HARVARD
Office for Sustainability

## Carbon Solutions Living Lab

# Carbon Removal Strategy for Harvard University

Spring 2022

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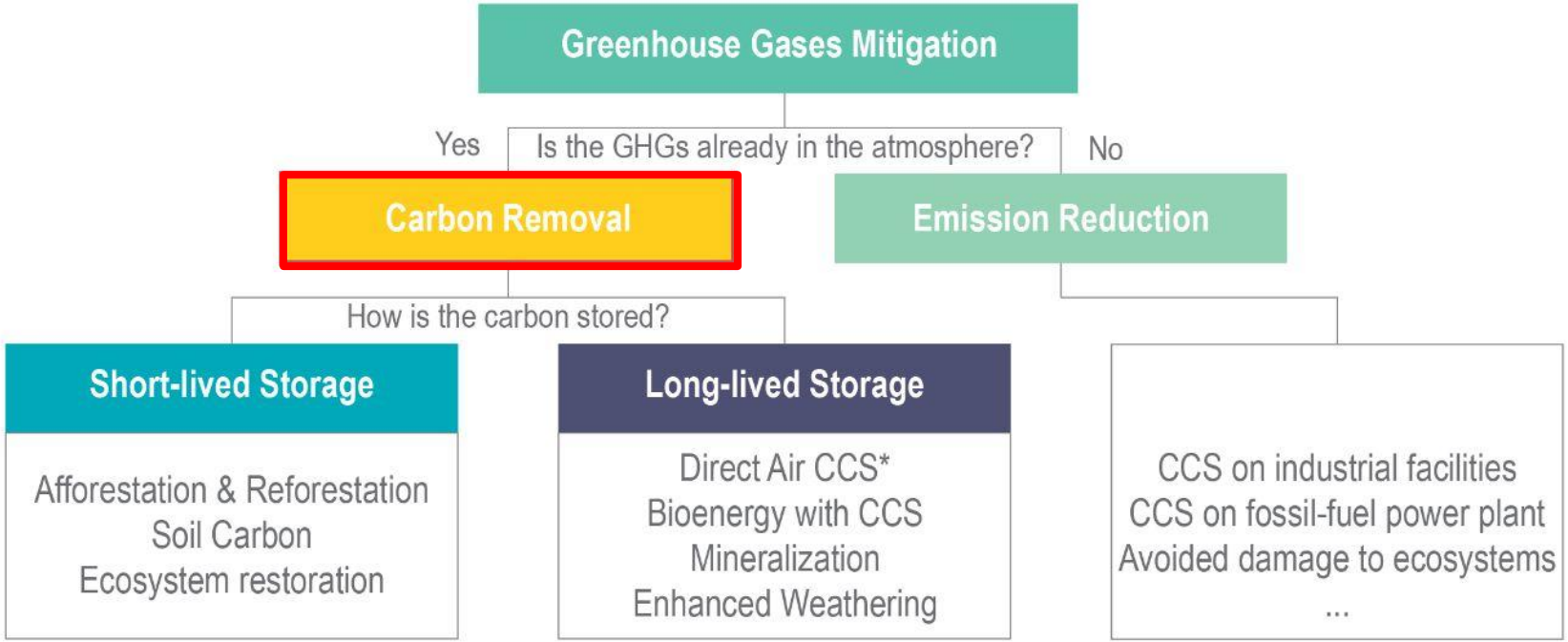
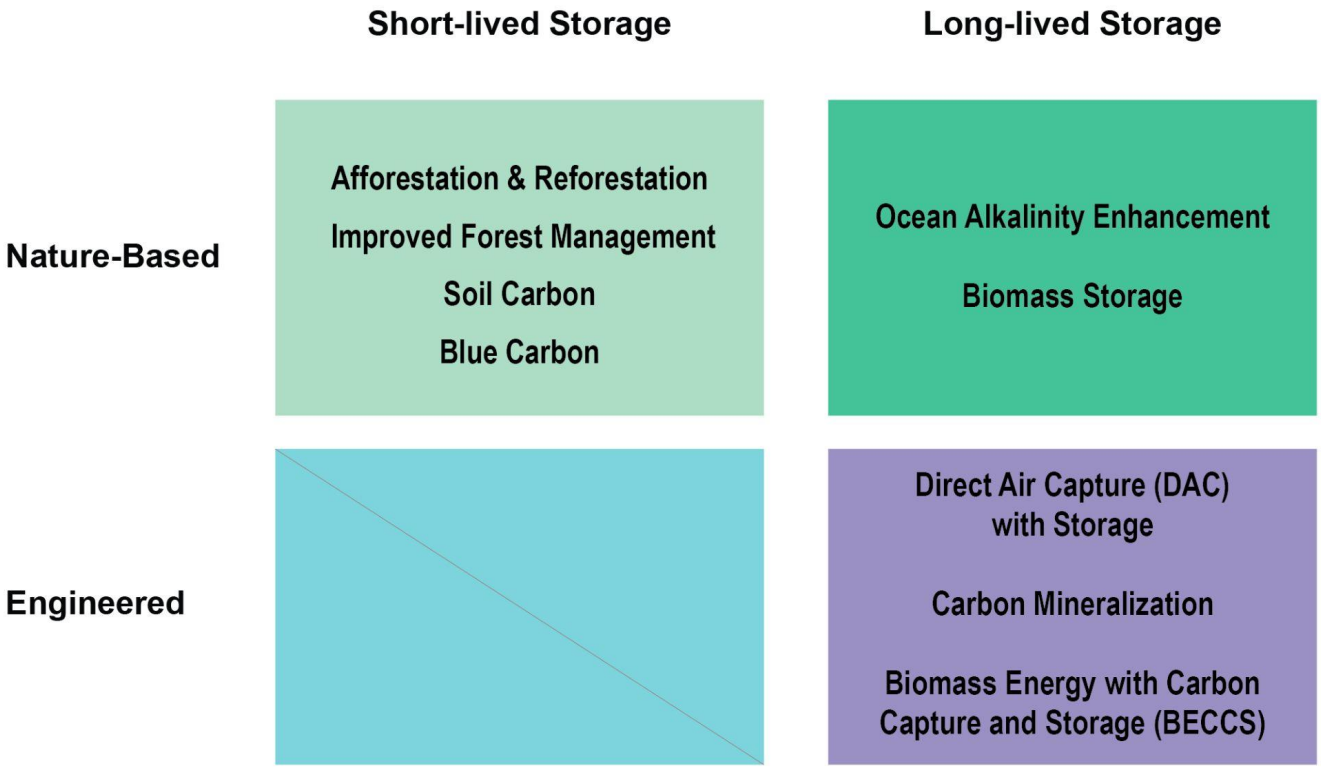
# What Exactly Is Carbon Dioxide Removal (CDR)?




Source: Adapted from The Oxford Principles for Net Zero Aligned Carbon Offsetting, September 2020

# Nature-based vs. engineered




Source: CDR Primer

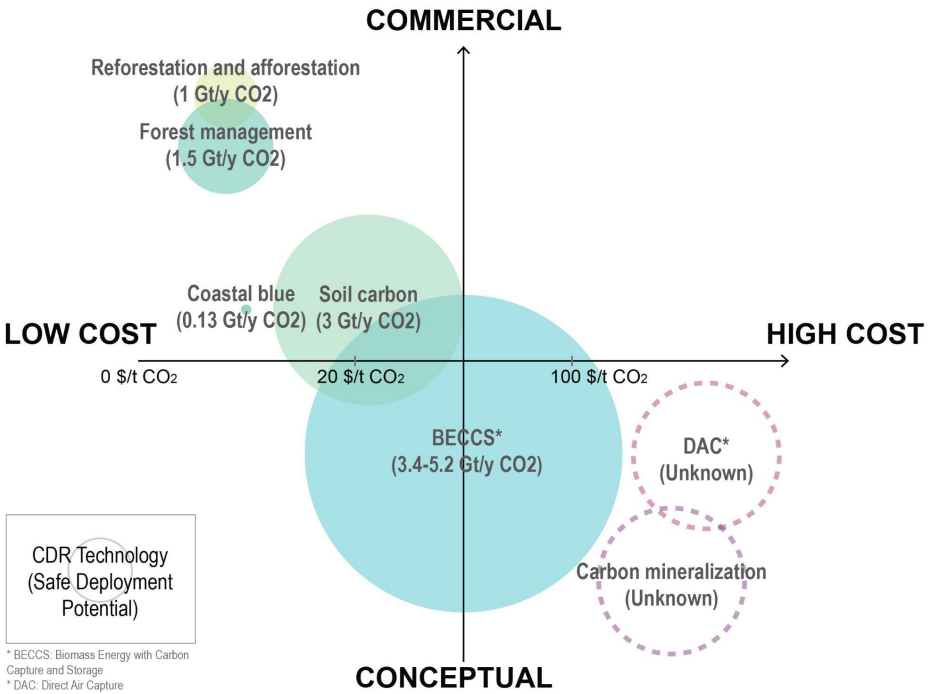
# Nature-based vs. engineered

| | Short-lived Storage | Long-lived Storage |
|---|---|---|
| **Nature-Based** | Afforestation & Reforestation<br>Improved Forest Management<br>Soil Carbon<br>Blue Carbon | Ocean Alkalinity Enhancement<br>Biomass Storage |
| **Engineered** | | Direct Air Capture (DAC) with Storage<br>Carbon Mineralization<br>Biomass Energy with Carbon Capture and Storage (BECCS) |

Source: CDR Primer

#MeanRemovals

# Vastly different potentials to scale



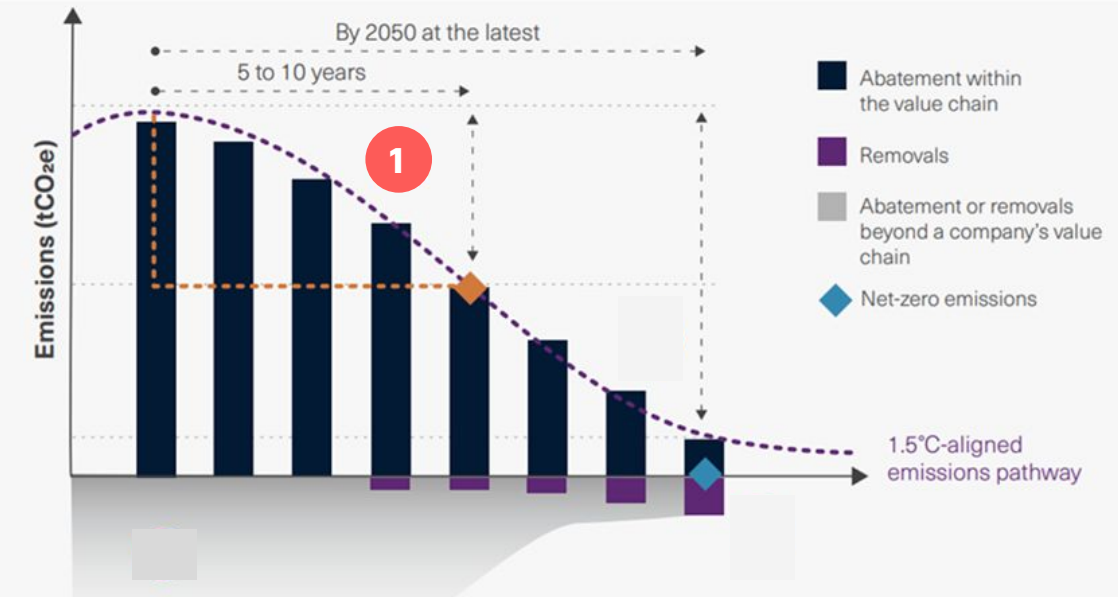

IPCC WG3 report predicts that the deployment of CDR will reach **5.8 GtCO2/yr** in 2050:

- **2.75 GtCO2/yr** of BECCS
- **2.98 GtCO2/yr** of land-based carbon removal (e.g. soil carbon)
- **0.02 GtCO2/yr** of DAC

Source: National Academies of Sciences, Engineering, and Medicine. 2019. Negative Emissions Technologies and Reliable Sequestration: A Research Agenda.
Technical Summary. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

# Removal in the context of Harvard's Fossil Fuel-Neutral Goals: Counterbalancing unavoidable emissions

## Guidance according to Science Based Targets initiative (SBTi)




Source: Science-based Targets Initiative (SBTi)

## Implications to Harvard

1 Near-term targets

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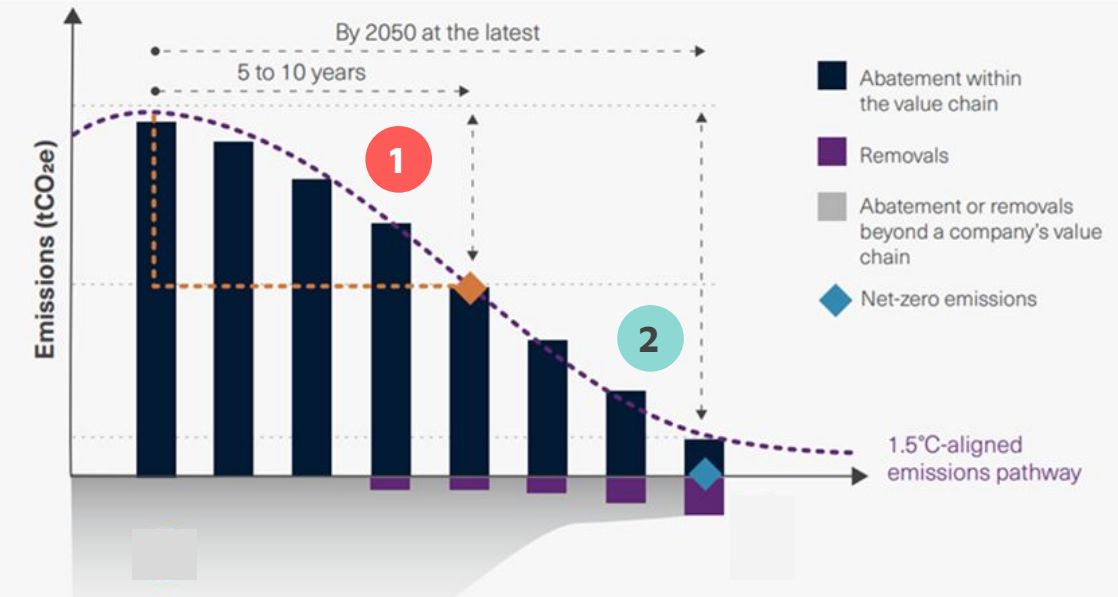


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## Implications to Harvard

1. Near-term targets
2. Long-term targets

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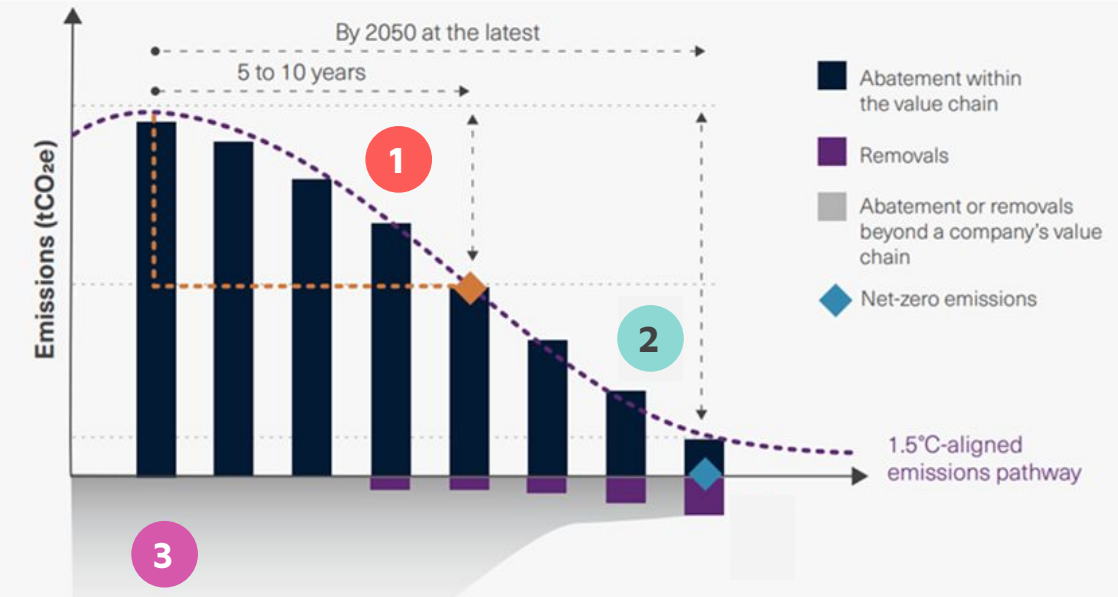


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## Implications to Harvard

1. Near-term targets
2. Long-term targets
3. Beyond value chain mitigation

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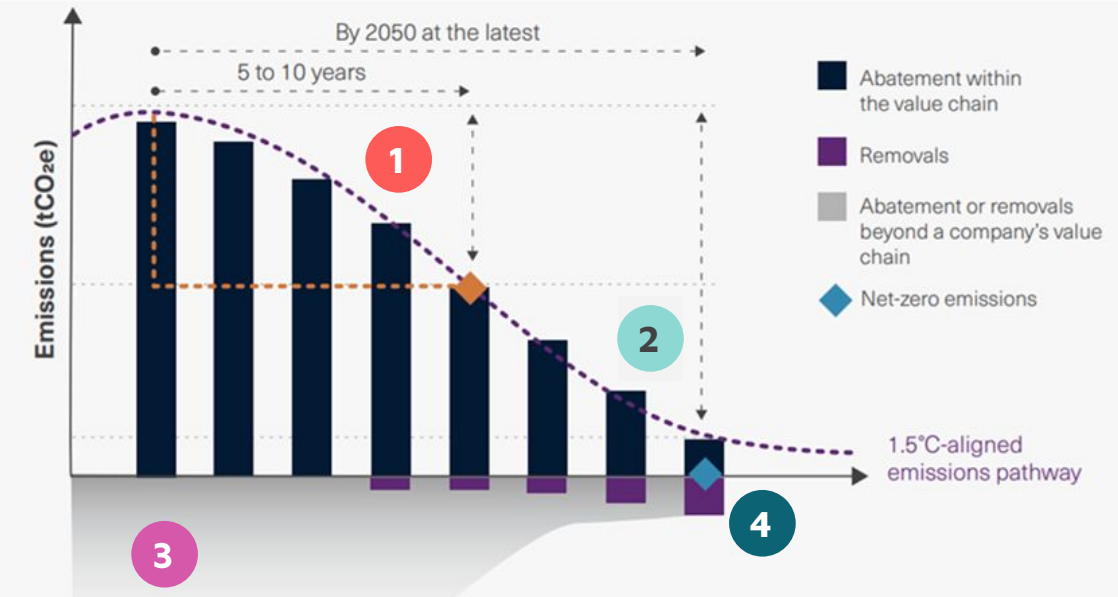
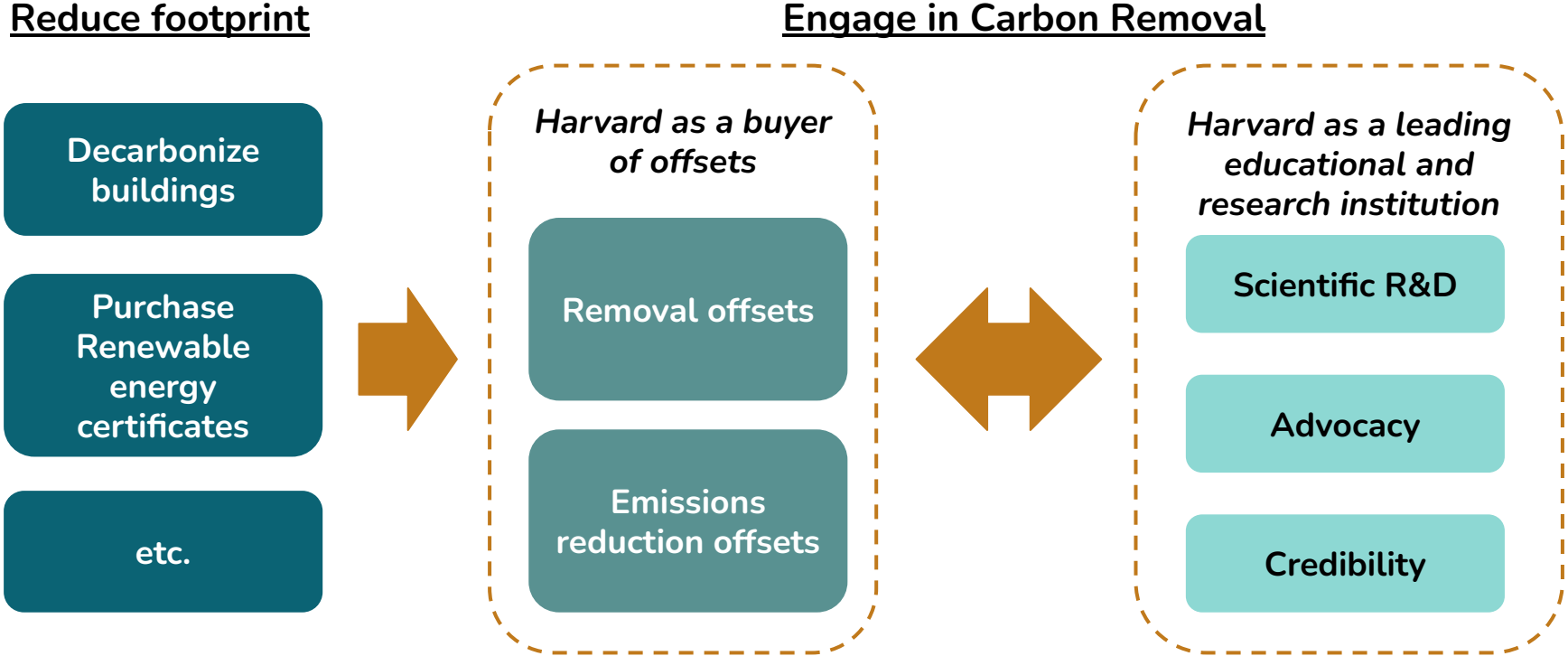



Source: Science-based Targets Initiative (SBTi)

## Implications to Harvard

1. Near-term targets
2. Long-term targets
3. Beyond value chain mitigation
4. Neutralization of residual emissions

# Engaging in CDR beyond offsets



# Both Capture AND Storage are necessary for complete carbon removal

## Simultaneous Solutions

- Improved Forest Management
- Blue Carbon
- Ocean Alkalinity

## Sequential Solutions

1. DAC (Climeworks) +
2. Mineralization (Carbfix)

climeworks + Carbfix

Source: ClimeWorks, Running Tide

# Carbon removal market is nascent

| Supply side | Demand side |
| --- | --- |
| • **<100** startups backed by venture capital<br>• Variable in scientific rigor<br>• **Lack of supply will constrain the market** in the future<br>• Seek **long-term** offtake & **early** buyers | • **~30** known buyers[1]<br>• First movers accrue **reputational gains** as thought leaders<br>• Cannot rely on widely known standards; conduct due diligence **in house or through 3rd parties**<br>• **Frontier**: $925 Mil commitment |

[1]https://docs.google.com/spreadsheets/d/1BH_B_Df_7e2l6AH8_8a0aK70nlAJXfCTwfyCgxkL5C8/edit#gid=0

# Scope of our project: Key questions

**1**

What **proportion** of offset credits purchases be removal credits?

What else can Harvard do to scale carbon removal **beyond buying offsets**?

**2**

Which categories of carbon **removal technology are most attractive** to include in Harvard's offset portfolio?

**3**

How should Harvard **operationalize its removal offset strategy**?

Specifically, how can Harvard **ensure validity** of the offset credits it purchases and **reduce transaction risks through contracting**?

1

# Recommendations for Harvard

**Become an early and thoughtful buyer of removal offsets by joining Frontier consortium**

**Foster scientific research to unblock technical constraints in removal technologies and assess risks**

**Advocate for adoption of removal standards in policy**

1

# Criteria led to three purchasing principles

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## Criteria

- **Cost attractiveness -** current cost and future potential
- **Quality -** permanence, additionality
- **Ability to scale -** technical maturity, regulatory support
- **Co-benefits -** employment, innovation spillover
- **Potential for negative impacts**

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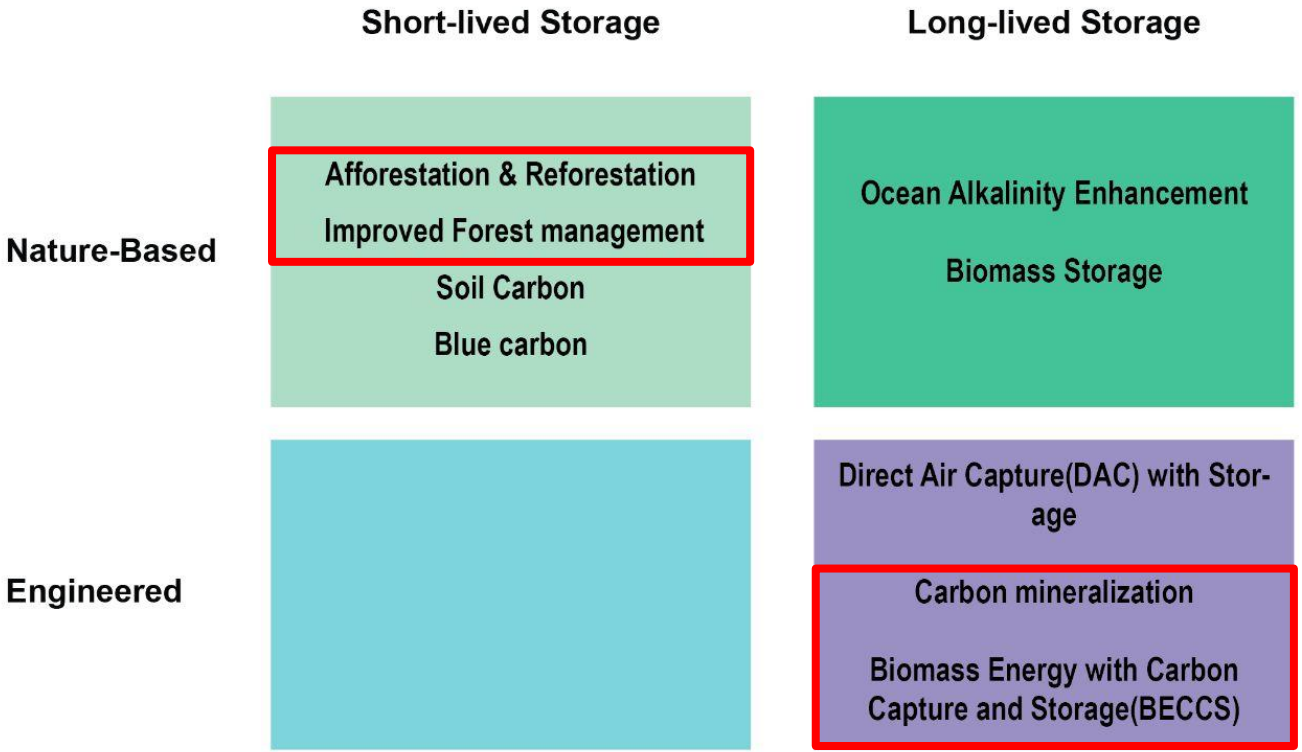
## Purchasing principles

1. **Purchase thoughtfully** rather than focus on total money spent or % of offset portfolio
2. **Balance the portfolio** too early to bet on one technology or company
3. **Build the market** long term offtake, join other credible buyers (i.e. Frontier)

# Recommendations based on criteria



2

# Four key technologies recommended

**Afforestation & Reforestation**

- Ranks high on **cost attractiveness** and **market maturity**
- Should **emphasize co-benefits** (community, health)

**Tech-enabled forest management**

- New tech for better **monitoring, reporting & verification (MRV)**
- Support **"additionality"** claims of nature-based offsets

**Carbon mineralization**

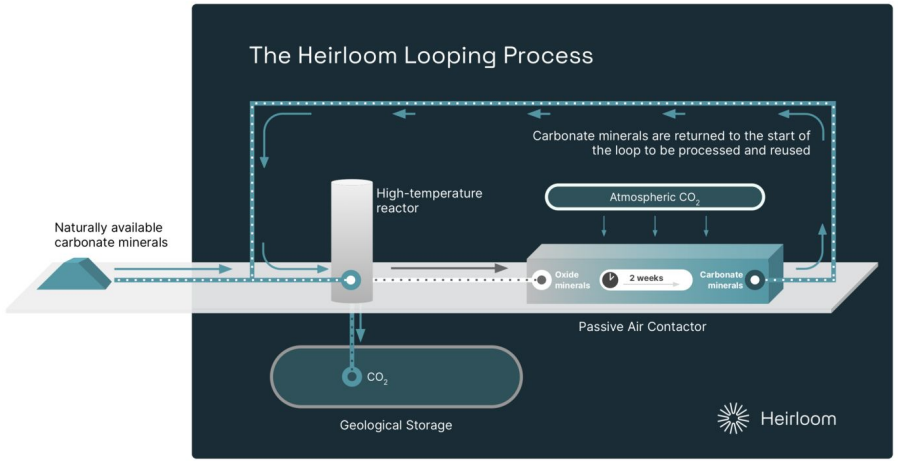
- Catalyze "high quality" **nascent technology**
- Potential **lower energy usage** compared to DAC

**Biomass ("Storage" and "Energy + CCS")**

- **Highest removal potential**, comparable to DAC (0.2 $GtCO_2$ per year with US biomass alone)
- Ability to leverage $H_2$ production to low **<$50/t$CO_2$ cost**

# CASE STUDY: How to Purchase Removal Credits from Heirloom (Mineralization DAC)

Heirloom



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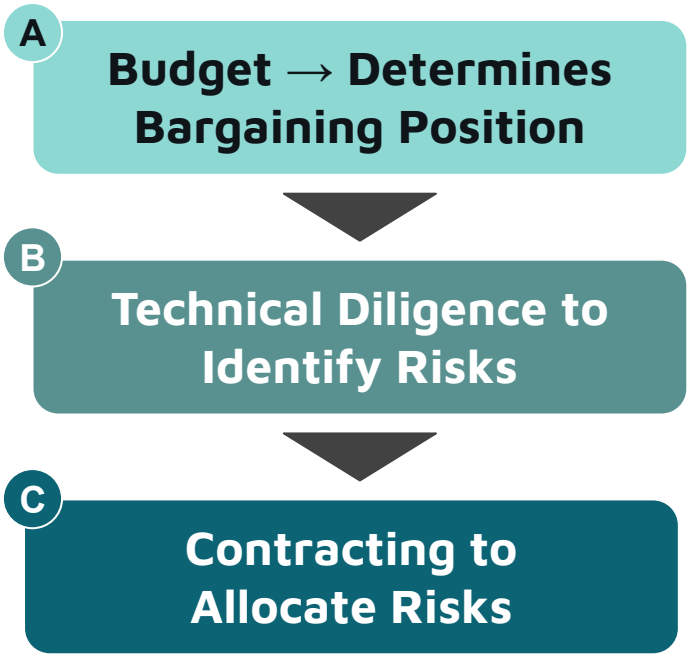

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# CASE STUDY: How to Purchase Removal Credits from Heirloom (Mineralization DAC)

A **Budget → Determines Bargaining Position**

B **Technical Diligence to Identify Risks**

C **Contracting to Allocate Risks**

- Offsets
- Entire Facility

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- Student Learning Opportunity
- 3P e.g. CarbonPlan

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- Duration
- Audits
- Co-benefits
- Walk-away or Renegotiation Provisions

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per ton of carbon removed. By December 31, 2022, Company will allow Stripe to visit Company's plant to view the plant's operations.

As part of the completion of the Carbon Removal Purchase, Company will furnish a written report to Stripe outlining: (i) how funds were used to remove carbon; (ii) how many tons of carbon were removed and at what cost; (iii) proof of tons removed; and (iv) a narrative description of Company's progress and challenges to completing the Project. Company shall provide Stripe with copies of any research or publications that it produces in connection with the Carbon Removal Purchase and Project.

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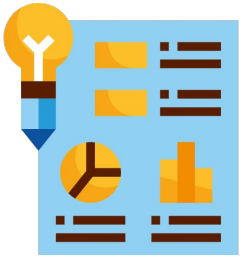
- Audits
- Co-benefits
- Walk-away or Renegotiation Provisions

# Overview of Tools

**Factsheet on carbon removal**



Infographics comparing and ranking different CDR technologies

**Sample contract language**

Hypothetical contract for a carbon removal offset deal with Heirloom

**Resource hub on removal offsets**

Public website containing all established standards for removals

# Thank you

**Experts interviewed**

1. Katie Holligan (Charm Industrial)
2. Max Scholten (Heirloom)
3. Bradley Rochin (Running Tide)
4. Karan Khimji (44.01)
5. Celia Francis (Terraformation)
6. Henry Lee (Harvard Kennedy School)
7. Jop Wettering (McKinsey)
8. Ariel Hayward (Patch)

**CSLL teaching team**

Aladdine Joroff, Debra Stump, Jacqueline Calahong, Henry Tepper

**Guest speakers**

Stacy Kauk (Shopify), James Stock (Harvard), Marcus Extavour (XPrize Foundation), Elizabeth Willmott (Microsoft)