Carbon Dioxide Removal Research and Development Act

Background: The consensus of the global scientific community is that all pathways limiting warming to 1.5 or 2 degrees Celsius rely on significant deployment of carbon dioxide removal (CDR) technologies over the 21st century. According to the National Academies, the scale of removal required to meet our climate goals is immense. Even with ambitious emission-reduction efforts, 10 billion metric tons of excess carbon dioxide will need to be removed from the atmosphere globally every year by 2050, rising to 20 billion annually in 2100. Fortunately, there is a wide range of techniques that could help us achieve this scale. Some, like tree-planting and direct air capture, are ready for deployment, but have limitations of scale or cost. Others, like soil carbon management, advanced plant cultivars, enhanced carbon mineralization, and ocean-based carbon removal, are at an earlier stage of development.

Solution: In 2018, the National Academies released a groundbreaking report, *Negative Emissions Technologies and Reliable Sequestration: A Research Agenda*, which stated that the United States should "launch a substantial research initiative to advance negative emissions technologies as soon as practicable." The National Academies' recommended research program is a multi-year effort that includes early-stage research and development investment, pilot-scale projects, and eventual commercial-scale deployments. The National Academies note that research into carbon removal methods will increase U.S. competitiveness, create new jobs, and enhance exports. Building on this work, in 2019, the Energy Futures Initiative released a detailed multi-agency federal spending framework for designing and implementing a whole-of-government research, development, and demonstration program on CDR.

This bill translates that framework into action. Together, these provisions will help the United States lead the world in CDR technology development.

Partial list of CDR approaches addressed in this legislation:

- Direct air capture and storage
- Terrestrial and biological carbon removal
    - Biomass-based carbon dioxide removal
    - Reforestation and forest carbon management
    - Soil carbon sequestration
    - Advanced cultivars (crop types that yield higher soil carbon)
- Enhanced carbon mineralization (the process by which carbon dioxide reacts with minerals to form solid carbonate materials)
    - In situ (belowground) mineralization and ex situ (aboveground) mineralization
- Ocean-based carbon removal
    - Aquatic biomass capture and sequestration
    - Ocean alkalinity enhancement (adding minerals or other alkaline substances to seawater to enhance the ocean's natural carbon sink)
    - Ocean fertilization (introducing nutrients to certain areas of the ocean to stimulate phytoplankton growth and increased carbon uptake)
- Carbon utilization
    - Carbonate construction and transportation materials
    - Carbon dioxide to fuels

Breakdown of authorized funding by agency:

Bill Section	Agency / Office	10-yr Authorization ($ millions)
Title I	**Department of Energy**	
101	Fossil Energy and Carbon Management	$5,451
102	Energy Efficiency and Renewable Energy	$688
103	Science	$717
Subtotal, DOE		$6,856
Title II	**Department of Agriculture**	
203	Agriculture Advanced Research and Development Authority	$100
204	National Institute of Food and Agriculture	$224
205	Agricultural Research Service	$642
206	Natural Resources Conservation Service	$68
207	U.S. Forest Service	$154
Subtotal, USDA		$1,188
Title III	**Department of Commerce**	
301	National Oceanic and Atmospheric Administration	$1,083
302	National Institute of Standards and Technology	$40
Subtotal, Commerce		$1,123
Title IV	**Department of Defense**	
401	U.S. Army Corps of Engineers	$393
Subtotal, DoD		$393
Title V	**Department of Interior**	
501	U.S. Geological Survey	$202
502	Land and Minerals Management	$20
Subtotal, DOI		$222
Title VI	**Department of Transportation**	
601	Federal Highway Administration	$650
Subtotal, DOT		$650
Title VII	**Environmental Protection Agency**	
701	Office of Research and Development	$311
Subtotal, EPA		$311
Title VIII	**National Aeronautics and Space Administration**	
801	Earth Science Division	$170
Subtotal, NASA		$170
Title IX	**National Science Foundation**	
901	Directorate for Biological Sciences	$45
902	Directorate for Engineering	$29
903	Directorate for Geosciences	$583
904	Directorate for Mathematical and Physical Sciences	$281
905	Directorate for Social, Behavioral, and Economic Sciences	$120
906	Directorate for Social and Economic Sciences	$43
Subtotal, NSF		$1,101
Total, government-wide		$12,014