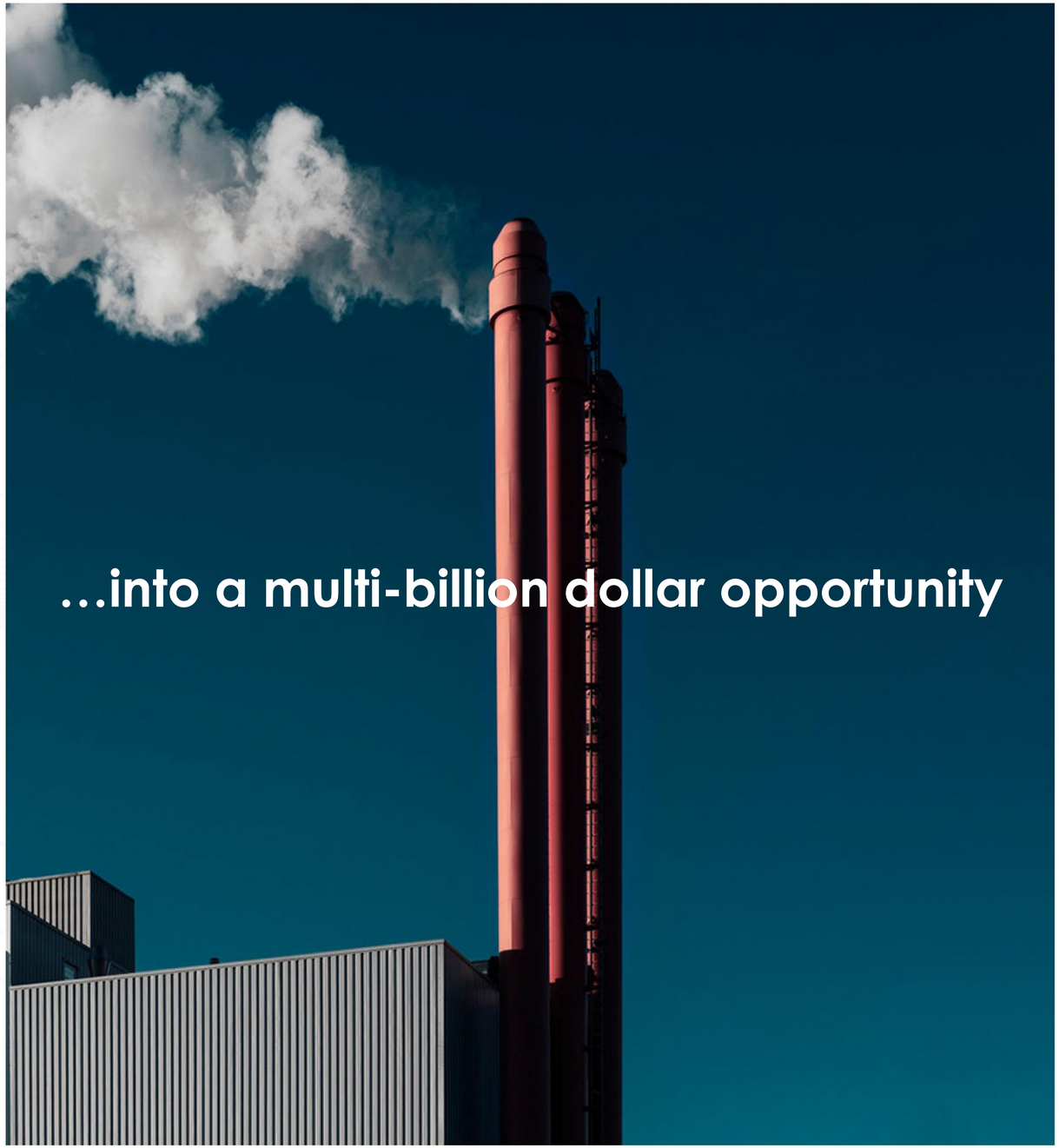
opus 12

Scaling-up CO_2 Utilization:

Etosha Cave, Co-Founder | Cave@Opus-12.com

Prepared for Stanford Carbon Management Workshop


Transforming global CO_2 Emissions...


...into a multi-billion dollar opportunity

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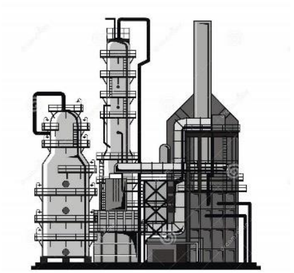
A platform technology that recycles CO_2 back into chemicals and fuels

1

INPUTS: CO_2, WATER, ELECTRICITY



CO_2

H_2O

Electricity

2

ELECTROCHEMICAL REDUCTION OF CO_2

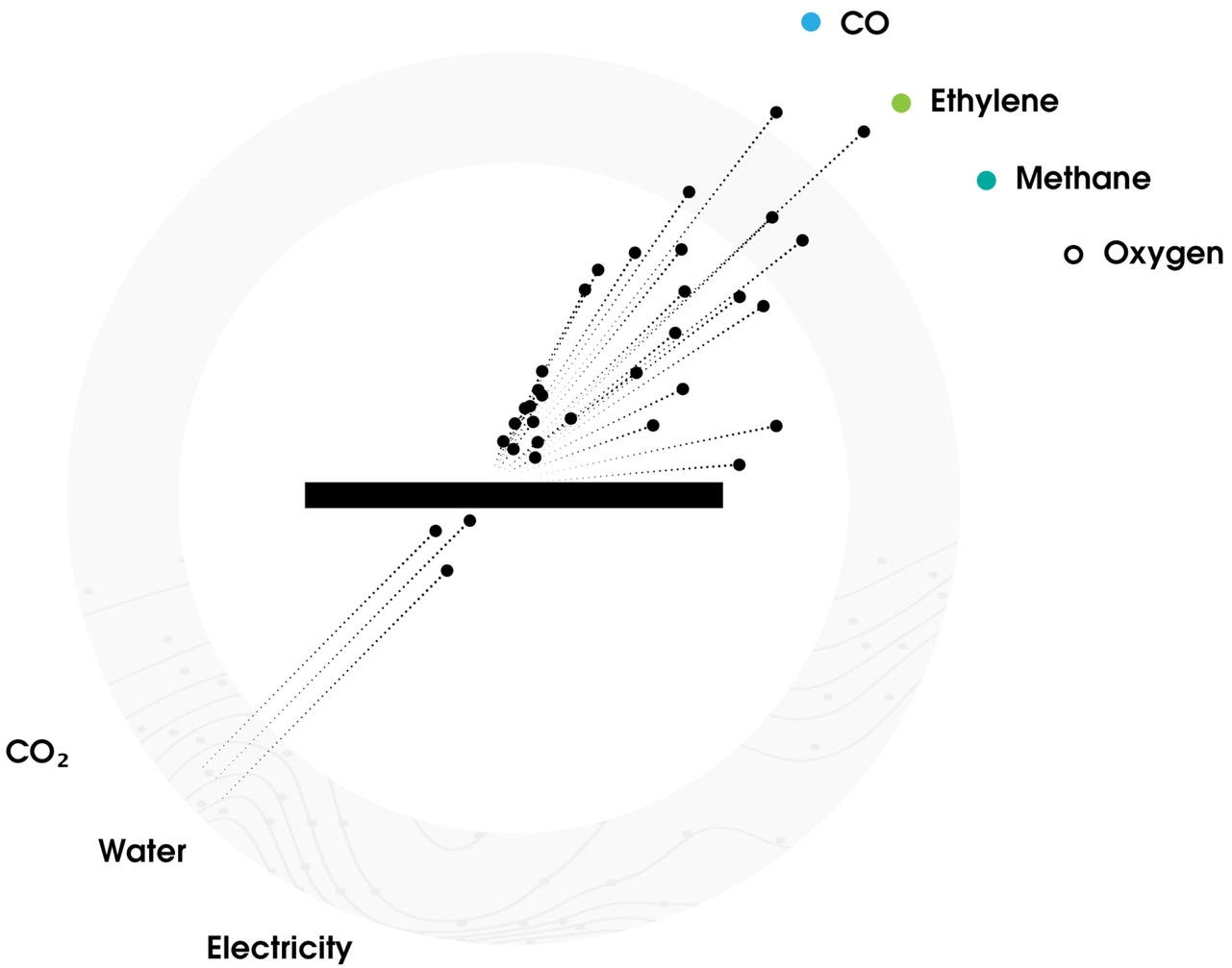
Fuels & Chemicals

O_2

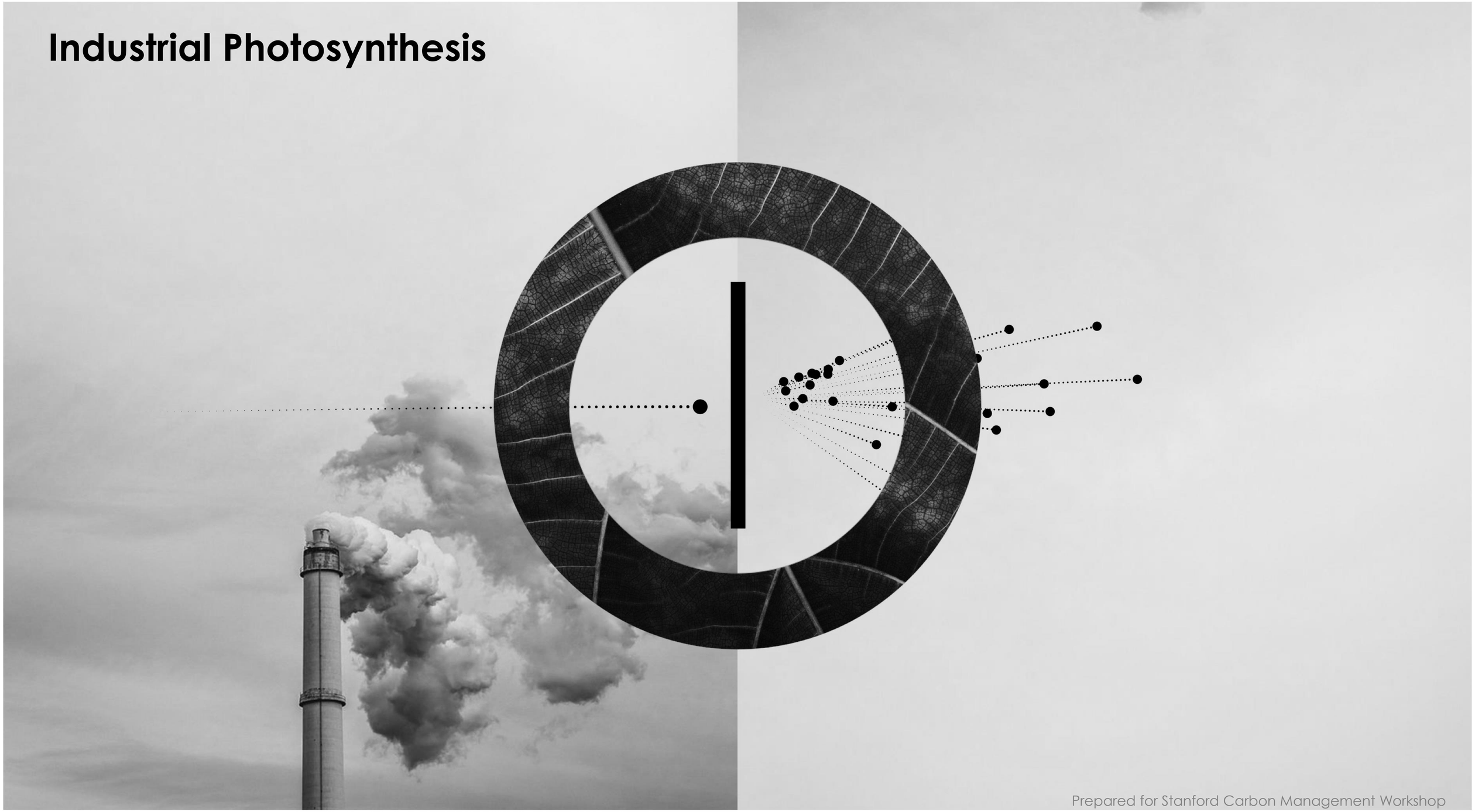
3

OUTPUTS: PRODUCTS THAT DROP INTO EXISTING SUPPLY CHAINS

We transform CO_2 into critical chemical products



Industrial Photosynthesis




37,000 trees in a suitcase
Prepared for Stanford Carbon Management Workshop

Founded at Stanford and Lawrence Berkeley National Lab in 2016

Founding team

Dr. Kendra Kuhl
CTO

PhD in Chemistry, Stanford, Post doc, SLAC
Research: Transition metal catalyzed CO_2 electroreduction, reactor design

Nicholas Flanders
CEO

MS E-IPER, Stanford
Work Experience: COO/CFO Levo, McKinsey CleanTech practice

Dr. Etosha Cave
COO

PhD in Mechanical Eng, Stanford
Research: Modified gold catalysts for CO_2 electroreduction, reactor design

STANFORD UNIVERSITY

cyclotronroad

Rolling Stone
"25 People Shaping the Next 50 Years"

MIT Technology Review INNOVATORS UNDER 35

Forbes 30 UNDER 30

Reverse Combustion

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Overall Reaction:

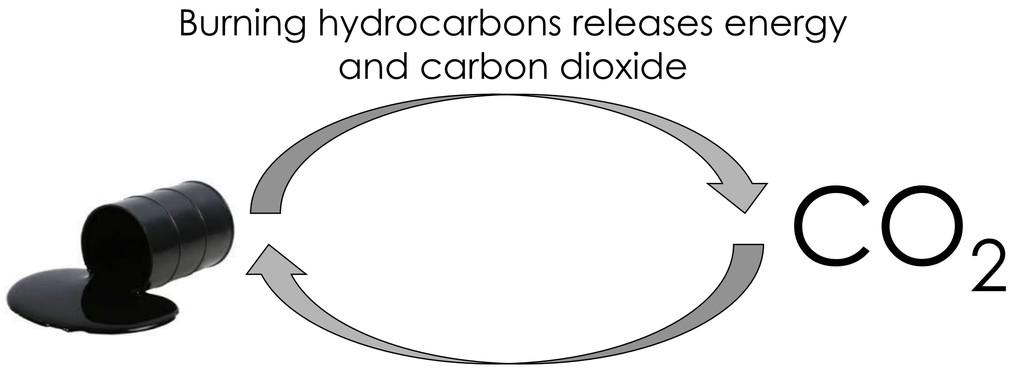
$$CO_2 + H_2O + Energy \rightarrow C_xH_yO_z + O_2$$

Split into electrochemical half reactions:

Water Oxidation (Anode)	E^o
$2H_2O \rightarrow O_2 + 4(H^+ + e^-)$	1.23 V
CO_2 Reduction (Cathode)	
$CO_2 + m(H^+ + e^-) \rightarrow C_xH_yO_z + nH_2O$	~0 V

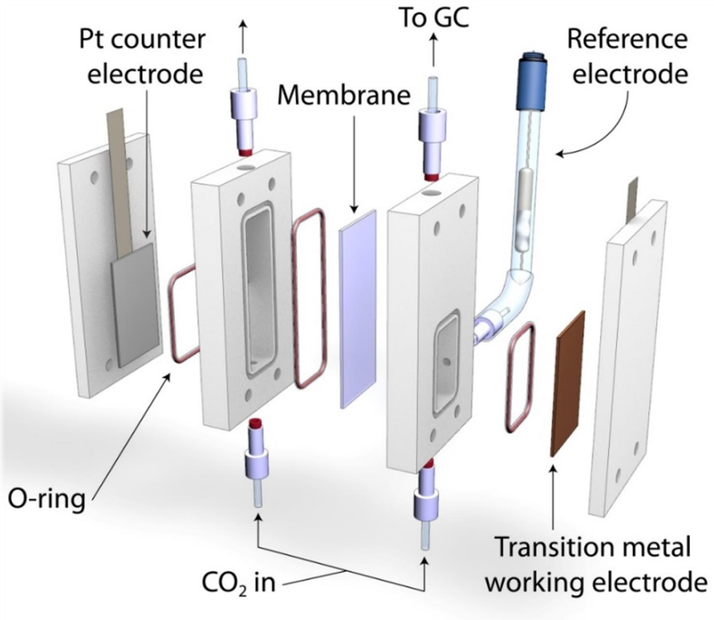
Fuels & Chemicals

Determines minimum energy required for ECO2R to various products



The project began as we explored the fundamentals of CO_2 conversion electrochemistry

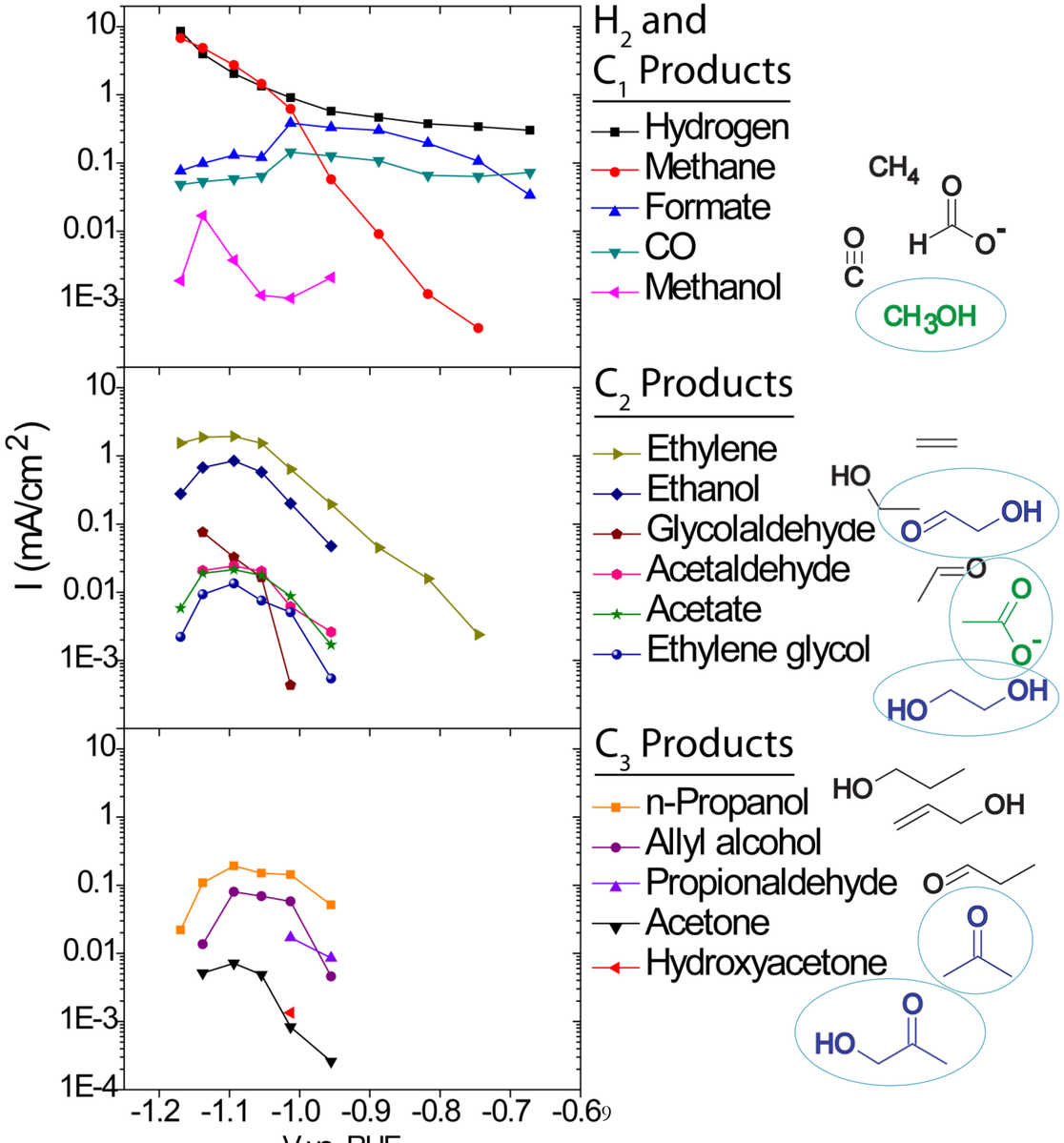
Thomas Jaramillo
Professor – Stanford University
Expert in electro-catalysis and high through-put catalyst testing



Electrochemical reactor

NMR

GC

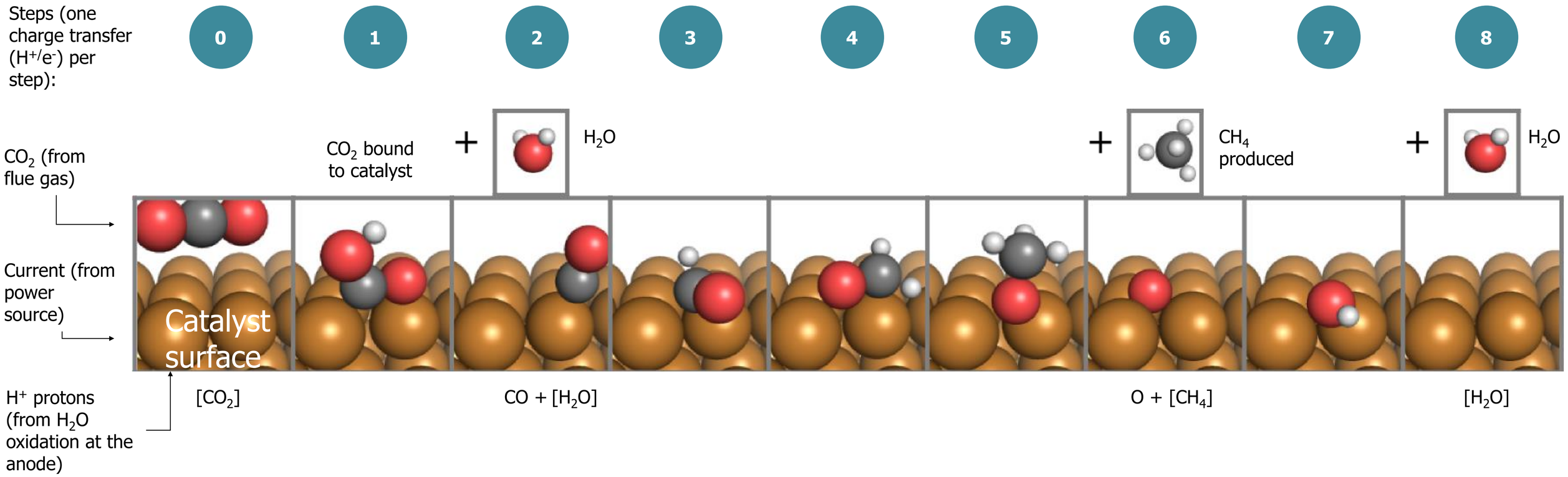


ECO2R can turn CO_2 into higher-value molecules in a single, low-temperature catalytic reaction

The transformation occurs as charges are transferred at the catalyst surface

Illustration: CO_2 to methane (CH_4)

$$CO_2 + 8H^+ \rightarrow CH_4 + 2H_2O$$



Andrew A. Peterson , Frank Abild-Pedersen , Felix Studt , Jan Rossmeisl and Jens K. Nørskov
Energy Environ. Sci., 2010,**3**, 1311-1315

Known Scale-up Pathway

Integration into existing electrolyzer designs

1

Lab

2-10 kW

2

Commercial

50-250 kW

3

Industrial

1-2 MW

4

Plant

5-100 MW

We partner with electrolyzer producers to build CO_2 conversion systems

Future of Carbon Tech

Opus 12
491 followers
1w

It's not every day that Bill Gates visits our lab. Fortunately for us, it's captured in his newly released documentary Inside Bill's Brain on Netflix (see part 3 on #climate)! In his words: "You might be one of the first applications that fits that niche." #carbontech #climatesolutions #CO2

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