

10 (8) by inserting after subsection (n) the fol-
11 lowing:

12 “(o) HIGH-PERFORMANCE COMPUTATION COLLABO-
13 RATIVE RESEARCH PROGRAM.—

14 “(1) IN GENERAL.—The Secretary shall carry
15 out a program to conduct and support collaborative
16 research, development, and demonstration of fusion
17 energy technologies, through high-performance com-
18 putation modeling and simulation techniques, in
19 order to—

20 “(A) support fundamental research in plas-
21 mas and matter at very high temperatures and
22 densities;

23 “(B) inform the development of a broad
24 range of fusion energy systems; and

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

3 “(2) COORDINATION.—In carrying out the pro-
4 gram under paragraph (1), the Secretary shall co-
5 ordinate with relevant Federal agencies, and
6 prioritize the following objectives:

7 “(A) Using expertise from the private sec-
8 tor, institutions of higher education, and the
9 National Laboratories to leverage existing, and
10 develop new, computational software and capa-
11 bilities that prospective users may use to accel-
12 erate research and development of fusion energy
13 systems.

14 “(B) Developing computational tools to
15 simulate and predict fusion energy science phe-
16 nomena that may be validated through physical
17 experimentation.

18 “(C) Increasing the utility of the research
19 infrastructure of the Department by coordi-
20 nating with the Advanced Scientific Computing
21 Research program within the Office of Science.

22 “(D) Leveraging experience from existing
23 modeling and simulation entities sponsored by
24 the Department.

1 “(E) Ensuring that new experimental and
2 computational tools are accessible to relevant
3 research communities, including private sector
4 entities engaged in fusion energy technology de-
5 velopment.

6 “(F) Ensuring that newly developed com-
7 putational tools are compatible with modern vir-
8 tual engineering and visualization capabilities to
9 accelerate the realization of fusion energy tech-
10 nologies and systems.

11 “(3) DUPLICATION.—The Secretary shall en-
12 sure the coordination of, and avoid unnecessary du-
13 plication of, the activities of this program with the
14 activities of—

15 “(A) other research entities of the Depart-
16 ment, including the National Laboratories, the
17 Advanced Research Projects Agency–Energy,
18 the Advanced Scientific Computing Research
19 program; and

20 “(B) industry.

21 “(4) HIGH-PERFORMANCE COMPUTING FOR FU-
22 SION INNOVATION CENTER.—In carrying out the
23 program under paragraph (1), the Secretary shall,
24 in coordination with the Innovation Network for Fu-
25 sion Energy, establish and operate a national High-

1 Performance Computing for Fusion Innovation Cen-
2 ter (referred to in this subsection as the ‘Center’),
3 to support the program under paragraph (1) by pro-
4 viding, to the extent practicable, a centralized entity
5 for multidisciplinary, collaborative, fusion energy re-
6 search and development through high performance
7 computing and advanced data analytics technologies
8 and processes.

9 “(5) SELECTION.—The Secretary shall select
10 the Center under this subsection on a competitive,
11 merit-reviewed basis. The Secretary shall consider
12 applications from National Laboratories, institutions
13 of higher education, multi-institutional collabora-
14 tions, and other appropriate entities.

15 “(6) EXISTING ACTIVITIES.—The Center may
16 incorporate existing research activities that are con-
17 sistent with the program described in paragraph (1).

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

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

1 “(9) TERMINATION.—Consistent with the exist-
2 ing authorities of the Department, the Secretary
3 may terminate the Center for cause during the per-
4 formance period.

5 “(p) MATERIAL PLASMA EXPOSURE EXPERIMENT.—

6 “(1) IN GENERAL.—The Secretary shall con-
7 struct a Material Plasma Exposure Experiment fa-
8 cility as described in the 2020 publication approved
9 by the Fusion Energy Sciences Advisory Committee
10 titled ‘Powering the Future: Fusion and Plasmas’.
11 The Secretary shall consult with the private sector,
12 universities, National Laboratories, and relevant
13 Federal agencies to ensure that this facility is capa-
14 ble of meeting Federal research needs for steady
15 state, high-heat-flux and plasma-material interaction
16 testing of fusion materials over a range of fusion en-
17 ergy relevant parameters.

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

21 “(A) A magnetic field at the target of 1
22 Tesla.

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

1 “(C) The ability to expose previously irra-
2 diated plasma facing material samples to plas-
3 ma.

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

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

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

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

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

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

18 “(q) MATTER IN EXTREME CONDITIONS INSTRU-
19 MENT UPGRADE.—

20 “(1) IN GENERAL.—The Secretary shall provide
21 for the upgrade to the Matter in Extreme Conditions
22 endstation at the Linac Coherent Light Source as
23 described in the 2020 publication approved by the
24 Fusion Energy Sciences Advisory Committee titled
25 ‘Powering the Future: Fusion and Plasmas’. The

1 Secretary shall consult with the private sector, uni-
2 versities, National Laboratories, and relevant Fed-
3 eral agencies to ensure that this facility is capable
4 of meeting Federal research needs for understanding
5 physical and chemical changes to plasmas at funda-
6 mental timescales, and explore new regimes of dense
7 material physics, astrophysics, planetary physics,
8 and short-pulse laser-plasma interactions.

9 “(2) START OF OPERATIONS.—The Secretary
10 shall, subject to the availability of appropriations,
11 ensure that the start of full operations of the facility
12 under this section occurs before December 31,
13 2028.”; and

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

17 “(2) \$1,002,900,000 for fiscal year 2022;

18 “(3) \$1,095,707,000 for fiscal year 2023;

19 “(4) \$1,129,368,490 for fiscal year 2024;

20 “(5) \$1,149,042,284 for fiscal year 2025; and

21 “(6) \$1,243,097,244 for fiscal year 2026.”.

22 (b) ITER CONSTRUCTION.—Section 972 of the En-
23 ergy Policy Act of 2005 (42 U.S.C. 16312) is amended
24 in subsection (c)(3)—

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

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

5 “(B) \$300,000,000 for fiscal year 2022;

6 “(C) \$325,000,000 for fiscal year 2023;

7 “(D) \$350,000,000 for fiscal year 2024;

8 “(E) \$350,000,000 for fiscal year 2025;

9 and

10 “(F) \$350,000,000 for fiscal year 2026.”.

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

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

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

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

19 “(b) 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 in elementary particle physics and ad-
23 vanced technology research and development to improve
24 the understanding of the fundamental properties of the

1 universe, including constituents of matter and energy and
2 the nature of space and time.

3 “(c) HIGH ENERGY FRONTIER RESEARCH.—As part
4 of the program described in subsection (b), the Director
5 shall carry out research using high energy accelerators
6 and advanced detectors, including accelerators and detec-
7 tors that will function as national user facilities, to create
8 and study interactions of elementary particles and inves-
9 tigate fundamental forces.”.

10 (b) INTERNATIONAL COLLABORATION.—Section
11 305(d) of the Department of Energy Research and Inno-
12 vation Act (42 U.S.C. 18643(d)), as redesignated under
13 subsection (a), is amended to read as follows:

14 “(d) INTERNATIONAL COLLABORATION.—The Direc-
15 tor shall—

16 “(1) as practicable and in coordination with
17 other appropriate Federal agencies as necessary, en-
18 sure the access of United States researchers to the
19 most advanced accelerator facilities and research ca-
20 pabilities in the world, including the Large Hadron
21 Collider;

22 “(2) to the maximum extent practicable, con-
23 tinue to leverage United States participation in the
24 Large Hadron Collider, and prioritize expanding
25 international partnerships and investments in the

1 Long-Baseline Neutrino Facility and Deep Under-
2 ground Neutrino Experiment; and

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

8 (c) COSMIC FRONTIER RESEARCH.—Section 305(f)
9 of the Department of Energy Research and Innovation Act
10 (42 U.S.C. 18645(f)), as redesignated by subsection (a),
11 is amended to read as follows:

12 “(f) COSMIC FRONTIER RESEARCH.—The Director
13 shall carry out research activities on the nature of the pri-
14 mary contents of the universe, including the nature of
15 dark energy and dark matter. These activities shall, to the
16 maximum extent practicable, be consistent with the re-
17 search priorities identified by the High Energy Physics
18 Advisory Panel or the National Academy of Sciences, and
19 may include—

20 “(1) collaborations with the National Aero-
21 nautics and Space Administration, the National
22 Science Foundation, or international partners on rel-
23 evant projects; and

1 “(2) the development of space-based, land-
2 based, water-based, and underground facilities and
3 experiments.”.

4 (d) FURTHER ACTIVITIES.—Section 305 of the De-
5 partment of Energy Research and Innovation Act (42
6 U.S.C. 18645) is further amended by adding at the end
7 the following:

8 “(g) FACILITY CONSTRUCTION AND MAJOR ITEMS
9 OF EQUIPMENT.—

10 “(1) PROJECTS.—Consistent with the Office of
11 Science’s project management practices, the Director
12 shall, to the maximum extent practicable, incor-
13 porate the findings and recommendations of the
14 2014 Particle Physics Project Prioritization Panel
15 (P5) report titled ‘Building for Discovery’, and sup-
16 port construction or fabrication of—

17 “(A) an international Long-Baseline Neu-
18 trino Facility based in the United States;

19 “(B) the Proton Improvement Plan II;

20 “(C) Second Generation Dark Matter ex-
21 periments;

22 “(D) the Legacy Survey of Space and
23 Time camera;

24 “(E) upgrades to detectors and other com-
25 ponents of the Large Hadron Collider; and

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

“(2) LONG-BASELINE NEUTRINO FACILITY.—

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

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

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

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

1 “(iii) Cryogenic systems to support
2 neutrino detectors.

3 “(C) START OF OPERATIONS.—The Sec-
4 retary shall, subject to the availability of appro-
5 priations, ensure that the start of full oper-
6 ations of the facility under this subsection oc-
7 curs before December 31, 2031.

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

13 “(i) \$200,000,000 for fiscal year
14 2022;

15 “(ii) \$325,000,000 for fiscal year
16 2023;

17 “(iii) \$400,000,000 for fiscal year
18 2024;

19 “(iv) \$375,000,000 for fiscal year
20 2025; and

21 “(v) \$250,000,000 for fiscal year
22 2026.

23 “(3) PROTON IMPROVEMENT PLAN—II ACCEL-
24 ERATOR UPGRADE PROJECT.—

1 “(A) IN GENERAL.—The Secretary of En-
2 ergy shall support construction of the Proton
3 Improvement Plan II, an upgrade to the
4 Fermilab accelerator complex identified in the
5 2014 Particle Physics Project Prioritization
6 Panel (P5) report titled ‘Building for Dis-
7 covery’, to provide the world’s most intense
8 beam of neutrinos to the international Long
9 Baseline Neutrino Facility as well as abroad
10 range of future high energy physics experi-
11 ments. The Secretary of Energy shall work with
12 international partners to enable further signifi-
13 cant contributions to the capabilities of this
14 project.

15 “(B) FACILITY CAPABILITIES.—The Sec-
16 retary shall ensure that the facility described in
17 paragraph (1) will provide, at a minimum, the
18 following capabilities:

19 “(i) A state-of-the-art 800
20 megaelectron volt (MeV) superconducting
21 linear accelerator.

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

1 “(iii) A flexible design to enable high
2 power beam delivery to multiple users si-
3 multaneously and customized beams tai-
4 lored to specific scientific needs.

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

7 “(C) START OF OPERATIONS.—The Sec-
8 retary shall, subject to the availability of appro-
9 priations, ensure that the start of full oper-
10 ations of the facility under this section occurs
11 before December 31, 2028.

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

17 “(i) \$191,000,000 for fiscal year
18 2022;

19 “(ii) \$150,000,000 for fiscal year
20 2023;

21 “(iii) \$120,000,000 for fiscal year
22 2024;

23 “(iv) \$120,000,000 for fiscal year
24 2025; and

1 “(v) \$100,000,000 for fiscal year
2 2026.

3 “(4) COSMIC MICROWAVE BACKGROUND STAGE

4 4.—

5 “(A) IN GENERAL.—The Secretary of En-
6 ergy, in partnership with the Director of the
7 National Science Foundation, shall support con-
8 struction of the Cosmic Microwave Background
9 Stage 4 project to survey the cosmic microwave
10 background to test theories of cosmic inflation
11 as described in the 2014 Particle Physics
12 Prioritization Panel (P5) report titled ‘Building
13 for Discovery: Strategic Plan for U.S. Particle
14 Physics in the Global Context.’.

15 “(B) CONSULTATION.—The Secretary
16 shall consult with the private sector, univer-
17 sities, National Laboratories, and relevant Fed-
18 eral agencies to ensure that this experiment is
19 capable of meeting Federal research needs in
20 accessing the ultra-high energy physics of infla-
21 tion and important neutrino properties.

22 “(C) EXPERIMENTAL CAPABILITIES.—The
23 Secretary shall ensure to the maximum extent
24 practicable that the facility described in sub-
25 section (a) will provide at minimum, 500,000

1 superconducting detectors deployed on an array
2 of mm wave telescopes with the required range
3 in frequency, sensitivity, and survey speed
4 which will provide sufficient capability to enable
5 an order of magnitude advance in observations
6 of the Cosmic Microwave Background, deliv-
7 ering transformative discoveries in fundamental
8 physics, cosmology, and astrophysics.

9 “(D) START OF OPERATIONS.—The Sec-
10 retary shall, subject to the availability of appro-
11 priations, ensure that the start of full oper-
12 ations of the facility under this section occurs
13 before December 31, 2030.

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

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

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

21 “(iii) \$70,000,000 for fiscal year
22 2024;

23 “(iv) \$80,000,000 for fiscal year
24 2025; and

25 “(v) \$90,000,000 for fiscal year 2026.

1 “(h) ACCELERATOR AND DETECTOR UPGRADES.—
2 The Director shall upgrade accelerator facilities and detec-
3 tors, as necessary and appropriate, to increase beam
4 power, sustain high reliability, and improve precision
5 measurement to advance the highest priority particle phys-
6 ics research programs. In carrying out facility upgrades,
7 the Director shall continue to work with international
8 partners, when appropriate and in the United States’ in-
9 terest, to leverage investments and expertise in critical
10 technologies to help build and upgrade accelerator and de-
11 tector facilities in the United States.

12 “(i) ACCELERATOR AND DETECTOR RESEARCH AND
13 DEVELOPMENT.—As part of the program described in
14 subsection (b), the Director shall carry out research and
15 development in particle beam physics, accelerator science
16 and technology, and particle and radiation detection with
17 relevance to the specific needs of the High Energy Physics
18 program, in coordination with the Accelerator Research
19 and Development program authorized in section 310.

20 “(j) UNDERGROUND SCIENCE.—The Director shall—
21 “(1) support an underground science program
22 consistent with the missions of the Department and
23 the scientific needs of the High Energy Physics pro-
24 gram, including those articulated in the most recent
25 report of the Particle Physics Project Prioritization

1 Panel of the High Energy Physics Advisory Panel,
 2 that leverages the capabilities of relevant under-
 3 ground science and engineering facilities; and

4 “(2) carry out a competitive grant program to
 5 award scientists and engineers at institutions of
 6 higher education, nonprofit institutions, and Na-
 7 tional Laboratories to conduct research in under-
 8 ground science and engineering.

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

12 “(1) \$1,355,690,000 for fiscal year 2022;

13 “(2) \$1,517,628,300 for fiscal year 2023;

14 “(3) \$1,652,112,281 for fiscal year 2024;

15 “(4) \$1,711,460,141 for fiscal year 2025; and

16 “(5) \$1,656,012,351 for fiscal year 2026.”.

17 **SEC. 8. NUCLEAR PHYSICS PROGRAM.**

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

21 (1) by striking subsection (a);

22 (2) by redesignating subsection (b) as sub-
 23 section (d); and

24 (3) by inserting the following before subsection

25 (d), as so redesignated:

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 program, and support relevant facilities, to dis-
5 cover and understand various forms of nuclear matter.

6 “(b) USER FACILITIES.—

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

8 “(A) IN GENERAL.—The Secretary shall
9 support construction of a Facility for Rare Iso-
10 tope Beams to advance the understanding of
11 rare nuclear isotopes and the evolution of the
12 cosmos.

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

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 under this section occurs
22 before March 1, 2022.

23 “(2) ELECTRON-ION COLLIDER.—

24 “(A) IN GENERAL.—The Secretary shall
25 support construction of an Electron Ion Collider

1 as described in the 2015 Long Range Plan of
2 the Nuclear Science Advisory Committee and
3 the report from the National Academies of
4 Science, Engineering, and Medicine titled ‘An
5 Assessment of U.S.-Based Electron-Ion Collider
6 Science’, in order to measure the internal struc-
7 ture of the proton and the nucleus and answer
8 fundamental questions about the nature of visi-
9 ble matter.

10 “(B) FACILITY CAPABILITY.—The Sec-
11 retary shall ensure that the facility meets the
12 requirements in the 2015 Long Range Plan, in-
13 cluding—

14 “(i) at least 70 percent polarized
15 beams of electrons and light ions;

16 “(ii) ion beams from deuterium to the
17 heaviest stable nuclei;

18 “(iii) variable center of mass energy
19 from 20 to 140 GeV;

20 “(iv) high collision luminosity of
21 $10^{33-34}\text{cm}^{-2}\text{s}^{-1}$; and

22 “(v) the possibility of more than one
23 interaction region.

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

priations, ensure that the start of full operations of the facility under this section occurs before December 31, 2030.

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

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

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

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

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

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

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

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

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

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

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

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

2 **SEC. 9. ACCELERATOR RESEARCH AND DEVELOPMENT.**

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

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

7 “(a) PROGRAM.—As part of the activities authorized
8 under section 209 of the Department of Energy Organiza-
9 tion Act (42 U.S.C. 7139), the Director shall carry out
10 a research program to—

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

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

17 “(3) support the development of a skilled, di-
18 verse, and inclusive accelerator workforce; and

19 “(4) provide access to accelerator design and
20 engineering resources.

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

24 “(1) research activities in cross-cutting accel-
25 erator technologies including superconducting

1 magnets and accelerators, beam physics, data ana-
2 lytics-based accelerator controls, simulation software,
3 new particle sources, advanced laser technology, and
4 transformative research; and

5 “(2) optimal operation of the Accelerator Test
6 Facility.

7 “(c) ACCELERATOR DEVELOPMENT.—In carrying out
8 the program authorized under subsection (a), the Director
9 shall support partnerships to foster the development, dem-
10 onstration, and commercial application of accelerator tech-
11 nologies including, advanced superconducting wire and
12 cable, superconducting RF cavities, and high efficiency ra-
13 diofrequency power sources for accelerators.

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

17 “(1) consider the requirements necessary to
18 support translational research and development for
19 medical, industrial, security, and defense applica-
20 tions; and

21 “(2) leverage investments in accelerator tech-
22 nologies and fundamental research in particle phys-
23 ics by partnering with institutes of higher education,
24 industry, and other Federal agencies to enable the

1 commercial application of advanced accelerator tech-
 2 nologies.

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

6 “(1) \$24,000,000 for fiscal year 2022;

7 “(2) \$25,680,000 for fiscal year 2023;

8 “(3) \$27,477,600 for fiscal year 2024;

9 “(4) \$29,401,032 for fiscal year 2025; and

10 “(5) \$31,459,104 for fiscal year 2026.”.

11 **SEC. 10. ISOTOPE DEVELOPMENT AND PRODUCTION FOR**
 12 **RESEARCH APPLICATIONS.**

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

16 **“SEC. 311. ISOTOPE DEVELOPMENT AND PRODUCTION FOR**
 17 **RESEARCH APPLICATIONS.**

18 “(a) IN GENERAL.—The Director—

19 “(1) shall carry out a program in coordination
 20 with other relevant programs across the Department
 21 for the production of isotopes, including the develop-
 22 ment of techniques to produce isotopes, that the Sec-
 23 retary determines are needed for research, medical,
 24 industrial, or related purposes, to the maximum ex-
 25 tent practicable, in accordance with the 2015 Nu-

1 clear Science Advisory Committee ‘Meeting Isotope
2 Needs and Capturing Opportunities For The Fu-
3 ture’ report; and

4 “(2) shall ensure that isotope production activi-
5 ties carried out under the program under this para-
6 graph do not compete with private industry unless
7 the Director determines that critical national inter-
8 ests require the involvement of the Federal Govern-
9 ment.

10 “(b) AUTHORIZATION OF APPROPRIATIONS.—There
11 are authorized to be appropriated to carry out the pro-
12 gram under this section—

13 “(1) \$90,000,000 for fiscal year 2022;

14 “(2) \$96,300,000 for fiscal year 2023;

15 “(3) \$103,041,000 for fiscal year 2024;

16 “(4) \$110,253,870 for fiscal year 2025; and

17 “(5) \$117,971,641 for fiscal year 2026.”.

18 **SEC. 11. SCIENCE LABORATORIES INFRASTRUCTURE PRO-**
19 **GRAM.**

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

23 “(c) APPROACH.—In carrying out this section, the
24 Director shall utilize all available approaches and mecha-
25 nisms, including capital line items, minor construction

1 projects, energy savings performance contracts, and utility
2 energy service contracts, as appropriate.

3 “(d) MID-SCALE INSTRUMENTATION PROGRAM.—
4 The Director, in coordination with each of the programs
5 carried out by the Office of Science, shall establish a mid-
6 scale instrumentation program to enable the development
7 and acquisition of novel, state-of-the-art instruments rang-
8 ing in cost from \$1 million to \$20 million each that would
9 significantly accelerate scientific breakthroughs at user fa-
10 cilities.

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

15 **SEC. 12. INCREASED COLLABORATION WITH TEACHERS**
16 **AND SCIENTISTS.**

17 (a) IN GENERAL.—The Department of Energy Re-
18 search and Innovation Act (42 U.S.C. 18601 et seq.) is
19 amended by adding after section 311, as added by this
20 Act, the following:

21 **“SEC. 312. INCREASED COLLABORATION WITH TEACHERS**
22 **AND SCIENTISTS.**

23 “The Director shall support the development of a sci-
24 entific workforce through programs that facilitate collabo-
25 ration between K–12, university students, early-career re-

1 searchers, faculty, and the National Laboratories, includ-
 2 ing through the use of proven techniques to expand the
 3 number of individuals from underrepresented groups pur-
 4 suing and attaining skills or undergraduate and graduate
 5 degrees relevant to the Office’s mission.”.

6 (b) AUTHORIZATION OF APPROPRIATIONS.—Section
 7 3169 of the Department of Energy Science Education En-
 8 hancement Act (42 U.S.C. 7381e) is amended—

9 (1) by striking, “programs”, and inserting
 10 “programs, including the NSF INCLUDES Na-
 11 tional Network,”; and

12 (2) by striking, “year 1991”, and inserting
 13 “years 2022 through 2026”.

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

16 (1) IN GENERAL.—The Department of Energy
 17 Science Education Enhancement Act (42 U.S.C.
 18 7381 et seq.) is amended by inserting the following
 19 sections after section 3167 (42 U.S.C. 7381c–1):

20 **“SEC. 3167A. BROADENING PARTICIPATION FOR TEACHERS**
 21 **AND SCIENTISTS.**

22 “(a) IN GENERAL.—The Secretary shall expand op-
 23 portunities to increase the number and the diversity, eq-
 24 uity, and inclusion of highly skilled science, technology, en-
 25 gineering, and mathematics (STEM) professionals work-

1 ing in Department of Energy mission-relevant disciplines
2 and broaden the recruitment pool to increase diversity, in-
3 cluding expanded partnerships with Historically Black
4 Colleges, Tribal Colleges, Minority Serving Institutions,
5 emerging research institutions, and scientific societies.

6 “(b) PLAN.—Not later than 1 year after the date of
7 enactment of the Department of Energy Science for the
8 Future Act, the Secretary shall submit to the Committee
9 on Science, Space, and Technology of the House of Rep-
10 resentatives and the Committee on Energy and Natural
11 Resources and the Committee on Commerce, Science, and
12 Transportation of the Senate and make available to the
13 public a plan for broadening participation of underrep-
14 resented groups in science, technology, engineering, and
15 mathematics in programs supported by the Department
16 programs, including—

17 “(1) a plan for supporting and leveraging the
18 National Science Foundation INCLUDES National
19 Network;

20 “(2) metrics for assessing the participation of
21 underrepresented groups in Department programs;

22 “(3) experienced and potential barriers to
23 broadening participation of underrepresented groups
24 in Department programs, including recommended
25 solutions; and

1 “(4) any other activities the Secretary finds ap-
2 propriate.

3 “(c) AUTHORIZATION OF APPROPRIATIONS.—Of the
4 amounts authorized to be appropriated in section 3169
5 (42 U.S.C. 7381e), at least \$2,000,000 shall be made
6 available each fiscal year for the activities described under
7 this subsection.

8 **“SEC. 3167B. EXPANDING OPPORTUNITIES TO INCREASE**
9 **THE DIVERSITY, EQUITY, AND INCLUSION OF**
10 **HIGHLY SKILLED SCIENCE, TECHNOLOGY,**
11 **ENGINEERING, AND MATHEMATICS (STEM)**
12 **PROFESSIONALS.**

13 “(a) IN GENERAL.—The Secretary shall expand op-
14 portunities to increase the number and the diversity, eq-
15 uity, and inclusion of highly skilled science, technology, en-
16 gineering, and mathematics (STEM) professionals work-
17 ing in Department of Energy mission-relevant disciplines
18 and broaden the recruitment pool to increase diversity, in-
19 cluding expanded partnerships with minority-serving insti-
20 tutions, non-Research I universities, and scientific soci-
21 eties.

22 “(b) PLAN AND OUTREACH STRATEGY.—

23 “(1) PLAN.—Not later than 6 months after the
24 date of enactment of the Department of Energy
25 Science for the Future Act, the Secretary shall sub-

1 mit to the Committee on Science, Space, and Tech-
2 nology of the House of Representatives and the
3 Committee on Energy and Natural Resources of the
4 Senate a 10-year educational plan to fund and ex-
5 pand new or existing programs administered by the
6 Office of Science and sited at the National Labora-
7 tories and Department of Energy user facilities to
8 expand educational and workforce opportunities for
9 underrepresented high school, undergraduate, and
10 graduate students as well as recent graduates,
11 teachers and faculty in STEM fields. This may in-
12 clude paid internships, fellowships, temporary em-
13 ployment, training programs, visiting student and
14 faculty programs, sabbaticals, and research support.

15 “(2) OUTREACH CAPACITY.—The Secretary
16 shall include in the plan under paragraph (1) an
17 outreach strategy to improve the advertising, recruit-
18 ment, and promotion of educational and workforce
19 programs to community colleges, Historically Black
20 Colleges and Universities, Tribal Colleges, Minority
21 Serving Institutions, and emerging research institu-
22 tions.

23 “(c) BUILDING RESEARCH CAPACITY.—The Sec-
24 retary shall develop programs that strengthen the research
25 capacity relevant to Office of Science disciplines at emerg-

1 ing research institutions, including minority-serving insti-
2 tutions, tribal colleges and universities, Historically Black
3 Colleges and Universities, and colleges and universities.
4 This may include enabling mutually beneficial and jointly
5 managed partnerships between research-intensive institu-
6 tions and emerging research institutions, and soliciting re-
7 search proposals, fellowships, training programs, and re-
8 search support directly from emerging research institu-
9 tions.

10 “(d) TRAINEESHIPS.—The Secretary shall establish
11 a university-led Traineeship Program to address workforce
12 training needs in STEM fields relevant to the Depart-
13 ment. The focus should be on supporting training and re-
14 search experiences for underrepresented undergraduate
15 and graduate students and increasing participation from
16 underrepresented populations. The traineeships should in-
17 clude opportunities to build the next-generation workforce
18 in research areas critical to maintaining core competencies
19 across the Office of Science’s programs.

20 “(e) EVALUATION.—The Secretary shall establish key
21 performance indicators to measure and monitor progress
22 of education and workforce programs and expand Depart-
23 mental activities for data collection and analysis. The Sec-
24 retary shall submit a report 2 years after the date of en-
25 actment of the Department of Energy Science for the Fu-

1 ture Act, and every 2 years thereafter, to the Committee
2 on Science, Space, and Technology of the House of Rep-
3 resentatives and the Committee on Energy and Natural
4 Resources of the Senate summarizing progress toward
5 meeting key performance indicators.

6 “(f) DEFINITIONS.—In this section:

7 “(1) MINORITY-SERVING INSTITUTION.—The
8 term ‘minority-serving institution’ includes the enti-
9 ties described in any of paragraphs (1) through (7)
10 of section 371(a) of the Higher Education Act of
11 1965 (20 U.S.C. 1067q(a)).

12 “(2) HISTORICALLY BLACK COLLEGE AND UNI-
13 VERSITIES.—The term ‘Historically Black Colleges
14 and Universities’ has the meaning given in ‘part B
15 institution’ in section 322 of the Higher Education
16 Act of 1965 (20 U.S.C. 1061).

17 “(3) STEM.—The term ‘STEM’ means the
18 field or disciplines listed in section 2 of the STEM
19 Education Act of 2015 (42 U.S.C. 6621 note).

20 “(4) TRIBAL COLLEGES AND UNIVERSITIES.—
21 The term ‘Tribal College or University’ has the
22 meaning given in section 316 of the Higher Edu-
23 cation Act of 1965 (20 U.S.C. 1059c).”.

24 (2) CLERICAL AMENDMENT.—The table of con-
25 tents in section 2(b) of the National Defense Au-

1 thorization Act for Fiscal Year 1991 is amended by
 2 inserting after the item relating to section 3167 the
 3 following:

“Sec. 3167A. Broadening participation for teachers and scientists.

“Sec. 3167B. Expanding opportunities to increase the diversity, equity, and inclusion of highly skilled science, technology, engineering, and mathematics (STEM) professionals.”.

4 **SEC. 13. HIGH INTENSITY LASER RESEARCH INITIATIVE;**
 5 **OFFICE OF SCIENCE EMERGING INFECTIOUS**
 6 **DISEASE COMPUTING RESEARCH INITIATIVE;**
 7 **HELIUM CONSERVATION PROGRAM; AUTHOR-**
 8 **IZATION OF APPROPRIATIONS.**

9 (a) IN GENERAL.—The Department of Energy Re-
 10 search and Innovation Act (42 U.S.C. 18601 et seq.) is
 11 amended by adding at the 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, ‘Op-
 16 portunities in Intense Ultrafast Lasers: Reaching for the
 17 Brightest Light’, and the report from the Brightest Light
 18 Initiative workshop on ‘The Future of Intense Ultrafast
 19 Lasers in the U.S.’. This initiative should include research
 20 and development of petawatt-scale and of high average
 21 power laser technologies necessary for future facility needs
 22 in discovery science and to advance energy technologies,

1 as well as support for a user network of academic and
2 national laboratory high intensity laser facilities.

3 “(b) LEVERAGE.—The Director shall leverage new
4 laser technologies for more compact, less complex, and
5 low-cost accelerator systems needed for science applica-
6 tions.

7 “(c) COORDINATION.—The Director shall coordinate
8 this initiative among all relevant programs within the Of-
9 fice of Science, and the Under Secretary for Science shall
10 coordinate this initiative with other relevant programs
11 within the Department as well as within other Federal
12 agencies.

13 “(d) AUTHORIZATION OF APPROPRIATIONS.—Out of
14 funds authorized to be appropriated for the Office of
15 Science there are authorized to be appropriated to the Sec-
16 retary to carry out the activities described in this sec-
17 tion—

18 “(1) \$50,000,000 for fiscal year 2022;

19 “(2) \$100,000,000 for fiscal year 2023;

20 “(3) \$150,000,000 for fiscal year 2024;

21 “(4) \$200,000,000 for fiscal year 2025; and

22 “(5) \$250,000,000 for fiscal year 2026.

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

24 “(a) IN GENERAL.—The Secretary shall establish a
25 program to reduce the consumption of helium for Depart-

1 ment grant recipients and facilities and encourage helium
2 recycling and reuse. The program shall competitively
3 award grants for—

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

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

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

11 “(b) REPORT.—In carrying out the program under
12 this section, the Director shall submit to the Committee
13 on Science, Space, and Technology of House of Represent-
14 atives and the Committee on Energy and Natural Re-
15 sources of the Senate a report, not later than two years
16 after the date of enactment of the Department of Energy
17 Science for the Future Act, and every 3 years thereafter,
18 on the purchase of helium as part of research projects and
19 facilities supported by the Department. The report shall
20 include—

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

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

1 “(3) the predominant production sources for
2 such helium;

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

6 “(5) recommendations for reducing Department
7 grant recipients’ exposure to volatile helium prices.

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

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

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

19 **“SEC. 315. OFFICE OF SCIENCE EMERGING INFECTIOUS**
20 **DISEASE COMPUTING RESEARCH INITIATIVE.**

21 “(a) IN GENERAL.—The Secretary, in coordination
22 with the Director of the National Science Foundation and
23 the Administrator of the National Aeronautics and Space
24 Administration, shall establish within the Office of
25 Science, a cross-cutting research initiative to leverage the

1 Federal Government’s innovative analytical resources and
2 tools, user facilities, and advanced computational and net-
3 working capabilities in order to prevent, prepare for, and
4 respond to emerging infectious diseases, including
5 COVID–19. The Secretary shall carry out this initiative
6 through a competitive, merit-reviewed process, and con-
7 sider applications from National Laboratories, institutions
8 of higher education, multi-institutional collaborations, in-
9 dustry partners and other appropriate entities.

10 “(b) ACTIVITIES.—In carrying out the initiative es-
11 tablished under subsection (a), the Secretary shall coordi-
12 nate with programs across the Office of Science and with
13 relevant Federal agencies to determine a comprehensive
14 set of technical milestones for these research activities and
15 prioritize the following objectives—

16 “(1) supporting fundamental research and de-
17 velopment in advanced analytics, experimental stud-
18 ies, materials synthesis, high-performance computing
19 technologies needed to characterize, model, simulate,
20 and predict complex phenomena and biological mate-
21 rials related to emerging infectious diseases, includ-
22 ing COVID–19 challenges, including a focus on test-
23 ing and diagnostics, experimental data acquisition,
24 sharing and management, advanced manufacturing,
25 and molecular design and modeling;

1 “(2) using expertise from the private sector, in-
2 stitutions of higher education, and the National
3 Laboratories to develop computational software and
4 capabilities that prospective users may accelerate
5 emerging infectious diseases research and develop-
6 ment;

7 “(3) leveraging the research infrastructure of
8 the Department, including scientific computing user
9 facilities, x-ray light sources, neutron scattering fa-
10 cilities, nanoscale science research centers, and se-
11 quencing and bio-characterization facilities by co-
12 ordinating with the Advanced Scientific Computing
13 Research, Basic Energy Sciences, and Biological and
14 Environmental Research programs within the Office
15 of Science;

16 “(4) leveraging experience from existing mod-
17 eling and simulation research and work sponsored by
18 the Department and promoting collaboration and
19 data sharing between National Laboratories, re-
20 search entities, and user facilities of the Department
21 by providing the necessary access and secure data
22 transfer capabilities; and

23 “(5) ensuring that new experimental and com-
24 putational tools are accessible to relevant research
25 communities, including private sector entities to ad-

1 dress emerging infectious diseases, including
2 COVID–19 challenges.

3 “(c) COORDINATION.—In carrying out this initiative,
4 the Secretary shall ensure, to the maximum extent prac-
5 ticable, coordination of these activities with the Depart-
6 ment of Energy National Laboratories, institutions of
7 higher education, and the private sector.

8 “(d) EMERGING INFECTIOUS DISEASES HIGH PER-
9 FORMANCE COMPUTING RESEARCH CONSORTIUM.—

10 “(1) IN GENERAL.—The Secretary in coordina-
11 tion with the Director of the National Science Foun-
12 dation and the Director of the Office of Science and
13 Technology Policy shall establish and operate an
14 Emerging Infectious Diseases High Performance
15 Computing Research Consortium (referred to in this
16 section as the ‘Consortium’), to support the initiative
17 under subsection (a) by providing, to the extent
18 practicable, a centralized entity for multidisciplinary,
19 collaborative, emerging infectious disease research
20 and development through high performance com-
21 puting and advanced data analytics technologies and
22 processes.

23 “(2) MEMBERSHIP.—The members of such con-
24 sortium may include representatives from relevant
25 Federal agencies, the private sector, institutions of

1 higher education, which can each contribute relevant
2 compute time, capabilities, or other resources.

3 “(3) ACTIVITIES.—The Consortium shall—

4 “(A) match applicants with available Fed-
5 eral and private sector computing resources;

6 “(B) consider supplemental awards for
7 computing partnerships with Consortium mem-
8 bers to qualifying entities on a competitive
9 merit-review basis;

10 “(C) encourage collaboration and commu-
11 nication among member representatives of the
12 consortium and awardees;

13 “(D) make available the high-performance
14 computing capabilities, expertise, and user fa-
15 cilities of the Department and the National
16 Laboratories; and

17 “(E) submit an annual report to the Sec-
18 retary summarizing the activities of the Consor-
19 tium, including—

20 “(i) describing each project under-
21 taken by the Consortium;

22 “(ii) detailing organizational expendi-
23 tures; and

1 “(iii) evaluating contribution to the
2 achievement of technical milestones as de-
3 termined in subsection (a).

4 “(4) COORDINATION.—The Secretary shall en-
5 sure the coordination of, and avoid unnecessary du-
6 plication of, the activities of the Consortium with the
7 activities of other research entities of the Depart-
8 ment, institutions of higher education and the pri-
9 vate sector.

10 “(e) REPORT.—Not later than 2 years after the date
11 of enactment of the Department of Energy Science for the
12 Future Act, the Secretary shall submit to the Committee
13 on Science, Space, and Technology of the House, and the
14 Committee on Energy and Natural Resources of the Sen-
15 ate, and the Committee on Commerce, Science, and
16 Transportation of the Senate a report detailing the effec-
17 tiveness of—

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

21 “(2) the collaborative research achievements of
22 the initiative, including the achievement of the tech-
23 nical milestones determined under subsection (a);
24 and

1 “(3) potential opportunities to expand the tech-
2 nical capabilities of the Department.

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

8 “(g) PROHIBITION.—

9 “(1) IN GENERAL.—In carrying out this Act,
10 the Secretary may not carry out gain-of-function re-
11 search of concern.

12 “(2) GAIN-OF-FUNCTION RESEARCH DE-
13 FINED.—For the purposes of this subsection, ‘gain-
14 of-function research of concern’ means research ac-
15 tivities with the potential to generate pathogens with
16 high transmissibility and high virulence in humans.

17 **“SEC. 316. AUTHORIZATION OF APPROPRIATIONS.**

18 “There are authorized to be appropriated to the Sec-
19 retary to carry out the activities described in this title—

20 “(1) \$8,801,915,000 for fiscal year 2022;

21 “(2) \$9,451,015,300 for fiscal year 2023;

22 “(3) \$10,160,677,621 for fiscal year 2024;

23 “(4) \$10,693,625,004 for fiscal year 2025; and

24 “(5) \$11,145,798,345 for fiscal year 2026.”.

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

“Sec. 310. Accelerator research and development.

“Sec. 311. Isotope Development and Production for Research Applications.

“Sec. 312. Increased collaboration with teachers and scientists.

“Sec. 313. High intensity laser research initiative.

“Sec. 314. Helium conservation program.

“Sec. 315. Office of Science Emerging Infectious Disease Computing Research
Initiative.

“Sec. 316. Authorization of appropriations.”.

5 **SEC. 14. STATE-OWNED ENTERPRISES PROHIBITION.**

6 (a) INNOVATE IN AMERICA.—In carrying out this Act
 7 or the amendments made by this Act, the Secretary may
 8 not award a contract, subcontract, grant, or loan to an
 9 entity that—

10 (1) is owned or controlled by, is a subsidiary of,
 11 or is otherwise related legally or financially to a cor-
 12 poration based in a country that—

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

17 (B) was identified by the United States
 18 Trade Representative in the most recent report
 19 required by section 182 of the Trade Act of
 20 1974 (19 U.S.C. 2242) as a priority foreign

1 country under subsection (a)(2) of that section;
2 and

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

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

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

13 (c) INTERNATIONAL AGREEMENTS.—This section
14 shall be applied in a manner consistent with the obliga-
15 tions of the United States under international agreements.

16 **SEC. 15. DETERMINATION OF BUDGETARY EFFECTS.**

17 The budgetary effects of this Act, for the purpose of
18 complying with the Statutory Pay-As-You-Go Act of 2010,
19 shall be determined by reference to the latest statement
20 titled “Budgetary Effects of PAYGO Legislation” for this
21 Act, submitted for printing in the Congressional Record
22 by the Chairman of the House Budget Committee, pro-

- 1 vided that such statement has been submitted prior to the
- 2 vote on passage.

Passed the House of Representatives June 28, 2021.

Attest:

Clerk.

117TH CONGRESS
1ST Session

H. R. 3593

AN ACT

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