HOLOCENE

ORNL – DOE Better Plants Technology Days

2024

Holocene's founding team

Our founders have been designing, building, and commercializing the world's first DAC facilities for over a decade

Anca Timofte

Co-Founder, CEO

ETH zürich · climeworks · STANFORD BUSINESS SCHOOL OF GRADUATE

Joined Climeworks as the 6th employee and first chemical/process engineer; invented and patented heat recovery systems for ORCA

7 years of direct air capture R&D and project execution, followed by a Stanford MBA

Keeton Ross

Co-Founder, President

McKinsey & Company · CO280 Carbon Negative Solutions · Patch

Supported dozens of climate tech / hard-tech start-ups in roles at McKinsey & Company, Evok Innovations (VC), and Patch.

Invested in & commercialized DAC companies; Co-founded a bio-CDR project developer, CO280.

Tobias Rüesch

Co-Founder, CTO

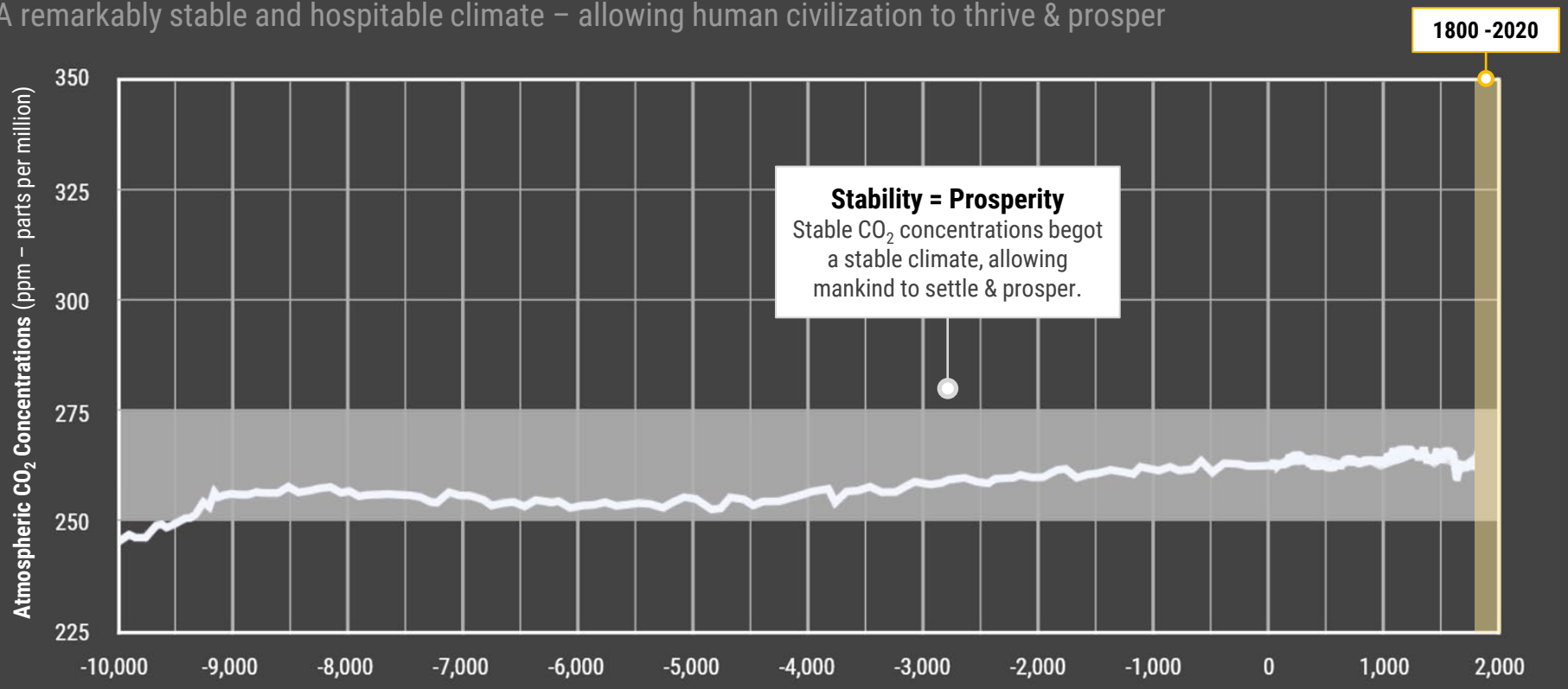
ETH zürich · climeworks · Hitz Hitachi Zosen

Joined Climeworks as the 2nd employee and first mechanical engineer, overseeing development of 1st DAC plant (Hinwil)

3 years at Hitachi Zosen building waste to energy plants around the globe

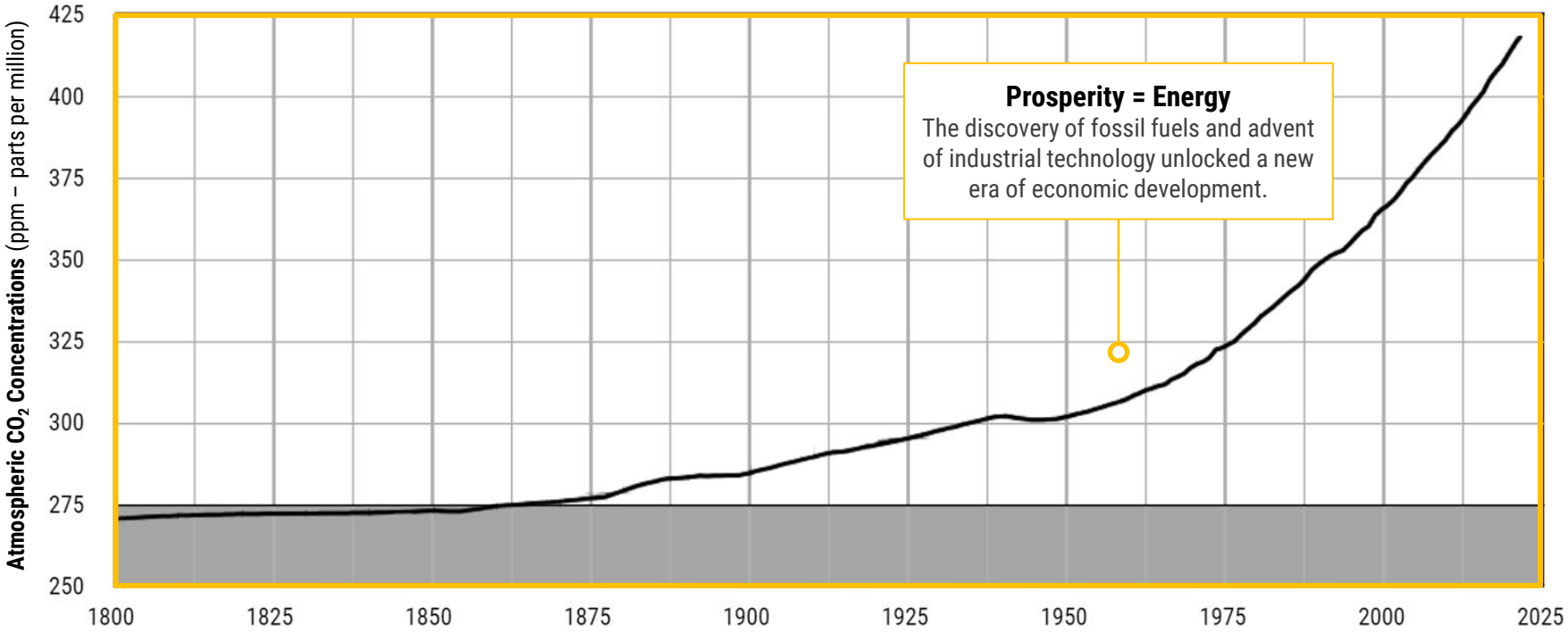
The Holocene Epoch

A remarkably stable and hospitable climate – allowing human civilization to thrive & prosper



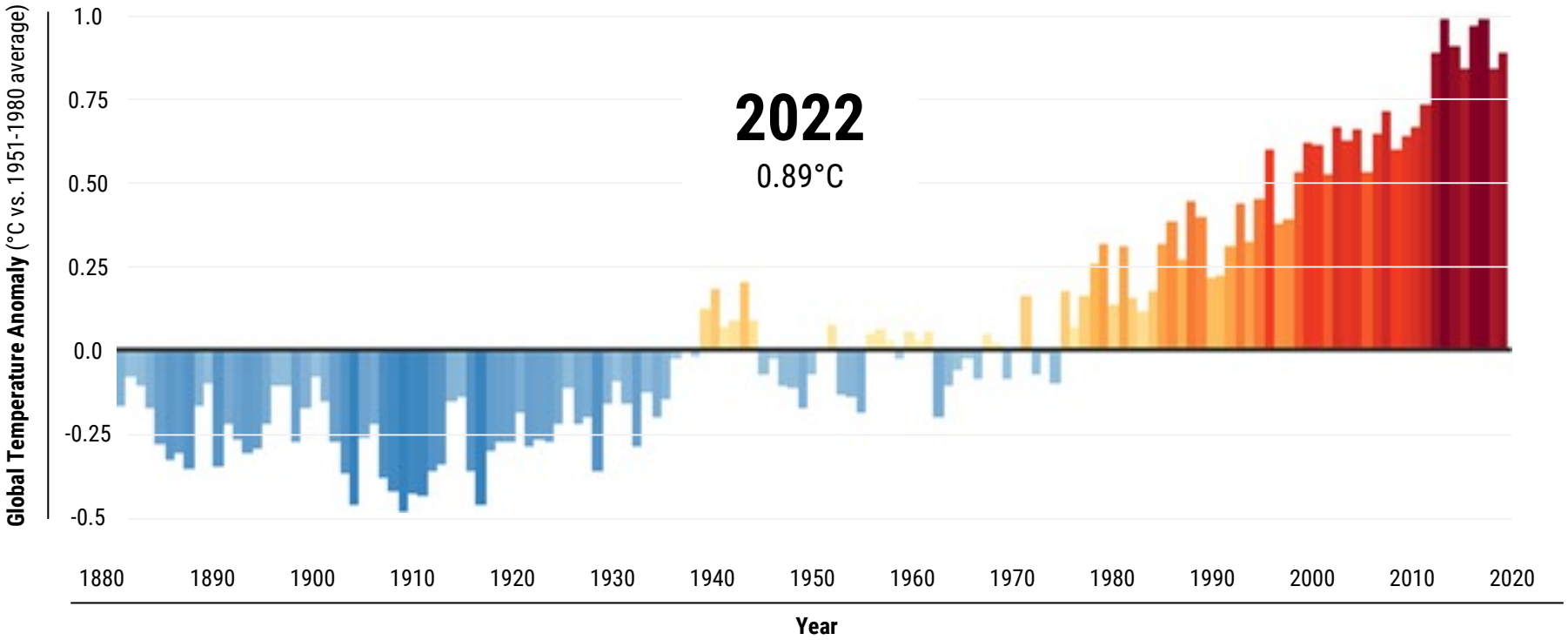
The Anthropocene Epoch

An intensely rapid period of human and economic development – thanks to the extraction & utilization of fossil fuels



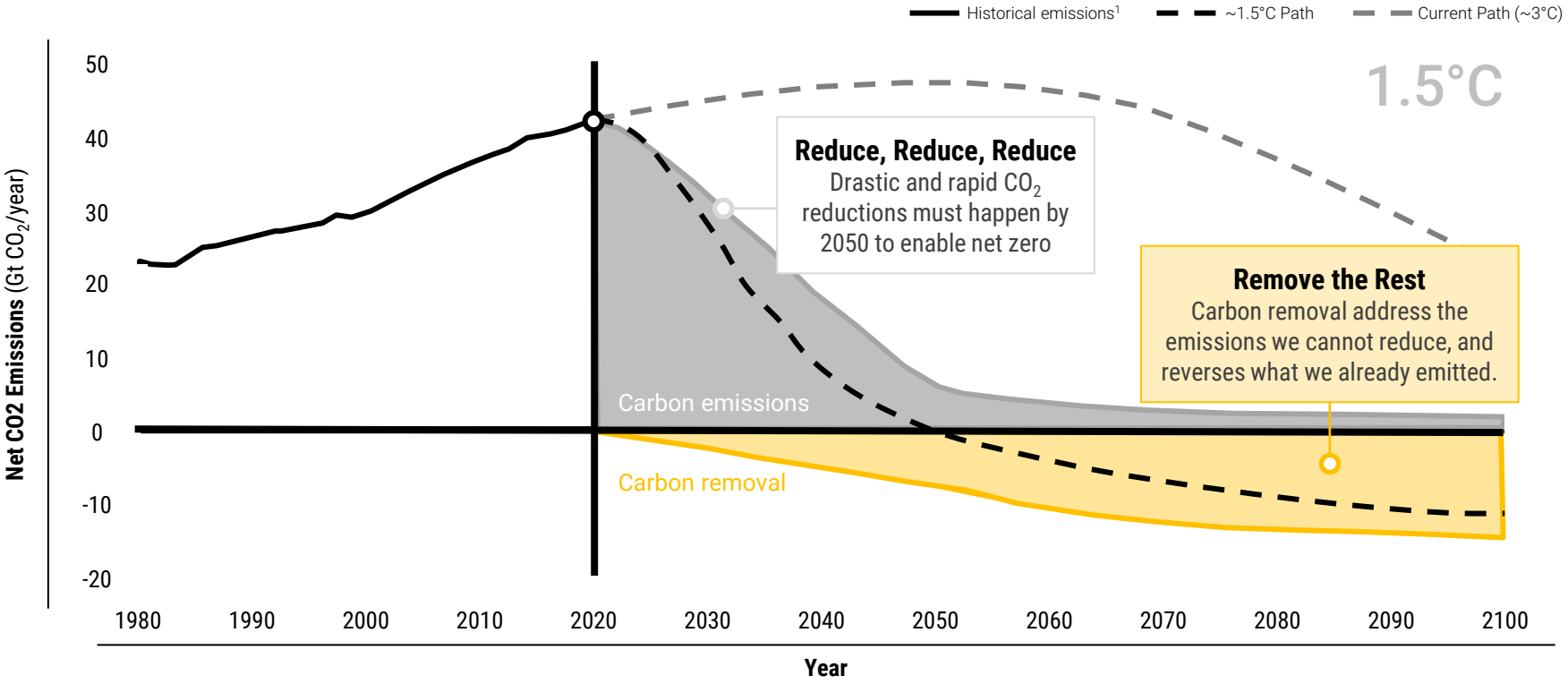
Direct relationship: Atmospheric CO_2 & Temperature

Driven by the greenhouse effect – and predominantly caused by CO_2 emissions – temperatures are rising dangerously



Restoring the Holocene – sustaining progress, avoiding pain

The path to restoring the Holocene Epoch while maintaining progress means creating a net-new industry, carbon removal



Source: Global Carbon Project; IPCC Scenarios SSP4-6.0; style adapted from Frontier Climate; 1 – CO_2 emissions only, rather than CO_2 equivalent

We are creating a net-new industry with unprecedented scale

Carbon removal ambitions result in moving as much physical mass as the oil & waste industry combined, annually.

Oil & Gas Industry[1]

5Bn tonnes
Of oil consumed annually (~100MMboe)

$500/tonne
Market price of oil (~$60/barrel)

160 years
Since the start of the oil industry (~1860)

Waste Management Industry[2]

2Bn tonnes
Of municipal solid waste created annually

$800/tonne
Global price of garbage removal services

180 years
Since the first organized MSW industry (1840)

Carbon Removal Industry[3] (2050)

7Bn tonnes
Projected size of CDR industry (2050)

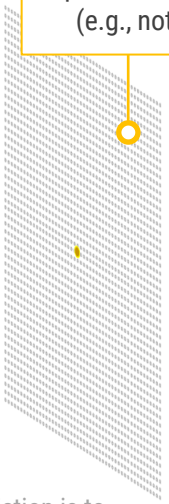
$100/tonne
Target price for carbon removal costs

40 years
Between start of DAC (2010) and 2050

A direct air capture machine

Pulling carbon dioxide directly out of the atmosphere

Selectivity
Only grabbing the 1 part per ~2500 that is CO2* (e.g., not H2O, O2, …)



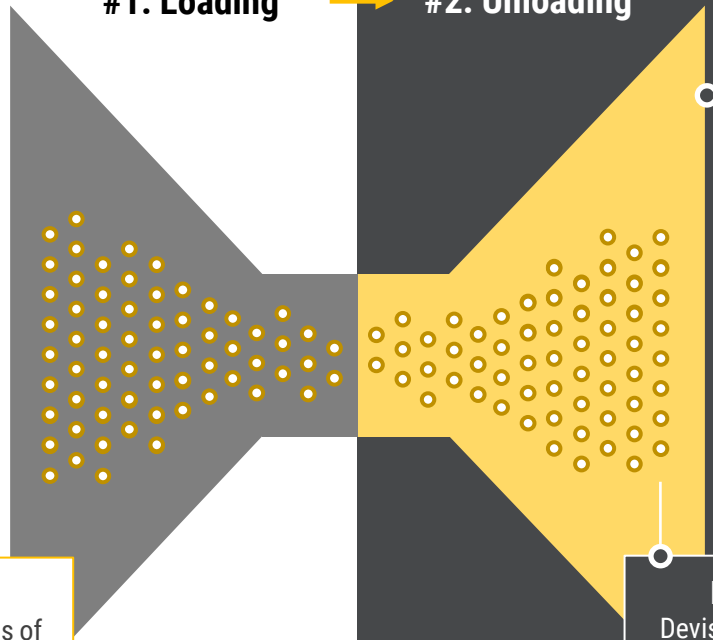
Depiction is to scale (2500:1), yellow dot represents CO_2

Ambient Air

x1,000,000+

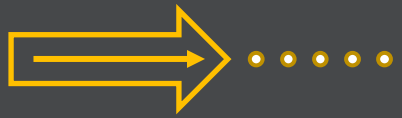
Mass Transfer
Moving massive amounts of air via a highly durable system to make a meaningful impact

#1: Loading → **#2: Unloading**



Energy Efficiency
Optimizing for regeneration energies, heat recovery, and total system energy loads

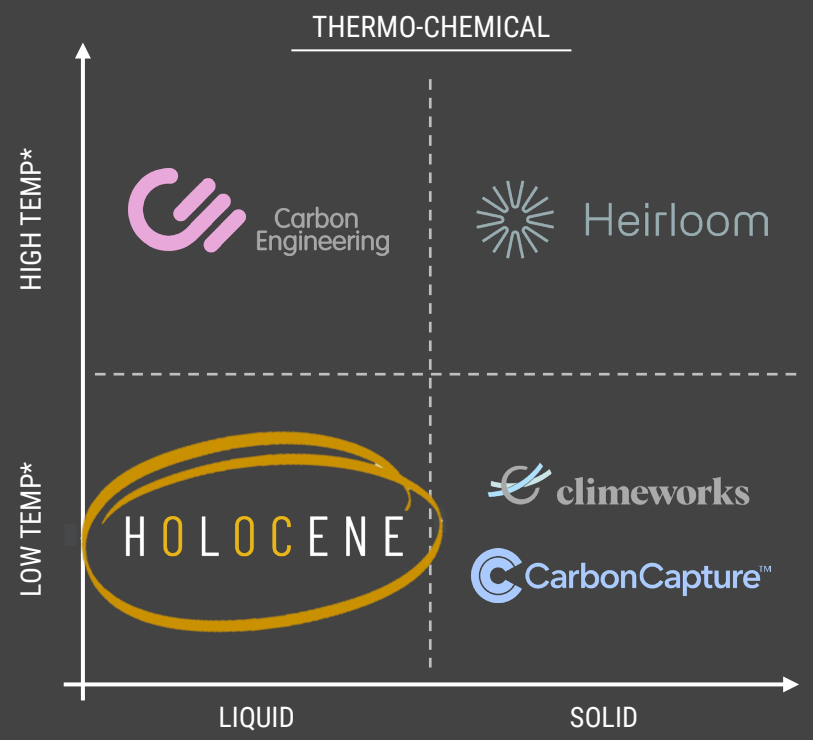
Pure CO_2

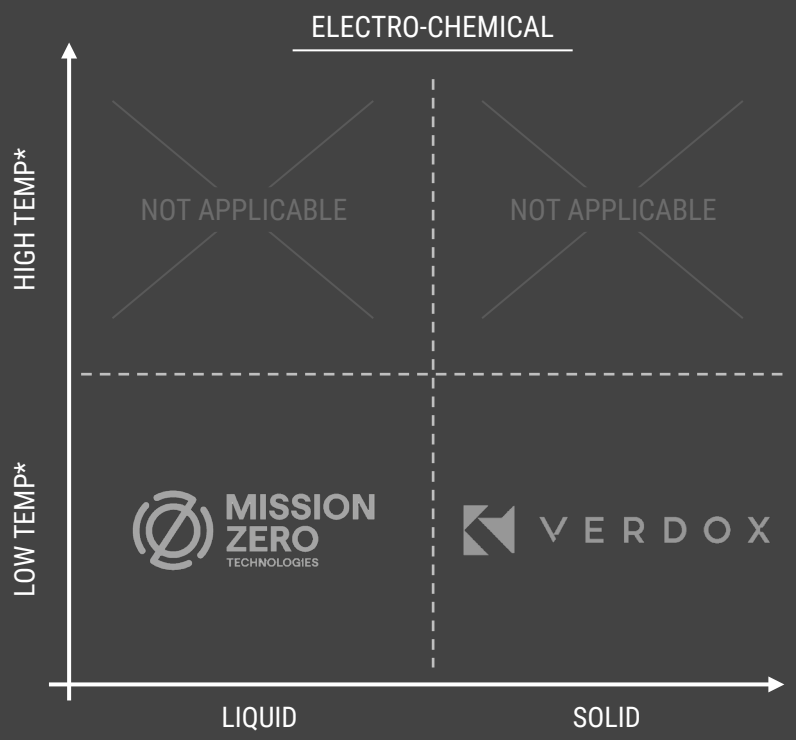


Energy Delivery
Devising an energy transfer system to extract the CO2 reliably from the system

Discovering a white-space approach across technologies

Holocene's low-temperature, liquid (aqueous), thermo-chemical approach taps into an unexplored white space for DAC





*Low temperature refers to 80-120C or lower, high temperature refers to ~700-900C

Companies and governments are seeking CDR services

Net zero is in the board room and the cabinet room – and all paths to net zero lead through direct air capture

2020-2030

Apple
Net zero by 2030

Proctor & Gamble
Net zero by 2030

Best Buy
Net zero by 2030

Google (Alphabet)
Net zero by 2030

IKEA
Carbon negative by 2030

Intel
Net zero by 2030

Microsoft
Carbon negative 2030

2030-2040

PepsiCo
Net zero by 2040

Michelin
Net zero by 2040

Home Depot
Net zero by 2035

Walmart
Net zero by 2040

AT&T
Net zero by 2035

Amazon
Net zero by 2040

Mercedes Benz
Net zero by 2040

2040 – 2050

USA, UK, Germany
Net zero by 2050

BP
Net zero by 2050

Danone
Net zero by 2050

Ford
Net zero by 2050

Nestlé
Net zero by 2050

Nike
Net zero by 2050

Shell
Net zero by 2050

Source: https://zerotracker.net/

And they are proving that they are willing to pay for it

Net zero is in the board room and the cabinet room – and all paths to net zero lead through direct air capture

CNBC

Charm gets $53 million to turn corn leftovers into oil and inject it into abandoned oil and gas wells

Frontier has $1 billion in commitments for carbon removal and on Thursday announced its first big deal for carbon to be sequestered with...

May 18, 2023

Reuters

Occidental buys carbon air capture tech firm for $1.1 billion

U.S. oil and gas producer Occidental Petroleum on Tuesday agreed to pay $1.1 billion for technology supplier Carbon Engineering Ltd to help...

3 weeks ago

Reuters

US awards $1.2 billion to Oxy, Climeworks-led carbon air capture hubs

The U.S. Department of Energy on Friday announced that projects in Texas and Louisiana to remove more than 2 million metric tons of carbon...

1 month ago

Carbon Herald

Japanese Airline ANA Will Purchase Carbon Removal Credits From 1PointFive

ANA has announced a carbon dioxide removal credit purchase from 1PointFive, a compnay focused on direct air capture.

1 month ago

CarbonCredits.com

Microsoft's $200M Carbon Removal Deal Advances Heirloom's DAC Solution

Explore how Microsoft's $200 million investment in Heirloom revolutionizes CDR and DAC, while advancing America's climate leadership.

1 day ago

Reuters

U.S. Energy Department to spend $3.7 billion on carbon removal

The U.S. Department of Energy on Tuesday agreed to commit $3.7 billion to finance projects to remove planet-warming carbon from the...

Dec 15, 2022

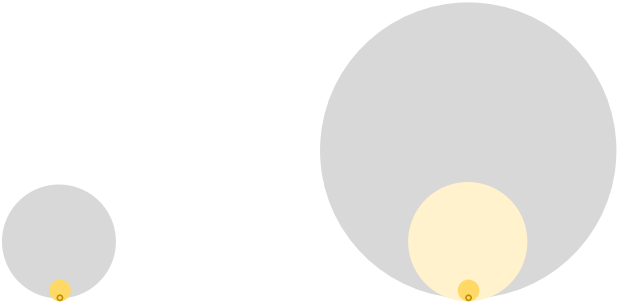
$1.2Bn
DOE DAC Hub awards

$2.5Bn
CDR purchases

>$1Trn
Expected 2050 TAM

Source: cdr.fyi; press search

Our development pathway – how we will meet this demand



Facility Name	TEST		PILOT		DEMONSTRATION		COMMERCIAL
Capacity *(tonnes p.a.)*	10	~150X	1,500	~50X	75,000	~10X	500,000+
Online Date *(year)*	Q1 2024	… 2yrs …	Q1 2026	… 2yrs …	Q1 2028	… 2yrs …	Q1 2030
LCOR* *($/tonne-$CO_2$)*	>$2500/t-CO2		~$1000/t-CO2		~$250/t-CO2		<$100/t-CO2

* = Levelized cost of removal, including full end-of-life (e.g., transport, storage, compression)

Building alongside a growing bench of supporters

CUSTOMERS

Frontier

shopify

stripe

$0.5Mn
Revenue to date

FUNDERS

Breakthrough Energy Fellows

XPRIZE CARBON REMOVAL

ELON MUSK

U.S. DEPARTMENT OF ENERGY

>$6Mn
Funding awarded

PARNTERS

TVA TENNESSEE VALLEY AUTHORITY

Stanford | ENERGY
Stanford Climate Ventures

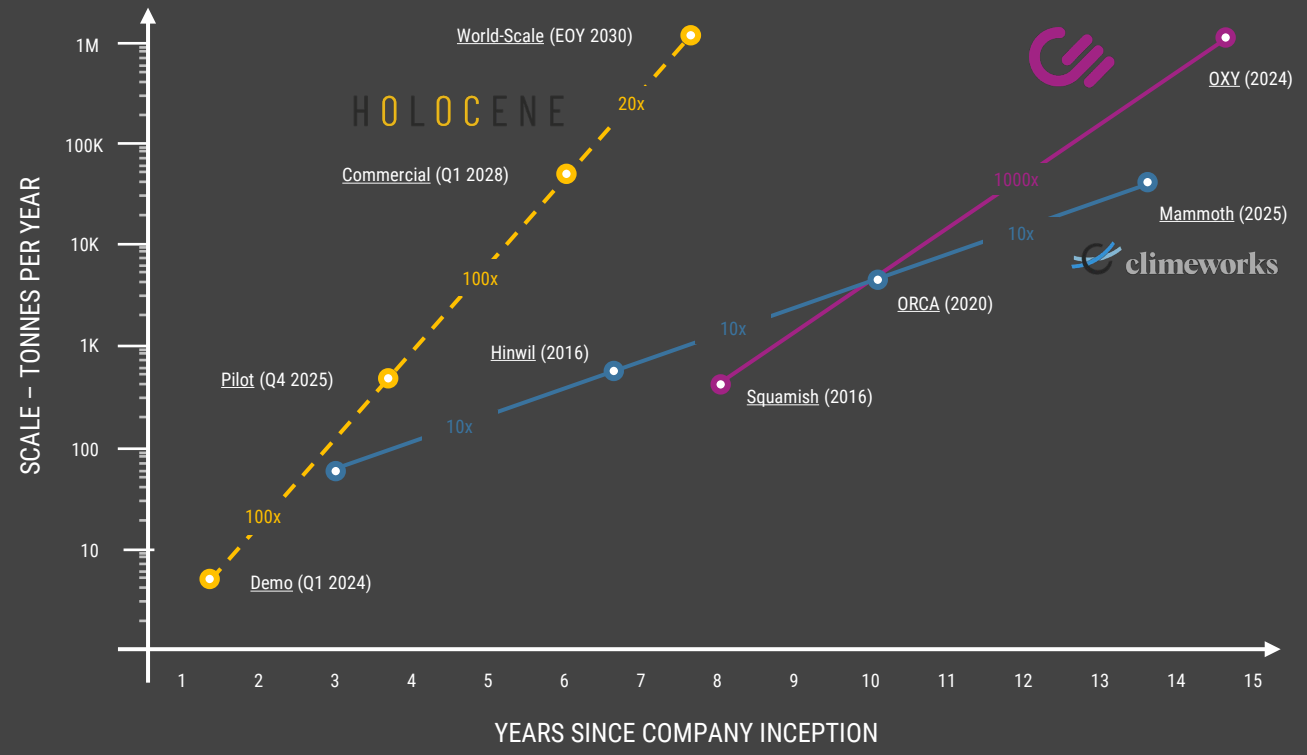
SPARK INNOVATION CENTER

INNOVATION CROSSROADS
OAK RIDGE NATIONAL LABORATORY

4+
Partnerships

An ambition to be bigger, faster, stronger

Tech & business experience, tech pathways, and market development pave the way



WHY NOW, WHY HOLOCENE?

1 We've done this before

- Our leadership & technical teams know where the "potholes" lie in DAC and business building and have made 100x leaps before.

2 Our technology lends to scale

- Liquid system rely on mature, at-scale equipment supply chains – requiring no new "inventions".
- This chemistry has been de-risked over the last 6 years.

3 The market has developed

- The market (both revenues & financing) was nearly non-existent from 2012-2020, today's private and public landscape is very different.

Thank You + Q&A

anca@theholocene.co