



Direct Air Capture: a clean and unlimited source of carbon for e-fuels

PRESENTED BY: Marcus Temke

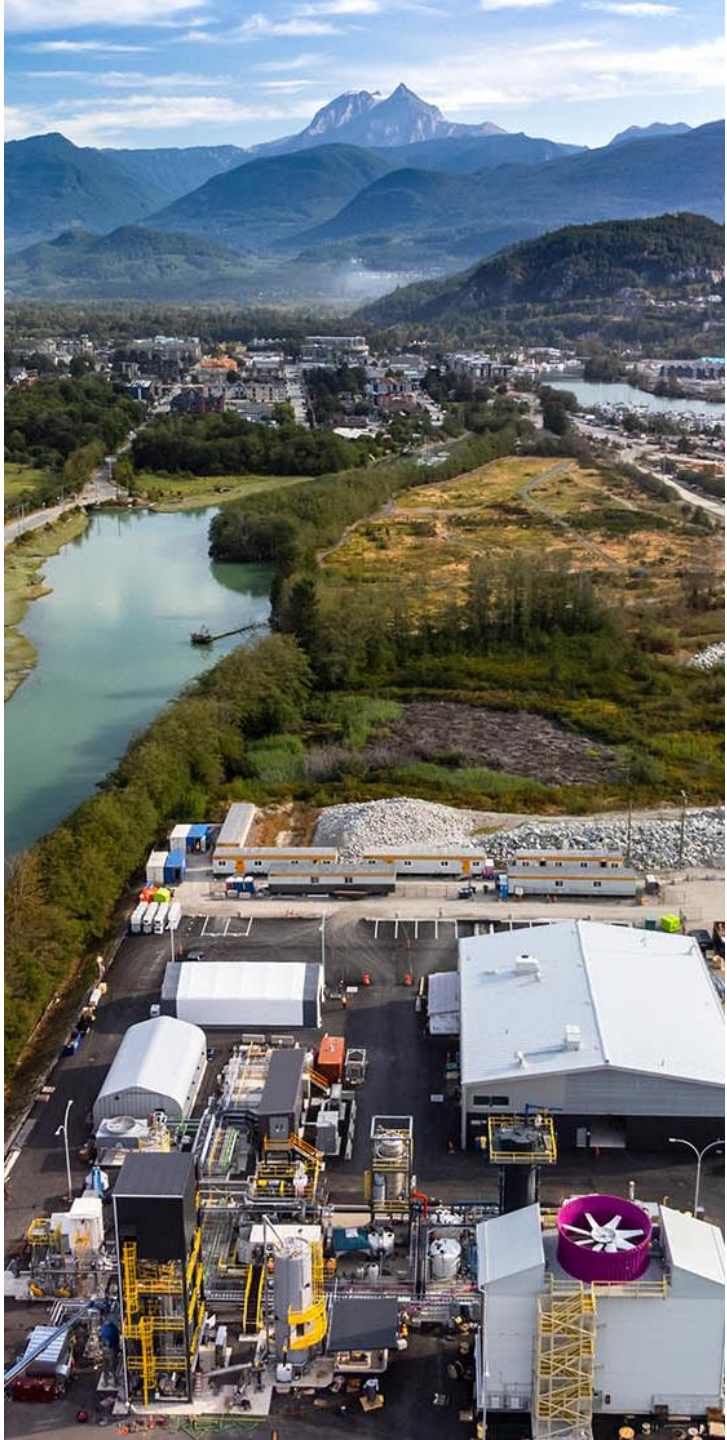
COMPANY: Carbon Engineering Ltd.

PRESENTED TO: Topsoe Catalyst Forum

DATE: September 2023

Agenda

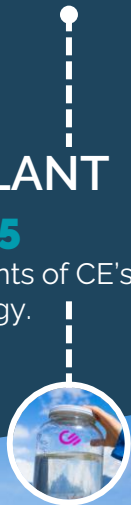
- ▶ Carbon Engineering History
- ▶ Carbon Engineering Technology
- ▶ Commercial Plant Deployment
- ▶ Why DAC for e-fuels



FEASIBLE, FINANCIALLY COMPELLING CLIMATE SOLUTIONS

Large Scale Deployment Underway

AIR TO FUELS™
DEMO
BUILT 2017



PILOT PLANT

BUILT 2015

Piloted elements of CE's DAC technology.

INNOVATION CENTRE

BUILT 2021

R&D platform for technological advancements to incorporate into commercial plants.

STRATOS PERMIAN SITE CONSTRUCTION UNDERWAY

Expected to be largest in the world.

SOUTH TEXAS DAC HUB ENGINEERING UNDERWAY

Enables potential for 30 MTPA DAC

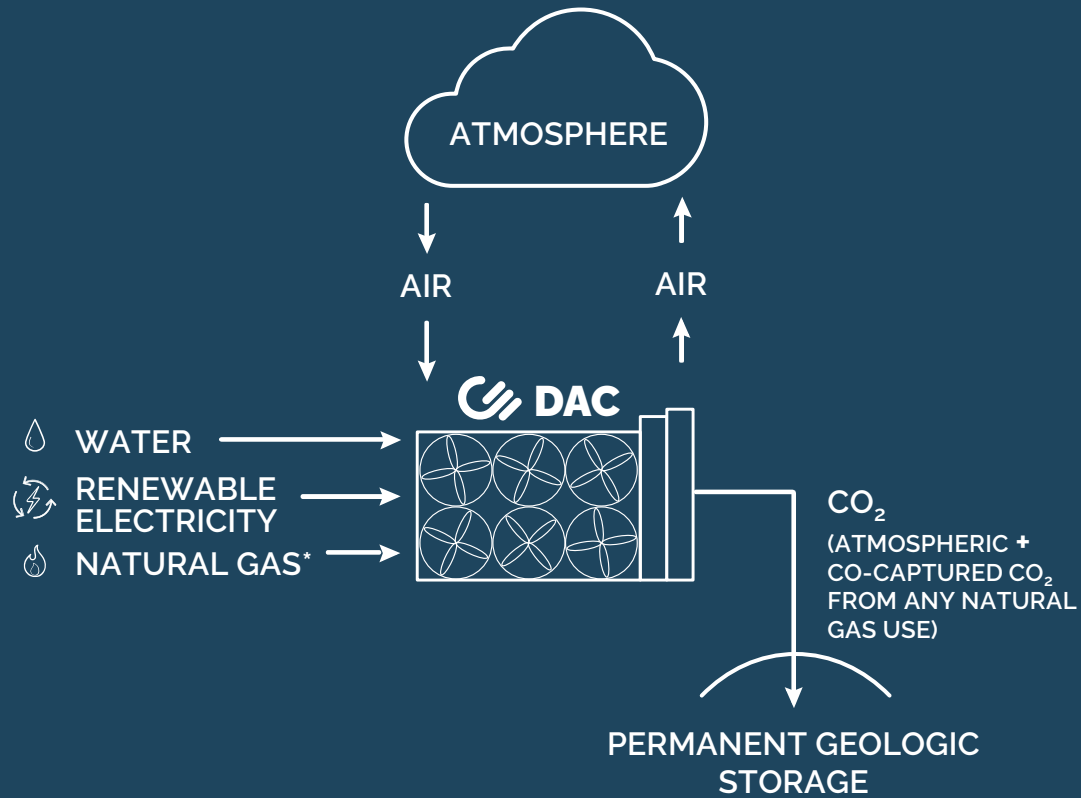
100 Mt by 2035
1POINTFIVE DEV. SCENARIO

Advancing feasibility studies and plant designs in other locations across the globe

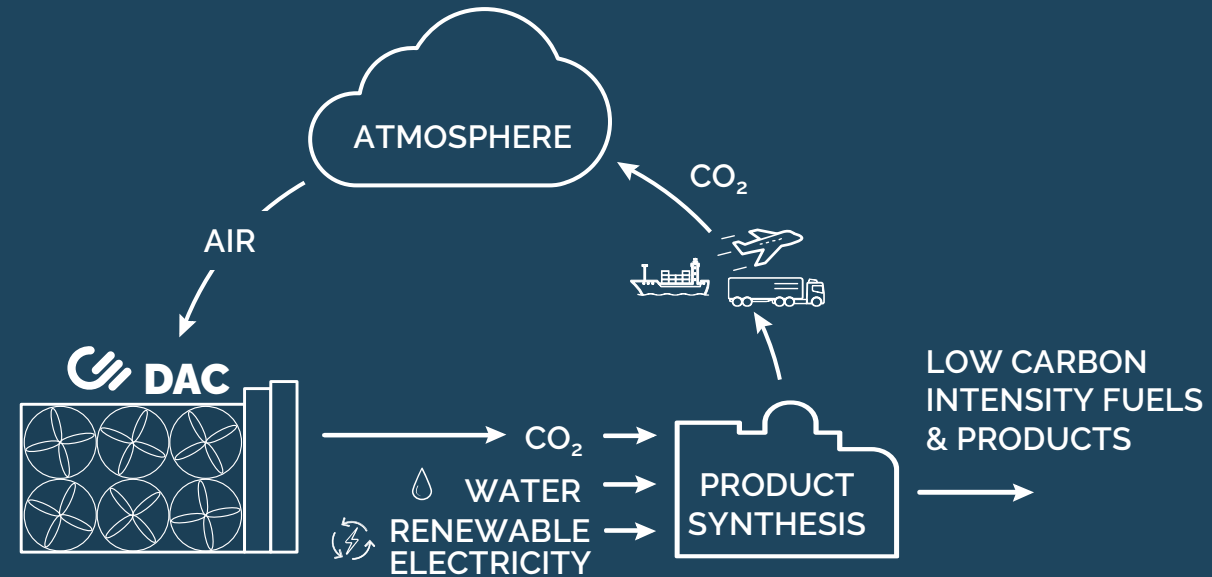


CE DAC enables complementary solutions for reduction and removal

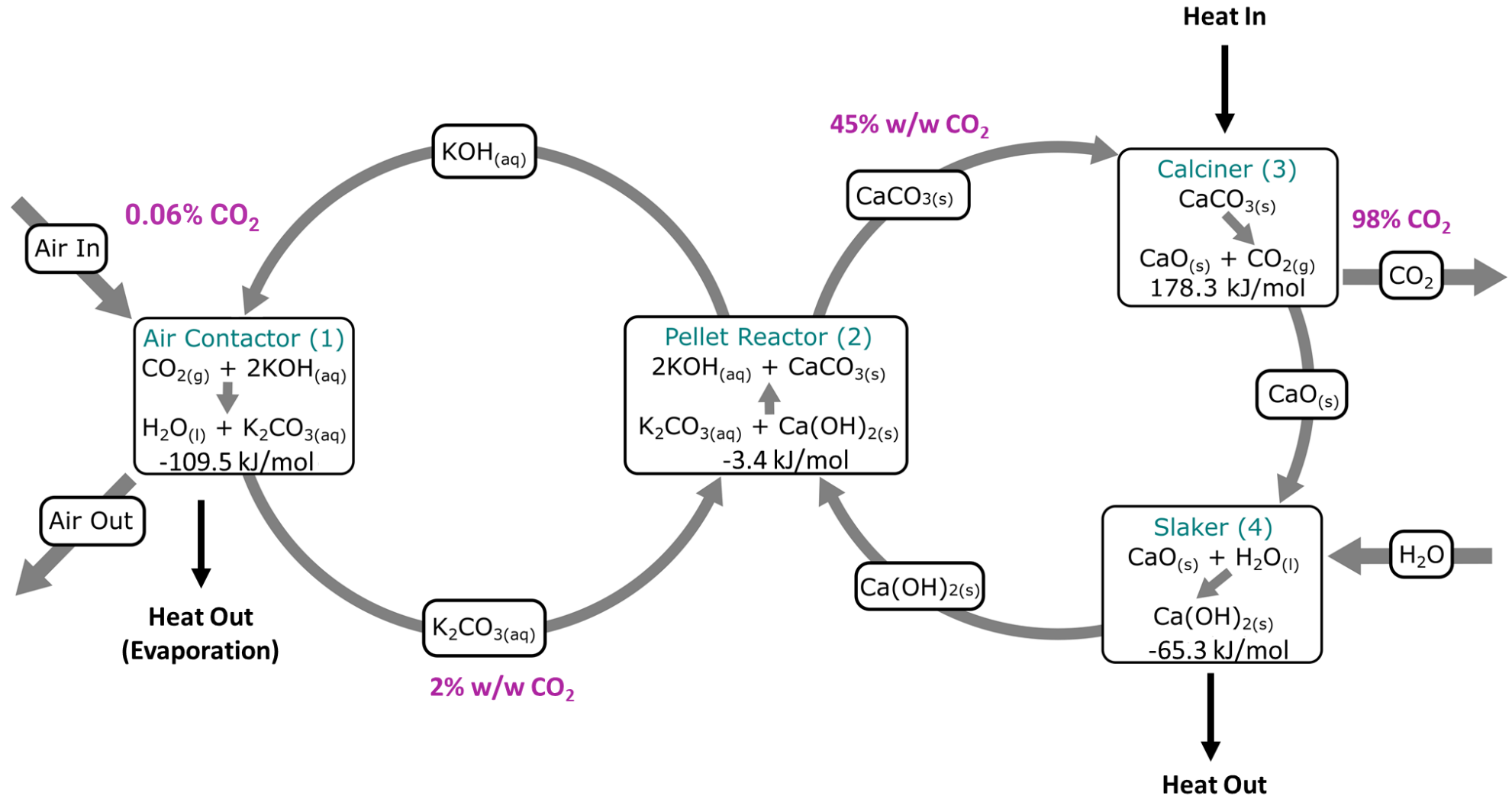
CARBON DIOXIDE REMOVAL



LOW CARBON INTENSITY FUELS & PRODUCTS



Chemical Looping: Mass and Energy Efficiency



CE's process was designed to be deployed at scale

1 INDUSTRIAL EQUIPMENT WITH PRECEDENT

- ▶ A combination of pre-existing technologies adapted and combined with patented innovations and proprietary know-how
- ▶ Reduces scale up risk & improves cost estimation

2 CLOSED CHEMICAL LOOPS

- ▶ Non-volatile non-toxic chemical process
- ▶ Meets environmental health and safety standards

3 FREEDOM OF LOCATION

- ▶ Plants can be located where economics are optimum to take advantage of low-cost local energy or proximity to sequestration sites or demand centre

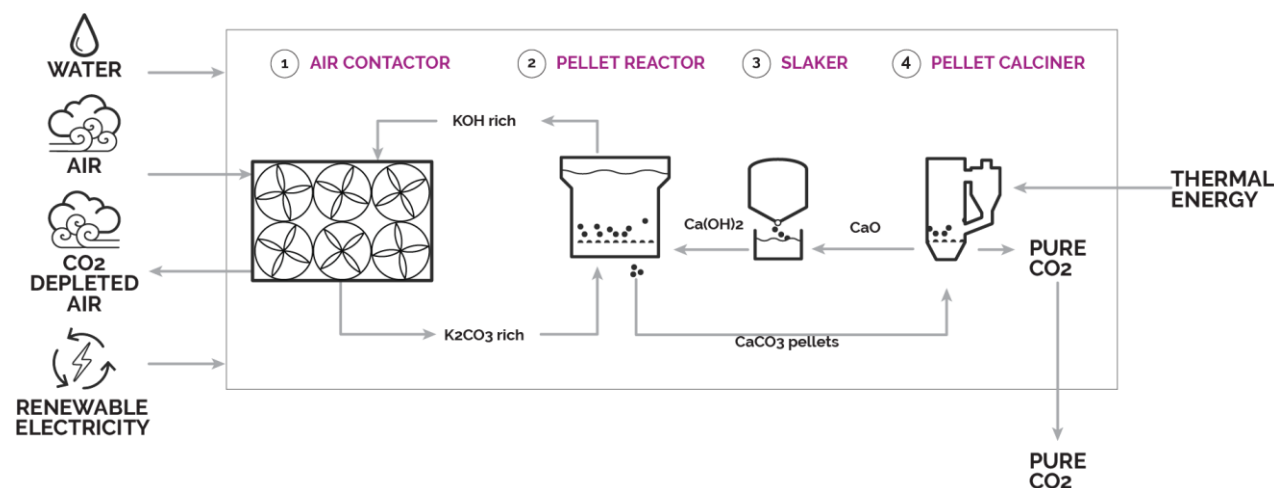
4 LICENSED PROCESS BUSINESS MODEL

- ▶ Partners with experienced plant developers and world leading EPC
- ▶ Standardized 1MT design, focus on modularization and pre-fabrication

1

EQUIPMENT	INDUSTRIAL PRECEDENT
AIR CONTACTOR	Industrial cooling tower
PELLET REACTOR	Water treatment technology
SLAKER	Standard equipment for converting Calcium Oxide to Calcium Hydroxide
CALCINER	Refractory lined circulating fluidized bed calciners are commonly used in mining for ore processing

2



Our DAC platform is designed from the
inside out for large scale

Scale-up

Proven components and established, global supply chains

Equipment	Pilot Plant	CE Innovation Center		DAC-1	
		Design Basis	Ratio to Pilot	Design Basis	Ratio to CEIC
Air Contactor	Cross Flow Cooling Tower aa' tall packed section	Cross Flow Cooling Tower bb' tall packed section	~2	Cross Flow Cooling Tower cc' tall packed section	~2
Pellet Reactor	Cylindrical Vessel dd' ID	Cylindrical Vessel ee' ID	~2	Cylindrical Vessel ff' ID	~2
Slaker	Detention Type gg' ID	Detention Type hh' ID	~1.5	Detention Type ii' ID	~5
Calciner	Oxy-fired CFB jj' ID	Oxy-fired CFB kk' ID	~2	Oxy-fired CFB ll' ID	~10

BUILT 2015



CE'S DIRECT AIR CAPTURE PILOT PLANT, SHOWING THE CALCINER & AIR CONTACTOR

BUILT 2021



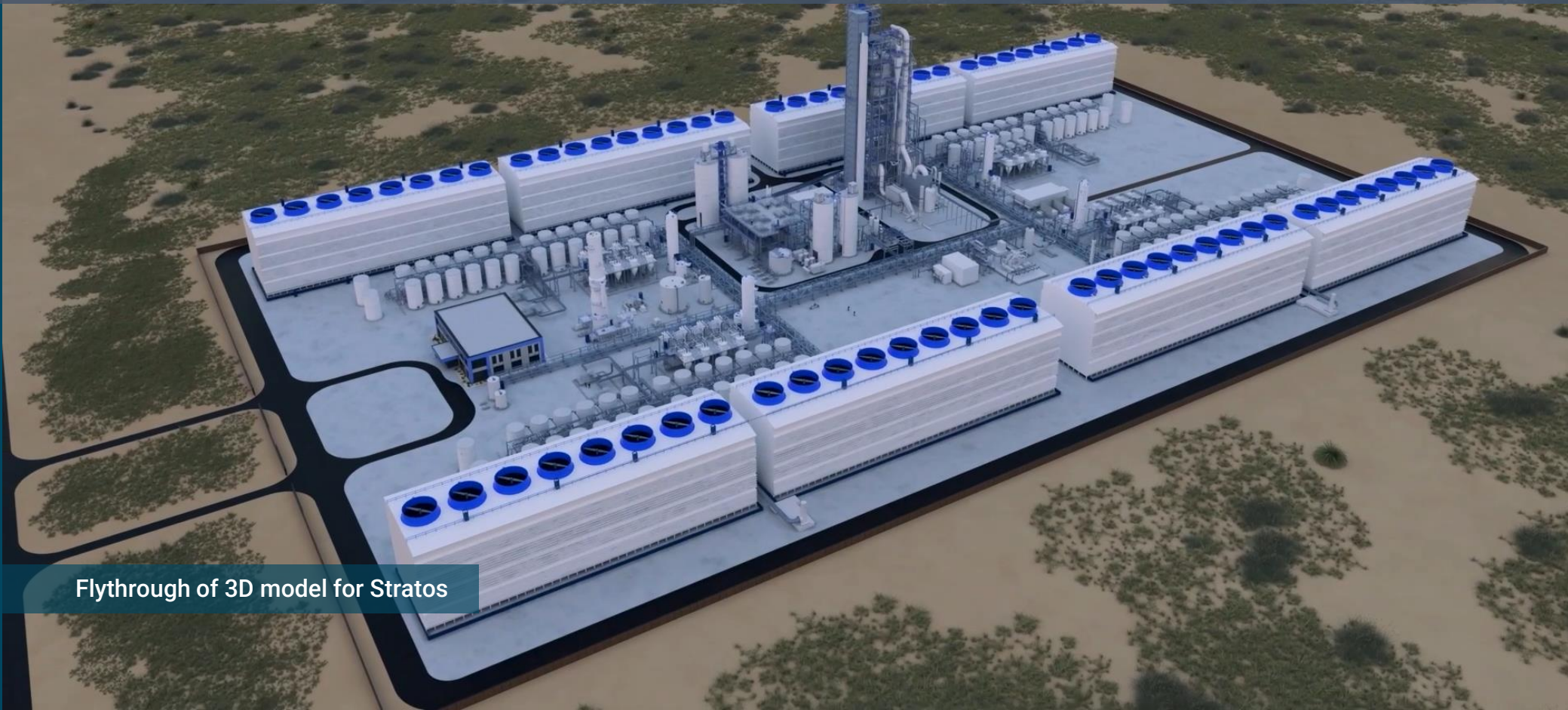
9 CARBON ENGINEERING CONSULTANTS © 2023

CE'S INNOVATION CENTRE & TECHNOLOGY DEVELOPMENT HEADQUARTERS

1PointFive is building the world's largest DAC plant in West Texas

Introducing **STRATOS**

Celebrating breaking ground on the first facility to utilize CE's technology



Flythrough of 3D model for Stratos

STRATOS

- ▶ Permian Basin, Texas, US
- ▶ Expected to capture 500kt/year once fully complete
- ▶ EPC at ~30% progress
- ▶ Class VI permit filed
- ▶ Site prep and early construction started Q4 2022
- ▶ Operations targeting mid-2025





Department of Energy

Biden-Harris Administration Announces Up To \$1.2 Billion For Nation's First Direct Air Capture Demonstrations in Texas and Louisiana

AUGUST 11, 2023

[Energy.gov](#) »[Biden-Harris Administration Announces Up To \\$1.2 Billion For Nation's First Direct Air Capture Demonstrations in Texas and Louisiana](#)

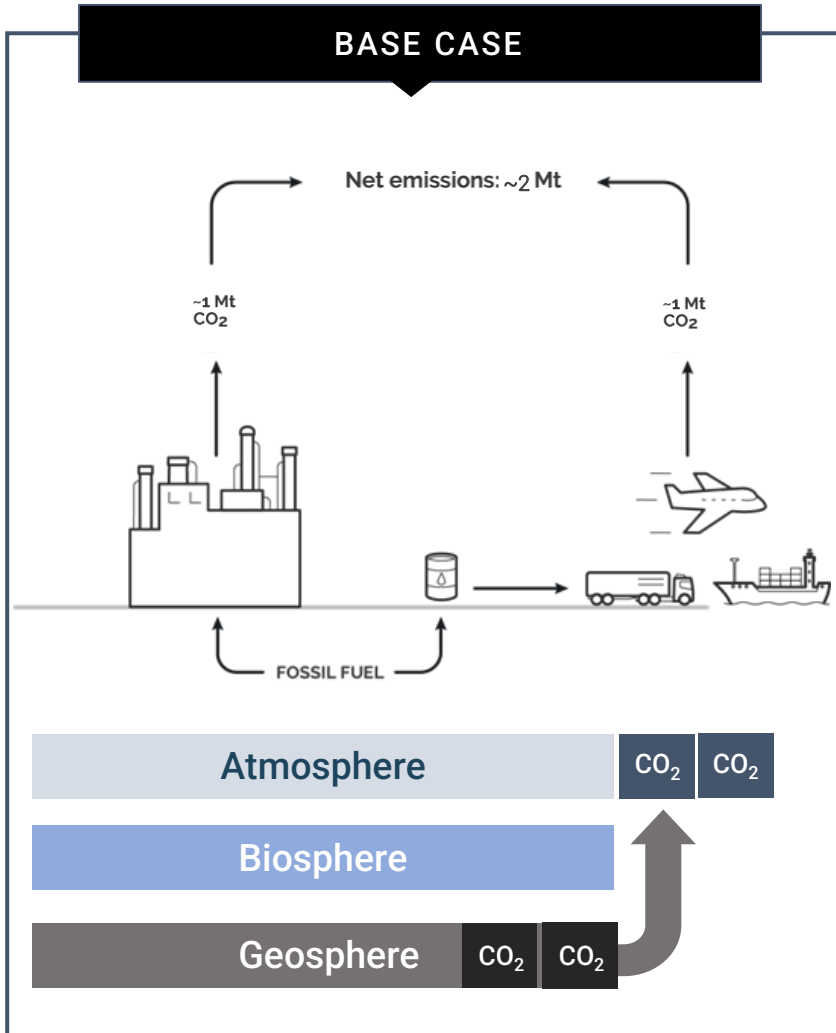
President Biden's Investing in America Agenda Will Fund Projects to Kickstart Critical New Industry, Remove Historic Climate-Harming Carbon Emissions Out of the Air, and Create 4,800 Good-Paying Jobs

WASHINGTON, D.C. — As part of President Biden's Investing in America [agenda](#), the U.S. Department of Energy (DOE) today announced up to \$1.2 billion to advance the development of two commercial-scale direct air capture facilities in [Texas](#) and Louisiana. These projects—the first of this scale in the United States—represent the initial selections from the President's Bipartisan Infrastructure Law-funded Regional Direct Air Capture (DAC) Hubs program, which aims to kickstart a nationwide network of large-scale carbon removal sites to address legacy carbon dioxide pollution and complement rapid emissions reductions. These emissions are already in the atmosphere, fueling climate change and extreme weather and jeopardizing public health and ecosystems across the globe. The Hubs are expected to ensure meaningful community and labor engagement and contribute to the President's [Justice40 Initiative](#). Together, these projects are expected to remove more than 2 million metric tons of carbon dioxide (CO₂) emissions each year from the atmosphere—an amount equivalent to the annual emissions from roughly 445,000 gasoline-powered cars—and create 4,800 good-paying jobs in Texas and Louisiana.

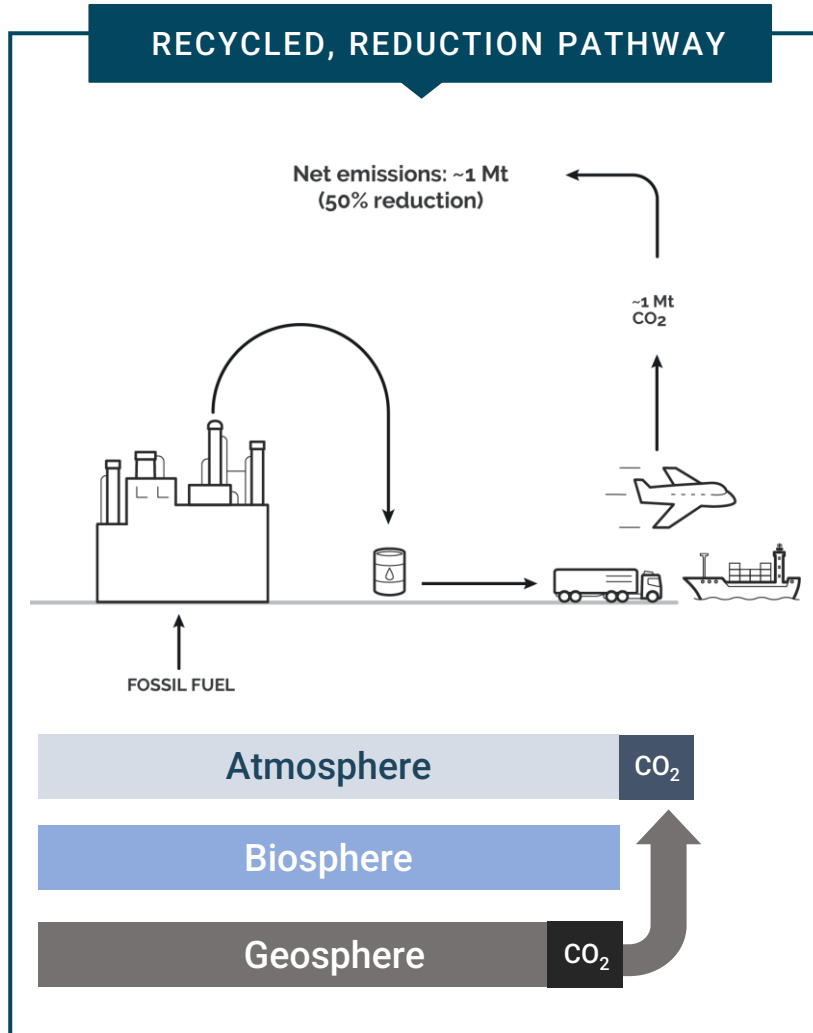
- **South Texas DAC Hub (Kleberg County, TX):** [1PointFive](#), a subsidiary of Occidental, and its partners, [Carbon Engineering Ltd.](#) and [Worley](#), seek to develop and demonstrate a DAC facility designed to remove up to 1 million metric tons of CO₂ annually with an associated saline geologic CO₂ storage site. The project is estimated to create approximately 2,500 jobs in construction, operations, and maintenance with existing agreements for local hiring. The selectees will also establish a Citizen Advisory Board to ensure meaningful community engagement.

Why make eFuels from atmospheric carbon?

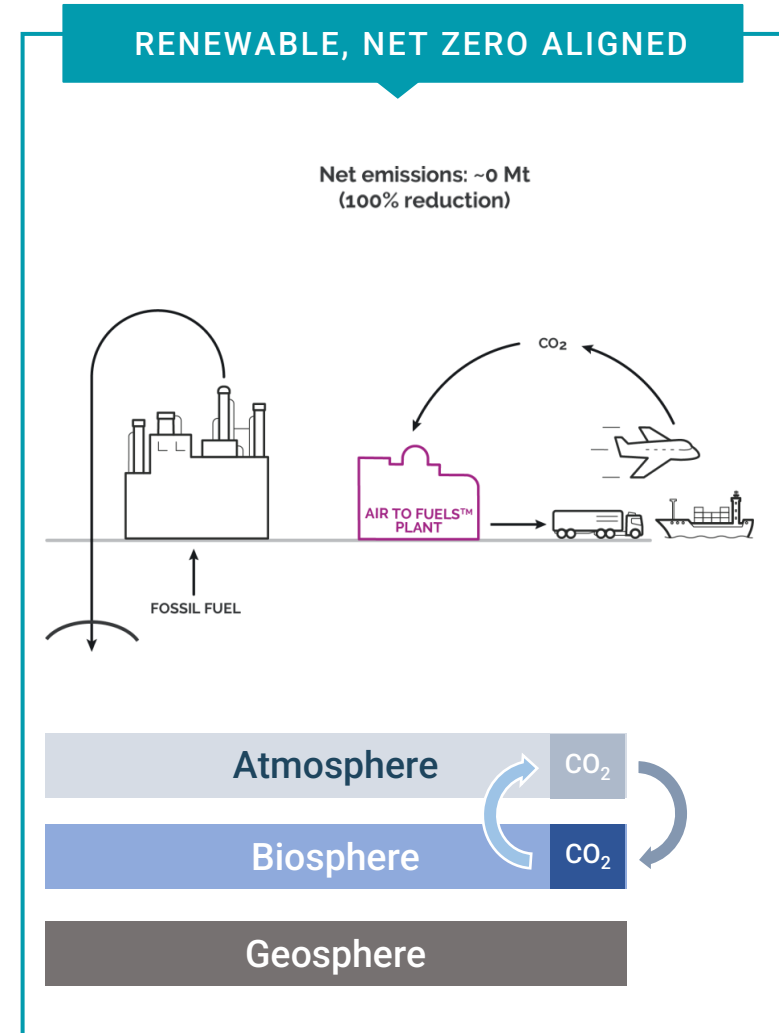
BASE CASE



RECYCLED, REDUCTION PATHWAY



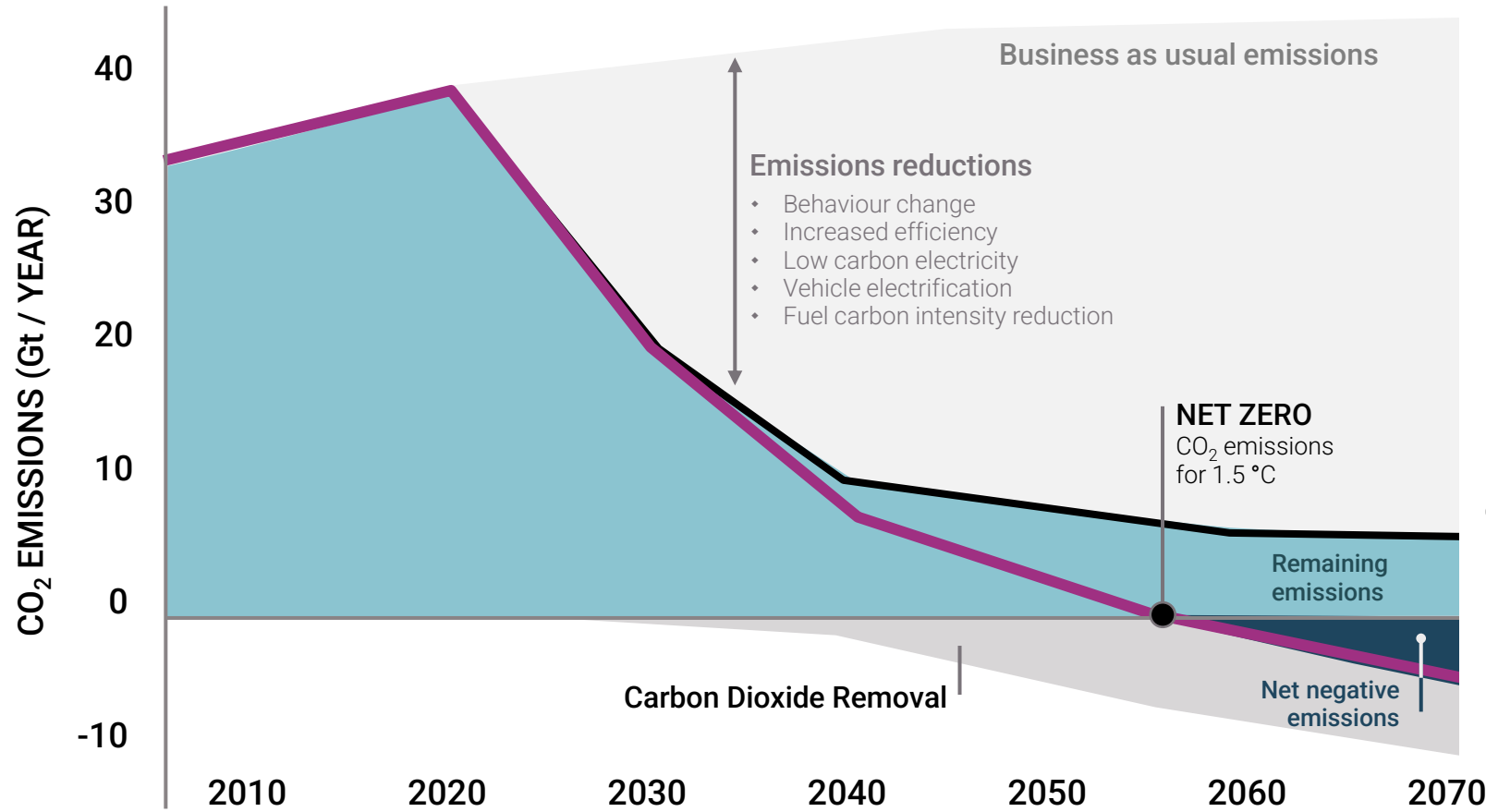
RENEWABLE, NET ZERO ALIGNED



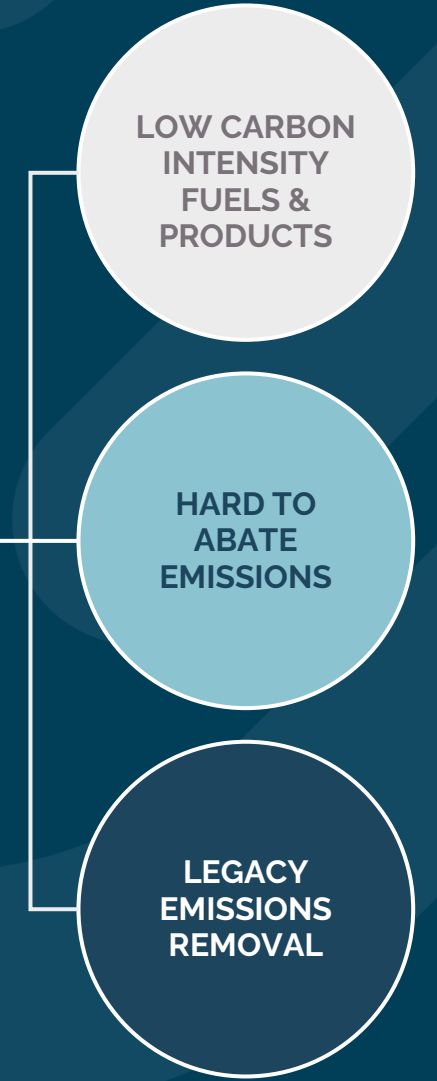
ATMOSPHERIC CARBON PROVIDES A PATHWAY FOR NET-ZERO ALIGNED eFUELS

1.5°C requires large-scale and rapid mitigation

Carbon Dioxide Removal (CDR) can compensate for emissions from sectors that cannot completely decarbonize ¹



Market Opportunities

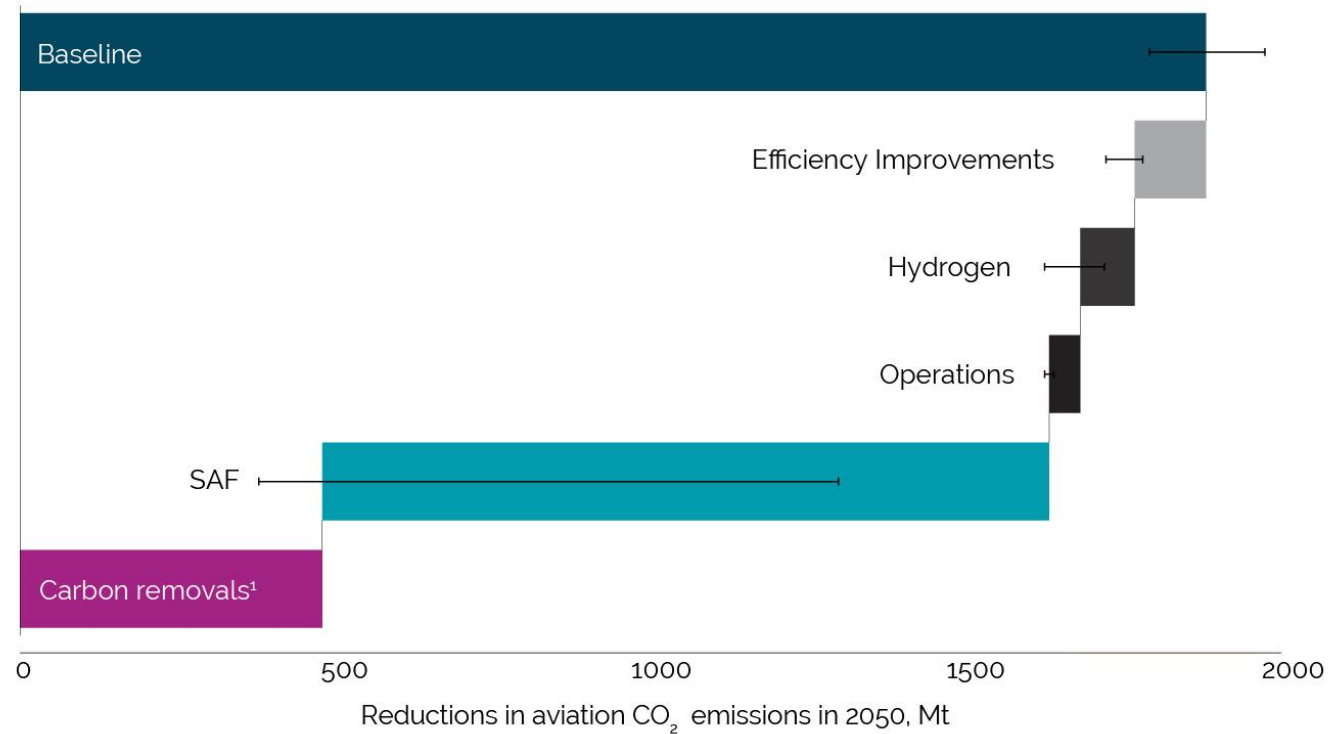


Sources:
 1. IPCC Special Report on 1.5 degrees
 2. Illustrative chart adapted by Carbon Engineering to illustrate market opportunities for DAC based on median emissions levels across the 46 pathways in the SR15 scenario database that are 1.5°C compatible calculated by Climate Analytics

Recognising uncertainties in each decarbonisation lever, in particular SAF, carbon removals can provide additional confidence in reaching net zero

IATA 2050 Net Zero Estimates

Reduction in aviation CO₂ emissions in 2050 achieved through different levers of action



Solid bar indicates the central case and the black lines indicate maximum and minimum reductions based on the scenarios modeled

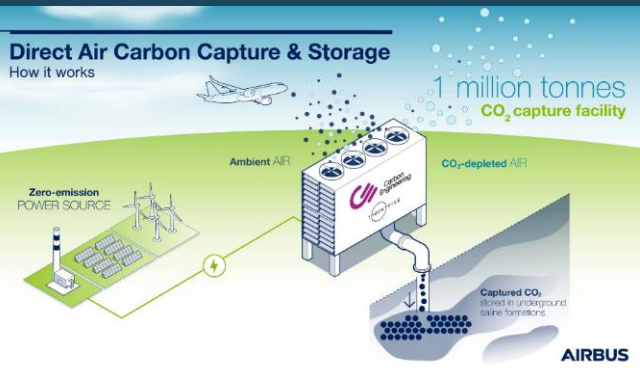
¹ includes market-based measures

Source: IATA Sustainability and Economics, ICAO LTAG SAF availability scenarios

Over the last 18 months, aviation partners have joined CE/1P5 to accelerate DAC

1 **March 2022**
Airbus pre-purchased **400,000 tonnes** of CDR from 1PointFive

AIRBUS



2 **July 2022**
Airbus announced a CDR collaboration with seven other airlines (and airline groups) at the Farnborough airshow



3 **November 2022**
Carbon Engineering announced significant R&D investments by Airbus and Air Canada

AIRBUS



4 **August 2023**
All Nippon Airways announced the pre-purchase of **30,000 tonnes** of CDR from 1PointFive, becoming the first airline to directly purchase CDR.





Closing Remarks

With the development of the technology and the Inflation Reduction Act (IRA), a business case for DAC exists today in in the United States.

SAF can be produced from a slip stream from a DAC Hub. IRA provides further incentives for renewable electricity, green H₂ and end products.

Opportunities exist to have an integrated and optimized design of DAC facilities and fuels plants, where several synergies can be explored.



MORE INFORMATION CAN BE FOUND AT:

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