

117TH CONGRESS
2D SESSION

S. 4420

To provide for advancements in carbon removal research, quantification, and commercialization, including by harnessing natural processes, and for other purposes.

IN THE SENATE OF THE UNITED STATES

JUNE 16, 2022

Ms. COLLINS (for herself and Ms. CANTWELL) introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources

A BILL

To provide for advancements in carbon removal research, quantification, and commercialization, including by harnessing natural processes, 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 Removal and Emissions Storage Technologies
6 Act of 2022” or the “CREST Act of 2022”.

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—CARBON REMOVAL RESEARCH AND DEVELOPMENT

Subtitle A—Biomass Carbon Removal

Sec. 101. Biomass carbon removal programs.

Sec. 102. Biological carbon dioxide conversion programs.

Subtitle B—Geological Carbon Removal

Sec. 111. Carbon mineralization pilot projects.

Sec. 112. Carbon mineralization resource assessment.

Sec. 113. Tailings and waste mineralization program.

Subtitle C—Aquatic Carbon Removal

Sec. 121. Ocean carbon removal mission.

Sec. 122. Direct ocean capture assessment.

Sec. 123. Offshore carbon storage program and assessment.

Subtitle D—Atmospheric Carbon Removal

Sec. 131. Direct air capture technology manufacturing research program.

Subtitle E—Carbon Removal Quantification

Sec. 141. Carbon removal quantification.

TITLE II—CARBON REMOVAL PURCHASING PILOT PROGRAM

Sec. 201. Carbon removal purchasing pilot program.

1 **SEC. 2. DEFINITIONS.**

2 In this Act:

3 (1) CARBON REMOVAL.—The term “carbon re-
 4 moval” means the intentional removal, including by
 5 harnessing natural processes, of carbon dioxide di-
 6 rectly from the atmosphere or upper hydrosphere
 7 and subsequent storage of the carbon dioxide in geo-
 8 logical, biobased, or ocean reservoirs or in value-
 9 added products that results in a net removal of car-
 10 bon dioxide from the atmosphere, as measured on a
 11 lifecycle basis.

(2) CARBON REMOVAL TECHNOLOGY OR APPROACH.—The term “carbon removal technology or approach” includes—

(A) direct air capture with durable storage;

(B) soil carbon sequestration;

(C) biomass carbon removal and storage;

(D) enhanced mineralization;

(E) ocean-based carbon dioxide removal;

and

(F) afforestation or reforestation.

(3) SECRETARY.—The term “Secretary” means the Secretary of Energy.

TITLE I—CARBON REMOVAL RESEARCH AND DEVELOPMENT Subtitle A—Biomass Carbon Removal

SEC. 101. BIOMASS CARBON REMOVAL PROGRAMS.

(a) OFFICE OF SCIENCE.—Section 306 of the Department of Energy Research and Innovation Act (42 U.S.C. 18644) is amended by adding at the end the following:

“(e) ALGAL BIOMASS CARBON REMOVAL.—

“(1) IN GENERAL.—The Director shall carry out a research and development program to gain understanding of the underlying biology of algal bio-

1 mass systems and the possible use of algal biomass
 2 systems as a means of carbon removal (as defined
 3 in section 2 of the Carbon Removal and Emissions
 4 Storage Technologies Act of 2022) from the air and
 5 aquatic sources.

6 “(2) REQUIREMENTS.—The program carried
 7 out under paragraph (1) shall—

8 “(A) support efforts to reduce long-term
 9 technical barriers for algal biomass with carbon
 10 capture; and

11 “(B) coordinate closely with the Bioenergy
 12 Technologies Office and the Office of Fossil En-
 13 ergy and Carbon Management.”.

14 (b) OFFICE OF ENERGY EFFICIENCY AND RENEW-
 15 ABLE ENERGY.—Section 932 of the Energy Policy Act of
 16 2005 (42 U.S.C. 16232) is amended—

17 (1) in subsection (b)—

18 (A) in paragraph (5), by striking “and”
 19 after the semicolon;

20 (B) in paragraph (6), by striking the pe-
 21 riod and inserting “; and”; and

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

23 “(7) biological carbon removal (as defined in
 24 section 2 of the Carbon Removal and Emissions
 25 Storage Technologies Act of 2022).”; and

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

3 “(f) BIOLOGICAL CARBON REMOVAL.—

4 “(1) DEFINITION OF CARBON REMOVAL.—In
5 this subsection, the term ‘carbon removal’ has the
6 meaning given the term in section 2 of the Carbon
7 Removal and Emissions Storage Technologies Act of
8 2022.

9 “(2) GOALS.—The goals of the biological car-
10 bon removal program under subsection (b)(7) shall
11 be to develop and deploy, in partnership with indus-
12 try and institutions of higher education—

13 “(A) improved tools and understanding of
14 feedstocks, supplies, and logistics with respect
15 to carbon removal using biomass sources;

16 “(B) technologies for the optimized conver-
17 sion of aquatic and terrestrial biomass for car-
18 bon removal;

19 “(C) cost-competitive carbon capture tech-
20 nologies applied to bioenergy, including—

21 “(i) algal, terrestrial, and marine bio-
22 mass;

23 “(ii) biofuels; and

24 “(iii) bioproducts; and

1 “(D) applied research on best practices in
 2 macroalgae cultivation and phenotype selection,
 3 including by carrying out aquatic pilot projects.

4 “(3) COORDINATION.—Activities conducted
 5 under this subsection shall be coordinated with the
 6 relevant programs of the Office of Science, the Of-
 7 fice of Fossil Energy and Carbon Management, and
 8 the Department of Agriculture.”.

9 (c) OFFICE OF FOSSIL ENERGY AND CARBON MAN-
 10 AGEMENT.—Section 962(b) of the Energy Policy Act of
 11 2005 (42 U.S.C. 16292(b)) is amended—

12 (1) in paragraph (1), by striking “performance
 13 of” and all that follows through the period at the
 14 end and inserting the following: “performance of—

15 “(A) coal and natural gas use;

16 “(B) biomass with carbon capture for utili-
 17 zation or permanent storage; and

18 “(C) manufacturing and industrial facili-
 19 ties.”; and

20 (2) in paragraph (3)—

21 (A) in subparagraph (A)—

22 (i) in clause (v), by striking “and”
 23 after the semicolon;

24 (ii) in clause (vi), by striking the pe-
 25 riod at the end and inserting “; and”; and

1 (iii) by adding at the end the fol-
 2 lowing:

3 “(vii) developing advanced boilers to
 4 enable net-negative lifecycle carbon emis-
 5 sions through co-firing with biomass.”; and
 6 (B) by adding at the end the following:

7 “(G) Developing carbon capture tech-
 8 nologies applied to bioenergy systems that re-
 9 sult in net-negative lifecycle carbon emissions,
 10 including—

11 “(i) biofuels production;

12 “(ii) bioproducts;

13 “(iii) biomass used in power systems
 14 and industrial applications; and

15 “(iv) fossil fuel power systems and in-
 16 dustrial systems co-fired with biomass.”.

17 (d) OFFICE OF ENERGY EFFICIENCY AND RENEW-
 18 ABLE ENERGY.—

19 (1) IN GENERAL.—The Energy Independence
 20 and Security Act of 2007 (42 U.S.C. 17001 et seq.)
 21 is amended by striking section 228 (121 Stat. 1535)
 22 and inserting the following:

23 **“SEC. 228. AQUATIC BIOMASS.**

24 “(a) IN GENERAL.—The Director of the Bioenergy
 25 Technologies Office shall carry out applied research on—

1 “(1) microalgae and macroalgae cultivation and
2 phenotype selection; and

3 “(2) optimization of aquatic biomass conversion
4 pathways.

5 “(b) REQUIREMENTS.—The research carried out
6 under subsection (a) shall support efforts—

7 “(1) to develop best practices in microalgae and
8 macroalgae cultivation and phenotype selection, in-
9 cluding by carrying out aquatic pilot projects—

10 “(A) on microalgae and macroalgae; and

11 “(B) in freshwater and seawater; and

12 “(2) to optimize aquatic biomass conversion
13 pathways that result in carbon removal (as defined
14 in section 2 of the Carbon Removal and Emissions
15 Storage Technologies Act of 2022) for biopower,
16 biofuels, and other uses.

17 “(c) FUNDING.—There are authorized to be appro-
18 priated to the Secretary to carry out this section—

19 “(1) \$3,000,000 for fiscal year 2023;

20 “(2) \$8,000,000 for fiscal year 2024; and

21 “(3) \$20,000,000 for each of fiscal years 2025
22 through 2027.”.

23 (2) CLERICAL AMENDMENT.—The table of con-
24 tents for the Energy Independence and Security Act
25 of 2007 (Public Law 110–140; 121 Stat. 1493) is

1 amended by striking the item relating to section 228
2 and inserting the following:

“Sec. 228. Aquatic biomass.”.

3 **SEC. 102. BIOLOGICAL CARBON DIOXIDE CONVERSION PRO-**
4 **GRAMS.**

5 (a) IN GENERAL.—The Energy Policy Act of 2005
6 is amended by inserting after section 977 (42 U.S.C.
7 16317) the following:

8 **“SEC. 977A. BIOLOGICAL CARBON DIOXIDE CONVERSION**
9 **PROGRAMS.**

10 “(a) GENETIC MODELING AND TOOLS;
11 BIOPROSPECTING.—

12 “(1) IN GENERAL.—The Director of the Office
13 of Science shall establish a program to improve ge-
14 netic modeling and manipulation for carbon dioxide
15 conversion.

16 “(2) METHODOLOGY.—The program established
17 under paragraph (1) shall—

18 “(A) support efforts to improve carbon di-
19 oxide uptake and conversion through genetic
20 manipulation of crops and trees, including—

21 “(i) soil enhancements;

22 “(ii) enhanced photosynthesis, includ-
23 ing microbial soil amendments and
24 perennialization; and

25 “(iii) root growth; and

1 “(B) support efforts to bioprospect using
2 tools and high-throughput screening methods
3 for organisms with unique attributes related to
4 carbon dioxide conversion.

5 “(3) COORDINATION.—In carrying out the pro-
6 gram established under paragraph (1), the Director
7 of the Office of Science shall coordinate with the
8 National Science Foundation and the Agricultural
9 Research Service.

10 “(b) NEW MATERIALS DEVELOPMENT AND APPLICA-
11 TION.—

12 “(1) DEFINITION OF CARBON REMOVAL.—In
13 this subsection, the term ‘carbon removal’ has the
14 meaning given the term in section 2 of the Carbon
15 Removal and Emissions Storage Technologies Act of
16 2022.

17 “(2) PROGRAM.—The Assistant Secretary for
18 Energy Efficiency and Renewable Energy, in con-
19 sultation with the Secretary of Agriculture, shall es-
20 tablish a program to develop new biologically based
21 carbon dioxide utilization products and coproducts
22 that result in carbon removal.

23 “(3) METHODOLOGY.—The program established
24 under paragraph (2) shall—

1 “(A) support efforts to develop new carbon
 2 dioxide utilization products that result in car-
 3 bon removal;

4 “(B) prioritize products that have the po-
 5 tential to be deployed at a large scale; and

6 “(C) support efforts to develop valorization
 7 of coproducts for—

8 “(i) feed;

9 “(ii) fuel; and

10 “(iii) other uses.”.

11 (b) CLERICAL AMENDMENT.—The table of contents
 12 for the Energy Policy Act of 2005 (Public Law 109–58;
 13 119 Stat. 600) is amended by inserting after the item re-
 14 lating to section 977 the following:

“Sec. 977A. Biological carbon dioxide conversion programs.”.

15 **Subtitle B—Geological Carbon** 16 **Removal**

17 **SEC. 111. CARBON MINERALIZATION PILOT PROJECTS.**

18 (a) IN GENERAL.—The Energy Policy Act of 2005
 19 is amended by inserting after section 963 (42 U.S.C.
 20 16293) the following:

21 **“SEC. 963A. CARBON MINERALIZATION PILOT PROJECTS.**

22 “(a) IN GENERAL.—The Secretary, in consultation
 23 with the Administrator of the National Oceanic and At-
 24 mospheric Administration and the Director of the United
 25 States Geological Survey, shall conduct field experiments

1 of ex situ and in situ carbon mineralization approaches
 2 for the purposes of advancing carbon removal technologies
 3 or approaches (as defined in section 2 of the Carbon Re-
 4 moval and Emissions Storage Technologies Act of 2022).

5 “(b) ACTIVITIES.—In carrying out subsection (a), the
 6 Secretary shall—

7 “(1) conduct field experiments of ex situ carbon
 8 mineralization—

9 “(A) using desalination brine treatment;
 10 and

11 “(B) through the broadcast of reactive
 12 minerals on—

13 “(i) soils;

14 “(ii) beaches; and

15 “(iii) shallow oceans; and

16 “(2) conduct field experiments of in situ carbon
 17 mineralization, including through drilling and injec-
 18 tion in reactive formations for—

19 “(A) mantle peridotite;

20 “(B) basalt; and

21 “(C) other relevant formations.

22 “(c) FIELD EXPERIMENT GOALS AND OBJEC-
 23 TIVES.—The Secretary shall develop goals and objectives
 24 for field experiments carried out under this section to de-

1 crease the energy requirements and costs to produce the
2 resulting mineralized carbon.

3 “(d) ENVIRONMENTAL IMPACT.—In carrying out
4 field experiments under this section, the Secretary shall
5 comply with all applicable environmental laws and regula-
6 tions.

7 “(e) FUNDING.—There are authorized to be appro-
8 priated to the Secretary to carry out this section—

9 “(1) \$4,000,000 for fiscal year 2023;

10 “(2) \$9,000,000 for fiscal year 2024;

11 “(3) \$18,000,000 for fiscal year 2025; and

12 “(4) \$30,000,000 for each of fiscal years 2026
13 and 2027.”.

14 (b) CLERICAL AMENDMENT.—The table of contents
15 for the Energy Policy Act of 2005 (Public Law 109–58;
16 119 Stat. 600) is amended by inserting after the item re-
17 lating to section 963 the following:

“Sec. 963A. Carbon mineralization pilot projects.”.

18 **SEC. 112. CARBON MINERALIZATION RESOURCE ASSESS-**
19 **MENT.**

20 (a) IN GENERAL.—The Secretary of the Interior (re-
21 ferred to in this section as the “Secretary”) shall complete
22 a national assessment of the potential for using carbon
23 mineralization for carbon removal, in accordance with the
24 methodology developed under subsection (b).

1 (b) METHODOLOGY.—Not later than 2 years after
2 the date of enactment of this Act, the Secretary, acting
3 through the Director of the United States Geological Sur-
4 vey, shall develop a methodology to assess geological re-
5 sources, mine tailings, and other alkaline industrial wastes
6 to identify sustainable sources of reactive minerals suit-
7 able for carbon mineralization, while taking into consider-
8 ation minerals and mineral classes with high reactivity and
9 fast kinetics.

10 (c) COORDINATION.—

11 (1) FEDERAL COORDINATION.—To ensure the
12 maximum usefulness and success of the assessment
13 under subsection (a), the Secretary shall—

14 (A) consult with the Secretary of Energy
15 and the Administrator of the Environmental
16 Protection Agency on the format and content of
17 the assessment; and

18 (B) share relevant data with the Depart-
19 ment of Energy and the Environmental Protec-
20 tion Agency.

21 (2) STATE COORDINATION.—The Secretary
22 shall consult with State geological surveys and other
23 relevant entities to ensure, to the maximum extent
24 practicable, the usefulness and success of the assess-
25 ment under subsection (a).

1 (d) REPORT.—

2 (1) IN GENERAL.—Not later than 180 days
3 after the date on which the assessment under sub-
4 section (a) is completed, the Secretary shall submit
5 to the Committee on Energy and Natural Resources
6 of the Senate and the Committee on Natural Re-
7 sources of the House of Representatives a report de-
8 scribing the findings under the assessment, including
9 the locations and available quantities of suitable re-
10 active minerals.

11 (2) PUBLIC AVAILABILITY.—Not later than 30
12 days after the date on which the Secretary submits
13 the report under paragraph (1), the Secretary shall
14 make the report publicly available.

15 **SEC. 113. TAILINGS AND WASTE MINERALIZATION PRO-**
16 **GRAM.**

17 (a) TAILINGS AND WASTE MINERALIZATION PRO-
18 GRAM.—

19 (1) IN GENERAL.—The Secretary shall conduct
20 field experiments to examine the use of mine tailings
21 and industrial wastes for the purpose of carbon min-
22 eralization.

23 (2) ACTIVITIES.—The field experiments using
24 mine tailings and industrial wastes conducted under
25 paragraph (1) shall assess—

1 (A) the reusing of industrial slags and
2 mine tailings in manufacturing; and

3 (B) other industrial wastes that may have
4 carbon mineralization properties.

5 (b) STUDY ON ENVIRONMENTAL IMPACTS OF MIN-
6 ERALIZATION PRODUCTS.—

7 (1) IN GENERAL.—Not later than 3 years after
8 the date of enactment of this Act, the Secretary
9 shall conduct, and submit to Congress a report that
10 describes the results of, a study on the environ-
11 mental impacts of—

12 (A) broadcasting materials and distrib-
13 uting piles of mine tailings at various scales for
14 the purposes of enhanced carbon mineralization;
15 and

16 (B) additional mining for the purposes of
17 carbon mineralization.

18 (2) REQUIREMENTS.—The study under para-
19 graph (1) shall include an analysis of—

20 (A) the relative carbon removal potential
21 associated with various scales of carbon min-
22 eralization;

23 (B) the cost of environmental mitigation of
24 the environmental impacts identified under the
25 study; and

- 1 (C) opportunities—
 2 (i) for remediation;
 3 (ii) to co-extract reactive minerals
 4 with conventional mining operations; and
 5 (iii) for the use of reactive minerals in
 6 mining remediation.

7 **Subtitle C—Aquatic Carbon**
 8 **Removal**

9 **SEC. 121. OCEAN CARBON REMOVAL MISSION.**

10 Section 969D of the Energy Policy Act of 2005 (42
 11 U.S.C. 16298d) is amended—

12 (1) in subsection (a) by inserting “and aquatic
 13 sources” after “atmosphere”; and

14 (2) in subsection (c)—

15 (A) in paragraph (5), by striking “and”
 16 after the semicolon;

17 (B) in paragraph (6), by striking the pe-
 18 riod at the end and inserting a semicolon; and

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

20 “(7) ocean carbon removal and strategies, such
 21 as—

22 “(A) blue carbon, which is the manage-
 23 ment of vegetated coastal habitats (including
 24 mangroves, tidal marshes, seagrasses, kelp for-
 25 ests, and other tidal, freshwater, or saltwater

1 wetlands) that sequester carbon (including
 2 autochthonous carbon and allochthonous car-
 3 bon) from the atmosphere, accumulate carbon
 4 in biomass, and store the carbon in soils;

5 “(B) direct ocean capture (as described in
 6 section 122(a) of the Carbon Removal and
 7 Emissions Storage Technologies Act of 2022);

8 “(C) microalgae and macroalgae cultiva-
 9 tion for—

10 “(i) biofuels;

11 “(ii) bioproducts; and

12 “(iii) carbon storage; and

13 “(D) ocean alkalinity enhancement; and

14 “(8) any combination of activities described in
 15 paragraphs (1) through (7) that have the potential
 16 for significant carbon removal (as defined in section
 17 2 of the Carbon Removal and Emissions Storage
 18 Technologies Act of 2022).”.

19 **SEC. 122. DIRECT OCEAN CAPTURE ASSESSMENT.**

20 (a) IN GENERAL.—The Secretary shall conduct a
 21 comprehensive assessment of the potential for removing
 22 carbon dioxide directly from the oceans.

23 (b) METHODOLOGY.—In conducting the assessment
 24 under subsection (a), the Secretary shall consider the po-
 25 tential and relative merits of—

1 (1) pathways, methods, and technologies that
2 are able to directly remove carbon dioxide from the
3 oceans through engineered or inorganic processes;
4 and

5 (2) technologies such as filters, membranes,
6 phase change systems, chemical conversion, or other
7 technological pathways.

8 (c) INCLUSION.—In conducting the assessment under
9 subsection (a), the Secretary shall incorporate any infor-
10 mation on the results of activities conducted under section
11 223 of the National Defense Authorization Act for Fiscal
12 Year 2020 (10 U.S.C. 4001 note; Public Law 116–92).

13 (d) REPORT.—Not later than 1 year after the date
14 of enactment of this Act, the Secretary, in consultation
15 with the Administrator of the National Oceanic and At-
16 mospheric Administration, shall submit to the Committees
17 on Energy and Natural Resources and Commerce,
18 Science, and Transportation of the Senate and the Com-
19 mittee on Energy and Commerce of the House of Rep-
20 resentatives a report describing the results of the assess-
21 ment under subsection (a).

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

25 (1) \$2,000,000 for fiscal year 2023;

- 1 (2) \$4,000,000 for fiscal year 2024; and
2 (3) \$8,000,000 for each of fiscal years 2025
3 through 2027.

4 **SEC. 123. OFFSHORE CARBON STORAGE PROGRAM AND AS-**
5 **SESSMENT.**

6 (a) CARBON DIOXIDE IMPACTS AND FATE IN THE
7 OCEAN.—

8 (1) IN GENERAL.—The Department of Energy
9 Carbon Capture and Sequestration Research, Devel-
10 opment, and Demonstration Act of 2007 (Public
11 Law 110–140; 121 Stat. 1704) is amended by add-
12 ing at the end the following:

13 **“SEC. 709. CARBON DIOXIDE IMPACTS AND FATE IN THE**
14 **OCEAN.**

15 “(a) IN GENERAL.—The Secretary shall establish a
16 program to monitor, research, and model the ecological
17 impacts of ocean carbon dioxide removal and storage tech-
18 niques.

19 “(b) COORDINATION.—In carrying out the program
20 established under subsection (a), the Secretary shall co-
21 ordinate with the Administrator of the National Oceanic
22 and Atmospheric Administration and the Administrator of
23 the National Aeronautics and Space Administration.

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

4 “(1) \$2,000,000 for fiscal year 2023; and

5 “(2) \$5,000,000 for each of fiscal years 2024
 6 through 2027.”.

7 (2) CLERICAL AMENDMENT.—The table of con-
 8 tents for the Energy Independence and Security Act
 9 of 2007 (Public Law 110–140; 121 Stat. 1496) is
 10 amended by inserting after the item relating to sec-
 11 tion 708 the following:

“Sec. 709. Carbon dioxide impacts and fate in the ocean.”.

12 (b) OUTER CONTINENTAL SHELF RESOURCE AS-
 13 SESSMENT.—

14 (1) IN GENERAL.—Not later than 1 year after
 15 the date of enactment of this Act, the Secretary
 16 shall—

17 (A) expand the CarbonSAFE Initiative of
 18 the Department of Energy to complete a na-
 19 tional carbon mineralization assessment that ex-
 20 amines the full range of carbon mineralization
 21 storage potential for the outer Continental
 22 Shelf region; and

23 (B) submit to the Committees on Energy
 24 and Natural Resources and Commerce, Science,
 25 and Transportation of the Senate and the Com-

1 mittee on Energy and Commerce of the House
 2 of Representatives a report describing the re-
 3 sults of the assessment.

4 (2) AUTHORIZATION OF APPROPRIATIONS.—

5 There is authorized to be appropriated to the Sec-
 6 retary to carry out this subsection \$5,000,000 for
 7 each of fiscal years 2023 through 2027.

8 (c) ASSESSMENT TO DETERMINE THE POTENTIAL
 9 FOR OFFSHORE CARBON STORAGE.—

10 (1) IN GENERAL.—The Secretary, in consulta-
 11 tion with the Secretary of the Interior, the Adminis-
 12 trator of the Environmental Protection Agency, and
 13 the Administrator of the National Oceanic and At-
 14 mospheric Administration, shall conduct a com-
 15 prehensive assessment of the potential for offshore
 16 carbon storage, including an assessment of—

17 (A) the potential for offshore carbon stor-
 18 age—

19 (i) in deep offshore sub-seabed loca-
 20 tions, such as in geological formations;

21 (ii) at the seabed, such as through
 22 biomass sinking; and

23 (iii) within the oceans, such as liquid
 24 carbon dioxide storage; and

1 (B) other relevant methods of offshore car-
 2 bon storage.

3 (2) INCLUSION.—The assessment under para-
 4 graph (1) shall include recommendations of meas-
 5 ures that the Department of Energy may take to im-
 6 prove the ease, safety, and security of offshore car-
 7 bon dioxide storage.

8 (3) REPORTING.—Not later than 2 years after
 9 the date of enactment of this Act, the Secretary
 10 shall submit to the Committees on Energy and Nat-
 11 ural Resources and Commerce, Science, and Trans-
 12 portation of the Senate and the Committee on En-
 13 ergy and Commerce of the House of Representatives
 14 a report describing the results of the assessment
 15 under paragraph (1).

16 **Subtitle D—Atmospheric Carbon** 17 **Removal**

18 **SEC. 131. DIRECT AIR CAPTURE TECHNOLOGY MANUFAC-** 19 **TURING RESEARCH PROGRAM.**

20 (a) INITIATIVE.—

21 (1) IN GENERAL.—The Secretary shall establish
 22 a program for the research, development, and dem-
 23 onstration of manufacturing techniques for direct air
 24 capture technologies (referred to in this section as
 25 the “program”).

1 (2) COORDINATION.—In carrying out the pro-
2 gram, the Secretary shall leverage expertise and re-
3 sources from—

4 (A) the Office of Science;

5 (B) the Office of Energy Efficiency and
6 Renewable Energy; and

7 (C) the Office of Fossil Energy and Car-
8 bon Management.

9 (b) CONTACTOR DESIGN.—

10 (1) IN GENERAL.—In carrying out the program,
11 the Secretary shall conduct research on applied tech-
12 nology development of air contactor design.

13 (2) REQUIREMENTS.—The research under para-
14 graph (1) shall support efforts to improve air
15 contactors with—

16 (A) low pressure drop;

17 (B) high surface area; and

18 (C) high longevity.

19 (c) MANUFACTURING IMPROVEMENT.—

20 (1) IN GENERAL.—In carrying out the program,
21 the Secretary shall conduct research scaling-up man-
22 ufacturing of direct air capture components.

23 (2) REQUIREMENTS.—The research under para-
24 graph (1) shall—

1 (A) support efforts to improve techniques
 2 for low-cost manufacturing of direct air capture
 3 components and materials; and

4 (B) be coordinated with private industry
 5 and universities.

6 (d) AUTHORIZATION OF APPROPRIATIONS.—There
 7 are authorized to be appropriated to the Secretary—

8 (1) to carry out subsection (b)—

9 (A) \$3,000,000 for fiscal year 2023;

10 (B) \$7,000,000 for fiscal year 2024; and

11 (C) \$10,000,000 for each of fiscal years
 12 2025 through 2027; and

13 (2) to carry out subsection (c)—

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

15 (B) \$5,000,000 for fiscal year 2024; and

16 (C) \$10,000,000 for each of fiscal years
 17 2025 through 2027.

18 **Subtitle E—Carbon Removal** 19 **Quantification**

20 **SEC. 141. CARBON REMOVAL QUANTIFICATION.**

21 (a) IN GENERAL.—Title V of the Energy Act of 2020
 22 (42 U.S.C. 16298e et seq.) is amended by adding at the
 23 end the following:

1 **“SEC. 5003. QUANTIFYING THE BENEFITS OF CARBON RE-**
 2 **MOVAL.**

3 “(a) PURPOSES.—The purposes of this section are—

4 “(1) to quantify the net carbon removed
 5 through atmospheric and aquatic carbon removal
 6 pathways;

7 “(2) to determine the current and projected
 8 carbon removal capacity of atmospheric and aquatic
 9 carbon removal pathways;

10 “(3) to determine the current and likely future
 11 technical readiness of carbon removal technologies or
 12 approaches for large-scale carbon removal deploy-
 13 ment; and

14 “(4) to aid in the commercialization of carbon
 15 removal technologies or approaches.

16 “(b) DEFINITIONS.—In this section:

17 “(1) CARBON REMOVAL; CARBON REMOVAL
 18 TECHNOLOGY OR APPROACH.—The terms ‘carbon re-
 19 moval’ and ‘carbon removal technology or approach’
 20 have the meanings given the terms in section 2 of
 21 the Carbon Removal and Emissions Storage Tech-
 22 nologies Act of 2022.

23 “(2) ELIGIBLE ENTITY.—The term ‘eligible en-
 24 tity’ means any of the following entities:

25 “(A) An institution of higher education.

26 “(B) A National Laboratory.

1 “(C) A Federal research agency.

2 “(D) A State research agency.

3 “(E) A nonprofit research organization.

4 “(F) An industrial entity.

5 “(G) A consortium of 2 or more entities
6 described in subparagraphs (A) through (F).

7 “(3) SECRETARY.—The term ‘Secretary’ means
8 the Secretary of Energy.

9 “(c) CARBON REMOVAL FOOTPRINT PROGRAM.—

10 “(1) ESTABLISHMENT.—Not later than 1 year
11 after the date of enactment of this section, the Sec-
12 retary shall establish a program to carry out the
13 purposes described in subsection (a), including by
14 providing financial assistance to eligible entities to
15 examine the technological, economic, and environ-
16 mental impacts of carbon removal pathways and
17 technologies.

18 “(2) ELIGIBLE ACTIVITIES.—Activities eligible
19 to receive financial assistance under this section in-
20 clude—

21 “(A) assessments of technological or eco-
22 nomic barriers to the widescale deployment of
23 carbon removal pathways and technologies; and

24 “(B) lifecycle assessments for carbon re-
25 moval pathways and technologies, including

1 gathering data in partnership with a direct air
2 capture test center authorized under section
3 969D(f)(1) of the Energy Policy Act of 2005
4 (42 U.S.C. 16298d(f)(1)).

5 “(3) APPLICATIONS.—An eligible entity seeking
6 financial assistance under this section shall submit
7 to the Secretary an application that includes a de-
8 scription of—

9 “(A) the applicable project;

10 “(B) the software programs, consultants,
11 and general methodologies to be used to con-
12 duct the assessment;

13 “(C) the location of any applicable facility
14 or project;

15 “(D) expected feedstocks and other inputs;
16 and

17 “(E) the expected use of carbon removed.

18 “(4) PRIORITY.—In selecting eligible entities to
19 receive financial assistance under this section, the
20 Secretary shall give priority to eligible entities
21 that—

22 “(A) make the assessment publicly avail-
23 able, with confidential business information re-
24 dacted or removed; and

1 “(B) have not previously received financial
2 assistance under this section.”.

3 (b) CLERICAL AMENDMENT.—The table of contents
4 for the Energy Act of 2020 (Public Law 116–260; 134
5 Stat. 2419) is amended by inserting after the item relating
6 to section 5002 the following:

“Sec. 5003. Quantifying the benefits of carbon removal.”.

7 **TITLE II—CARBON REMOVAL**
8 **PURCHASING PILOT PROGRAM**

9 **SEC. 201. CARBON REMOVAL PURCHASING PILOT PRO-**
10 **GRAM.**

11 (a) IN GENERAL.—Subtitle F of title IX of the En-
12 ergy Policy Act of 2005 (42 U.S.C. 16291 et seq.) is
13 amended by adding at the end the following:

14 **“SEC. 969E. CARBON REMOVAL PURCHASING PILOT PRO-**
15 **GRAM.**

16 “(a) PURPOSES.—The purposes of this section are—

17 “(1) to accelerate the deployment and commer-
18 cialization of carbon removal pathways and tech-
19 nologies;

20 “(2) to stimulate the development and commer-
21 cialization of low-carbon products made with carbon
22 dioxide removed from the atmosphere or oceans; and

23 “(3) to support the development of technologies
24 relating to carbon removal.

25 “(b) DEFINITIONS.—In this section:

1 “(1) ADDITIONAL.—The term ‘additional’, with
2 respect to carbon dioxide removed from the atmos-
3 phere or upper hydrosphere, means that carbon di-
4 oxide was removed pursuant to an intentional carbon
5 removal activity that delivers a net removal of car-
6 bon dioxide from the atmosphere, measured on a
7 lifecycle basis, that would not have occurred without
8 the carbon removal activity.

9 “(2) ALL-IN COST.—The term ‘all-in cost’
10 means the total cost of—

11 “(A) the capture, transport, and storage of
12 carbon dioxide; and

13 “(B) the measurement, reporting, and
14 verification of carbon dioxide removed on a net
15 ton carbon dioxide equivalent basis.

16 “(3) ELIGIBLE ENTITY.—The term ‘eligible en-
17 tity’ means a carbon removal facility that—

18 “(A) is located in the United States;

19 “(B) meets all applicable Federal and
20 State permitting requirements; and

21 “(C) meets financial and technical criteria
22 established by the Secretary.

23 “(4) REMOVAL.—The term ‘removal’ means—

1 “(A) the capture of carbon dioxide from
 2 the atmosphere or upper hydrosphere through a
 3 chemical, physical, or other process; and

4 “(B) the subsequent permanent storage or
 5 use of the carbon dioxide in a manner that en-
 6 sures that the carbon dioxide does not reenter
 7 the atmosphere or upper hydrosphere.

8 “(5) UPPER HYDROSPHERE.—The term ‘upper
 9 hydrosphere’ means the total liquid water existing
 10 on the surface level of the earth, including—

11 “(A) oceans;

12 “(B) lakes;

13 “(C) rivers; and

14 “(D) other surface bodies of water.

15 “(c) PROGRAM.—

16 “(1) ESTABLISHMENT.—The Secretary shall es-
 17 tablish a competitive purchasing pilot program under
 18 which the Secretary shall purchase from eligible en-
 19 tities carbon dioxide removed from the atmosphere
 20 or upper hydrosphere.

21 “(2) PURCHASE.—In carrying out the pilot pro-
 22 gram under paragraph (1), the Secretary shall pur-
 23 chase, subject to the availability of appropriations,
 24 removed carbon dioxide from eligible entities—

1 “(A) until the date on which the first re-
 2 verse auction is held under paragraph (3), by
 3 making a payment per net ton carbon equiva-
 4 lent basis to account for lifecycle greenhouse
 5 gas inputs to carbon removal in an amount de-
 6 termined by the Secretary; and

7 “(B) beginning with the first reverse auc-
 8 tion held under paragraph (3), in accordance
 9 with the reverse auction procedures described in
 10 that paragraph.

11 “(3) REVERSE AUCTION PROCEDURES.—

12 “(A) IN GENERAL.—Not later than 2 years
 13 after the date of enactment of this section, and
 14 annually thereafter, the Secretary shall conduct
 15 a reverse auction under which—

16 “(i) the Secretary shall solicit bids
 17 from eligible entities in each tier described
 18 in subparagraph (B)(ii) (referred to in this
 19 section as a ‘permanence tier’); and

20 “(ii) eligible entities shall submit to
 21 the Secretary sealed bids describing—

22 “(I) a desired price for the re-
 23 moved carbon dioxide on a per net ton
 24 carbon dioxide equivalent basis;

1 “(II) the estimated net ton car-
2 bon dioxide equivalent removed by the
3 eligible entity annually that the eligi-
4 ble entity desires the Secretary to
5 purchase at the desired price;

6 “(III) details of the permanence
7 of the removed carbon dioxide;

8 “(IV) details on the purity, loca-
9 tion, and transportation options for
10 the removed carbon dioxide to be pur-
11 chased by the Secretary for purposes
12 of the all-in costs;

13 “(V) a lifecycle assessment of the
14 operation to quantify the net carbon
15 dioxide removed, while accounting for
16 greenhouse gas emissions associated
17 with the production of the inputs nec-
18 essary for the carbon dioxide removal
19 and storage processes; and

20 “(VI) any other details the Sec-
21 retary may require.

22 “(B) SELECTION.—

23 “(i) IN GENERAL.—The Secretary
24 shall—

1 “(I) examine the bids submitted
2 under subparagraph (A)(ii) to deter-
3 mine which bids are acceptable under
4 the criteria established by the Sec-
5 retary for the applicable permanence
6 tier; and

7 “(II) of the bids determined to be
8 acceptable under subclause (I), select
9 the bids containing the lowest desired
10 price for carbon dioxide until the
11 amount of funds available for the ap-
12 plicable permanence tier of the reverse
13 auction is obligated.

14 “(ii) PERMANENCE TIERS.—In select-
15 ing bids under clause (i), the Secretary
16 shall group the permanence of each carbon
17 removal bid into 1 of the following 2 tiers:

18 “(I) Medium-term tier for bids
19 providing for the removal of carbon
20 dioxide for at least 100 years, but
21 fewer than 1,000 years.

22 “(II) Long-term tier for bids pro-
23 viding for the removal of carbon diox-
24 ide for 1,000 years or more.

1 “(iii) PRIORITY.—In any case in
 2 which the desired price in 2 or more bids
 3 submitted under subparagraph (A)(ii) for
 4 an applicable permanence tier is equal, the
 5 Secretary shall give priority to eligible enti-
 6 ties that demonstrate outstanding potential
 7 for local and regional economic develop-
 8 ment in carrying out projects to remove
 9 carbon dioxide from ambient air or aquatic
 10 sources.

11 “(4) COST CAP.—

12 “(A) IN GENERAL.—Subject to subpara-
 13 graph (B), for purposes of a reverse auction
 14 under paragraph (3), the Secretary shall—

15 “(i) determine the current average
 16 market price per net ton carbon dioxide
 17 equivalent basis to account for lifecycle
 18 greenhouse gas inputs of removed carbon
 19 within each permanence tier; and

20 “(ii) set that price as the maximum
 21 price per ton to be paid under the reverse
 22 auction within each permanence tier.

23 “(B) INCREASED CAP.—In the case of an
 24 eligible entity that uses a technology that has
 25 the potential to eventually remove carbon diox-

1 ide at an all-in cost of less than \$100 per net
2 ton carbon dioxide equivalent, the Secretary
3 shall double the maximum price per net ton
4 carbon dioxide equivalent established under
5 subparagraph (A)(ii) with respect to the eligible
6 entity.

7 “(5) REQUIREMENT.—In purchasing removed
8 carbon dioxide under the program under paragraph
9 (1), the Secretary shall determine that the carbon
10 dioxide—

11 “(A) is additional;

12 “(B) shall be delivered not later than 5
13 years after the date of the purchase;

14 “(C) shall have a monitoring, reporting,
15 and verification plan approved by the Depart-
16 ment of Energy; and

17 “(D) has not less than a 99 percent likeli-
18 hood of being stored for not fewer than 100
19 years.

20 “(d) USE OF CARBON DIOXIDE.—Carbon dioxide
21 purchased under the pilot program under subsection (c),
22 at the discretion of the Secretary, may be used or stored
23 in any manner that ensures that the carbon dioxide does
24 not reenter the atmosphere or upper hydrosphere during

1 the time period associated with the applicable permanence
2 tier.

3 “(e) PILOT PROGRAM COORDINATION.—Amounts
4 made available under this section may be made available
5 to carry out pilot and demonstration projects described in
6 section 969D(f)(2)(B) and section 969D(g).

7 “(f) CONFIDENTIALITY.—The Secretary shall estab-
8 lish procedures to ensure that any confidential, private,
9 proprietary, or privileged information that is included in
10 a sealed bid submitted under this section is not publicly
11 disclosed or otherwise improperly used.

12 “(g) AUTHORIZATION OF APPROPRIATIONS.—

13 “(1) IN GENERAL.—There are authorized to be
14 appropriated to the Secretary to carry out this sec-
15 tion—

16 “(A) \$20,000,000 for fiscal year 2023;

17 “(B) \$30,000,000 for fiscal year 2024; and

18 “(C) \$60,000,000 for each of fiscal years
19 2025 through 2027.

20 “(2) ALLOCATION.—Amounts made available
21 under paragraph (1) for each fiscal year shall be al-
22 located between the permanence tiers as follows:

23 “(A) 70 percent shall be allocated for the
24 permanence tier described in subsection
25 (c)(3)(B)(ii)(II).

1 “(B) 30 percent shall be allocated for the
2 permanence tier described in subsection
3 (c)(3)(B)(ii)(I).”.

4 (b) CLERICAL AMENDMENT.—The table of contents
5 for the Energy Policy Act of 2005 (Public Law 109–59;
6 119 Stat. 600; 134 Stat. 2550) is amended by adding at
7 the end of the items relating to subtitle F of title IX the
8 following:

“Sec. 969E. Carbon removal purchasing pilot program.”.

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