

Carbon Capture, Utilization, and Sequestration

On the forefront of reducing carbon emissions



About Climate Angels

Climate Angels, one of India's first Climate Tech-focused funds, is a SEBI-registered AIF. We have invested in **18 climate tech** startups in the last **2 years**. The startups are operating in areas such as battery recycling, eco-friendly products, circular economy, waste-to-energy, wastewater management, EV financing, and EV charging infrastructure.

Investment Focus Areas

Although we scout for startups cracking the climate tech code across the board, here are a few sectors we have expertise in:

Clean Energy

Sustainable Build Environment

Water and Sanitation

Clean Mobility

Waste Management

Sustainable Consumption

Sustainable Food and Agriculture

Reach out to us at invest@climateangels.in

Some of our Investments



SHERU

Bidirectional battery swapping to give power back to the grid



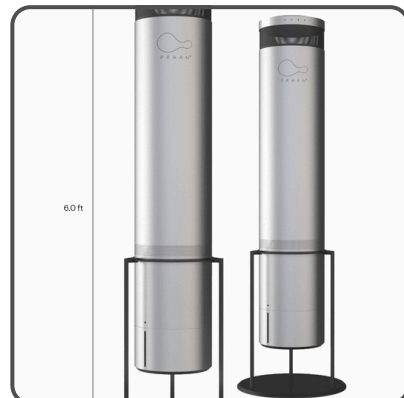
solar square

End-to-end rooftop solar solutions for homeowners



ACE Green Recycling

IP-focused, modularised platform for battery recycling



Affordable, filter-less tech to capture & upcycle pollutants



BECO

Bamboo-based, eco-friendly home care products



E-MOTORAD

4-in-1 mode E-bikes for last mile personal mobility



MATTER

Electric 2W vehicles & energy storage solution platforms



Zero Cow Factory

Animal-free milk using bioengineering and microbial fermentation



INDRA

Decentralised, modular water treatment systems

About Massive Earth Fellowship

Massive Earth Fellowship brings together a community of **climate experts, investors, founders**, and **passionate individuals** to empower climate champions, foster innovation, and build a sustainable future. Join our global community for exclusive events, resources, and networking to drive meaningful change for our planet.

Join to get access to

Community

Get access to community of climate experts, investors, founders, and passionate individuals.

Knowledge

Access to Climate 101
Monthly knowledge sessions, reports and research papers.

Guidance

Expert guidance for startup and access to partnership, investment and fundraising opportunities

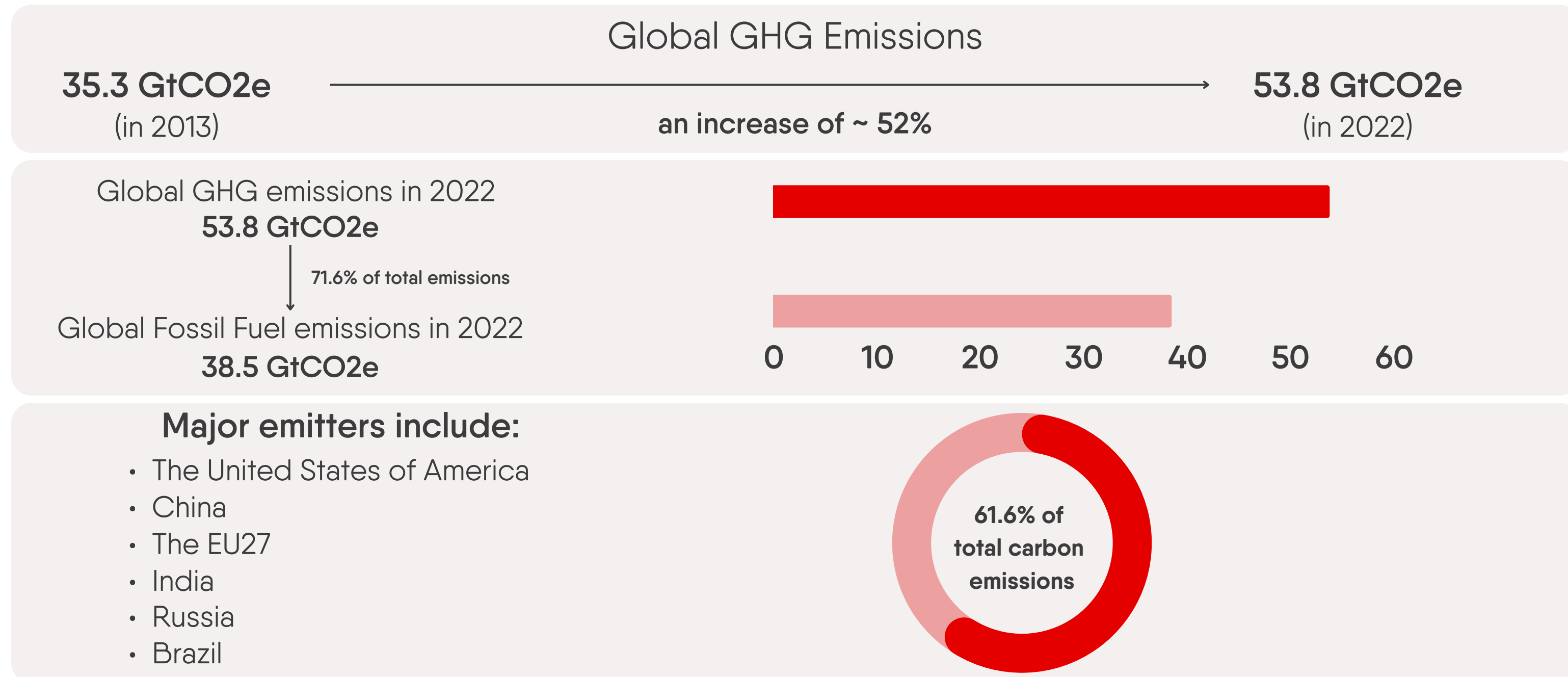
Opportunity

Chance to connect, interact and collaborate with like minded individuals and industry stakeholders.

Check us out at [Massive Earth Fellowship](#)

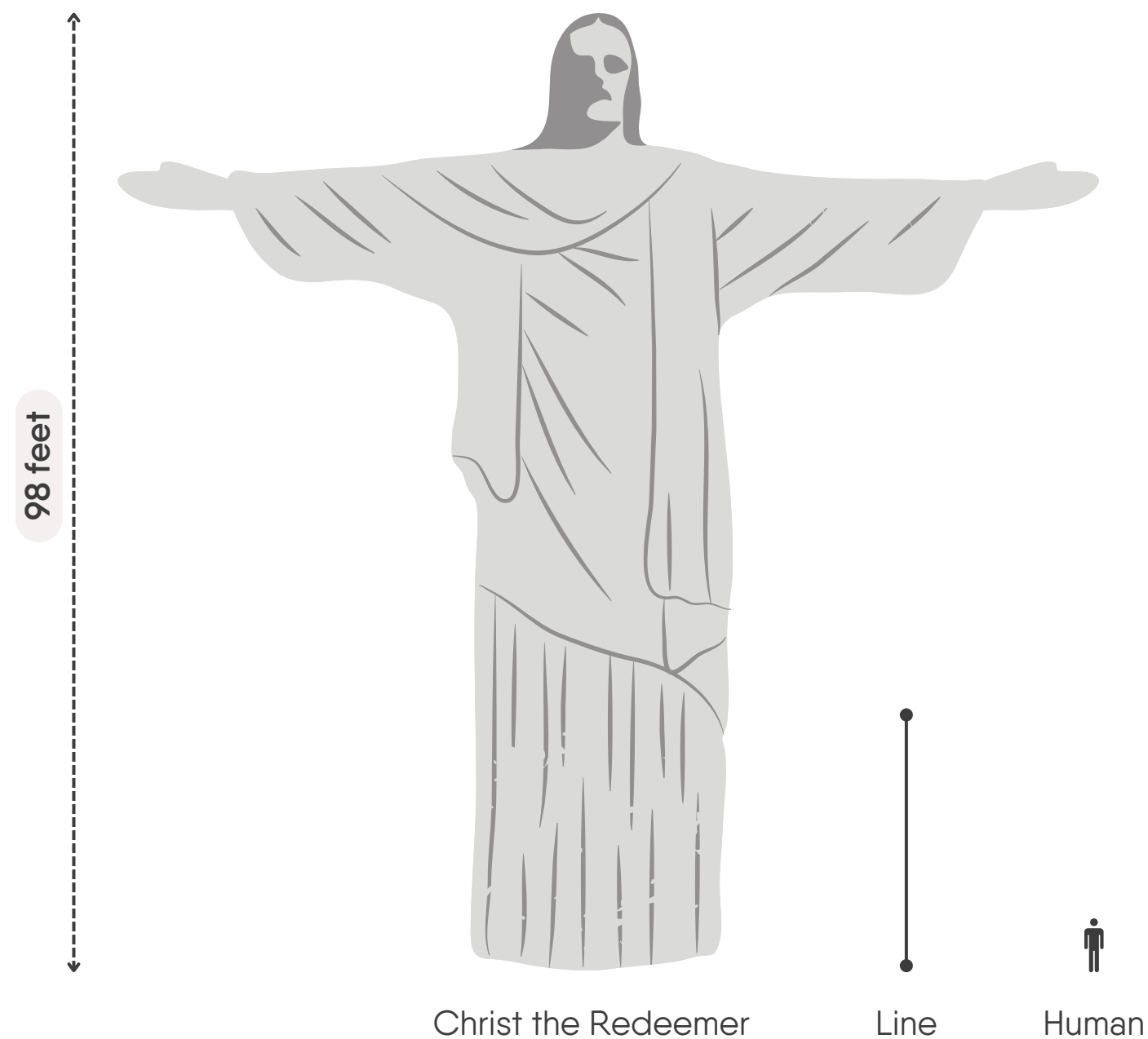
Issue Statement

The mountain of carbon emissions keeps piling up



How much does a ton of CO2 look like?

Introducing a visual to aid in understanding

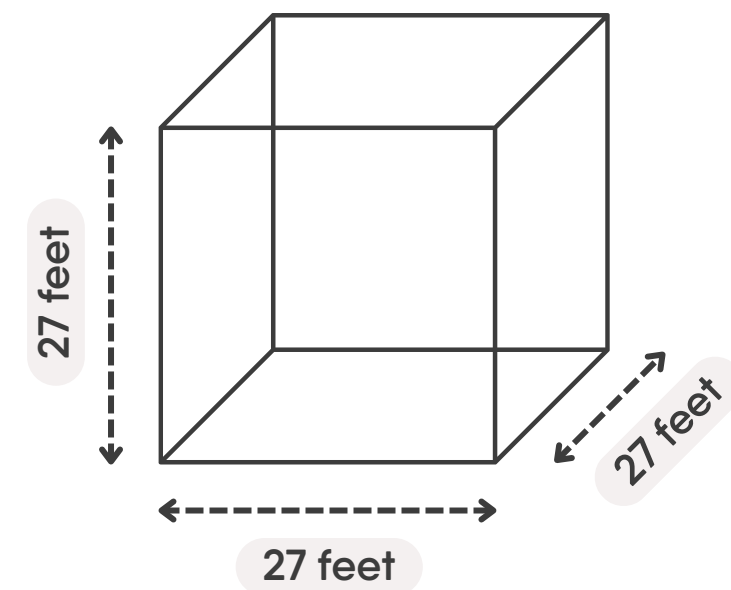


Height Comparison

Christ the Redeemer: 98 feet

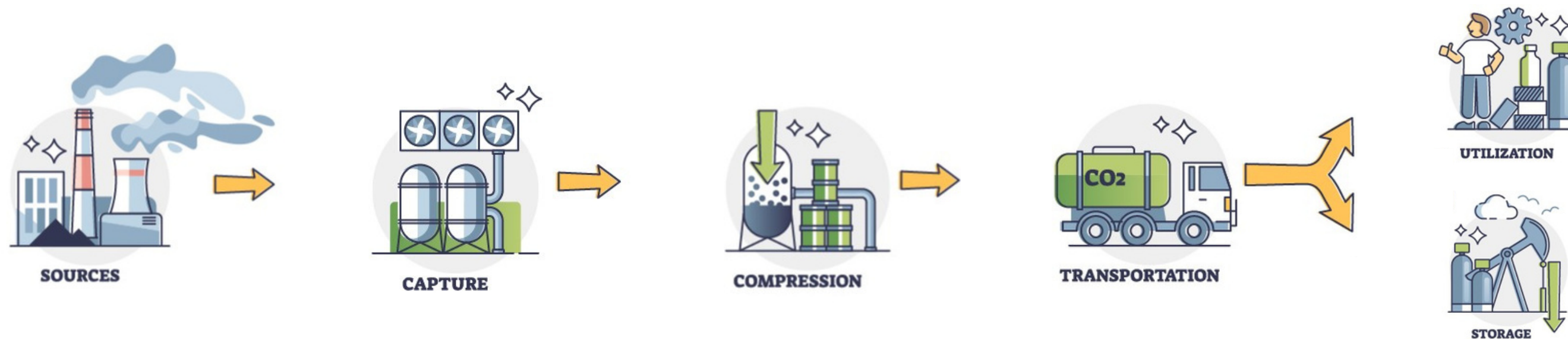
Line: 27 feet

Human: 5.5 feet



CCUS – A Pioneering Deep-Tech Solution

CCUS is a technology that has the potential to capture and store carbon for a long time, making it an excellent aid to contemporary technology. The process is as follows:



① Carbon Capture

Carbon capture from **industrial plants** and **power generation facilities** takes place. After compression, CO₂ is transported to a storage facility via **pipelines, ships or trucks**.

② Carbon Use

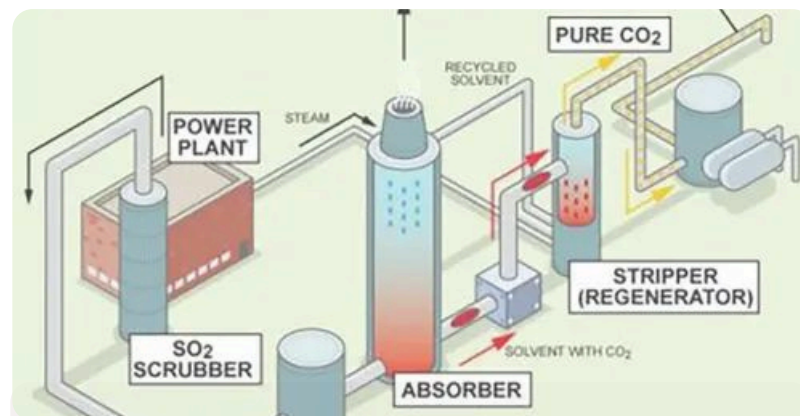
Concrete, used in construction and **plastics**, can be produced from captured carbon. Utilising it as **feedstock** prevents CO₂ from releasing into the atmosphere and is used as input in multiple industries.

③ Carbon Storage

Captured carbon is injected into **deep underground geological formations**, either **onshore** or **offshore**, which could include depleted oil and gas reserves or saline aquifers.

Carbon Capture

Types of carbon capture include:



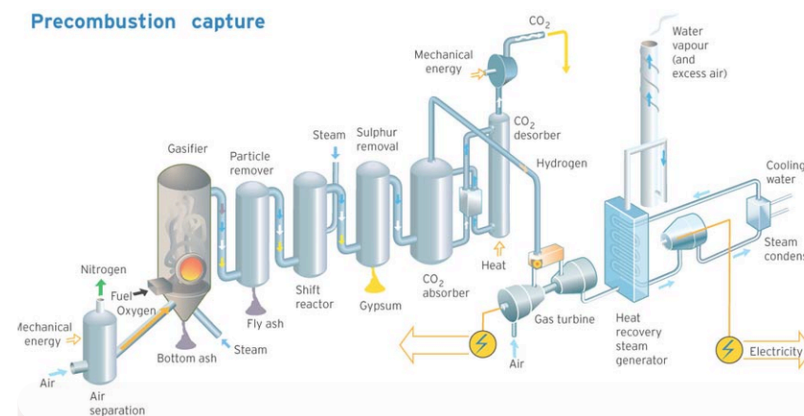
Post - Combustion Technologies

Fossil fuels like coal, oil, natural gas, etc. are burnt in presence of air to release

N_2 CO_2 (3-15%)

High-volume chemical solvent (amine) is circulated for carbon capture

↓
This makes the process energy and cost-intensive



Pre - Combustion Technologies

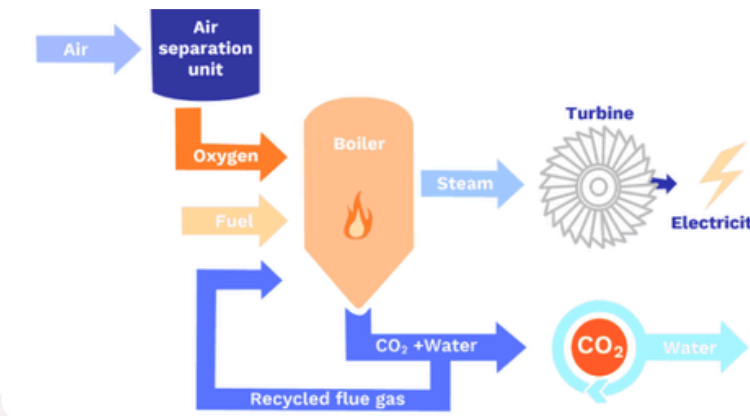
Carbon-based fuel undergoes gasification, to form a mixture called syngas

(made of CO , CO_2 , H_2 , and CH_4)

Syngas undergoes water-gas shift reaction where



CO_2 is captured from the syngas, to be transported for sequestration



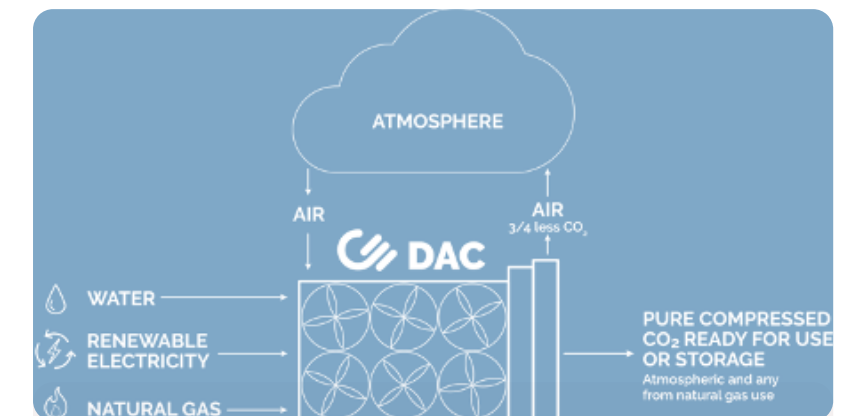
Oxy - fuel Combustion Technologies

Oxy-fuel combustion technologies are in early developmental phase.

Here, fuel is burned in pure O_2 rather than air (N_2 and O_2)

Flue gas composed of H_2O and CO_2 , rather than N_2 .

High purity CO_2 can be recovered by condensation of water.



Direct Air Capture

Direct Air Capture captures diluted CO_2 (400 ppm) from the air

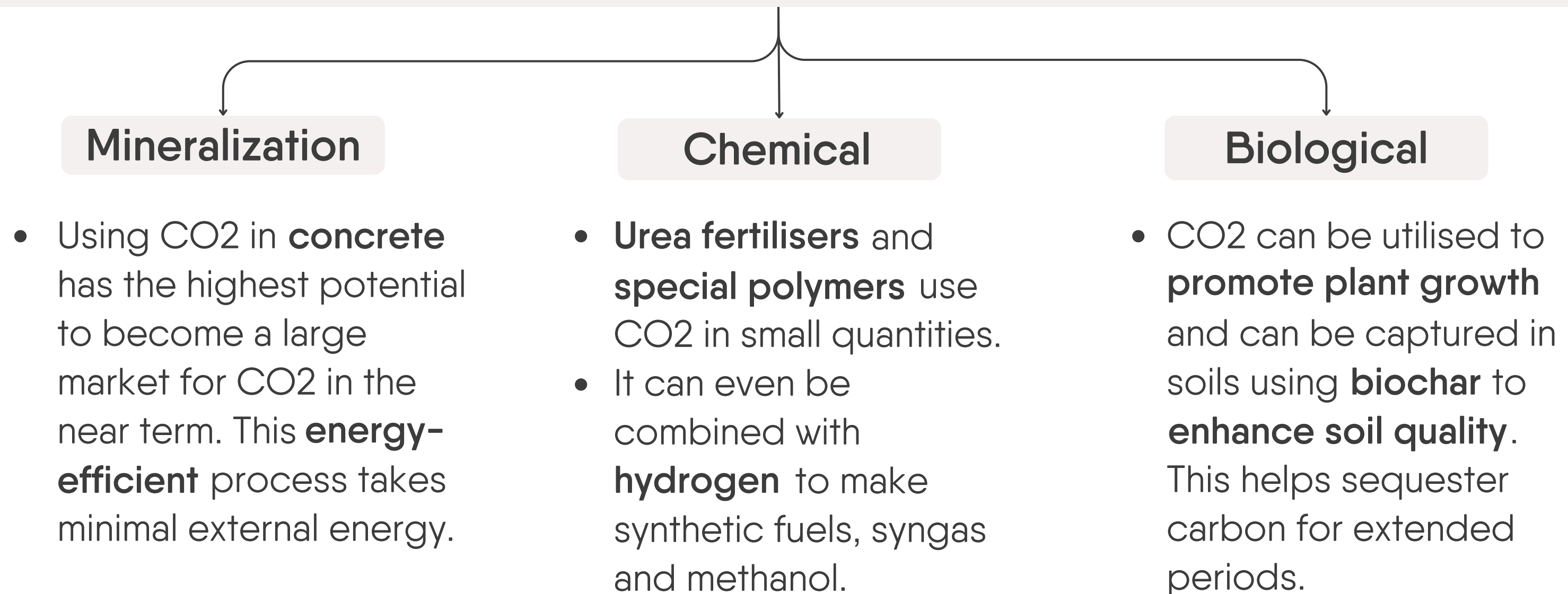
It has wide applicability, as it is independent of the **source** and **concentration of the emissions**.

The captured carbon can be **sequestered geologically** or **applied to another use**.

Carbon Usage

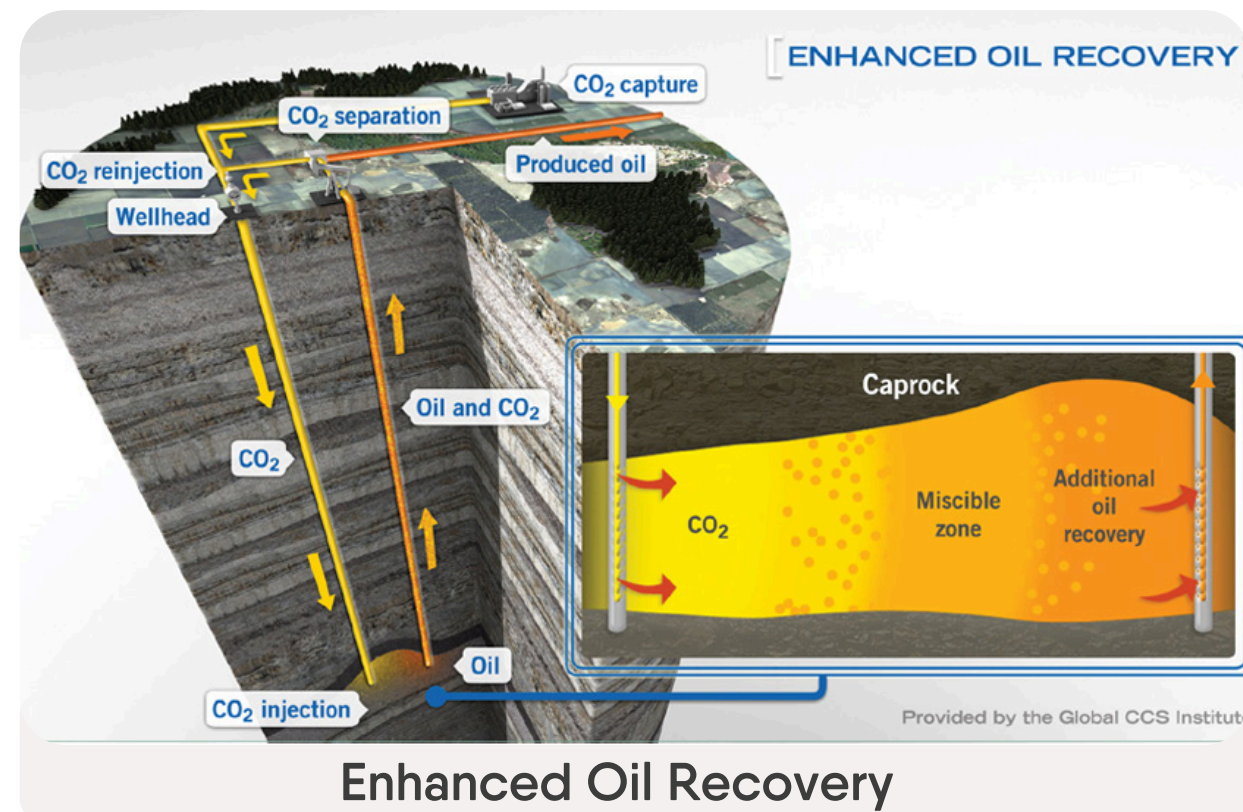
Ways in which captured carbon can be utilised are:

The aim of carbon utilisation is to create **economic value** by using carbon dioxide to make multiple products. Carbon utilisation has three sub-areas.

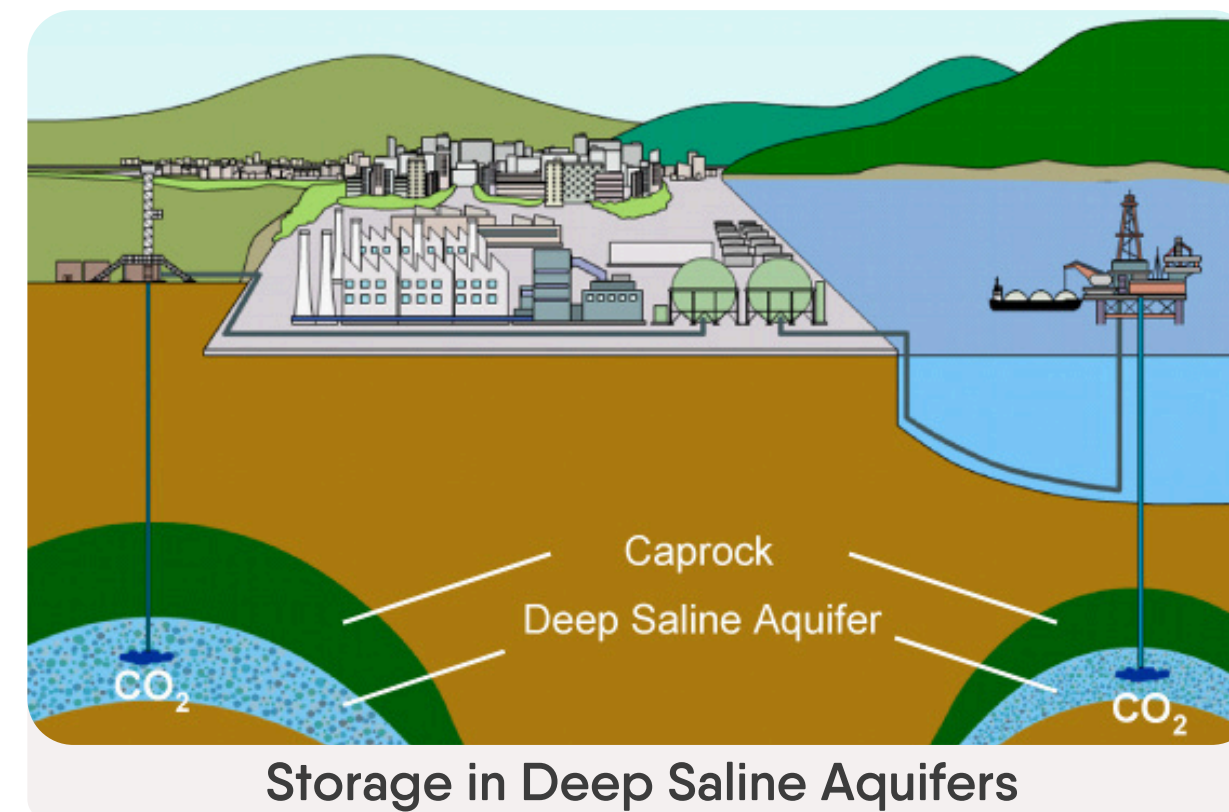


Carbon Storage

Captured carbon can be permanently stored via:



- During EOR, the reservoir is injected with **compressed CO₂**. When compressed to high densities, it mixes well with oil.
- This mixture causes the **oil to swell** and reduces its thickness, moving away from rock formations and towards the production wells.
- However, a **minimum pressure** is necessary for CO₂ and oil to mix properly.



- CO₂ can be stored underground by **injecting it into rocks**. When CO₂ is injected into an aquifer, it displaces the **brine** and creates a **plume** at the top of the aquifer.
- At the interface of CO₂ and brine, some CO₂ will dissolve in the brine. As a result, the **acidity** in the aquifer, **increases** affecting the natural chemical reactions. The CO₂ can **mineralize** to form rock over millions of years.

The role of CCUS in achieving Net Zero

Here are four significant ways in which CCUS can play a pivotal role in the transition of the global energy system to net zero:



Tackling existing energy emissions

Emissions cut required from
power stations and **heavy industries**
 for the global transition to **clean energy**
 CCUS is vital for
 repurposing existing facilities
 to reduce environmental impact by capturing CO₂



Solution for emissions in hard-to-abate sectors

CCUS technology developed as a solution to capture CO₂
 ↓
hard-to-abate industries
 ↓
aviation, **heavy manufacturing (cement, steel, etc.)**, and **shipping**
 where fossil fuels are predominantly used due to **cost and practicality constraints**



Removing carbon from the atmosphere

Planting trees and **enhancing natural processes** with advanced biochar are effective in reducing atmospheric carbon.
 Hence, a **backup plan** is available
 ↓
 to address challenges in implementing other tech commercially.

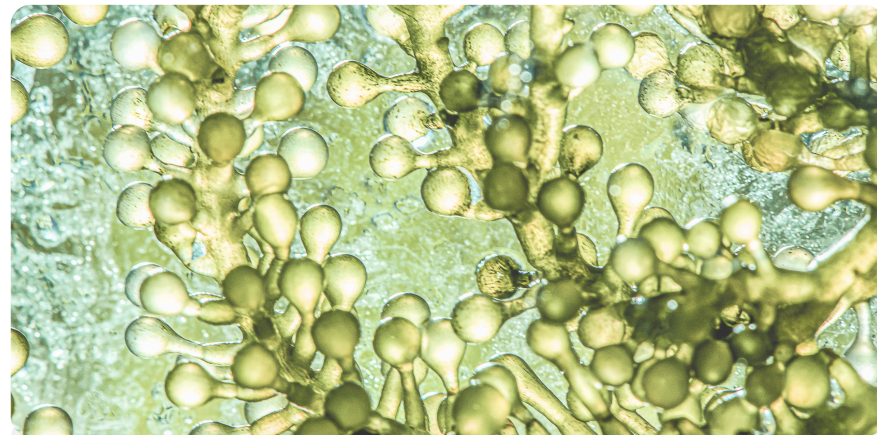


Platform for low-carbon hydrogen production

CCUS supplements the **production of clean hydrogen** from
natural gas and **coal**
 to bring low-carbon hydrogen into market at **lower cost**.
 It could prove to be a gamechanger for sectors like **industry and transportation** that rely on hydrogen.

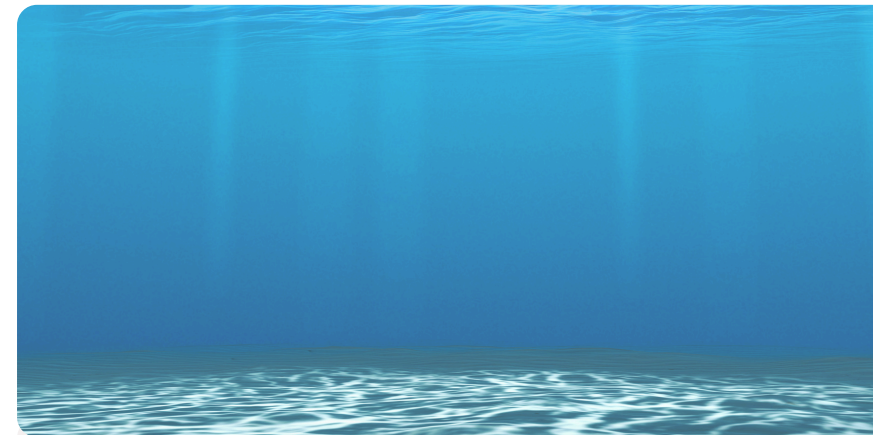
Emerging Trends in the CCUS Industry

CCUS innovations are noteworthy in combating carbon emissions, with emerging technologies in early development, which are as follows:



Microalgae-based Carbon Capture

- Microalgae, microscopic organisms, play a crucial role in capturing CO₂ through photosynthesis, **fixing it at the seabed**.
- **Trap**  **for growth and release** 
- They trap **more CO₂** than terrestrial plants and **deacidify water**.
- **Applications:** Bioenergy
Wastewater Management
Bioproducts



Ocean-based Carbon Capture

- Enhancing ocean processes to sequester CO₂ is crucial due to the ocean's **significant carbon storage capacity**.
- **Abiotic Approach** alters the chemical properties of oceans.
- **Biotic Approach** impacts photosynthesising organisms in the ocean to protect and enhance the ocean's carbon absorption abilities.



Enhanced Mineralization

- Weathering is the natural breakdown of rocks and minerals due to factors like water, air, and temperature changes.
- Minerals like **calcite** react with CO₂ to form **carbonates**, storing CO₂.
- Enhanced weathering accelerates this process by using rocks like **olivine** or **basalt** to absorb CO₂, providing long-term carbon storage.

Associated Risks with CCUS

The key risks associated with the CCUS value chain should be addressed as it involves managing complex multi-stakeholder relationships:

① Huge Infrastructure Capex

Implementation of CCUS → High upfront cost

- Building facilities
- Pipelines for transportation
- Storage infrastructure

② Integrity of Storage

Potential risk factors:

- Leakage through geological faults or fractures
- Inadequate sealing of injection wells
- CO2 escape

③ Environmental Impact

Captured CO2 → utilization → Enhanced Oil Recovery

Negative environmental impacts if the process relies on emission generating energy sources

④ Public Perception and Acceptance

Effective stakeholder management is paramount



To assuage concerns regarding:

- Safety
- Environmental Impact
- Long-Term Liabilities

⑤ Regulatory and Policy Risks

Viability and profitability of CCUS projects depends on:

- Government Policies
- Regulations
- Financial Incentives

⑥ Technological Risks

CCUS Tech faces technical headwinds related to:

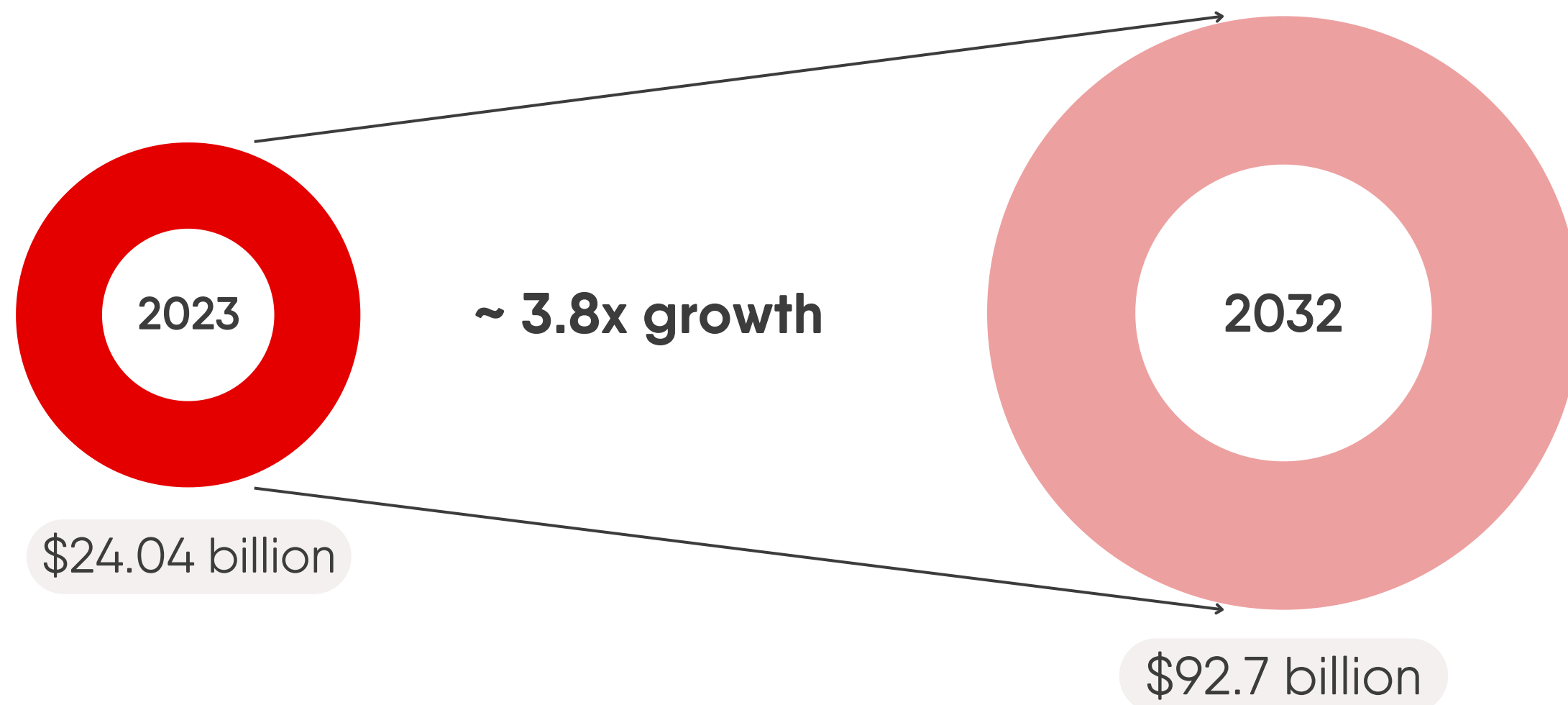
- Scalability
- Efficiency
- Reliability



R&D efforts address technological risks but require targeted investments

Market Size of CCUS (Europe and the US)

According to CMI, the total market size of carbon capture, utilisation, and storage in Europe and the US was estimated to be **\$24.04 billion** in 2023 and is poised to grow at a CAGR of **14.4 %** from 2023 to 2032. Based on their estimates, the CCUS market will hit **\$92.7 billion** by 2032.



Startups with Ingenious CCUS Solutions

Looking at global startups cropping up in the CCUS space.

loam



CarbonBuilder

Founded: 2019

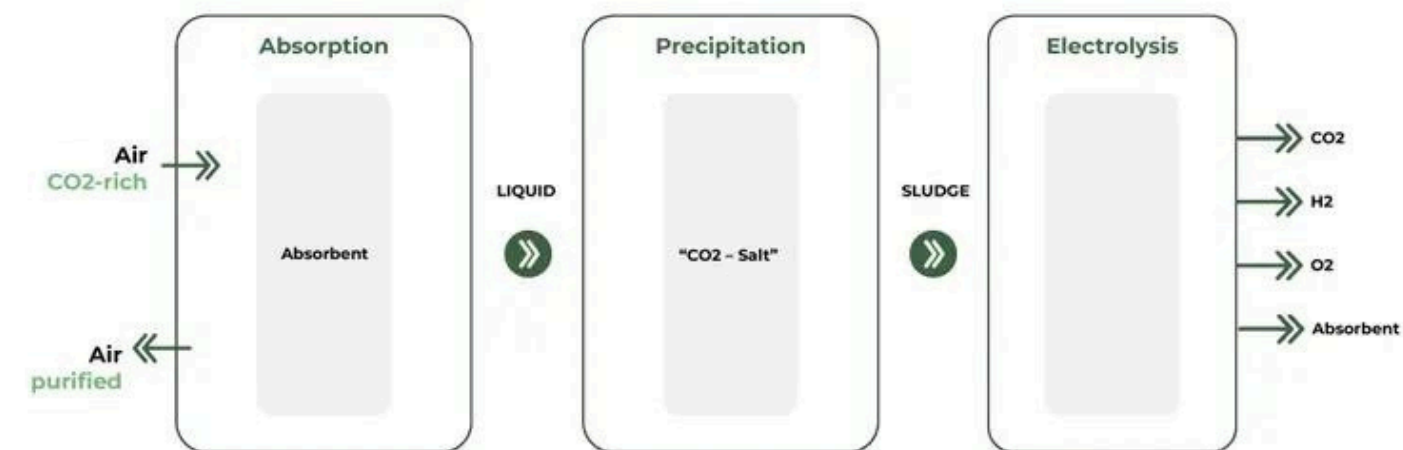
Based out of: Orange, Australia

Funding: \$150 million (Last round – Series B of \$105 million in February 2023)

Investors: Lowercarbon Capital, Wollemi Capital, Grok Ventures

GCT

Greenlyte Carbon Technologies



Absorption

Precipitation

Electrolysis

Founded: 2022

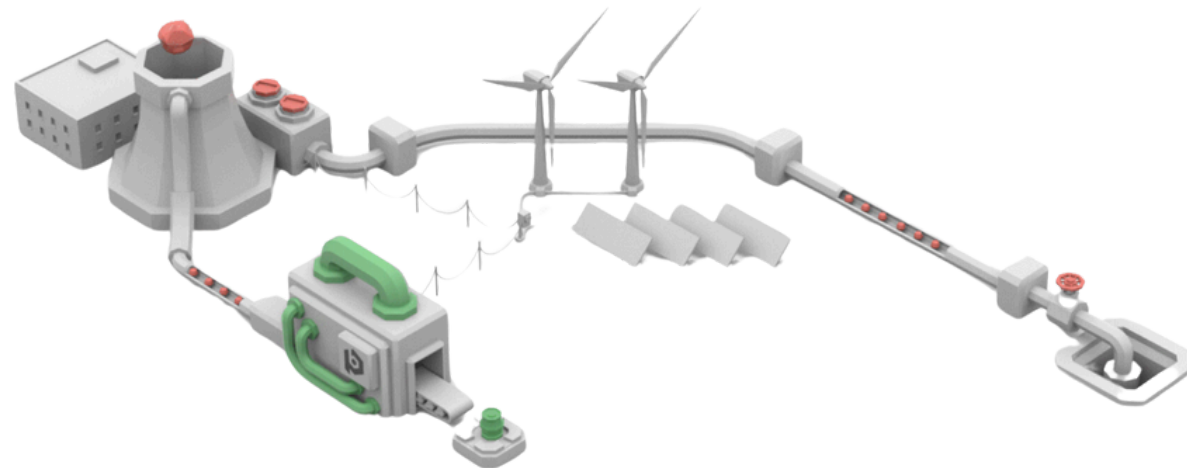
Based out of: Essen, Germany

Funding: \$22 million (Last round – Pre-Series A of \$11.5 million in March 2024)

Investors: Earlybird Venture Capital, Green Generation Fund, Carbon Removal Partners

Startups with Ingenious CCUS Solutions

Looking at global startups cropping up in the CCUS space.



Gas Fermentation Process

Founded: 2020

Based out of: Nottingham, The UK

Funding: \$125,000 (Last round – Seed of \$125,000 in March 2022)

Investors: Y Combinator, Transition



Sustainable Concrete

Founded: 2007

Based out of: Dartmouth, Canada

Funding: \$169 million (Last round – Series E of \$80 million in July 2023)

Investors: Blue Earth Capital, Taronga Ventures, Breakthrough Energy Ventures

Global Startups in the CCUS Ecosystem

The United States
of America

LanzaTech

FORTERA

opus 12

Solugen

CHARM

RUBI

REMORA

ebb carbon

Heirloom

The European Union

PYREG
NET ZERO TECHNOLOGY

skytree

CATALYST

mecaware
eco-cycling for better future

CarbonWorks

NEOCARBON

Carbfix

climeworks

Paebbl™

The United Kingdom

carbon clean

MISSION ZERO TECHNOLOGIES

nuada

The Tyre Collective.

Cquestr8

SEABOUND

Brilliant Planet

SPIRITUS

Rest of the World

Svante

Carbon Engineering

44.01

DEEP SKY

OCTAVIA CARBON

CarbiCrete

cleanO₂

CAPTURE6

Indian Startups in the CCUS Ecosystem



Startup Name: Carbonlites

Total Funding: \$1.67 million

Investors: Sangam Ventures, Schneider Electric, T&I Global



Startup Name: ArSta Eco

Total Funding: \$524,000

Investors: Paul Guire and other Angels



Startup Name: BillionCarbon

Total Funding: Undisclosed

Investors: i-Hub Gujarat (Grant)



Startup Name: Boomitra

Total Funding: \$4 million

Investors: Yara International, Chevron Technology Ventures



Startup Name: CarbonCraft

Total Funding: Bootstrapped

Investors: NA



Startup Name: CarbonStrong

Total Funding: NA

Investors: Bharat Founders Fund



Startup Name: AgroMorph

Total Funding: Undisclosed

Investors: XCarb India Accelerator



Startup Name: AltCarbon

Total Funding: \$550,000

Investors: Shastra VC, consortium of angel investors

Thank You



Climate Angels

Website : [Climate Angels](#)
Contact : invest@climateangels.in