

**AMENDMENT IN THE NATURE OF A SUBSTITUTE
TO H.R. 3593
OFFERED BY MS. JOHNSON OF TEXAS**

Strike all after the enacting clause and insert the following:

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.—

1 “(1) IN GENERAL.—The Secretary—

2 “(A) shall ensure the coordination of the
3 Office of Science with the other activities of the
4 Department;

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

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

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

13 “(2) WITHIN THE OFFICE OF SCIENCE.—The
14 Director shall ensure the coordination of programs
15 and activities carried out by the Office of Science.”.

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

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

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

23 (2) by inserting before subsection (c), as so re-
24 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)(3), as so redesignated—

20 (A) in subparagraph (C), by striking
21 “and” at the end;

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

24 (C) by inserting after subparagraph (C)

25 the following:

1 “(D) autonomous chemistry and materials
2 synthesis and characterization facilities that le-
3 verage advances in artificial intelligence; and”;
4 (4) in subsection (d), as so redesignated, by
5 adding at the end the following:

6 “(4) ADVANCED PHOTON SOURCE UPGRADE.—

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

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

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

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

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

1 ations of the upgrade under this paragraph oc-
2 curs before March 31, 2026.

3 “(D) FUNDING.—Out of funds authorized
4 to be appropriated under subsection (j), there
5 shall be made available to the Secretary to
6 carry out the upgrade under this paragraph
7 \$157,000,000 for fiscal year 2022.

8 “(5) SPALLATION NEUTRON SOURCE PROTON
9 POWER UPGRADE.—

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

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

18 “(i) the publication titled ‘Facilities
19 for the Future of Science: A Twenty-Year
20 Outlook’, published by the Office of
21 Science of the Department of Energy in
22 December, 2003;

23 “(ii) the publication titled ‘Four Years
24 Later: An Interim Report on Facilities for
25 the Future of Science: A Twenty-Year

1 Outlook’, published by the Office of
2 Science of the Department of Energy in
3 August, 2007; and

4 “(iii) the publication approved by the
5 Basic Energy Sciences Advisory Committee
6 on June 9, 2016, titled ‘Report on Facility
7 Upgrades’.

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

13 “(D) 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 upgrade under this paragraph
17 \$49,800,000 for fiscal year 2022.

18 “(6) SPALLATION NEUTRON SOURCE SECOND
19 TARGET STATION.—

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

23 “(B) SECOND TARGET STATION DE-
24 FINED.—For the purposes of this paragraph,
25 the term ‘second target station’ means the

1 Spallation Neutron Source second target station
2 described in—

3 “(i) the publication titled, ‘Facilities
4 for the Future of Science: A Twenty-Year
5 Outlook’, published by the Office of
6 Science of the Department of Energy in
7 December, 2003;

8 “(ii) the publication titled, ‘Four
9 Years Later: An Interim Report on Facili-
10 ties for the Future of Science: A Twenty-
11 Year Outlook’, published by the Office of
12 Science of the Department of Energy in
13 August, 2007; and

14 “(iii) the publication approved by the
15 Basic Energy Sciences Advisory Committee
16 on June 9, 2016, titled ‘Report on Facility
17 Upgrades’.

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 second target station under this
22 paragraph occurs before December 31, 2030,
23 with the option for early operation in 2029.

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

1 shall be made available to the Secretary to
2 carry out the activities under this paragraph,
3 including construction—

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

5 “(ii) \$127,000,000 for fiscal year
6 2023;

7 “(iii) \$204,000,000 for fiscal year
8 2024;

9 “(iv) \$279,000,000 for fiscal year
10 2025; and

11 “(v) \$300,000,000 for fiscal year
12 2026.

13 “(7) ADVANCED LIGHT SOURCE UPGRADE.—

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

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

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

20 “(B) IN GENERAL.—The Secretary shall
21 provide for the upgrade to the Advanced Light
22 Source described in the publication approved by
23 the Basic Energy Sciences Advisory Committee
24 on June 9, 2016, titled ‘Report on Facility Up-
25 grades’, including the development of a

1 multibend achromat lattice to produce a high
2 flux of coherent x-rays within the soft x-ray en-
3 ergy region.

4 “(C) START OF OPERATIONS.—The Sec-
5 retary shall, subject to the availability of appro-
6 priations, ensure that the start of full oper-
7 ations of the upgrade under this paragraph oc-
8 curs before September 30, 2029.

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

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

14 “(ii) \$135,000,000 for fiscal year
15 2023;

16 “(iii) \$102,500,000 for fiscal year
17 2024;

18 “(iv) \$25,000,000 for fiscal year
19 2025; and

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

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

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

24 “(i) HIGH ENERGY X-RAY.—The term
25 ‘high energy x-ray’ means a photon with

1 an energy in the 5 to 13 kiloelectron volt
2 range.

3 “(ii) HIGH REPETITION RATE.—The
4 term ‘high repetition rate’ means the deliv-
5 ery of x-ray pulses up to 1 million pulses
6 per second.

7 “(iii) ULTRA-SHORT PULSE X-RAYS.—
8 The term ‘ultra-short pulse x-rays’ means
9 x-ray bursts capable of durations of less
10 than 100 femtoseconds.

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

12 “(i) provide for the upgrade to the
13 Linac Coherent Light Source II facility de-
14 scribed in the publication approved by the
15 Basic Energy Sciences Advisory Committee
16 on June 9, 2016, titled ‘Report on Facility
17 Upgrades’, including the development of
18 experimental capabilities for high energy x-
19 rays to reveal fundamental scientific dis-
20 coveries; and

21 “(ii) ensure such upgrade enables the
22 production and use of high energy, ultra-
23 short pulse x-rays delivered at a high rep-
24 etition rate.

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 December 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 “(i) \$106,925,000 for fiscal year
11 2022;

12 “(ii) \$125,925,000 for fiscal year
13 2023;

14 “(iii) \$115,000,000 for fiscal year
15 2024;

16 “(iv) \$89,000,000 for fiscal year
17 2025; and

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

19 “(9) CRYOMODULE REPAIR AND MAINTENANCE
20 FACILITY.—

21 “(A) IN GENERAL.—The Secretary shall
22 provide for the construction of a cryomodule re-
23 pair and maintenance facility to service the
24 Linac Coherent Light Source II and upgrades
25 to the facility. The Secretary shall consult with

1 the private sector, universities, National Lab-
2 oratories, and relevant Federal agencies to en-
3 sure that this facility has the capability to
4 maintain, repair, and test superconducting ra-
5 diofrequency accelerator components.

6 “(B) 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 activities under this paragraph—

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

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

12 “(iii) \$25,000,000 for fiscal year
13 2024; and

14 “(iv) \$17,000,000 for fiscal year
15 2025.

16 “(10) NANOSCALE SCIENCE RESEARCH CENTER
17 RECAPITALIZATION PROJECT.—

18 “(A) IN GENERAL.—The Secretary shall
19 provide for the recapitalization of the Nanoscale
20 Science Research Centers, to include the up-
21 grade of equipment at each Center supported
22 by the Office of Science on the date of enact-
23 ment of the Department of Energy Science for
24 the Future Act, to accelerate advances in the
25 various fields of science including nanoscience,

1 materials, chemistry, biology, and quantum in-
2 formation science.

3 “(B) FUNDING.—Out of funds authorized
4 to be appropriated under subsection (j), there
5 shall be made available to the Secretary to
6 carry out the recapitalization under this para-
7 graph—

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

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

10 “(iii) \$20,000,000 for fiscal year
11 2024; and

12 “(iv) \$20,000,000 for fiscal year
13 2025.”;

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

15 “(h) COMPUTATIONAL MATERIALS AND CHEMICAL
16 SCIENCES.—

17 “(1) IN GENERAL.—The Director shall support
18 a program of research and development for the ap-
19 plication of advanced computing practices to
20 foundational and emerging research problems in
21 chemistry and materials science. Research activities
22 shall include—

23 “(A) chemical catalysis research and devel-
24 opment;

1 “(B) the use of large data sets to model
2 materials phenomena, including through ad-
3 vanced characterization of materials, materials
4 synthesis, processing, and innovative use of ex-
5 perimental and theoretical data;

6 “(C) co-design of chemical system and
7 chemistry modeling software with advanced
8 computing systems and hardware technologies;
9 and

10 “(D) modeling of chemical processes, as-
11 semblies, and reactions such as molecular dy-
12 namics and quantum chemistry, including
13 through novel computing methods.

14 “(2) COMPUTATIONAL MATERIALS AND CHEM-
15 ICAL SCIENCES CENTERS.—

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

21 “(i) develop open-source, robust, and
22 validated computational codes and user-
23 friendly software, coupled with innovative
24 use of experimental and theoretical data,
25 to enable the design, discovery, and devel-

1 opment of new materials and chemical sys-
2 tems; and

3 “(ii) focus on overcoming challenges
4 and maximizing the benefits of exascale
5 and other high performance computing
6 underpinned by accelerated node tech-
7 nologies.

8 “(B) SELECTION.—The Director shall se-
9 lect centers under subparagraph (A) on a com-
10 petitive, merit-reviewed basis. The Director
11 shall consider applications from the National
12 Laboratories, institutes of higher education,
13 multi-institutional collaborations, and other ap-
14 propriate entities.

15 “(C) DURATION.—

16 “(i) A center selected under subpara-
17 graph (A) shall receive support for a pe-
18 riod of not more than 5 years beginning on
19 the date of establishment of that center,
20 subject to the availability of appropria-
21 tions.

22 “(ii) A center already in existence on
23 the date of enactment of the Department
24 of Energy Science for the Future Act may
25 continue to receive support for a period of

1 not more than 5 years beginning on the
2 date of establishment of that center.

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

8 “(E) TERMINATION.—Consistent with the
9 existing authorities of the Department, the Di-
10 rector may terminate an underperforming cen-
11 ter for cause during the performance period.

12 “(i) MATERIALS RESEARCH DATABASE.—

13 “(1) IN GENERAL.—The Director shall support
14 the development of a web-based platform to develop
15 and provide access to a database of computed infor-
16 mation on known and predicted materials properties
17 and computational tools to accelerate breakthroughs
18 in materials discovery and design.

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

21 “(A) conduct cooperative research with in-
22 dustry, academia, and other research institu-
23 tions to advance understanding, prediction, and
24 manipulation of materials and facilitate the de-
25 sign of novel materials;

1 “(B) develop and maintain data infrastruc-
2 ture at user facilities that generate data to col-
3 lect, analyze, label, and otherwise prepare the
4 data for inclusion in the database;

5 “(C) leverage existing high performance
6 computing systems to conduct high throughput
7 calculations, and develop computational and
8 data mining algorithms for the prediction of
9 material properties;

10 “(D) strengthen the foundation for new
11 technologies and advanced manufacturing; and

12 “(E) drive the development of advanced
13 materials for applications that span the Depart-
14 ment’s missions in energy, environment, and
15 national security.

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

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

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

4 “(1) \$2,727,705,000 for fiscal year 2022;

5 “(2) \$2,828,896,600 for fiscal year 2023;

6 “(3) \$3,019,489,612 for fiscal year 2024;

7 “(4) \$3,161,698,885 for fiscal year 2025; and

8 “(5) \$3,291,651,600 for fiscal year 2026.”.

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

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

14 “(4) FUNDING.—From within funds authorized
15 to be appropriated for Basic Energy Sciences, the
16 Secretary shall make available for carrying out ac-
17 tivities under this subsection \$50,000,000 for each
18 of fiscal years 2022 through 2031.”; and

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

21 “(4) FUNDING.—From within funds authorized
22 to be appropriated in section 316 of the Department
23 of Energy Research and Innovation Act, the Sec-
24 retary shall make available for carrying out activities

1 under this subsection \$50,000,000 for each of fiscal
2 years 2022 through 2026.”.

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

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

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

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

15 “(4) FUNDING.—From within funds authorized
16 to be appropriated in section 316 of the Department
17 of Energy Research and Innovation Act, the Sec-
18 retary shall make available for carrying out activities
19 under this subsection \$50,000,000 for each of fiscal
20 years 2022 through 2026.”; and

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

23 “(4) FUNDING.—From within funds authorized
24 to be appropriated in section 316 of the Department
25 of Energy Research and Innovation Act, the Sec-

1 retary shall make available for carrying out activities
2 under this subsection \$20,000,000 for each of fiscal
3 years 2022 through 2026.”.

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

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

9 (1) by redesignating subsection (a) as sub-
10 section (b);

11 (2) by inserting before subsection (b), as reded-
12 signed under paragraph (1), the following:

13 “(a) PROGRAM.—As part of the duties of the Director
14 authorized under section 209 of the Department of En-
15 ergy Organization Act (42 U.S.C. 7139), and coordinated
16 with the activities authorized under sections 303 and 304
17 of this Act, the Director shall carry out a program of re-
18 search and development in the areas of biological systems
19 science and climate and environmental science, including
20 subsurface science, relevant to the development of new en-
21 ergy technologies and to support the energy, environ-
22 mental, and national security missions of the Department.

23 “(b) BIOLOGICAL SYSTEMS.—The Director shall
24 carry out research and development activities in genomic
25 science including fundamental research on plants and mi-

1 probes to increase systems-level understanding of the com-
2 plex biological systems, which may include activities to—

3 “(1) accelerate breakthroughs and new knowl-
4 edge that would enable the cost-effective, sustainable
5 production of—

6 “(A) biomass-based liquid transportation
7 fuels;

8 “(B) bioenergy; and

9 “(C) biobased materials from renewable
10 biomass;

11 “(2) improve fundamental understanding of
12 plant and microbial processes impacting the global
13 carbon cycle, including processes for removing car-
14 bon dioxide from the atmosphere, through photosyn-
15 thesis and other biological processes, for sequestra-
16 tion and storage;

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

20 “(4) develop the computational approaches and
21 integrated platforms for open access collaborative
22 science;

23 “(5) leverage tools and approaches across the
24 Office of Science to expand research to include novel
25 processes, methods, and science to develop bio-based

1 chemicals, polymers, inorganic materials, including
2 research to—

3 “(A) advance biosystems design research
4 to advance the understanding of how CRISPR
5 tools and other gene editing tools and tech-
6 nologies work in nature, in the laboratory, and
7 in practice;

8 “(B) deepen genome-enabled knowledge of
9 root architecture and growth in crops, including
10 trees; and

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

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

16 “(c) BIOMOLECULAR CHARACTERIZATION AND IMAG-
17 ING SCIENCE.—The Director shall carry out research and
18 development activities in biomolecular characterization
19 and imaging science, including development of integrative
20 imaging and analysis platforms and biosensors to under-
21 stand the expression, structure, and function of genome
22 information encoded within cells and for real-time meas-
23 urements in ecosystems and field sites of relevance to the
24 mission of the Department of Energy.”;

1 (3) by striking subsection (b) as redesignated
2 under paragraph (1); and

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

5 (b) BIOENERGY RESEARCH CENTERS.—Section
6 977(f) of the Energy Policy Act of 2005 (42 U.S.C.
7 16317(f)) is amended to read as follows:

8 “(f) BIOENERGY RESEARCH CENTERS.—

9 “(1) IN GENERAL.—In carrying out the pro-
10 gram under section 306(a) of the Department of
11 Energy Research and Innovation Act (42 U.S.C.
12 18644(a)), the Director shall support up to six bio-
13 energy research centers to conduct fundamental re-
14 search in plant and microbial systems biology, bio-
15 logical imaging and analysis, and genomics, and to
16 accelerate advanced research and development of
17 biomass-based liquid transportation fuels, bioenergy,
18 or biobased materials, chemicals, and products that
19 are produced from a variety of regionally diverse
20 feedstocks, and to facilitate the translation of re-
21 search results to industry. The activities of the cen-
22 ters authorized under this subsection may include—

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

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

3 “(B) developing the science and techno-
4 logical advances to ensure process sustainability
5 is considered in the creation of biofuels and bio-
6 products from lignocellulose; and

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

13 “(2) SELECTION AND DURATION.—

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

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

24 “(C) EXISTING CENTERS.—A center al-
25 ready in existence on the date of enactment of

1 the Department of Energy Science for the Fu-
2 ture Act may continue to receive support for a
3 period of not more than 5 years beginning on
4 the date of establishment of that center.

5 “(3) RENEWAL.—After the end of either period
6 described in paragraph (2), the Director may renew
7 support for the center for a period of not more than
8 5 years on a merit-reviewed basis. For a center in
9 operation for 10 years after its previous selection on
10 a competitive, merit-reviewed basis, the Director
11 may renew support for the center on a competitive,
12 merit-reviewed basis for a period of not more than
13 5 years, and may subsequently provide an additional
14 renewal on a merit-reviewed basis for a period of not
15 more than 5 years.

16 “(4) TERMINATION.—Consistent with the exist-
17 ing authorities of the Department, the Director may
18 terminate an underperforming center for cause dur-
19 ing the performance period.

20 “(5) ACTIVITIES.—Centers shall undertake re-
21 search activities to accelerate the production of
22 biofuels and bioproducts from advanced biomass re-
23 sources by identifying the most suitable species of
24 plants for use as energy crops; and improving meth-
25 ods of breeding, propagation, planting, producing,

1 harvesting, storage and processing. Activities may
2 include the following:

3 “(A) Research activities to increase sus-
4 tainability, including—

5 “(i) advancing knowledge of how bio-
6 energy crop interactions with biotic and
7 abiotic environmental factors influence
8 crop growth, yield, and quality;

9 “(ii) identifying the most impactful
10 research areas that address the economics
11 of biofuels and bioproducts production; and

12 “(iii) utilizing multiscale modeling to
13 advance predictive understanding of biofuel
14 cropping ecosystems.

15 “(B) Research activities to further feed-
16 stock development, including lignocellulosic,
17 algal, gaseous wastes including carbon oxides
18 and methane, and direct air capture of single
19 carbon gases via plants and microbes, includ-
20 ing—

21 “(i) developing genetic and genomic
22 tools, high-throughput analytical tools, and
23 biosystems design approaches to enhance
24 bioenergy feedstocks and their associated
25 microbiomes;

1 “(ii) conducting field testing of new
2 potential bioenergy feedstock crops under
3 environmentally benign and geographically
4 diverse conditions to assess viability and
5 robustness; and

6 “(iii) developing quantitative models
7 informed by experimentation to predict
8 how bioenergy feedstocks perform under
9 diverse conditions.

10 “(C) Research activities to improve
11 lignocellulosic deconstruction and separation
12 methods, including—

13 “(i) developing feedstock-agnostic
14 deconstruction processes capable of effi-
15 ciently fractionating biomass into targeted
16 output streams;

17 “(ii) gaining a detailed understanding
18 of plant cell wall biosynthesis, composition,
19 structure, and properties during
20 deconstruction; and

21 “(iii) improving enzymes and ap-
22 proaches for biomass breakdown and cel-
23 lulose, hemicellulose, and lignin processing.

1 “(D) Research activities to improve the
2 feedstock conversion process for advanced
3 biofuels and bioproducts, including—

4 “(i) developing high-throughput meth-
5 ods to screen or select high-performance
6 microbial strains and communities to im-
7 prove product formation rates, yields, and
8 selectivity;

9 “(ii) establishing a broad set of plat-
10 form microorganisms and microbial com-
11 munities suitable for metabolic engineering
12 to produce biofuels and bioproducts, as
13 well as high-throughput methods for exper-
14 imental validation of gene function;

15 “(iii) developing techniques to en-
16 hance microbial robustness for tolerating
17 toxins to improve biofuel and bioproduct
18 yields and to gain a better understanding
19 of the cellular and molecular bases of toler-
20 ance for major chemical classes of inhibi-
21 tors found in these processes;

22 “(iv) advancing technologies for the
23 use of batch, continuous, as well as con-
24 solidated bioprocessing;

1 “(v) identifying, creating, and opti-
2 mizing microbial and chemical pathways to
3 produce promising, atom-economical inter-
4 mediates and final bioproducts from bio-
5 mass with considerations given to environ-
6 mentally benign processes;

7 “(vi) developing high-throughput,
8 real-time, in situ analytical techniques to
9 understand and characterize the pre- and
10 post-bioproduct separation streams in de-
11 tail;

12 “(vii) creating methodologies for effi-
13 ciently identifying viable target molecules,
14 identifying high-value bioproducts in exist-
15 ing biomass streams, and utilizing current
16 byproduct streams;

17 “(viii) identifying and improving plant
18 feedstocks with enhanced extractable levels
19 of desired bioproducts or bioproduct pre-
20 cursors, including lignin streams; and

21 “(ix) developing integrated biological
22 and chemical catalytic approaches to
23 valorize and produce a diverse portfolio of
24 advanced fuels and bioproducts.

1 “(6) INDUSTRY PARTNERSHIPS.—Centers shall
2 establish industry partnerships to translate research
3 results to commercial applications.

4 “(7) COORDINATION.—In coordination with the
5 Bioenergy Technologies Office of the Department,
6 the Director shall support interdisciplinary research
7 activities to improve the capacity, efficiency, resil-
8 ience, security, reliability, and affordability, of the
9 production and use of biofuels and bioproducts, as
10 well as activities to enable positive impacts and avoid
11 the potential negative impacts that the production
12 and use of biofuels and bioproducts may have on
13 ecosystems, people, and historically marginalized
14 communities.”.

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

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

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

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

23 “(E) \$40,000,000 for fiscal year 2025; and

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

1 (d) LOW-DOSE RADIATION AND SPACE RADIATION
2 RESEARCH PROGRAM.—Section 306(f) of the Department
3 of Energy Research and Innovation Act (42 U.S.C.
4 18644(d)), as redesignated under subsection (a), is
5 amended to read as follows:

6 “(f) LOW-DOSE RADIATION AND SPACE RADIATION
7 RESEARCH PROGRAM.—

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

15 “(2) PURPOSE.—The purpose of this program
16 is to accelerate breakthroughs in low-dose and low
17 dose-rate radiation research and development as de-
18 scribed in subsection (d) and to inform the advance-
19 ment of new tools, technologies, and advanced mate-
20 rials needed to facilitate long-duration space explo-
21 ration.”.

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

1 “(g) EARTH AND ENVIRONMENTAL SYSTEMS
2 SCIENCES ACTIVITIES.—

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

11 “(A) understand, observe, and model the
12 response of Earth’s atmosphere and biosphere
13 to increased concentrations of greenhouse gas
14 emissions and any associated changes in cli-
15 mate, including frequency and intensity of ex-
16 treme weather events;

17 “(B) understand the coupled physical,
18 chemical, and biological processes to transform,
19 immobilize, remove, or move carbon, nitrogen,
20 and other energy production-derived contami-
21 nants such as radionuclides and heavy metals,
22 and understand the process of sequestration
23 and transformation of these, carbon dioxide,
24 and other relevant molecules in subsurface envi-
25 ronments;

1 “(C) understand, observe, and model the
2 cycling of water, carbon, and nutrients in ter-
3 restrial systems and at scales relevant to re-
4 sources management;

5 “(D) understand the biological, biogeo-
6 chemical, and physical processes across the
7 multiple scales that control the flux of environ-
8 mentally relevant compounds between the ter-
9 restrial surface and the atmosphere; and

10 “(E) inform potential natural mitigation
11 and adaptation options for increased concentra-
12 tions of greenhouse gas emissions and any asso-
13 ciated changes in climate.

14 “(2) PRIORITIZATION.—In carrying out the
15 program authorized under paragraph (1), the Direc-
16 tor shall prioritize—

17 “(A) the development of software and algo-
18 rithms to enable the productive application of
19 environmental systems and extreme weather in
20 climate and Earth system prediction models in
21 high-performance computing systems; and

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

1 “(3) ENVIRONMENTAL SYSTEMS SCIENCE RE-
2 SEARCH.—

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

12 “(B) COORDINATION.—

13 “(i) DIRECTOR.—The Director shall
14 carry out activities under this paragraph in
15 accordance with priorities established by
16 the Secretary to support and accelerate the
17 decontamination of relevant facilities man-
18 aged by the Department.

19 “(ii) SECRETARY.—The Secretary
20 shall ensure the coordination of activities
21 of the Department, including activities
22 under this paragraph, to support and ac-
23 celerate the decontamination of relevant fa-
24 cilities managed by the Department.

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

15 “(A) integrated capabilities for modeling
16 multisectoral interactions, including socio-
17 economic factors as appropriate, which may in-
18 clude the impacts of climate policies on social
19 and regional equity and well-being, and the
20 interdependencies and risks at the energy-
21 water-land nexus;

22 “(B) greenhouse gas emissions, air quality,
23 energy supply and demand, and other critical
24 elements; and

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

4 “(5) MID-SCALE FUNDING MECHANISM.—

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

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

16 “(h) BIOLOGICAL AND ENVIRONMENTAL RESEARCH
17 USER FACILITIES.—

18 “(1) IN GENERAL.—The Director shall carry
19 out a program for the development, construction, op-
20 eration, and maintenance of user facilities to en-
21 hance the collection and analysis of observational
22 data related to complex biological, climate, and envi-
23 ronmental systems.

24 “(2) FACILITY REQUIREMENTS.—To the max-
25 imum extent practicable, the user facilities devel-

1 oped, constructed, operated, or maintained under
2 paragraph (1) shall include—

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

6 “(B) analytical techniques, instruments,
7 and modeling resources for understanding the
8 physical, chemical, and cellular processes of bio-
9 logical and environmental systems;

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

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

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

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

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

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

18 “(5) EARTH AND ENVIRONMENTAL SYSTEMS
19 SCIENCES USER FACILITIES.—

20 “(A) IN GENERAL.—In carrying out the
21 activities authorized under paragraph (1), the
22 Director shall establish and operate user facili-
23 ties to advance the collection, validation, and
24 analysis of atmospheric data, including activi-
25 ties to advance knowledge and improve model

1 representations and measure the impact of at-
2 mospheric gases, aerosols, and clouds on earth
3 and environmental systems.

4 “(B) SELECTION.—The Director shall se-
5 lect user facilities under paragraph (1) on a
6 competitive, merit-reviewed basis. The Director
7 shall consider applications from the National
8 Laboratories, institutes of higher education,
9 multi-institutional collaborations, and other ap-
10 propriate entities.

11 “(C) EXISTING FACILITIES.—To the max-
12 imum extent practicable, the Director shall uti-
13 lize existing facilities to carry out this sub-
14 section.

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

18 “(A) consults and coordinates with the Na-
19 tional Oceanic Atmospheric Administration, the
20 Environmental Protection Agency, the National
21 Aeronautics and Space Administration, the De-
22 partment of Agriculture, the Department of the
23 Interior, and any other relevant Federal agency
24 on the collection, validation, and analysis of at-
25 mospheric data; and

1 “(B) coordinates with relevant stake-
2 holders, including institutes of higher education,
3 nonprofit research institutions, industry, State,
4 local, and tribal governments, and other appro-
5 priate entities to ensure access to the best avail-
6 able relevant atmospheric and historical weath-
7 er data.

8 “(i) COASTAL ZONE RESEARCH INITIATIVE.—

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

18 “(2) NATIONAL SYSTEM FOR COASTAL DATA
19 COLLECTION.—The Director shall establish, in con-
20 sultation with the National Oceanic and Atmospheric
21 Administration and other relevant agencies, an inte-
22 grated system of geographically diverse field re-
23 search sites in order to improve the quantity and
24 quality of observational data, and that encompass

1 the major land water interfaces of the United
2 States, including—

3 “(A) the Great Lakes region;

4 “(B) the Pacific coast;

5 “(C) the Atlantic coast;

6 “(D) the Arctic; and

7 “(E) the Gulf coast.

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

15 “(4) COORDINATION.—For the purposes of car-
16 rying out the programs and establishing the field re-
17 search sites under the Initiative, the Secretary may
18 enter into agreements with Federal Departments
19 and agencies with complementary capabilities.

20 “(5) REPORT.—Not less than 2 years after the
21 date of the enactment of the Department of Energy
22 Science for the Future Act, the Director shall pro-
23 vide to the Committee on Science, Space, and Tech-
24 nology and the Committee on Appropriations of the
25 House of Representatives and the Committee on En-

1 ergy and Natural Resources and the Committee on
2 Appropriations of the Senate a report examining
3 whether the system described in this section should
4 be established as a National User Facility.

5 “(j) TECHNOLOGY DEVELOPMENT.—The Director
6 shall support a technology research program for the devel-
7 opment of instrumentation and other research tools re-
8 quired to meet the missions of the Department and to pro-
9 vide platform technologies for the broader scientific com-
10 munity. Technologies shall include but are not limited to—

11 “(1) cryo-electron microscopy;

12 “(2) fabricated ecosystems;

13 “(3) next generation sensors including quantum
14 sensors for biological integration and bioproduction;

15 “(4) technologies to accelerate data analysis;

16 and

17 “(5) plant and microbial phenotyping for gene
18 discovery.

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

22 “(1) \$820,360,000 for fiscal year 2022;

23 “(2) \$886,385,200 for fiscal year 2023;

24 “(3) \$956,332,164 for fiscal year 2024;

25 “(4) \$1,020,475,415 for fiscal year 2025; and

1 “(5) \$1,099,108,695 for fiscal year 2026.”.

2 **SEC. 5. ADVANCED SCIENTIFIC COMPUTING RESEARCH**
3 **PROGRAM.**

4 (a) ADVANCED SCIENTIFIC COMPUTING RE-
5 SEARCH.—Section 304 of the Department of Energy Re-
6 search and Innovation Act (42 U.S.C. 18642) is amend-
7 ed—

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

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

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

18 “(1) steward applied mathematics, computa-
19 tional science, and computer science research rel-
20 evant to the missions of the Department and the
21 competitiveness of the United States;

22 “(2) develop modeling, simulation, and other
23 computational tools relevant to other scientific dis-
24 ciplines and to the development of new energy tech-
25 nologies and other technologies;

1 “(3) advance computing and networking ca-
2 pabilities for data-driven discovery; and

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

6 (3) in subsection (b) (as redesignated under
7 paragraph (1))—

8 (A) by striking “the Director” and insert-
9 ing “(1) DIRECTOR.—The Director”; and

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

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

20 (4) by amending subsection (d), as so redesign-
21 ated, to read as follows:

22 “(d) APPLIED MATHEMATICS AND SOFTWARE DE-
23 VELOPMENT FOR HIGH-END COMPUTING SYSTEMS AND
24 COMPUTER SCIENCES RESEARCH.—

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

3 “(A) mathematics, statistics, and algo-
4 rithms for modeling complex systems relevant
5 to the missions of the Department, including on
6 advanced computing architectures; and

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

12 “(2) PORTFOLIO BALANCE.—

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

19 “(i) applied mathematical, computa-
20 tional, and computer sciences research
21 needs relevant to the mission of the De-
22 partment, including foundational areas
23 that are critical to the advancement of en-
24 ergy sciences and technologies and new
25 and emerging computing technologies; and

1 “(ii) associated high-performance
2 computing hardware and facilities.

3 “(B) EXASCALE ECOSYSTEM
4 SUSTAINMENT.—

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

16 “(ii) IN GENERAL.—The Secretary
17 shall seek to sustain and evolve the eco-
18 system referenced in clause (i) to ensure
19 that the exascale software stack and other
20 research software will continue to be main-
21 tained, hardened, and otherwise optimized
22 for long-term use on exascale systems and
23 beyond and reliable availability to the user
24 community.”; and

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

3 “(e) NEXT GENERATION COMPUTING PROGRAM.—

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

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

19 “(B) retain best practices and maintain
20 support for essential hardware, applications,
21 and software elements of the Exascale Com-
22 puting Program that are necessary for sus-
23 taining the vitality of a long-term capable soft-
24 ware ecosystem for exascale and beyond; and

1 “(C) develop a Department-wide strategy
2 for balancing on-premises and cloud-based com-
3 puting and scientific data management.

4 “(2) REPORT.—Not later than one year after
5 the date of the enactment of this Act, the Secretary
6 shall submit to the Committee on Science, Space,
7 and Technology of the House of Representatives,
8 and the Committee on Energy and Natural Re-
9 sources of the Senate, a report on the development
10 and implementation of the strategy outlined in para-
11 graph (1).

12 “(f) ARCHITECTURAL RESEARCH IN HETERO-
13 GENEOUS COMPUTING SYSTEMS.—

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

1 “(2) COORDINATION.—In carrying out this pro-
2 gram, the Secretary shall ensure coordination be-
3 tween research activities undertaken by the Ad-
4 vanced Scientific Computing Research program and
5 materials research supported by the Basic Energy
6 Sciences program within the Department of Energy
7 Office of Science.

8 “(g) ENERGY EFFICIENT COMPUTING PROGRAM.—

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

16 “(2) EXECUTION.—

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

20 “(i) establish a partnership for Na-
21 tional Laboratories, industry partners, and
22 institutions of higher education for co-
23 design of energy efficient hardware, tech-
24 nology, software, and applications across
25 all applicable program offices of the De-

1 partment, and provide access to energy ef-
2 ficient computing resources to such part-
3 ners;

4 “‘(ii) develop hardware and software
5 technologies that decrease the energy needs
6 of advanced computing practices, including
7 through data center co-design; and

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

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

21 “(B) SELECTION OF PARTNERS.—In se-
22 lecting participants for the partnership estab-
23 lished under subparagraph (A)(i), the Secretary
24 shall select participants through a competitive,
25 merit review process.

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

9 “(i) the activities conducted under
10 subparagraph (A); and

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

15 “(h) ENERGY SCIENCES NETWORK.—

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

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

1 “(A) To provide high bandwidth scientific
2 networking across the continental United States
3 and the Atlantic Ocean.

4 “(B) To ensure network reliability.

5 “(C) To protect the network infrastructure
6 from cyber-attacks.

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

11 “(E) To contribute to the integration of
12 heterogeneous computing frameworks and sys-
13 tems.

14 “(i) COMPUTATIONAL SCIENCE GRADUATE FELLOW-
15 SHIP.—

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

24 “(2) FUNDING.—From within funds authorized
25 to be appropriated for Advanced Scientific Com-

1 puting Research Program, the Secretary shall make
2 available for carrying out the activities under this
3 section—

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

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

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

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

8 and

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

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

13 “(1) \$1,126,350,000 for fiscal year 2022;

14 “(2) \$1,222,674,500 for fiscal year 2023;

15 “(3) \$1,324,320,715 for fiscal year 2024;

16 “(4) \$1,431,660,115 for fiscal year 2025; and

17 “(5) \$1,535,090,121 for fiscal year 2026.”.

18 (b) QUANTUM SCIENCE NETWORK.—

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

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

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

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

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

11 **“SEC. 403. DEPARTMENT OF ENERGY QUANTUM NETWORK**
12 **INFRASTRUCTURE RESEARCH AND DEVELOP-**
13 **MENT PROGRAM.**

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

19 “(1) facilitate the advancement of distributed
20 quantum computing systems through the internet
21 and intranet;

22 “(2) improve the precision of measurements of
23 scientific phenomena and physical imaging tech-
24 nologies; and

1 “(3) develop secure national quantum commu-
2 nications technologies and strategies.

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

5 “(1) coordinate with—

6 “(A) the Director of the National Science
7 Foundation;

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

10 “(C) the Chair of the subcommittee on
11 Quantum Information Science of the National
12 Science and Technology Council established
13 under section 103(a); and

14 “(D) the Chair of the subcommittee on the
15 Economic and Security Implications of Quan-
16 tum Science;

17 “(2) conduct cooperative research with indus-
18 try, National Laboratories, institutions of higher
19 education, and other research institutions to facili-
20 tate new quantum infrastructure methods and tech-
21 nologies, including—

22 “(A) quantum-limited detectors, ultra-low
23 loss optical channels, space-to-ground connec-
24 tions, and classical networking and cybersecu-
25 rity protocols;

1 “(B) entanglement and hyper-entangled
2 state sources and transmission, control, and
3 measurement of quantum states;

4 “(C) quantum interconnects that allow
5 short range local connections between quantum
6 processors;

7 “(D) transducers for quantum sources and
8 signals between optical and telecommunications
9 regimes and quantum computer-relevant do-
10 mains, including microwaves;

11 “(E) development of quantum memory
12 buffers and small-scale quantum computers
13 that are compatible with photon-based quantum
14 bits in the optical or telecommunications wave-
15 lengths;

16 “(F) long-range entanglement distribution
17 at both the terrestrial and space-based level
18 using quantum repeaters, allowing entangle-
19 ment-based protocols between small- and large
20 scale quantum processors;

21 “(G) quantum routers, multiplexers, re-
22 peaters, and related technologies necessary to
23 create secure long-distance quantum commu-
24 nication; and

1 “(H) integration of systems across the
2 quantum technology stack into traditional com-
3 puting networks, including the development of
4 remote controlled, high performance, and reli-
5 able implementations of key quantum network
6 components;

7 “(3) engage with the Quantum Economic De-
8 velopment Consortium (QED-C) to transition com-
9 ponent technologies to help facilitate as appropriate
10 the development of a quantum supply chain for
11 quantum network technologies;

12 “(4) advance basic research in advanced sci-
13 entific computing, particle and nuclear physics, and
14 material science to enhance the understanding, pre-
15 diction, and manipulation of materials, processes,
16 and physical phenomena relevant to quantum net-
17 work infrastructure;

18 “(5) develop experimental tools and testbeds
19 necessary to support cross-cutting fundamental re-
20 search and development activities with diverse stake-
21 holders from industry and institutions of higher edu-
22 cation; and

23 “(6) consider quantum network infrastructure
24 applications that span the Department of Energy’s

1 missions in energy, environment, and national secu-
2 rity.

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

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

8 “(2) the National Science Foundation;

9 “(3) the National Aeronautics and Space Ad-
10 ministration;

11 “(4) other relevant Federal agencies;

12 “(5) the National Laboratories;

13 “(6) industry stakeholders;

14 “(7) institutions of higher education; and

15 “(8) the National Quantum Information
16 Science Research Centers.

17 “(d) RESEARCH PLAN.—Not later than 180 days
18 after the date of the enactment of the Department of En-
19 ergy Science for the Future Act, the Secretary shall sub-
20 mit to the Committee on Science, Space, and Technology
21 of the House of Representatives and the Committee on
22 Energy and Natural Resources of the Senate, a 4-year re-
23 search plan that identifies and prioritizes basic research
24 needs relating to quantum network infrastructure.

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

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

9 **“SEC. 404. DEPARTMENT OF ENERGY QUANTUM USER EX-**
10 **PANSION FOR SCIENCE AND TECHNOLOGY**
11 **PROGRAM.**

12 “(a) IN GENERAL.—The Secretary of Energy (re-
13 ferred to in this section as the ‘Secretary’) shall establish
14 and carry out a program (to be known as the ‘Quantum
15 User Expansion for Science and Technology program’ or
16 ‘QUEST program’) to encourage and facilitate access to
17 United States quantum computing hardware and quantum
18 computing clouds for research purposes in order to—

19 “(1) enhance the United States quantum re-
20 search enterprise;

21 “(2) educate the future quantum computing
22 workforce; and

23 “(3) accelerate the advancement of United
24 States quantum computing capabilities.

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

3 “(1) coordinate with—

4 “(A) the Director of the National Science
5 Foundation;

6 “(B) the Director of the National Institute
7 of Standards and Technology;

8 “(C) the Chair of the Quantum Informa-
9 tion Science of the National Science and Tech-
10 nology Council established under section
11 103(a); and

12 “(D) the Chair of the subcommittee on the
13 Economic and Security Implications of Quan-
14 tum Science;

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

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

1 “(4) consult and coordinate with private sector
2 stakeholders, the user community, and interagency
3 partners on program development and best manage-
4 ment practices.

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

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

10 “(2) the National Science Foundation;

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

13 “(4) other relevant Federal agencies;

14 “(5) the National Laboratories;

15 “(6) industry stakeholders;

16 “(7) institutions of higher education; and

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

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

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

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

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

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

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

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

10 “(f) EQUITABLE USE OF HIGH-PERFORMANCE COM-
11 PUTING CAPABILITIES.—

12 “(1) SENSE OF CONGRESS.—It is the sense of
13 Congress that machine learning algorithms can ex-
14 hibit biases that cause harm to historically
15 marginalized communities.

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

1 **SEC. 6. FUSION ENERGY RESEARCH.**

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

5 (1) in subsection (b)—

6 (A) in the matter preceding paragraph (1),
7 by striking “As part of” and inserting “(1) IN
8 GENERAL.—As part of”;

9 (B) by redesignating—

10 (i) paragraphs (1) and (2) as sub-
11 paragraphs (A) and (B), respectively; and

12 (ii) in subparagraph (B) (as redesign-
13 nated by clause (i)), subparagraphs (A)
14 and (B) as clauses (i) and (ii), respectively;
15 and

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

17 “(2) AUTHORIZATION OF APPROPRIATIONS.—Out of
18 funds authorized to be appropriated under subsection (r),
19 there are authorized to be appropriated to the Secretary
20 to carry out activities described in paragraph (1)
21 \$50,000,000 for each of fiscal years 2022 through 2026.”;

22 (2) in subsection (d)(3)—

23 (A) by striking the period at the end and
24 inserting “and \$40,000,000 for fiscal year
25 2026.”; and

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

2 and

3 (3) in subsection (e)(4)—

4 (A) by striking the period at the end and
5 inserting “and \$75,000,000 for fiscal year
6 2026.”; and

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

8 (4) in subsection (i)(10)—

9 (A) In the matter preceding subparagraph
10 (A), by striking “(o)” and inserting “(r)”;

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

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

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

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

17 (5) in subsection (j)—

18 (A) by striking “The Director” and insert-
19 ing “(1) IN GENERAL.—The Director”; and

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

21 “(2) AUTHORIZATION OF APPROPRIATIONS.—

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

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

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

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

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

3 and

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

5 (6) in subsection (l)—

6 (A) by striking “sense of Congress that”

7 and inserting “sense of Congress that—”;

8 (B) by striking “United States should sup-

9 port” and inserting “(1) United States should

10 support”; and

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

12 “(2) the Director shall incorporate the findings

13 and recommendations of the report of the Fusion

14 Energy Sciences Advisory Committee entitled

15 ‘Powering the Future: Fusion and Plasmas’ and the

16 report of the National Academies entitled “Bringing

17 Fusion to the U.S. Grid” into the planning process

18 of the Department, including the development of fu-

19 ture budget requests to Congress.”;

20 (7) by redesignating subsection (o) as sub-

21 section (r);

22 (8) by inserting after subsection (n) the fol-

23 lowing:

24 “(o) HIGH-PERFORMANCE COMPUTATION COLLABO-

25 RATIVE RESEARCH PROGRAM.—

1 “(1) IN GENERAL.—The Secretary shall carry
2 out a program to conduct and support collaborative
3 research, development, and demonstration of fusion
4 energy technologies, through high-performance com-
5 putation modeling and simulation techniques, in
6 order to—

7 “(A) support fundamental research in plas-
8 mas and matter at very high temperatures and
9 densities;

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

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

14 “(2) COORDINATION.—In carrying out the pro-
15 gram under paragraph (1), the Secretary shall co-
16 ordinate with relevant Federal agencies, and
17 prioritize the following objectives:

18 “(A) Using expertise from the private sec-
19 tor, institutions of higher education, and the
20 National Laboratories to leverage existing, and
21 develop new, computational software and capa-
22 bilities that prospective users may use to accel-
23 erate research and development of fusion energy
24 systems.

1 “(B) Developing computational tools to
2 simulate and predict fusion energy science phe-
3 nomena that may be validated through physical
4 experimentation.

5 “(C) Increasing the utility of the research
6 infrastructure of the Department by coordi-
7 nating with the Advanced Scientific Computing
8 Research program within the Office of Science.

9 “(D) Leveraging experience from existing
10 modeling and simulation entities sponsored by
11 the Department.

12 “(E) Ensuring that new experimental and
13 computational tools are accessible to relevant
14 research communities, including private sector
15 entities engaged in fusion energy technology de-
16 velopment.

17 “(F) Ensuring that newly developed com-
18 putational tools are compatible with modern vir-
19 tual engineering and visualization capabilities to
20 accelerate the realization of fusion energy tech-
21 nologies and systems.

22 “(3) DUPLICATION.—The Secretary shall en-
23 sure the coordination of, and avoid unnecessary du-
24 plication of, the activities of this program with the
25 activities of—

1 “(A) other research entities of the Depart-
2 ment, including the National Laboratories, the
3 Advanced Research Projects Agency–Energy,
4 the Advanced Scientific Computing Research
5 program; and

6 “(B) industry.

7 “(4) HIGH-PERFORMANCE COMPUTING FOR FU-
8 SION INNOVATION CENTER.—In carrying out the
9 program under paragraph (1), the Secretary shall,
10 in coordination with the Innovation Network for Fu-
11 sion Energy, establish and operate a national High-
12 Performance Computing for Fusion Innovation Cen-
13 ter (referred to in this section as the ‘Center’), in
14 order to support the program under paragraph (1)
15 by providing, to the extent practicable, a centralized
16 entity for multidisciplinary, collaborative, fusion en-
17 ergy research and development through high per-
18 formance computing and advanced data analytics
19 technologies and processes.

20 “(5) SELECTION.—The Secretary shall select
21 the Center under this subsection on a competitive,
22 merit-reviewed basis. The Secretary shall consider
23 applications from National Laboratories, institutions
24 of higher education, multi-institutional collabora-
25 tions, and other appropriate entities.

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

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

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

12 “(9) TERMINATION.—Consistent with the exist-
13 ing authorities of the Department, the Secretary
14 may terminate the Center for cause during the per-
15 formance period.

16 “(p) MATERIAL PLASMA EXPOSURE EXPERIMENT.—

17 “(1) IN GENERAL.—The Secretary shall con-
18 struct a Material Plasma Exposure Experiment fa-
19 cility as described in the 2020 publication approved
20 by the Fusion Energy Sciences Advisory Committee
21 titled ‘Powering the Future: Fusion and Plasmas’.
22 The Secretary shall consult with the private sector,
23 universities, National Laboratories, and relevant
24 Federal agencies to ensure that this facility is capa-
25 ble of meeting Federal research needs for steady

1 state, high-heat-flux and plasma-material interaction
2 testing of fusion materials over a range of fusion en-
3 ergy relevant parameters.

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

7 “(A) A magnetic field at the target of 1
8 Tesla.

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

11 “(C) The ability to expose previously irra-
12 diated plasma facing material samples to plas-
13 ma.

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

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

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

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

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

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

3 “(q) MATTER IN EXTREME CONDITIONS INSTRU-
4 MENT UPGRADE.—

5 “(1) IN GENERAL.—The Secretary shall provide
6 for the upgrade to the Matter in Extreme Conditions
7 endstation at the Linac Coherent Light Source as
8 described in the 2020 publication approved by the
9 Fusion Energy Sciences Advisory Committee titled
10 ‘Powering the Future: Fusion and Plasmas’. The
11 Secretary shall consult with the private sector, uni-
12 versities, National Laboratories, and relevant Fed-
13 eral agencies to ensure that this facility is capable
14 of meeting Federal research needs for understanding
15 physical and chemical changes to plasmas at funda-
16 mental timescales, and explore new regimes of dense
17 material physics, astrophysics, planetary physics,
18 and short-pulse laser-plasma interactions.

19 “(2) START OF OPERATIONS.—The Secretary
20 shall, subject to the availability of appropriations,
21 ensure that the start of full operations of the facility
22 under this section occurs before December 31,
23 2028.”; and

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

4 “(2) \$1,002,900,000 for fiscal year 2022;

5 “(3) \$1,095,707,000 for fiscal year 2023;

6 “(4) \$1,129,368,490 for fiscal year 2024;

7 “(5) \$1,149,042,284 for fiscal year 2025; and

8 “(6) \$1,243,097,244 for fiscal year 2026.”.

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

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

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

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

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

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

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

20 and

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

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

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

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

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

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

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

20 (b) INTERNATIONAL COLLABORATION.—Section
21 305(d) of the Department of Energy Research and Inno-
22 vation Act (42 U.S.C. 18643(d)), as redesignated under
23 subsection (a), is amended to read as follows:

24 “(d) INTERNATIONAL COLLABORATION.—The Direc-
25 tor shall—

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

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

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

18 (c) COSMIC FRONTIER RESEARCH.—Section 305(f)
19 of the Department of Energy Research and Innovation Act
20 (42 U.S.C. 18645(f)), as redesignated by subsection (a),
21 is amended to read as follows:

22 “(f) COSMIC FRONTIER RESEARCH.—The Director
23 shall carry out research activities on the nature of the pri-
24 mary contents of the universe, including the nature of
25 dark energy and dark matter. These activities shall, to the

1 maximum extent practicable, be consistent with the re-
2 search priorities identified by the High Energy Physics
3 Advisory Panel or the National Academy of Sciences, and
4 may include—

5 “(1) collaborations with the National Aero-
6 nautics and Space Administration, the National
7 Science Foundation, or international partners on rel-
8 evant projects; and

9 “(2) the development of space-based, land-
10 based, water-based, and underground facilities and
11 experiments.”.

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

16 “(g) FACILITY CONSTRUCTION AND MAJOR ITEMS
17 OF EQUIPMENT.—

18 “(1) PROJECTS.—Consistent with the Office of
19 Science’s project management practices, the Director
20 shall, to the maximum extent practicable, incor-
21 porate the findings and recommendations of the
22 2014 Particle Physics Project Prioritization Panel
23 (P5) report titled ‘Building for Discovery’, and sup-
24 port construction or fabrication of—

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

3 “(B) the Proton Improvement Plan II;

4 “(C) Second Generation Dark Matter ex-
5 periments;

6 “(D) the Legacy Survey of Space and
7 Time camera;

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

10 “(F) other high priority projects rec-
11 ommended in the most recent report of the Par-
12 ticle Physics Project Prioritization Panel of the
13 High Energy Physics Advisory Panel.

14 “(2) LONG-BASELINE NEUTRINO FACILITY.—

15 “(A) IN GENERAL.—The Secretary shall
16 support construction of a Long-Baseline Neu-
17 trino Facility to facilitate the international
18 Deep Underground Neutrino Experiment to ex-
19 amine the fundamental properties of neutrinos,
20 explore physics beyond the Standard Model,
21 and better clarify the existence and nature of
22 antimatter.

23 “(B) FACILITY CAPABILITIES.—The Sec-
24 retary shall ensure that the facility described in

1 subparagraph (A) will provide, at a minimum,
2 the following capabilities:

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

7 “(ii) Three caverns excavated for a 70
8 kiloton fiducial detector mass and sup-
9 porting surface buildings and utilities.

10 “(iii) Cryogenic systems to support
11 neutrino detectors.

12 “(C) START OF OPERATIONS.—The Sec-
13 retary shall, subject to the availability of appro-
14 priations, ensure that the start of full oper-
15 ations of the facility under this subsection oc-
16 curs before December 31, 2031.

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

22 “(i) \$200,000,000 for fiscal year
23 2022;

24 “(ii) \$325,000,000 for fiscal year
25 2023;

1 “(iii) \$400,000,000 for fiscal year
2 2024;

3 “(iv) \$375,000,000 for fiscal year
4 2025; and

5 “(v) \$250,000,000 for fiscal year
6 2026.

7 “(3) PROTON IMPROVEMENT PLAN—II ACCEL-
8 ERATOR UPGRADE PROJECT.—

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

23 “(B) FACILITY CAPABILITIES.—The Sec-
24 retary shall ensure that the facility described in

1 paragraph (1) will provide, at a minimum, the
2 following capabilities:

3 “(i) A state-of-the-art 800
4 megaelectron volt (MeV) superconducting
5 linear accelerator.

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

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

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

15 “(C) START OF OPERATIONS.—The Sec-
16 retary shall, subject to the availability of appro-
17 priations, ensure that the start of full oper-
18 ations of the facility under this section occurs
19 before December 31, 2028.

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

1 “(i) \$191,000,000 for fiscal year
2 2022;

3 “(ii) \$150,000,000 for fiscal year
4 2023;

5 “(iii) \$120,000,000 for fiscal year
6 2024;

7 “(iv) \$120,000,000 for fiscal year
8 2025; and

9 “(v) \$100,000,000 for fiscal year
10 2026.

11 “(4) COSMIC MICROWAVE BACKGROUND STAGE

12 4.—

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

23 “(B) CONSULTATION.—The Secretary
24 shall consult with the private sector, univer-
25 sities, National Laboratories, and relevant Fed-

1 eral agencies to ensure that this experiment is
2 capable of meeting Federal research needs in
3 accessing the ultra-high energy physics of infla-
4 tion and important neutrino properties.

5 “(C) EXPERIMENTAL CAPABILITIES.—The
6 Secretary shall ensure to the maximum extent
7 practicable that the facility described in sub-
8 section (a) will provide at minimum, 500,000
9 superconducting detectors deployed on an array
10 of mm wave telescopes with the required range
11 in frequency, sensitivity, and survey speed
12 which will provide sufficient capability to enable
13 an order of magnitude advance in observations
14 of the Cosmic Microwave Background, deliv-
15 ering transformative discoveries in fundamental
16 physics, cosmology, and astrophysics.

17 “(D) START OF OPERATIONS.—The Sec-
18 retary shall, subject to the availability of appro-
19 priations, ensure that the start of full oper-
20 ations of the facility under this section occurs
21 before December 31, 2030.

22 “(E) FUNDING.—Out of funds authorized
23 to be appropriated under subsection (k), there
24 shall be made available to the Secretary to

1 carry out construction of the facility under this
2 subsection—

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

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

5 “(iii) \$70,000,000 for fiscal year
6 2024;

7 “(iv) \$80,000,000 for fiscal year
8 2025; and

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

10 “(h) ACCELERATOR AND DETECTOR UPGRADES.—

11 The Director shall upgrade accelerator facilities and detec-
12 tors, as necessary and appropriate, to increase beam
13 power, sustain high reliability, and improve precision
14 measurement to advance the highest priority particle phys-
15 ics research programs. In carrying out facility upgrades,
16 the Director shall continue to work with international
17 partners, when appropriate and in the United States’ in-
18 terest, to leverage investments and expertise in critical
19 technologies to help build and upgrade accelerator and de-
20 tector facilities in the United States.

21 “(i) ACCELERATOR AND DETECTOR RESEARCH AND
22 DEVELOPMENT.—As part of the program described in
23 subsection (a), the Director shall carry out research and
24 development in particle beam physics, accelerator science
25 and technology, and particle and radiation detection with

1 relevance to the specific needs of the High Energy Physics
2 program, in coordination with the Accelerator Research
3 and Development program authorized in section 311.

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

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

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

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

21 “(1) \$1,355,690,000 for fiscal year 2022;

22 “(2) \$1,517,628,300 for fiscal year 2023;

23 “(3) \$1,652,112,281 for fiscal year 2024;

24 “(4) \$1,711,460,141 for fiscal year 2025; and

25 “(5) \$1,656,012,351 for fiscal year 2026.”.

1 **SEC. 8. NUCLEAR PHYSICS PROGRAM.**

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

5 (1) by striking subsection (a);

6 (2) by redesignating subsection (b) as sub-
7 section (d); and

8 (3) by inserting the following before subsection
9 (d), as so redesignated:

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

15 “(b) USER FACILITIES.—

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

17 “(A) IN GENERAL.—The Secretary shall
18 support construction of a Facility for Rare Iso-
19 tope Beams to advance the understanding of
20 rare nuclear isotopes and the evolution of the
21 cosmos.

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

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 facility under this section occurs
5 before March 1, 2022.

6 “(2) ELECTRON-ION COLLIDER.—

7 “(A) IN GENERAL.—The Secretary shall
8 support construction of an Electron Ion Collider
9 as described in the 2015 Long Range Plan of
10 the Nuclear Science Advisory Committee and
11 the report from the National Academies titled
12 ‘An Assessment of U.S.-Based Electron-Ion
13 Collider Science’, in order to measure the inter-
14 nal structure of the proton and the nucleus and
15 answer fundamental questions about the nature
16 of visible matter.

17 “(B) FACILITY CAPABILITY.—The Sec-
18 retary shall ensure that the facility meets the
19 requirements in the 2015 Long Range Plan, in-
20 cluding—

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

23 “(ii) ion beams from deuterium to the
24 heaviest stable nuclei;

1 “(iii) variable center of mass energy
2 from 20 to 140 GeV;

3 “(iv) high collision luminosity of
4 $10^{33-34}\text{cm}^{-2}\text{s}^{-1}$; and

5 “(v) the possibility of more than one
6 interaction region.

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, 2030.

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

17 “(i) \$101,000,000 for fiscal year
18 2022;

19 “(ii) \$155,000,000 for fiscal year
20 2023;

21 “(iii) \$250,000,000 for fiscal year
22 2024;

23 “(iv) \$300,000,000 for fiscal year
24 2025; and

1 “(v) \$305,000,000 for fiscal year
2 2026.

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

7 “(2) \$879,390,000 for fiscal year 2023;

8 “(3) \$1,025,097,300 for fiscal year 2024;

9 “(4) \$1,129,354,111 for fiscal year 2025; and

10 “(5) \$1,192,408,899 for fiscal year 2026.”.

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

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

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

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

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

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

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

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

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

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

14 “(2) optimal operation of the Accelerator Test
15 Facility.

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

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

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

5 “(2) leverage investments in accelerator tech-
6 nologies and fundamental research in particle phys-
7 ics by partnering with institutes of higher education,
8 industry, and other Federal agencies to enable the
9 commercial application of advanced accelerator tech-
10 nologies.

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—

14 “(1) \$24,000,000 for fiscal year 2022;

15 “(2) \$25,680,000 for fiscal year 2023;

16 “(3) \$27,477,600 for fiscal year 2024;

17 “(4) \$29,401,032 for fiscal year 2025; and

18 “(5) \$31,459,104 for fiscal year 2026.”.

19 **SEC. 10. ISOTOPE DEVELOPMENT AND PRODUCTION FOR**
20 **RESEARCH APPLICATIONS.**

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

1 **“SEC. 311. ISOTOPE DEVELOPMENT AND PRODUCTION FOR**
2 **RESEARCH APPLICATIONS.**

3 “(a) IN GENERAL.—The Director—

4 “(1) shall carry out a program in coordination
5 with other relevant programs across the Department
6 of Energy for the production of isotopes, including
7 the development of techniques to produce isotopes,
8 that the Secretary determines are needed for re-
9 search, medical, industrial, or related purposes, to
10 the maximum extent practicable, in accordance with
11 the 2015 NSAC ‘Meeting Isotope Needs and Cap-
12 turing Opportunities For The Future’ report; and

13 “(2) shall ensure that isotope production activi-
14 ties carried out under the program under this para-
15 graph do not compete with private industry unless
16 the Director determines that critical national inter-
17 ests require the involvement of the Federal Govern-
18 ment.

19 “(b) AUTHORIZATION OF APPROPRIATIONS.—There
20 are authorized to be appropriated to carry out the pro-
21 gram under this subsection—

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

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

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

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

26 “(5) \$117,971,641 for fiscal year 2026.”.

1 **SEC. 11. SCIENCE LABORATORIES INFRASTRUCTURE PRO-**
2 **GRAM.**

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

6 “(c) APPROACH.—In carrying out this section, the
7 Director shall utilize all available approaches and mecha-
8 nisms, including capital line items, minor construction
9 projects, energy savings performance contracts, utility en-
10 ergy service contracts, alternative financing and expense
11 funding, as appropriate.

12 “(d) ALTERNATIVE FINANCING OF RESEARCH FA-
13 CILITIES AND INFRASTRUCTURE.—

14 “(1) IN GENERAL.—Consistent with section
15 161(g) of the Atomic Energy Act of 1954 (42
16 U.S.C. 2201(g)), the Management and Operating
17 contractors of the Department may enter into the
18 lease-purchase of research facilities and infrastruc-
19 ture under the scope of their contract with the De-
20 partment with the approval of the Secretary or their
21 designee.

22 “(2) LIMITATIONS.—To carry out lease-pur-
23 chases approved by the Secretary under subsection
24 (a), the Department shall only be required to have
25 budget authority in an amount sufficient to cover
26 the minimum required lease payments through the

1 period required to exercise a termination provision in
2 the lease agreement, plus any associated lease termi-
3 nation penalties, regardless of whether such leased
4 facility and infrastructure is on or off Government
5 land, and if—

6 “(A) the Department has established a
7 mission need for the facility or infrastructure to
8 be leased;

9 “(B) the facility or infrastructure is gen-
10 eral purpose, including offices, laboratories,
11 cafeterias, utilities, and data centers;

12 “(C) the Department is not a party to and
13 has no financial obligations under the lease-pur-
14 chase transaction entered into by the Manage-
15 ment and Operating contractor, other than al-
16 lowability of the lease cost and conveyance of
17 Government land, if needed;

18 “(D) the lease-purchase has an advance
19 notice termination provision with reasonable
20 pre-defined penalties that the Management and
21 Operating contractor may exercise, at the direc-
22 tion of the Department, if funding for the lease
23 is no longer available or the mission need ceases
24 to exist;

1 “(E) there is an option for a no cost trans-
2 fer of ownership to the Government once the
3 underlying financing is retired, but neither the
4 Management and Operating contractor nor the
5 Department are obligated to purchase the facil-
6 ity or infrastructure at any time during or after
7 the lease term;

8 “(F) the lease-purchase transaction, as-
9 suming exercise of the ownership option, is
10 demonstrated to be the lowest lifecycle cost al-
11 ternative for the Government; and

12 “(G) the cumulative annual base rent for
13 all lease-purchases of facilities and infrastruc-
14 ture, inclusive of any transactions under consid-
15 eration, does not exceed 2 percent of the Man-
16 agement and Operating contract operating
17 budget for the year the commitment is made for
18 the lease.

19 “(3) REPORTING.—Not later than one year
20 after the date of the enactment of the Department
21 of Energy Science for the Future Act, and biennially
22 thereafter, the Department shall submit to the Com-
23 mittee on Science, Space, and Technology and the
24 Committee on Appropriations of the House of Rep-
25 resentatives, and the Committee on Energy and Nat-

1 ural Resources and the Committee on Appropria-
2 tions of the Senate, a report on the lease-purchase
3 transactions that the Management and Operating
4 contractors of the Department entered into under
5 subsection (a) that includes—

6 “(A) a list of the lease-purchase trans-
7 actions entered into by each Management and
8 Operating contractor and their respective costs;

9 “(B) the annual percentage of each Man-
10 agement and Operating contract operating
11 budget that is used for lease-purchase trans-
12 actions for the year the commitments were
13 made; and

14 “(C) any other information the Secretary
15 finds appropriate.

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

24 “(e) AUTHORIZATION OF APPROPRIATIONS.—There
25 are authorized to be appropriated to the Secretary to carry

1 out the activities described in this section \$500,000,000
2 for each of fiscal years 2022 through 2026.”.

3 **SEC. 12. INCREASED COLLABORATION WITH TEACHERS**
4 **AND SCIENTISTS.**

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

9 **“SEC. 312. INCREASED COLLABORATION WITH TEACHERS**
10 **AND SCIENTISTS.**

11 “(a) IN GENERAL.—The Director shall support the
12 development of a scientific workforce through programs
13 that facilitate collaboration between K–12, university stu-
14 dents, early-career researchers, faculty, and the National
15 Laboratories, including through the use of proven tech-
16 niques to expand the number of individuals from under-
17 represented groups pursuing and attaining skills or under-
18 graduate and graduate degrees relevant to the Office’s
19 mission.

20 “(b) AUTHORIZATION OF APPROPRIATIONS.—Section
21 3169 of the Department of Energy Science Education En-
22 hancement Act (42 U.S.C. 7381e) is amended—

23 “(1) by striking, ‘programs’, and inserting ‘pro-
24 grams, including the NSF INCLUDES National
25 Network,’; and

1 Transportation of the Senate and make available to the
2 public a plan for broadening participation of underrep-
3 resented groups in science, technology, engineering, and
4 mathematics in programs supported by the Department
5 programs, including—

6 “(1) a plan for supporting and leveraging the
7 National Science Foundation INCLUDES National
8 Network;

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

11 “(3) experienced and potential barriers to
12 broadening participation of underrepresented groups
13 in Department programs, including recommended
14 solutions; and

15 “(4) any other activities the Secretary finds ap-
16 propriate.

17 “(c) AUTHORIZATION OF APPROPRIATIONS.—Of the
18 amounts authorized to be appropriated in section 3169
19 (42 U.S.C. 7381e), at least \$2,000,000 shall be made
20 available each fiscal year for the activities described under
21 this subsection.

1 **“SEC. 3167B. EXPANDING OPPORTUNITIES TO INCREASE**
2 **THE DIVERSITY, EQUITY, AND INCLUSION OF**
3 **HIGHLY SKILLED SCIENCE, TECHNOLOGY,**
4 **ENGINEERING, AND MATHEMATICS (STEM)**
5 **PROFESSIONALS.**

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

15 “(b) PLAN AND OUTREACH STRATEGY.—

16 “(1) PLAN.—Not later than 6 months after the
17 date of enactment of the Department of Energy
18 Science for the Future Act, the Secretary shall sub-
19 mit to the Committee on Science, Space, and Tech-
20 nology of the House of Representatives and the
21 Committee on Energy and Natural Resources of the
22 Senate a 10-year educational plan to fund and ex-
23 pand new or existing programs administered by the
24 Office of Science and sited at the national labora-
25 tories and Department of Energy user facilities to
26 expand educational and workforce opportunities for

1 underrepresented high school, undergraduate, and
2 graduate students as well as recent graduates,
3 teachers and faculty in STEM fields. This may in-
4 clude paid internships, fellowships, temporary em-
5 ployment, training programs, visiting student and
6 faculty programs, sabbaticals, and research support.

7 “(2) OUTREACH CAPACITY.—The Secretary
8 shall include in the plan under paragraph (1) an
9 outreach strategy to improve the advertising, recruit-
10 ment, and promotion of educational and workforce
11 programs to community colleges, Historically Black
12 Colleges and Universities, Tribal Colleges, Minority
13 Serving Institutions, and emerging research institu-
14 tions.

15 “(c) BUILDING RESEARCH CAPACITY.—The Sec-
16 retary shall develop programs that strengthen the research
17 capacity relevant to Office of Science disciplines at emerg-
18 ing research institutions, including minority-serving insti-
19 tutions, tribal colleges and universities, Historically Black
20 Colleges and Universities, and colleges and universities.
21 This may include enabling mutually beneficial and jointly
22 managed partnerships between research-intensive institu-
23 tions and emerging research institutions, and soliciting re-
24 search proposals, fellowships, training programs, and re-

1 search support directly from emerging research institu-
2 tions.

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

13 “(e) **EVALUATION.**—The Secretary shall establish key
14 performance indicators to measure and monitor progress
15 of education and workforce programs and expand Depart-
16 mental activities for data collection and analysis. The Sec-
17 retary shall submit a report 2 years after the date of en-
18 actment of the Department of Energy Science for the Fu-
19 ture Act, and every 2 years thereafter, to the Committee
20 on Science, Space, and Technology of the House of Rep-
21 resentatives and the Committee on Energy and Natural
22 Resources of the Senate summarizing progress toward
23 meeting key performance indicators.

24 “(f) **DEFINITIONS.**—In this section:

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

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

11 “(3) STEM.—The term ‘STEM’ has the mean-
12 ing given the term in the STEM Education Act of
13 2015 (42 U.S.C. 1861 et seq.).

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

18 **SEC. 13. HIGH INTENSITY LASER RESEARCH INITIATIVE;**
19 **OFFICE OF SCIENCE EMERGING INFECTIOUS**
20 **DISEASE COMPUTING RESEARCH INITIATIVE;**
21 **HELIUM CONSERVATION PROGRAM; AUTHOR-**
22 **IZATION OF APPROPRIATIONS.**

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

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

2 “(a) IN GENERAL.—The Director shall establish a
3 high intensity laser research initiative consistent with the
4 recommendations of the National Academies report, ‘Op-
5 portunities in Intense Ultrafast Lasers: Reaching for the
6 Brightest Light’, and the report from the Brightest Light
7 Initiative workshop on ‘The Future of Intense Ultrafast
8 Lasers in the U.S.’. This initiative should include research
9 and development of petawatt-scale and of high average
10 power laser technologies necessary for future facility needs
11 in discovery science and to advance energy technologies,
12 as well as support for a user network of academic and
13 national laboratory high intensity laser facilities.

14 “(b) LEVERAGE.—The Director shall also leverage
15 new laser technologies for more compact, less complex,
16 and low-cost accelerator systems needed for science appli-
17 cations.

18 “(c) COORDINATION.—The Director shall coordinate
19 this initiative among all relevant programs within the Of-
20 fice of Science, and the Under Secretary for Science shall
21 coordinate this initiative with other relevant programs
22 within the Department as well as within other Federal
23 agencies.

24 “(d) AUTHORIZATION OF APPROPRIATIONS.—Out of
25 funds authorized to be appropriated for the Office of
26 Science there are authorized to be appropriated to the Sec-

1 retary to carry out the activities described in this sub-
2 section—

3 “(1) \$50,000,000 for fiscal year 2022;

4 “(2) \$100,000,000 for fiscal year 2023;

5 “(3) \$150,000,000 for fiscal year 2024;

6 “(4) \$200,000,000 for fiscal year 2025; and

7 “(5) \$250,000,000 for fiscal year 2026.

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

9 “(a) IN GENERAL.—The Secretary shall establish a
10 program to reduce the consumption of helium for Depart-
11 ment grant recipients and facilities and encourage helium
12 recycling and reuse. The program shall competitively
13 award grants for—

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

16 “(2) the installation, maintenance, and repair
17 of new and existing helium capture, reuse, and recy-
18 cling equipment; and

19 “(3) helium alternatives research and develop-
20 ment activities.

21 “(b) REPORT.—In carrying out the program under
22 this section, the Director shall submit to the Committee
23 on Science, Space, and Technology of House of Represent-
24 atives and the Committee on Energy and Natural Re-
25 sources of the Senate a report, not later than two years

1 after the date of enactment of the Department of Energy
2 Science for the Future Act, and every 3 years thereafter,
3 on the purchase of helium as part of research projects and
4 facilities supported by the Department. The report shall
5 include—

6 “(1) the quantity of helium purchased for
7 projects and facilities supported by Department
8 grants;

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

10 “(3) the predominant production sources for
11 such helium;

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

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

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

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

24 “(e) RENEWAL.—Upon expiration of any period of
25 support of the program under this section, the Director

1 may renew support for the program for a period of not
2 more than 5 years.

3 **“SEC. 315. OFFICE OF SCIENCE EMERGING INFECTIOUS**
4 **DISEASE COMPUTING RESEARCH INITIATIVE.**

5 “(a) IN GENERAL.—The Secretary, in coordination
6 with the Director of the National Science Foundation and
7 the Administrator of the National Aeronautics and Space
8 Administration, shall establish within the Office of
9 Science, a cross-cutting research initiative to leverage the
10 Federal Government’s innovative analytical resources and
11 tools, user facilities, and advanced computational and net-
12 working capabilities in order to prevent, prepare for, and
13 respond to emerging infectious diseases, including
14 COVID–19. The Secretary shall carry out this initiative
15 through a competitive, merit-reviewed process, and con-
16 sider applications from National Laboratories, institutions
17 of higher education, multi-institutional collaborations, in-
18 dustry partners and other appropriate entities.

19 “(b) ACTIVITIES.—In carrying out the initiative es-
20 tablished under subsection (a), the Secretary shall coordi-
21 nate with programs across the Office of Science and with
22 relevant Federal agencies to determine a comprehensive
23 set of technical milestones for these research activities and
24 prioritize the following objectives—

1 “(1) supporting fundamental research and de-
2 velopment in advanced analytics, experimental stud-
3 ies, materials synthesis, high-performance computing
4 technologies needed to characterize, model, simulate,
5 and predict complex phenomena and biological mate-
6 rials related to emerging infectious diseases, includ-
7 ing COVID–19 challenges, including a focus on test-
8 ing and diagnostics, experimental data acquisition,
9 sharing and management, advanced manufacturing,
10 and molecular design and modeling;

11 “(2) using expertise from the private sector, in-
12 stitutions of higher education, and the National
13 Laboratories to develop computational software and
14 capabilities that prospective users may accelerate
15 emerging infectious diseases research and develop-
16 ment;

17 “(3) leveraging the research infrastructure of
18 the Department, including scientific computing user
19 facilities, x-ray light sources, neutron scattering fa-
20 cilities, nanoscale science research centers, and se-
21 quencing and bio-characterization facilities by co-
22 ordinating with the Advanced Scientific Computing
23 Research, Basic Energy Sciences, and Biological and
24 Environmental Research programs within the Office
25 of Science;

1 “(4) leveraging experience from existing mod-
2 eling and simulation research and work sponsored by
3 the Department and promoting collaboration and
4 data sharing between National Laboratories, re-
5 search entities, and user facilities of the Department
6 by providing the necessary access and secure data
7 transfer capabilities; and

8 “(5) ensuring that new experimental and com-
9 putational tools are accessible to relevant research
10 communities, including private sector entities to ad-
11 dress emerging infectious diseases, including
12 COVID–19 challenges.

13 “(c) COORDINATION.—In carrying out this initiative,
14 the Secretary shall ensure, to the maximum extent prac-
15 ticable, coordination of these activities with the Depart-
16 ment of Energy National Laboratories, institutions of
17 higher education, and the private sector.

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

20 “(1) IN GENERAL.—The Secretary in coordina-
21 tion with the Director of the National Science Foun-
22 dation and the Director of the Office of Science and
23 Technology Policy shall establish and operate an
24 Emerging Infectious Diseases High Performance
25 Computing Research Consortium (referred to in this

1 section as the ‘Consortium’), in order to support the
2 initiative under subsection (a) by providing, to the
3 extent practicable, a centralized entity for multidisci-
4 plinary, collaborative, emerging infectious disease re-
5 search and development through high performance
6 computing and advanced data analytics technologies
7 and processes.

8 “(2) MEMBERSHIP.—The members of such con-
9 sortium may include representatives from relevant
10 Federal agencies, the private sector, institutions of
11 higher education, which can each contribute relevant
12 compute time, capabilities, or other resources.

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

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

16 “(B) consider supplemental awards for
17 computing partnerships with Consortium mem-
18 bers to qualifying entities on a competitive
19 merit-review basis;

20 “(C) encourage collaboration and commu-
21 nication among member representatives of the
22 consortium and awardees;

23 “(D) make available the high-performance
24 computing capabilities, expertise, and user fa-

1 ilities of the Department and the National
2 Laboratories; and

3 “(E) submit an annual report to the Sec-
4 retary summarizing the activities of the Consor-
5 tium, including—

6 “(i) describing each project under-
7 taken by the Consortium;

8 “(ii) detailing organizational expendi-
9 tures; and

10 “(iii) evaluating contribution to the
11 achievement of technical milestones as de-
12 termined in subsection (a).

13 “(4) COORDINATION.—The Secretary shall en-
14 sure the coordination of, and avoid unnecessary du-
15 plication of, the activities of the Consortium with the
16 activities of other research entities of the Depart-
17 ment, institutions of higher education and the pri-
18 vate sector.

19 “(e) REPORT.—Not later than 2 years after the date
20 of enactment of the Department of Energy Science for the
21 Future Act, the Secretary shall submit to the Committee
22 on Science, Space, and Technology of the House, and the
23 Committee on Energy and Natural Resources of the Sen-
24 ate, and the Committee on Commerce, Science, and

1 Transportation of the Senate a report detailing the effec-
2 tiveness of—

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

6 “(2) the collaborative research achievements of
7 the initiative, including the achievement of the tech-
8 nical milestones determined under subsection (a);
9 and

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

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

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.”.

