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Exploring the Policy Landscape of Carbon Dioxide Removal

Thursday, September 12, 2024

About EESI

WORLD RESOURCES INSTITUTE

EESI Environmental and Energy Study Institute

Non-partisan Educational Resources for Policymakers

A bipartisan Congressional caucus founded EESI in 1984 to provide non-partisan information on environmental, energy, and climate policies

Direct Assistance for Equitable and Inclusive Financing Program

In addition to a full portfolio of federal policy work, EESI provides direct assistance to utilities to develop “on-bill financing” programs

Commitment to Diversity, Equity, Inclusion, and Justice

We recognize that systemic barriers impede fair environmental, energy, and climate policies and limit the full participation of Black, Indigenous, people of color, and legacy and frontline communities in decision-making

Sustainable Solutions

Our mission is to advance science-based solutions for climate change, energy, and environmental challenges in order to achieve *our vision of a sustainable, resilient, and equitable world*.

Policymaker Education

Briefings and Webcasts

Live, in-person and online public briefings, archived webcasts, and written summaries

Climate Change Solutions

Bi-weekly newsletter with everything policymakers and concerned citizens need to know, including a legislation and hearings tracker

Fact Sheets and Issue Briefs

Timely, objective coverage of environmental, clean energy, and climate change topics

Social Media (@EESIOnline)

Active engagement on Twitter, Facebook, LinkedIn, and YouTube

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Thursday, September 12, 2024

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Senator Michael Bennet

U.S. Senator (D-Colo.)

Thursday, September 12, 2024

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EXPLORING THE POLICY LANDSCAPE OF CARBON DIOXIDE REMOVAL

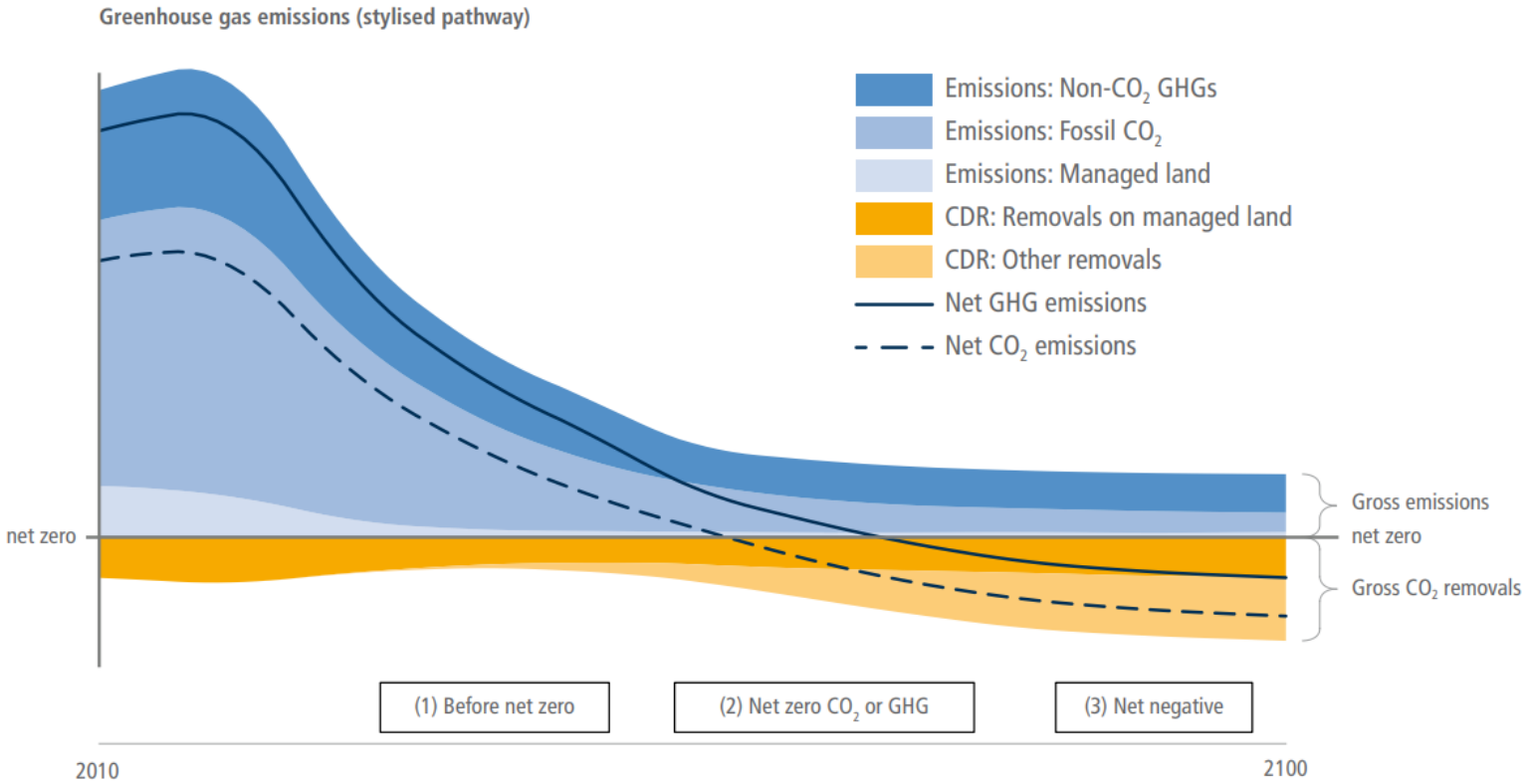
Carbon removal needs and options

KATIE LEBLING, WORLD RESOURCES INSTITUTE

AGENDA

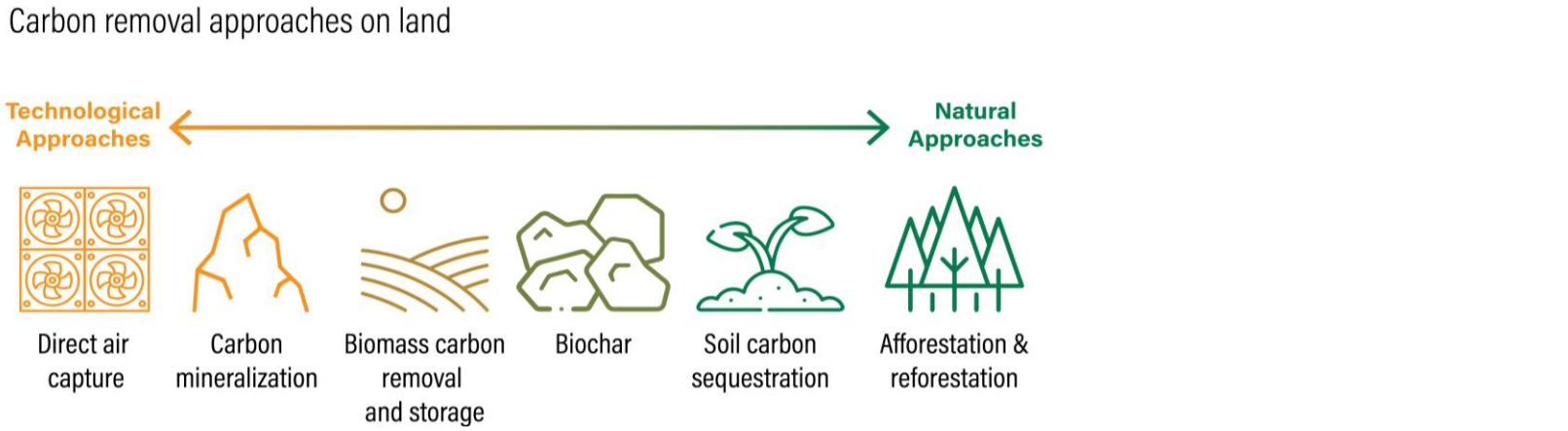
1. What is CDR?
2. Why do we need it?
3. What are some of the main CDR approaches?
4. How much do we need?
5. Why policy is critical?

NECESSITY OF CARBON REMOVAL



Source: IPCC, 2022

CARBON REMOVAL INCLUDES MANY THINGS



DIRECT AIR CAPTURE (DAC)

- Uses chemicals that react with CO_2 in the air to capture it
- CO_2 must be stored somewhere (e.g., underground)
- Energy intensive; requires scaled up renewable and zero-carbon energy
- Handful of projects operational; largest is in Iceland, removing 36,000 tCO_2/yr
- Megaton-scale projects in development in the US

Solid sorbent DAC system

Photo source: Katie Lebling

CARBON MINERALIZATION

Carbon mineralization

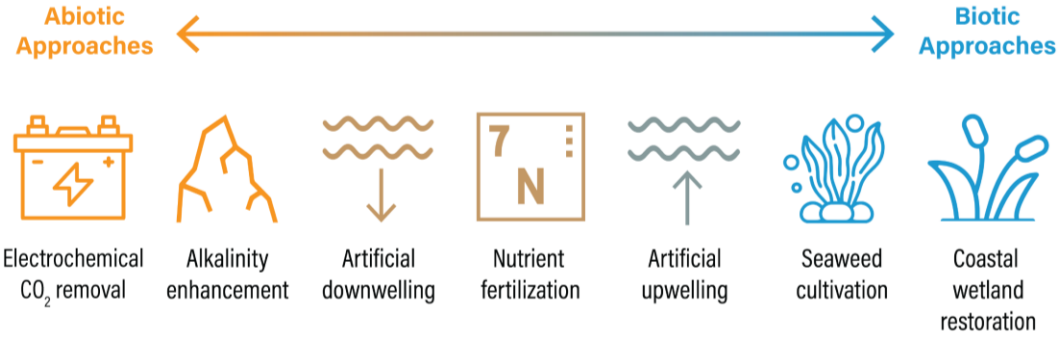
- Accelerates naturally occurring rock weathering that takes up CO_2
- Can be done in many ways – e.g., applying alkaline rock dust on croplands, coastal areas, ocean; using mine tailings or industrial waste; or as an underground storage option for CO_2 captured elsewhere

Basalts react with CO2 dissolved in water, forming solid carbonates

Agricultural liming, which is similar in application to enhanced rock weathering on croplands

Photo sources: Katie Lebling; Jack Hill / Openverse

MARINE CARBON REMOVAL



- Wide range of ocean CDR approaches, some analogous to CDR options on land
- All are at early stages of development or demonstration and face knowledge gaps around efficacy and ecological impacts

Green olivine sand can be used for coastal alkalinity enhancement

Photo source: iStock

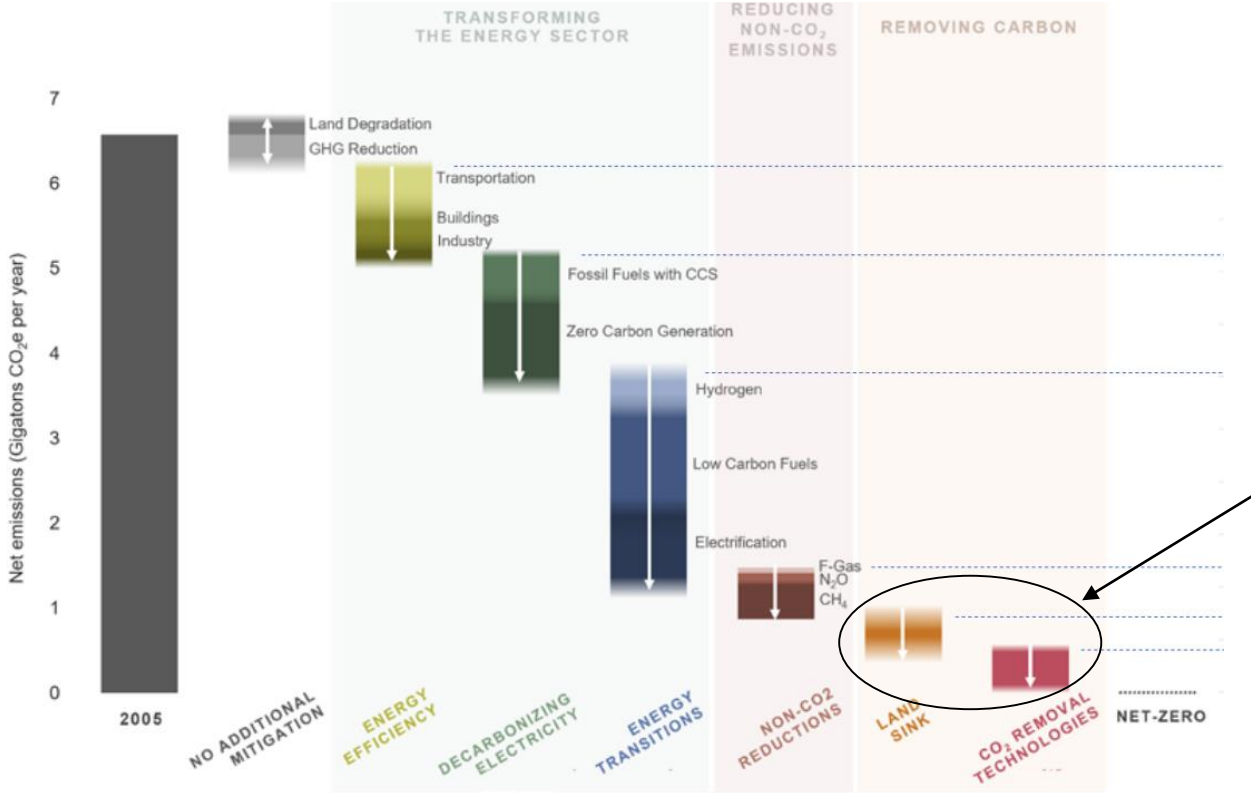
BIOMASS CARBON REMOVAL AND STORAGE

- Uses biomass, which contains CO_2 captured through photosynthesis, and prevents the carbon from being released
- Options include: pyrolysis to bio-oil, gasification with hydrogen production, biochar, biomass burial
- Sourcing biomass that does not cause habitat conversion or displace food production is critical to net-negativity

Biomass waste can be used for carbon removal

Photo sources: Emilian Robert Vicol / Flickr

U.S. NEED FOR CARBON REMOVAL



"Contributions from land sink enhancement range from 1-6%. Contributions from CO2 removal range from 6-8%"
Total: ~0.5-0.9 Gt

The Long-Term Strategy of the United States, 2021

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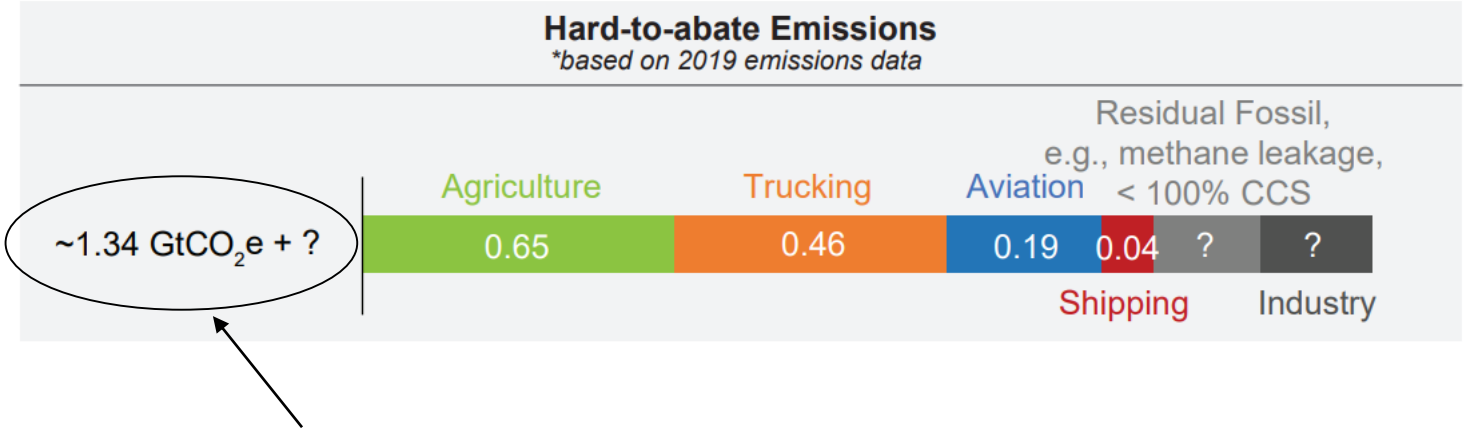
U.S. NEED FOR CARBON REMOVAL



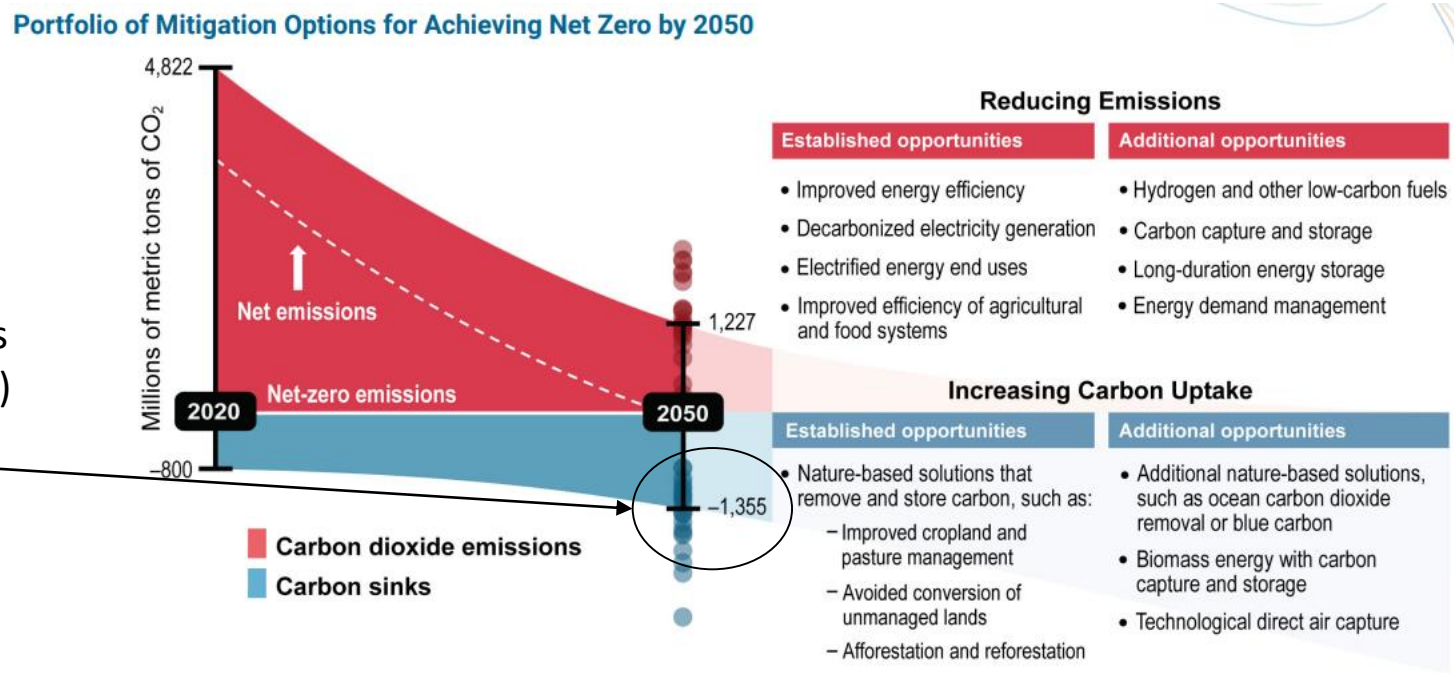
At least 1.34 Gt, based on a bottom-up assessment of residual emissions

Total: ≥1.34 Gt

Department of Energy, Office of Fossil Energy and Carbon Management Strategic Vision, 2022

U.S. NEED FOR CARBON REMOVAL

Contributions from nature-based carbon sinks and other opportunities (mCDR, BiCRS, DAC)
Total: ~0.5-1 Gt



U.S. Global Change Research Program Fifth National Climate Assessment, 2023

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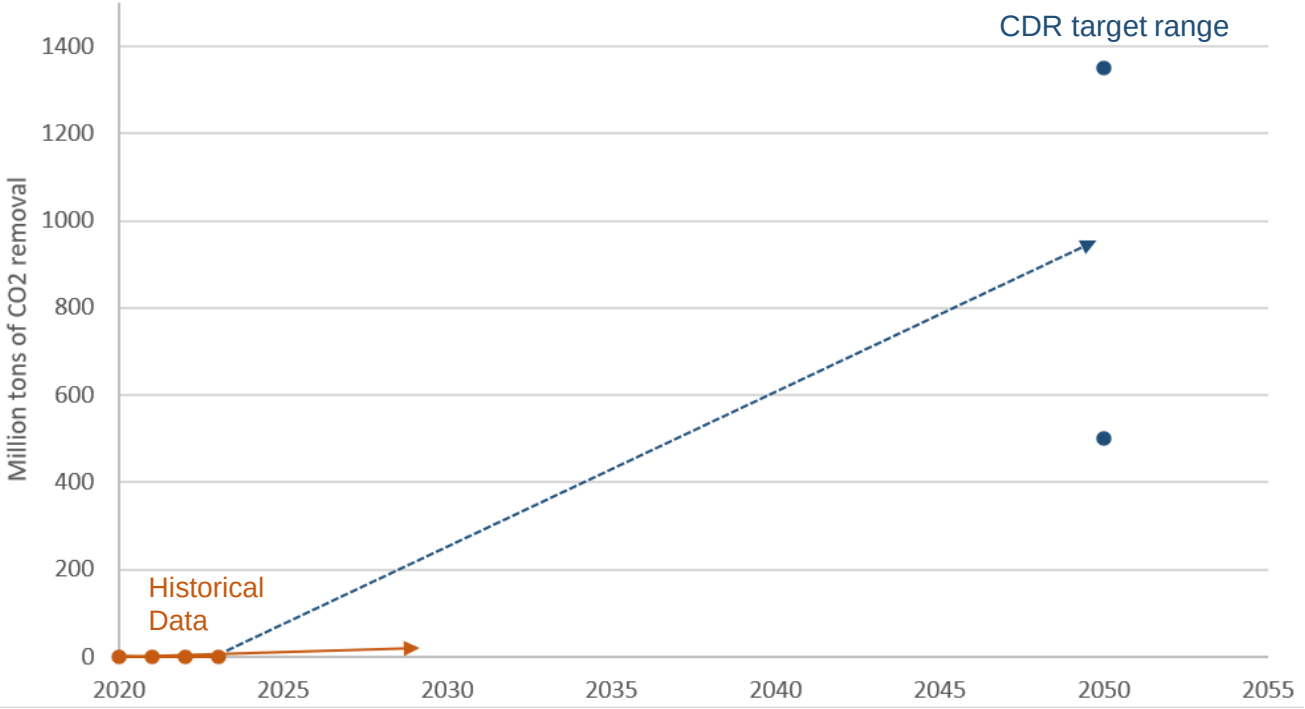
WHERE ARE WE TODAY?

Historical rate of change in scaling CDR vs. rate of change needed to reach national climate goals



Source: Historical data based on Systems Change Lab; targets basted on ranges included in the U.S. LTS, Fifth National Climate Assessment, and FECM Strategic Vision.

WHY POLICY IS CRITICAL FOR CDR

1. CDR is largely a public good
2. It doesn’t have a built-in market
3. Policy is needed to create supply and demand faster than it would otherwise happen

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THANK YOU!

Rhodium Group

The Landscape of Carbon Dioxide Removal

US Policies to Scale Solutions

Energy & Climate

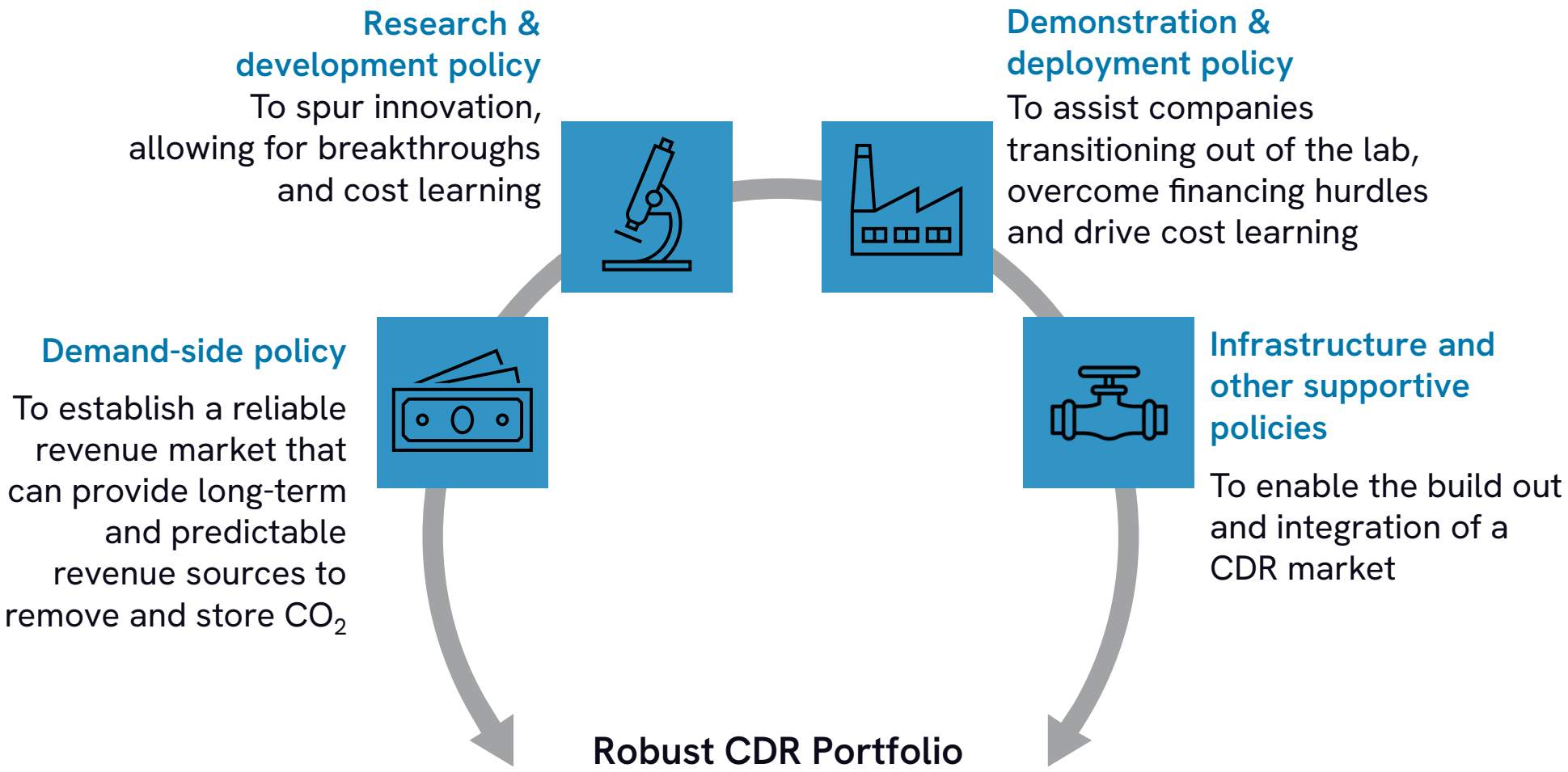
September 12, 2024

Galen Bower

Contents

- Types of policies need to support CDR
- Current US CDR Policy and its impact
- US policy options to scale CDR

Types of policies needed to support CDR

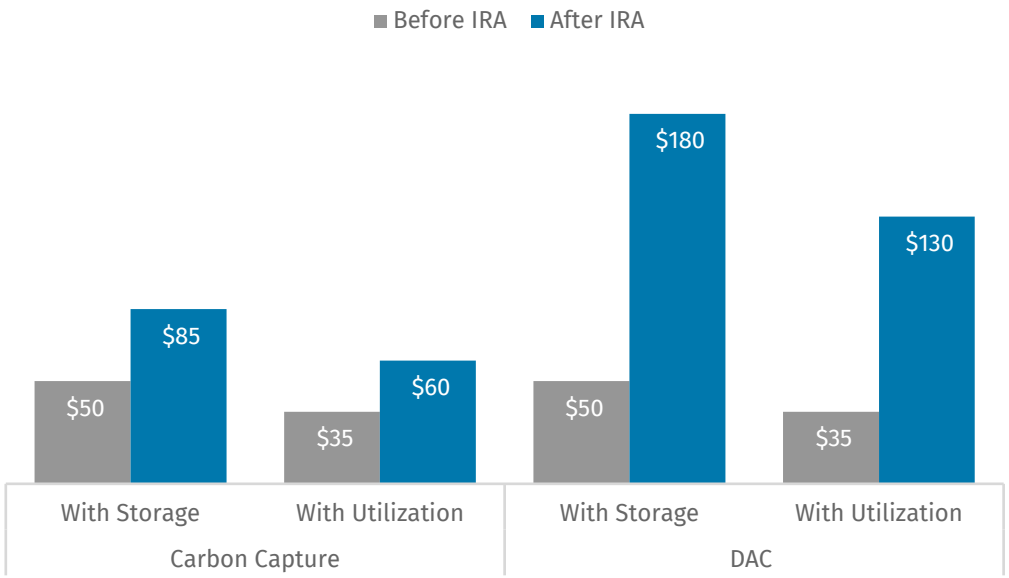


Current US CDR Policy

Current demand-side policy

Non-exhaustive list

45Q enhancements



USDA programs funded by the IRA

Through the US Department of Agriculture (USDA), the IRA has funded several conservation programs that promote natural CDR methods.

Low-carbon fuel standards

Designed to decrease greenhouse gas emissions associated with the transportation sector. Some CDR solutions are supported by an LCFS through eligibility for the generation of compliance credits.

State procurement targets

Some states have begun establishing CDR procurement targets, committing to purchasing certain levels of carbon removal over a determined amount of time.

Current research, development, and demonstration policies for CDR

Non-exhaustive list

Regional Direct Air Capture Hubs

- The Infrastructure Investment and Jobs Act (IIJA) includes $3.5 billion in funding to develop four DAC hubs that will capture at least 1 million metric tons of CO_2 per year at each hub.
- The DAC Hubs program also includes support for projects at earlier stages of development, including funding for feasibility assessments and front-end engineering and design (FEED) studies.

Infrastructure and other supportive policies

IIJA funding

State Primacy for Class VI Wells

The IIJA includes over $48 million in funding for additional states to apply for and implement Class VI primacy programs

CO_2 Locate Database

Designed to keep track of active and abandoned wells to inform decision-makers for Class VI wells and to minimize risk

CarbonSAFE

Carbon Storage Assurance Facility Enterprise (CarbonSAFE) designed to explore carbon storage feasibility at potential geologic storage locations

Carbon storage validation and testing

Gives funding to eligible participants for permitting, site characterization, and construction of carbon storage sites

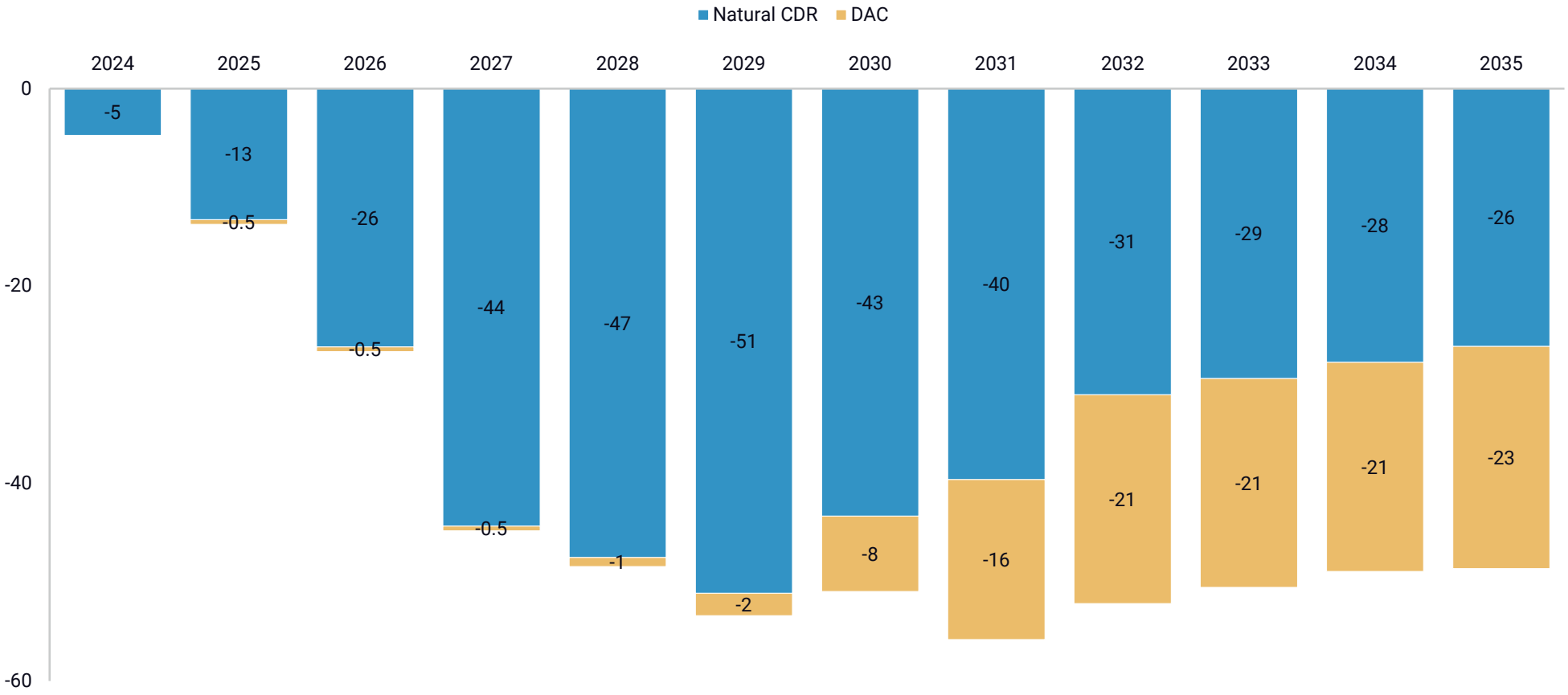
CIFIA

The Carbon Dioxide Transportation Infrastructure Finance and Innovation Act (CIFIA) to support a network of CO_2 transport

Current policy is not sufficient to get the US to a gigaton of CDR

CDR in the US, excluding baseline natural CDR

Net million metric tons (MMT) of CO_2e removal



Source: Rhodium Group's Taking Stock 2023, under our mid-emissions scenario.

Policies to Scale CDR

Demand-side policies for CDR

To establish a long-term revenue market

Tax credits

- Make 45Q more inclusive to advance CDR approaches beyond BECCS and DAC.
- Establish a separate, more inclusive tax credit where the sole focus is CDR and therefore encompasses a wider range of CDR technologies.

Federal procurement

The federal government pays for CDR services in increasing amounts over time.

A procurement program can be structured to pay by the ton for CDR or pay for practices that provide CDR.

Regulatory policies

Economy-wide or sectoral-level emissions standards can create compliance markets that can permit CDR credits as a means of compliance.

Research and development policies

US policies to expand the CDR portfolio

R&D and pilot programs for CDR

- R&D programs are particularly beneficial to CDR projects that are still in the lab stage of development.
- Pilot programs help fuel innovation and spur competition. These programs can fund feasibility studies, basic engineering, and pilot-scale demonstrations for CDR approaches.

Monitoring Reporting and Verification (MRV) R&D

- While start-ups and organizations are starting to pop up to fill this need, government support will serve as a catalyst for this research.
- This will require continued investments in the research and development of methods to ensure high levels of scientific certainty on CO_2 removal and reemission expectations.
- It's important for the government to invest in MRV now so that there are strong protocols once more CDR technologies scale.

Demonstration and deployment policies

US policies to scale CDR solutions

Demonstration programs

These policies support approaches in the demonstration and early-commercialization stage of development by providing or securing a large part of the capital investment required to build CDR facilities.

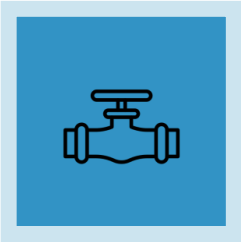
Policy support for each stage ensures the approach will successfully achieve full-scale deployment assuming long-term revenue support is available. Demonstration programs for a CDR approaches beyond DAC would be beneficial.

Loan guarantees

The federal government can provide loan guarantees at a favorable rate compared to the open market and assume a large part of the financial risk. This funding can come from DOE's Loan Programs Office or the Office of Clean Energy Demonstrations.

Infrastructure and other supportive policies

To set the stage for a gigaton CDR market



CO_2 transport and storage

Building upon funding under the IIJA to develop a CO_2 transport and storage system.

Opportunities for states

Many of the federal policy options can be adopted and tailored to the state level. Any action taken by states will complement federal efforts and further support the deployment of CDR in the US.

Workforce development

Scaling CDR methods will require a skilled workforce. Occupational training programs will be imperative.

Public Education

To garner more support and awareness of the variety of CDR approaches.

Rhodium Group

The Landscape of Carbon Dioxide Removal and US Polices to Scale Solutions

https://rhg.com/research/carbon-dioxide-removal-us-policy/

New York | California | Washington, DC | Paris
Website: www.rhg.com

Roads to Removal

A Comprehensive Assessment of Carbon Dioxide Removal Options in the United States

Pete Psarras

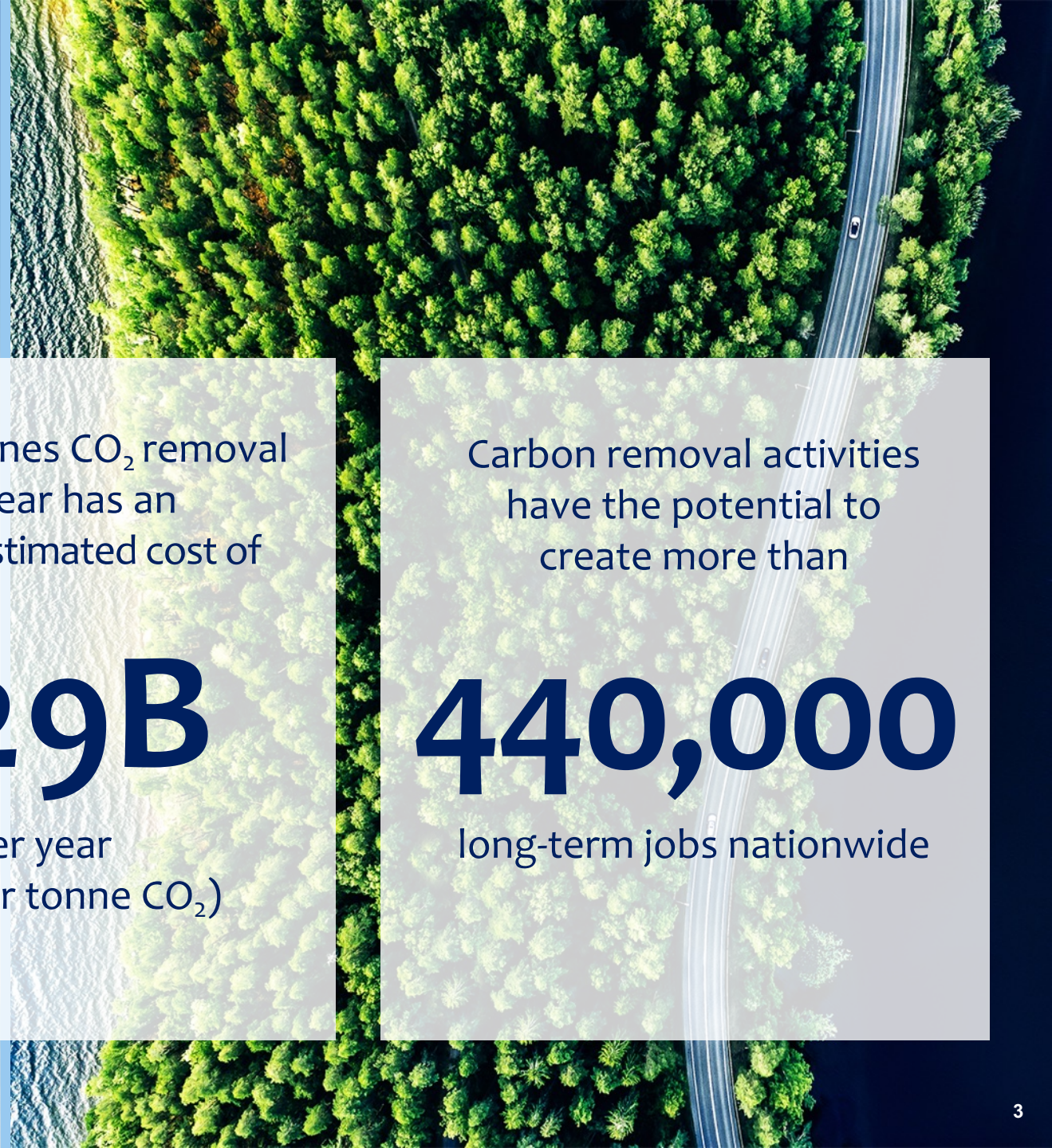
University of Pennsylvania

Jennifer Pett-Ridge, Sarah E. Baker, Bruno Basso, Mark Bradford, Susan Hovorka, Sara Kuebbing, Kimberley K. Mayfield, Allegra Mayer, Simon Pang, George Peridas, Briana Schmidt, Corinne Scown, Eric Slessarev, G. Philip Robertson, Roger D. Aines...
(+ many more)

THE CALIFORNIA REPORT

THE UNITED STATES REPORT

Achieving US national carbon removal goals is possible



The United States can remove at least

1B

tonnes of CO_2 per year by 2050 using demonstrated technologies

1 billion tonnes CO_2 removal per year has an average estimated cost of

$129B

per year ($129 per tonne CO_2)

Carbon removal activities have the potential to create more than

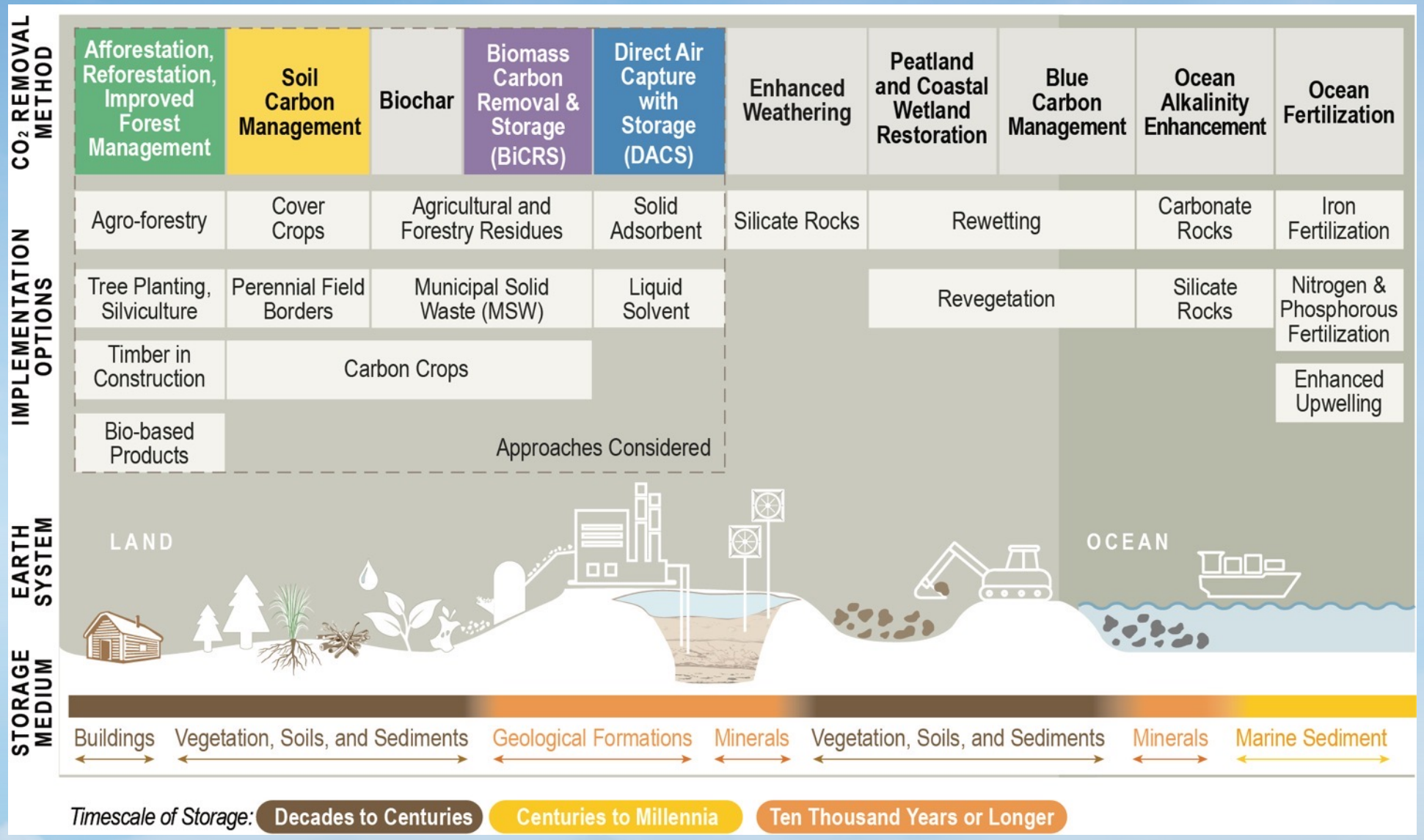
440,000

long-term jobs nationwide

Our analysis focused on *mature* tech

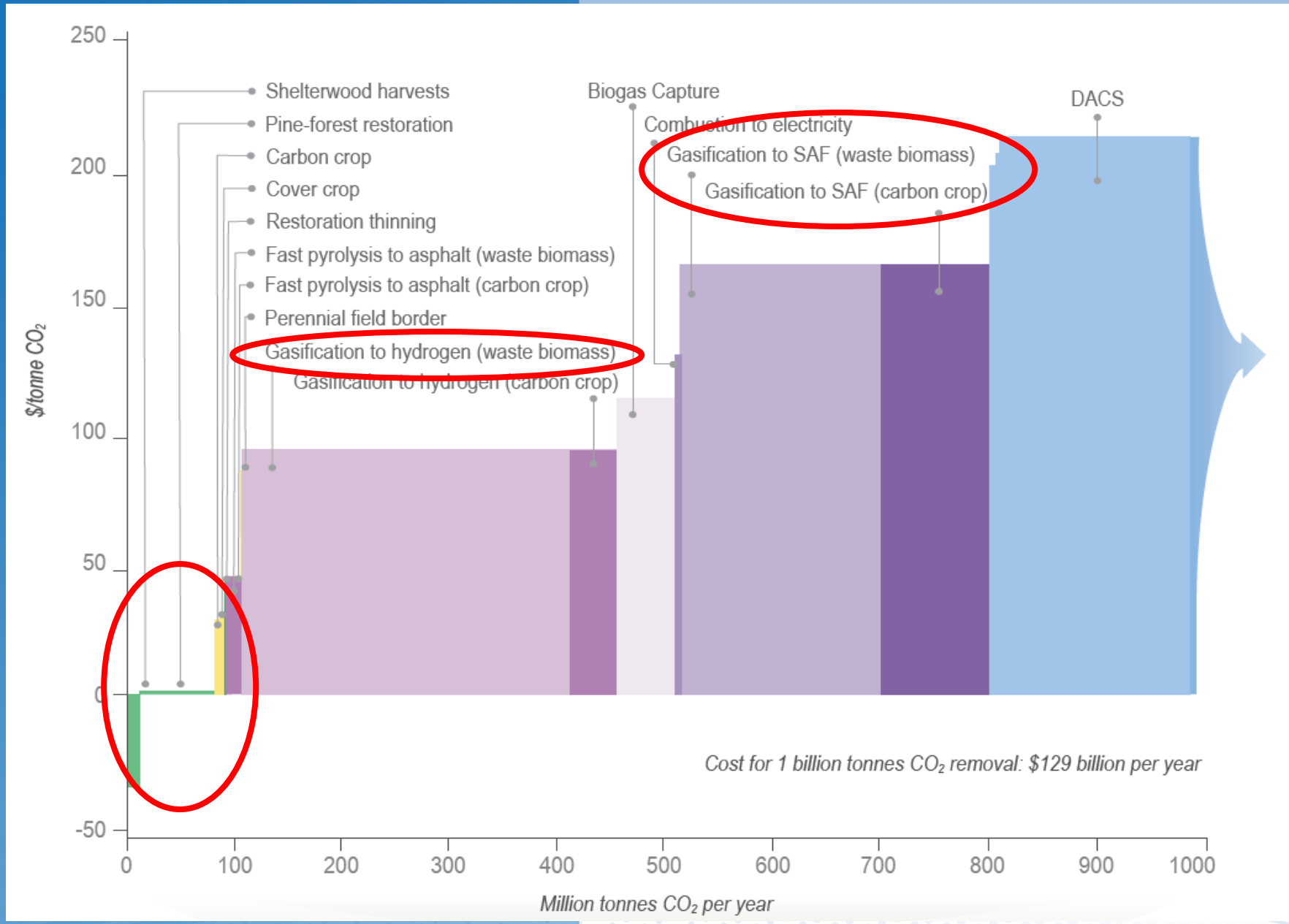
***Must be 'true' negative emissions*

***Only 'mature technologies'*



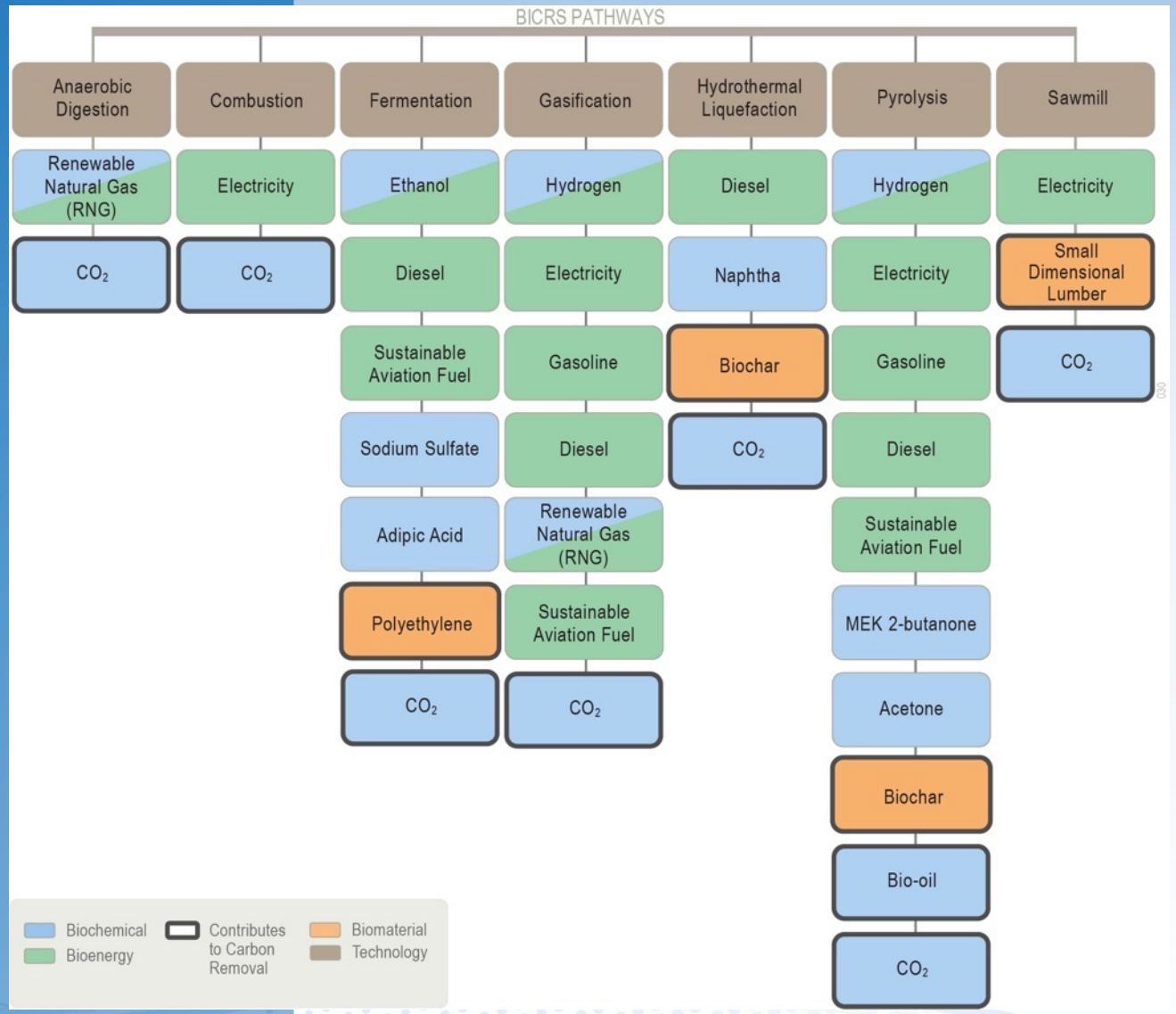
What will it cost?

- We have more CO_2 removal capacity that we need
- 'Extra' removal capacity allows each region to make choices that match local needs…
- Converting waste biomass to H_2 is a large, affordable option



Using organic wastes, we can remove millions of tonnes of CO_2 per year

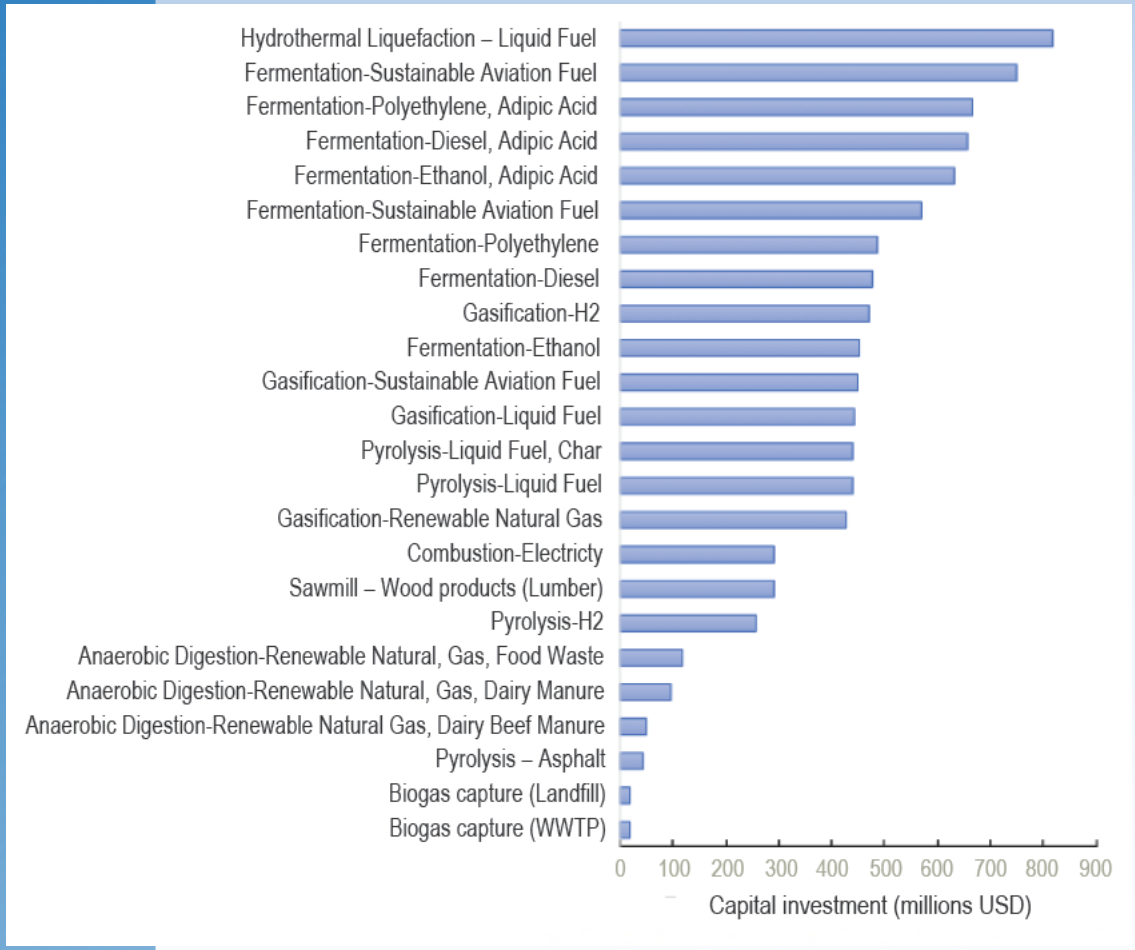
- Targeted areas with biomass (feedstock), good geologic storage, & regional co-benefits
- Avoided land where we grow food
- In-depth technical-economic analysis for 27 mature biomass conversion pathways
- Would require ~300 new biorefineries across the USA



27 unique biomass conversion pathways

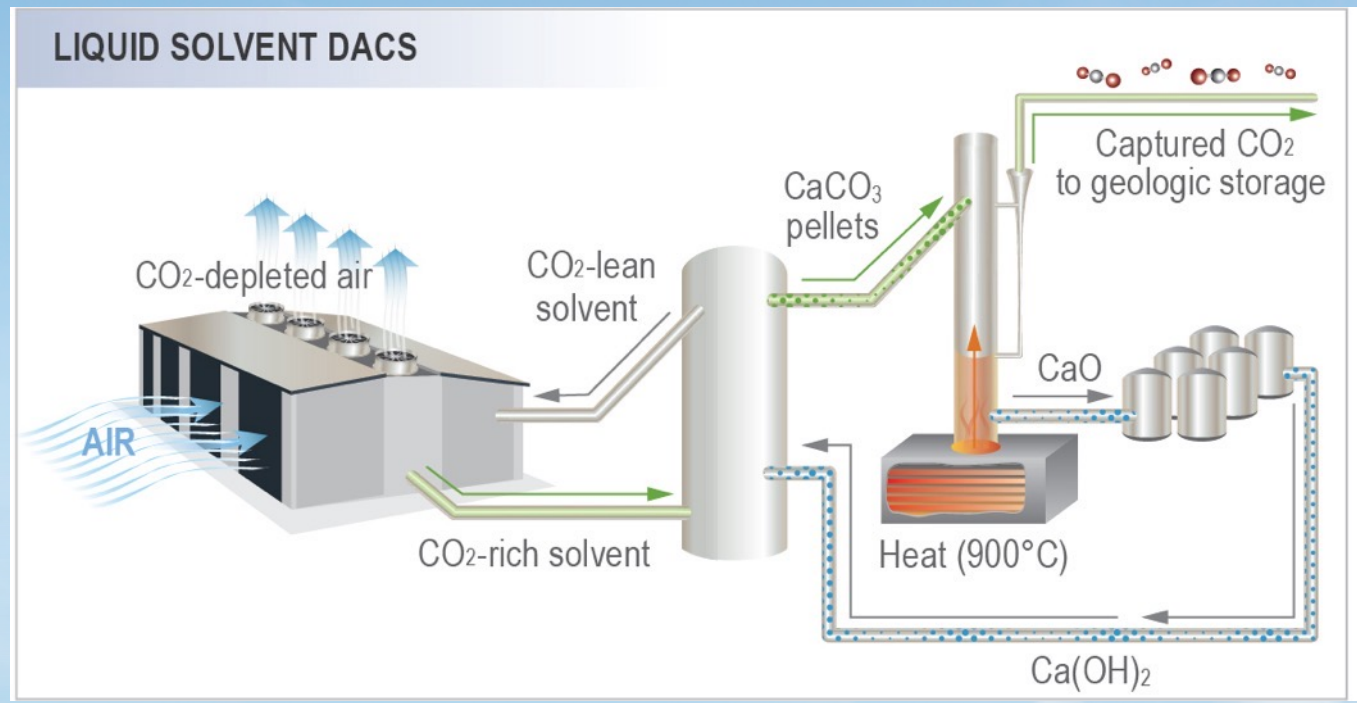
Carbon capture from biomass is a key part of solution to meet US climate goals

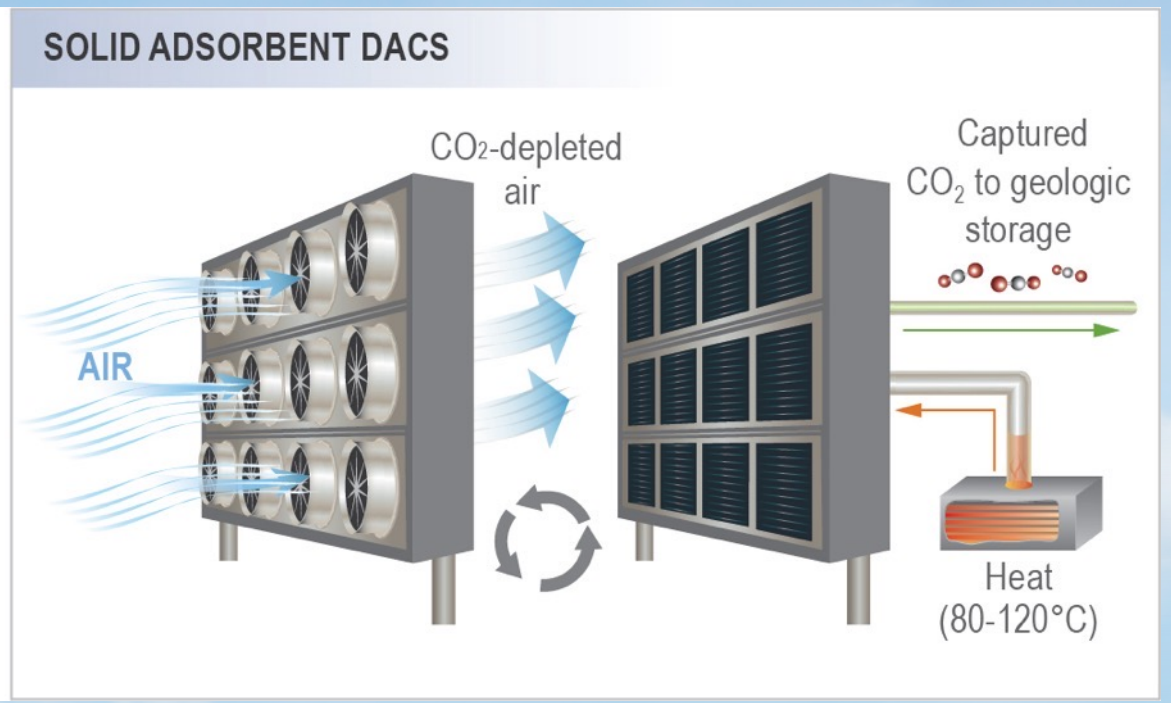
- 800 million tonnes of CO_2 removal per year from 300+ biorefineries
- 34 million tonnes of hydrogen production, 150 TWh of electricity production, 1.4 million tonnes biochar production
- cost < $100 per tonne



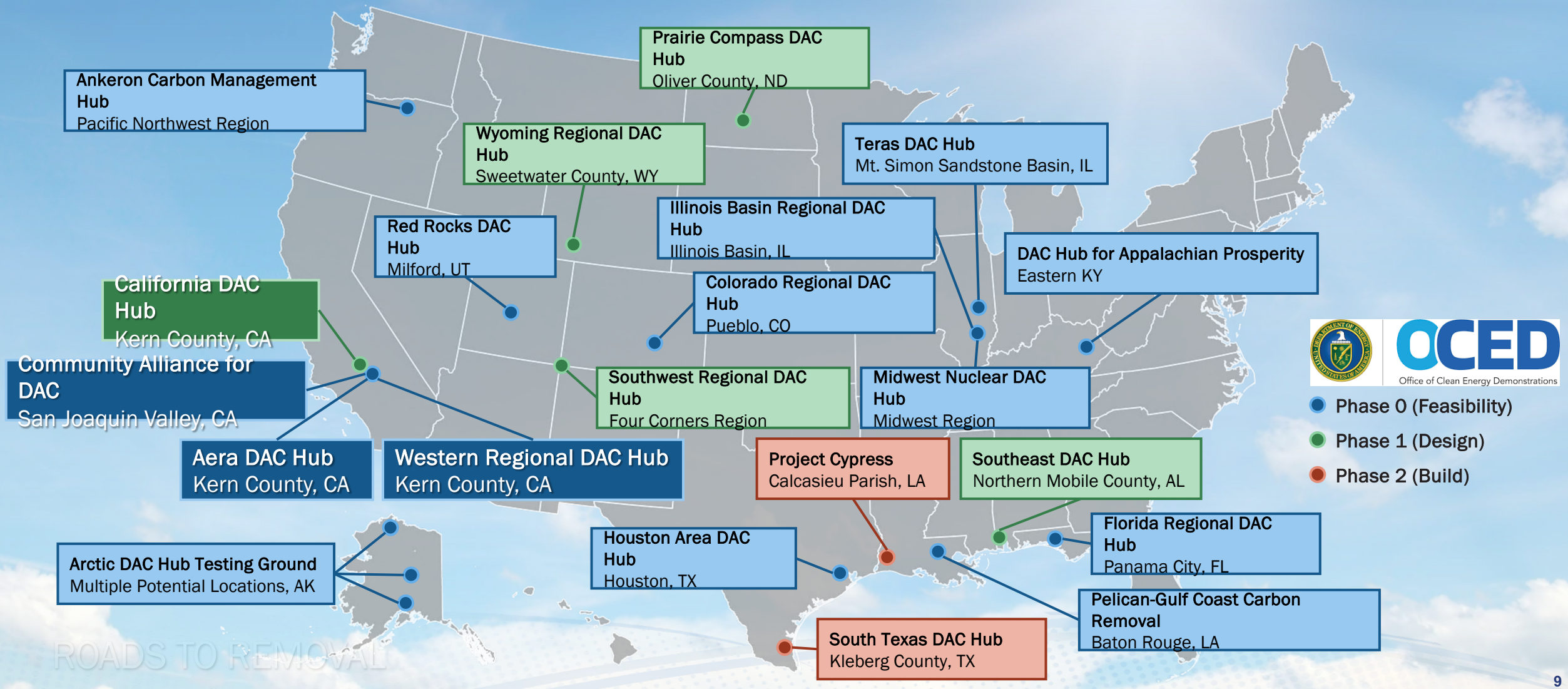
- BiCRS capital investment costs are significant

Direct air capture uses engineered materials and systems to remove CO_2 from the atmosphere

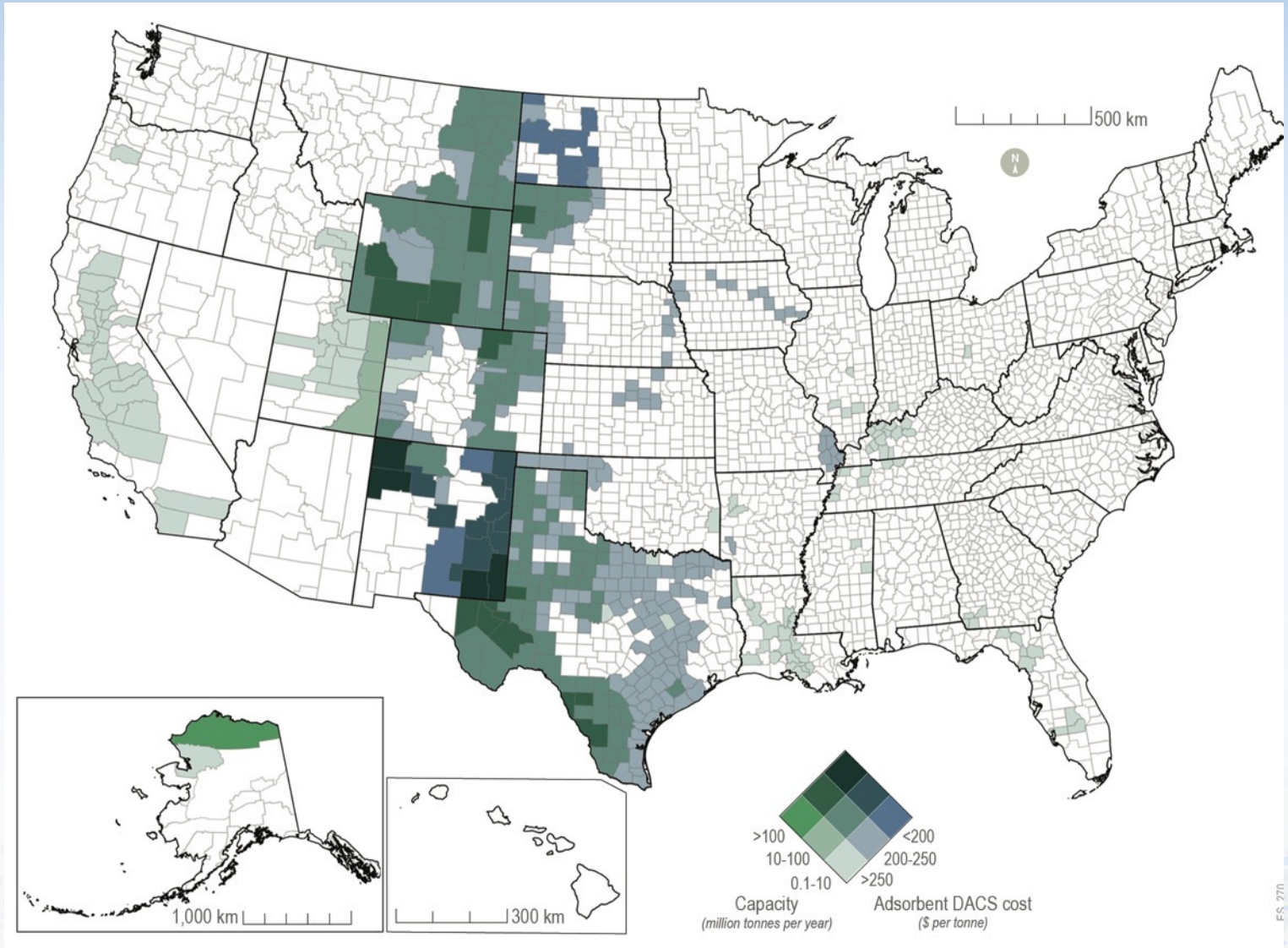




The USA has invested in many DAC demonstration projects

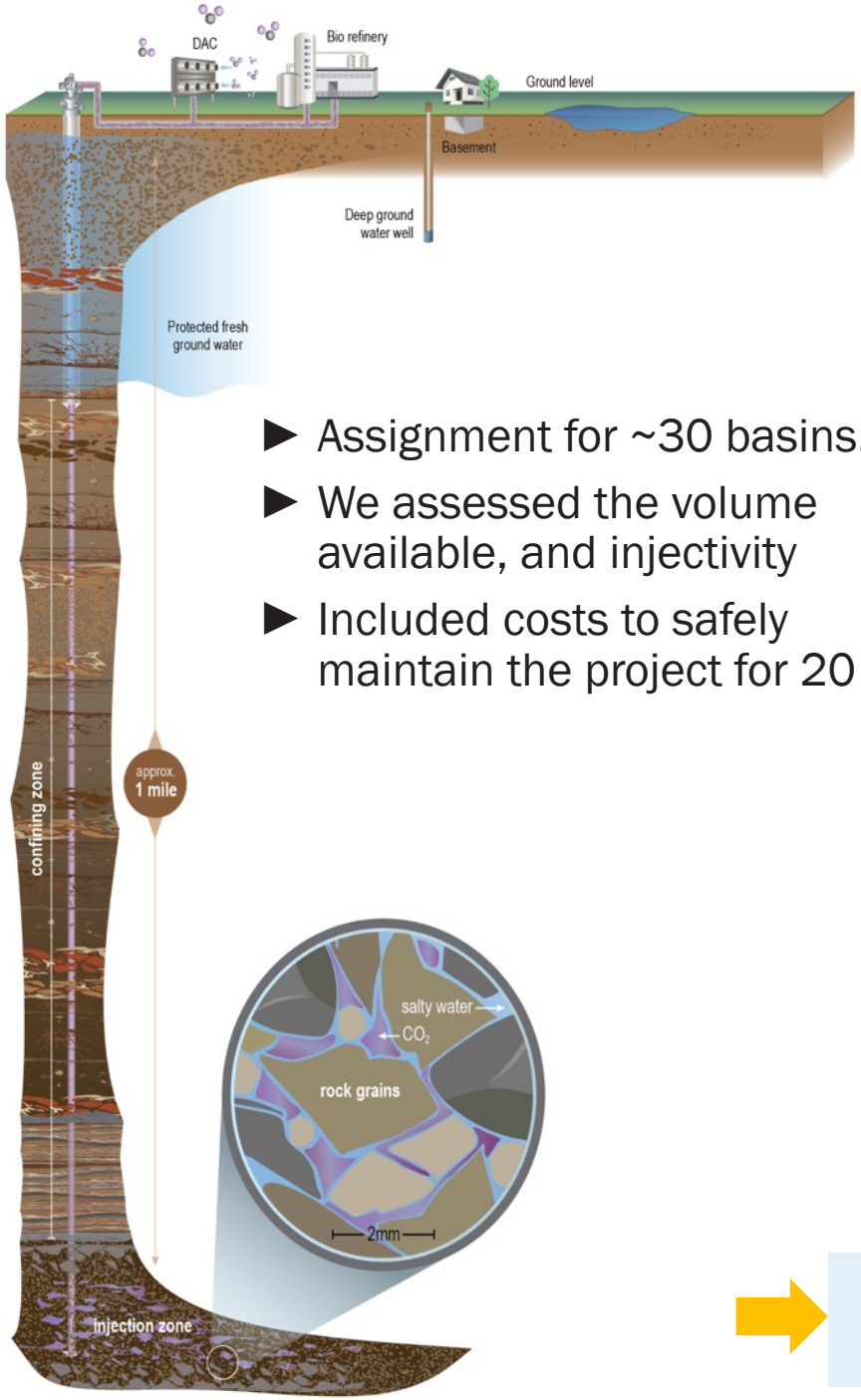


Direct air capture (DAC): Best land is near regions of high energy and CO_2 storage

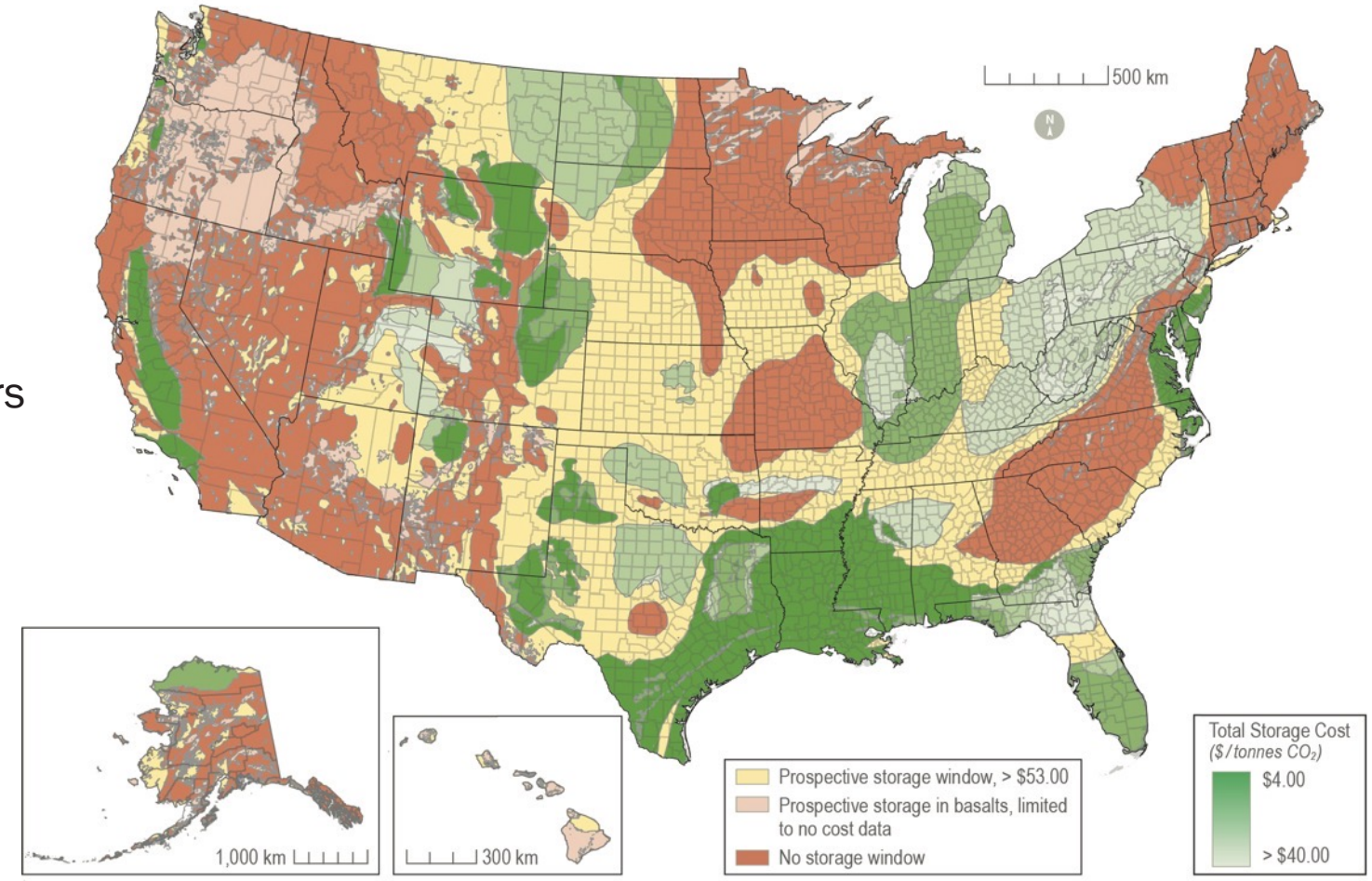


- DAC can remove over 9 billion tonnes of CO_2 per year, at \$200 - \$250/tonne CO_2.
- West Texas, Upper and Lower Rocky Mountains, and parts of the Upper and Lower Midwest have the largest potential for DACS deployment with renewable energy
- Priority regions for DACS have nearby geologic storage and land for renewable energy

We have plenty of reliable geologic storage

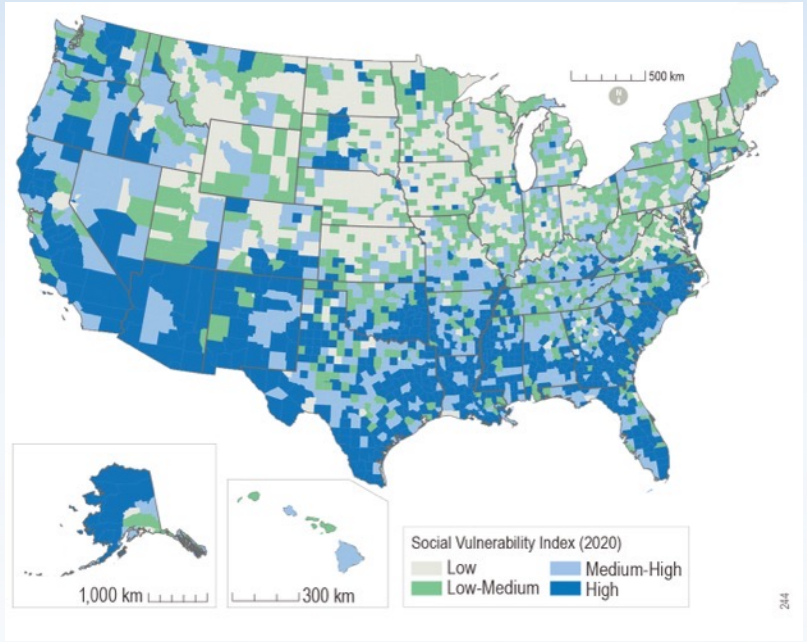


- Assignment for ~30 basins.
- We assessed the volume available, and injectivity
- Included costs to safely maintain the project for 20 yrs

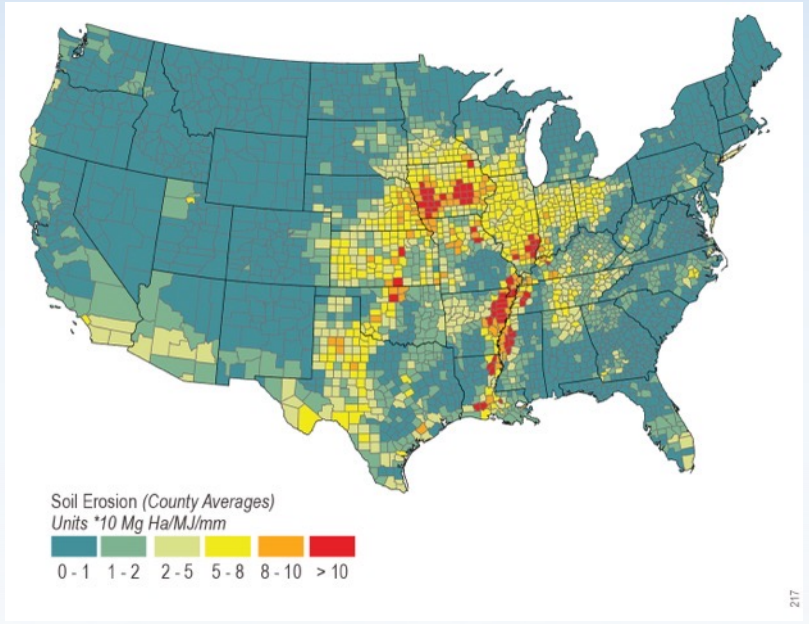


More than half the land area in the United States has potential for safe, affordable (<$40/tonne) CO_2 geologic storage

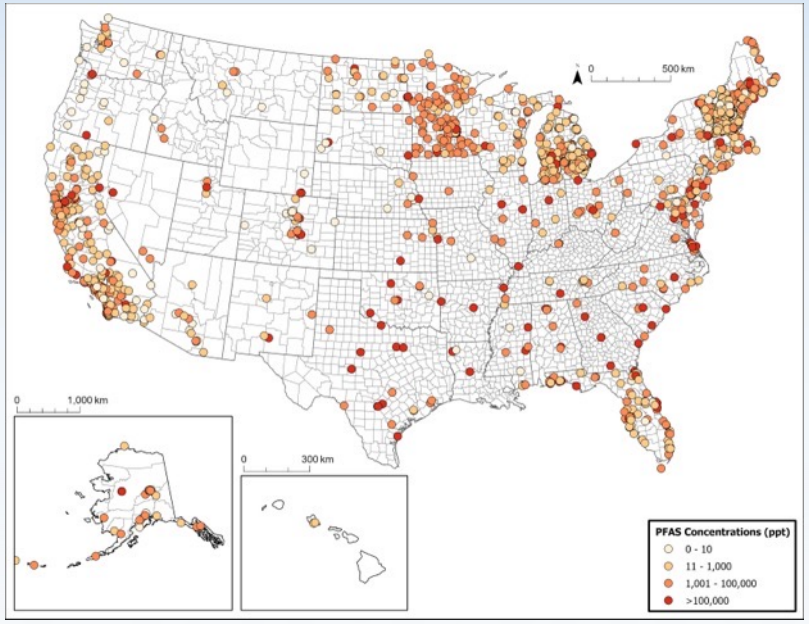
EEEJ Analysis: where can CO_2 removal approaches benefit the environment, communities, or both?



Social vulnerability index

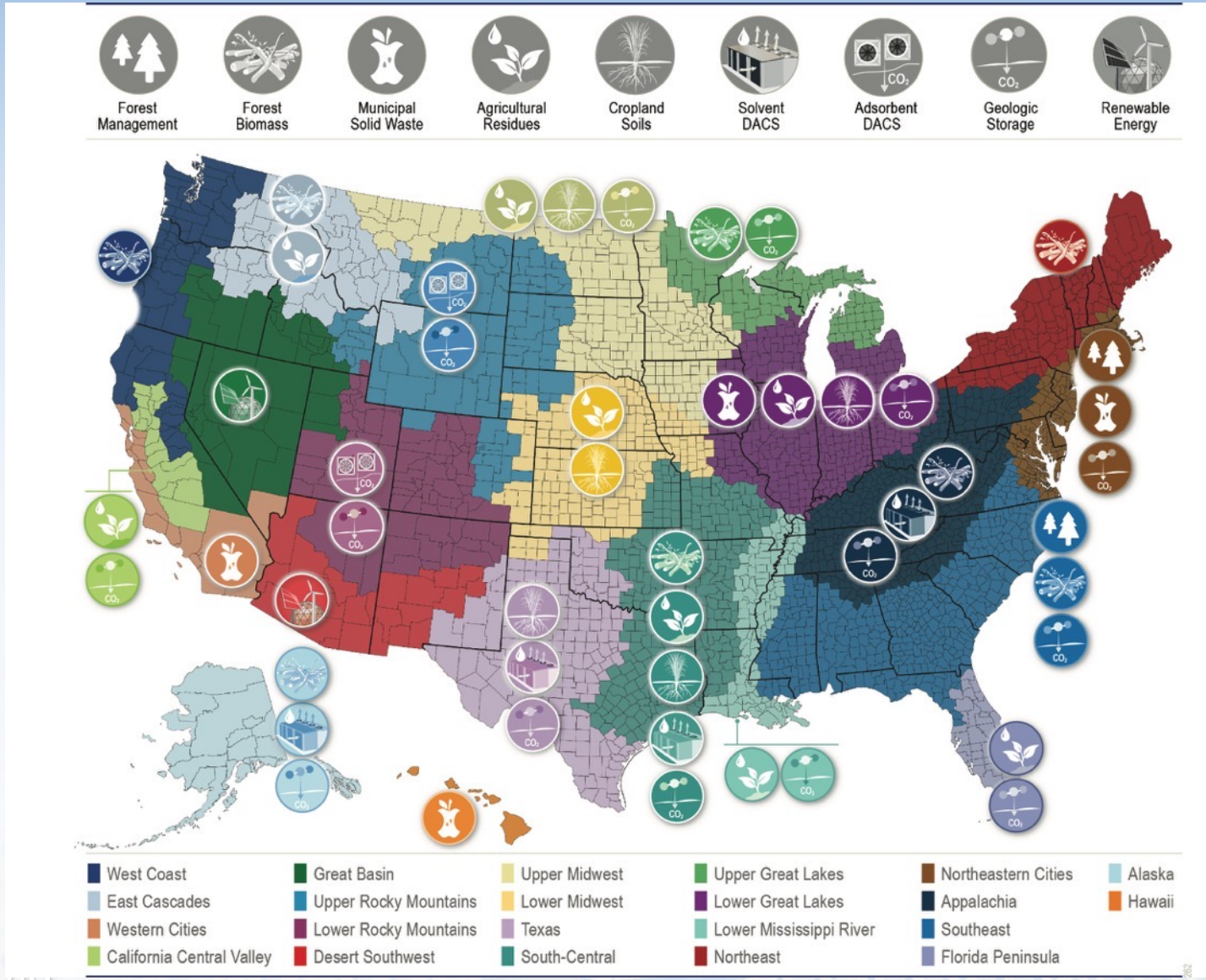


Soil erosion



PFAS concentrations

Every US Region Has a Story and an Opportunity



THANKS

roads2removal.org

U.S. DEPARTMENT OF ENERGY
Fossil Energy and Carbon Management

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy
BIOENERGY TECHNOLOGIES OFFICE

climateworks FOUNDATION

Breakthrough Energy

Grantham Foundation for the Protection of the Environment

Carbon Removal Alliance

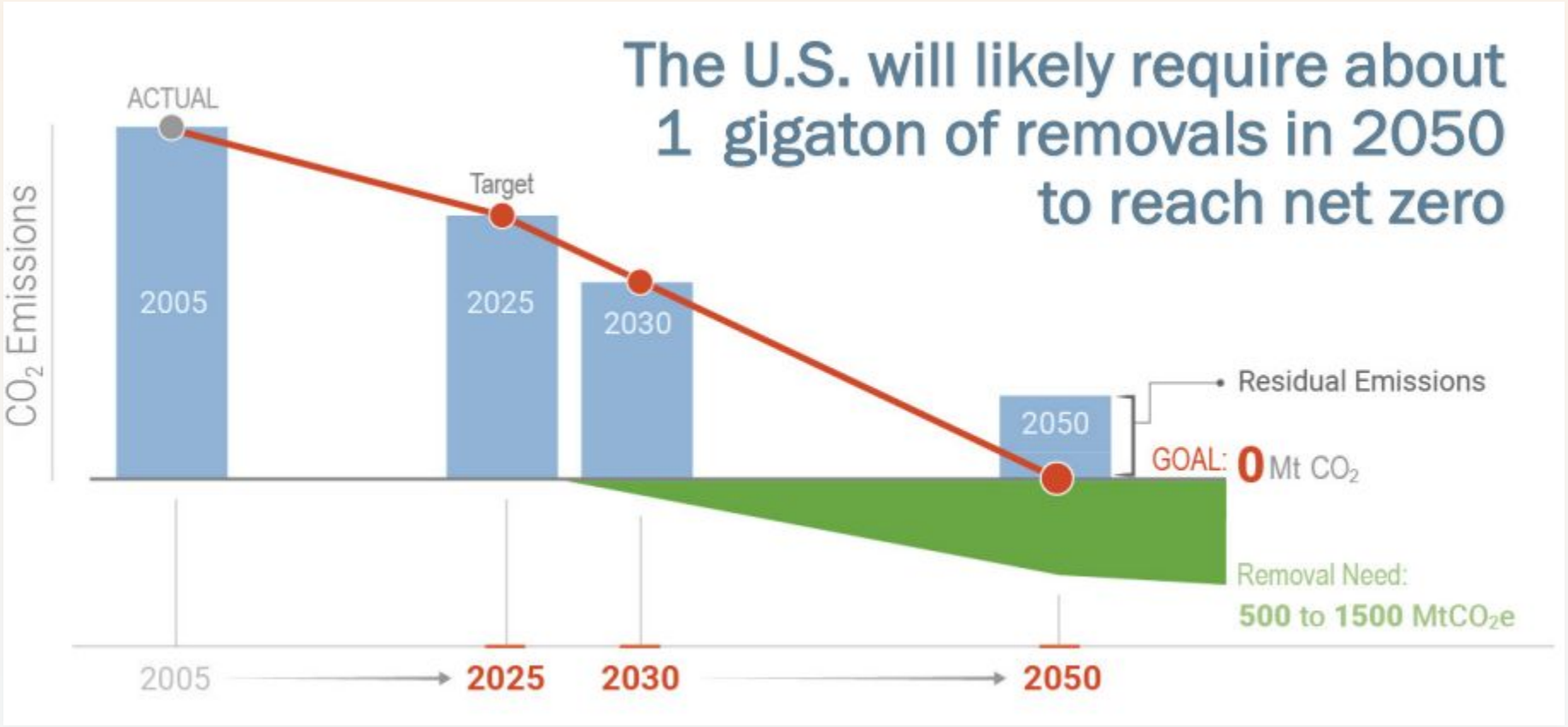
September 2024

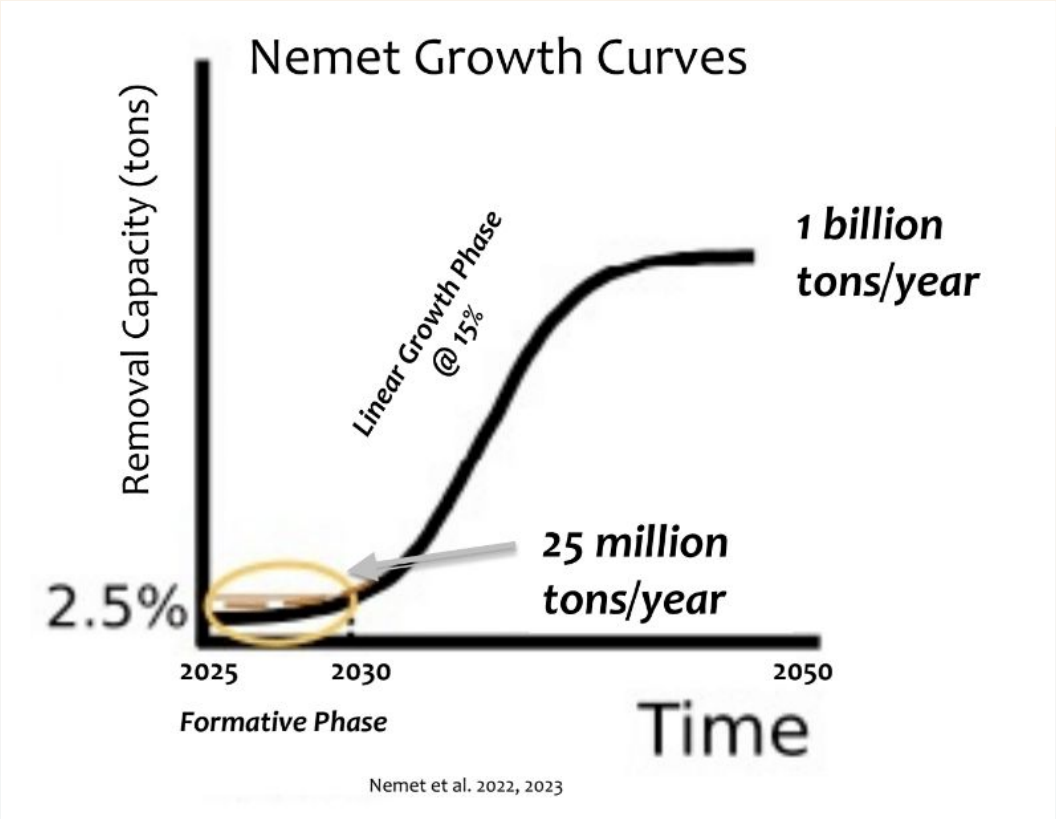
Exploring the Policy Landscape of CDR

Image courtesy of CarbFix

What are we trying to do?

Image courtesy of Climeworks.


The U.S. will likely require about
1 gigaton of removals in 2050
to reach net zero
ACTUAL
Target
CO_2 Emissions
2005
2025
2030
2050
Residual Emissions
GOAL: 0 Mt CO_2
Removal Need:
500 to 1500 $MtCO_2e$
2005
2025
2030
2050


Nemet Growth Curves
Removal Capacity (tons)
Linear Growth Phase @ 15%
1 billion tons/year
25 million tons/year
2.5%
2025
2030
2050
Formative Phase
Time
Nemet et al. 2022, 2023

How are we going to get there?

Image courtesy of Arca.

Building a gigaton CDR sector

- Monitoring, Reporting, and Verification (MRV)
- Procurement
- Level playing field on tax
- We’re just getting started...

Monitoring, Reporting, & Verification

Monitoring

Measuring carbon removal activities and effects over time to confirm that the carbon that was removed stays safely and permanently locked away.

Reporting

Collecting and sharing the full picture of a carbon removal project, including tons removed, energy consumed, public safety metrics, and ecosystem impacts.

Verification

Using open-source, peer-reviewed, third-party protocols to reduce the risk of fraud and make sure that projects meet the principles of quality carbon removal.

Carbon180

TLDR: The process of proving the climate benefit of carbon removal work.

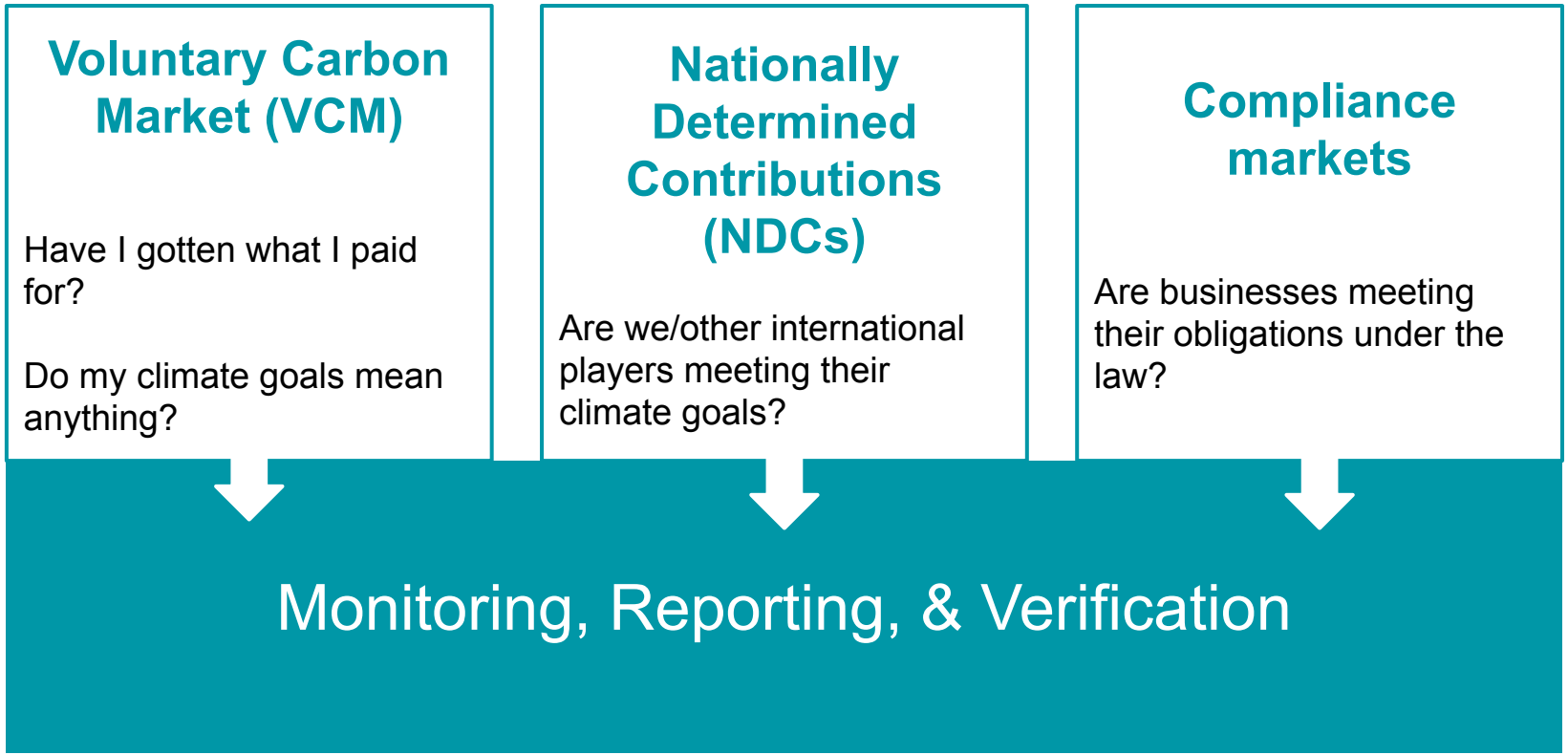
What is MRV?

Carbon Market Faces Upheaval as 32% of All Credits Fail Test

(Bloomberg) -- The market for carbon offsets faces renewed upheaval after a major category of credits failed to win approval from a key oversight body.

Bloomberg News
Natasha White and Akshat Rathi

Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows


Voluntary Carbon Market (VCM)
Have I gotten what I paid for?
Do my climate goals mean anything?
Nationally Determined Contributions (NDCs)
Are we/other international players meeting their climate goals?
Compliance markets
Are businesses meeting their obligations under the law?
Monitoring, Reporting, & Verification

Our Forthcoming Recommendations

MRV needs a systemic overhaul. CRA's recommendations coming this October are in 5 key areas

Standards

A set of requirements a protocol must meet to accurately quantify removals for a given pathway

Protocols

industry-specific project design, operating requirements, and methods for quantifying mitigation outcomes and reaching identified standard criteria

Data, Collection, Reporting, & Transparency

Aligning data reporting expectations can both streamline project delivery and increase our trust and understanding of carbon removal projects.

Innovation

Federal investments in innovation on MRV can help reduce these costs while improving accuracy and unlocking the full potential of the carbon removal market

Coordination & Oversight

Interagency government oversight structures balanced with private sector self-regulation

Procurement

The USG buys carbon removal!

Energy & Water Appropriations

- **FY23** DOE Pilot Purchase Prize - $35 million
- **FY24** - $20 million
- **FY25** - $40 million (Senate)

CDR Leadership Act (S. 3615/HR 7054)

- Scales to 10 million tons of CDR by 2035 and beyond
- Cost controls
- Set asides for small projects

CREST Act (S. 1576)

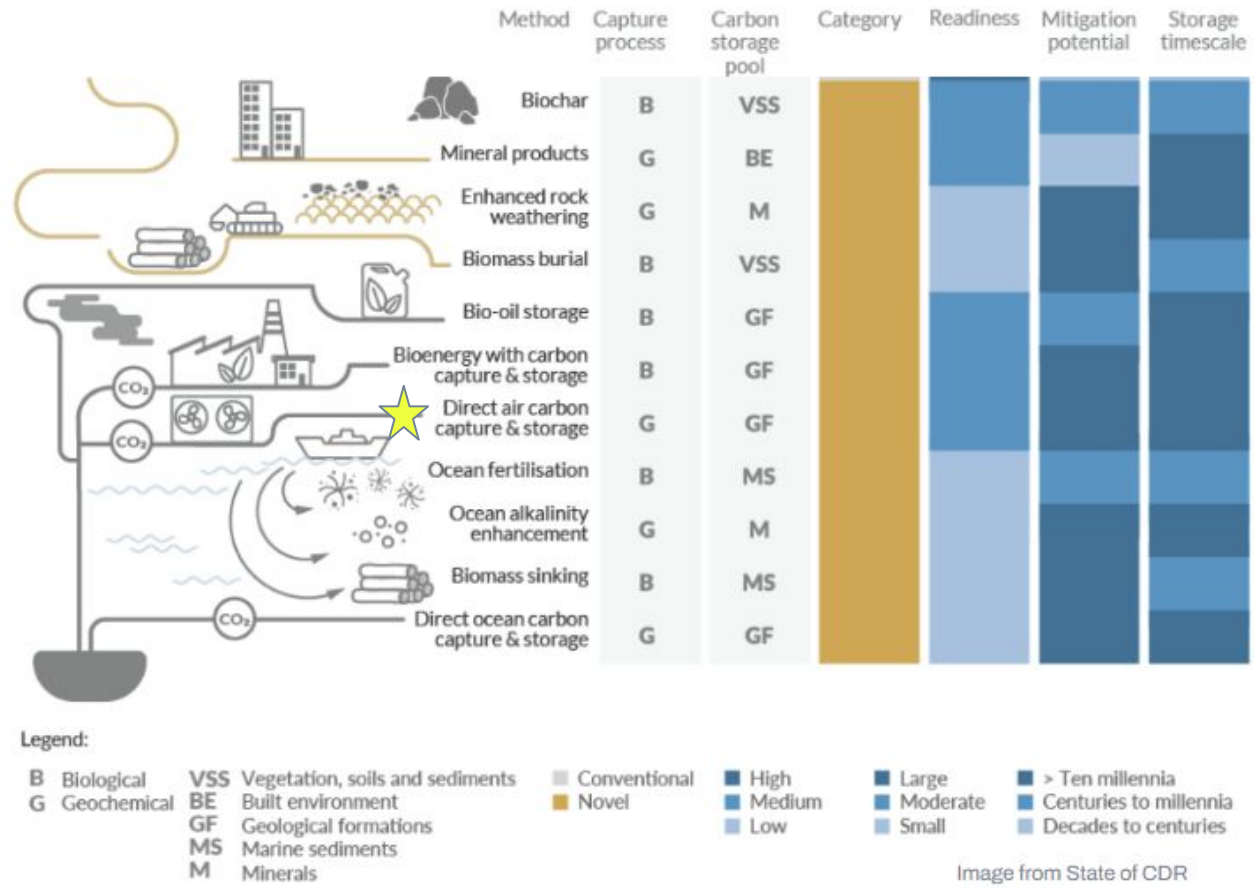
- R&D Programs
- 5-year pilot purchasing program
- Medium durability and permanent(> 1000 years) categories
- Up to $60 million worth of CDR

Level the playing field on tax

45Q Eligibility

45Q PTC for CDR at $180 per ton.

Only applies to DAC and is insufficient to scale the sector.



Thank you.

For any additional information or questions please contact Laura@carbonremovalalliance.org.

Carbon Removal Alliance