CARBON CAPTURE, UTILIZATION & STORAGE
ACCELERATING CCUS TOGETHER
AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

Clean Energy Ministerial CCUS Initiative Webinar:

Direct Air Capture of CO_2: Helping to Achieve Net-Zero Emissions

Tuesday 21 April 2020
10:00 EDT | 16:00 CET | 22:00 CST

CLEAN ENERGY MINISTERIAL
Advancing Clean Energy Together

Agenda

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Welcome & Introductory Remarks

- **Jarad Daniels**
  Director, Office of Strategic Planning, Analysis, and Engagement
  U.S. Department of Energy

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Presentation

- **Dr. Julio Friedmann**
  Senior Research Scholar
  Center on Global Energy Policy, Columbia University
- **Lori Guetre**
  Vice President of Business Development
  Carbon Engineering
- **Christoph Beuttler**
  CDR Manager
  Climeworks
- **Dr. Peter Eisenberger**
  Chief Technology Officer
  Global Thermostat
- **Mark Ackiewicz**
  Director, Division of CCUS R&D
  U.S. Department of Energy

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Question and Answer Session

Jarad Daniels
Director, Office of Strategic Planning, Analysis, and Engagement
U.S. Department of Energy

Jarad Daniels leads the Office of Strategic Planning, Analysis, and Engagement within the Department of Energy (DOE) Office of Fossil Energy, including domestic programs and international engagements conducted in close collaboration with industry, academia, and multi-lateral organizations.

Mr. Daniels has twenty-five years of experience with the DOE, managing advanced technology programs and working in several national laboratories throughout the United States. His expertise includes domestic and global energy and environmental technologies, policies, and programs.

Mr. Daniels holds a Master of Science degree in Chemical Engineering from the University of California at Berkeley.

Panelist

Dr. Julio Friedmann

Senior Research Scholar

Center on Global Energy Policy, Columbia University

Dr. Julio Friedmann is a Senior Research Scholar at the Center for Global Clean Energy Policy at Columbia University, where he leads a new initiative in carbon management. He is also CEO of Carbon Wrangler, LLC. Recently, he served as Principal Deputy Assistant Secretary for the Office of Fossil Energy at the Department of Energy, where he held responsibility for DOE's R&D program in advanced fossil energy systems, carbon capture, and storage (CCS), CO2 utilization, and clean coal deployment. His expertise includes Large-Scale Carbon Management, CO2 removal, CO2 recycling, Oil and Gas systems, international engagements in clean energy, and inter-agency engagements within the US government. He has also held positions at Lawrence Livermore National Laboratory, including Senior Advisor for Energy Innovation and Chief Energy Technologist, is a Distinguished Associate at the Energy Futures Initiative, and serves as a special advisor to Total SA and the Global CCS Institute. He was recently named as a Senior Fellow to the Breakthrough Institute and a Stanford Precourt Scholar.

Dr. Friedmann is one of the most widely known and authoritative experts in the U.S. on carbon removal (CO2 drawdown from the air and oceans), CO2 conversion and use (carbon-to-value), and carbon capture and sequestration. Dr. Friedmann received his Bachelor of Science and Master of Science degrees from the Massachusetts Institute of Technology (MIT), followed by a Ph.D. in Geology at the University of Southern California. He worked for five years as a senior research scientist at ExxonMobil, then as a research scientist at the University of Maryland.

Lori Guetre
Vice President of Business Development
Carbon Engineering

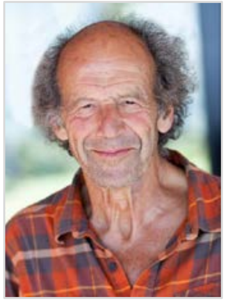
Lori has been with Carbon Engineering since April 2018 and brings more than 28 years of experience in the engineering, business development, and financing of complex, mission-critical systems. At CE she leads the development of DAC-based decarbonization solutions in the United States.

Before joining CE, Lori held a variety of senior executive positions in the aerospace sector including General Manager and VP Business Development. Lori holds a Bachelor’s in Computer Engineering and a Master’s in Electrical Engineering.

Christoph Beuttler
Carbon Dioxide Removal Manager
Climeworks

Christoph Beuttler is Carbon Dioxide Removal Manager at Swiss Direct Air Capture pioneers Climeworks. He is also deputy director of Risk Dialogue Foundation, a Swiss NGO, and visiting lecturer in Risk Perception and Communication in Science and Policy at the Swiss Federal Institute of Technology (ETH) in Zürich.

Christoph in an expert on Negative Emissions as well as CO2 utilization with several years of experience in the field. He was educated in Heidelberg and London. His background is in Economics, Management and Sustainability.



Dr. Peter Eisenberger
Chief Technology Officer
Global Thermostat

Dr. Peter Eisenberger is a renowned scientist, corporate research executive, business entrepreneur, and leading academic. He started his career at Bell Labs during its heyday, where he pioneered the use of particle accelerators to produce intense X-rays to conduct basic research on the fundamental properties of materials. Dr. Eisenberger was then recruited by Exxon following the oil shocks of the late seventies to lead their Physical Sciences R&D laboratory, where he led a team of international scientists looking at alternative energy technologies including solar energy.

He left Exxon for Princeton University, where he was appointed Professor of Physics and founded the Princeton Material Institute, which focused on multidisciplinary applied research in environmental technologies, among others. In 1996, Dr. Eisenberger joined Columbia University where he was appointed Professor of Earth and Planetary Sciences, Vice-Provost, and founding Director of the Columbia Earth Institute and Director of the renowned Lamont-Doherty Earth Observatory.

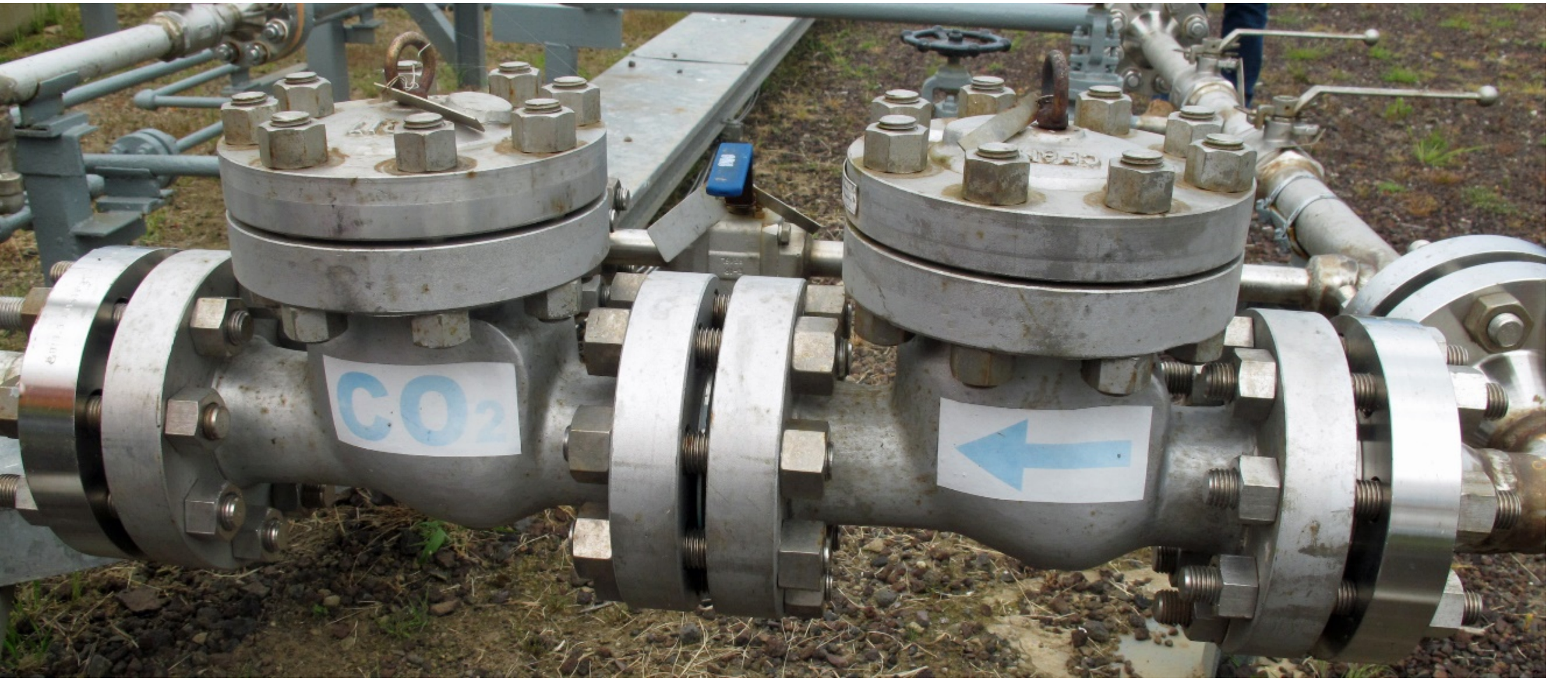
In 2006, he co-founded Global Thermostat, which has developed a unique technology for the capture of carbon dioxide from air. Dr. Eisenberger holds degrees in physics from Princeton and Harvard.

Mark Ackiewicz
Director, Division of CCUS R&D
U.S. Department of Energy

Mr. Mark Ackiewicz is the Director for the Division of Carbon Capture, Utilization and Storage (CCUS) Research and Development (R&D) at the Department of Energy (DOE). He is responsible for planning, management, and administration of the division's R&D portfolio. In this role, he leads a team of scientists and engineers that are collaborating and working domestically and internationally with industry, national laboratories, and universities on developing advanced and transformational CCUS technologies.

Before joining DOE in 2007, he worked as a consultant, providing technical, analytical, and strategic planning services to the DOE and its technical research programs. Early in his career, Mark worked in the private sector in various industrial research and engineering positions, where he was responsible for process development and scale-up activities.

Mark has a B.S. in Chemical Engineering from Johns Hopkins University, and a Master's in Engineering Management from George Washington University.



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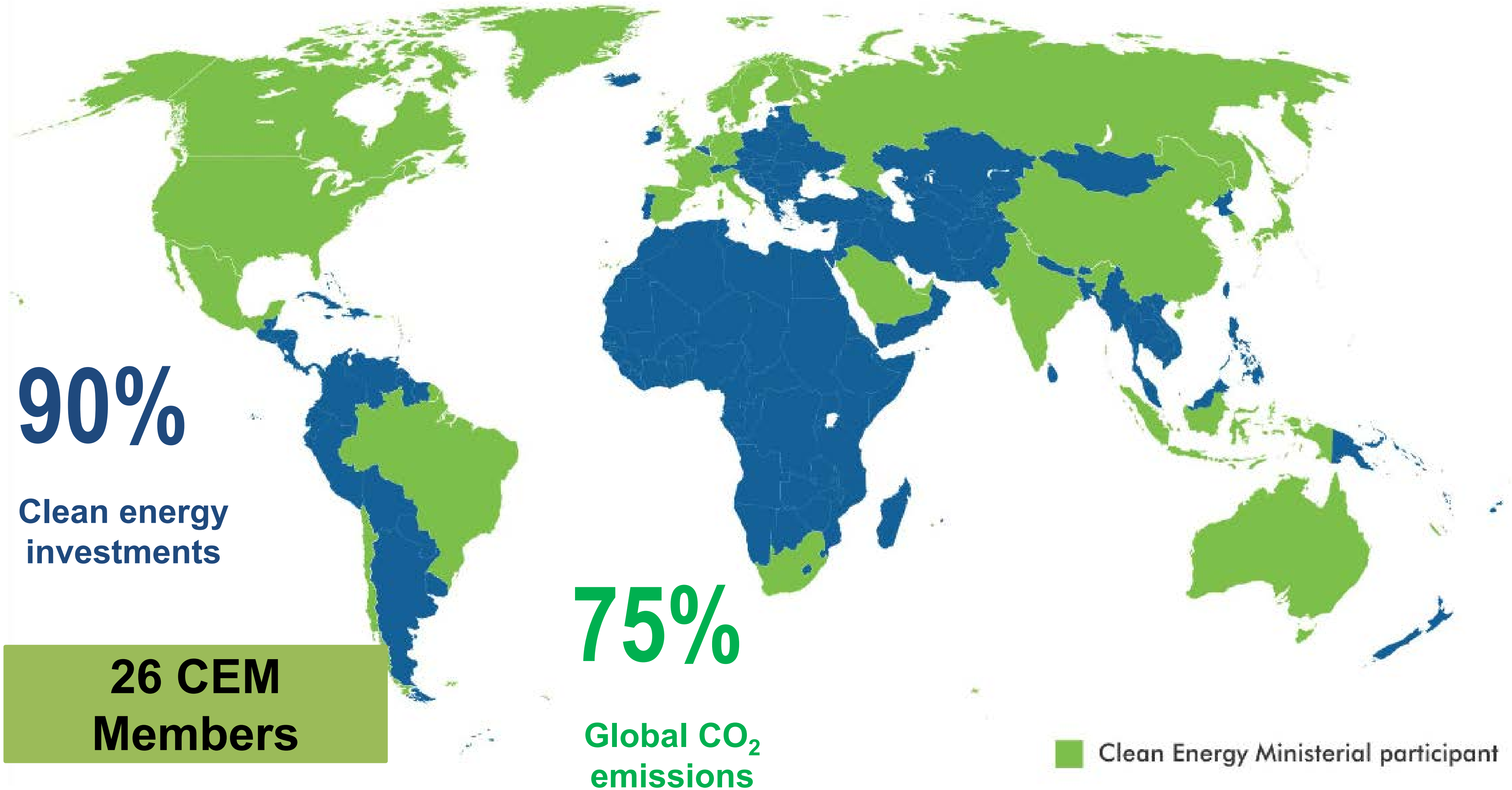
Clean Energy Ministerial: global process to accelerate clean energy



90%

Clean energy investments

26 CEM Members

75%

Global CO_2 emissions

www.cleanenergyministerial.org

CEM CCUS Initiative Member Governments

United States

South Africa

Saudi Arabia

Norway

Japan

United Kingdom

United Arab Emirates

Mexico

Observer:

China

Netherlands

Canada

CARBON CAPTURE, UTILIZATION & STORAGE
ACCELERATING CCUS TOGETHER
AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL

Accelerating CCUS Together by:

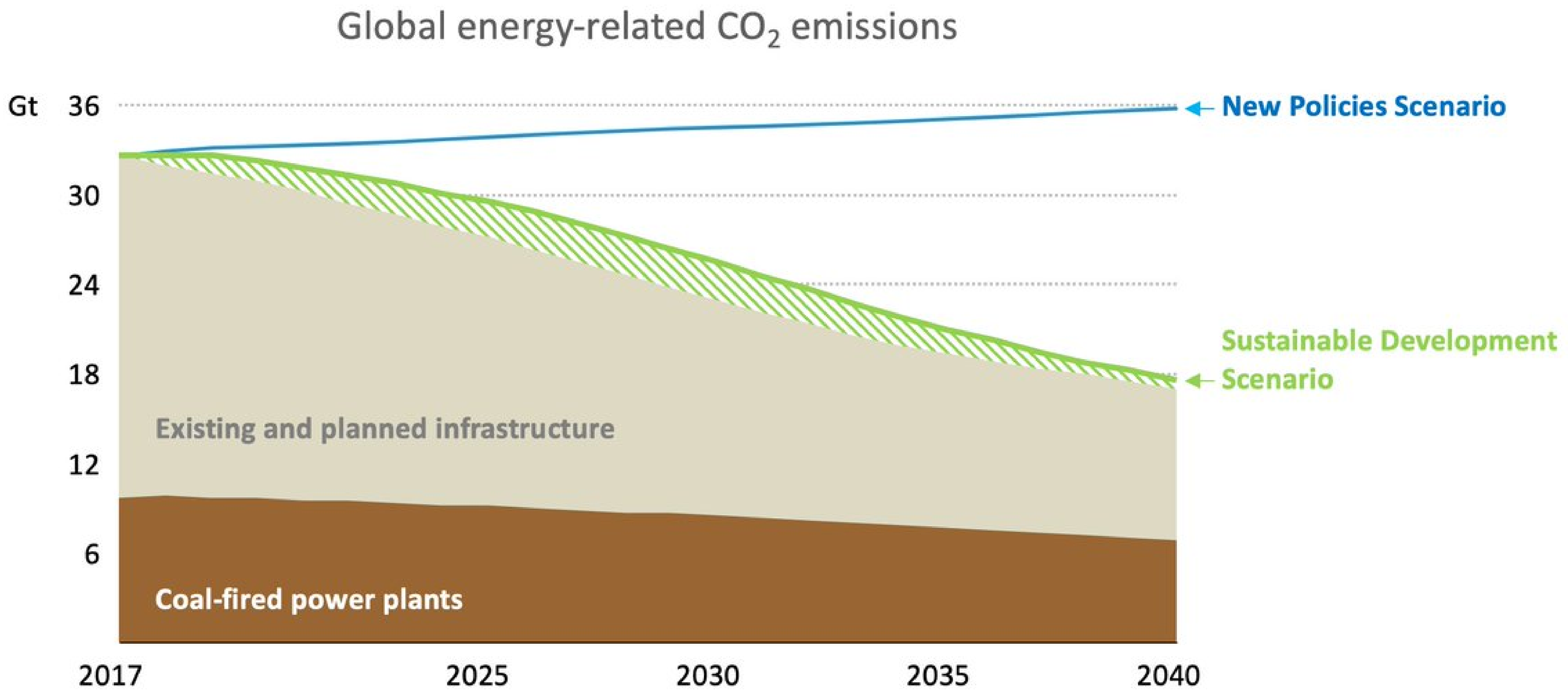
1. Actively **including** CCUS within global clean energy agenda
2. Bringing **together** the private sector, governments and the investment community
3. Facilitating identification of both near and longer-term **investment opportunities**
4. Disseminating **best practice** in CCUS policy, regulation and investment

COLUMBIA | SIPA
Center on Global Energy Policy

Direct Air Capture: What it is & why we need it

Dr. S. Julio Friedmann
Center for Global Energy Policy, Columbia Univ.
Clean Energy Ministerial Webinar, April 21st, 2020

Already at 95% lock-in. All IPCC pathways 2ºC or less require CCS



IEA: World Energy Outlook 2018

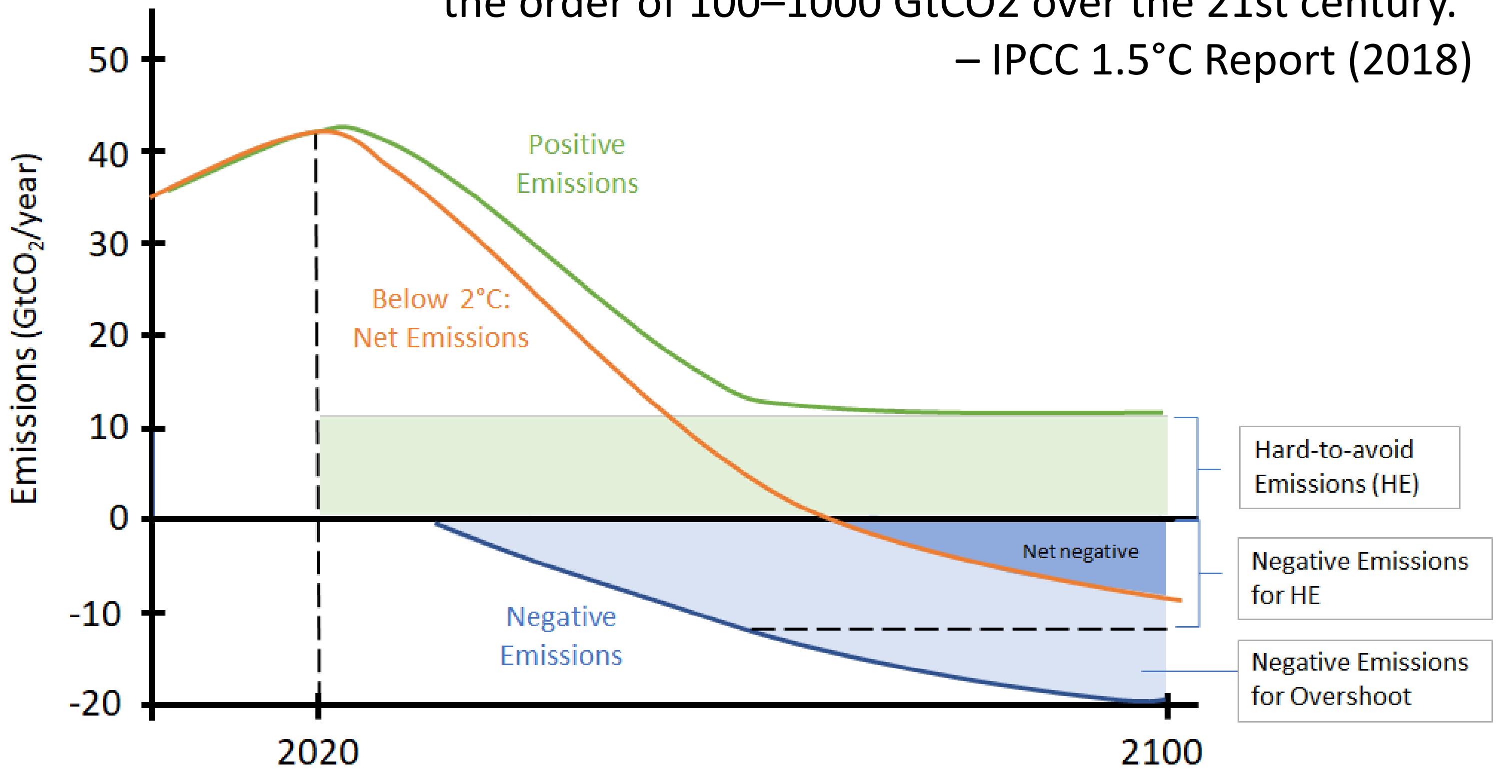
CO_2 removal will become one of the world's largest markets

Climate math asks for 10-20 Gt CO_2/y

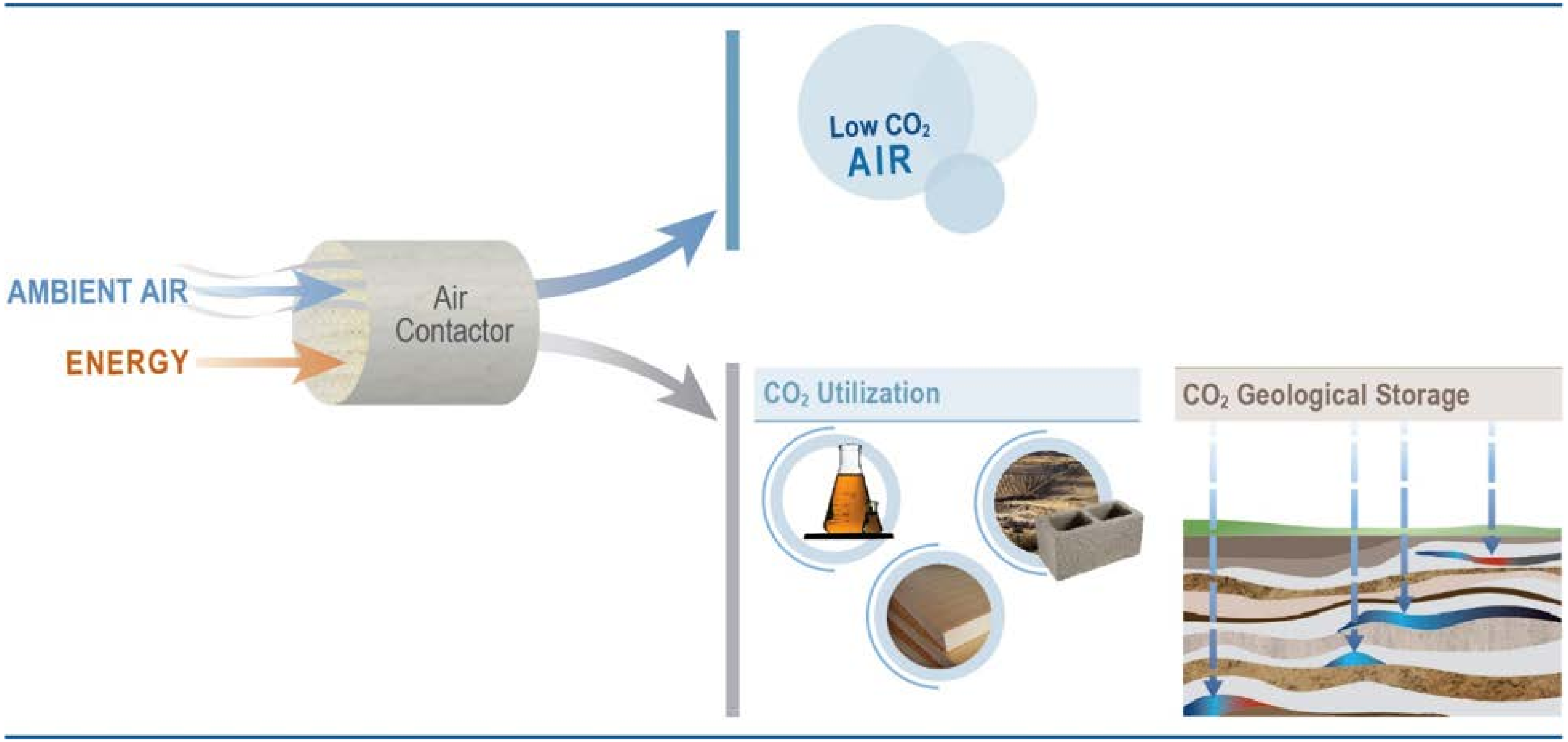
At $50-100/ton, that's a HUGE market

Needs create markets
Tech creates opportunities

"All pathways that limit global warming to 1.5°C … project the use of carbon dioxide removal (CDR) on the order of 100–1000 GtCO2 over the 21st century."
– IPCC 1.5°C Report (2018)



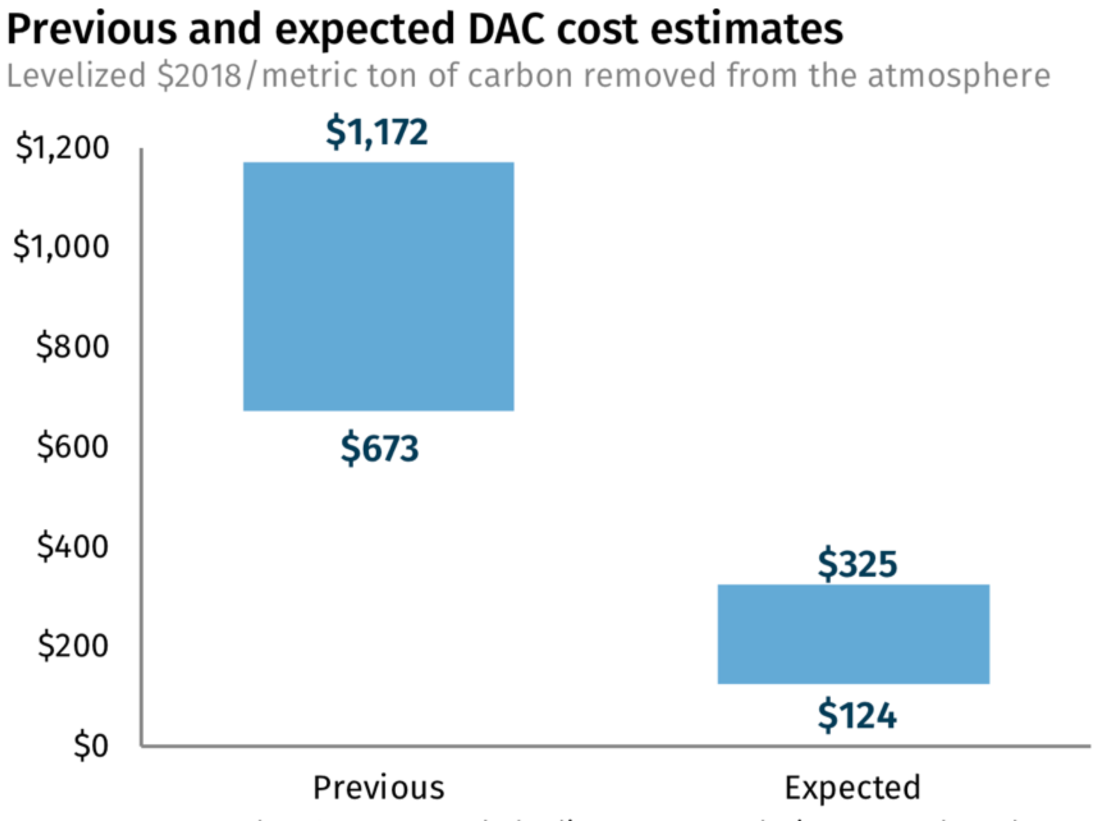
Direct Air Capture: separating CO_2 from the air for either use or storage

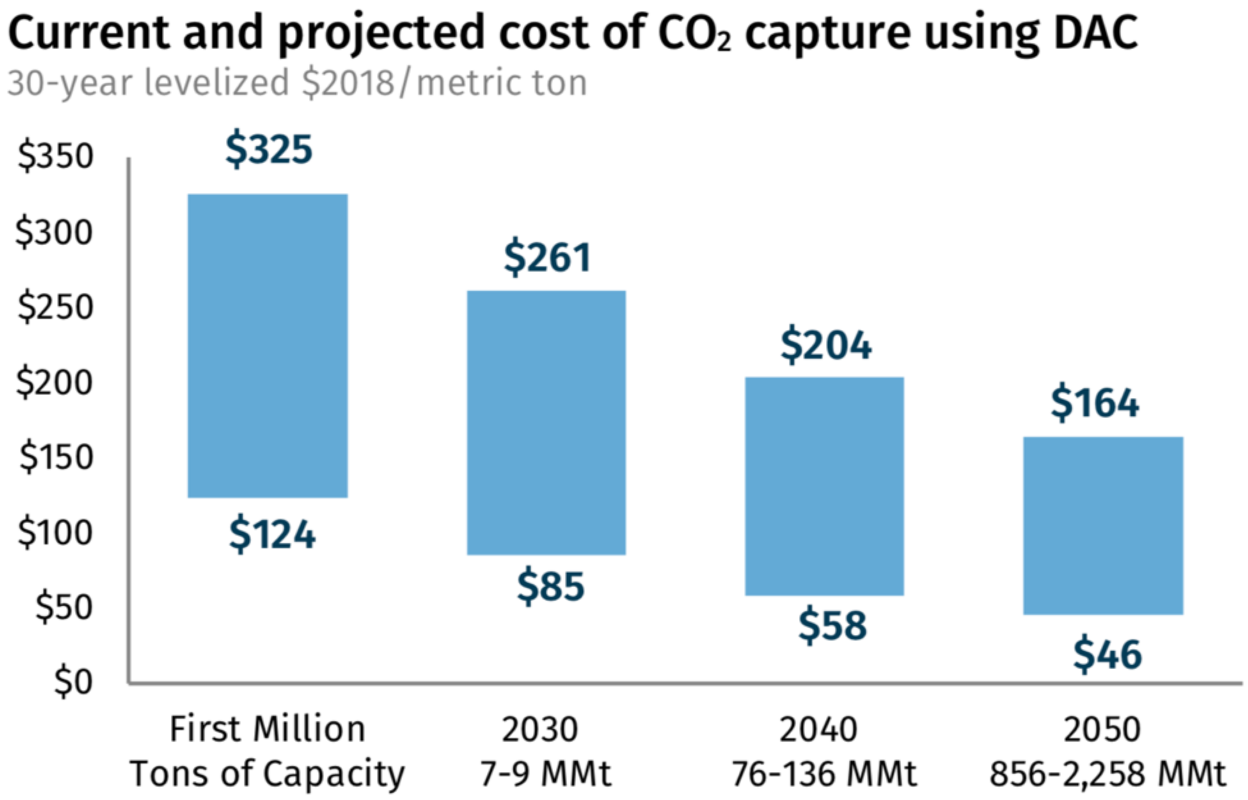


ICEF Roadmap, 2019

DACCS has no resource constraint and "uniform" costs for application

Cost curve is flat, so cost should vary chiefly as a function of deployment





Rhodium Group, 2019

Happy
Talk

We know the problem

We need to rethink our approach

Beyond "moral hazard"

- All options are acceptable and likely required
- Be humble and generous

Clear-eyed on carbon

- TONS are the metric – reduce, remove, recycle
- Avoided emissions ≭ reduced or returned emissions

We need more

- Innovation: in technology, policy, finance, and business
- Learning through doing works

Not what should we do – what CAN we do

Carbon Engineering

CLEAN ENERGY MINISTERIAL CCUS WEBINAR

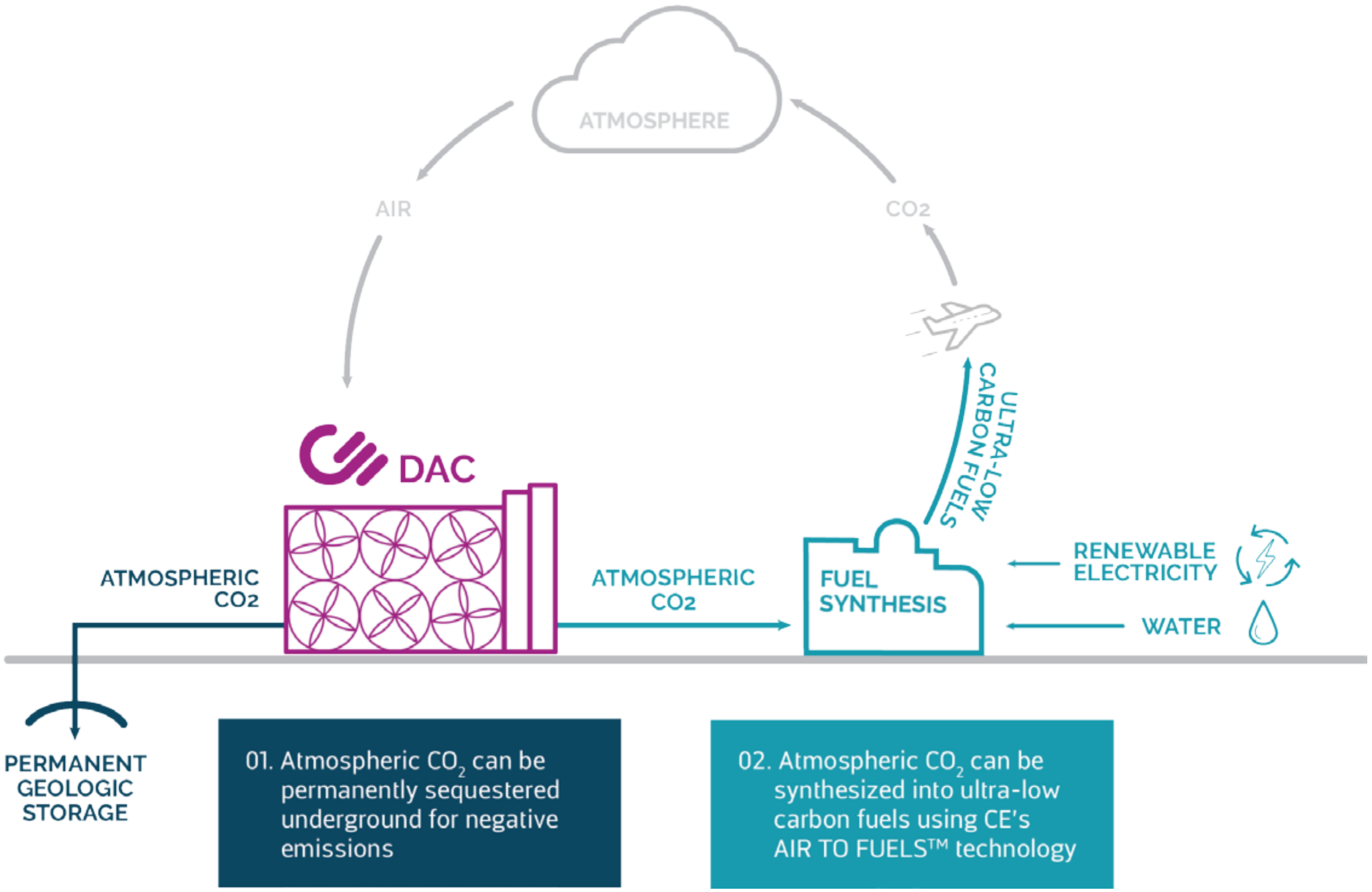
Direct Air Capture of CO2: Helping to Achieve Net-Zero Emissions

PRESENTED BY
Lori Guetre, VP Business Development

DATE
April 21, 2020

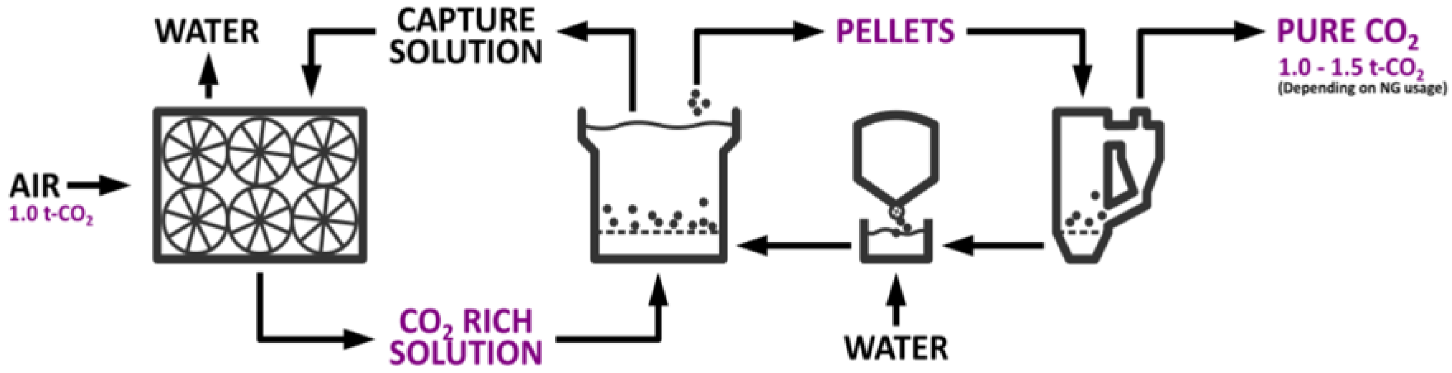
Carbon Engineering Brings…

- Negative emissions by removing CO_2 from the atmosphere.
- Drop-in compatible fuels that reduce the carbon intensity of transportation fuels by recycling atmospheric carbon



ELIMINATION OF ANY EMISSION, OF ANY TYPE, FROM ANYWHERE AND ANY TIME

Carbon Engineering's Direct Air Capture Technology



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 iron ore processing

INDUSTRIALLY SCALABLE

A combination of pre-existing technologies have been adapted and combined with patented innovations and proprietary know-how, which has allowed us to scale rapidly to the full commercial size of 1 Mt/yr.

CLOSED CHEMICAL CYCLE

Non-volatile, non-toxic, closed-loop chemical process that meets environmental health and safety standards and minimizes operating costs.

FREEDOM OF LOCATION

Plants can be located where economics are optimum to take advantage of low-cost local energy and proximity to geologic sequestration sites, low-carbon fuel markets, or other demand center.

https://www.cell.com/joule/pdf/S2542-4351(18)30225-3.pdf

AIR TO FUELS™ Solution: A Convergence of Innovations

Harnessing Trends in Four Technologies

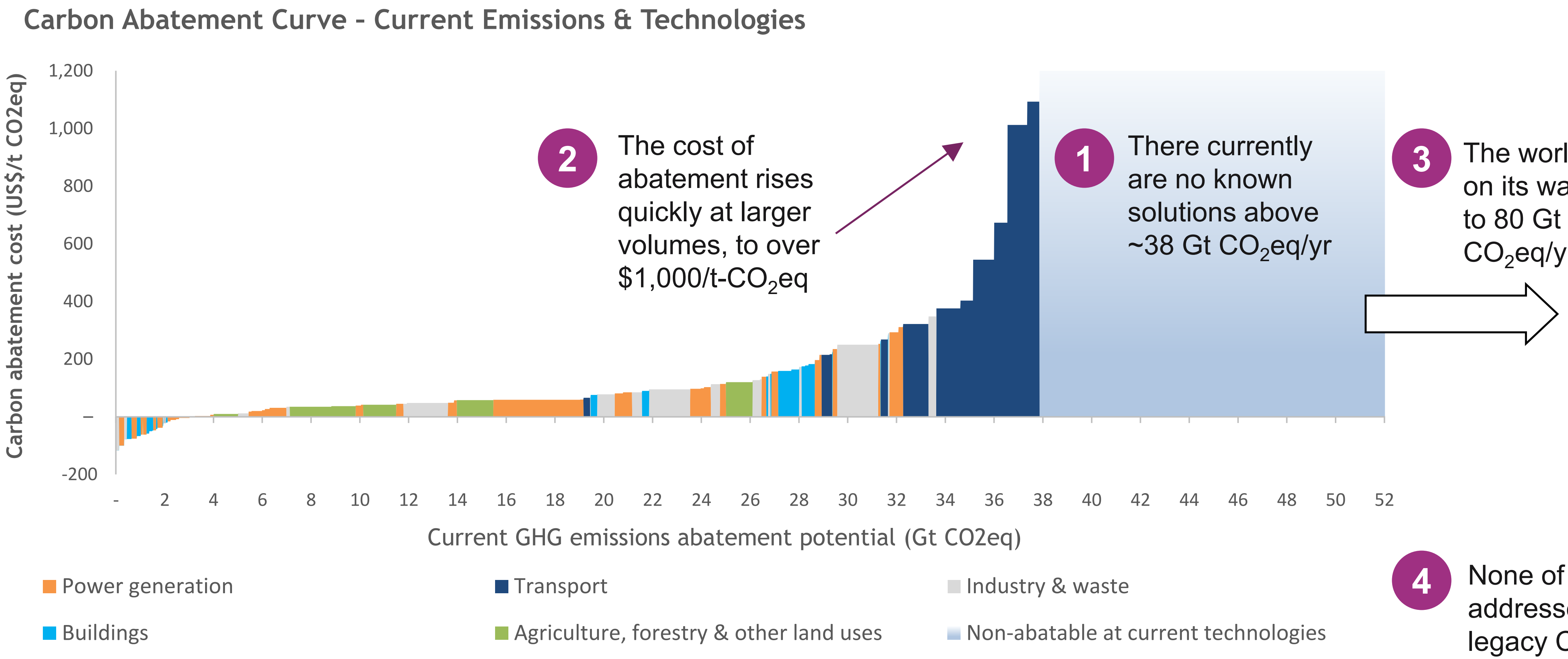
Key Enablers	
CE Direct Air Capture Technology	• Collects atmospheric CO_2 at large scale and low cost.
Advances in Electrolysis	• Megawatt scale electrolyzers are emerging. Levelized costs in the range of $15-20/MJ.
Abundance of Low-Cost Renewable Power	• Solar PV and Wind have become the cheapest sources of electricity with prices falling below $20/MWh from the best generating locations.
AIR TO FUELS™ Fischer Tropsch Fuel Synthesis	• Proven Technology - 250,000 bbl/day of liquid fuels are produced from a variety of feedstocks from Fischer-Tropsch process.

Advantages

- ✓ Ultra low carbon intensity
- ✓ Drop-in compatible
- ✓ Fully transportable around the world with existing infrastructure
- ✓ 30x the energy density of batteries
- ✓ 100x lower land/water use impact than biofuels
- ✓ Highly scalable

CE'S AIR TO FUELS™ PROCESS HARNESSES LOW-COST ENERGY AND CONVERTS CO2 INTO HIGH-VALUE LIQUID FUELS

CE's Vision for the Next Ten Years? Tackle the Abatement Challenge…



Source: Goldman Sachs Global Investment Research

4 None of this addresses legacy CO_2 which is 95% of the problem

THE WORLD NEEDS TO ACCELERATE TECHNOLOGICAL SOLUTIONS THAT ARE AFFORDABLE AND CAN SCALE

The Missing Piece

Only one solution is available today that:

1. Can solve today's abatement gap
2. Is affordable compared to alternatives for many emissions
3. "Has the potential to be almost infinitely scalable"[1]
4. Supports climate restoration through permanent carbon removal ("negative emissions")

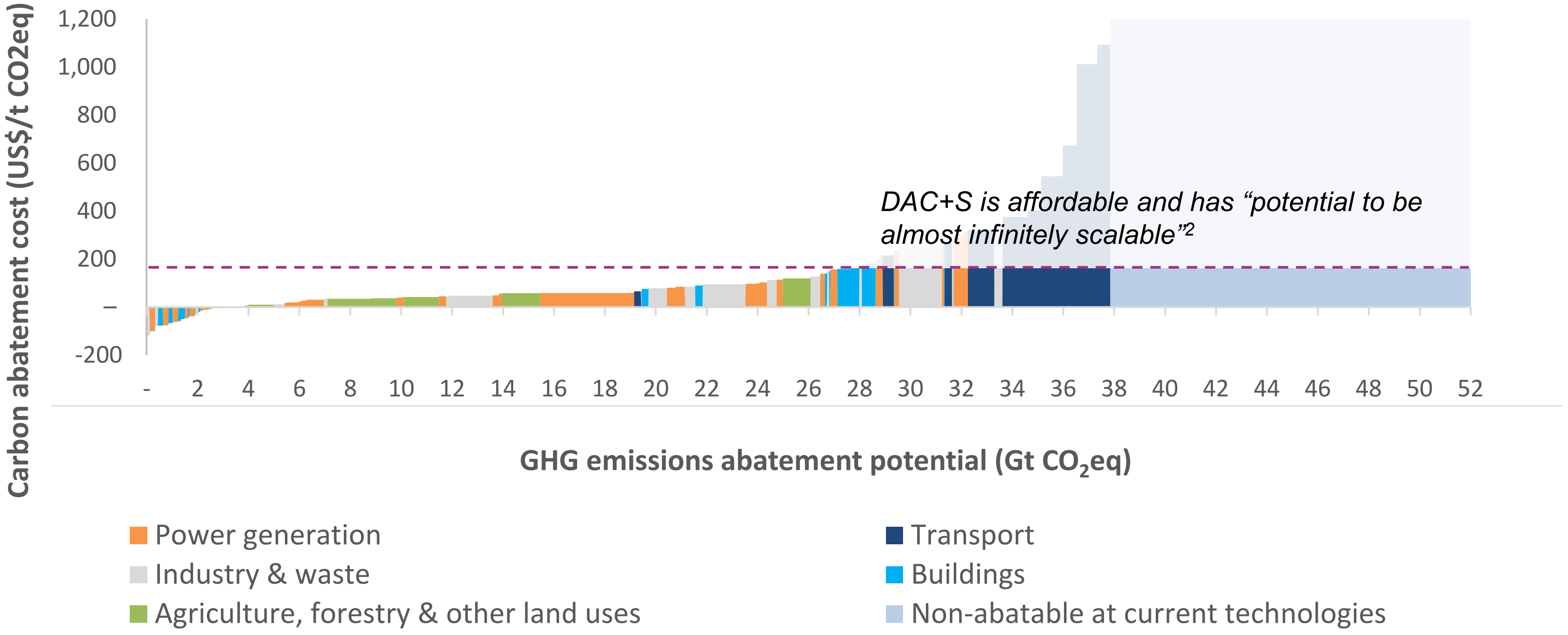
→

1. Goldman Sachs – Carbonomics: The Future of Energy in the Age of Climate Change

Hypothetical Cost for "Net Zero" Today – With DAC+S at $150/t[1]

The first 38 Gt would cost approximately $3 trillion / yr (capping the cost at $150/t) + The next 14 Gt would cost $2 trillion /yr (at $150/t) =

Total cost for net zero today: $5 trillion / yr



- That's **~6%** of 2018 global GDP of $85 trillion
- Innovation will drive DAC+S costs lower:
  - At $100/t, this drops to **~4.5%** of 2018 GDP
  - At $50/t, this drops to ~**2.5%** of 2018 GDP

Source: Goldman Sachs Global Investment Research

1. First plants will cost >$150/t. Nth plants will cost <$150/t.
2. Goldman Sachs – Carbonomics: The Future of Energy in the Age of Climate Change

History and Deployment Plan

2009

Carbon Engineering Founded

2015

DAC Pilot Plant

Enabled by:

- ~$100M private equity
- ~$40M Government support
- 10 years of research

2018

1st Commercial Plant (1Mt/year)

Enabled by:

- 45Q tax credit,
- California's Low Carbon Fuel Standard

2030

Broad Plant Rollout

- DAC and A2F plant rollout in jurisdictions with the strongest policies and highest corporate and government targets
- Ongoing innovation

2050

Global Operations

Significant role in the global effort to achieve net zero and restore safe levels of atmospheric CO_2

TECHNOLOGY ENABLES RAPID, CLIMATE-RELEVANT DECARBONIZATION

MORE INFORMATION CAN BE FOUND AT:

www.carbonengineering.com

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Carbon Engineering Ltd.

CarbonEngineering

CLIMEWORKS

Capturing CO_2 from air

DIRECT AIR CAPTURE OF CO2 – HELPING TO ACHIEVE NET-ZERO EMISSIONS

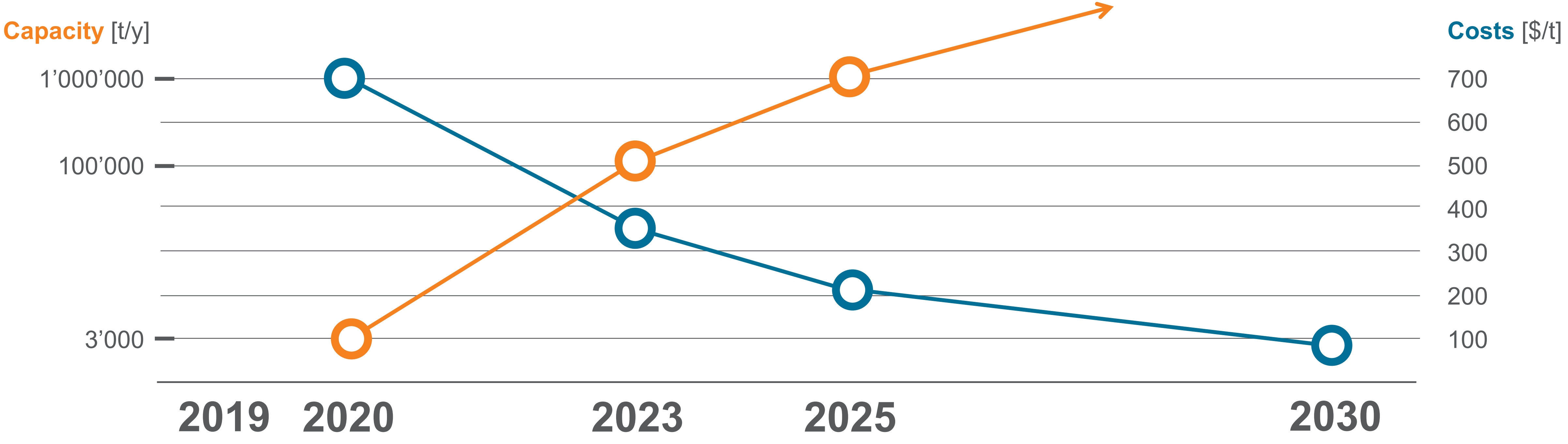
Webinar: Clean Energy Ministerial CCUS, April 21st

Christoph Beuttler, CDR Manager, chb@climeworks.com

CLIMEWORKS - OVERVIEW

- **14 plants** in operation across Europe
- **100+** FTEs with headquarters in **Zurich**, Switzerland, subsidiary in **Cologne**, Germany
- **World's first** company supplying atmospheric CO_2 to customers
- **Modular** CO_2 capture plants. **Scale-up** via mass production of CO_2 collectors
- **Energy Source: waste heat at 100 °C** (4/5th) and renewable electricity (1/5th)
- **Minimal carbon footprint:** 90%-95% net efficiency with cradle to grave LCA

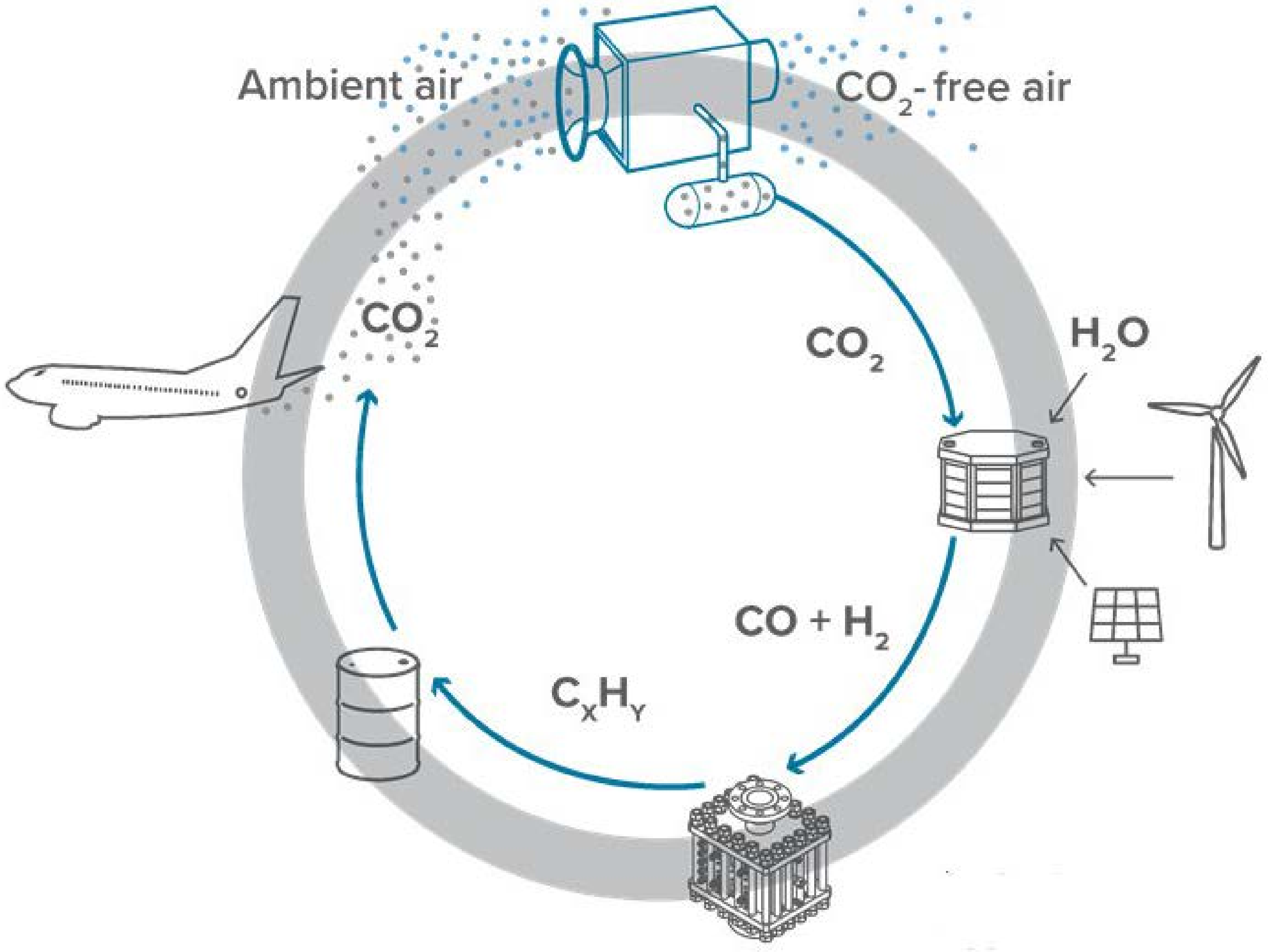
ROADMAP FOR LARGE-SCALE CO_2 REMOVAL



Cost optimizations	Optimized collector design	Production of larger plants	Mass production of collectors	Scale up production
Capacity increase	Installation of a **3'000** t/y plant in Iceland, in execution	Installation of a **100'000** t/y plant	Installation of a **1'000'000** t/y plant	Upscale to remove gigatons of CO_2 from the air

FUELS FROM AIR: CLOSING THE CARBON CYCLE

- **Direct Air Capture** (DAC): Captures CO_2 from ambient air
- **DAC** allows for near carbon neutral e-fuel production
- **No change in infrastructure needed** – closing the gap in renewable fuels



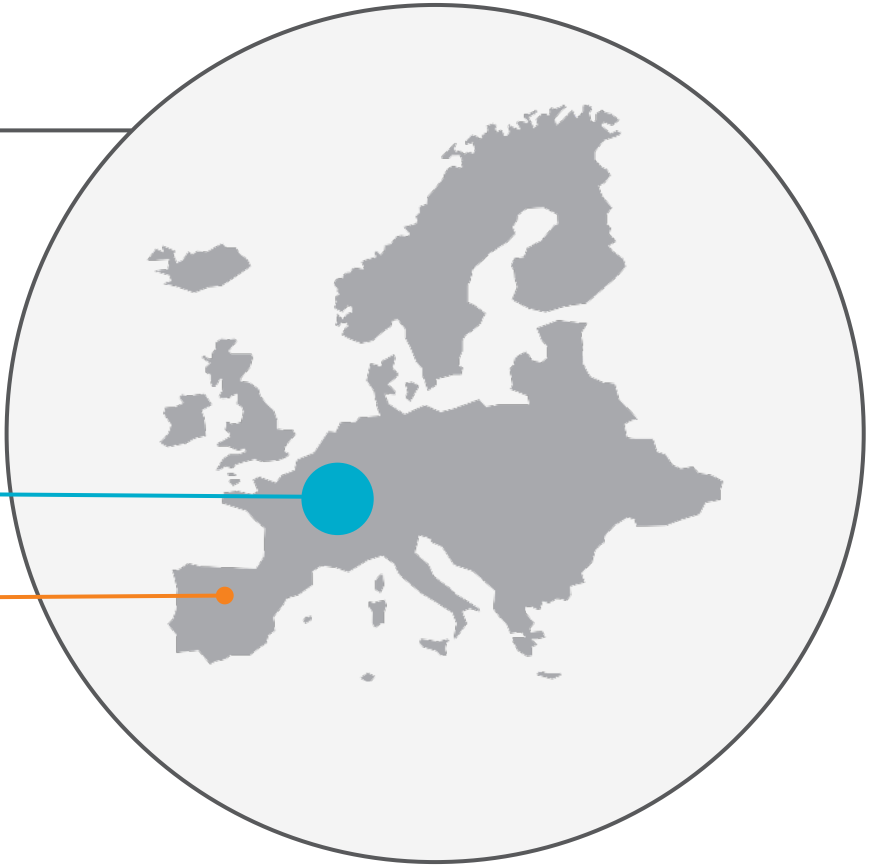
SCALEABILITY AND LAND REQUIREMENT

Surface area needed to meet the 2010 EU transportation energy demand (17,000 pJ/year)

Corn Biofuel
28’000’000 km^2
of arable land
(yield assumption 18 g/ac/y)

Algae Biofuel
200’000 km^2
of barren land
(yield assumption 2’500 g/ac/y)

Renewable Synfuels
14’200 km^2
of barren land
(assumption: 1’900kWh/m^2,
$\eta_{PV} = 25\%, \eta_{PtX} = 70\%$)



CARBON DIOXIDE REMOVAL FLAGSHIP

COMPARISON OF CO_2 REMOVAL APPROACHES

AFFORESTATION

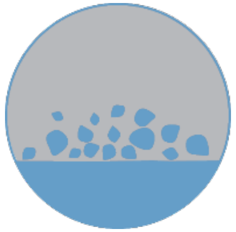
Large-scale tree plantations to increase carbon storage in biomass.

BECCS

Bioenergy in combination with carbon capture and storage.

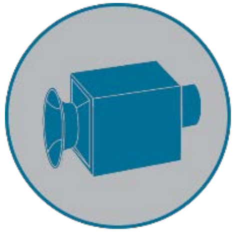
ENHANCED WEATHERING

Distribution of crushed silicate rocks on soil surface to absorb CO_2 chemically.



DIRECT AIR CAPTURE

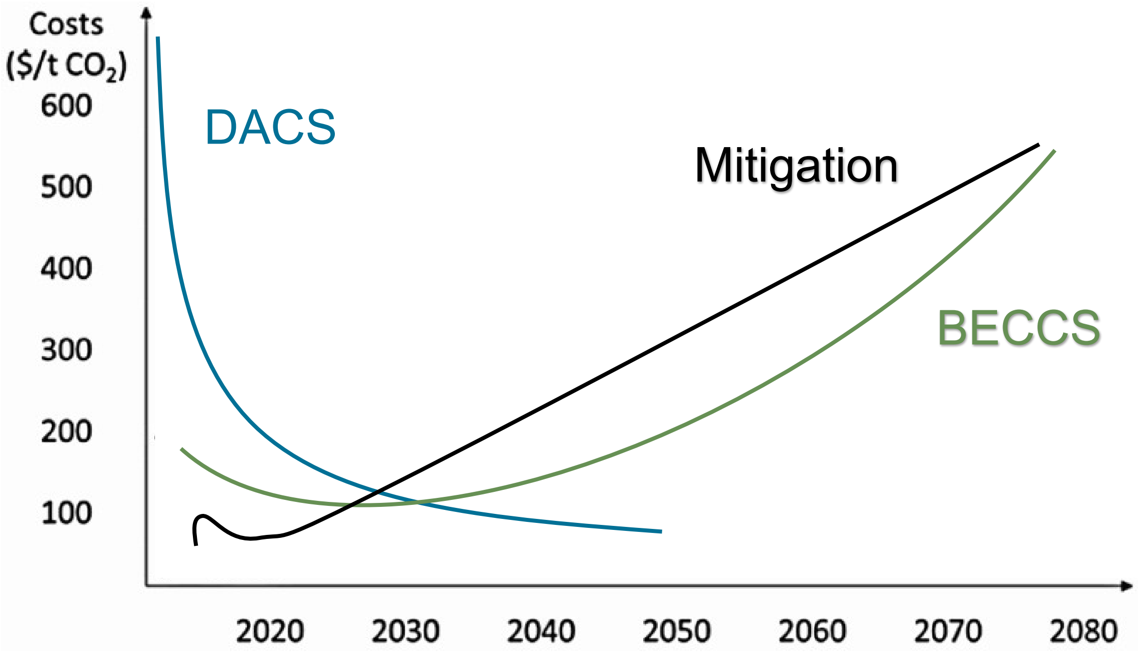
Direct capture of CO_2 from ambient air through engineered chemical reactions.



AREA REQUIRED

to remove 8 Gt CO_2 per year

Economics of Mitigation, BECCS & DACS



Source: Reiner & Honegger 2018: Development of costs of BECCS, DACS and classical mitigation over time assuming strong political will to cover mitigation costs.
Note: Curves are indicative.

- Cost of DACS is falling (blue curve)
- Whilst costs of Mitigation and plant based CDR (BECCS) will be rising in the long run due to resource constraints (Land, Water)

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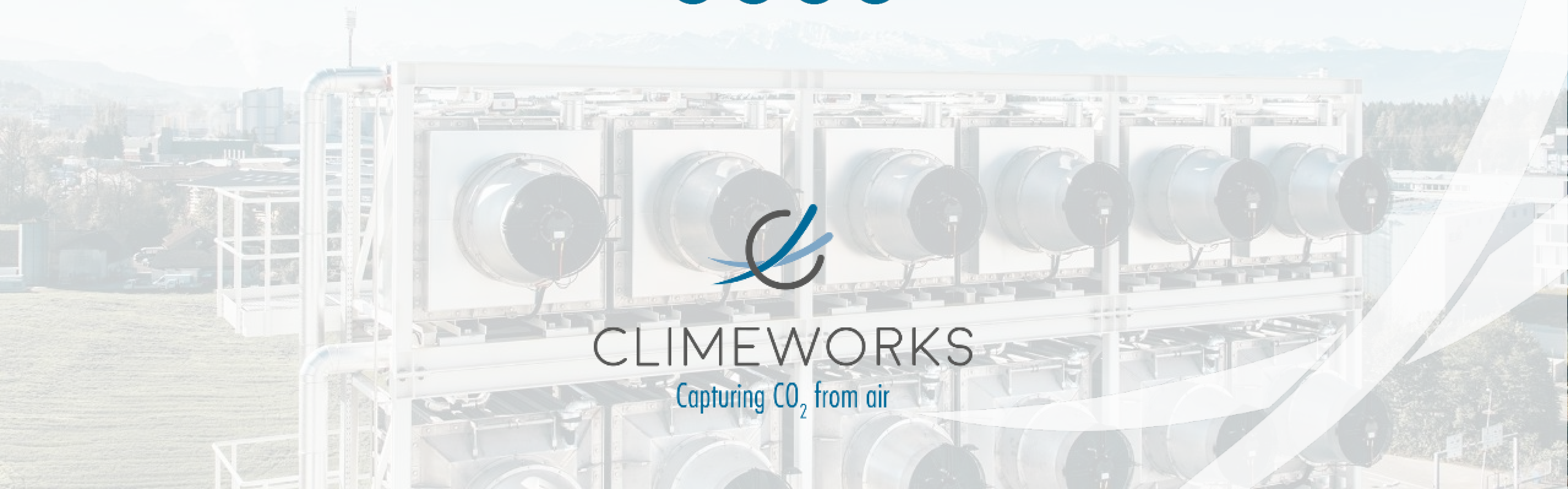


CLIMEWORKS

Capturing CO_2 from air

Direct Air Capture

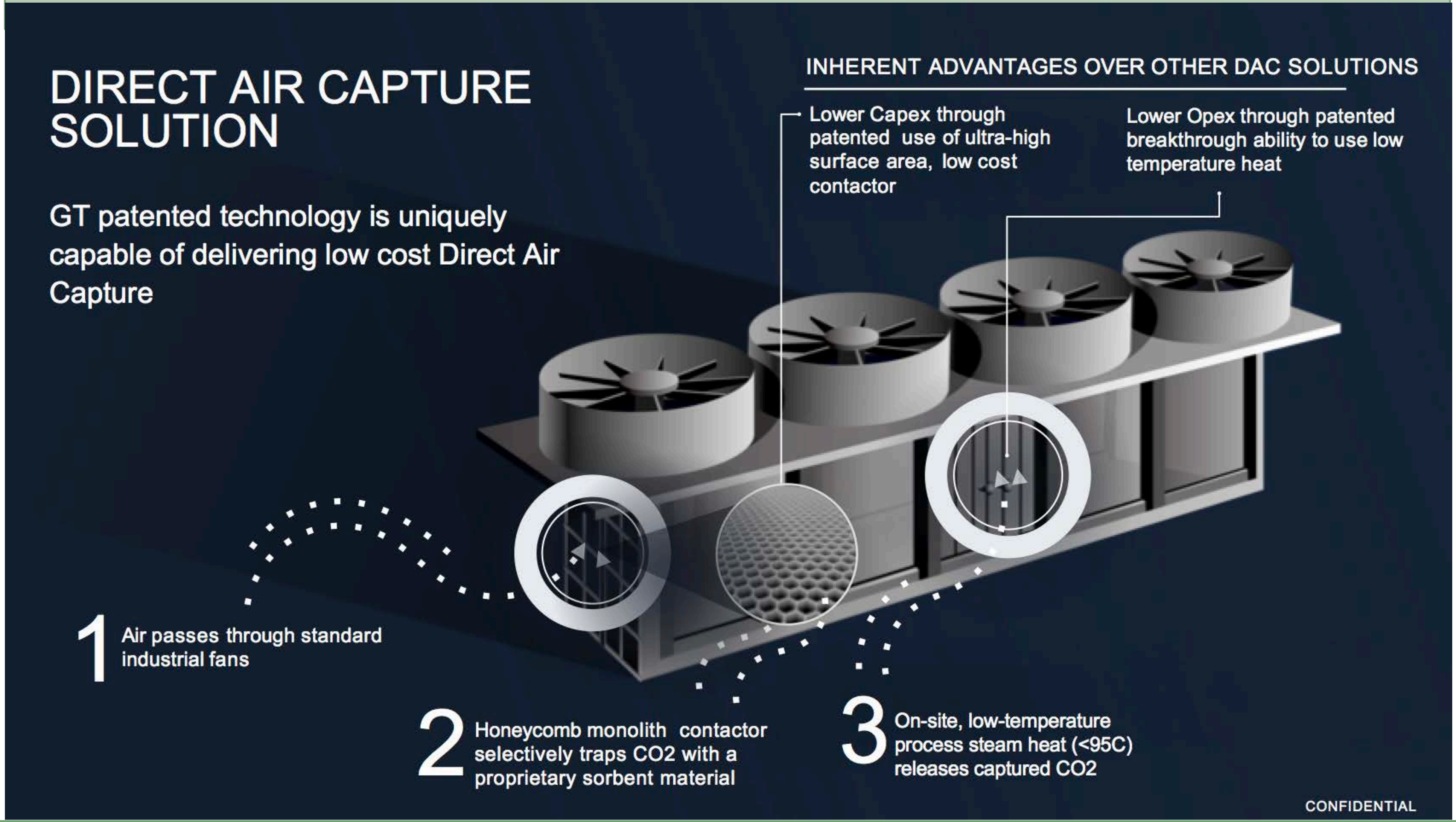
Renewable Energy and Materials Economy

Transforming the Climate Threat into an Opportunity

Peter Eisenberger

Global Thermostat

Technology Overview



Cost Impact of GT Breakthroughs:
At scale under $50 per Tonne of CO_2

Contactor Efficiency

- Increased throughput at low pressure drop
  - High Air Velocity-5m/sec
  - Lowers CAPEX/tonne - more throughput per year
  - Lowers OPEX/tonne - low pressure drop-less electricity per tonne

Regeneration Efficiency & Heat Recovery

- By using steam as sweep gas and direct heat transfer fluid
  - Enables use of low temperature process/waste heat
  - Lowers CAPEX /tonne-fast kinetics –more CO_2 collected/time
  - Lowers OPEX/tonne – less heat and lower cost heat

GT Pilots and Commercial Demo Plant

Menlo Park 2011

Initial Pilot Plant
GT DAC 1

1 adsorption panel
1 regeneration chamber
2.5 m/s air velocity

Menlo Park 2013

Second Pilot Plant
GT DAC 2 / GT Carb 1

2 adsorption panels
2 regenerator chambers
2.5 m/s air velocity

Huntsville 2018

First Commercial Demo Plant
GT DAC 4000

20 adsorption panels
2 regeneration chambers
5 m/s air velocity

Our Technology Partners

Partner	Activity	Relationship Terms
SRI International	▪ Pilot plant operation and R&D; ▪ lab testing	▪ Contract R&D
Linde	▪ Carburetor Pilot/EPC Contractor	▪ EPC Contractor
Haldor Topsoe, Corning	▪ Monolith development/supply	▪ Strategic Supplier
Applied Catalysts	▪ Contactor development/supply	▪ Joint development, Strategic Supplier
Cormetech	▪ Porous monolith development/supply	▪ Joint development
Georgia Tech	▪ Sorbent R&D; contactor testing	▪ Contract R&D
Air Liquide	▪ Plant development; pilot testing	▪ Strategic commercial partner
Streamline Automation	▪ System design, engineering, fabrication	▪ Contract EPC
Gastech Engineering	▪ Value engineering, mass manufacturing	▪ Contract EPC
EMRE	▪ Scaling up technology	▪ Joint development

SRI International

GT

THE LINDE GROUP

nrg

CARMAGEN Engineering, Inc.

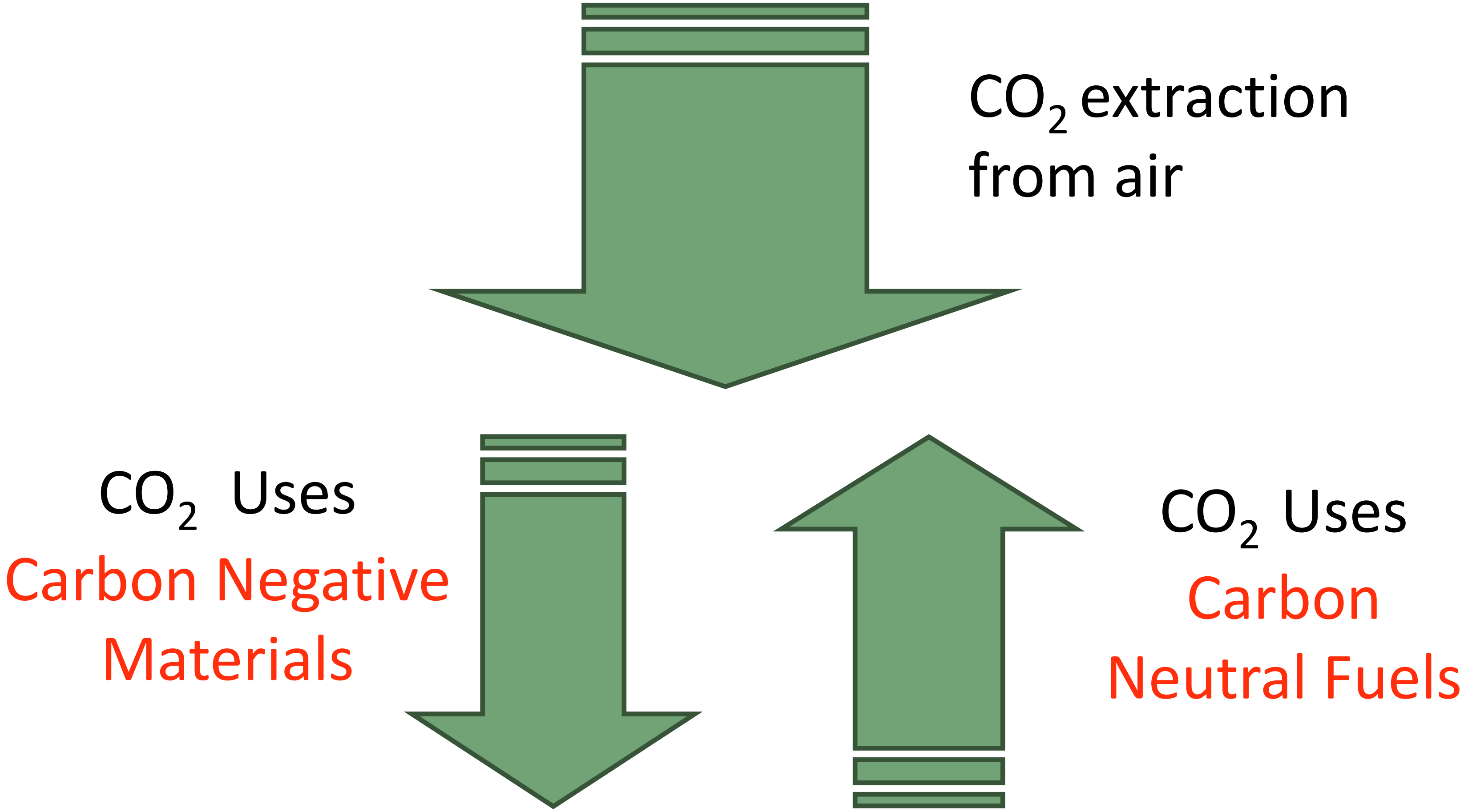
ExxonMobil Research and Engineering

Air Liquide

G.A.WEST

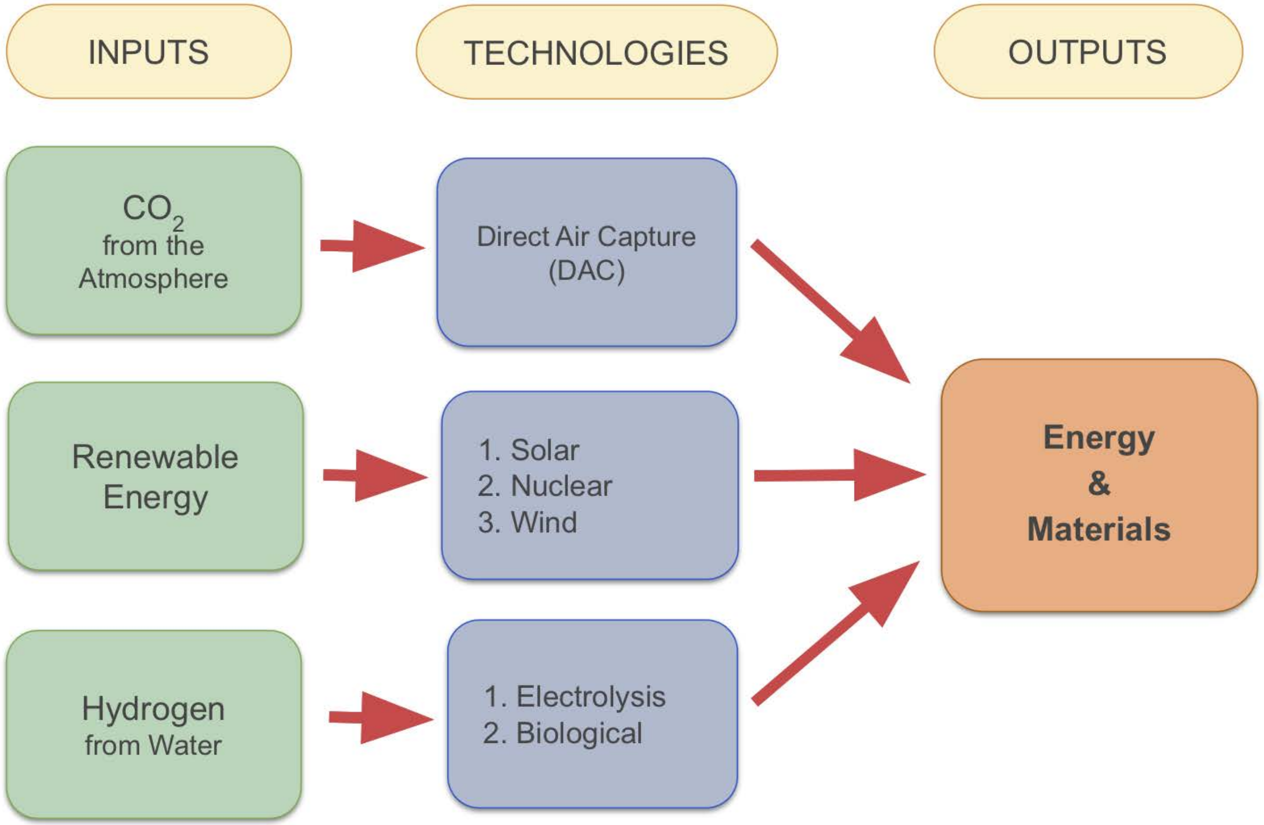
GasTech Engineering LLC PROCESS PLANTS AND EQUIPMENT

Direct Air Capture
Human Controlled Carbon Cycle



REME

Renewable Energy & Materials Economy



REME
Positive Feedback: Development and Environment

Social Cost =Private Cost + External Impact Cost

Natural Resource Economy – External Impact Cost High

- Increases Pollution
- Climate Change Damage
- Biodiversity Lose

The more development - more damage to the environment

REME External Costs are negative – makes things better

- Reduces Climate Change Damage
- Biodiversity Thrives
- Stimulates Economy –creates jobs

The more development - the better the environment

MARKET OPPORTUNITY:

CO_2 UTILIZATION (CARBON-TO-VALUE/PRODUCTS)

CARBON-BASED ECONOMY

Much of today's economy is dependent on carbon-based products.

FOSSIL DEPENDENT TODAY

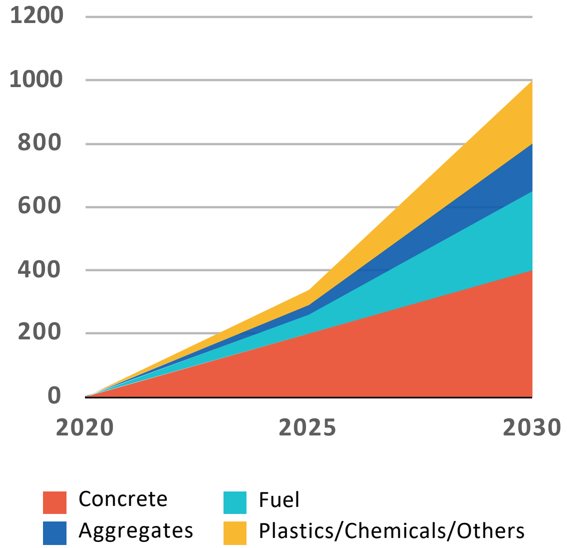
However, most of this carbon is derived from fossil fuels. This now comes with increasing downsides:

- HIGH COST
- COMMODITY RISK
- GEOPOLITICAL INSTABILITY
- ENVIRONMENTAL POLLUTION
- KEY DRIVER OF CLIMATE CHANGE

SOURCE: https://assets.ctfassets.net/xg0gv1arhdr3/27vQZEvrxaQiQEAsGyoSQu/44ee0b72ceb9231ec53ed180cb759614/CO2U_ICEF_Roadmap_FINAL_2016_12_07.pdf

CO_2: A BETTER SOURCE OF CARBON

The emerging CO_2 utilization market is forecast to grow to $1 trillion+ by 2030 and beyond



As the cost & technology leader, GT ideally positioned to capture opportunities in these verticals

Renewable Energy and Materials Economy

MIMICS NATURE

Inputs **- Sun ,CO_2 from Air, Hydrogen from Water**

Outputs **- Energy and Materials** we need

REME TECHNOLGIES

Solar Energy Predicted To Cost 1-2 Cts Kwhr

Hydrogen $1/Kilogram

$50 Per Tonne CO_2 =$20 Per Barrel Oil

REME OUTPUTS

$3 Per Gallon Gasoline

Competitively priced Hydrocarbons

Competitively priced Building Materials

Sequesters Enough Carbon To Meet Paris Targets

RENEWABLE ENERGY AND MATERIALS ECONOMY
A Sustainable Solution

The Industrial Version Of Photosynthesis

Positive Environmental Externalities - Addresses Climate Change Threat

No Resource Constraints - Sun, Air, and Water

Positive Feedback Between Development And Environment

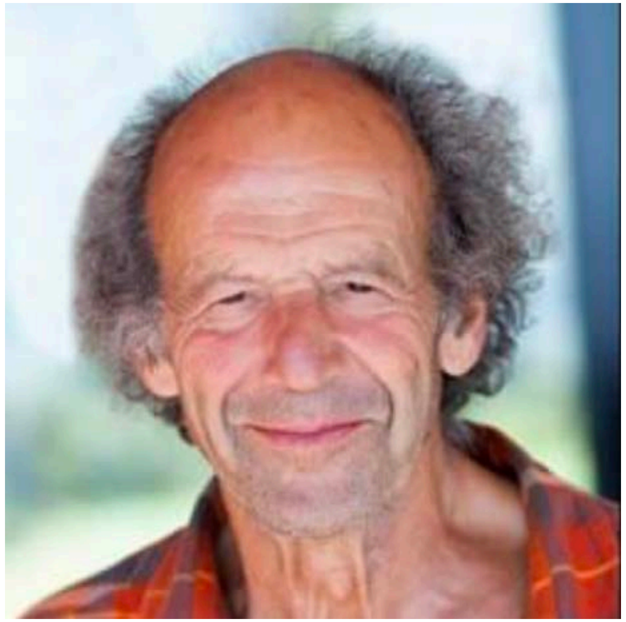
The more REME the more carbon is sequestered - increased CLIMATE CHANGE PROTECTION

The more REME the more jobs are created – increased PROSPERITY

The more REME the more locally produced energy – increased energy SECURITY

Mobilize To Implement REME Now!

Creating Global Prosperity While Addressing the Climate Change Threat.



Peter Eisenberger

Chief Technology Officer & Co-Founder

Global Thermostat

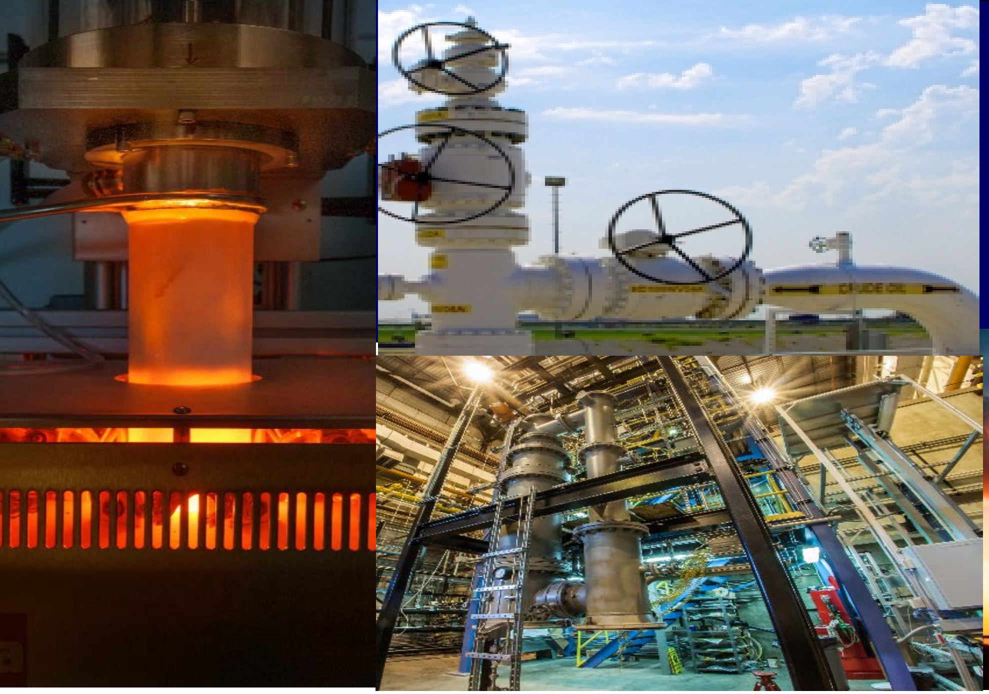
www.globalthermostat.com

Download latest Paper:

REME - Renewable Energy and Materials Economy

by Peter Eisenberger, April 2020

https://elkinstitute.files.wordpress.com/2020/04/reme-1.zip



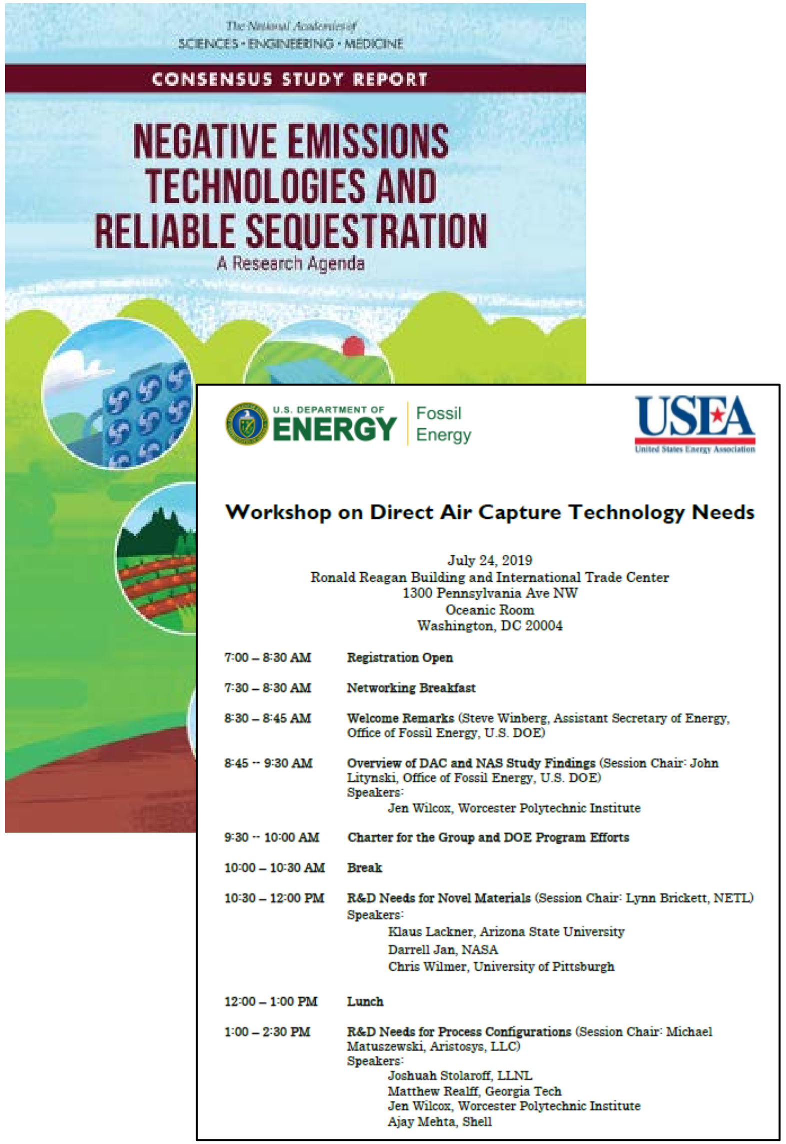
U.S. DEPARTMENT OF ENERGY | Office of Fossil Energy

Future R&D Focus Areas for Direct Air Capture

April 21, 2020
CEM CCUS Initiative Webinar

Mark Ackiewicz
Director, Division of CCUS R&D
U.S. Department of Energy

KEY R&D OPPORTUNITIES



U.S. DEPARTMENT OF ENERGY | Fossil Energy
USEA United States Energy Association

Workshop on Direct Air Capture Technology Needs

July 24, 2019
Ronald Reagan Building and International Trade Center
1300 Pennsylvania Ave NW
Oceanic Room
Washington, DC 20004

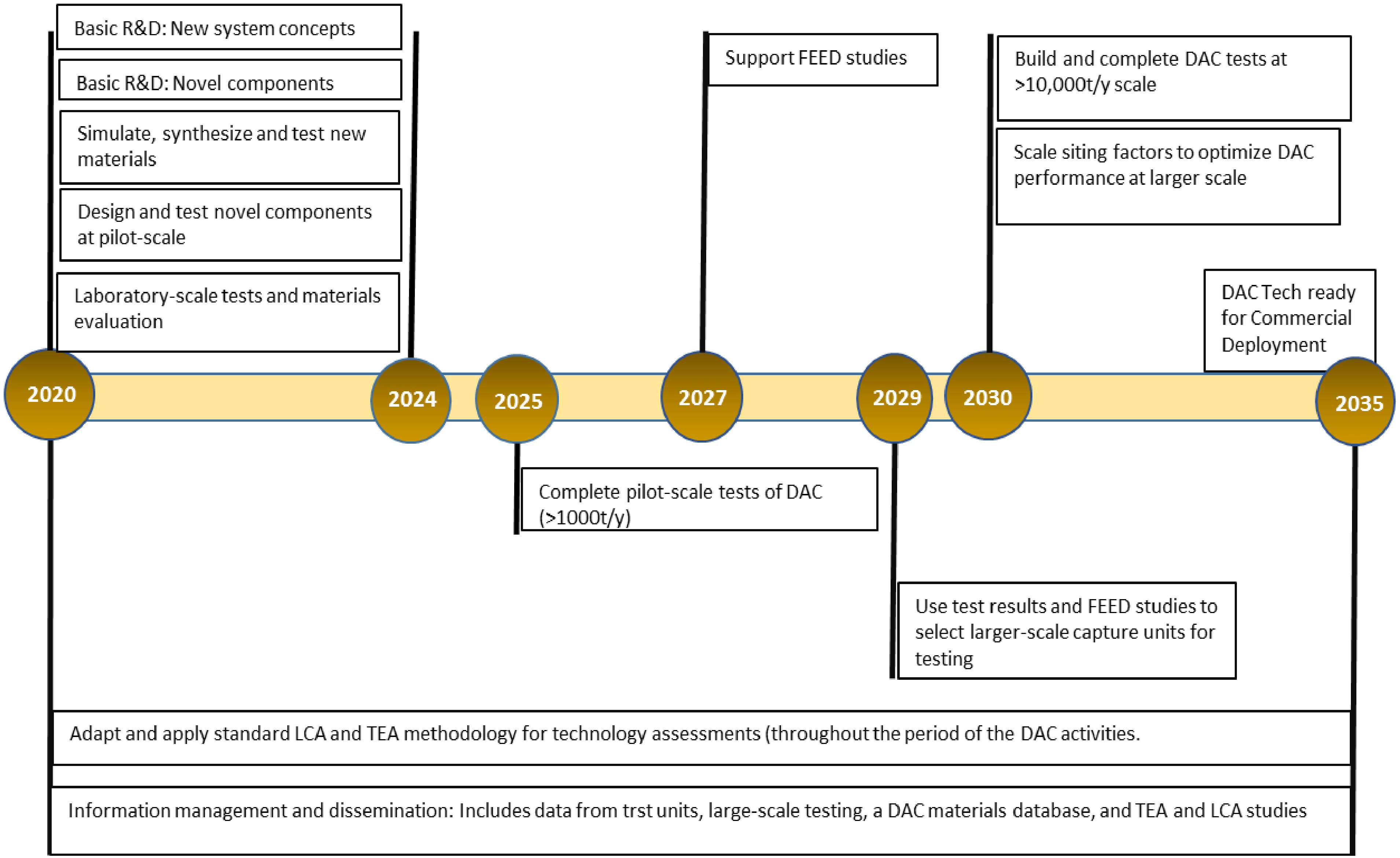
7:00 – 8:30 AM	**Registration Open**
7:30 – 8:30 AM	**Networking Breakfast**
8:30 – 8:45 AM	**Welcome Remarks** (Steve Winberg, Assistant Secretary of Energy, Office of Fossil Energy, U.S. DOE)
8:45 – 9:30 AM	**Overview of DAC and NAS Study Findings** (Session Chair: John Litynski, Office of Fossil Energy, U.S. DOE) Speakers: Jen Wilcox, Worcester Polytechnic Institute
9:30 – 10:00 AM	**Charter for the Group and DOE Program Efforts**
10:00 – 10:30 AM	**Break**
10:30 – 12:00 PM	**R&D Needs for Novel Materials** (Session Chair: Lynn Brickett, NETL) Speakers: Klaus Lackner, Arizona State University Darrell Jan, NASA Chris Wilmer, University of Pittsburgh
12:00 – 1:00 PM	**Lunch**
1:00 – 2:30 PM	**R&D Needs for Process Configurations** (Session Chair: Michael Matuszewski, Aristosys, LLC) Speakers: Joshuah Stolaroff, LLNL Matthew Realff, Georgia Tech Jen Wilcox, Worcester Polytechnic Institute Ajay Mehta, Shell

The Challenge: Dilute CO_2 streams challenging and more costly to separate compared to more concentrated systems

The Opportunity

- Materials development
- Process optimization
- Resource and logistic challenges (water/land use; siting)
- DAC integration with capture/conversion operations
- Lifecycle (LCA) and techno-economic (TEA) analyses

DRAFT R&D PLAN FOR ADVANCED DAC TECHNOLOGY DEVELOPMENT



*FEED – Font-End Engineering Design

RECENT U.S. DOE ACTIVITIES AND OPPORTUNITIES FOR DAC

45Q tax credit

- \$35/tonne for utilization, \$50/tonne saline
- Thresholds for DAC to qualify: 100 ktCO_2/year for storage and EOR; 25 ktCO_2/year for utilization

Funding Opportunity Announcements

- \$22 million announcement from DOE for basic science and applied R&D
- For details: https://www.energy.gov/articles/department-energy-provide-22-million-research-capturing-carbon-dioxide-air

Question and Answer Session

Jarad Daniels

Director, Office of Strategic Planning, Analysis, and Engagement

U.S. DOE

Dr. Julio Friedmann

Senior Research Scholar

Center on Global Energy Policy, Columbia University

Lori Guetre

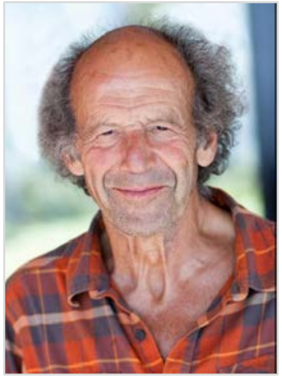
Vice President of Business Development

Carbon Engineering

Christoph Beuttler

CDR Manager

Climeworks



Dr. Peter Eisenberger

Chief Technology Officer

Global Thermostat

Mark Ackiewicz

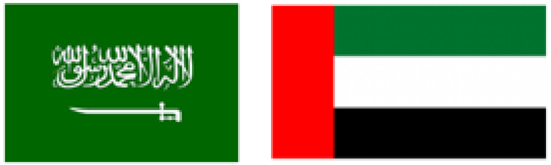
Director, Division of CCUS R&D

U.S. DOE

Webinar recordings provided on YouTube

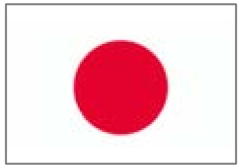
https://www.youtube.com/user/cleanenergypolicy

Upcoming webinars by the CEM CCUS Initiative:



Carbon Capture, Utilization and Storage in the Gulf Region

May 2020



Carbon Capture, Utilization and Storage in Japan

June 2020

Want to know more?

CEM CCUS INITIATIVE

https://www.linkedin.com/company/clean-energy-ministerial-ccus-initiative/

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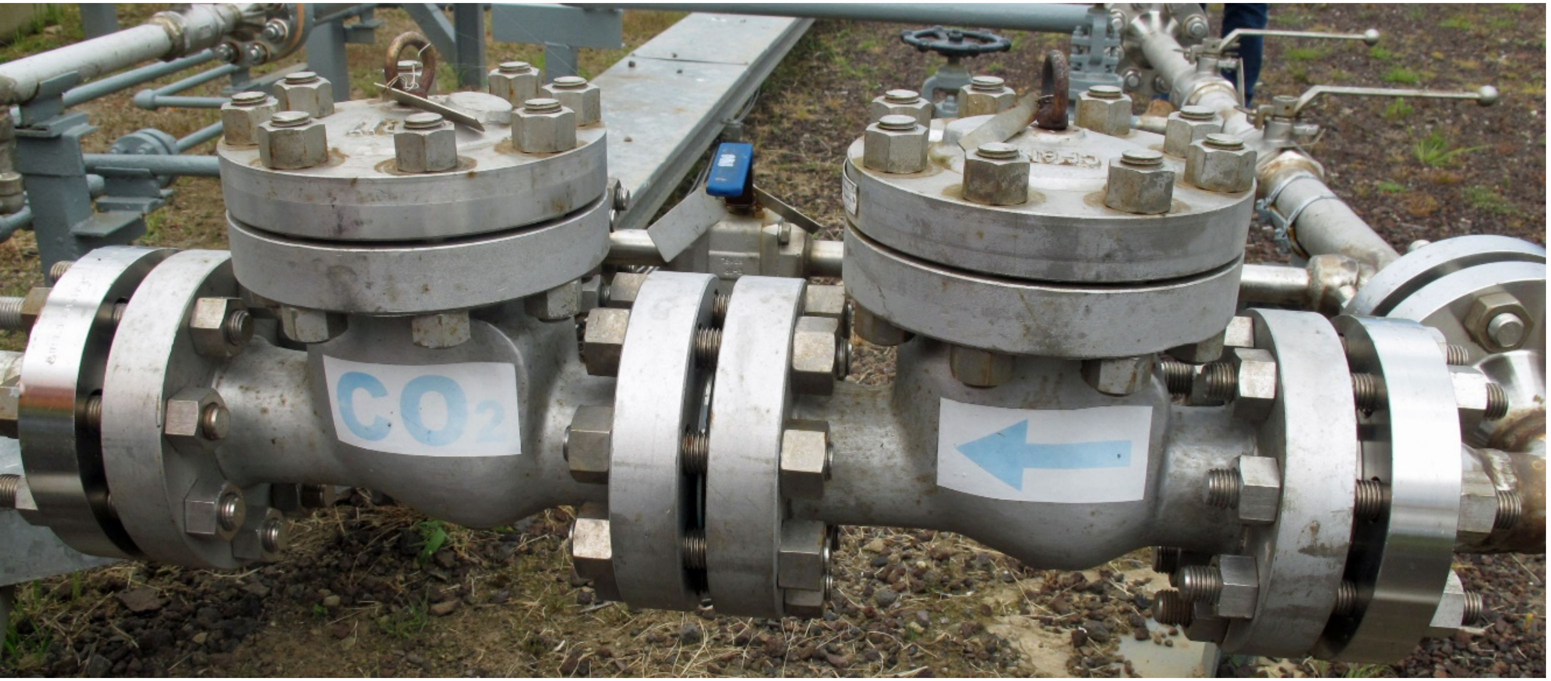
cemccus@outlook.com

TODAY'S SPEAKERS

- https://energypolicy.columbia.edu/
- https://carbonengineering.com/
- https://www.climeworks.com/
- https://globalthermostat.com/ ; https://elkinstitute.files.wordpress.com/2020/04/reme-1.zip
- https://www.energy.gov/fe/science-innovation/office-clean-coal-and-carbon-management/carbon-capture-utilization-and-storage

CARBON CAPTURE, UTILIZATION & STORAGE
ACCELERATING CCUS TOGETHER
AN INITIATIVE OF THE CLEAN ENERGY MINISTERIAL



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