

118TH CONGRESS  
1ST SESSION

# S. 2812

To support carbon dioxide removal research and development, and for other purposes.

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## IN THE SENATE OF THE UNITED STATES

SEPTEMBER 14, 2023

Mr. SCHATZ (for himself, Mr. BENNET, Mr. COONS, Mr. HEINRICH, Mr. HICKENLOOPER, Mr. LUJÁN, Ms. SMITH, Mr. WHITEHOUSE, and Mr. WELCH) introduced the following bill; which was read twice and referred to the Committee on Health, Education, Labor, and Pensions

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## A BILL

To support carbon dioxide removal research and development, and for other purposes.

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

3 **SECTION 1. SHORT TITLE; TABLE OF CONTENTS.**

4 (a) SHORT TITLE.—This Act may be cited as the  
5 “Carbon Dioxide Removal Research and Development Act  
6 of 2023”.

7 (b) TABLE OF CONTENTS.—The table of contents for  
8 this Act is as follows:

- Sec. 1. Short title; table of contents.
- Sec. 2. Definitions.

## TITLE I—DEPARTMENT OF ENERGY

- Sec. 101. Fossil energy and carbon management.
- Sec. 102. Energy efficiency and renewable energy.
- Sec. 103. Office of Science.
- Sec. 104. Department-wide considerations.

## TITLE II—DEPARTMENT OF AGRICULTURE

- Sec. 201. Definitions.
- Sec. 202. Objectives and organization.
- Sec. 203. Agriculture advanced research and development authority.
- Sec. 204. National Institute of Food and Agriculture.
- Sec. 205. Agricultural Research Service.
- Sec. 206. Natural Resources Conservation Service.
- Sec. 207. Forest Service.

## TITLE III—DEPARTMENT OF COMMERCE

- Sec. 301. National Oceanic and Atmospheric Administration.
- Sec. 302. National Institute of Standards and Technology.

## TITLE IV—DEPARTMENT OF DEFENSE

- Sec. 401. Corps of Engineers.

## TITLE V—DEPARTMENT OF THE INTERIOR

- Sec. 501. United States Geological Survey.
- Sec. 502. Land and minerals management.

## TITLE VI—DEPARTMENT OF TRANSPORTATION

- Sec. 601. Federal Highway Administration.

## TITLE VII—ENVIRONMENTAL PROTECTION AGENCY

- Sec. 701. Office of research and development.

TITLE VIII—NATIONAL AERONAUTICS AND SPACE  
ADMINISTRATION

- Sec. 801. Earth science division program.

## TITLE IX—NATIONAL SCIENCE FOUNDATION

- Sec. 901. Directorate for biological sciences.
- Sec. 902. Directorate for engineering.
- Sec. 903. Directorate for geosciences.
- Sec. 904. Directorate for mathematical and physical sciences.
- Sec. 905. Directorate for social, behavioral, and economic sciences.
- Sec. 906. Division of social and economic sciences.

## TITLE X—OTHER MATTERS

- Sec. 1001. Plan for international collaboration.

1 **SEC. 2. DEFINITIONS.**

2 In this Act:

3 (1) CARBON DIOXIDE REMOVAL.—The term  
4 “carbon dioxide removal” means—

5 (A) the intentional capture of carbon diox-  
6 ide directly from the ambient air or upper hy-  
7 drosphere, combined with the storage of that  
8 carbon dioxide, which results in a net removal  
9 of carbon dioxide from the atmosphere, as  
10 measured on a lifecycle basis, including, at a  
11 minimum, through—

- 12 (i) direct air capture and storage;  
13 (ii) enhanced carbon mineralization;  
14 (iii) biomass-based carbon dioxide re-  
15 moval;  
16 (iv) forest restoration;  
17 (v) soil carbon management; and  
18 (vi) ocean-based carbon removal.

19 (2) TERRESTRIAL AND BIOLOGICAL CARBON DI-  
20 OXIDE REMOVAL.—The term “terrestrial and bio-  
21 logical carbon dioxide removal” means carbon diox-  
22 ide removal which uses living biomass or soils to  
23 capture and/or store carbon dioxide.

1           **TITLE I—DEPARTMENT OF**  
2                                   **ENERGY**

3   **SEC. 101. FOSSIL ENERGY AND CARBON MANAGEMENT.**

4           (a) OFFICE OF FOSSIL ENERGY AND CARBON MAN-  
5   AGEMENT.—

6           (1) IN GENERAL.—Title II of the Department  
7           of Energy Organization Act (42 U.S.C. 7131 et  
8           seq.) is amended by adding at the end the following:

9   **“SEC. 218. OFFICE OF FOSSIL ENERGY AND CARBON MAN-**  
10                                   **AGEMENT.**

11           “(a) ESTABLISHMENT.—There is established within  
12           the Department an Office of Fossil Energy and Carbon  
13           Management (referred to in this section as the ‘Office’).

14           “(b) ASSISTANT SECRETARY FOR FOSSIL ENERGY  
15           AND CARBON MANAGEMENT.—

16           “(1) IN GENERAL.—The Office shall be headed  
17           by the Assistant Secretary for Fossil Energy and  
18           Carbon Management (referred to in this section as  
19           the ‘Assistant Secretary’), who shall be appointed by  
20           the President in accordance with section 203.

21           “(2) DUTIES OF OFFICE.—In carrying out re-  
22           search, development, and demonstration relating to  
23           carbon dioxide removal, the Assistant Secretary  
24           shall—

1           “(A) incorporate best practices from the  
2 existing carbon capture and storage research  
3 programs within the Department of Energy into  
4 the Office;

5           “(B) be responsible for crosscut coordina-  
6 tion of planning and budget for all research, de-  
7 velopment, and demonstration programs of the  
8 Department of Energy relating to carbon diox-  
9 ide removal (as defined in section 2 of the Car-  
10 bon Dioxide Removal Research and Develop-  
11 ment Act of 2023);

12           “(C) serve as the primary point of contact  
13 for any relevant interagency planning and co-  
14 ordination efforts;

15           “(D) conduct analyses and technology as-  
16 sessments of carbon dioxide removal systems,  
17 development, and demonstration programs, in-  
18 cluding by engaging with the National Labora-  
19 tories (as defined in section 2 of the Energy  
20 Policy Act of 2005 (42 U.S.C. 15801)) to as-  
21 sess lifecycle performance of carbon dioxide re-  
22 moval systems; and

23           “(E) provide project management services  
24 for all demonstration-scale projects emerging  
25 from the technological carbon dioxide removal

1 research, development, and demonstration port-  
2 folio.

3 “(c) MISSION.—The mission of the Office shall in-  
4 clude the research, development, and demonstration of di-  
5 rect air capture and carbon mineralization technologies.

6 “(d) LEAD OFFICE.—The National Energy Tech-  
7 nology Laboratory shall have the lead responsibility within  
8 the Department of Energy for planning and managing re-  
9 search, development, and demonstration activities relating  
10 to direct air capture and carbon storage, with the goal  
11 of establishing and driving down technology-specific cost  
12 targets.

13 “(e) PROJECT MANAGEMENT REQUIREMENTS.—All  
14 projects carried out by the Office shall be subject to rig-  
15 orous project management requirements and procedures  
16 modeled on Department Order 413.3b (relating to pro-  
17 gram and project management for the acquisition of cap-  
18 ital assets) (or a successor order).”.

19 (2) CLERICAL AMENDMENT.—The table of con-  
20 tents for the Department of Energy Organization  
21 Act (Public Law 95–91; 91 Stat. 565; 119 Stat.  
22 764) is amended by adding at the end of the items  
23 relating to title II the following:

“Sec. 218. Office of Fossil Energy and Carbon Management.”.

24 (3) REFERENCES IN LAW.—Any reference in a  
25 law, regulation, document, paper, or other record to

1 the “Office of Fossil Energy” shall be deemed to be  
2 a reference to the “Office of Fossil Energy and Car-  
3 bon Management”.

4 (b) CARBON DIOXIDE REMOVAL RESEARCH, DEVEL-  
5 OPMENT, AND DEMONSTRATION.—Section 969D of the  
6 Energy Policy Act of 2005 (42 U.S.C. 16298d) is amend-  
7 ed—

8 (1) in subsection (c), by striking paragraph (5)  
9 and inserting the following:

10 “(5) ecologically sound, resilience-oriented, and  
11 carbon-sequestering forest management techniques,  
12 forest restoration, urban tree planting and manage-  
13 ment, and reforestation such that negative land-use  
14 change impacts, such as endangering food security  
15 and biodiversity loss, can be avoided; and”;

16 (2) by redesignating subsections (d), (e), (f),  
17 (g), (h), (i), (j), and (k) as subsections (e), (f), (g),  
18 (i), (j), (k), (l), and (m), respectively;

19 (3) by inserting after subsection (c) the fol-  
20 lowing:

21 “(d) PROGRAM FOCUS AREAS.—

22 “(1) DIRECT AIR CAPTURE AND STORAGE  
23 TECHNOLOGIES.—In carrying out subsection (c)(1),  
24 the Secretary shall consider carrying out activities  
25 relating to—

- 1           “(A) contactor design;
- 2           “(B) low- and zero-carbon heat;
- 3           “(C) advanced or unconventional systems
- 4           and components;
- 5           “(D) scale-up studies and pilot plants;
- 6           “(E) operational data collection;
- 7           “(F) engineering design support for large-
- 8           scale projects;
- 9           “(G) external techno-economic analyses;
- 10          and
- 11          “(H) monitoring, reporting, and
- 12          verification capabilities.

13          “(2) BIOENERGY WITH CARBON CAPTURE AND

14          STORAGE.—In carrying out subsection (c)(2), the

15          Secretary shall consider carrying out activities relat-

16          ing to advanced biomass-to-power conversion.

17          “(3) ENHANCED GEOLOGICAL WEATHERING.—

18          In carrying out subsection (c)(3), the Secretary shall

19          consider carrying out activities relating to—

- 20                 “(A) alkalinity resource assessments;
- 21                 “(B) pilot studies of ex situ mineralization;
- 22                 and
- 23                 “(C) pilot studies of in situ mineralization
- 24                 for carbon storage.



1           “(4) CARBON UTILIZATION.—In carrying out  
2 carbon utilization activities under the program, the  
3 Secretary shall consider carrying out activities relat-  
4 ing to the integration of carbonation with carbon di-  
5 oxide capture processes.

6           “(5) CROSSCUTTING ACTIVITIES.—In carrying  
7 out cross-cutting activities under the program, the  
8 Secretary shall consider carrying out activities relat-  
9 ing to—

10                   “(A) carbon dioxide removal data collection  
11 and publication;

12                   “(B) technology cost and performance;

13                   “(C) integrated carbon systems modeling;  
14 and

15                   “(D) decision science.”;

16           (4) by inserting after subsection (g) (as so re-  
17 designated) the following:

18           “(h) COMPETITIVE DEMONSTRATION AWARDS.—

19                   “(1) IN GENERAL.—Not later than 2 years  
20 after the date of enactment of this subsection the  
21 Secretary shall make competitive awards for a port-  
22 folio of carbon dioxide removal demonstration  
23 projects described in paragraph (2).

24                   “(2) ELIGIBILITY.—Subject to subsection (e),  
25 to be eligible for an award under paragraph (1), a

1 carbon dioxide removal demonstration project  
2 shall—

3 “(A) use 1 or more technologies and strat-  
4 egies described in subsection (c), including ac-  
5 tivities described in subsection (i);

6 “(B) have a total cost of not less than  
7 \$10,000,000;

8 “(C) be located in the United States or, in  
9 the case of ocean-based projects, within the ter-  
10 ritorial sea or exclusive economic zone of the  
11 United States;

12 “(D) have the potential for large-scale,  
13 cost-effective replication; and

14 “(E) meet such other provisions as may be  
15 established by the Secretary consistent with the  
16 purposes of this section.

17 “(3) ALLOCATION.—In making awards under  
18 paragraph (1), out of the funds provided under sub-  
19 section (m)(1), the Secretary shall allocate—

20 “(A) \$500,000,000 to projects with total  
21 costs of not less than \$10,000,000 and not  
22 more than \$100,000,000;

23 “(B) \$750,000,000 to projects—

24 “(i) with a total cost of more than  
25 \$100,000,000; and

1           “(ii) under which all captured carbon  
2           dioxide is disposed of in geologic storage in  
3           saline aquifers; and

4           “(C) \$750,000,000 to projects with a total  
5           cost of more than \$100,000,000, without regard  
6           to the type of storage.

7           “(4) COST-SHARE.—

8           “(A) IN GENERAL.—Except as provided in  
9           subparagraph (B), with respect to a project re-  
10          ceiving an award under paragraph (1), the Sec-  
11          retary shall require that—

12           “(i) in the case of a project that dis-  
13           poses of carbon dioxide in geologic storage  
14           in an operating oil and gas field, not less  
15           than 50 percent of the total project cost  
16           shall be provided by a non-Federal source;  
17           and

18           “(ii) in the case of a project that is  
19           not described in clause (i), not less than 20  
20           percent of the total project cost shall be  
21           provided by a non-Federal source.

22           “(B) EXCLUSION.—the Federal share of  
23           the cost of a project receiving an award under  
24           paragraph (1) with a total cost of not less than

1           \$10,000,000 and not more than \$100,000,000  
2           may be up to 100 percent.”; and

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

6           “(1) \$2,089,000,000 for fiscal year 2024, of  
7           which \$2,000,000,000 shall be used to carry out  
8           subsection (h), to remain available until expended;

9           “(2) \$217,000,000 for fiscal year 2025;

10          “(3) \$312,000,000 for fiscal year 2026;

11          “(4) \$360,000,000 for fiscal year 2027;

12          “(5) \$440,000,000 for fiscal year 2028;

13          “(6) \$441,000,000 for fiscal year 2029;

14          “(7) \$451,000,000 for fiscal year 2030;

15          “(8) \$424,000,000 for fiscal year 2031;

16          “(9) \$380,000,000 for fiscal year 2032; and

17          “(10) \$337,000,000 for fiscal year 2033.”.

18 **SEC. 102. ENERGY EFFICIENCY AND RENEWABLE ENERGY.**

19          (a) **ADVANCED MATERIALS AND MANUFACTURING**  
20 **TECHNOLOGIES OFFICE.—**

21               (1) **IN GENERAL.—**The Secretary of Energy  
22               shall establish direct air capture as a research pri-  
23               ority of the Advanced Materials and Manufacturing  
24               Technologies Office, with a focus on improved tech-

1 niques for low-cost manufacturing of direct air cap-  
2 ture components and materials.

3 (2) COORDINATION.—The Advanced Materials  
4 and Manufacturing Technologies Office shall carry  
5 out research relating to direct air capture under  
6 paragraph (1) in coordination with the Office of  
7 Fossil Energy and Carbon Management.

8 (3) RESEARCH, DEVELOPMENT, AND DEM-  
9 ONSTRATION.—The Secretary of Energy, acting  
10 through the Assistant Secretary for Energy Effi-  
11 ciency and Renewable Energy (referred to in this  
12 section as the “Assistant Secretary”), shall carry out  
13 research, development, and demonstration activities  
14 in the areas described in this paragraph.

15 (A) SYSTEMS ENGINEERING AND PROCESS  
16 DESIGN.—The Assistant Secretary shall carry  
17 out research, development, and demonstration  
18 activities relating to integrated catalyst reactor  
19 design optimized for carbon dioxide removal  
20 and utilization.

21 (B) ALKALINITY SOURCE PATHWAYS.—

22 (i) IN GENERAL.—The Assistant Sec-  
23 retary shall carry out research, develop-  
24 ment, and demonstration activities relating  
25 to development of new, low-emissions

1 sources of alkalinity for carbon mineraliza-  
2 tion.

3 (ii) COLLABORATION.—The Assistant  
4 Secretary shall carry out the activities in  
5 clause (i) in collaboration with the Director  
6 of the United States Geological Survey.

7 (C) CONTACTOR DESIGN.—The Assistant  
8 Secretary shall carry out research, development,  
9 and demonstration activities relating to design  
10 of air contactors for direct air capture with low  
11 pressure drop, high surface area, and high lon-  
12 gevity.

13 (D) MANUFACTURING IMPROVEMENT.—  
14 The Assistant Secretary shall carry out re-  
15 search, development, and demonstration activi-  
16 ties relating to low-cost manufacturing of direct  
17 air capture components and materials.

18 (E) OTHER ACTIVITIES.—The Assistant  
19 Secretary shall carry out other carbon dioxide  
20 removal research, development, and demonstra-  
21 tion activities, as determined by the Secretary  
22 of Energy.

23 (b) BIOENERGY TECHNOLOGIES OFFICE.—

24 (1) IN GENERAL.—The Secretary of Energy  
25 shall establish terrestrial and biological carbon diox-

1       ide removal as a research objective in the biomass  
2       energy program of the Bioenergy Technologies Of-  
3       fice.

4           (2) OBJECTIVE.—In carrying out research, de-  
5       velopment, and demonstration described in para-  
6       graph (5), the Secretary of Energy shall seek to ad-  
7       vance carbon dioxide removal approaches that gen-  
8       erate net-negative emissions based on full lifecycle  
9       analysis.

10          (3) CONSIDERATIONS.—In carrying out the full  
11       lifecycle analysis described in paragraph (2), the  
12       Bioenergy Technologies Office shall consider—

13           (A) the emissions impacts of biomass har-  
14       vest and processing, including—

15           (i) unintended disturbances to eco-  
16       system carbon stocks;

17           (ii) indirect land-use change; and

18           (iii) alternative fates of biomass used;

19           (B) the risk of impacts on biodiversity and  
20       food security; and

21           (C) the social impacts of any air pollut-  
22       ants.

23          (4) RISK CONSIDERATIONS.—In carrying out  
24       research, development, and demonstration described

1 in paragraph (5), the Bioenergy Technologies Office  
2 shall—

3 (A) conduct risk assessment of species cul-  
4 tivated or utilized for terrestrial and biological  
5 carbon dioxide removal; and

6 (B) take all feasible and prudent measures  
7 to minimize risk of economic, environmental,  
8 and social harm caused by invasive species.

9 (5) RESEARCH, DEVELOPMENT, AND DEM-  
10 ONSTRATION.—

11 (A) IN GENERAL.—The Secretary of En-  
12 ergy, acting through the Assistant Secretary,  
13 shall carry out research, development, and dem-  
14 onstration activities in the areas described in  
15 subparagraphs (B) through (I).

16 (B) ALGAL BIOMASS CAPTURE.—The As-  
17 sistant Secretary shall carry out research, de-  
18 velopment, and demonstration activities relating  
19 to microalgae growth, dewatering, and conver-  
20 sion, including pathways such as bioreactors  
21 and non-photosynthetic pathways.

22 (C) BIOMASS SUPPLY, LOGISTICS, AND  
23 PRE-TREATMENT.—

24 (i) IN GENERAL.—The Assistant Sec-  
25 retary, in collaboration with the Director



1 of the National Institute of Food and Agri-  
2 culture, shall establish 1 or more test fa-  
3 cilities to conduct innovative approaches  
4 for treating biomass for use in fuels and  
5 electricity generation, including modeling  
6 and analysis of optimizing biomass gath-  
7 ering, upgrading, and supply.

8 (ii) TEST FACILITY CONSIDER-  
9 ATIONS.—In selecting facilities to be estab-  
10 lished as test facilities under clause (i), the  
11 Assistant Secretary shall—

12 (I) consider whether the facility  
13 has the capability for small-scale and  
14 mobile applications; and

15 (II) prioritize facilities that use  
16 waste feedstocks from managed eco-  
17 systems, urban areas, and areas dam-  
18 aged by severe weather events.

19 (D) BIOMASS CONVERSION TO FUELS WITH  
20 BIOCHAR.—

21 (i) IN GENERAL.—The Assistant Sec-  
22 retary shall carry out research, develop-  
23 ment, and demonstration activities relating  
24 to—

1 (I) research on conversion path-  
2 ways, including fast pyrolysis;

3 (II) development of—

4 (aa) mobile processing units;

5 and

6 (bb) pollutant emissions con-

7 trol technology; and

8 (III) assessments of overall car-  
9 bon dioxide removal potential.

10 (ii) COLLABORATION.—The Assistant  
11 Secretary shall carry out the activities  
12 under clause (i) in collaboration with the  
13 Director of the National Institute of Food  
14 and Agriculture.

15 (E) BIOMASS TO FUEL WITH CARBON CAP-  
16 TURE AND STORAGE.—

17 (i) IN GENERAL.—The Assistant Sec-  
18 retary shall carry out research, develop-  
19 ment, and demonstration activities relating  
20 to biomass to advanced cellulosic ethanol  
21 with carbon capture and storage, taking  
22 into consideration direct and indirect land-  
23 use impacts from biomass feedstocks.

24 (ii) COLLABORATION.—The Assistant  
25 Secretary shall carry out the activities

1 under clause (i) in collaboration with the  
2 Assistant Secretary for Office of Fossil  
3 Energy and Carbon Management.

4 (F) AQUATIC BIOMASS CULTIVATION.—

5 (i) IN GENERAL.—The Assistant Sec-  
6 retary shall carry out research, develop-  
7 ment, and demonstration activities relating  
8 to management best practices and pheno-  
9 type selection for aquatic macroalgae bio-  
10 mass production optimized for carbon diox-  
11 ide removal, including limited-scale experi-  
12 ments at sea, designed and monitored to  
13 avoid impacts beyond the zone of the ex-  
14 periment.

15 (ii) COLLABORATION.—The Assistant  
16 Secretary shall carry out the activities  
17 under clause (i) in collaboration with the  
18 Administrator of the National Oceanic and  
19 Atmospheric Administration.

20 (G) AQUATIC BIOMASS ENERGY CONVER-  
21 SION.—The Assistant Secretary shall carry out  
22 research, development, and demonstration ac-  
23 tivities relating to technology development and  
24 pilots for aquatic biomass conversion and car-

1 bon capture, including possible large-scale  
2 ocean-based experiments.

3 (H) NEW MATERIALS DEVELOPMENT AND  
4 APPLICATIONS.—

5 (i) IN GENERAL.—The Assistant Sec-  
6 retary shall carry out research, develop-  
7 ment, and demonstration activities relating  
8 to development of new carbon dioxide utili-  
9 zation products.

10 (ii) COLLABORATION.—The Assistant  
11 Secretary shall carry out the activities  
12 under clause (i) in collaboration with—

13 (I) the Assistant Secretary for  
14 Fossil Energy and Carbon Manage-  
15 ment; and

16 (II) the Administrator of the Ag-  
17 ricultural Research Service.

18 (I) OTHER ACTIVITIES.—The Assistant  
19 Secretary shall carry out research, development,  
20 and demonstration activities relating to other  
21 terrestrial and biological carbon dioxide removal  
22 research, development, and demonstration ac-  
23 tivities not described in subparagraphs (B)  
24 through (H), as determined by the Secretary.

25 (c) BUILDING TECHNOLOGIES OFFICE.—

1           (1) RESEARCH, DEVELOPMENT, AND DEM-  
2           ONSTRATION.—The Secretary of Energy, acting  
3           through the Building Technologies Office, shall  
4           carry out research, development, and demonstration  
5           activities in each of the areas described in this sub-  
6           section.

7           (2) CONSTRUCTION MATERIALS.—

8                   (A) IN GENERAL.—The Building Tech-  
9                   nologies Office shall carry out research, devel-  
10                   opment, and demonstration activities relating to  
11                   development, testing, and certification of car-  
12                   bonate materials for construction materials.

13                   (B) COLLABORATION.—The Building  
14                   Technologies Office shall carry out activities  
15                   under clause (i) in collaboration with the Na-  
16                   tional Institute of Standards and Technology.

17           (3) OTHER ACTIVITIES.—The Building Tech-  
18           nologies Office shall carry out other carbon dioxide  
19           removal research, development, and demonstration  
20           activities, as determined by the Secretary of Energy.

21           (d) AUTHORIZATION OF APPROPRIATIONS.—There  
22           are authorized to be appropriated to the Secretary of En-  
23           ergy to carry out this section—

24                   (1) \$26,000,000 for fiscal year 2024;

25                   (2) \$54,000,000 for fiscal year 2025;

- 1 (3) \$83,000,000 for fiscal year 2026;
- 2 (4) \$93,000,000 for fiscal year 2027;
- 3 (5) \$93,000,000 for fiscal year 2028;
- 4 (6) \$88,000,000 for fiscal year 2029;
- 5 (7) \$83,000,000 for fiscal year 2030;
- 6 (8) \$73,000,000 for fiscal year 2031;
- 7 (9) \$53,000,000 for fiscal year 2032; and
- 8 (10) \$42,000,000 for fiscal year 2033.

9 **SEC. 103. OFFICE OF SCIENCE.**

10 (a) RESEARCH.—

11 (1) IN GENERAL.—The Secretary of Energy,  
12 acting through the Director of the Office of Science  
13 (referred to in this section as the “Director”), shall  
14 carry out use-inspired fundamental research activi-  
15 ties in each of the areas described in this subsection.

16 (2) DEPARTMENT OF ENERGY FRONTIER RE-  
17 SEARCH CENTERS.—The Director shall carry out re-  
18 search activities relating to the establishment of new  
19 energy frontier research centers focused on materials  
20 research and early-stage application of sorbents, sol-  
21 vents, membranes, and related direct air capture  
22 components.

23 (3) GRANTS AND COOPERATIVE AGREE-  
24 MENTS.—The Director shall make grants and enter  
25 into cooperative agreements to carry out materials

1 research relating to sorbents, solvents, membranes,  
2 and related direct air capture components.

3 (4) SOIL CARBON.—

4 (A) IN GENERAL.—The Director shall  
5 carry out research activities relating to plant-  
6 root-fungi interactions, deep inversion of soils,  
7 and other topics.

8 (B) COLLABORATION.—The Director shall  
9 carry out the activities under subparagraph (A)  
10 in collaboration with—

11 (i) the Director of the National  
12 Science Foundation; and

13 (ii) the Director of the Agricultural  
14 Research Service.

15 (5) ALGAL BIOMASS CAPTURE.—The Director  
16 shall carry out research activities relating to—

17 (A) microalgae growth;

18 (B) dewatering; and

19 (C) conversion, including bioreactors and  
20 nonphotosynthetic pathways.

21 (6) CARBON MINERALIZATION.—

22 (A) IN GENERAL.—The Director shall  
23 carry out research activities relating to—

24 (i) mineralization kinetics;

25 (ii) geomechanics;

- 1 (iii) rock physics;  
2 (iv) utilization-oriented carbonation;  
3 and  
4 (v) other topics.

5 (B) COLLABORATION.—The Director shall  
6 carry out the activities under subparagraph (A)  
7 in collaboration with the Director of the Na-  
8 tional Science Foundation.

9 (7) OCEAN ALKALINITY.—

10 (A) IN GENERAL.—The Director shall  
11 carry out research activities relating to tech-  
12 niques for and ecological impacts of artificial  
13 modification of ocean alkalinity.

14 (B) COLLABORATION.—The Director shall  
15 carry out the activities under subparagraph (A)  
16 in collaboration with the Director of the Na-  
17 tional Science Foundation.

18 (8) CARBON CYCLE.—

19 (A) IN GENERAL.—The Director shall  
20 carry research activities and modeling relating  
21 to—

- 22 (i) the effectiveness and ecological im-  
23 pacts of ocean iron fertilization; and  
24 (ii) nitrogen and phosphorous fer-  
25 tilization.



1 (B) COLLABORATION.—The Director shall  
2 carry out the activities under subparagraph (A)  
3 in collaboration with—

4 (i) the Director of the National  
5 Science Foundation; and

6 (ii) the Administrator of the National  
7 Oceanic and Atmospheric Administration.

8 (9) CARBON DIOXIDE IMPACTS AND FATE IN  
9 OCEANS.—

10 (A) IN GENERAL.—The Director shall  
11 carry out monitoring, research, and modeling  
12 on ecological impacts of ocean carbon dioxide  
13 removal techniques.

14 (B) COLLABORATION.—The Director shall  
15 carry out the activities under subparagraph (A)  
16 in collaboration with the Administrator of the  
17 National Oceanic and Atmospheric Administra-  
18 tion.

19 (10) CARBONATION.—

20 (A) IN GENERAL.—The Director shall  
21 carry out research activities relating to—

22 (i) methods to control carbonation re-  
23 actions;

24 (ii) methods to accelerate carbonation;  
25 and

1 (iii) research to understand structure-  
2 property relationships.

3 (B) COLLABORATION.—The Director shall  
4 carry out the activities under subparagraph (A)  
5 in collaboration with the Director of the Na-  
6 tional Science Foundation.

7 (11) CATALYSTS.—

8 (A) IN GENERAL.—The Director shall  
9 carry out research activities relating to—

10 (i) impurity-tolerant catalyst develop-  
11 ment;

12 (ii) coupled reduction and oxidation  
13 reactions; and

14 (iii) reduced additives.

15 (B) COLLABORATION.—The Director shall  
16 carry out the activities under subparagraph (A)  
17 in collaboration with the Director of the Na-  
18 tional Science Foundation.

19 (12) NEW MATERIALS DEVELOPMENT AND AP-  
20 PPLICATIONS.—

21 (A) IN GENERAL.—The Director shall  
22 carry out research activities relating to develop-  
23 ment of new materials for capturing and uti-  
24 lizing carbon dioxide, including materials with  
25 carbon-carbon bonds.

1           (B) COLLABORATION.—The Director shall  
2 carry out the activities under subparagraph (A)  
3 in collaboration with the Director of the Na-  
4 tional Science Foundation.

5 (13) GENETIC MODELING AND TOOLS.—

6           (A) IN GENERAL.—The Director shall  
7 carry out research, development, and dem-  
8 onstration of technologies to improve carbon di-  
9 oxide uptake, conversion, and product accumu-  
10 lation through genetic manipulation of biologi-  
11 cal organisms for carbon dioxide removal and  
12 utilization.

13           (B) COLLABORATION.—The Director shall  
14 carry out the activities under subparagraph (A)  
15 in collaboration with the Director of the Na-  
16 tional Science Foundation.

17 (14) BIOPROSPECTING.—

18           (A) IN GENERAL.—The Director shall  
19 carry out research activities relating to develop-  
20 ment of tools and high-throughput screening for  
21 organisms with unique attributes relating to  
22 carbon dioxide conversion.

23           (B) COLLABORATION.—The Director shall  
24 carry out the activities under subparagraph (A)

1 in collaboration with the Administrator of the  
2 Agricultural Research Service.

3 (15) OTHER RESEARCH.—The Director shall  
4 carry out other research on carbon dioxide removal,  
5 as determined by the Secretary.

6 (b) COORDINATION.—The Director shall carry out  
7 this section in coordination with the Assistant Secretary  
8 for Fossil Energy and Carbon Management.

9 (c) AUTHORIZATION OF APPROPRIATIONS.—There  
10 are authorized to be appropriated to the Secretary of En-  
11 ergy to carry out this section—

- 12 (1) \$30,000,000 for fiscal year 2024;
- 13 (2) \$65,000,000 for fiscal year 2025;
- 14 (3) \$79,000,000 for fiscal year 2026;
- 15 (4) \$83,000,000 for fiscal year 2027;
- 16 (5) \$88,000,000 for fiscal year 2028;
- 17 (6) \$84,000,000 for fiscal year 2029;
- 18 (7) \$81,000,000 for fiscal year 2030;
- 19 (8) \$70,000,000 for fiscal year 2031;
- 20 (9) \$70,000,000 for fiscal year 2032; and
- 21 (10) \$67,000,000 for fiscal year 2033.

22 **SEC. 104. DEPARTMENT-WIDE CONSIDERATIONS.**

23 (a) LIFECYCLE ANALYSES.—In carrying out re-  
24 search, development, and demonstration under this title,  
25 the Secretary of Energy, in collaboration with the heads

1 of other appropriate Federal agencies, shall conduct full-  
 2 system lifecycle analyses of emissions and other environ-  
 3 mental impacts from carbon dioxide removal technologies  
 4 and methods.

5 (b) ENVIRONMENTAL JUSTICE ANALYSES.—In car-  
 6 rying out research, development, and demonstration under  
 7 this title, the Secretary of Energy shall conduct environ-  
 8 mental justice analyses of carbon dioxide removal tech-  
 9 nologies, methods, and siting, including impacts on local  
 10 and regional conventional air pollution.

## 11 **TITLE II—DEPARTMENT OF** 12 **AGRICULTURE**

### 13 **SEC. 201. DEFINITIONS.**

14 In this title:

15 (1) DEPARTMENT.—The term “Department”  
 16 means the Department of Agriculture.

17 (2) LAND-GRANT COLLEGES AND UNIVER-  
 18 SITIES.—

19 (A) IN GENERAL.—The term “land-grant  
 20 colleges and universities” has the meaning  
 21 given the term in section 1404 of the National  
 22 Agricultural Research, Extension, and Teaching  
 23 Policy Act of 1977 (7 U.S.C. 3103).

24 (B) INCLUSION.—The term “land-grant  
 25 colleges and universities” includes a 1994 Insti-

1           tution (as defined in section 532 of the Equity  
2           in Educational Land-Grant Status Act of 1994  
3           (7 U.S.C. 301 note; Public Law 103–382)).

4           (3) SECRETARY.—The term “Secretary” means  
5           the Secretary of Agriculture.

6 **SEC. 202. OBJECTIVES AND ORGANIZATION.**

7           (a) DEPARTMENTAL MISSION.—The Secretary shall  
8           incorporate terrestrial and biological carbon dioxide re-  
9           moval mission responsibilities into the Strategic Plan of  
10          the Department to complement the food and fiber mission  
11          responsibilities of the Department.

12          (b) UNDER SECRETARY FOR RESEARCH, EDU-  
13          CATION, AND ECONOMICS.—

14                (1) IN GENERAL.—The Under Secretary for  
15                Research, Education, and Economics (referred to in  
16                this section as the “Under Secretary”) shall—

17                    (A) coordinate all carbon dioxide removal  
18                    research, development, and demonstration ac-  
19                    tivities within the Department; and

20                    (B) in carrying out subparagraph (A), col-  
21                    laborate with other senior Department officials  
22                    with related responsibilities, including the Chief  
23                    Economist.

24                (2) REVIEW AND ADVISE.—The Under Sec-  
25                retary shall—

1 (A) review and advise the Secretary on all  
2 budget proposals relating to carbon dioxide re-  
3 moval research, development, and demonstra-  
4 tion under Department programs; and

5 (B) provide oversight and evaluation of  
6 carbon dioxide removal research, development,  
7 and demonstration initiatives and projects of  
8 the Department.

9 (3) RESEARCH STRATEGIES.—In carrying out  
10 this subsection, the Under Secretary shall pursue re-  
11 search strategies that build on well-established agri-  
12 culture research infrastructure to pursue carbon di-  
13 oxide removal research, development, and dem-  
14 onstration objectives through new research models.

15 (4) RESEARCH, DEVELOPMENT, AND DEM-  
16 ONSTRATION PROGRAMS.—The Under Secretary  
17 shall incorporate terrestrial and biological carbon di-  
18 oxide removal research, development, and dem-  
19 onstration programs and projects—

20 (A) across the Department, including at—

21 (i) the Agricultural Research Service;

22 (ii) the Forest Service;

23 (iii) the Natural Resources Conserva-  
24 tion Service;

1 (iv) the National Institute of Food  
2 and Agriculture; and

3 (v) other Department agencies and of-  
4 fices; and

5 (B) in research portfolios of land-grant col-  
6 leges and universities.

7 (c) DEPARTMENT-WIDE CONSIDERATIONS.—

8 (1) OBJECTIVE.—In carrying out research, de-  
9 velopment, and demonstration under this title, the  
10 Secretary shall seek to advance carbon dioxide re-  
11 moval approaches that generate net-negative emis-  
12 sions based on full lifecycle analysis.

13 (2) CONSIDERATIONS.—In carrying out this  
14 title, the Secretary shall consider, in addition to  
15 emissions described in paragraph (1), the risk of im-  
16 pacts on biodiversity and food security, social im-  
17 pacts, and such other impacts as the Secretary de-  
18 termines to be appropriate.

19 (3) RISK CONSIDERATIONS.—In carrying out  
20 this title, the Secretary shall—

21 (A) conduct risk assessment of species cul-  
22 tivated or utilized for terrestrial and biological  
23 carbon dioxide removal; and



1 (B) take all feasible and prudent measures  
 2 to minimize risk of economic, environmental,  
 3 and social harm caused by invasive species.

4 (4) MEMORANDUM OF UNDERSTANDING.—The  
 5 Secretary shall enter into a memorandum of under-  
 6 standing with the Secretary of Energy to incorporate  
 7 carbon dioxide removal scientific objectives into—

8 (A) current joint research on genomics and  
 9 synthetic biology; and

10 (B) new and expanded joint research ini-  
 11 tiatives between the National Laboratories (as  
 12 defined in section 2 of the Energy Policy Act of  
 13 2005 (42 U.S.C. 15801)) and land-grant col-  
 14 leges and universities.

15 **SEC. 203. AGRICULTURE ADVANCED RESEARCH AND DE-**  
 16 **VELOPMENT AUTHORITY.**

17 Section 1473H of the National Agricultural Re-  
 18 search, Extension, and Teaching Policy Act of 1977 (7  
 19 U.S.C. 3319k) is amended—

20 (1) in subsection (b)(2)—

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

23 (B) in subparagraph (D), by striking the  
 24 period at the end and inserting “; and”; and

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

1           “(E) to advance technologies and methods  
 2 relating to terrestrial and biological carbon di-  
 3 oxide removal (as defined in section 2 of the  
 4 Carbon Dioxide Removal Research and Devel-  
 5 opment Act of 2023).”; and

6           (2) in subsection (d), by adding at the end the  
 7 following:

8           “(4) AUTHORIZATION OF APPROPRIATIONS FOR  
 9 CARBON DIOXIDE REMOVAL ACTIVITIES.—In addi-  
 10 tion to amounts otherwise made available under this  
 11 subsection, there are authorized to be appropriated  
 12 to carry out subsection (b)(2)(E), \$10,000,000 for  
 13 each of fiscal years 2024 through 2033, to remain  
 14 available until expended.”.

15 **SEC. 204. NATIONAL INSTITUTE OF FOOD AND AGRICULTURE.**  
 16 **CULTURE.**

17           (a) RESEARCH, DEVELOPMENT, AND DEMONSTRATION.—  
 18 TION.—

19           (1) IN GENERAL.—The Secretary, acting  
 20 through the National Institute of Food and Agri-  
 21 culture, shall carry out research, development, and  
 22 demonstration activities in each of the areas de-  
 23 scribed in this subsection.

24           (2) BIOMASS SUPPLY, LOGISTICS, AND PRE-  
 25 TREATMENT.—

1           (A) IN GENERAL.—The Secretary shall es-  
2           tablish 1 or more test facilities for innovative  
3           approaches for treating biomass for use in fuels  
4           and electricity generation, including modeling  
5           and analysis of optimizing biomass gathering,  
6           upgrading, and supply.

7           (B) CONSIDERATION; PRIORITY.—In car-  
8           rying out subparagraph (A), the Secretary  
9           shall—

10                   (i) consider facilities with the capa-  
11                   bility for small-scale and mobile applica-  
12                   tions; and

13                   (ii) prioritize waste feedstocks from  
14                   managed ecosystems, urban areas, and  
15                   areas damaged by severe weather events.

16           (3) BIOMASS CONVERSION TO FUELS WITH  
17           BIOCHAR.—The Secretary shall—

18                   (A) research pathways for the conversion  
19                   of biomass to fuels with biochar, including fast  
20                   pyrolysis, development of mobile processing  
21                   units, and pollution emissions control tech-  
22                   nology; and

23                   (B) conduct relevant assessments of overall  
24                   carbon dioxide removal potential.

1           (4) OTHER ACTIVITIES.—The Secretary shall  
2           carry out other carbon dioxide removal research, de-  
3           velopment, and demonstration activities, as deter-  
4           mined by the Secretary.

5           (b) COLLABORATION.—In carrying out the activities  
6           under subsection (a), the Secretary shall collaborate with  
7           the Assistant Secretary for Energy Efficiency and Renew-  
8           able Energy.

9           (c) CONSIDERATION.—In carrying out research, de-  
10          velopment, and demonstration on biomass as a feedstock,  
11          the Secretary shall consider—

12               (1) the emissions impacts of biomass harvest  
13               and processing;

14               (2) unintended disturbances to ecosystem car-  
15               bon stocks;

16               (3) indirect land-use change;

17               (4) alternative fates of biomass used; and

18               (5) the social impacts of any air pollutants.

19          (d) AUTHORIZATION OF APPROPRIATIONS.—There  
20          are authorized to be appropriated to the Secretary to carry  
21          out this section—

22               (1) \$6,000,000 for fiscal year 2024;

23               (2) \$15,000,000 for fiscal year 2025;

24               (3) \$25,000,000 for fiscal year 2026;

1           (4) \$30,000,000 for each of fiscal years 2027  
2 through 2030;

3           (5) \$25,000,000 for fiscal year 2031;

4           (6) \$18,000,000 for fiscal year 2032; and

5           (7) \$15,000,000 for fiscal year 2033.

6 **SEC. 205. AGRICULTURAL RESEARCH SERVICE.**

7           (a) RESEARCH, DEVELOPMENT, AND DEMONSTRATION.—  
8 TION.—

9           (1) IN GENERAL.—The Secretary, acting  
10 through the Agricultural Research Service, shall  
11 carry out research, development, and demonstration  
12 activities in each of the areas described in this sub-  
13 section.

14           (2) SOIL CARBON.—

15           (A) IN GENERAL.—The Secretary shall  
16 carry out fundamental research on plant-root-  
17 fungi interactions, deep inversion of soils, and  
18 other topics with the potential to advance car-  
19 bon dioxide removal.

20           (B) COLLABORATION.—The Secretary  
21 shall carry out the activities under subpara-  
22 graph (A) in collaboration with—

23           (i) the Director of the Office of  
24 Science of the Department of Energy; and

1 (ii) the Director of the National  
2 Science Foundation.

3 (3) HIGH-CARBON-INPUT CROP PHENOTYPES.—

4 (A) IN GENERAL.—The Secretary shall  
5 carry out development of advanced cultivars  
6 and forestry crops with enhanced carbon uptake  
7 and retention.

8 (B) COLLABORATION.—The Secretary  
9 shall carry out the activities under subpara-  
10 graph (A) in collaboration with the Chief of the  
11 Forest Service.

12 (4) CULTIVATION SYSTEM OPTIMIZATION.—

13 (A) IN GENERAL.—The Secretary shall  
14 carry out research on regionally specific best  
15 practices for soil health and carbon retention at  
16 not fewer than 10 sites, including at least 1 site  
17 in a tropical region.

18 (B) CONSIDERATION.—The Secretary shall  
19 consider co-locating sites described in subpara-  
20 graph (A) with sites used by the National Re-  
21 source Inventory of the Natural Resources Con-  
22 servation Service, the Long Term Ecological  
23 Research Network, the National Ecological Ob-  
24 servatory Network, and the Forest Inventory  
25 and Analysis Program.

1           (5) AGROFORESTRY.—The Secretary shall carry  
2           out research on integrating regionally appropriate  
3           trees and shrubs into crop and animal farming sys-  
4           tems as a carbon dioxide removal practice at no  
5           fewer than 5 geographically diverse test sites.

6           (6) PERENNIAL PLANTS AND MARGINAL  
7           LANDS.—The Secretary shall carry out research into  
8           the use of perennial plants for carbon dioxide re-  
9           moval, including research on—

10                   (A) genetic traits;

11                   (B) improved soil carbon sequestration  
12           modeling;

13                   (C) perennialization of useful annual crops;  
14           and

15                   (D) greater use on marginal land.

16           (7) SOIL AMENDMENTS IMPACT STUDIES.—The  
17           Secretary shall carry out research and field studies  
18           on the longevity and impact of soil amendments,  
19           such as biochar and reactive minerals, on produc-  
20           tivity, soil carbon retention, nutrient and water use,  
21           albedo, and other factors.

22           (8) MEASUREMENT, MODELING, AND PRE-  
23           DICTIVE TOOL DEVELOPMENT.—

24                   (A) IN GENERAL.—The Secretary shall  
25           carry out research to improve existing carbon

1 sequestration measurement and modeling tools  
2 and the development of simulation-based tools  
3 to predict and quantify soil carbon sequestra-  
4 tion.

5 (B) COLLABORATION.—The Secretary  
6 shall carry out the activities under subpara-  
7 graph (A) in collaboration with the Director of  
8 the National Science Foundation.

9 (9) CLIMATE HUBS.—

10 (A) IN GENERAL.—The Secretary shall  
11 carry out activities relating to increasing the ca-  
12 pacity of Department climate hubs and other  
13 research units to deliver climate- and carbon di-  
14 oxide removal-related science and tools to farm-  
15 ers, ranchers, and forest planners and man-  
16 agers.

17 (B) COLLABORATION.—The Secretary  
18 shall carry out the activities under subpara-  
19 graph (A) in collaboration with the Chief of the  
20 Forest Service.

21 (10) BIOPROSPECTING.—

22 (A) IN GENERAL.—The Secretary shall  
23 carry out activities relating to the development  
24 of tools and high-throughput screening for or-



1           ganisms with unique attributes relating to car-  
2           bon dioxide conversion.

3           (B) COLLABORATION.—The Secretary  
4           shall carry out the activities under subpara-  
5           graph (A) in collaboration with the Director of  
6           the Office of Science of the Department of En-  
7           ergy.

8           (11) NEW MATERIALS DEVELOPMENT AND AP-  
9           PLICATIONS.—

10           (A) IN GENERAL.—The Secretary shall  
11           carry out activities relating to development of  
12           new carbon dioxide utilization products.

13           (B) COLLABORATION.—The Secretary  
14           shall carry out the activities under subpara-  
15           graph (A) in collaboration with the Assistant  
16           Secretary for Office of Energy Efficiency and  
17           Renewable Energy of the Department of En-  
18           ergy.

19           (12) OTHER ACTIVITIES.—The Secretary shall  
20           carry out other carbon dioxide removal research, de-  
21           velopment, and demonstration activities, as deter-  
22           mined by the Secretary.

23           (b) AUTHORIZATION OF APPROPRIATIONS.—There  
24           are authorized to be appropriated to the Secretary to carry  
25           out this section—

- 1 (1) \$45,000,000 for fiscal year 2024;
- 2 (2) \$52,000,000 for fiscal year 2025;
- 3 (3) \$61,000,000 for fiscal year 2026;
- 4 (4) \$72,000,000 for each of fiscal years 2027
- 5 and 2028; and
- 6 (5) \$68,000,000 for each of fiscal years 2029
- 7 through 2033.

8 **SEC. 206. NATURAL RESOURCES CONSERVATION SERVICE.**

9 (a) RESEARCH, DEVELOPMENT, AND DEMONSTRATION.—

10 TION.—

11 (1) IN GENERAL.—The Secretary, acting

12 through the Natural Resources Conservation Service,

13 shall carry out research, development, and dem-

14 onstration activities in each of the areas described in

15 this subsection.

16 (2) ENHANCED SOIL MONITORING.—

17 (A) IN GENERAL.—The Secretary shall

18 carry out revisions to the National Resources

19 Inventory system of the National Resources

20 Conservation Service—

- 21 (i) to include measuring greenhouse
- 22 gasses, including carbon stocks and fluxes;
- 23 (ii) to include additional sites; and
- 24 (iii) to expand remote sensing to in-
- 25 crease frequency and geospatial resolution.

1           (B) COLLABORATION.—The Secretary  
2 shall carry out the activities under subpara-  
3 graph (A) in collaboration with the Adminis-  
4 trator of the National Aeronautics and Space  
5 Administration.

6           (3) CONSERVATION PRACTICES DATA COLLEC-  
7 TION.—The Secretary shall carry out revisions to  
8 the Conservation Effects Assessment Project of the  
9 Natural Resources Conservation Service to collect  
10 more frequent and robust data on how conservation  
11 practices impact greenhouse gas fluxes.

12           (4) EXTENSION OF AGRICULTURAL CARBON SE-  
13 QUESTRATION PRACTICES.—The Secretary shall  
14 carry out—

15           (A) projects to identify barriers to adop-  
16 tion of agricultural carbon sequestration tech-  
17 nologies; and

18           (B) extension of tools and practices, and  
19 research to promote uptake using existing con-  
20 servation programs of the Department.

21           (5) SOCIAL SCIENCE RESEARCH.—

22           (A) IN GENERAL.—The Secretary shall  
23 carry out social science research on uptake of  
24 agricultural carbon sequestration technologies  
25 and practices to inform outreach.

1 (B) CONSULTATION.—The Secretary shall  
2 carry out the activities under subparagraph (A)  
3 in consultation with the Administrator of the  
4 Economic Research Service.

5 (6) OTHER ACTIVITIES.—The Secretary shall  
6 carry out other carbon dioxide removal research, de-  
7 velopment, and demonstration activities, as deter-  
8 mined by the Secretary.

9 (b) AUTHORIZATION OF APPROPRIATIONS.—There  
10 are authorized to be appropriated to the Secretary to carry  
11 out this section—

12 (1) \$6,000,000 for each of fiscal years 2024  
13 through 2026;

14 (2) \$10,000,000 for each of fiscal years 2027  
15 and 2028; and

16 (3) \$6,000,000 for each of fiscal years 2029  
17 through 2033.

18 **SEC. 207. FOREST SERVICE.**

19 (a) RESEARCH, DEVELOPMENT, AND DEMONSTRATION.—  
20 TION.—

21 (1) IN GENERAL.—The Secretary, acting  
22 through the Chief of the Forest Service, shall carry  
23 out research, development, and demonstration activi-  
24 ties in at each of the areas described in this sub-  
25 section.

1 (2) ENHANCED FOREST STOCK MONITORING.—

2 (A) IN GENERAL.—The Secretary shall  
3 carry out activities relating to improving—

4 (i) capacity of the Forest Inventory  
5 and Analysis program to monitor forest  
6 carbon, including through remote sensing  
7 to increase frequency and geospatial reso-  
8 lution; and

9 (ii) forest carbon measurement and  
10 monitoring technologies, including satellite  
11 and remote sensing technologies.

12 (B) COLLABORATION.—The Secretary  
13 shall carry out the activities under subpara-  
14 graph (A) in collaboration with the Adminis-  
15 trator of the National Aeronautics and Space  
16 Administration.

17 (3) INTEGRATED ASSESSMENT MODEL AND  
18 GRASSLANDS AND FOREST IMPACTS MODELING.—

19 (A) IN GENERAL.—The Secretary shall  
20 carry out activities relating to technical, eco-  
21 nomic, and social modeling of impacts on land  
22 use from avoided conversion of grasslands and  
23 forests, reforestation, conservation,  
24 afforestation, and forest management changes.

1           (B) COLLABORATION.—The Secretary  
2 shall carry out the activities under subpara-  
3 graph (A) in collaboration with the Director of  
4 the National Science Foundation.

5           (4) FOREST CARBON MANAGEMENT DEM-  
6 ONSTRATION.—

7           (A) IN GENERAL.—The Secretary shall  
8 carry out activities, at not fewer than 5 geo-  
9 graphically diverse sites, relating to conducting  
10 large-scale field experiments of best practices  
11 for forest management and restoration that op-  
12 timize carbon dioxide removal while maintaining  
13 and enhancing ecosystems.

14           (B) COLLABORATION.—The Secretary  
15 shall carry out the activities under subpara-  
16 graph (A) in collaboration with the Assistant  
17 Administrator for Research and Development of  
18 the Environmental Protection Agency.

19           (5) CLIMATE RESILIENCE.—The Secretary shall  
20 carry out research and field experiments on enhance-  
21 ments to forest management practices for carbon di-  
22 oxide removal to reflect emerging needs due to the  
23 impact of climate change on forests over time.

24           (6) PRESERVATION OF HARVESTED WOOD.—

1 (A) IN GENERAL.—The Secretary shall  
2 carry out activities relating to the design and  
3 demonstration of landfills for woody biomass  
4 disposal and carbon storage.

5 (B) COLLABORATION.—The Secretary  
6 shall carry out the activities under subpara-  
7 graph (A) in collaboration with the Assistant  
8 Administrator for Research and Development of  
9 the Environmental Protection Agency.

10 (7) SOCIAL SCIENCE RESEARCH AND EXTEN-  
11 SION.—The Secretary shall carry out social science  
12 research and extension programs to promote uptake  
13 of forest management carbon sequestration tech-  
14 nologies and practices.

15 (8) CLIMATE HUBS.—

16 (A) IN GENERAL.—The Secretary shall  
17 carry out activities to increase the capacity of  
18 Department climate hubs and other research  
19 units to deliver climate and carbon dioxide re-  
20 moval-related science and tools to forest plan-  
21 ners and managers.

22 (B) COLLABORATION.—The Secretary  
23 shall carry out the activities under subpara-  
24 graph (A) in collaboration with the Adminis-  
25 trator of the Agricultural Research Service.

1           (9) OTHER ACTIVITIES.—The Secretary shall  
2           carry out other carbon dioxide removal research, de-  
3           velopment, and demonstration activities, as deter-  
4           mined by the Secretary.

5           (b) AUTHORIZATION OF APPROPRIATIONS.—There  
6           are authorized to be appropriated to the Secretary to carry  
7           out this section—

8                   (1) \$24,000,000 for each of fiscal years 2024  
9                   through 2026;

10                   (2) \$16,000,000 for each of fiscal years 2027  
11                   and 2028; and

12                   (3) \$10,000,000 for each of fiscal years 2029  
13                   through 2033.

14           **TITLE III—DEPARTMENT OF**  
15           **COMMERCE**

16           **SEC. 301. NATIONAL OCEANIC AND ATMOSPHERIC ADMIN-**  
17           **ISTRATION.**

18           (a) DEFINITION OF UNDER SECRETARY.—In this  
19           section, the term “Under Secretary” means the Under  
20           Secretary of Commerce for Oceans and Atmosphere.

21           (b) STRATEGIC MISSION OBJECTIVE.—The Secretary  
22           of Commerce shall incorporate carbon dioxide removal sci-  
23           entific objectives into the mission responsibilities of the  
24           National Oceanic and Atmospheric Administration for  
25           oceans and coastal area programs.



1 (c) RESEARCH OBJECTIVES AND CONSIDER-  
2 ATIONS.—

3 (1) OBJECTIVES.—In carrying out research, de-  
4 velopment, and demonstration under this section,  
5 the Under Secretary shall seek to develop a better  
6 understanding of the efficacy and impacts of carbon  
7 dioxide removal approaches in coastal areas and the  
8 ocean to help determine which could be feasible for  
9 larger scale deployment.

10 (2) CONSIDERATIONS.—In carrying out re-  
11 search, development, and demonstration under this  
12 section, the Under Secretary shall conform to na-  
13 tional and international governance frameworks and  
14 employ stringent monitoring to understand and min-  
15 imize negative ecosystem and social impacts and  
16 maximize co-benefits for communities and marine  
17 ecosystems.

18 (d) LEAD OFFICE.—

19 (1) CLIMATE PROGRAM OFFICE.—The Climate  
20 Program Office of the National Oceanic and Atmos-  
21 pheric Administration (referred to in this subsection  
22 as the “Office”) shall serve as the focal point for co-  
23 ordination and information dissemination on carbon  
24 dioxide removal activities across the National Oce-

1       anic and Atmospheric Administration, with an em-  
2       phasis on technological approaches.

3           (2) RESPONSIBILITIES.—The Office shall—

4               (A) coordinate all National Oceanic and  
5       Atmospheric Administration carbon dioxide re-  
6       moval research, development, and demonstra-  
7       tion on technologically enhanced coastal and  
8       ocean carbon capture, conversion, and storage;

9               (B) support the development and applica-  
10      tion of technologically enhanced methods of  
11      coastal and ocean carbon dioxide removal con-  
12      sistent with the research objectives and consid-  
13      erations described in subsection (c); and

14              (C) ensure effective utilization of the ocean  
15      research assets of the Administration, the Na-  
16      tional Science Foundation, and the Coast  
17      Guard in implementing carbon dioxide removal  
18      research projects.

19           (3) INTEGRATION.—The Director of the Office  
20      shall—

21              (A) coordinate existing ocean acidification  
22      monitoring and data collection programs in ex-  
23      istence as of the date of enactment of this Act  
24      with the carbon dioxide removal research port-

1 folio of the National Oceanic and Atmospheric  
2 Administration; and

3 (B) modify existing ocean acidification pro-  
4 gram plans to incorporate carbon dioxide re-  
5 moval research objectives.

6 (e) RESEARCH, DEVELOPMENT, AND DEMONSTRA-  
7 TION.—

8 (1) IN GENERAL.—The Under Secretary shall  
9 carry out research, development, and demonstration  
10 activities in each of the areas described in this sub-  
11 section.

12 (2) COASTAL MARINE CARBON FUNDAMENTAL  
13 RESEARCH.—

14 (A) IN GENERAL.—The Under Secretary  
15 shall carry out fundamental research of coastal  
16 ecosystem carbon dioxide sequestration.

17 (B) COLLABORATION.—The Under Sec-  
18 retary shall carry out the activities described in  
19 subparagraph (A) in collaboration with the Di-  
20 rector of the National Science Foundation.

21 (3) COASTAL RESOURCE ASSESSMENT.—

22 (A) IN GENERAL.—The Under Secretary  
23 shall carry out mapping and evaluation of  
24 coastal marine ecosystems for carbon dioxide  
25 removal potential.

1 (B) COLLABORATION.—The Under Sec-  
2 retary shall carry out the activities described in  
3 subparagraph (A) in collaboration with the Ad-  
4 ministrator of the National Aeronautics and  
5 Space Administration.

6 (4) COASTAL MARINE CARBON REGIONAL FIELD  
7 TRIALS.—

8 (A) IN GENERAL.—The Under Secretary  
9 shall carry out monitored field trials of coastal  
10 wetlands restoration optimized for carbon diox-  
11 ide removal.

12 (B) COORDINATION.—The Under Sec-  
13 retary shall carry out the activities described in  
14 subparagraph (A) in coordination with the  
15 grant program under section 906 of the Na-  
16 tional Oceans and Coastal Security Act (16  
17 U.S.C. 7505) and the Ecosystem Management  
18 and Restoration Research Program of the  
19 Corps of Engineers.

20 (5) NATIONAL COASTAL WETLAND DATA CEN-  
21 TER.—The Under Secretary shall integrate data on  
22 coastal ecosystem carbon dioxide removal research  
23 into the Digital Coast program established under  
24 section 4(a) of the Digital Coast Act (16 U.S.C.  
25 1467(a)).

1           (6) OCEAN MODELING.—The Under Secretary  
2 shall conduct research and modeling on the effect of  
3 ocean circulation on carbon dioxide uptake from the  
4 atmosphere in response to intentional carbon dioxide  
5 removal from the ocean.

6           (7) AQUATIC BIOMASS CULTIVATION.—

7           (A) IN GENERAL.—The Under Secretary  
8 shall research management best practices and  
9 phenotype selection for and use of aquatic  
10 macroalgae biomass production optimized for  
11 carbon dioxide removal, including limited-scale  
12 experiments at sea, designed and monitored to  
13 avoid impacts beyond the zone of the experi-  
14 ment.

15           (B) COLLABORATION.—The Under Sec-  
16 retary shall carry out the activities described in  
17 subparagraph (A) in collaboration with the As-  
18 sistant Secretary for Energy Efficiency and Re-  
19 newable Energy of the Department of Energy.

20           (C) RISK CONSIDERATIONS.—The Under  
21 Secretary shall take all feasible and prudent  
22 measures to minimize risk of economic, environ-  
23 mental, and social harm caused by invasive spe-  
24 cies.

1           (8) APPLIED ALKALINITY MODIFICATION TECH-  
2           NIQUES.—

3           (A) IN GENERAL.—The Under Secretary  
4           shall conduct limited-scale experiments on alka-  
5           linity enhancement techniques at sea, designed  
6           and monitored to avoid impacts beyond the  
7           zone of the experiment.

8           (B) COLLABORATION.—The Under Sec-  
9           retary shall carry out the activities described in  
10          subparagraph (A) in collaboration with the Di-  
11          rector of the National Science Foundation.

12          (9) SEAWATER CARBON EXTRACTION.—The  
13          Under Secretary shall conduct research and mod-  
14          eling on electrochemical seawater extraction, includ-  
15          ing process design and locations for minimizing re-  
16          source requirements, downstream chemical and bio-  
17          logical impacts, and storage or utilization methods.

18          (10) OCEAN FERTILIZATION FUNDAMENTAL RE-  
19          SEARCH.—

20          (A) IN GENERAL.—The Under Secretary  
21          shall conduct fundamental research and mod-  
22          eling on the impacts and effectiveness of ocean  
23          iron fertilization and nitrogen and phosphorous  
24          fertilization research.

1 (B) COLLABORATION.—The Under Sec-  
2 retary shall carry out the activities described in  
3 subparagraph (A) in collaboration with the Di-  
4 rector of the National Science Foundation and  
5 the Director of the Office of Science of the De-  
6 partment of Energy.

7 (11) ARTIFICIAL OCEAN MACRONUTRIENT FER-  
8 TILIZATION.—

9 (A) IN GENERAL.—The Under Secretary  
10 shall conduct limited-scale experiments on ocean  
11 macronutrient fertilization, designed and mon-  
12 itored to avoid impacts beyond the zone of the  
13 experiment and within internationally recog-  
14 nized frameworks.

15 (B) COLLABORATION.—The Under Sec-  
16 retary shall carry out the activities described in  
17 subparagraph (A) in collaboration with the Di-  
18 rector of the National Science Foundation.

19 (12) UPWELLING AND DOWNWELLING.—The  
20 Under Secretary shall conduct research on the im-  
21 pact and effectiveness of upwelling and downwelling  
22 as a carbon dioxide removal approach.

23 (13) CARBON DIOXIDE IMPACTS AND FATE IN  
24 OCEANS.—

1           (A) IN GENERAL.—The Under Secretary  
2           shall conduct monitoring, research, modeling,  
3           and small-scale field trials on ecological and so-  
4           cial impacts of coastal and deep ocean carbon  
5           dioxide removal techniques.

6           (B) COLLABORATION.—The Under Sec-  
7           retary shall carry out the activities described in  
8           subparagraph (A) in collaboration with the Di-  
9           rector of the Office of Science of the Depart-  
10          ment of Energy.

11          (14) ENHANCED MONITORING.—The Under  
12          Secretary shall conduct enhanced ocean, coastal, and  
13          atmospheric monitoring, quantification, and  
14          verification of carbon dioxide removal.

15          (15) OTHER ACTIVITIES.—The Under Secretary  
16          shall conduct other carbon dioxide removal research,  
17          development, and demonstration activities, as deter-  
18          mined by the Under Secretary.

19          (f) INPUT.—In carrying out the activities under sub-  
20          section (e), the Under Secretary shall receive input from  
21          the Director of the Office.

22          (g) AUTHORIZATION OF APPROPRIATIONS.—There  
23          are authorized to be appropriated to the Under Secretary  
24          to carry out subsection (d)—

25                 (1) \$25,000,000 for fiscal year 2024;



- 1 (2) \$50,000,000 for fiscal year 2025;
- 2 (3) \$100,000,000 for fiscal year 2026;
- 3 (4) \$124,000,000 for fiscal year 2027;
- 4 (5) \$148,000,000 for fiscal year 2028;
- 5 (6) \$150,000,000 for fiscal year 2029;
- 6 (7) \$138,000,000 for fiscal year 2030;
- 7 (8) \$126,000,000 for fiscal year 2031;
- 8 (9) \$117,000,000 for fiscal year 2032; and
- 9 (10) \$105,000,000 for fiscal year 2033.

10 (h) INTERNATIONAL COORDINATION.—In carrying  
11 out this section, the Under Secretary, acting through the  
12 Director of the Office, shall—

13 (1) coordinate with the Secretary of State and  
14 appropriate international entities;

15 (2) ensure compliance with all current inter-  
16 national agreements, including voluntary compliance  
17 agreements where the United States is not an offi-  
18 cial signatory; and

19 (3) to the extent practicable, seek joint sponsor-  
20 ship for experiments.

21 **SEC. 302. NATIONAL INSTITUTE OF STANDARDS AND TECH-**  
22 **NOLOGY.**

23 (a) RESEARCH, DEVELOPMENT, AND DEMONSTRA-  
24 TION.—

1           (1) IN GENERAL.—The Secretary of Commerce,  
2 acting through the Director of the National Institute  
3 of Standards and Technology (referred to in this  
4 section as the “Director”), shall carry out research,  
5 development, and demonstration activities in each of  
6 the areas described in this subsection.

7           (2) MATERIALS TESTING AND STANDARDS.—  
8 The Director shall develop standard reference mate-  
9 rials and standard testing procedures for tech-  
10 nologies and processes related to carbon dioxide re-  
11 moval.

12           (3) CONSTRUCTION MATERIALS.—

13           (A) IN GENERAL.—The Director shall de-  
14 velop, test, and establish standards for car-  
15 bonate or carbon-sequestering materials for  
16 construction markets.

17           (B) COLLABORATION.—The Director shall  
18 carry out the activities described in subpara-  
19 graph (A) in collaboration with the Assistant  
20 Secretary for Energy Efficiency and Renewable  
21 Energy of the Department of Energy.

22           (4) OTHER ACTIVITIES.—The Director shall  
23 conduct other carbon dioxide removal research, de-  
24 velopment, and demonstration activities, as deter-

1       mined by the Director of the National Institute of  
2       Standards and Technology.

3       (b) AUTHORIZATION OF APPROPRIATIONS.—There  
4       are authorized to be appropriated to the Director of the  
5       National Institute of Standards and Technology to carry  
6       out this section—

7             (1) \$4,000,000 for each of fiscal years 2024  
8       through 2026;

9             (2) \$7,000,000 for each of fiscal years 2027  
10       through 2029;

11            (3) \$2,000,000 for each of fiscal years 2030  
12       through 2032; and

13            (4) \$1,000,000 for fiscal year 2033.

14       **TITLE IV—DEPARTMENT OF**  
15       **DEFENSE**

16       **SEC. 401. CORPS OF ENGINEERS.**

17       (a) RESEARCH, DEVELOPMENT, AND DEMONSTRATION.—  
18       TION.—

19            (1) IN GENERAL.—The Secretary of Defense,  
20       acting through the Chief of Engineers, shall carry  
21       out research, development, and demonstration activi-  
22       ties in each of the areas described in this subsection.

23            (2) COASTAL MARINE CARBON REGIONAL FIELD  
24       TRIALS.—

1 (A) IN GENERAL.—The Secretary of De-  
2 fense, acting through the Chief of Engineers,  
3 shall carry out monitored field trials of coastal  
4 wetlands restoration optimized for carbon diox-  
5 ide removal.

6 (B) COORDINATION.—The Secretary of  
7 Defense, acting through the Chief of Engineers,  
8 shall carry out the activities described in sub-  
9 paragraph (A) in coordination with the grant  
10 program under section 906 of the National  
11 Oceans and Coastal Security Act (16 U.S.C.  
12 7505) and the Coastal Resilience Grants Pro-  
13 gram of the National Oceanic and Atmospheric  
14 Administration.

15 (3) OTHER ACTIVITIES.—The Secretary of De-  
16 fense, acting through the Chief of Engineers, shall  
17 conduct other carbon dioxide removal research, de-  
18 velopment, and demonstration activities, as deter-  
19 mined by the Secretary of Defense.

20 (b) AUTHORIZATION OF APPROPRIATIONS.—There  
21 are authorized to be appropriated to the Secretary of De-  
22 fense to carry out this section—

23 (1) \$24,000,000 for fiscal year 2024;

24 (2) \$45,000,000 for each of fiscal years 2025  
25 through 2027;

1           (3) \$53,000,000 for each of fiscal years 2028  
2 through 2030; and

3           (4) \$25,000,000 for each of fiscal years 2031  
4 through 2033.

5       **TITLE V—DEPARTMENT OF THE**  
6                                   **INTERIOR**

7       **SEC. 501. UNITED STATES GEOLOGICAL SURVEY.**

8           (a) RESEARCH, DEVELOPMENT, AND DEMONSTRA-  
9 TION.—

10           (1) IN GENERAL.—The Secretary of the Inte-  
11 rior, acting through the Director of the United  
12 States Geological Survey (referred to in this section  
13 as the “Director”), shall carry out research, develop-  
14 ment, and demonstration activities in each of the  
15 areas described in this subsection.

16           (2) RESOURCE ASSESSMENTS.—

17           (A) IN GENERAL.—The Director shall—

18                   (i) carry out mapping and technical  
19 and economic assessments of geological re-  
20 sources, mine tailings, and other alkaline  
21 industrial wastes for mineralization; and

22                   (ii) establish of a public database of  
23 results of the mapping and assessments  
24 carried out under clause (i).

1 (B) COLLABORATION.—The Director shall  
2 carry out the activities described in subpara-  
3 graph (A) in collaboration with the Assistant  
4 Secretary for Fossil Energy and Carbon Man-  
5 agement of the Department of Energy.

6 (3) TAILINGS AND WASTE MINERALIZATION.—

7 (A) IN GENERAL.—The Director shall  
8 carry out field experiments on carbon-seques-  
9 tering waste materials, including mine tailings  
10 and industrial wastes.

11 (B) COLLABORATION.—The Director shall  
12 carry out the activities described in subpara-  
13 graph (A) in collaboration with—

14 (i) the Assistant Secretary for of Fos-  
15 sil Energy and Carbon Management of the  
16 Department of Energy;

17 (ii) the Assistant Administrator for of  
18 Research and Development of the Environ-  
19 mental Protection Agency; and

20 (iii) the director of the Bureau of  
21 Land Management.

22 (4) ENVIRONMENTAL IMPACTS OF MINERALIZA-  
23 TION MATERIALS.—

24 (A) IN GENERAL.—The Director shall  
25 carry out research on the environmental im-

1           pacts of broadcasting materials, including dis-  
2           turbating piles of mine tailings.

3           (B) COLLABORATION.—The Director shall  
4           carry out the activities described in subpara-  
5           graph (A) in collaboration with—

6                     (i) the Assistant Secretary for Fossil  
7                     Energy and Carbon Management of the  
8                     Department of Energy; and

9                     (ii) the Assistant Administrator for  
10                    Research and Development of the Environ-  
11                    mental Protection Agency.

12           (5) ENVIRONMENTAL AND SOCIAL IMPACTS OF  
13           EXPANDED MINING FOR MINERALIZATION.—

14           (A) IN GENERAL.—The Director shall  
15           carry out research on the environmental and so-  
16           cial impacts of expanded mining activities for  
17           the purpose of mineralization, including the net  
18           carbon impact of those activities.

19           (B) COLLABORATION.—The Director shall  
20           carry out the activities described in subpara-  
21           graph (A) in collaboration with—

22                     (i) the Director of the National  
23                     Science Foundation;

1 (ii) the Assistant Secretary for Fossil  
2 Energy and Carbon Management of the  
3 Department of Energy; and

4 (iii) the Assistant Administrator for  
5 Research and Development of the Environ-  
6 mental Protection Agency.

7 (6) NEW MINERALIZATION PATHWAYS.—

8 (A) IN GENERAL.—The Director shall  
9 carry out development of new, low-emissions  
10 sources of alkalinity for carbon mineralization  
11 and new mineralization processes, such as loop-  
12 ing and direct air capture hybrids.

13 (B) COLLABORATION.—The Director shall  
14 carry out the activities described in subpara-  
15 graph (A) in collaboration with the Assistant  
16 Secretary for Energy Efficiency and Renewable  
17 Energy of the Department of Energy.

18 (7) REGIONAL PARTNERSHIPS.—

19 (A) IN GENERAL.—The Director shall es-  
20 tablish not more than 6 regional partnerships,  
21 the membership of which may be made up of 1  
22 or more—

23 (i) institutions of higher education;

24 (ii) State entities;

25 (iii) Federal entities;



1 (iv) Indian Tribes (as defined in sec-  
2 tion 4 of the Indian Self-Determination  
3 and Education Assistance Act (25 U.S.C.  
4 5304));

5 (v) Native Hawaiian organizations (as  
6 defined in section 6207 of the Elementary  
7 and Secondary Education Act of 1965 (20  
8 U.S.C. 7517));

9 (vi) nongovernmental organizations;  
10 and

11 (vii) other relevant entities.

12 (B) PURPOSE.—The purpose of a regional  
13 partnership established under subparagraph (A)  
14 shall be—

15 (i) to characterize regional resources  
16 for mineralization; and

17 (ii) to carry out field experiments and  
18 small-scale demonstration projects for min-  
19 eralization.

20 (C) COLLABORATION.—The Director shall  
21 carry out the activities described in this para-  
22 graph in collaboration with the Assistant Sec-  
23 retary for Fossil Energy and Carbon Manage-  
24 ment of the Department of Energy.

1           (8) OTHER ACTIVITIES.—The Director shall  
2           carry out other carbon dioxide removal research, de-  
3           velopment, and demonstration activities, as deter-  
4           mined by the Secretary of the Interior.

5           (b) AUTHORIZATION OF APPROPRIATIONS.—There  
6           are authorized to be appropriated to the Secretary of Inte-  
7           rior to carry out this section—

8                   (1) \$13,000,000 for fiscal year 2024;

9                   (2) \$19,000,000 for fiscal year 2025;

10                   (3) \$22,000,000 for each of fiscal years 2026  
11           through 2030;

12                   (4) \$21,000,000 for each of fiscal years 2031  
13           and 2032; and

14                   (5) \$18,000,000 for fiscal year 2033.

15 **SEC. 502. LAND AND MINERALS MANAGEMENT.**

16           (a) RESEARCH, DEVELOPMENT, AND DEMONSTRA-  
17           TION.—

18                   (1) IN GENERAL.—The Secretary of the Inte-  
19           rior, acting through the Assistant Secretary of Land  
20           and Minerals Management (referred to in this sec-  
21           tion as the “Assistant Secretary”), shall carry out  
22           research, development, and demonstration activities  
23           in each of the areas described in this subsection.

24                   (2) CARBON DIOXIDE REMOVAL ON FEDERAL  
25           LANDS.—

1 (A) IN GENERAL.—The Assistant Sec-  
2 retary shall carry out an assessment of the abil-  
3 ity to use Federal land and abandoned mine  
4 land, subject to the Office of Surface Mining,  
5 and associated subsurface regions, for carbon  
6 dioxide removal benefits and practices, includ-  
7 ing—

8 (i) ecologically appropriate revegeta-  
9 tion;

10 (ii) reforestation;

11 (iii) restoration to natural landscapes,  
12 including grasslands; and

13 (iv) underground geologic storage of  
14 carbon dioxide.

15 (B) REQUIREMENTS.—The assessment  
16 under subparagraph (A) shall—

17 (i) include data on carbon storage po-  
18 tential and climate resilience, including—

19 (I) safety for local communities;

20 (II) avoiding negative environ-  
21 mental impacts; and

22 (III) identifying regions with  
23 lower risks of reversing carbon dioxide  
24 removal practices over time; and

1 (ii) identify economic development op-  
2 portunities for local communities.

3 (3) OTHER ACTIVITIES.—The Assistant Sec-  
4 retary shall carry out other carbon dioxide removal  
5 research, development, and demonstration activities,  
6 as determined by the Secretary of the Interior.

7 (4) CONSULTATION.—The Assistant Secretary  
8 shall carry out the activities described in this section  
9 in consultation with—

10 (A) the Secretary of Agriculture;

11 (B) the Secretary of Energy; and

12 (C) the Chief of the Forest Service.

13 (b) AUTHORIZATION OF APPROPRIATIONS.—There  
14 are authorized to be appropriated to the Secretary of the  
15 Interior to carry out this section \$2,000,000 for each of  
16 fiscal years 2024 through 2033.

17 **TITLE VI—DEPARTMENT OF**  
18 **TRANSPORTATION**

19 **SEC. 601. FEDERAL HIGHWAY ADMINISTRATION.**

20 (a) DEFINITIONS.—In this section:

21 (1) CARBON-SEQUESTERING NEW MATERIAL.—

22 The term “carbon-sequestering new material” means  
23 a novel formulation of cement, concrete, or aggre-  
24 gate that allows captured carbon dioxide to be se-  
25 questered, including—

- 1 (A) carbon dioxide-adsorbing materials;  
2 (B) carbon dioxide-absorbing materials;  
3 (C) carbon dioxide-cured cement and con-  
4 crete;  
5 (D) new aggregate materials made from  
6 mineral carbonization;  
7 (E) cement formulations that substitute  
8 clinker with other materials, subject to the con-  
9 dition that such other materials comprise not  
10 less than 50 percent of the cement formulation;  
11 and  
12 (F) additional materials as designated by  
13 the Secretary.

14 (2) PROGRAM.—The term “program” means  
15 the research, development, and demonstration pro-  
16 gram established under subsection (b).

17 (3) SECRETARY.—The term “Secretary” means  
18 the Secretary of Transportation.

19 (b) ESTABLISHMENT.—The Secretary shall establish  
20 a program to carry out research, development, and dem-  
21 onstration activities for the use of carbon-sequestering  
22 new materials to lower the carbon impact of highway con-  
23 struction materials and public transportation construction  
24 materials.

25 (c) ACTIVITIES.—

1 (1) DEVELOPMENT AND DEPLOYMENT.—

2 (A) IN GENERAL.—In carrying out the  
3 program, the Secretary shall carry out research  
4 on mineral carbonation for use in carbon-se-  
5 questering new materials.

6 (B) CONSIDERATION.—The research under  
7 subparagraph (A) shall be informed by the rec-  
8 ommendations of the National Academies of  
9 Science, Engineering, and Medicine in chapter  
10 11 of the consensus study report entitled “Gas-  
11 eous Carbon Waste Streams Utilization: Status  
12 and Research Needs” and published in 2019.

13 (2) RESEARCH.—

14 (A) IN GENERAL.—In carrying out the  
15 program, the Secretary, in coordination with  
16 standard-setting organizations, such as the  
17 American Association of State Highway and  
18 Transportation Officials, shall carry out re-  
19 search—

20 (i) on the durability, strength, and  
21 stability of carbon-sequestering new mate-  
22 rials; and

23 (ii) to support the development of the  
24 necessary standards required for the use of  
25 carbon-sequestering new materials.

1           (B) STANDARDS.—Based on the results of  
2           the research under subparagraph (A), the Sec-  
3           retary shall coordinate and consult with other  
4           necessary governmental and nongovernmental  
5           entities, including the entities described in sub-  
6           paragraph (A), to support the development of  
7           standards for the use of carbon-sequestering  
8           new materials.

9           (3) GRANTS FOR STATE STANDARDS.—In car-  
10          rying out the program, the Secretary shall provide  
11          grants to a geographically diverse set of States to  
12          assist those States in adopting State standards for  
13          the procurement of carbon-sequestering new mate-  
14          rials in highway and public transportation construc-  
15          tion.

16          (4) LIFECYCLE ASSESSMENTS.—In carrying out  
17          the program, the Secretary shall carry out lifecycle  
18          assessments of the greenhouse gas emissions associ-  
19          ated with carbon-sequestering new materials.

20          (5) COORDINATION.—The Secretary shall co-  
21          ordinate with—

22                  (A) the Secretary of Energy in carrying  
23                  out paragraph (1);

1 (B) the Administrator of the Environ-  
2 mental Protection Agency in carrying out para-  
3 graph (4); and

4 (C) other Federal agencies as necessary to  
5 carry out the activities described in this sub-  
6 section.

7 (d) GRANT PROGRAM.—

8 (1) IN GENERAL.—Not later than 2 years after  
9 the date of enactment of this Act, the Secretary  
10 shall establish a program to provide grants to eligi-  
11 ble entities to assist those entities in procuring car-  
12 bon-sequestering new materials for eligible uses de-  
13 scribed in paragraph (4).

14 (2) ELIGIBLE ENTITIES.—An entity eligible to  
15 receive a grant under this subsection is—

16 (A) a State;

17 (B) a federally recognized Indian Tribe; or

18 (C) a unit of local government.

19 (3) APPLICATIONS.—To be eligible to receive a  
20 grant under this subsection, an eligible entity shall  
21 submit to the Secretary an application at such time,  
22 in such manner, and containing such information as  
23 the Secretary determines to be appropriate.



1           (4) USE OF FUNDS.—An eligible entity may use  
2 a grant under this subsection to procure and use  
3 carbon-sequestering new materials for—

4           (A) a highway or bridge project eligible for  
5 assistance under title 23, United States Code;

6           (B) a public transportation project eligible  
7 for assistance under chapter 53 of title 49,  
8 United States Code; and

9           (C) any other transportation infrastructure  
10 project as the Secretary determines to be ap-  
11 propriate.

12          (5) REQUIREMENTS.—

13           (A) HIGHWAY OR BRIDGE PROJECTS.—A  
14 project described in paragraph (4)(A) shall be  
15 subject to the requirements under title 23,  
16 United States Code, that would apply if the  
17 project was carried out under that title.

18           (B) PUBLIC TRANSPORTATION  
19 PROJECTS.—A project described in paragraph  
20 (4)(B) shall be subject to the requirements  
21 under chapter 53 of title 49, United States  
22 Code, that would apply if the project was car-  
23 ried out under that chapter.

24          (e) FUNDING.—

1           (1) AUTHORIZATION OF APPROPRIATIONS.—

2           There are authorized to be appropriated to the Sec-  
3           retary to carry out this section—

4                   (A) \$32,000,000 for fiscal year 2024;

5                   (B) \$57,000,000 for fiscal year 2025;

6                   (C) \$62,000,000 for fiscal year 2026;

7                   (D) \$67,000,000 for fiscal year 2027; and

8                   (E) \$72,000,000 for each of fiscal years  
9           2028 through 2033.

10          (2) ALLOCATION.—

11               (A) RESEARCH AND DEVELOPMENT.—Of  
12               the amounts made available under paragraph  
13               (1) for each fiscal year—

14                   (i) \$10,000,000 shall be for research  
15                   under subsection (c)(1);

16                   (ii) \$10,000,000 shall be for research  
17                   under subsection (c)(2);

18                   (iii) \$10,000,000 shall be for grants  
19                   for States under subsection (c)(3); and

20                   (iv) \$2,000,000 shall be for lifecycle  
21                   assessments under subsection (c)(4).

22               (B) GRANT PROGRAM.—Of the amounts  
23               made available under paragraph (1), the Sec-  
24               retary shall use to carry out the grant program  
25               under subsection (d)—

- 1 (i) \$25,000,000 for fiscal year 2025;  
 2 (ii) \$30,000,000 for fiscal year 2026;  
 3 (iii) \$35,000,000 for fiscal year 2027;  
 4 and  
 5 (iv) \$40,000,000 for each of fiscal  
 6 years 2028 through 2033.

7 (3) TREATMENT.—Amounts made available  
 8 under paragraph (1) shall be available for obligation  
 9 in the same manner as if those amounts were appor-  
 10 tioned under chapter 1 of title 23, United States  
 11 Code.

## 12 **TITLE VII—ENVIRONMENTAL** 13 **PROTECTION AGENCY**

### 14 **SEC. 701. OFFICE OF RESEARCH AND DEVELOPMENT.**

15 (a) RESEARCH, DEVELOPMENT, AND DEMONSTRATION.—  
 16 TION.—

17 (1) IN GENERAL.—The Administrator of the  
 18 Environmental Protection Agency, acting through  
 19 the Assistant Administrator of Research and Devel-  
 20 opment (referred to in this section as the “Assistant  
 21 Administrator”), shall carry out research, develop-  
 22 ment, and demonstration activities in each of the  
 23 areas described in this subsection.

24 (2) DIRECT AIR CAPTURE ENVIRONMENTAL IM-  
 25 PACTS.—The Assistant Administrator shall carry out

1 a lifecycle assessment of the environmental impacts  
2 of direct air capture, including—

3 (A) greenhouse gas emissions;

4 (B) air and water pollutants;

5 (C) water use; and

6 (D) land use.

7 (3) PRESERVATION OF HARVESTED WOOD.—

8 (A) IN GENERAL.—The Assistant Adminis-  
9 trator shall design and conduct a demonstration  
10 of landfills for woody biomass disposal and car-  
11 bon storage;

12 (B) COLLABORATION.—The Assistant Ad-  
13 ministrator shall carry out the activities de-  
14 scribed in subparagraph (A) in collaboration  
15 with the Chief of the Forest Service.

16 (4) ENVIRONMENTAL AND SOCIAL IMPACTS OF  
17 MINERALIZATION.—

18 (A) IN GENERAL.—The Assistant Adminis-  
19 trator shall conduct research on the environ-  
20 mental impacts of mineralization, including  
21 broadcasting materials, disturbing piles of mine  
22 tailings, and expanded mining activities.

23 (B) COLLABORATION.—The Assistant Ad-  
24 ministrator shall carry out the activities de-

1 scribed in subparagraph (A) in collaboration  
2 with—

3 (i) the Director of the National  
4 Science Foundation;

5 (ii) the Director of the United States  
6 Geological Survey; and

7 (iii) the Assistant Secretary for Fossil  
8 Energy and Carbon Management of the  
9 Department of Energy.

10 (5) RESEARCH ON DECISION SCIENCE.—

11 (A) IN GENERAL.—The Assistant Adminis-  
12 trator shall conduct research on decision  
13 science, social impacts, and public engagement  
14 on carbon dioxide removal technologies and  
15 methods.

16 (B) COLLABORATION.—The Assistant Ad-  
17 ministrator shall carry out the activities de-  
18 scribed in subparagraph (A) in collaboration  
19 with—

20 (i) the Director of the National  
21 Science Foundation; and

22 (ii) the Assistant Secretary for Fossil  
23 Energy and Carbon Management of the  
24 Department of Energy.

1           (6) ENVIRONMENTAL AND SOCIAL IMPACTS OF  
2 BIOMASS USE IN CARBON DIOXIDE REMOVAL TECH-  
3 NOLOGIES.—

4           (A) IN GENERAL.—The Assistant Adminis-  
5 trator shall carry out a life cycle analysis of the  
6 impact of biomass use in carbon dioxide re-  
7 moval technologies, including—

8           (i) emissions sequestered in materials;

9           (ii) emissions impacts of biomass har-  
10 vest, processing, and transportation;

11           (iii) unintended disturbances to eco-  
12 system carbon stocks;

13           (iv) indirect land-use change; and

14           (v) alternative fates of biomass used.

15           (B) CONSIDERATION.—In carrying out the  
16 analysis under subparagraph (A), the Assistant  
17 Administrator shall consider the social impacts  
18 of air pollution relating to biofuel and biomass  
19 combustion.

20           (C) COLLABORATION.—The Assistant Ad-  
21 ministrator shall carry out the activities de-  
22 scribed in subparagraphs (A) and (B) in col-  
23 laboration with the Assistant Secretary for En-  
24 ergy Efficiency and Renewable Energy of the  
25 Department of Energy.

1           (7) LIFECYCLE ASSESSMENT AND MONITORING  
2           FOR MINERALIZATION.—The Assistant Adminis-  
3           trator shall carry out a technoeconomic and lifecycle  
4           assessment of various mineralization pathways and  
5           research on protocols for monitoring and verification  
6           of carbon removed or sequestered through min-  
7           eralization.

8           (8) OTHER ACTIVITIES.—The Assistant Admin-  
9           istrator shall carry out other carbon dioxide removal  
10          research, development, and demonstration activities,  
11          as determined by the Administrator of the Environ-  
12          mental Protection Agency.

13          (b) AUTHORIZATION OF APPROPRIATIONS.—There  
14          are authorized to be appropriated to the Administrator of  
15          the Environmental Protection Agency to carry out this  
16          section—

17                 (1) \$24,000,000 for fiscal year 2024;

18                 (2) \$28,000,000 for fiscal year 2025;

19                 (3) \$35,000,000 for fiscal year 2026;

20                 (4) \$32,000,000 for each of fiscal years 2027  
21                 and 2028;

22                 (5) \$34,000,000 for each of fiscal years 2029  
23                 and 2030;

24                 (6) \$31,000,000 for each of fiscal years 2031  
25                 and 2032; and

1 (7) \$30,000,000 for fiscal year 2033.

2 **TITLE VIII—NATIONAL AERO-**  
3 **NAUTICS AND SPACE ADMIN-**  
4 **ISTRATION**

5 **SEC. 801. EARTH SCIENCE DIVISION PROGRAM.**

6 (a) RESEARCH, DEVELOPMENT, AND DEMONSTRA-  
7 TION.—

8 (1) IN GENERAL.—The Administrator of the  
9 National Aeronautics and Space Administration (re-  
10 ferred to in this section as the “Administrator”)  
11 shall carry out research, development, and dem-  
12 onstration activities in each of the areas described in  
13 this subsection.

14 (2) ABOVEGROUND CARBON MONITORING.—The  
15 Administrator shall carry out a long-term collection  
16 of continuous spaceborne LiDAR data to measure  
17 and track carbon stocks and carbon cycling in above-  
18 ground biomass, through extension of the Global  
19 Ecosystem Dynamics Investigation mission, or  
20 through other missions with similar or improved ca-  
21 pacity.

22 (3) RESOURCE ASSESSMENT.—

23 (A) IN GENERAL.—The Administrator  
24 shall carry out mapping and evaluation of



1 coastal marine ecosystems for carbon dioxide  
2 removal potential, including—

- 3 (i) wetlands;  
4 (ii) peatlands; and  
5 (iii) seagrass beds.

6 (B) COLLABORATION.—The Administrator  
7 shall carry out the activities described in sub-  
8 paragraph (A) in collaboration with the Admin-  
9 istrator of the National Oceanic and Atmos-  
10 pheric Administration.

11 (4) OTHER ACTIVITIES.—The Administrator  
12 shall carry out other carbon dioxide removal re-  
13 search, development, and demonstration activities, as  
14 determined by the Administrator.

15 (b) AUTHORIZATION OF APPROPRIATIONS.—There  
16 are authorized to be appropriated to the Administrator to  
17 carry out this section—

18 (1) \$53,000,000 for each of fiscal years 2024  
19 and 2025; and

20 (2) \$8,000,000 for each of fiscal years 2026  
21 through 2033.

22 **TITLE IX—NATIONAL SCIENCE**  
23 **FOUNDATION**

24 **SEC. 901. DIRECTORATE FOR BIOLOGICAL SCIENCES.**

25 (a) RESEARCH.—

1           (1) IN GENERAL.—The Director of the National  
2 Science Foundation (referred to in this section as  
3 the “Director”) shall award funding for research ac-  
4 tivities in each of the areas described in this sub-  
5 section.

6           (2) GENETIC MODELING AND TOOLS.—

7           (A) IN GENERAL.—The Director shall  
8 award funding for research to improve carbon  
9 dioxide uptake and conversion through genetic  
10 manipulation of biological materials for carbon  
11 dioxide removal and utilization and research on  
12 the potential ecological impacts of those im-  
13 provements.

14           (B) COLLABORATION.—The Director shall  
15 carry out the activities described in subpara-  
16 graph (A) in collaboration with—

17                   (i) the Director of the Office of  
18 Science of the Department of Energy;

19                   (ii) the Secretary of Agriculture; and

20                   (iii) the Administrator of the Environ-  
21 mental Protection Agency.

22           (3) OTHER RESEARCH.—The Director shall  
23 award funding for other carbon dioxide removal re-  
24 search, as determined by the Director of the Na-  
25 tional Science Foundation.

1 (b) AUTHORIZATION OF APPROPRIATIONS.—There  
2 are authorized to be appropriated to the Director to carry  
3 out this section—

4 (1) \$2,000,000 for fiscal year 2024;

5 (2) \$3,000,000 for fiscal year 2025; and

6 (3) \$5,000,000 for each of fiscal years 2026  
7 through 2033.

8 **SEC. 902. DIRECTORATE FOR ENGINEERING.**

9 (a) RESEARCH.—

10 (1) IN GENERAL.—The Director of the National  
11 Science Foundation (referred to in this section as  
12 the “Director”) shall award funding for research ac-  
13 tivities in each of the following areas described in  
14 this subsection.

15 (2) INTEGRATED PROCESS DESIGN.—

16 (A) IN GENERAL.—The Director shall  
17 award funding for research and development on  
18 the integration of carbonation with carbon diox-  
19 ide capture processes.

20 (B) COLLABORATION.—The Director shall  
21 carry out the activities described in subpara-  
22 graph (A) in collaboration with the Assistant  
23 Secretary for Fossil Energy and Carbon Man-  
24 agement of the Department of Energy.

1           (3) OTHER RESEARCH.—The Director shall  
2           award funding for other carbon dioxide removal re-  
3           search, as determined by the Director.

4           (b) AUTHORIZATION OF APPROPRIATIONS.—There  
5           are authorized to be appropriated to the Director to carry  
6           out this section—

7                   (1) \$2,000,000 for fiscal year 2024; and

8                   (2) \$3,000,000 for each of fiscal years 2025  
9           through 2033.

10 **SEC. 903. DIRECTORATE FOR GEOSCIENCES.**

11           (a) RESEARCH.—

12                   (1) IN GENERAL.—The Director of the National  
13           Science Foundation (referred to in this section as  
14           the “Director”) shall award funding for research ac-  
15           tivities in each of the following areas described in  
16           this subsection.

17                   (2) SOIL CARBON.—

18                           (A) IN GENERAL.—The Director shall  
19           award funding for fundamental research on  
20           plant-root-fungi interactions, deep inversion of  
21           soils, and other topics with the potential to ad-  
22           vance carbon dioxide removal.

23                           (B) COLLABORATION.—The Director shall  
24           carry out the activities described in subpara-  
25           graph (A) in collaboration with—

- 1 (i) the Director of the Office of  
2 Science of the Department of Energy; and  
3 (ii) the Administrator of the Agricultural  
4 Research Service.

5 (3) MODELING AND PREDICTIVE TOOL DEVELOPMENT.—  
6

7 (A) IN GENERAL.—The Director shall  
8 award funding for research to improve existing  
9 carbon sequestration modeling tools and the development  
10 of simulation-based tools to predict  
11 and quantify soil carbon sequestration.

12 (B) COLLABORATION.—The Director shall  
13 carry out the activities described in subparagraph  
14 (A) in collaboration with—

- 15 (i) the Administrator of the Agricultural  
16 Research Service; and  
17 (ii) the heads of other offices in the  
18 Department of Agriculture, as determined  
19 by the Secretary of Agriculture.

20 (4) CARBON MINERALIZATION.—

21 (A) IN GENERAL.—The Director shall  
22 award funding for fundamental research on  
23 mineralization kinetics, geomechanics, rock  
24 physics, and utilization-oriented carbonation

1 with the potential to advance carbon dioxide re-  
2 moval.

3 (B) COLLABORATION.—The Director shall  
4 carry out the activities described in subpara-  
5 graph (A) in collaboration with the Director of  
6 the Office of Science of the Department of En-  
7 ergy.

8 (5) PILOT STUDIES OF IN SITU MINERALIZA-  
9 TION.—

10 (A) IN GENERAL.—The Director shall  
11 award funding for field drilling and injection in  
12 reactive formations (including peridotite and  
13 basalt) to advance understanding of carbon  
14 mineralization.

15 (B) COLLABORATION.—The Director shall  
16 carry out the activities described in subpara-  
17 graph (A) in collaboration with the Assistant  
18 Secretary for Fossil Energy and Carbon Man-  
19 agement of the Department of Energy.

20 (6) ENVIRONMENTAL AND SOCIAL IMPACTS OF  
21 EXPANDED MINING FOR MINERALIZATION.—

22 (A) IN GENERAL.—The Director shall  
23 award funding for research on the environ-  
24 mental and social impacts of expanded mining

1 activities for the purpose of mineralization, in-  
2 cluding net carbon impact.

3 (B) COLLABORATION.—The Director shall  
4 carry out the activities described in subpara-  
5 graph (A) in collaboration with—

6 (i) the Director of the United States  
7 Geological Survey;

8 (ii) the Assistant Administrator for  
9 Research and Development of the Environ-  
10 mental Protection Agency; and

11 (iii) the Assistant Secretary for Office  
12 of Fossil Energy and Carbon Management  
13 of the Department of Energy.

14 (7) COASTAL MARINE CARBON FUNDAMENTAL  
15 RESEARCH.—

16 (A) IN GENERAL.—The Director shall  
17 award funding for fundamental research on  
18 coastal ecosystem carbon dioxide sequestration.

19 (B) COLLABORATION.—The Director shall  
20 carry out the activities described in subpara-  
21 graph (A) in collaboration with the Adminis-  
22 trator of the National Oceanic and Atmospheric  
23 Administration.

24 (8) OCEAN ALKALINITY.—

1           (A) IN GENERAL.—The Director shall  
2           award funding for fundamental and applied re-  
3           search on techniques for and impacts of artifi-  
4           cial modification of ocean alkalinity, including  
5           limited-scale experiments on alkalinity enhance-  
6           ment techniques at sea, designed and monitored  
7           to avoid impacts beyond the zone of the experi-  
8           ment and within internationally recognized  
9           frameworks.

10           (B) COLLABORATION.—The Director shall  
11           carry out the activities described in subpara-  
12           graph (A) in collaboration with—

13                   (i) the Director of the Office of  
14                   Science of the Department of Energy; and

15                   (ii) the Administrator of the National  
16                   Oceanic and Atmospheric Administration.

17           (9) OCEAN FERTILIZATION FUNDAMENTAL RE-  
18           SEARCH.—

19           (A) IN GENERAL.—The Director shall  
20           award funding for fundamental research and  
21           modeling on the impacts and effectiveness of  
22           ocean iron fertilization and nitrogen and phos-  
23           phorous fertilization research.



1 (B) COLLABORATION.—The Director shall  
2 carry out the activities described in subpara-  
3 graph (A) in collaboration with—

4 (i) the Director of the Office of  
5 Science of the Department of Energy; and

6 (ii) the Administrator of the National  
7 Oceanic and Atmospheric Administration.

8 (10) ARTIFICIAL OCEAN IRON FERTILIZA-  
9 TION.—

10 (A) IN GENERAL.—The Director shall  
11 award funding for limited-scale experiments to  
12 stimulate and measure large phytoplankton  
13 blooms, designed and monitored to avoid im-  
14 pacts beyond the zone of the experiment and  
15 within internationally recognized frameworks.

16 (B) COLLABORATION.—The Director shall  
17 carry out the activities described in subpara-  
18 graph (A) in collaboration with the Adminis-  
19 trator of the National Oceanic and Atmospheric  
20 Administration.

21 (11) ARTIFICIAL OCEAN MACRONUTRIENT FER-  
22 TILIZATION.—

23 (A) IN GENERAL.—The Director shall  
24 award funding for limited-scale experiments on  
25 ocean macronutrient fertilization, designed and

1 monitored to avoid impacts beyond the zone of  
2 the experiment and within internationally recog-  
3 nized frameworks.

4 (B) COLLABORATION.—The Director shall  
5 carry out the activities described in subpara-  
6 graph (A) in collaboration with the Adminis-  
7 trator of the National Oceanic and Atmospheric  
8 Administration.

9 (12) OTHER RESEARCH.—The Director shall  
10 award funding for other carbon dioxide removal re-  
11 search, as determined by the Director.

12 (b) AUTHORIZATION OF APPROPRIATIONS.—There  
13 are authorized to be appropriated to the Director to carry  
14 out this section—

15 (1) \$21,000,000 for fiscal year 2024;

16 (2) \$34,000,000 for fiscal year 2025;

17 (3) \$61,000,000 for fiscal year 2026;

18 (4) \$73,000,000 for each of fiscal years 2027  
19 and 2028;

20 (5) \$68,000,000 for each of fiscal years 2029  
21 and 2030;

22 (6) \$65,000,000 for fiscal year 2031; and

23 (7) \$60,000,000 for each of fiscal years 2032  
24 and 2033.

1 **SEC. 904. DIRECTORATE FOR MATHEMATICAL AND PHYS-**  
2 **ICAL SCIENCES.**

3 (a) RESEARCH.—

4 (1) IN GENERAL.—The Director of the National  
5 Science Foundation (referred to in this section as  
6 the “Director”) shall award funding for research ac-  
7 tivities in each of the following areas described in  
8 this subsection.

9 (2) NSF ENGINEERING RESEARCH CENTER.—

10 The Director shall establish a new National Science  
11 Foundation Engineering Research Center focused on  
12 materials research and early-stage application of  
13 sorbents, solvents, membranes, and related direct air  
14 capture components.

15 (3) DIRECT AIR CAPTURE MATERIALS RE-  
16 SEARCH.—The Director shall award funding for ma-  
17 terials research on sorbents, solvents, membranes,  
18 and related direct air capture components.

19 (4) CARBONATION.—

20 (A) IN GENERAL.—The Director shall  
21 award funding for research to control  
22 carbonation reactions, accelerate carbonation,  
23 and understand structure-property relation-  
24 ships.

25 (B) COLLABORATION.—The Director shall  
26 carry out the activities described in subpara-

1 graph (A) in collaboration with the Director of  
2 the Office of Science of the Department of En-  
3 ergy.

4 (5) CATALYSTS.—

5 (A) IN GENERAL.—The Director shall  
6 award funding for research on impurity-tolerant  
7 catalyst development, coupled reduction and ox-  
8 idation reactions, and reduced additives.

9 (B) COLLABORATION.—The Director shall  
10 carry out the activities described in subpara-  
11 graph (A) in collaboration with the Director of  
12 the Office of Science of the Department of En-  
13 ergy.

14 (6) NEW MATERIALS DEVELOPMENT AND AP-  
15 PPLICATIONS.—

16 (A) IN GENERAL.—The Director shall  
17 award funding for development of new mate-  
18 rials for capturing and utilizing carbon dioxide,  
19 including materials with carbon-carbon bonds.

20 (B) COLLABORATION.—The Director shall  
21 carry out the activities described in subpara-  
22 graph (A) in collaboration with the Director of  
23 the Office of Science of the Department of En-  
24 ergy.

1           (7) OTHER RESEARCH.—The Director shall  
2           award funding for other carbon dioxide removal re-  
3           search, as determined by the Director.

4           (b) AUTHORIZATION OF APPROPRIATIONS.—There  
5           are authorized to be appropriated to the Director to carry  
6           out this section—

7           (1) \$11,000,000 for fiscal year 2024;

8           (2) \$28,000,000 for fiscal year 2025;

9           (3) \$32,000,000 for each of fiscal years 2026  
10          and 2027;

11          (4) \$38,000,000 for each of fiscal years 2028  
12          and 2029;

13          (5) \$33,000,000 for fiscal year 2030;

14          (6) \$28,000,000 for fiscal year 2031;

15          (7) \$23,000,000 for fiscal year 2032; and

16          (8) \$18,000,000 for fiscal year 2033.

17 **SEC. 905. DIRECTORATE FOR SOCIAL, BEHAVIORAL, AND**  
18 **ECONOMIC SCIENCES.**

19          (a) RESEARCH.—

20           (1) IN GENERAL.—The Director of the National  
21           Science Foundation (referred to in this section as  
22           the “Director”) shall award funding for research ac-  
23           tivities in each of the following areas described in  
24           this subsection.

1           (2) INTEGRATED ASSESSMENT MODELING AND  
2 GRASSLANDS AND FOREST IMPACTS MODELING.—

3           (A) IN GENERAL.—The Director shall  
4 award funding for technical, economic, and so-  
5 cial modeling of impacts on land use from  
6 avoided conversion of grasslands and forests,  
7 reforestation, conservation, afforestation, and  
8 forest management changes.

9           (B) COLLABORATION.—The Director shall  
10 carry out the activities described in subpara-  
11 graph (A) in collaboration with the Secretary of  
12 Agriculture.

13          (3) INTEGRATED ASSESSMENT MODELING AND  
14 DIRECT AIR CAPTURE IMPACTS MODELING.—The Di-  
15 rector shall award funding for technical, economic,  
16 and social modeling of impacts on land and energy  
17 use from direct air capture, including future elec-  
18 tricity grid mix scenarios.

19          (4) ETHICAL, LEGAL, AND SOCIAL IMPACTS OF  
20 BIOTECHNOLOGY.—The Director shall award fund-  
21 ing for research on the ethical, legal, and social im-  
22 plications of biotechnology use in carbon dioxide re-  
23 moval.

24          (5) GOVERNANCE FRAMEWORKS.—The Director  
25 shall award funding for research into governance

1 frameworks for safe and sustainable experimentation  
2 with ocean-based carbon dioxide removal.

3 (6) OTHER RESEARCH.—The Director shall  
4 award funding for other carbon dioxide removal re-  
5 search, as determined by the Director.

6 (b) AUTHORIZATION OF APPROPRIATIONS.—There is  
7 authorized to be appropriated to the Director to carry out  
8 this section \$12,000,000 for each of fiscal years 2024  
9 through 2033.

10 **SEC. 906. DIVISION OF SOCIAL AND ECONOMIC SCIENCES.**

11 (a) RESEARCH.—

12 (1) IN GENERAL.—The Director of the National  
13 Science Foundation (referred to in this section as  
14 the “Director”) shall award funding for research ac-  
15 tivities in each of the following areas described in  
16 this subsection.

17 (2) RESEARCH ON DECISION SCIENCE.—

18 (A) IN GENERAL.—The Director shall  
19 award funding for research on decision science,  
20 social impacts, and public engagement relating  
21 to carbon dioxide removal technologies and  
22 methods.

23 (B) COLLABORATION.—The Director shall  
24 carry out the activities described in subpara-  
25 graph (A) in collaboration with—

1 (i) the Assistant Administrator for  
2 Research and Development of the Environ-  
3 mental Protection Agency; and

4 (ii) the Assistant Secretary for Fossil  
5 Energy and Carbon Management of the  
6 Department of Energy.

7 (3) OTHER RESEARCH.—The Director shall  
8 award funding for other carbon dioxide removal re-  
9 search, as determined by the Director.

10 (b) AUTHORIZATION OF APPROPRIATIONS.—There  
11 are authorized to be appropriated to the Director to carry  
12 out this section—

13 (1) \$2,000,000 for fiscal year 2024;

14 (2) \$4,000,000 for each of fiscal years 2025  
15 through 2028; and

16 (3) \$5,000,000 for each of fiscal years 2029  
17 through 2033.

## 18 **TITLE X—OTHER MATTERS**

### 19 **SEC. 1001. PLAN FOR INTERNATIONAL COLLABORATION.**

20 (a) IN GENERAL.—The Director of the Office of  
21 Science and Technology Policy shall establish a plan for  
22 international coordination on research, development, and  
23 demonstration projects for carbon dioxide removal.



1           (b) COORDINATION.—In carrying out subsection (a),  
2 the Director of the Office of Science and Technology Pol-  
3 icy shall coordinate with—

4                   (1) the Secretary of State; and

5                   (2) the Secretary of Energy.

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