Designing a Federal CDR RD&D Initiative:

Implications for Oceans-Based RD&D

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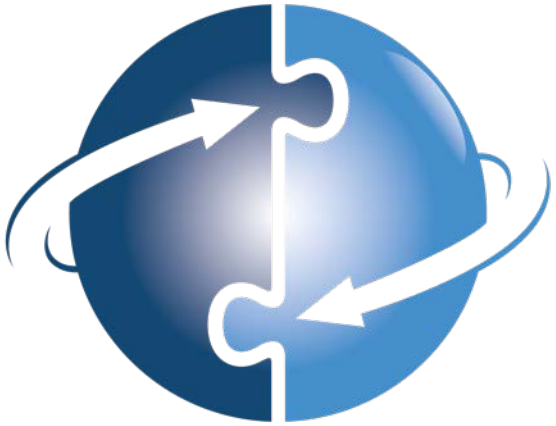

ENERGY FUTURES INITIATIVE

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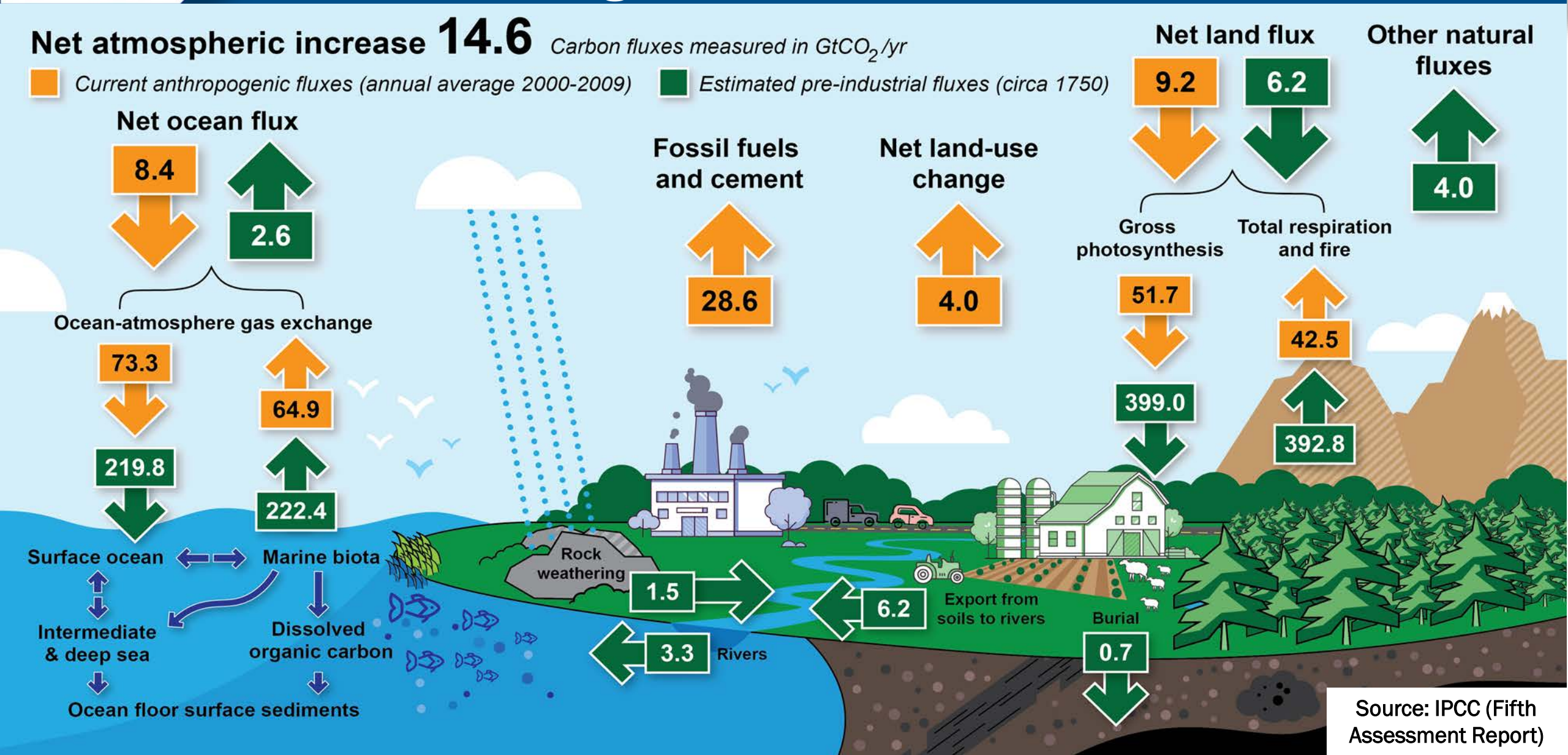
Returning to Net-Zero Balance Requires Both Emissions Mitigation and Carbon Removal



Source: IPCC (Fifth Assessment Report)

Federal CDR RD&D Initiative: Goal, Structure, Funding, and Portfolio

ENERGY FUTURES INITIATIVE

Goal

Comprehensive 10-year RD&D initiative focused on multiple CDR technology pathways.
Capable of gigaton-scale deployment, at technology-specific cost targets, with minimal ecological impact

Organization

Federal Committee on Large-Scale Carbon Management. 12-agency, whole-of-government effort involving planning, budgeting, and coordination

Proposed Funding

Budget of $10.7B over 10 years, with $325M in the first full year. Funding distributed among 10 agencies in six separate appropriations bills

RD&D Portfolio

Capture Technology Pathways				CO_2 Disposition		Cross-Cutting	
Direct Air Capture	Terrestrial & Biological	Carbon Mineralization	Coastal & Oceans	Geologic Sequestration	CO_2 Utilization	Systems Analysis	Large-Scale Demonstration Projects

27 Individual Portfolio Elements

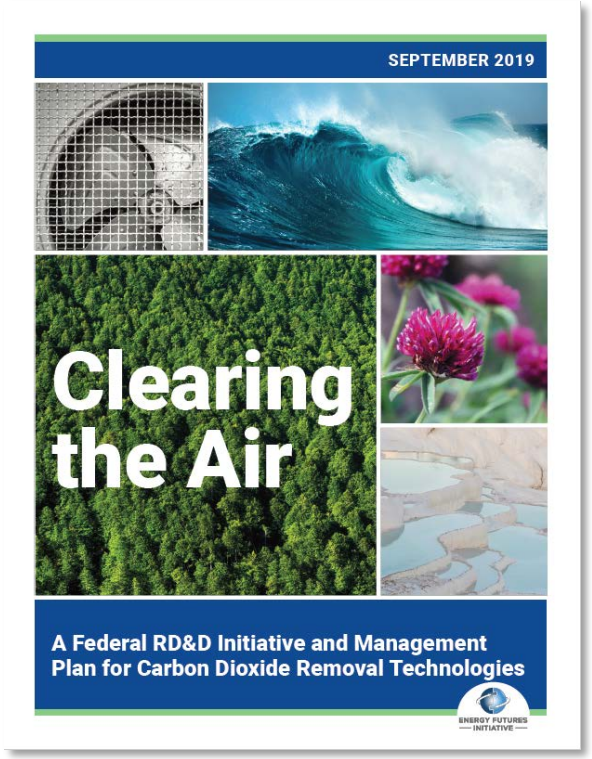
Source: EFI, 2020.

Coastal and Oceans CDR RD&D Portfolio (from EFI Clearing the Air Report)

Objective: Develop a better understanding of the effectiveness and ecosystem impacts of carbon removal processes in coastal areas and deep ocean waters to provide the basis for determining feasibility of future CDR implementation measures

Portfolio Programmatic Elements:

- Fundamental research and resource assessment for blue carbon coastal techniques
- Regional field trials and database development for coastal CDR
- Applied research on aquatic biomass cultivation, harvesting, and conversion
- Fundamental research and small-scale applied field trials of ocean alkalinity modification
- Fundamental research and preparation for small-scale applied field trials of ocean iron and macronutrient fertilization
- Fundamental research and modeling on environmental impacts from ocean and coastal CDR techniques



Funding: $1.75B over 10 years across DOC/NOAA, NSF, NASA and DOD

Oceans CDR Frontiers: RD&D Priorities Identified in EFI Experts Workshop

1. RD&D on **specific biological and nonbiological pathways** for efficacy and scale
2. RD&D on **new and emerging pathways**
3. Methods for **monitoring and verifying** CDR, ecosystem effects, and lifecycle impacts
4. Predictive **modeling and planning tools**
5. Integration into carbon **markets** and creating markets for co-products
6. Addressing **social license** concerns
7. Creating an enabling **governance framework**

Summary of Characteristics of Selected Marine CDR Methods

CDR Method	Readiness	Advancement Potential via New RD&D
Microalgae: ocean fertilization	Low	Moderate
Microalgae: culture	Moderate	High
Blue carbon	High	Low
Macroalgae culture	Moderate	High
Upwelling/ downwelling	Moderate	Moderate
Ocean alkalization: natural sources	Low	High
Ocean alkalization: synthetic sources	Low	High
Seawater carbon extraction	Moderate	High

Implementation and Management of Oceans CDR RD&D

From EFI Clearing the Air Report—

1. Add CDR to the NOAA mission through the NOAA R&D plan
2. Establish of a new Office of Ocean Technologies with a portfolio including CDR
3. Harness ocean research assets at NOAA and NSF

Additional Ideas Emerging from EFI Expert Workshop—

1. Specific funding for quickly scalable approaches, such as blue carbon and mariculture
2. Adoption of a U.S. protocol for field experimentation in line with international standards
3. Formal collaboration with the EU OceansNET initiative
4. Create ARPA-O jointly administered by NOAA/DOE/NSF
5. NOAA-NASA partnership with industry and academia on sensor technologies
6. New funding mechanism for NOAA to do stakeholder and local community outreach around ocean-based CDR