TechTour Investor Club

Tech Tour Energy Transition 2021 Investors (IVC) Round Table

17 Nov 2021

www.techtour.com/investorsclub

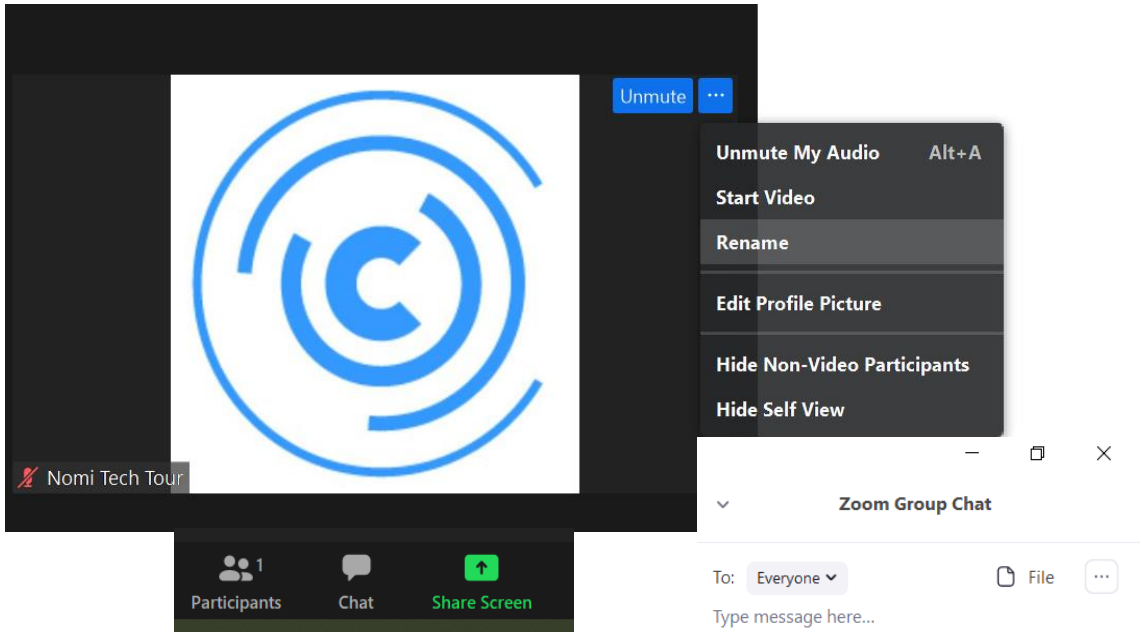
Welcome & Opening of IVC RoundTable

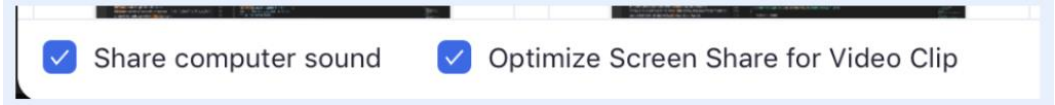
Radostina Tsenova

Tech Tour Investors Club Manager

TechTour

Housekeeping Rules





- **Recording** the session
- **Rename yourself**
- **Turn on your camera** all the time
- **Turn off your microphone** – only when invited
- **Chat functionality** – use it actively
- **Share Screen** – when it's your turn to present

- **Key combination to mute/unmute** – ALT+A
- **Key combination to open chat** – ALT+H

TechTour Investors Club Members

Independent

ADARA VENTURES
AlmazCapital
ARMILAR VENTURE PARTNERS
ASTANOR Where tech meets nature
ATLANTIC BRIDGE
Breakthrough Energy VENTURES
REPLY BREED
btov
Capricorn PARTNERS
COTTONWOOD technology fund
CHRYSALIX VENTURE CAPITAL
ECBF European Circular Bioeconomy Fund
etf partners
Eiffel Investment Group
finindus
HEALTHCARE PARTNERS
ICOS CAPITAL
imec xpand
INDACO VENTURE PARTNERS SCR
INDICO CAPITAL PARTNERS
innovestor ventures
Joltcapital
KBC FOCUS FUND
KREOS CAPITAL
LBO FRANCE
MCROCK CAPITAL
mtip
NordicNinja by JB Nordic Ventures
NORGINE Partner for a healthy life
PANAKÈS PARTNERS
PEPPERMINT VENTURE PARTNERS
ROTTERDAM PORT FUND
the Untitled. VENTURES
TVM Capital LIFE SCIENCE VENTURE CAPITAL
ZOBITO Growth Capital with a twist

Corporate

AGC
BASF We create chemistry
#G4A
BEKAERT better together
Boston Scientific
Debiopharm WE DEVELOP FOR PATIENTS
DOW
EVONIK Leading Beyond Chemistry
FLUXUNIT OSRAM Ventures
HAMAMATSU
Johnson & Johnson INNOVATION
Kubota
logitech
Medtronic
MERCK
GLOBAL HEALTH INNOVATION
MITSUI & CO.
PHILIPS
PM EQUITY PARTNER
sabic
SAMSUNG
saudi aramco energy ventures
Severstal
SOLVAY
SONAE IM
SONY
Swisscanto Invest
swisscom
SWISS POST
TEIJIN
TRUMPF
ucb

Institutional

Bayern Kapital 25 JAHRE Venture Capital für Bayern
FUND OF FUNDS FUND MANAGER OF FINANCIAL INSTRUMENTS IN BULGARIA
INVESTNL
IVF RT
INTESA SANPAOLO INNOVATION CENTER
imec
NRW.BANK Promoting Ideas
PMV Voor de zelfstandige ondernemer
TESI
VÆKSTFONDEN
Cleantech ALPS

TechTour Programmes

2022

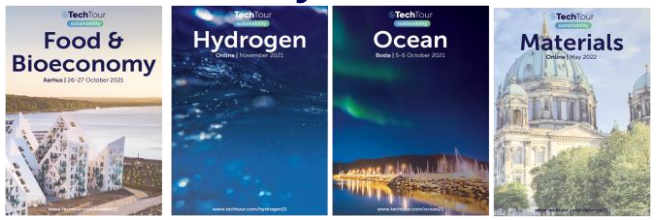
Regional

Growth

Digital

Health

Sustainability



2023

Regional

Growth

Investors (IVC) Round Table - Agenda

3 min	**Welcome and Opening by Tech Tour**
5 min	**Welcome & Opening by Fred van Beuningen**
90 min	**Part 1 of the IVC Roundtable – Insights Session on CCU** • Anastasios Perimenis, Secretary General, CO2 Value Europe • Arij van Berkel, LUX Research • Bob Hoomans, Programme Manager Materials & Energy at University of Twente • Timo HERBERZ, Innovation Fund / DG Clima • Daniel Marenne, ENGIE • Alfred Lam, Chrysalix Venture Capital
15 min	**Short Break**
60 min	**Part 2 of the IVC Roundtable – Deal Syndication Session** • Peter van Gelderen, Icos Capital • Michael Claes, SABIC • Iliya Bozhkov, Saudi Aramco
5 min	**Feedback Poll** & Next Steps
Total: min	

TechTour Investor Club

IVC Roundtable

Insights Session on CCU

Welcome & Opening of IVC RoundTable

Fred van Beuningen

Managing Director

CHRYSALIX VENTURE CAPITAL

Investor Insight Session on CCU

Anastasios Perimenis

Secretary General

CO_2 VALUE EUROPE

CCU developments in Europe

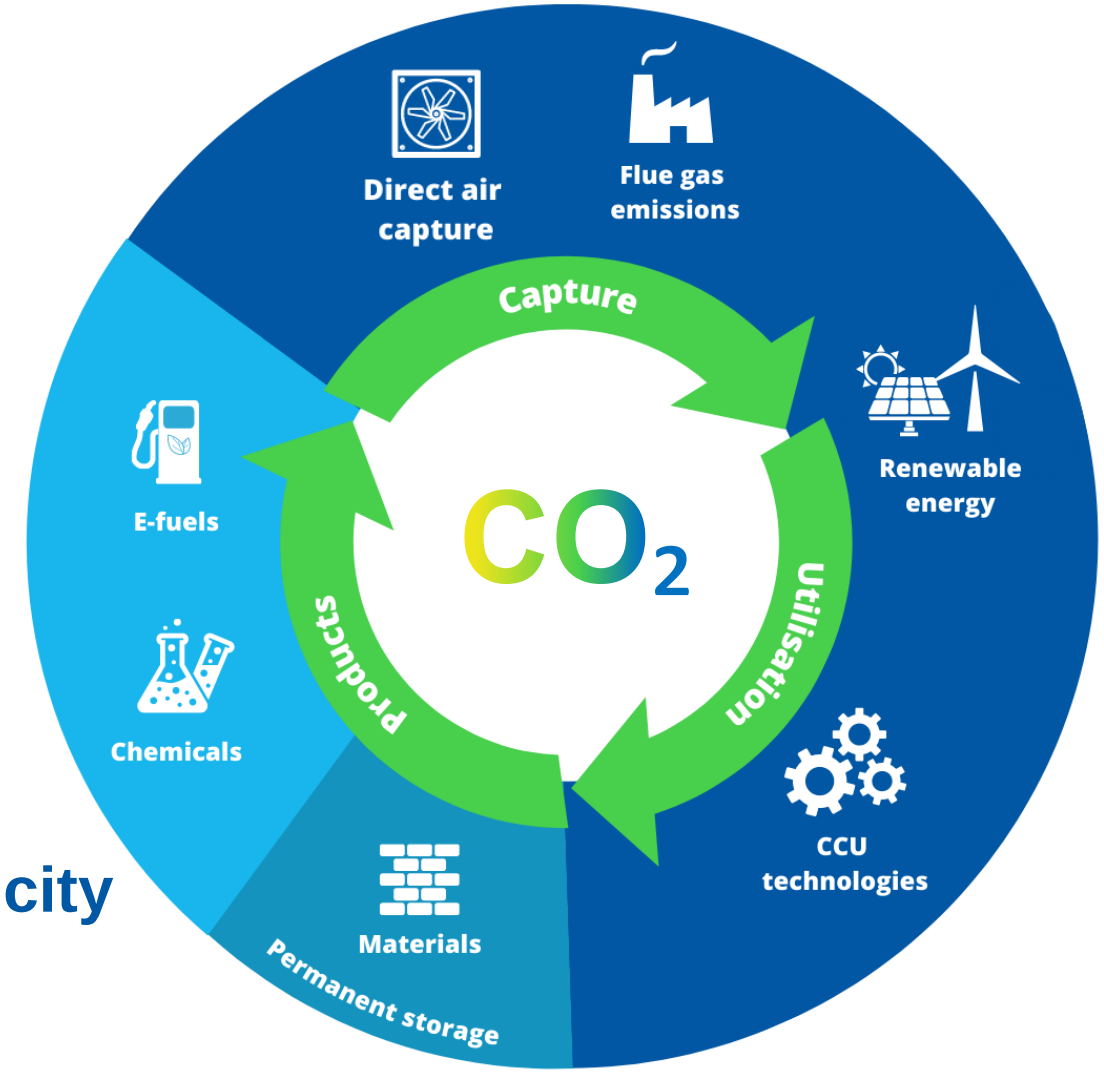
Anastasios Perimenis, Secretary General

Investor insights on CCU

17 November 2021 – TechTour Energy 2021 - Rotterdam

Why Carbon Capture & Utilisation (CCU)?

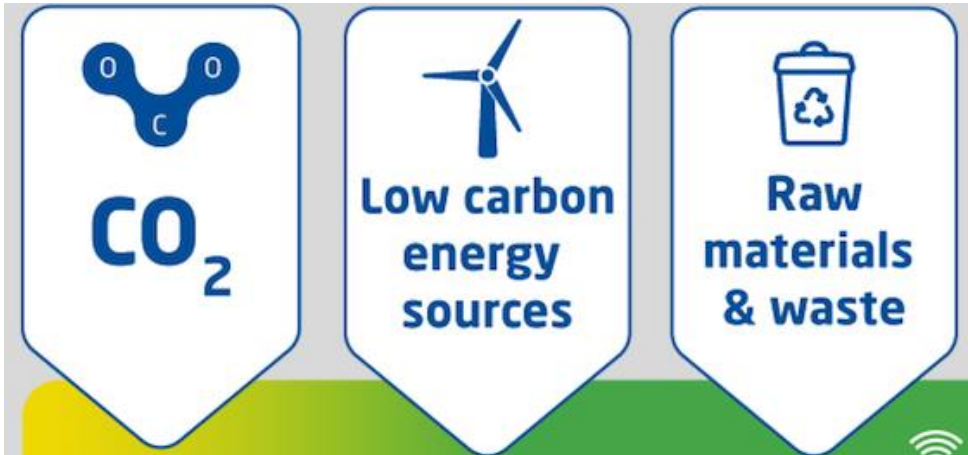
- Net-zero to negative emissions
- Alternative carbon feedstock
- Circularity and waste management
- Sustainable & resilient industry
- Storage & transport of renewable electricity



CO_2 Value Europe integrates stakeholders from the complete CCU value chain across industries

We are focusing on the deployment of CCU and representing the CCU community in front of the EU authorities. We bring together partners from **the complete value chain!**

Upstream



Products

- Chemical building blocks
- Synthetic fuels
- Building materials

Downstream

Refining, distribution infrastructure & markets for CCU products

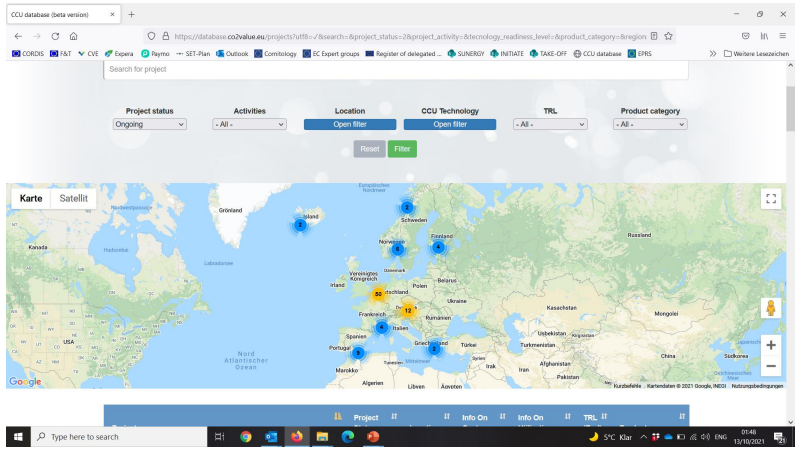
Multinational Companies, SMEs, Regional Clusters, Research Institutions, Universities

Our activities

Collective intelligence on CCU technologies

Up-scaling and innovation

Policy, advocacy, communication



CCUS SET-PLAN

TAKE-OFF
Sustainable aviation fuel from CO_2

CO_2 VALUE EUROPE

CO_2SMOS
Solutions for a circular biobased industry

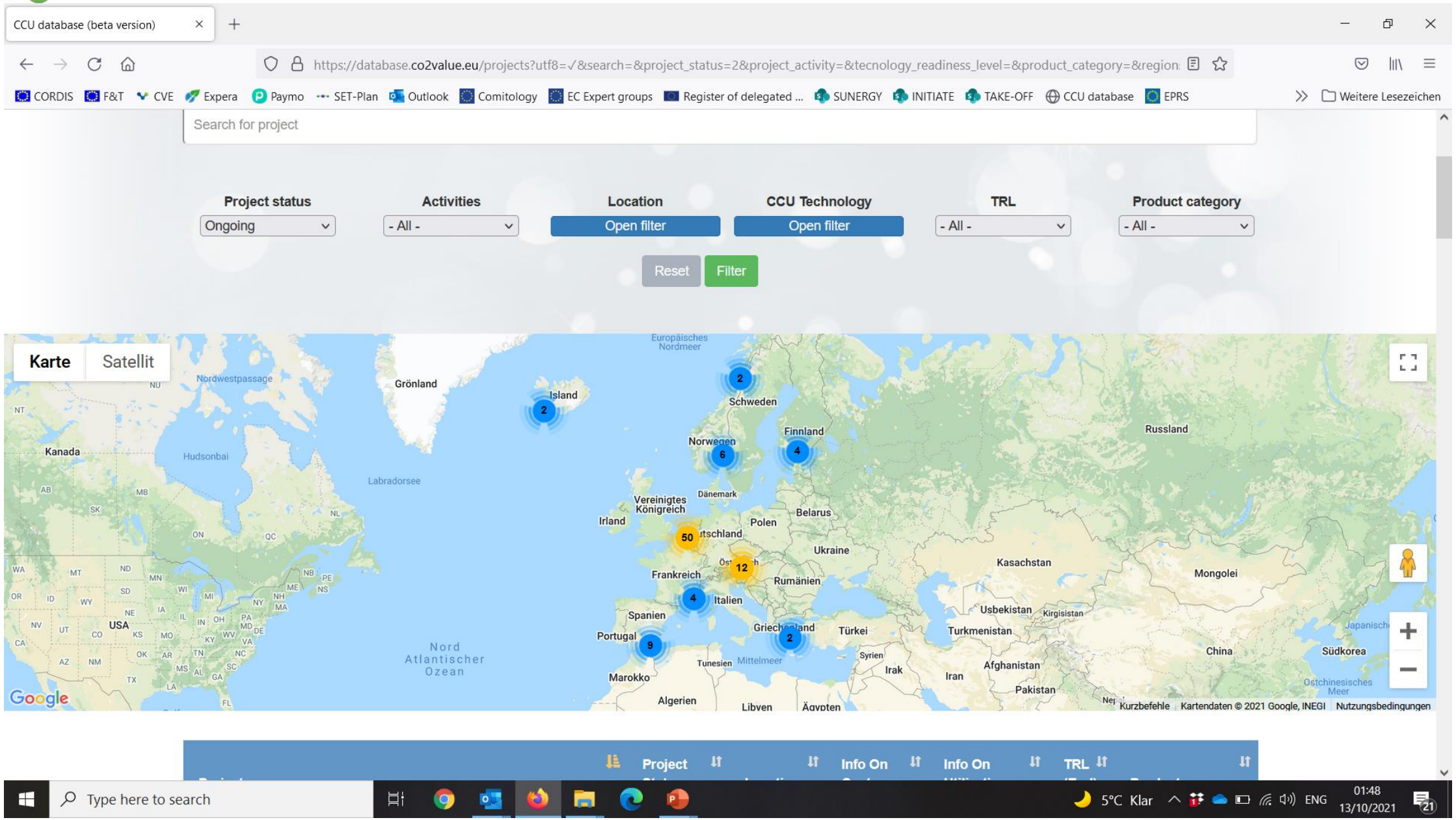
vivaldi
Turns CO_2 emissions into sustainable bioproducts

INITIATE
A STEPWISE PROJECT

EUROPEAN GREEN DEAL
DELIVERING ON OUR TARGETS

CCU is happening now…

CCU is happening now…



CCU is happening now…

CHEMICAL REVIEWS

Review

Cite This: *Chem. Rev.* 2018, 118, 434−504 pubs.acs.org/CR

Sustainable Conversion of Carbon Dioxide: An Integrated Review of Catalysis and Life Cycle Assessment

Jens Artz, Thomas E. Müller, and Katharina Thenert

Institut für Technische und Makromolekulare Chemie, RWTH Aachen University, Worringerweg 2, Aachen 52074, Germany

Johanna Kleinekorte, Raoul Meys, André Sternberg, and André Bardow*

Chair of Technical Thermodynamics, RWTH Aachen University, Schinkelstrasse 8, Aachen 52056, Germany

Walter Leitner*

Institut für Technische und Makromolekulare Chemie, RWTH Aachen University, Worringerweg 2, Aachen 52074, Germany
Max-Planck-Institute for Chemical Energy Conversion, Stiftstrasse 34-36, Mülheim an der Ruhr 45470, Germany

Sustainable Energy & Fuels

PAPER

View Article Online
View Journal | View Issue

Check for updates

Cite this: *Sustainable Energy Fuels*, 2018, 2, 1153

Closing the carbon cycle to maximise climate change mitigation: power-to-methanol *vs.* power-to-direct air capture

H. A. Daggash, [abc] C. F. Patzschke,[d] C. F. Heuberger, [bc] L. Zhu,[c] K. Hellgardt,[c] P. S. Fennell,†[d] A. N. Bhave,[e] A. Bardow [f] and N. Mac Dowell [‡*bc]

frontiers in Energy Research

ORIGINAL RESEARCH
published: 14 February 2020
doi: 10.3389/fenrg.2020.00015

Check for updates

A Guideline for Life Cycle Assessment of Carbon Capture and Utilization

*Leonard Jan Müller[1], Arne Kätelhön[1], Marvin Bachmann[1], Arno Zimmermann[2], André Sternberg[3] and André Bardow[1,4]**

Applied Energy 263 (2020) 114599

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

Environmental impacts of CO_2-based chemical production: A systematic literature review and meta-analysis

M.A. Nils Thonemann

International Journal of Greenhouse Gas Control 93 (2020) 102882

Contents lists available at ScienceDirect

International Journal of Greenhouse Gas Control

journal homepage: www.elsevier.com/locate/ijggc

Environmental assessment of CO_2 mineralisation for sustainable construction materials

Andrea Di Maria[a,*], Ruben Snellings[b], Luc Alaert[a], Mieke Quaghebeur[b], Karel Van Acker[a,c]

[a] Sustainability Assessment of Material Life Cycle, Katholieke Universiteit Leuven (KUL), Kasteelpark Arenberg 44 box 2450, BE-3001 Leuven, Belgium
[b] Sustainable Materials Unit, Vlaamse Instelling voor Technologisch Onderzoek (VITO), Boeretang 200, 2400 Mol, Belgium
[c] Center for Economics and Corporate Sustainability (CEDON), KU Leuven, Warmoesberg 26, BE-1000 Brussels, Belgium

nature

Explore content | About the journal | Publish with us

nature > perspectives > article

Perspective | Published: 06 November 2019

The technological and economic prospects for CO_2 utilization and removal

Cameron Hepburn, Ella Adlen, John Beddington, Emily A. Carter, Sabine Fuss, Niall Mac Dowell, Jan C. Minx, Pete Smith & Charlotte K. Williams

Nature **575**, 87–97 (2019) | Cite this article

PNAS Proceedings of the National Academy of Sciences of the United States of America

Keyword, Author,

Home | Articles | Front Matter | News | Podcasts | Authors

RESEARCH ARTICLE

Climate change mitigation potential of carbon capture and utilization in the chemical industry

Arne Kätelhön, Raoul Meys, Sarah Deutz, Sangwon Suh, and André Bardow
+ See all authors and affiliations

Support in Research, Innovation & Deployment

Several (>30) topics of interest for CCU in 2021-2022

First deadlines 10/2021

European Commission

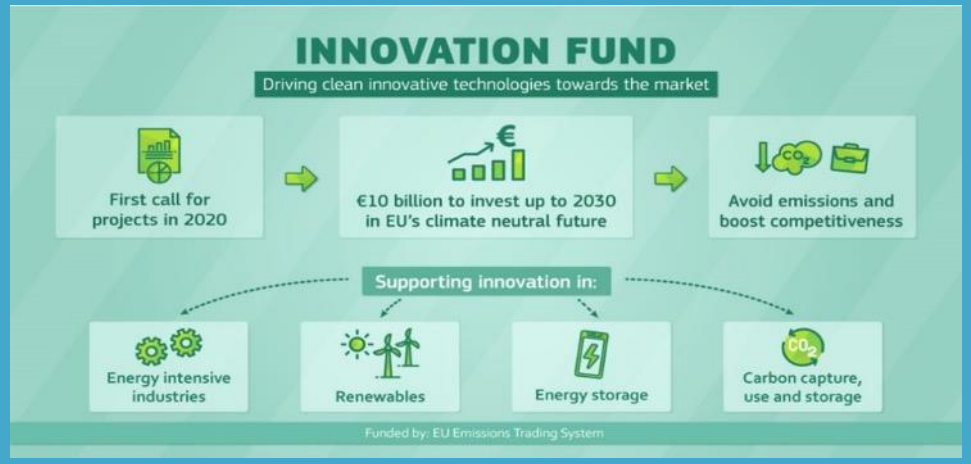
IMPORTANT PROJECTS OF COMMON INTEREST (IPCEI)

Based on Strategic Value Chains, two of which are linked to CCU:

- Hydrogen Technologies
- Low CO_2 emissions industries

CCUS SET-PLAN

CCU/CCS is a priority in the Strategic Energy Technology Plan



CCU is part of the Innovation Fund

Two calls already published (for large- and small-scale projects)

More than €10+ billion for 10 years; yearly calls

High TRL, mature, innovative, pre-commercial projects with significant climate mitigation benefit

✓ ***H2020 : More than 90 collaborative projects receiving more that 650 M€***

Complex regulatory framework

non exhaustive list

- **Sustainable Taxonomy ***
- **RED II revision**
- **ETS revision**
- **Carbon Removal Certification Mechanism ***
- **ReFuel Aviation / FuelEU Maritime**
- **Energy System Integration → *CCUS Forum* ***
- **SET-Plan CCUS Action 9**
- **Sustainable Products Initiative**
- **Alternative Fuels Infrastructure**
- **Hydrogen Strategy**
- **Next Generation EU → *Recovery & Resilience Fund* ***
- **New Industrial Strategy**
- **Climate Law**
- **Energy Taxation Directive**
- **Carbon Border Adjustment Mechanism ***
- **CO2 emissions for cars and vans**
- **….**

CCU in Fit-for-55 Package

Launched on 14 July 2021 by the European Commission

Policy instrument	Impact on CCU
EU Emissions Trading System (EU ETS) revision	✓ CO_2 which is chemically and permanently bound in a product under normal use (e.g. CO_2 mineralisation) is excluded from the obligation to surrender allowances; ✓ Avoid double-counting of emissions released by the use of RFNBOs*.
Renewable Energy Directive (REDII) revision	✓ At least 2.6% of the energy supplied to transport by 2030 is covered by RFNBOs; ✓ 50% of the use of hydrogen in the industry is covered by RFNBOs.
ReFuelEU Aviation	✓ Binding targets per volume shares for RFNBOs: min 0.7%, 8%, 28% of RFNBOs by 2030, 2040, 2050, respectively and minimum 28% by 2050.
Fuel EU Maritime	✓ Binding GHG reduction targets for ships: 2%, 6%, 26%, 75% in 2025, 2030, 2040, 2050, respectively, by including RFNBOs to reach these targets.
Energy Taxation Directive revision	✓ Minimum taxation rate of zero for 10 years for RFNBOs for specific types of air and waterborne navigation.

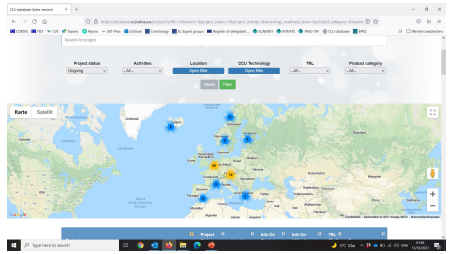
** RFNBO: Renewable fuels of non-biological origin (i.e. incl. CCU fuels)*

Steps forward

➢ Science is confirming

- CCU can utilize up to 7 Gt CO_2 per year by 2050 *Hepburn et al., 2019*
- CCU can lead to annual reductions of up to 3.5 Gt CO_2-eq in the **chemical** sector in 2030 *Kätelhön et al., 2019*
- **Mineralisation** can reduce climate impacts over the entire life cycle based on the current state-of-the-art *Ostovari et al., 2020*
- DAC-to-**fuel** pathways can provide climate benefit over conventional fuel if low carbon electricity is used *Liu et al., 2020*

➢ Projects are showcasing



➢ Upscaling is key

Research & Innovation	Policy	Funding
• Materials & catalysts • Process integration • CCU in modelling & scenarios • Metrology for CO_2 • LCA/TEA/Societal	• EU Taxonomy • Renewable electricity • Market-pull mechanisms • ….	• Ecosystem of public, private and industrial investors • Synchronisation between national & EU schemes • …

Anastasios Perimenis
Secretary General

anastasios.perimenis@co2value.eu
www.co2value.eu

Investor Insight Session on CCU

Arij van Berkel

Research Director

luxresearch

Milligrams to Megatons

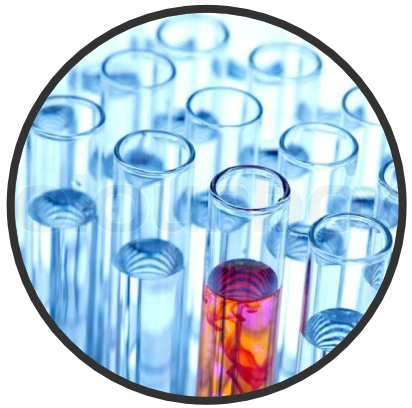
Following the innovation journey of CO_2 utilization

Arij van Berkel
Vice President, Energy transition

Lux Research

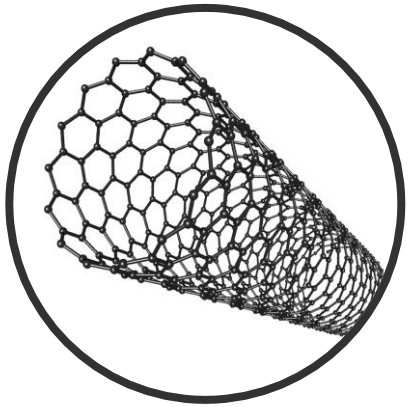
A range of products can be made from CO_2 using novel carbon utilization technologies


Concrete


Chemical


Fuel

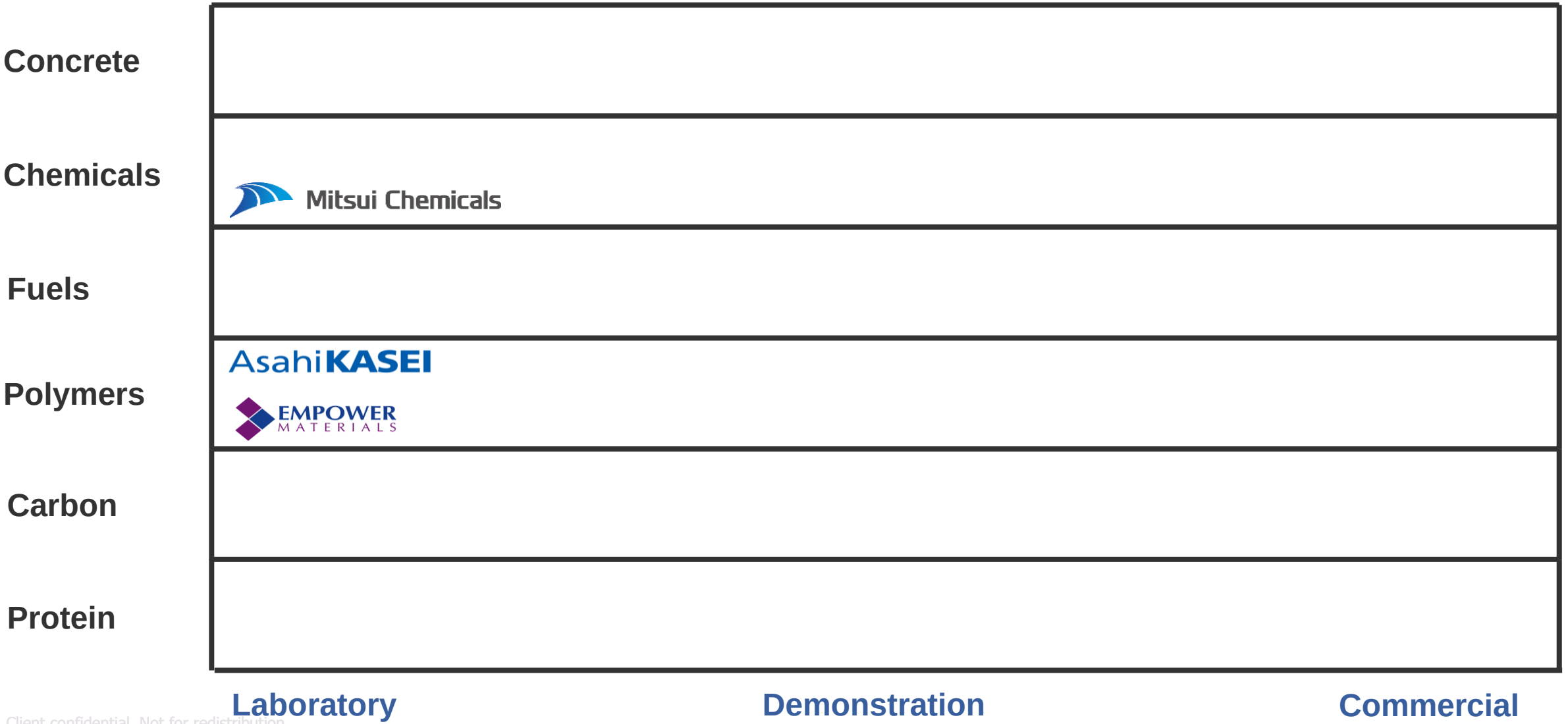

Polymer


Carbon


Protein

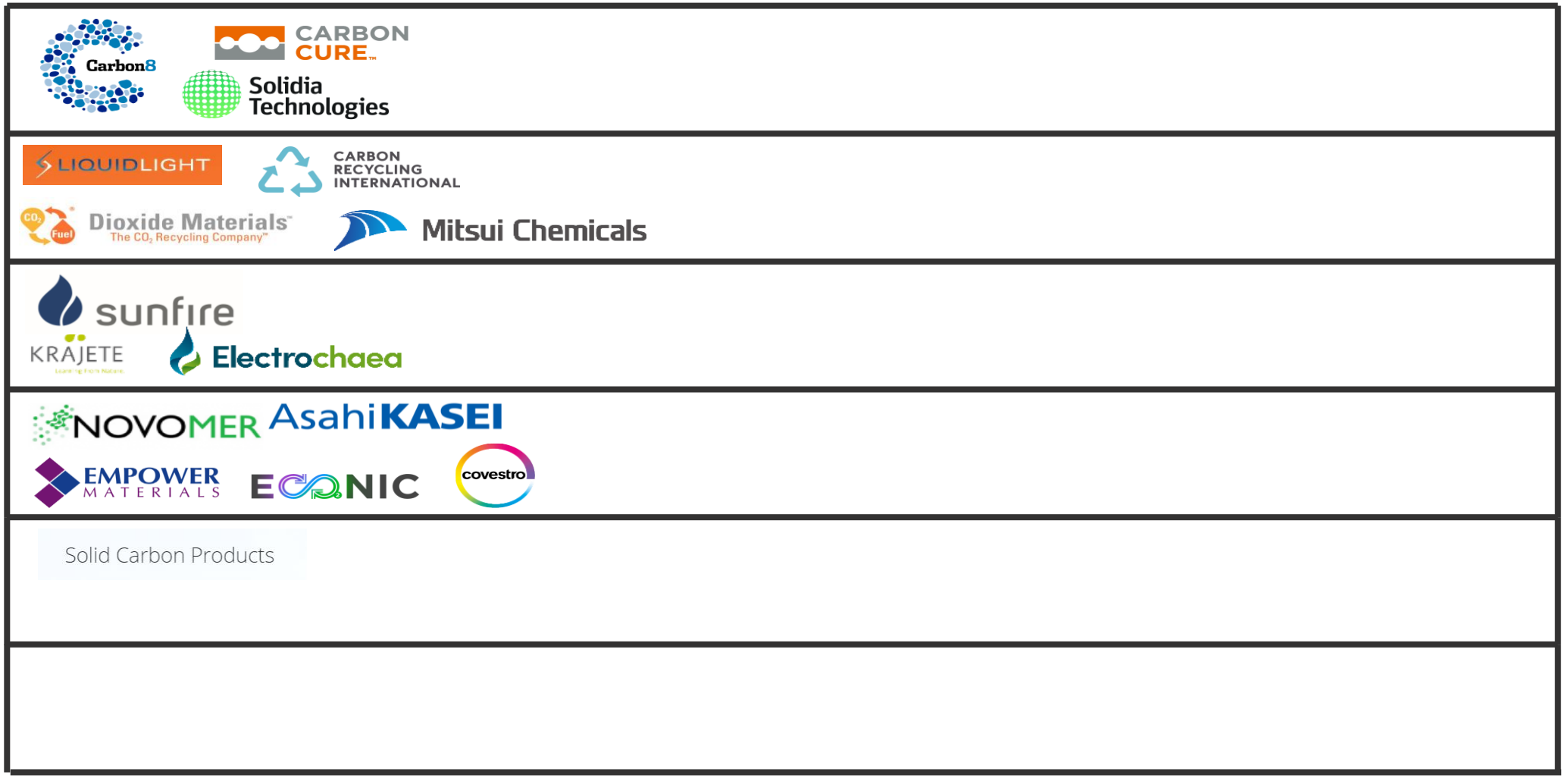
In 2000, only three companies had publicly disclosed R&D initiatives in carbon utilization

2000



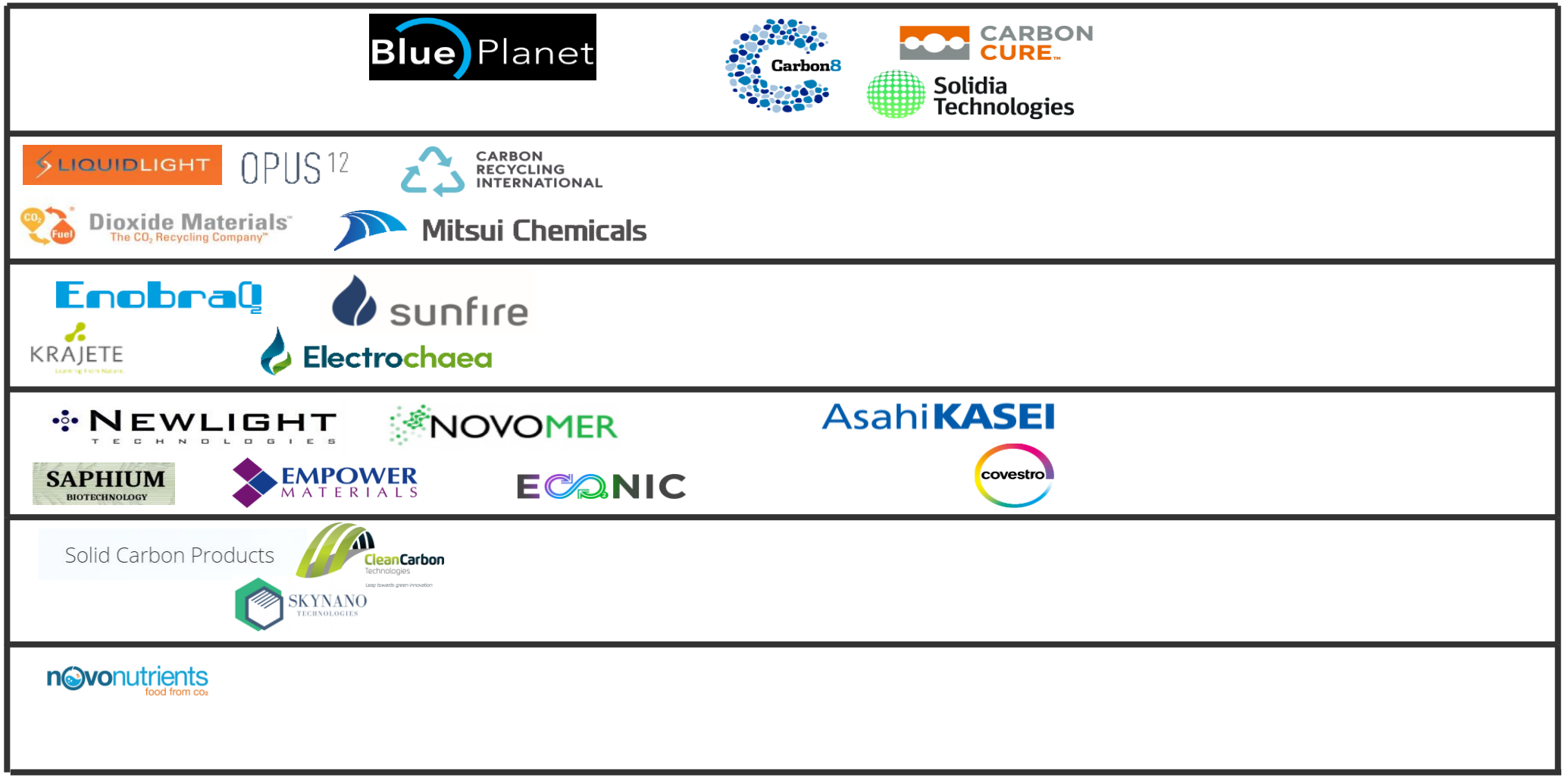
The landscape rapidly evolves with multiple companies founded by 2010

2010



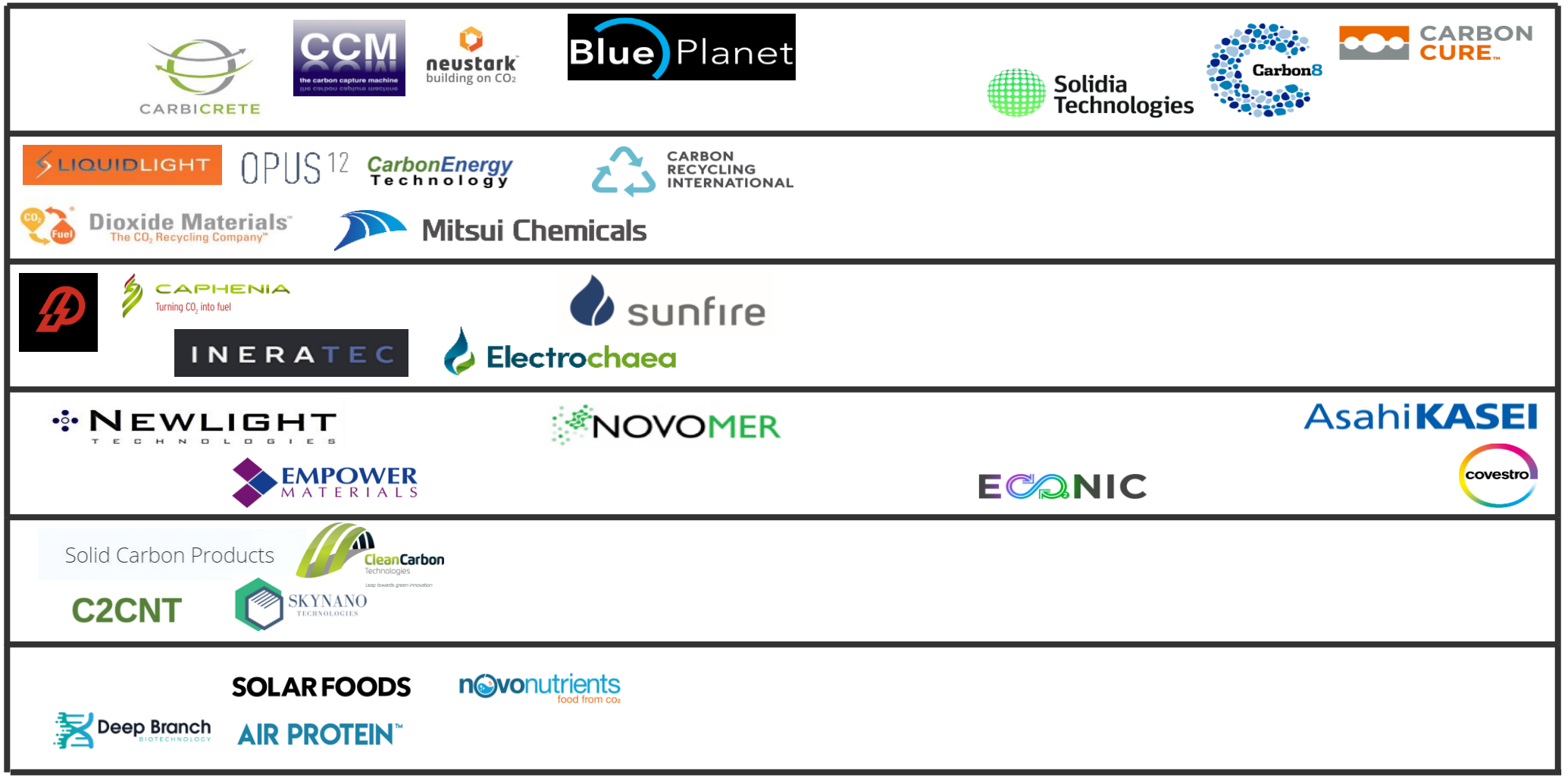
Varying degrees of challenges in CO_2 utilization technologies become pronounced by 2015

2015

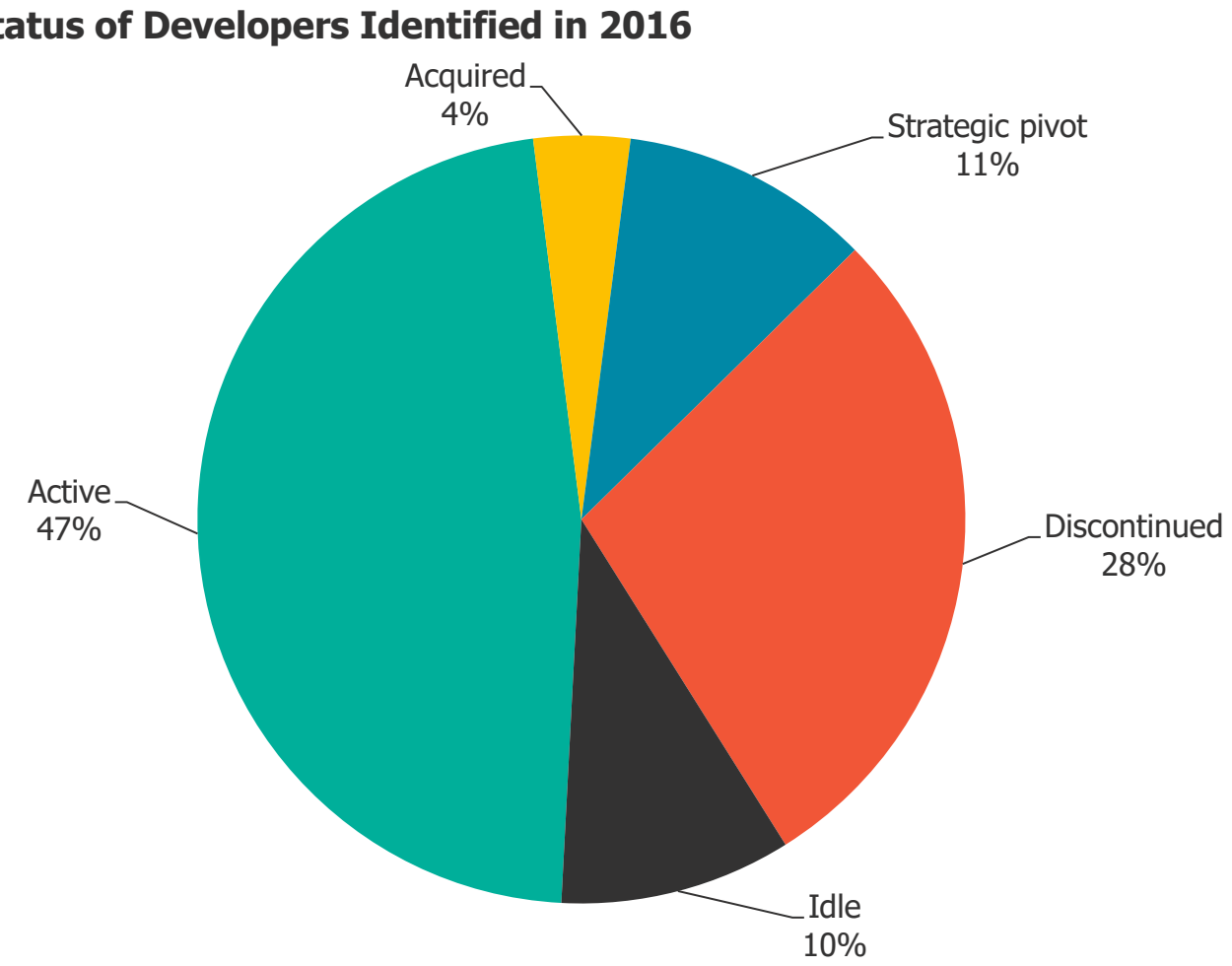


Concrete and polymers established as near-term opportunities in CO_2 utilization

2020

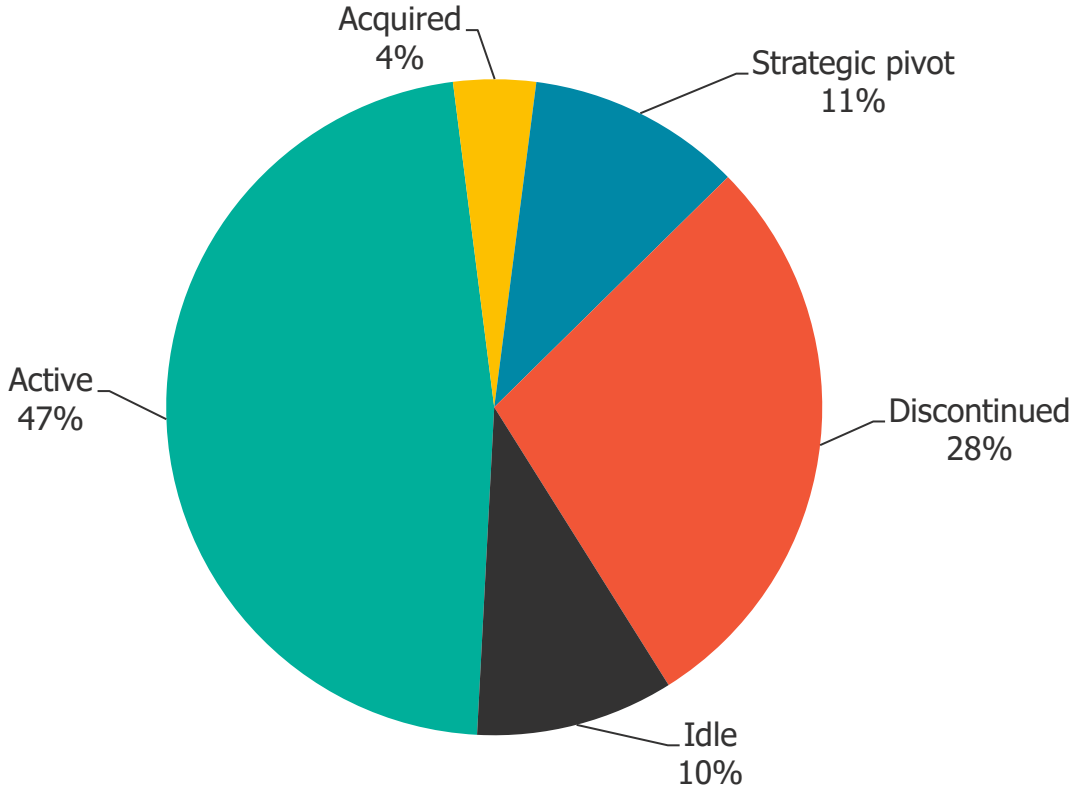


Only 47% of 2016 developers remain active in CCU



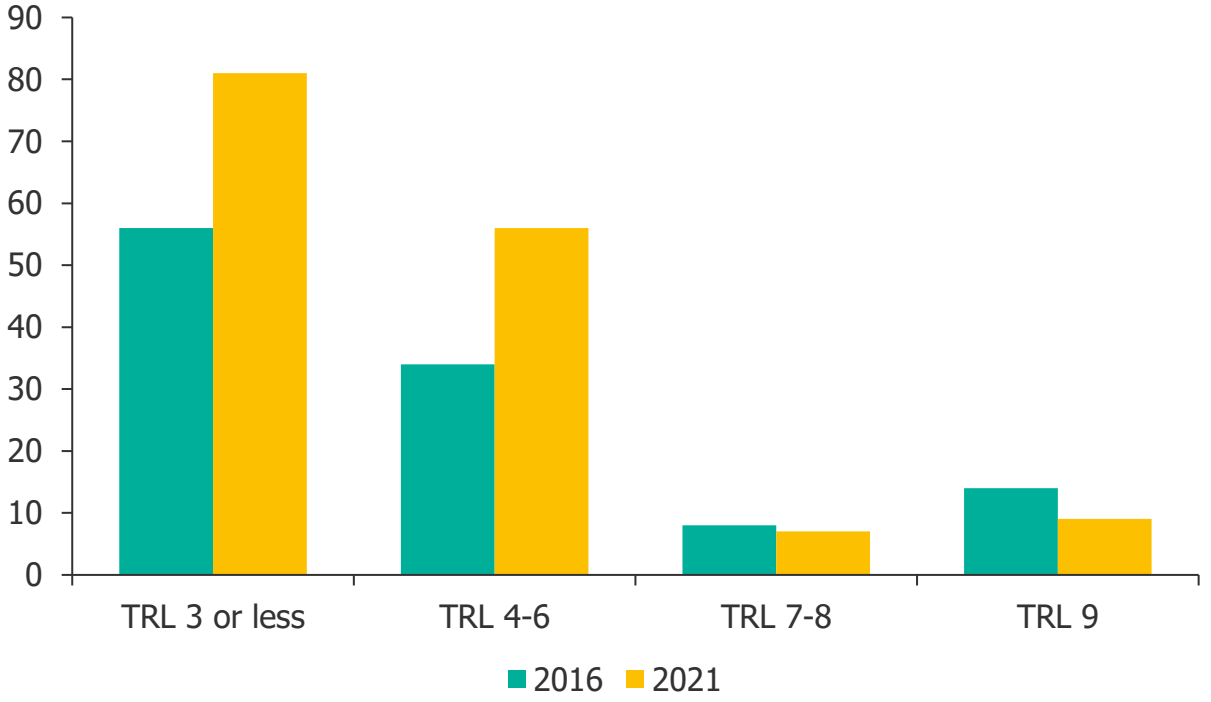
However, the pipeline of options is filling faster

2021 Status of Developers Identified in 2016



Rising Number of Early-Stage Developers Will Likely Feed the Commercialization Pipeline

Number of developers

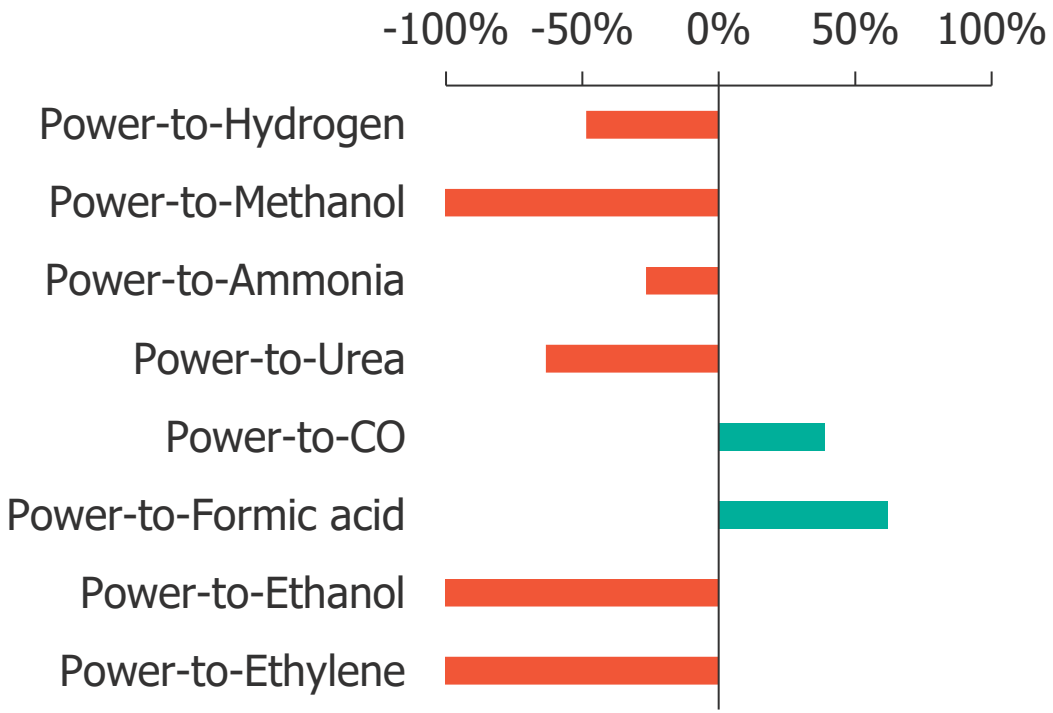


THE REALITY OF CO_2 AS FEEDSTOCK

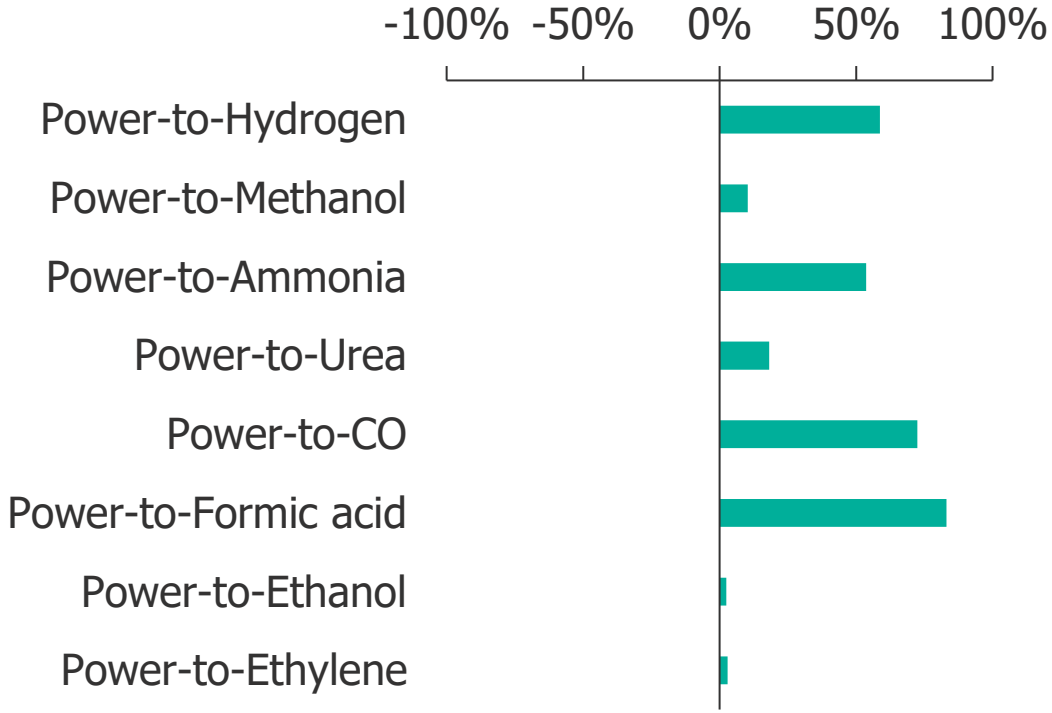
CO_2 as feedstock depends on cheap renewable electricity

Relative cost of P2C to CCS

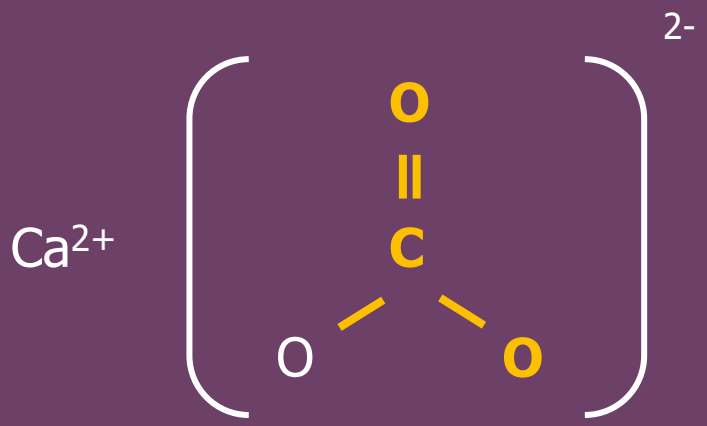
CO_2 tax: €50/ton | Electricity: €0.05/kWh



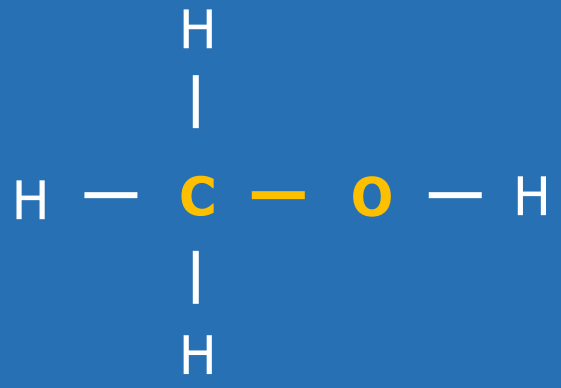
CO_2 tax: €50/ton | Electricity: €0.01/kWh



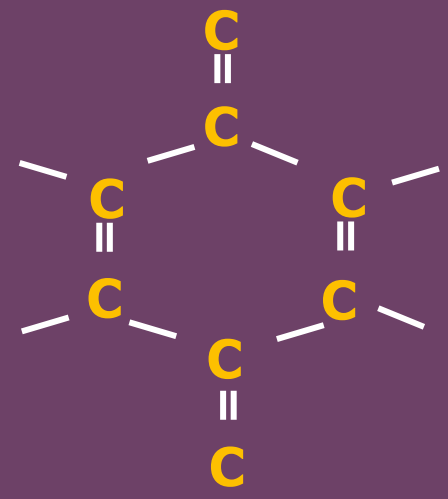
Lux Research



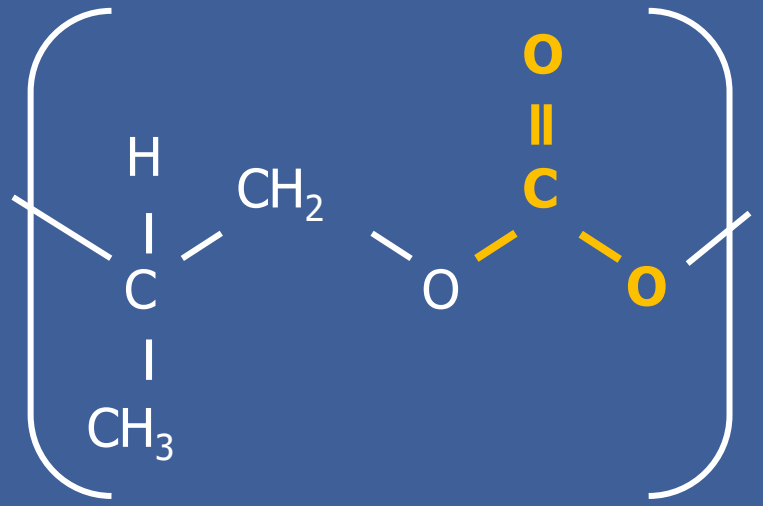
Concrete



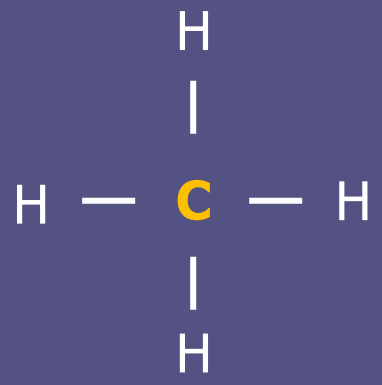
Chemicals



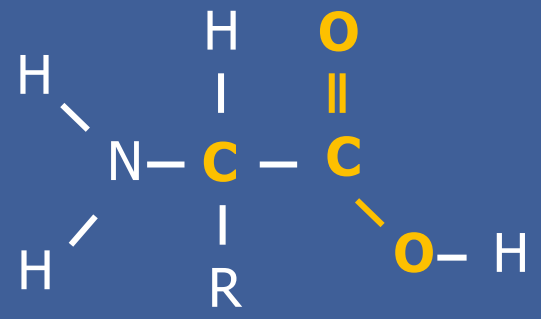
Carbon



Polymers



Fuels

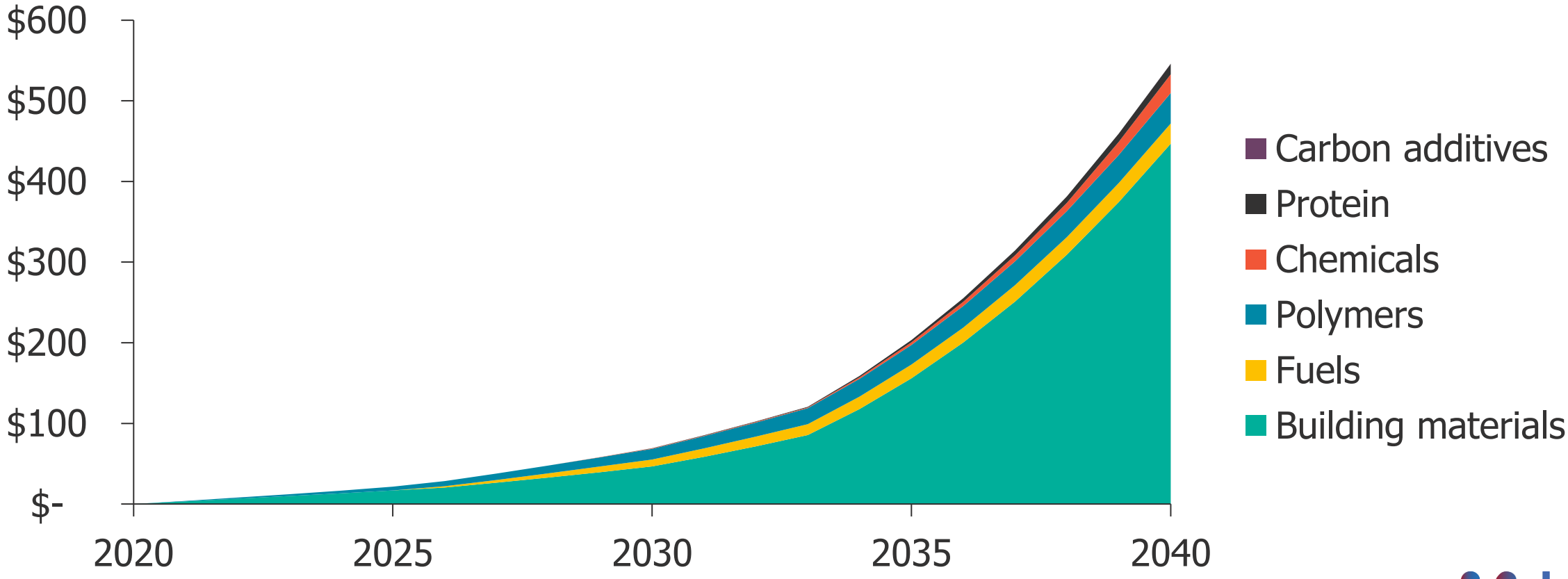


Food

CO_2 utilization will be a $550 billion dollar market by 2040, driven by the building materials sector

GLOBAL CO_2 UTILIZATION MARKET

Market size (billion dollars, USD)



Lux Research

Arij van Berkel

+ 31 20 280 7908

arij vanberkel@luxresearchinc.com

Investor insights

1

CO2 utilization is still an early-stage technology area
Investors have to watch university research and early start-ups. The best innovations are yet to be invented here. Watch developments such as plasmonics.

2

Building materials is the first market but is temporary
If the goal is to lock up as much carbon as possible, then you have to focus on building materials. As the world decarbonizes, the use of CO2 in bulk for building materials makes less sense and you need to focus on applications with an intrinsic need for carbon

3

The use of carbon in the future resembles any other oxide-based industry
Recycling is cheaper and easier than reducing oxides. Like steel and glass, the carbon industry needs to put recycling first and fresh carbon second. They go hand-in-hand

The future carbon industry is like the steel industry and CO2 is carbon-ore

Investor Insight Session on CCU

Bob Hoomans

Programme Manager

University of Twente
The Netherlands

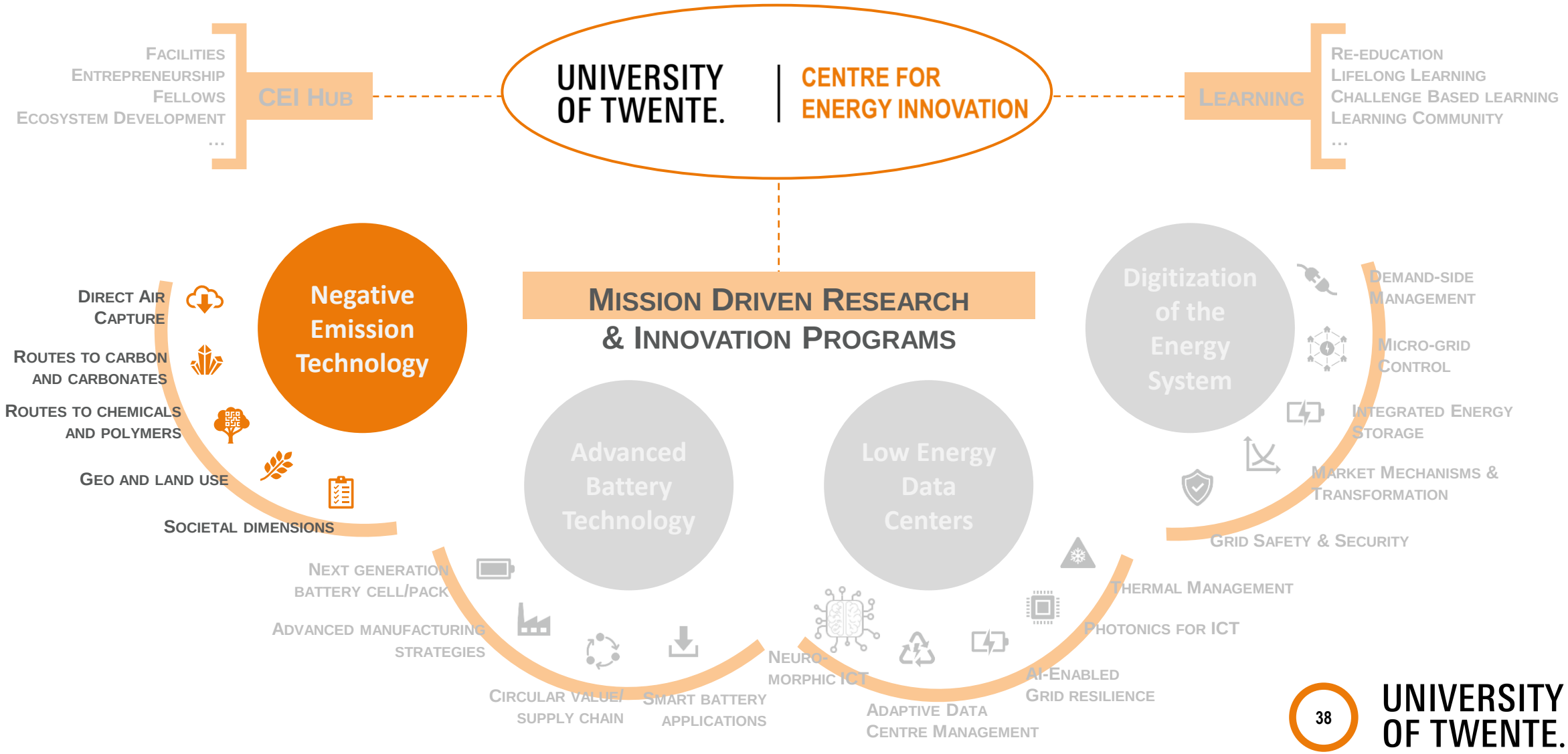
Tech Tour 17 November 2021
Investors (IVC) Round Table - Rotterdam

NEGATIVE EMISSION TECHNOLOGIES

BOB HOOMANS, LEON LEFFERTS, JOS KEURENTJES
UT CENTER FOR ENERGY INNOVATION

UNIVERSITY OF TWENTE.

UT CENTER FOR ENERGY INNOVATION

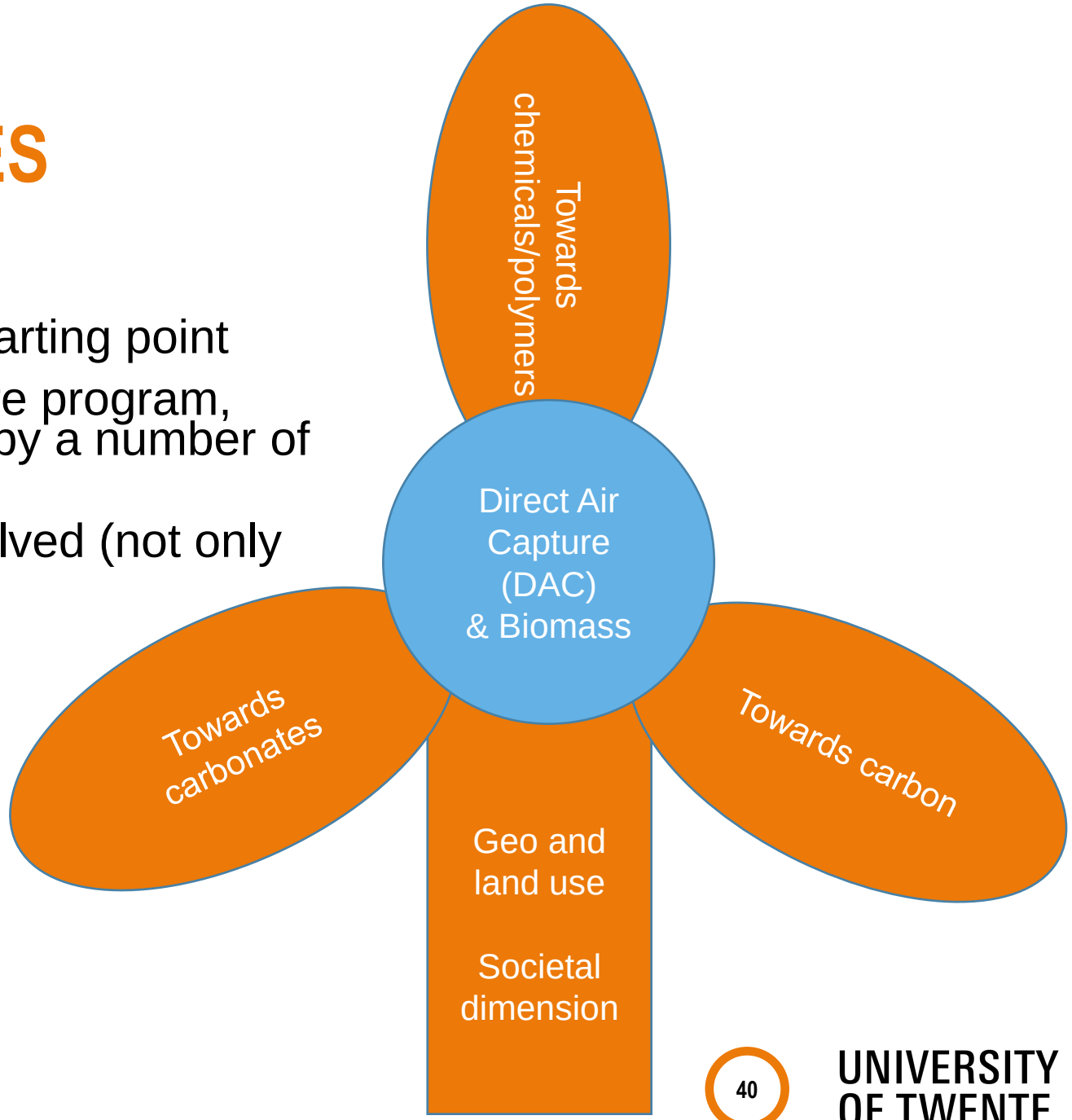


UNIVERSITY OF TWENTE.


CO2

NET TECHNOLOGIES

- UT knowledge base as a starting point
- Direct Air Capture is the core program, surrounded and supported by a number of specific programs
- Many different aspects involved (not only technical)



UNIVERSITY OF TWENTE.

MULTI-DISCIPLINARY APPROACH IN THE PROPOSED RESEARCH PROGRAM, BUILDING ON A STRONG FOUNDATION OF RESEARCHERS

Negative Emission Technology

Direct Air Capture
- Low pressure drop systems
- Novel desorption triggers
- Low desorption energy materials

To carbon and carbonates
- Mineral routes
- Electrochemical technologies

To chemicals and polymers
- Plasma technologies
- Carbonate based polymers
- To circular solutions

Geo and land use
- Optimized local solutions
- Carbon as soil enhancement

Societal dimension
- Ethics of NET
- Governance and sociotechnical implications
- Responsible design of NET

Leon Lefferts
TNW / MESA+

Albert van den Berg
EEMCS / MESA+

Wim Brilman
TNW

Frieder Mugele
TNW / MESA+

Gerrit Brem
ET

Sascha Kersten
TNW / ISPT

Peter Paul Verbeek
BMS

Sissi de Beer
TNW / MESA+

Bob Hoomans
CEI / MESA+
b.p.b.hoomans@utwente.nl

Guido Mul
TNW / MESA+

Jimmy Faria
TNW / MESA+

Fredrik Wurm
TNW / MESA+

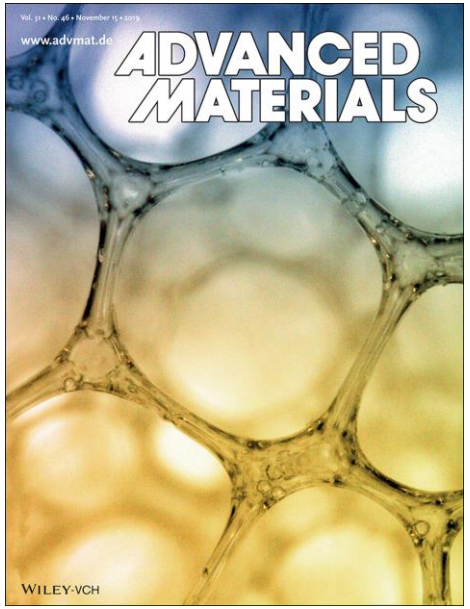
Alfred Stein
ITC

DIRECT AIR CAPTURE (1)

Direct Air Capture (DAC)

Challenge 1: Low ΔP for treating large volumes of air

- Wind, Natural convection (“Physics”, “Equipment”)
- Open structures (3D printed foams, Visser)
- UT PI’s: Theory/Fluid Dynamics (Stevens/Lohse), Equipment (Brem/Brilman), Location (“ITC”), Material characterization (Bäumer)



UNIVERSITY OF TWENTE.

DIRECT AIR CAPTURE (2)

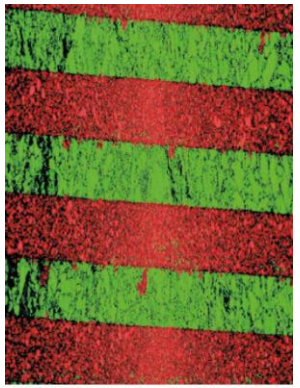
Direct Air Capture (DAC)

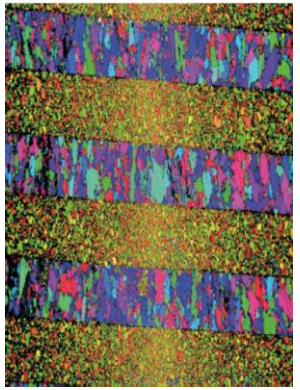
Challenge 2: Low ΔE materials (low desorption energy)

- Solid materials (IMC group, Lefferts, Nijmeijer)
- Phase change materials (polymers/liquids) (Brilman/de Beer)
- Other release mechanism than T (P, electrical, magnetic, sound - Rijnders, ten Elshof)

The water challenge (and opportunity!)

Alternative sources as a starting point: existing point sources and biomass

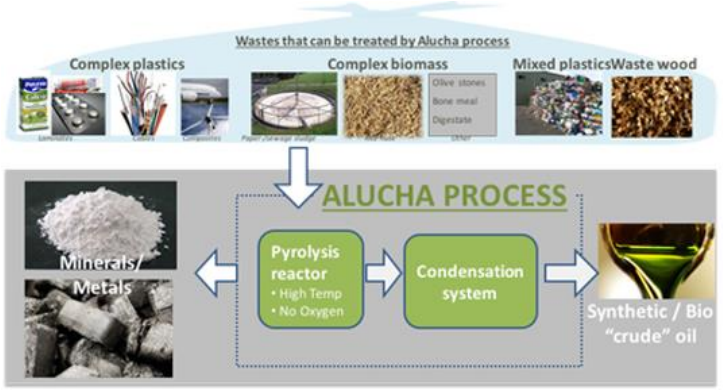


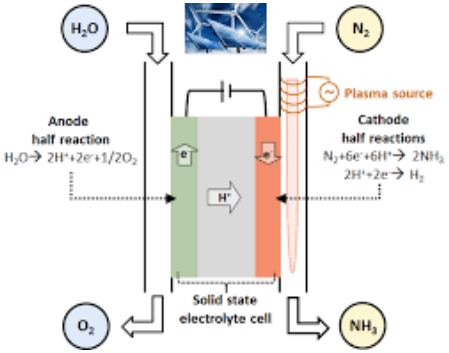


Towards carbon

TOWARDS CARBON

- Source: CO_2, biomass (“the good one”), waste, bioCH_4 (Brem, Mul, Mei..)
- Products: C, O_2, H_2
- Applications of C
  - Fillers in rubbers (Dierkes/Blume)
  - C in materials (high-tech, moderate volumes)
  - Soil enhancement in agriculture (Lievens)
- Technologies
  - Electrochemical (Mul, Mei, Lohse, Banerjee)
  - Pyrolysis/torrefaction (Brem)
  - Catalysis + Plasma (Lefferts)
  - High-T solar (direct decomposition of CO_2)



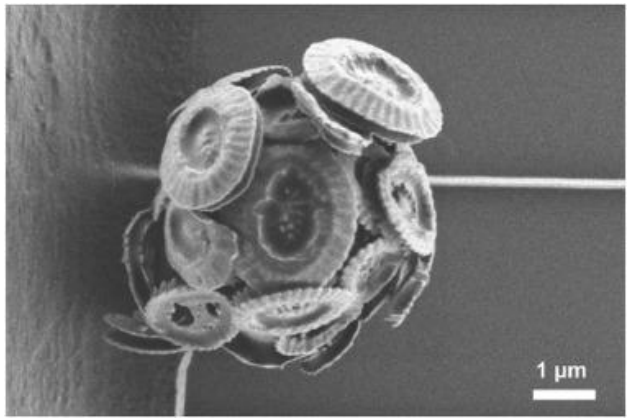


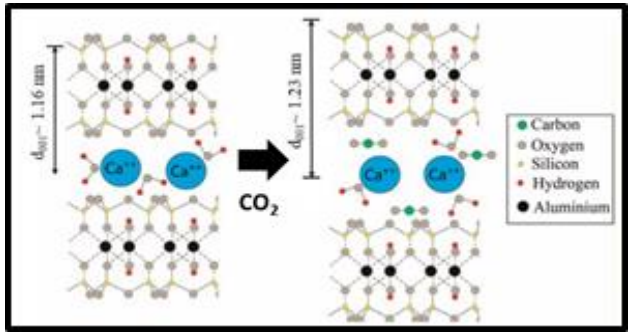
UNIVERSITY OF TWENTE.

TOWARDS CARBONATES

Towards carbonates

- Sources: biomass and CO_2
  $CO_2 + CaO \rightarrow CaCO_3$
  $C_6H_{12}O_6 + 6CaO \rightarrow 6\ CaCO_3 + 6H_2$
- Products can be stored or used as construction materials (Doree)
- Technologies
  - Sorption-enhanced reforming (Kersten, Lefferts, ...)
  - Biological, e.g. carbonate algae (Odijk, vd Berg,..)
  - Weathering of minerals (Luding, “ITC”,…)
    - Direct in subsurface (Mugele)
    - Technology-enhanced (tuning material and particle size to maximize CO_2 uptake (Odijk)
    - Enhanced weathering by passivation layer breakup



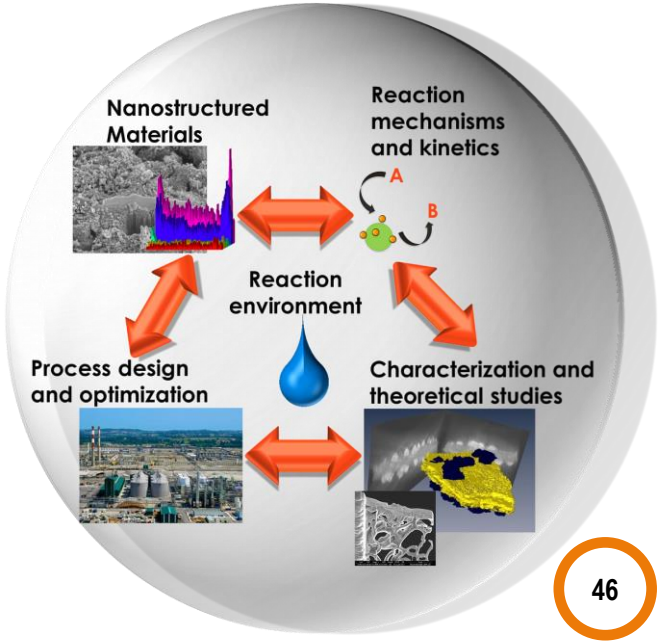


UNIVERSITY OF TWENTE.

TOWARDS CHEMICALS AND POLYMERS

Towards chemicals/polymers

- Sources are biomass and CO_2
- Oxygen-rich products
- Not fully “NET” but supportive
- Carbonate based polymers (Wurm, de Beer, Faria)
- Base materials (Schuur)
  - DMC and other carbonates
  - Crotonic acid (Schuur)
  - Alcohols (MeOH, DME) (Brilman)



UNIVERSITY OF TWENTE.

ECOSYSTEM IS UNDER CONSTRUCTION

Industrial partners – conversations ongoing

Microsoft

CHRYSALIX VENTURE CAPITAL

bp

sasol

Eneco

VATTENFALL

Green Minerals

RIWALD recycling

climeworks

Research institutes involved

UNIVERSITY OF TWENTE. | MESA+ INSTITUTE

KIT Karlsruher Institut für Technologie

vito

Brightsite Transforming industry

DESIGNLAB UTWENTE

Copernicus Institute of Sustainable Development

Other funding opportunities

BEZOS EARTH FUND

BILL & MELINDA GATES foundation

UNIVERSITY OF TWENTE.

TAKE AWAY MESSAGES DAC

- LOW PRESSURE DROP PROCESSES
- LOW DESORPTION ENERGY PROCESSES
- USE THE WATER CHALLENGE TO ADVANTAGE
- INTEGRATED APPROACH

Bob Hoomans
b.p.b.hoomans@utwente.nl

UNIVERSITY OF TWENTE.

Investor Insight Session on CCU

Timo Herberz

Policy Officer

European Commission

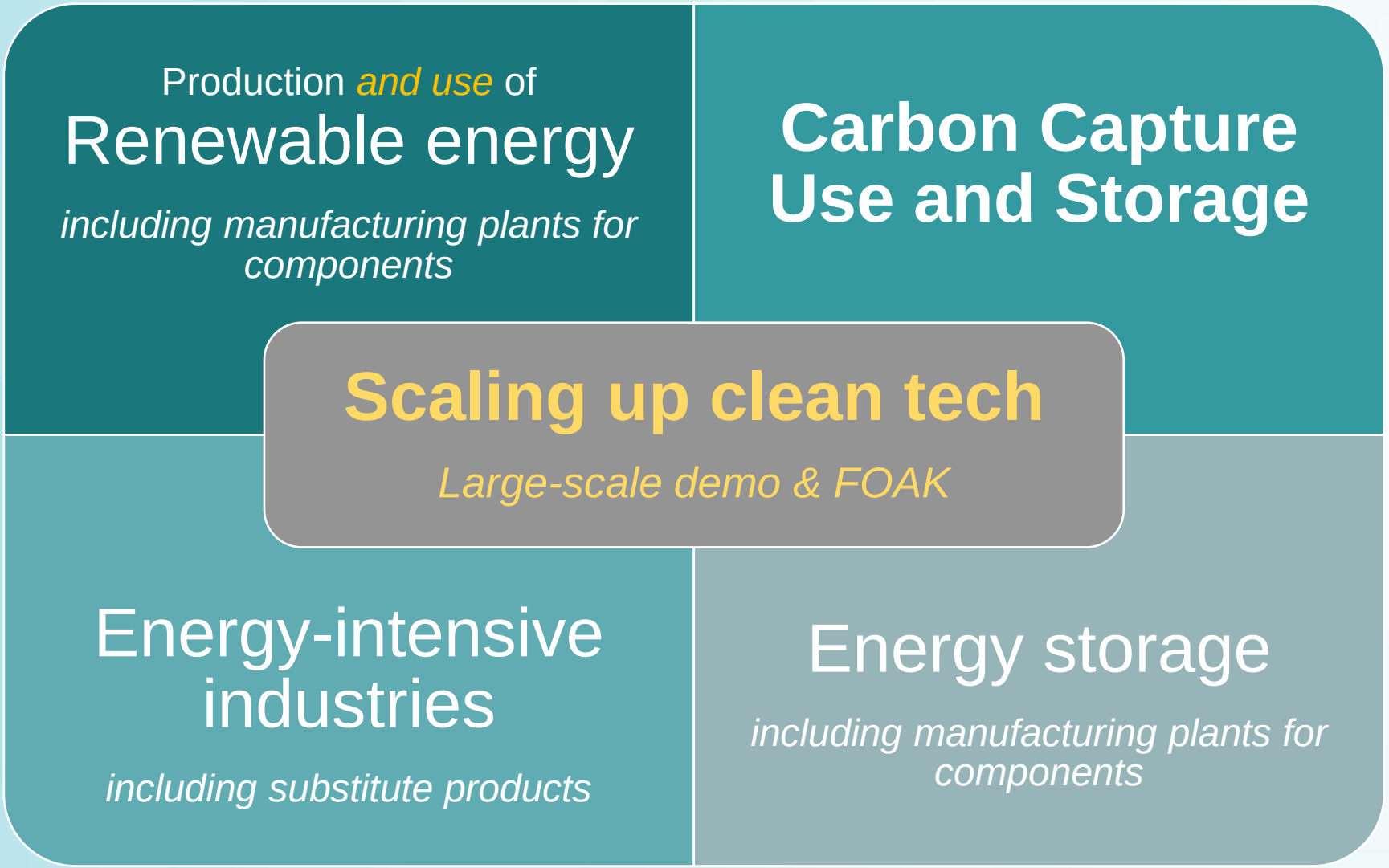
Innovation Fund

Investor Insights Session on Carbon Capture Utilisation

17 November 2021

Timo Herberz
DG Climate Action

Innovation Fund



European Commission

Key features

Financed from the revenues of the EU Emissions Trading System

Volume: EUR 25 billion* until 2030 (depending on carbon price)

**at EUR 50 / tCO2*

Large projects: Support of up to 60% of additional capital and operating costs (up to 10 years)
Small projects: up to 60% of CAPEX

Up to 40% of grant disbursed at financial close

Up to 60% of grant disbursed during **10-years** operating period against GHG emission avoidance

Small scale projects – shorter **3-years** period

Annual calls for large-scale and small-scale projects

Single applicant or consortium
Projects must be implemented in the EU, NO and IC

Project development assistance

European Commission

Award criteria

GHG emission avoidance

- **Absolute** GHG emission avoidance (tCO2)
- **Relative** GHG emission avoidance (%)
- **Quality and credibility** of the calculation, other GHG emission savings, net carbon removals

Degree of innovation

- How much beyond the state-of-the-art?
- Impact on EU policy objectives: energy efficiency, circularity, deployment of renewable electricity

Project maturity

- **Technical**: Is the project feasible at the proposed scale?
- **Financial**: Ready to reach financial close within 4 years? Viable investment?
- **Operational**: Capacity and readiness to implement

Scalability

- Market potential for widespread application: at project, regional, sector and economy level

Cost efficiency

- Requested support per ton of CO2

- **Single-stage call launched on 26 October 2021**
- **Deadline for submission 3 March 2022**
- **Expected results in July 2022**
- **Volume of 1.5 billion**

INNOVATION FUND

Second call for large-scale projects

Funded by: EU Emissions Trading System

Package to deliver the European Green Deal

14 July 2021

The proposal for a revised EU ETS also increases the Innovation Fund:

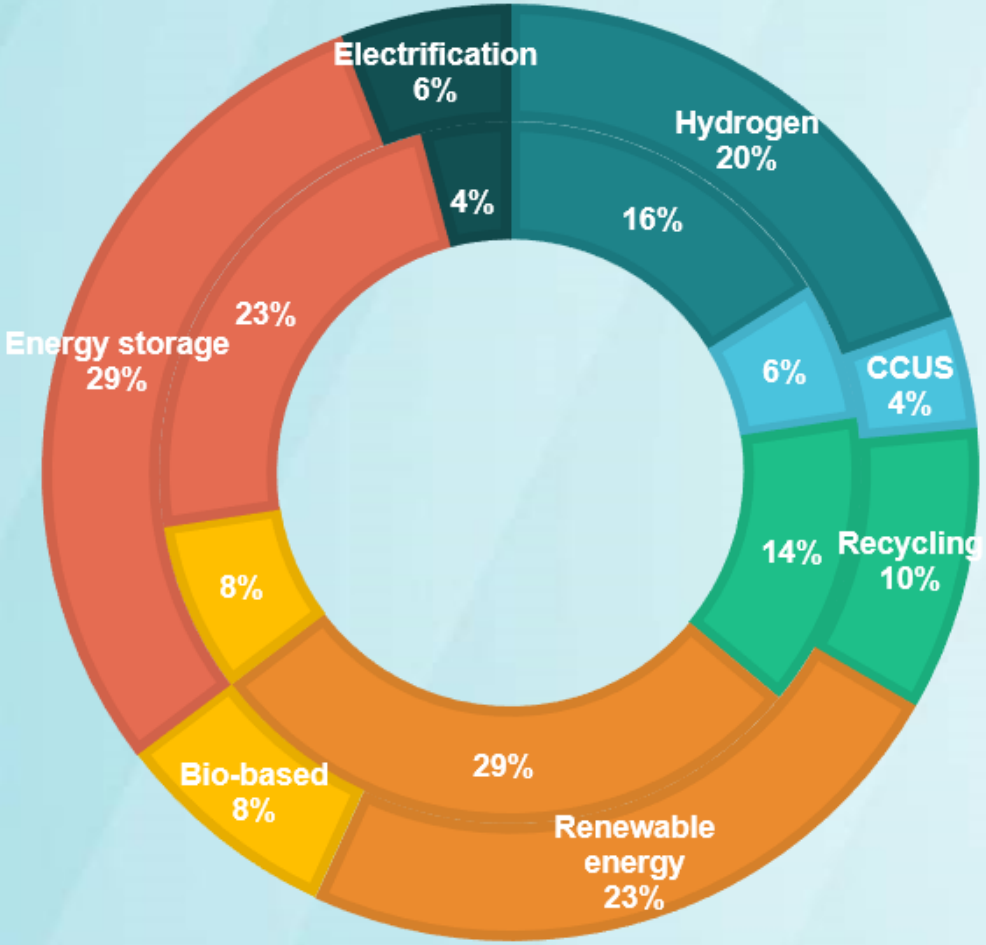
- Increase by 200 million allowances
- Allowances could be added that would no longer be allocated for free to sectors protected against carbon leakage by a new Carbon Border Adjustment Mechanism
- This could bring the Innovation Fund to up to **EUR 47 billion** (in today's prices of EUR50/tCO_2) to be invested over 10 years
- In addition, the scope of the Innovation Fund is proposed to be extended to provide support to projects through **carbon contracts for difference**

First call for small-scale projects

Project overview

First call for small-scale projects

32 successful small-scale projects



3 CCUS relevant projects:

- **AGGREGACO2**: Fabrication of CO_2 negative aggregates based on disruptive accelerated carbonation processes fueled by carbon capture in refineries
- **Silverstone**: Full-scale CO_2 capture and mineral storage at the Hellisheidi power station
- **FirstBio2Shipping**: First Bio-LNG to marine shipping

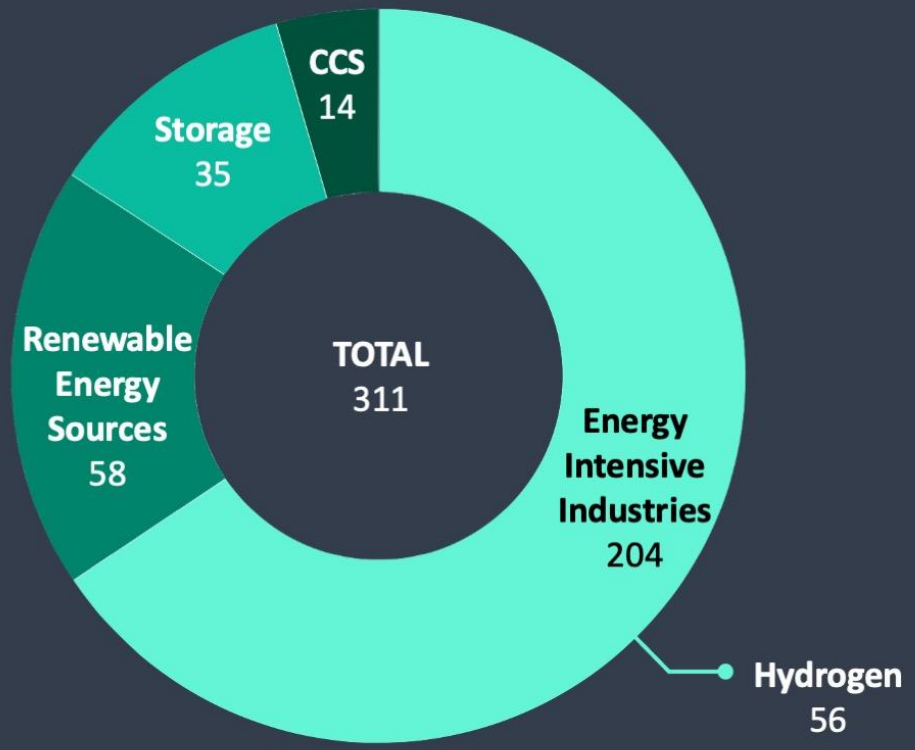
Legend: High-level screening of applied technological pathways. Classification of projects can be overlapping.
Inner circle: applications received

European Commission

First call for large-scale projects

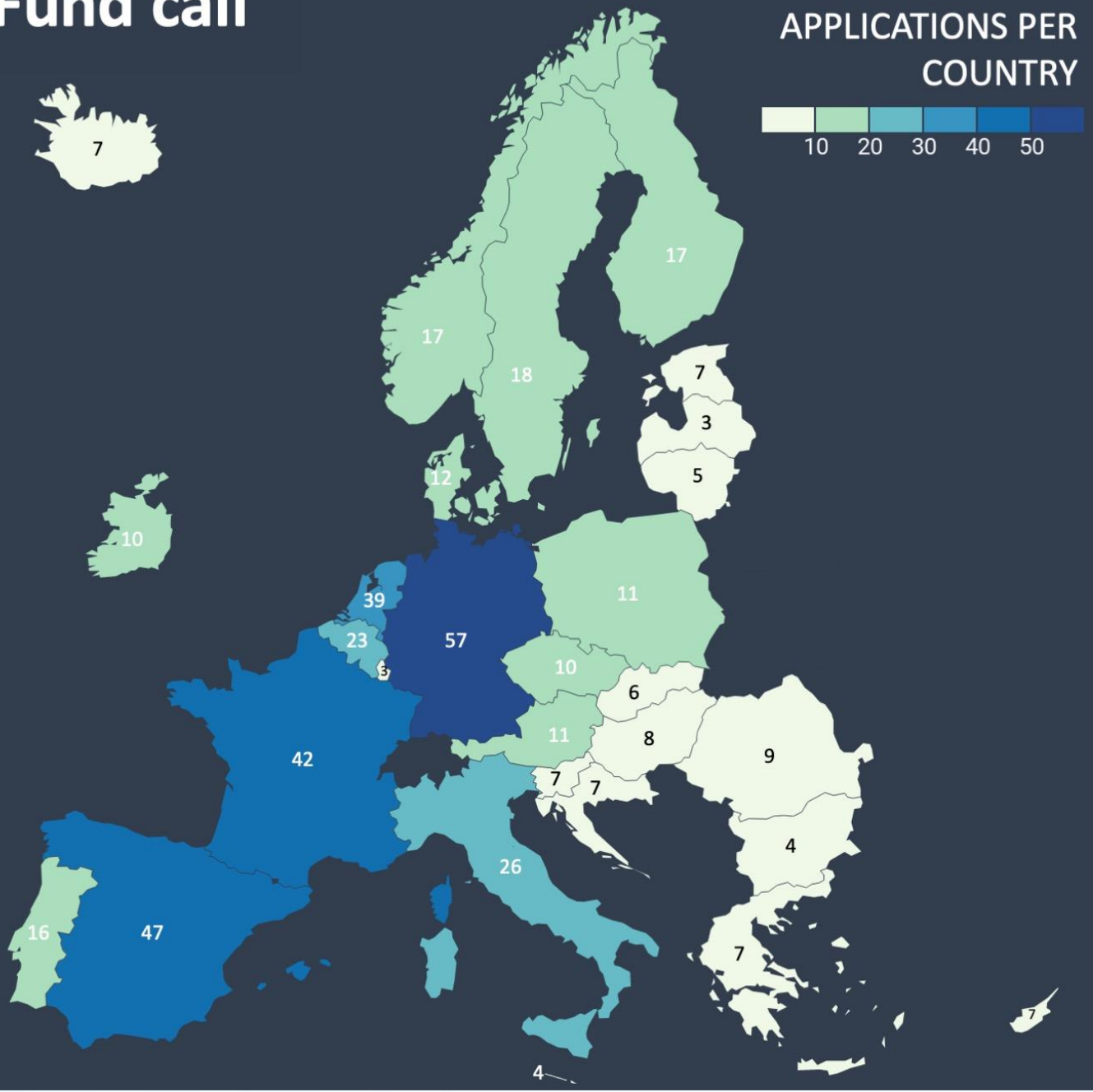
Project overview

Applications to first Innovation Fund call



APPLICATIONS PER ACTIVITY

of which some are cross-sectoral applications



Where to find more information?

All call documents available on the Funding and Tenders Portal including:

- ✓ Guidance and calculation tools on GHG emissions and relevant costs
- ✓ Frequently asked questions

https://europa.eu/!QB67by

Further info, planning of new calls, recorded webinars and videos available on the IF Website:

https://europa.eu/!rx34Dt

Innovation Fund - YouTube

https://bit.ly/2WxK8w7

European Commission

Investor Insight Session on CCU

Daniel Marenne

Energy Solution Architect

ENGIE

Columbus project

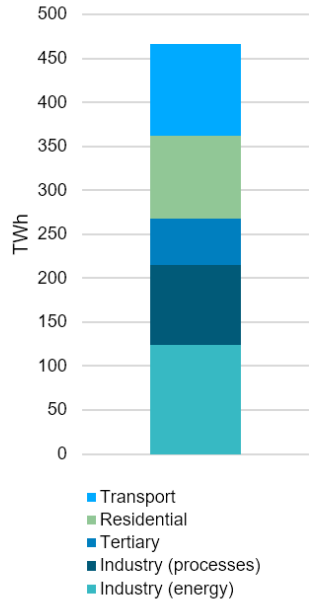
Wallonia leader of the energy transition

First step in defossilizing the industry worldwide

John Cockerill ENGIE CARMEUSE

Aiming at climate neutrality

Belgium final energy & non energy fuel consumption per sector (2019) (**)



How low-carbon solutions could meet the demand (by 2050)

- Energy efficiency
- Renewable Electricity
- Renewable Heat
- H_2 Hydrogen and E-molecules (CCU)
- Natural gas with Carbon capture and storage (CCS)

Belgium

Import & export

After Energy efficiency, **green** electrification is the cheapest way to achieve carbon neutrality.

Hydrogen & E-fuels are part of the solution for hard to abate sectors.

- **E fuels have the highest energy density**

  best solution for hard to abate sector

  1. Maritime (E-LNG) *
  2. Aviation (E-Kerozine)
  3. Petrochemical feed stock.

- **E Fuels can be used today for industry**

  - Transport, distribution and storage infrastructure **already** exist.
  - E fuels are similar than fossil fuels

  1. **No** need of new **investment** to become carbon neutral.
  2. Industrials can focus their innovation in process improvement and new products development (for instance the **new Carmeuse kiln**).

* https://www.engie.com/en/journalists/press-releases/cma-cgm-and-engie-a-strategic-and-industrial-partnership-to-decarbonize-shipping

E fuel production

How do we produce e-methane ?

$$RES + 4\,H_2O \rightarrow 2\,O_2 + 4\,H_2$$

$$+$$

$$CO_2 \rightarrow CH_4 + 2\,H_2O$$

Renewable Energy Sources
9 MWh green electricity

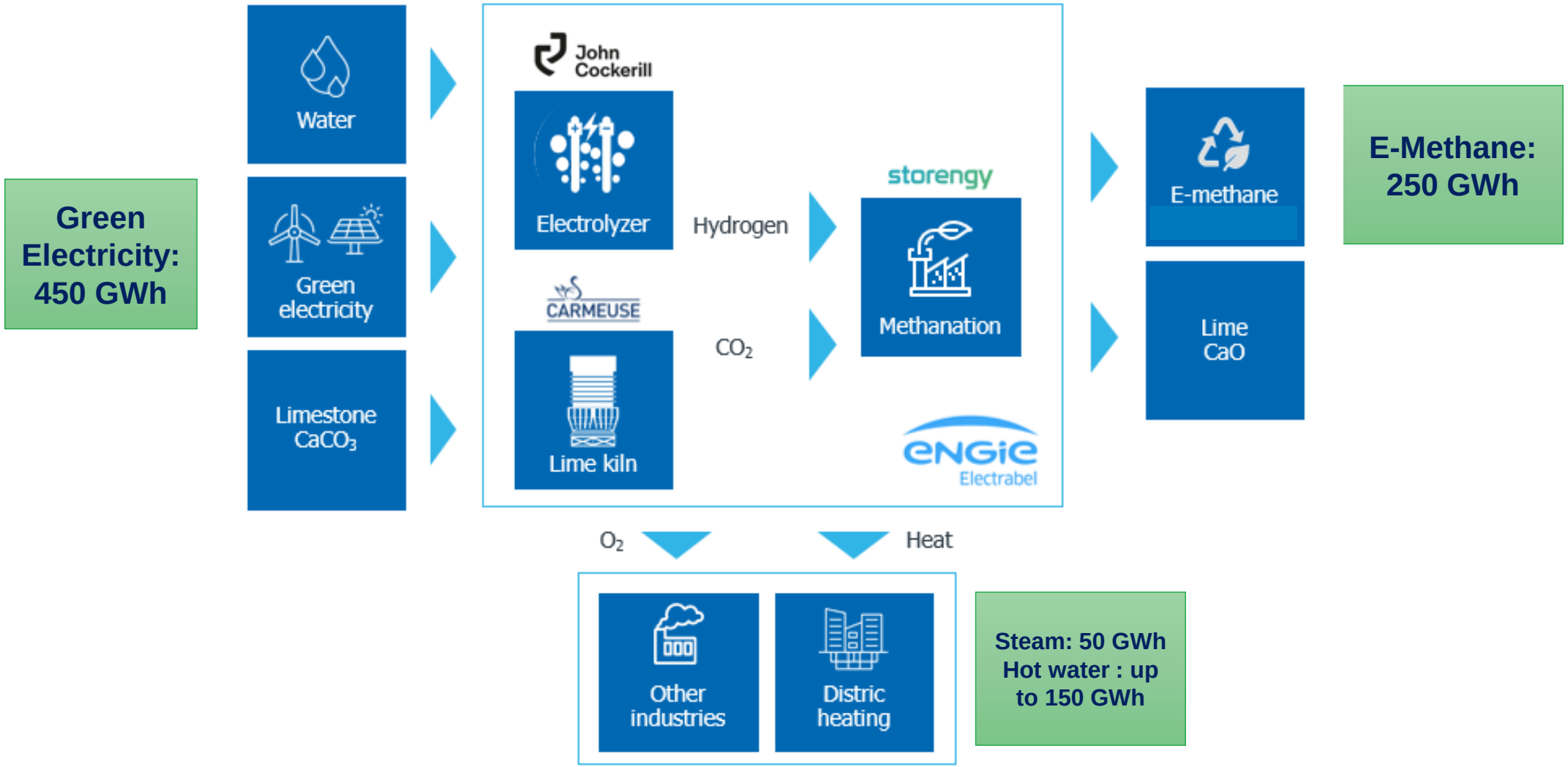
Hydrogen & CO_2
6 MWh green H_2 + 1 tCO_2

E-Methane & Heat
5 MWh green CH_4 + 1 MWh heat

Advantage: methanation heat can be used to capture the CO_2

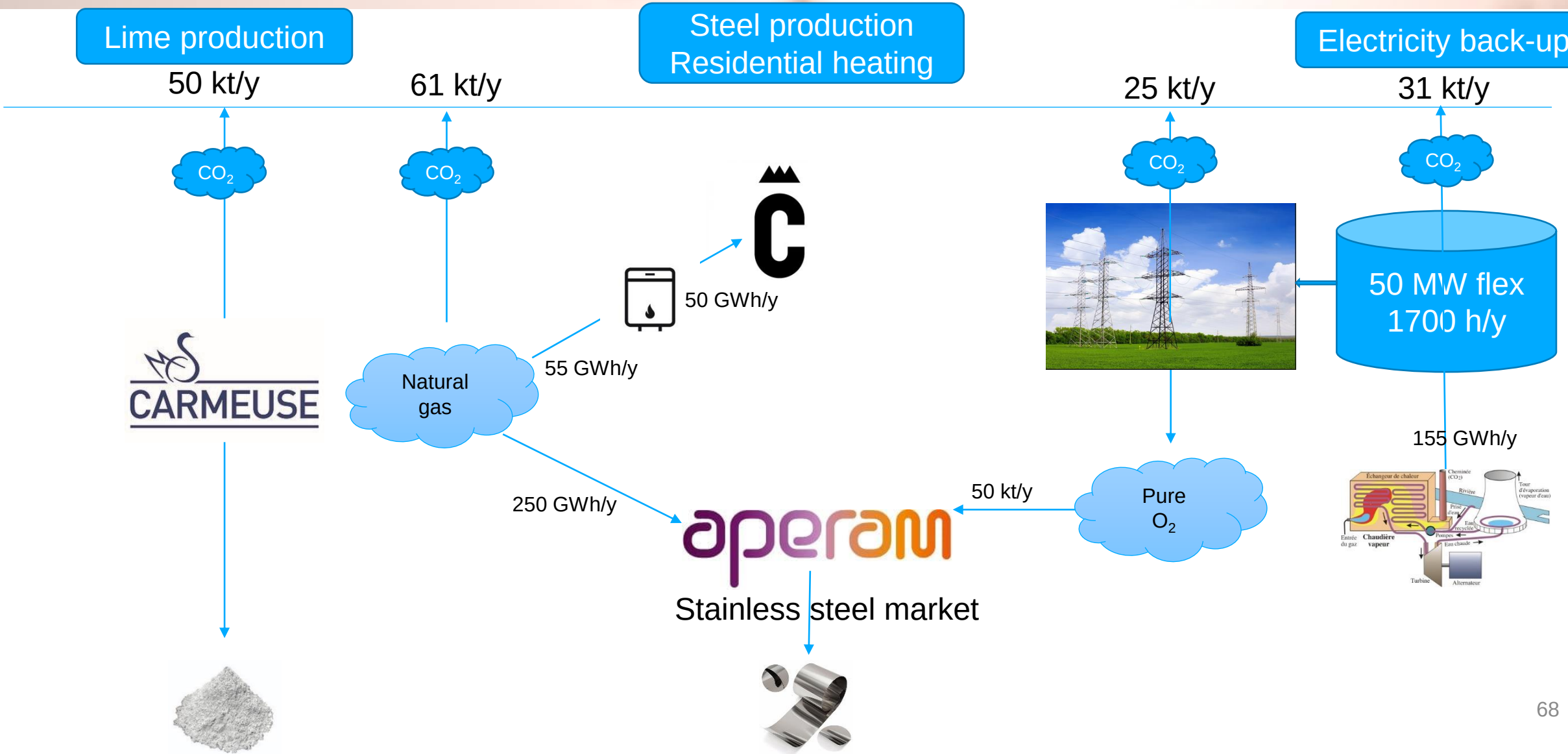
Columbus Project: scope

Producing green H2, green lime, and carbon neutral fuel gas (methane)



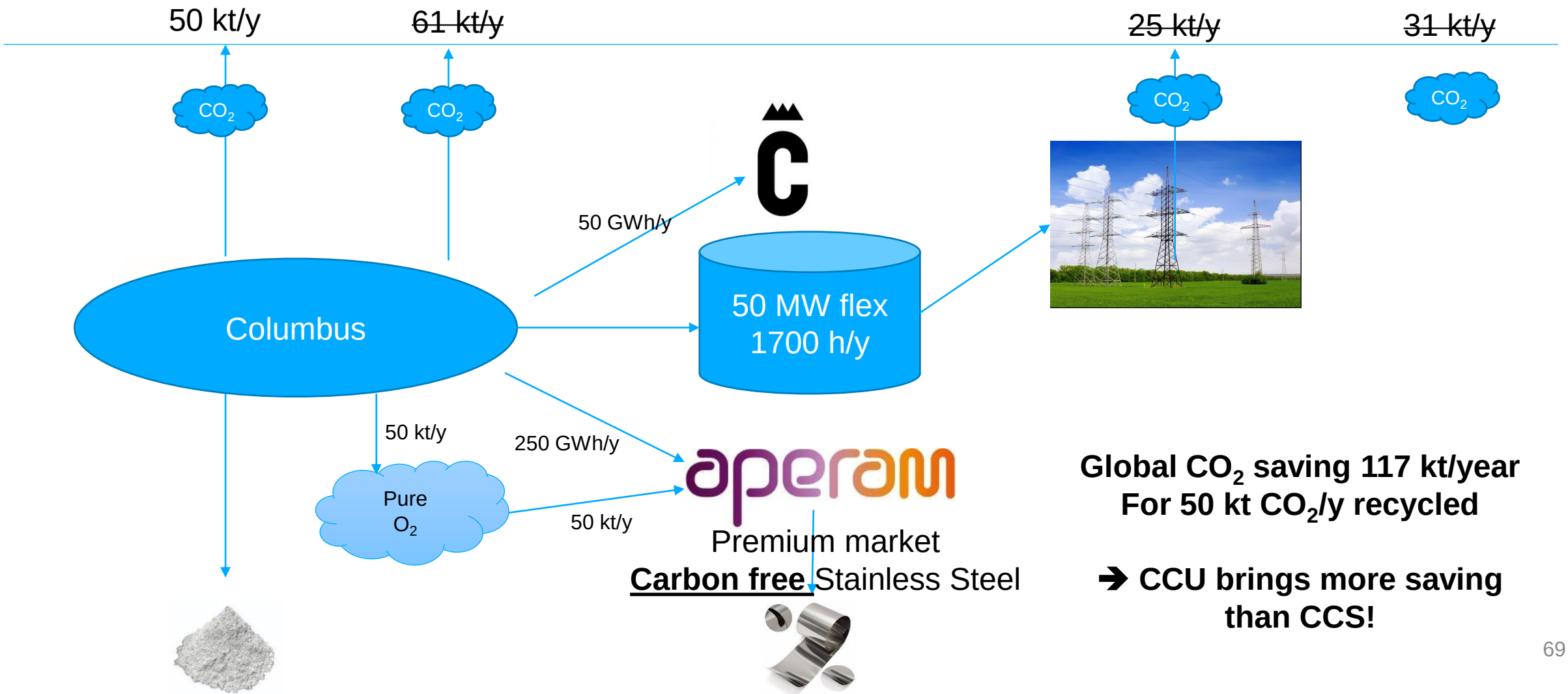
Current situation Linear Economy

No integration



Columbus circular hub

New economy



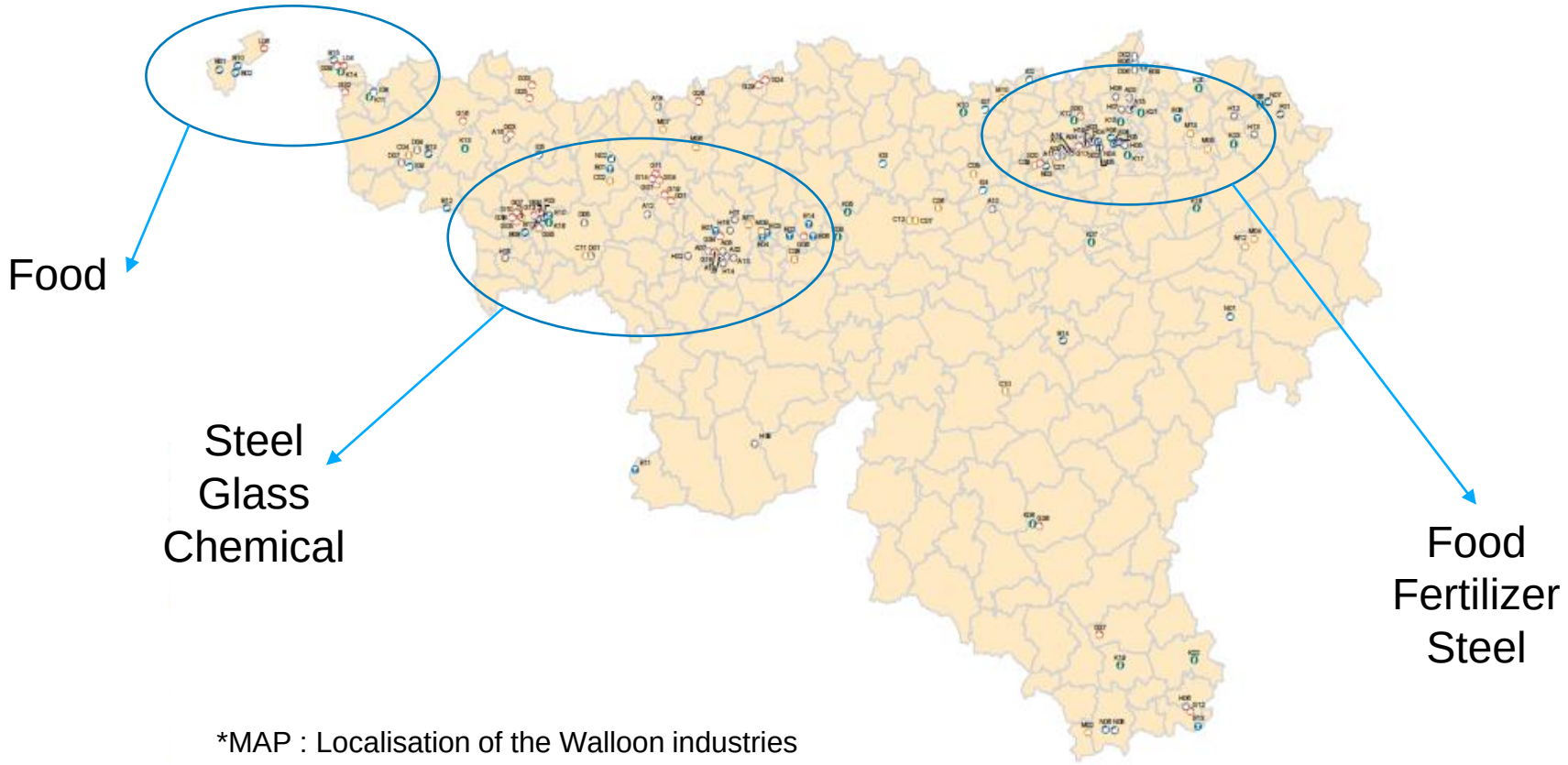
Global CO_2 saving 117 kt/year
For 50 kt CO_2/y recycled

➔ CCU brings more saving than CCS!

Decarbonizing Walloon Industry

Columbus concept can be scaled-up very quickly as premium carbon free product market is increasing.

Walloon industry **needs carbon neutral** gas.
The Columbus project will produce only 1/50 of this need.
➔ Great replicability potential of the Columbus concept.



*MAP : Localisation of the Walloon industries

Methane consumption per sector in Wallonia*

Steel:	3,4 TWh/y
Glass:	2,5 TWh/y
Chemical:	1,9 TWh/y
Food:	2,5 TWh/y
Fertilizer:	1,2 TWh/y
Total:	11,5 TWh/y
Columbus	0,25 TWh/y

* **BILAN ENERGETIQUE DE LA WALLONIE 2018**

Policy & regulation

Create the market conditions to build the business

- **Certification** as well as Guarantees of Origin (**GOs**) for renewable and low-carbon gases
  - E methane must be considered as carbon neutral fuel otherwise Columbus project has no sense.
  - A company using E-methane must be able to valorise the use of **carbon neutral fuel** to produce a **carbon neutral product** (e.g. green steel).

- Create adequate **regulatory framework**
  - Creating a **mechanism to secure** the investor payback (e.g. contract for difference)
  - Setting up **economy-wide renewable gas target** comprising both renewable methane and renewable H_2 .
  - Possibility to use fuel switch to achieve carbon neutrality.
  - **End-use sector-specific targets** for renewable H_2/synthetic fuels in transport (complementing the biomethane/biofuels target), for renewable H_2 and other renewable gases in (certain) industries and/or for green products in construction and other sectors (e.g. green steel, green cement, green plastics)

Columbus project

Thank you

daniel.marenne@engie.com

John Cockerill ENGIE CARMEUSE

Investor Insight Session on CCU

Alfred Lam

Vice President

CHRYSALIX VENTURE CAPITAL

CHRYSALIX
VENTURE CAPITAL

Investor Round Table

ELECTROCHEMICAL CCU INVESTMENT INSIGHTS

Chrysalix Venture Capital

20 YEAR HISTORY OF CLEANTECH & INDUSTRIAL TECH INVESTING

CRV Fund - $100M
Decarb Fund - $150M+

Worldwide investments in early stage startups

Global coverage
North America
Europe
Asia

Investment Focus

What we will be looking for

Market driven opportunities; Seed and Series A

Startups addressing our investor's innovation needs

Energy Transition & Step-change innovation

Industries

Oil & Gas, Utilities, Metals & Mining, Chemicals, Manufacturing Mobility & Construction

Technology Scope

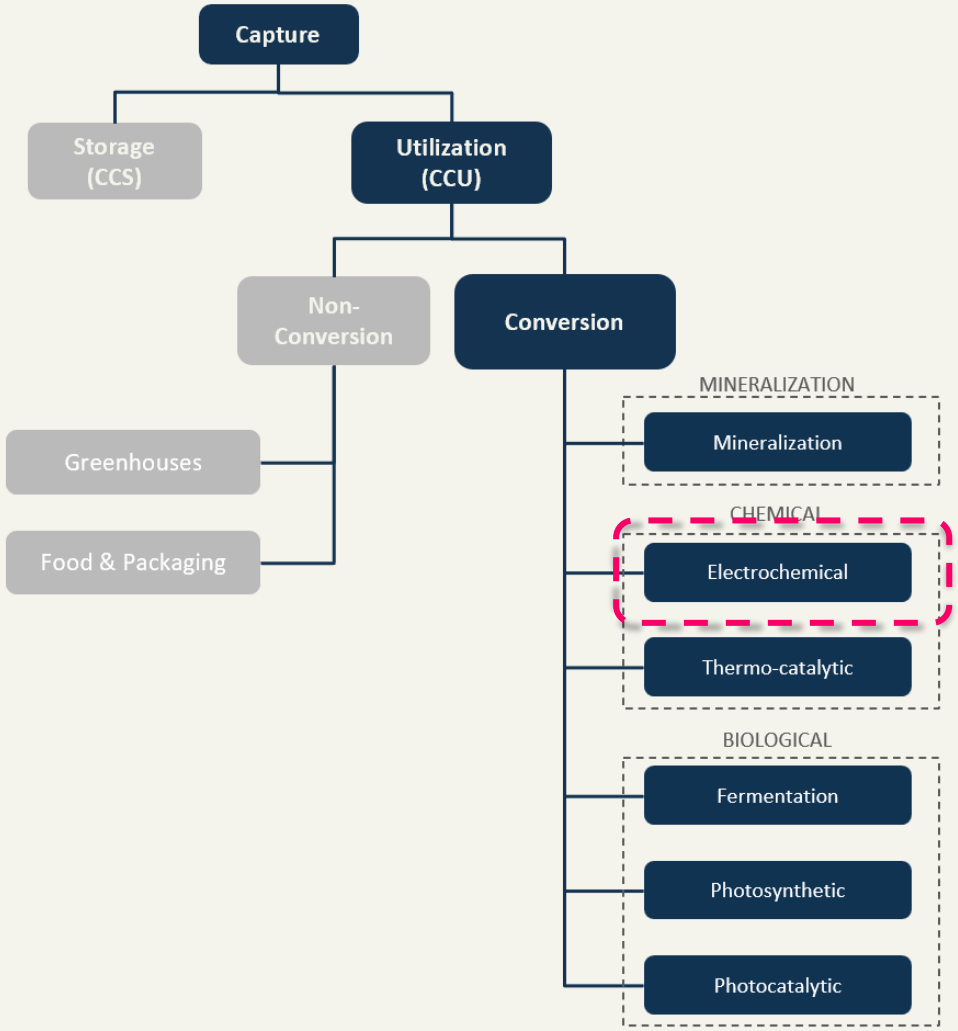
Decarbonization & Resource Productivity Solutions

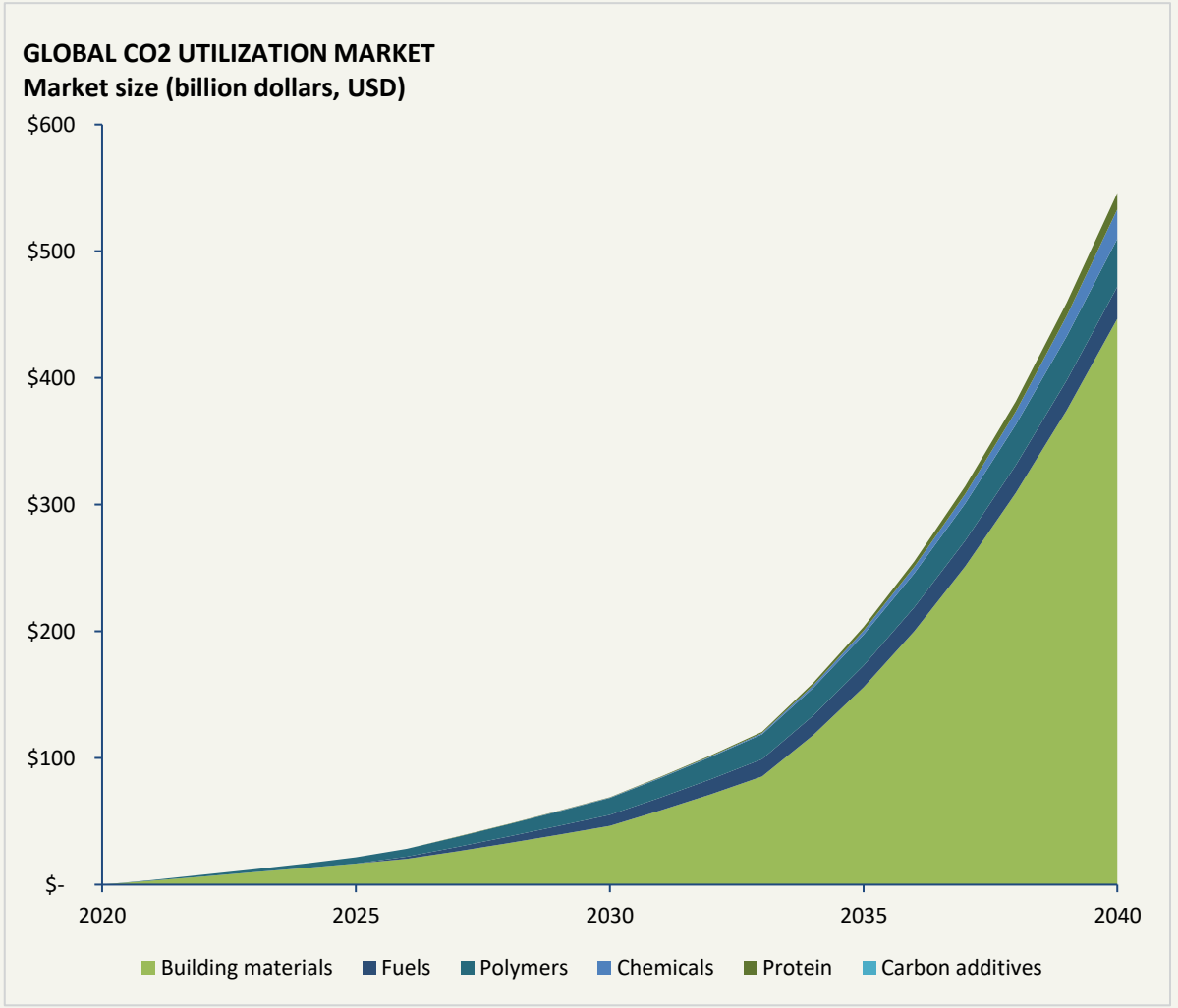
Industry 4.0: AI, IoT, sensors, robotics etc.

Current & Historical Investors

CO_2 Utilization Pathways and Applications

FORECASTED TO BE A $550 BILLION DOLLAR MARKET BY 2040

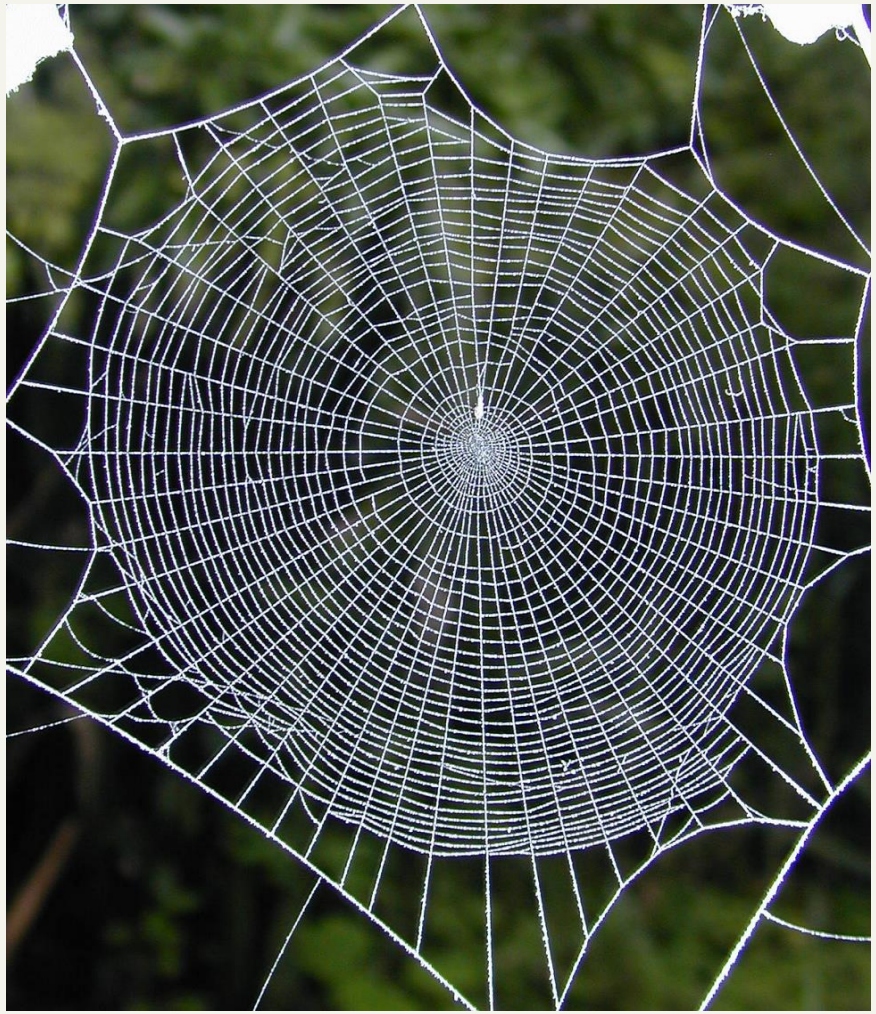




Global CCS Institute, 2019; Lux Research, 2020

Electrochemical CCU – What Makes it Difficult?

OPTIMIZATION OF NON-LINEAR INTERRELATED VARIABLES



Technology Fundamentals Impacting Economics

- Current Density
  - Reaction rates & active area
- Current Efficiency
  - Product yields & post treatment
- Voltage Losses
  - Activation; Ohmic; Mass Transfer
  - Material/Catalysts/polymers
  - Operational conditions (T,P, Conc.)
- Energy Requirements
- Material Durability & Compatibility

Balancing Exuberance w/ Fundamentals

WHAT NEEDS TO BE TRUE?

AND/OR

- Low cost electricity
- Carbon pricing
- High fossil/feedstock prices
- High product prices
- Technology Breakthroughs

Chrysalix Venture Capital

GETTING IN TOUCH

DR. ALFRED LAM

Partner

Chrysalix RoboValley Fund
Delft, Netherlands

alam@chrysalix.com

T +33 (0) 61 3728643

TechTour Investor Club

Break

Back at 16:45

TechTour Investor Club

IVC Roundtable

Deal Syndication Session

Deal Syndication Session

Peter van Gelderen

General Partner

ICOS CAPITAL

Deal Syndication Session

Michael Claes

Senior Technology

Deal Syndication Session

Iliya Bozhkov

Investment Associate

saudi aramco
energy ventures

Feedback Survey & Closing Remarks

Radostina Tsenova

Tech Tour Investors Club Manager

TechTour


TechTour
sustainability
Rotterdam
November 2021
Energy Transition
Programme Overview
#TTEnergy21 | www.techtour.com/Energy21

TechTour Energy Transition 2021 Hosts & Partners

Hosting Partners

City of Rotterdam

Clean Tech Delta

Gold Partners

Bryan, Garnier & Co

Wilson Sonsini

Bronze Partner

ICOS Capital

Supporting Partners

CO_2 Value Europe

rotterdam partners

Programme Partners

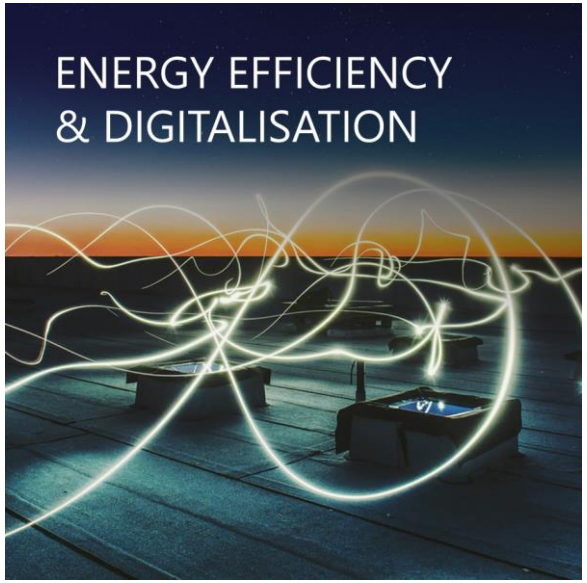
Interreg Vlaanderen-Nederland
Europees Fonds voor Regionale Ontwikkeling

INNORATE

InnoRate has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 821518.

INVEST HORIZON

Selection & Pitching **Tracks**



Co-Pilot Hydrogen

INVEST HORIZON

TechTour Investors Club

Online Opening Tour

- On 18.11.2021 – from 09:30 until 11:40 CET

Overview of Hosts, Partners, selected Entrepreneurs and engaged Investors & Partners

Online Pitching Sessions:

- On 08.12.2021 – from 14:00 until 16:00 CET

Tech Tracks: Alternative Energy, Alternative Carbon, Energy Efficiency & Digitalisation

- On 09.12.2021 – from 14:00 until 16:00 CET

Tech Tracks: Alternative Energy, Energy Efficiency & Digitalisation, IH Co-Pilot Hydrogen

TechTour Investor Club

Tech Tour Energy Transition 2021 Investors (IVC) Round Table

17 Nov 2021

www.iventureclub.com