Carbon Capture
Von CO2 zu Kunststoff

C2PAT CarbontoProductAustria | LAFARGE VERBUND OMV BOREALIS

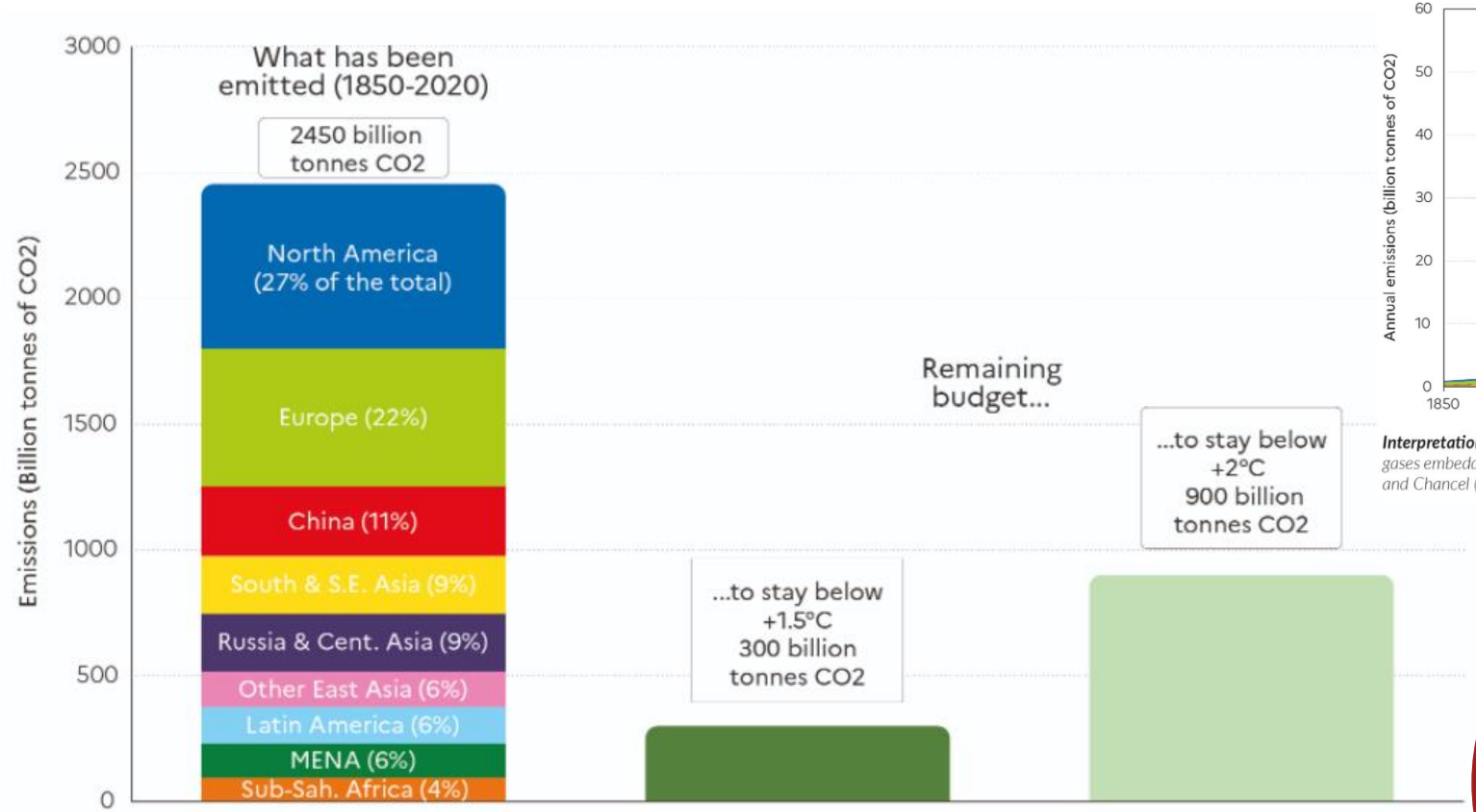
LAFARGE | A MEMBER OF HOLCIM

WING-Forum - „Energiewende – Welche Lösungen haben wir?“

2. Juni 2023, Joseph Kitzweger / Holcim Österreich

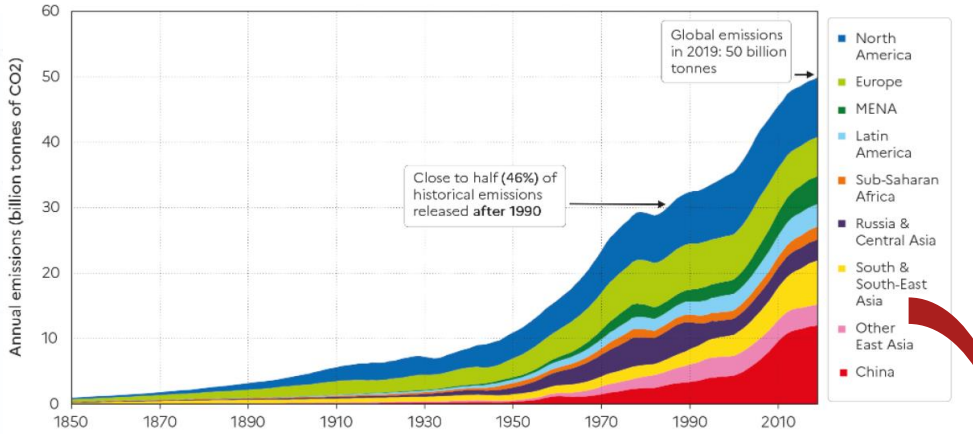
1. Treibhausgas-Emissionen – Klimaintensive Industrie

Historical emissions vs. remaining carbon budget



Interpretation: *The graph shows historical emissions by region (left bar) and the remaining global carbon budget (center and right bars) to have 83% chances to stay under 1.5°C and 2°C, according to IPCC AR6 (2021). Regional emissions are net of carbon embedded in imports of goods and services from other regions.* ***Sources and series:*** *wir2022.wid.world/methodology and Chancel (2021). Historical data from the PRIMAP-hist dataset.*

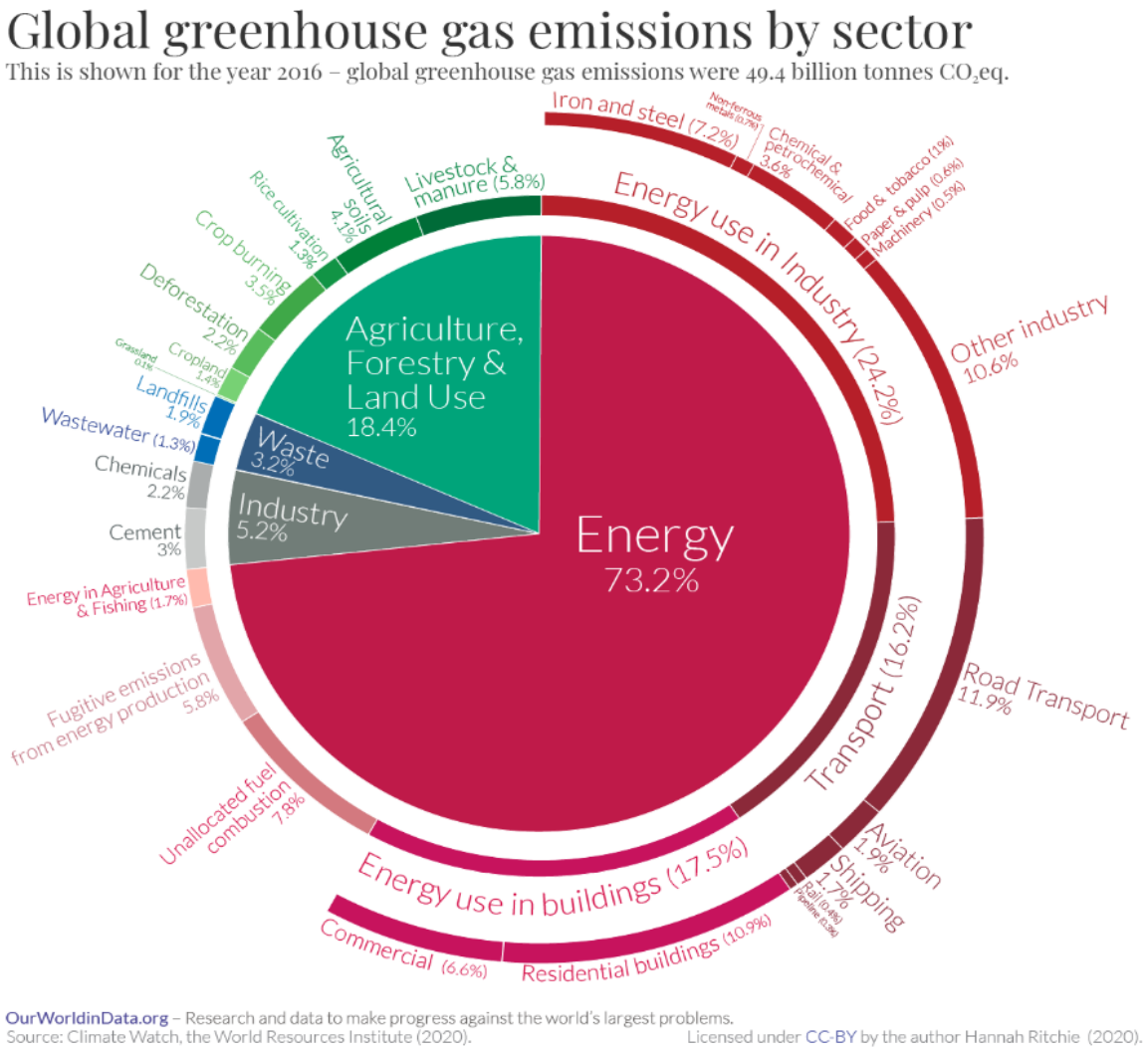
Source: https://wir2022.wid.world



Interpretation: *The graph shows annual global emissions by world regions. After 1990, emissions include carbon and other greenhouse gases embedded in imports/exports of goods and services from/to other regions.* ***Sources and series:*** *wir2022.wid.world/methodology and Chancel (2021). Historical data from the PRIMAP-hist dataset. Post-1990 data from Global Carbon Budget.*

Global emissions are reaching about **50 billion tons of CO2eq today.**
When remaining at this level, the 1.5°C budget will be depleted in six years and 2°C budget in 18 years.

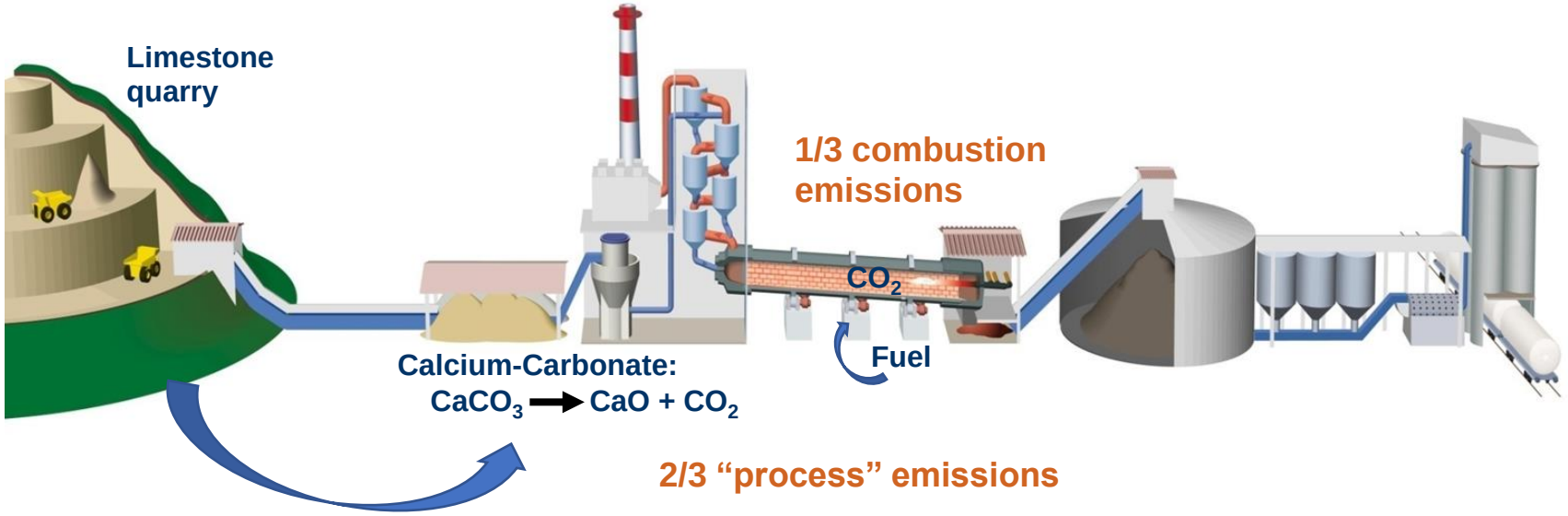
Cement Industry: 4-5% of global CO2eq.emissions



- **Global GHG emissions:** 50 Gt CO2 eq./y
- **Fossil Fuels and Deforestation** are the main causes for the rising CO2 in the atmosphere
- **Cement Industry:** around 2,2 Gt CO2 eq./y (4,5%)
  - 1,5 Gt Process Emissions (3,0%)
  - 0,7 Gt Energy (1,5%)
- **Industry:** 30% of global GHG-emissions
- **Energy-intensive industries** are key players on the path to CO2-neutrality

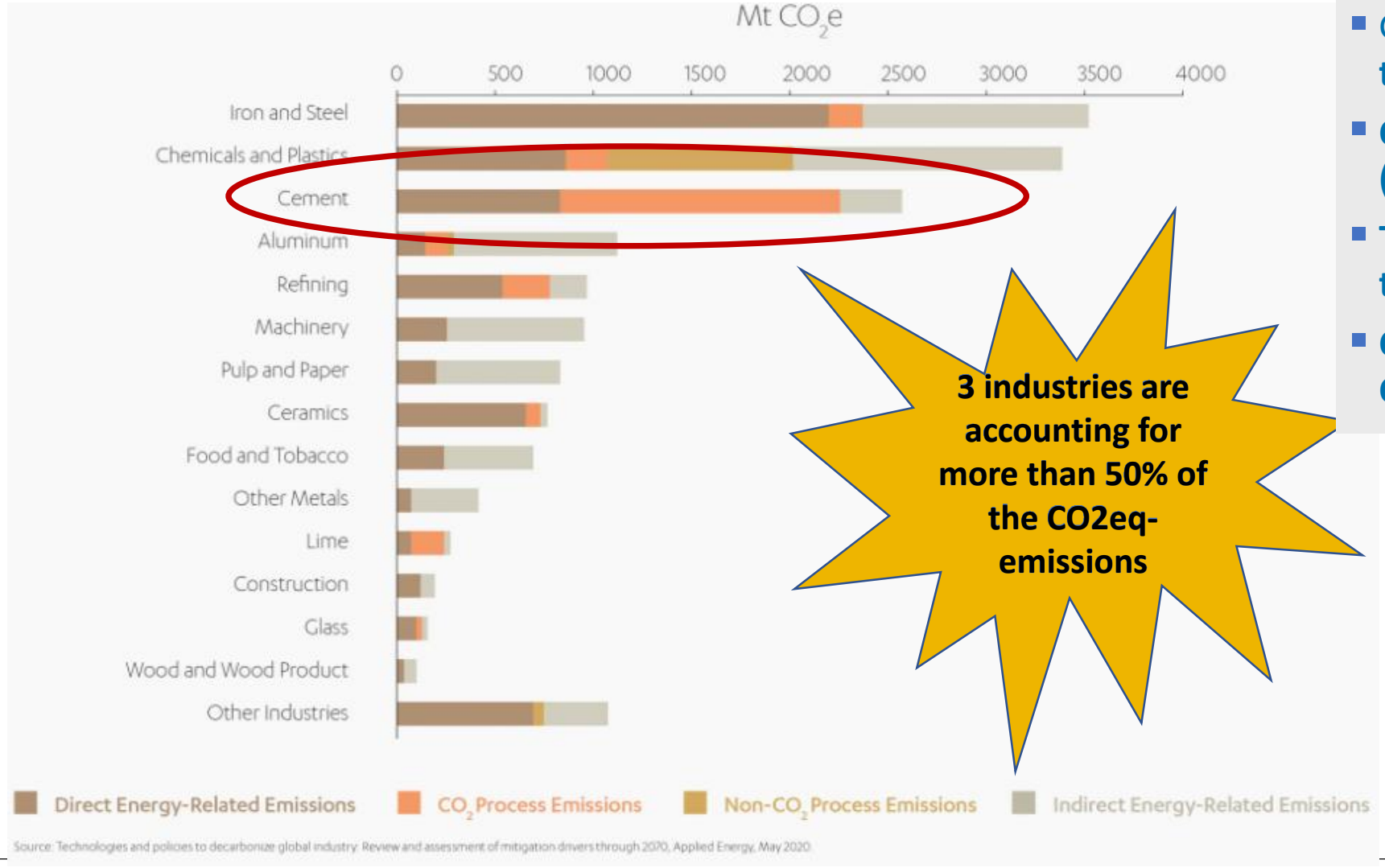
2. Die Rolle der „Hard-to-abate“-Industry am Bespiel der Zementindustrie

Example „Hard to abate process industry“
2/3 of cement CO2 emissions are from raw-material



- Scope 1 direct emissions: about 800 kg CO_2/ton clinker, 400-600 kg CO_2/ton cement
- Scope 2 indirect emissions, mainly electricity ……. estimated at 10% of direct emissions
- Scope 3 emissions in supply and value chain, 10 – 15% mainly dominated by transport emissions

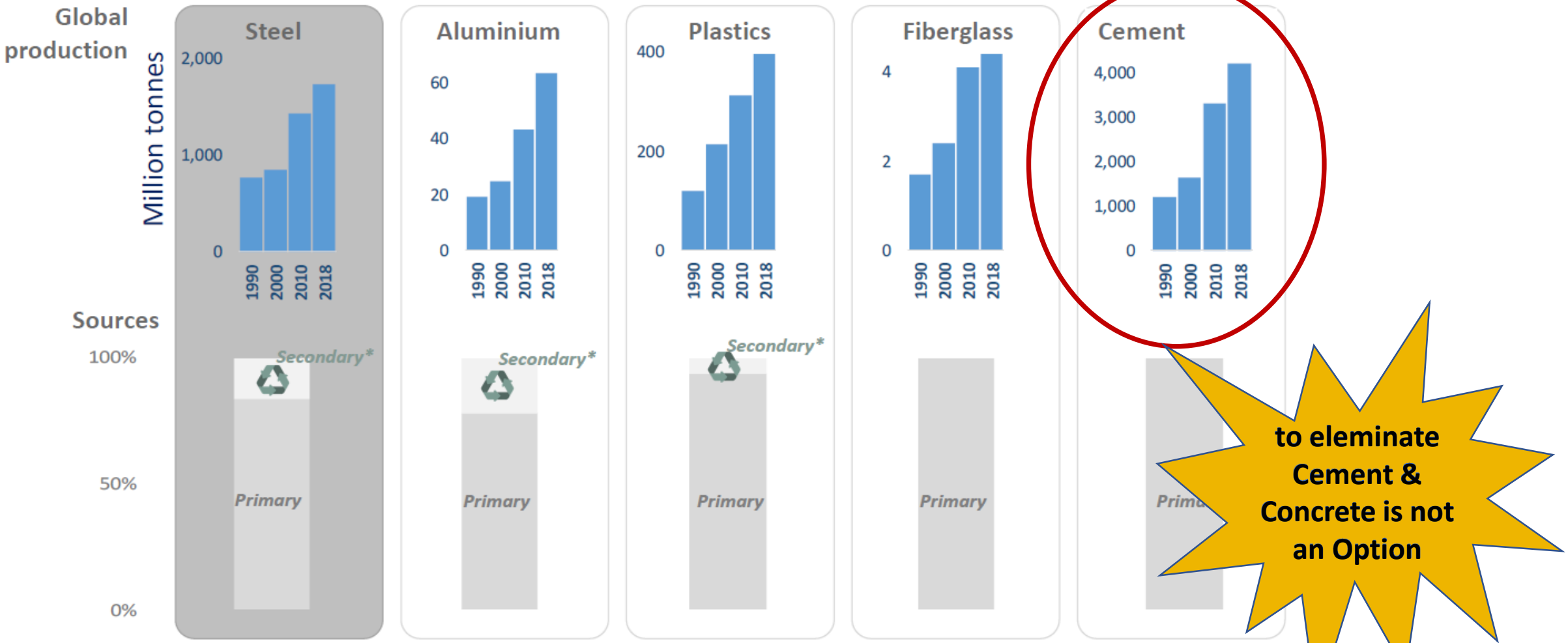
Global GHG Emissions by Industry



3 industries are accounting for more than 50% of the CO2eq-emissions

- Global emissions: ca. **50 billion tons of CO2eq.**
- **Ca 1/3 from industrial processes (around 15 Gt/a)**
- **Top 3 emitters account for more than 50%**
- **Cement Emissions dominated by CO2-emissions from raw-material**

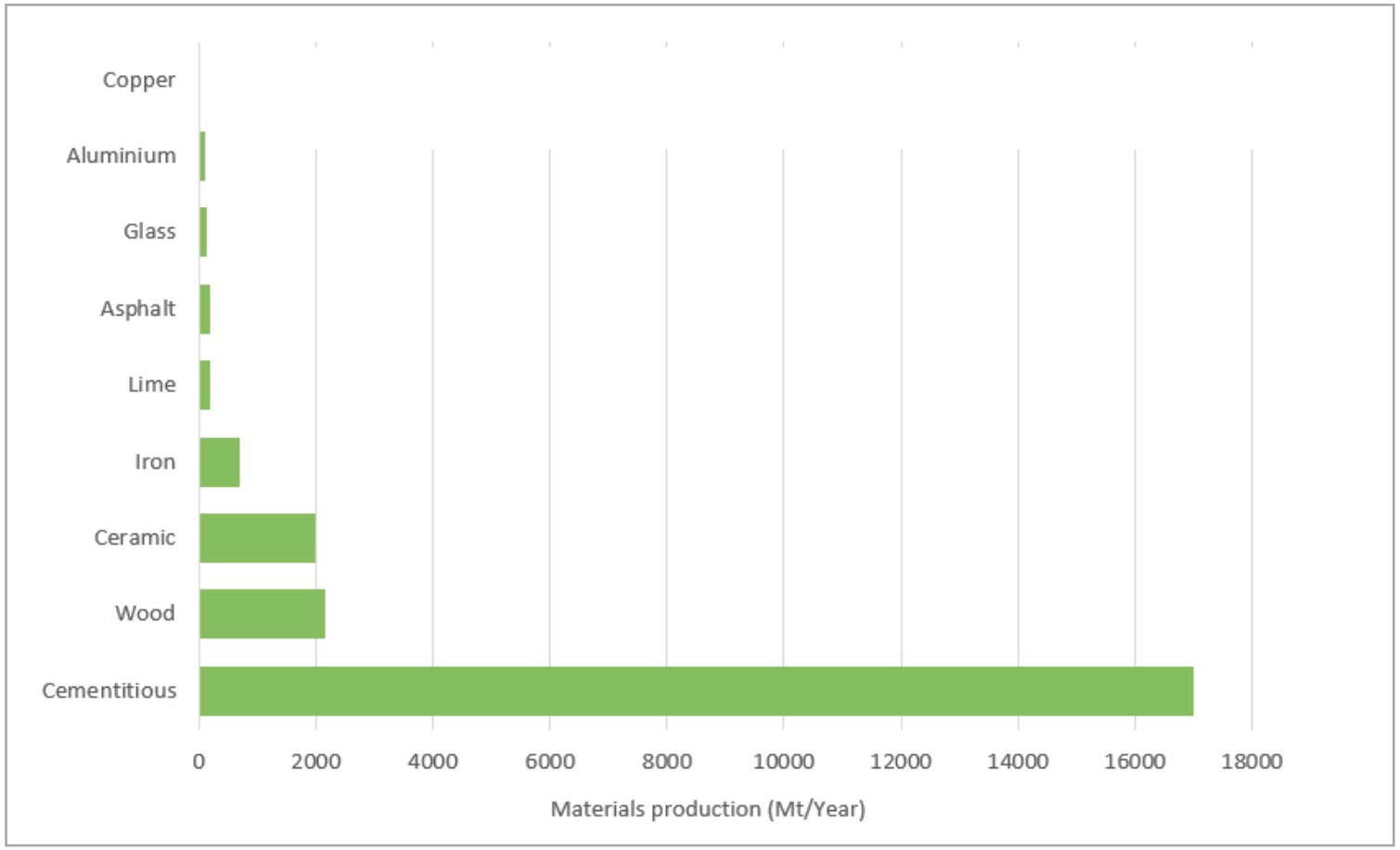
Materials: global consumption for most materials has tripled since 1990 - material production today relies heavily on primary sources



* Defined as end of life material recycled to make same material again

Sources: WSA, World Aluminium, Plastics Europe, ArcelorMittal Corporate Strategy analysis

Concrete is 50 % from everything we produce …



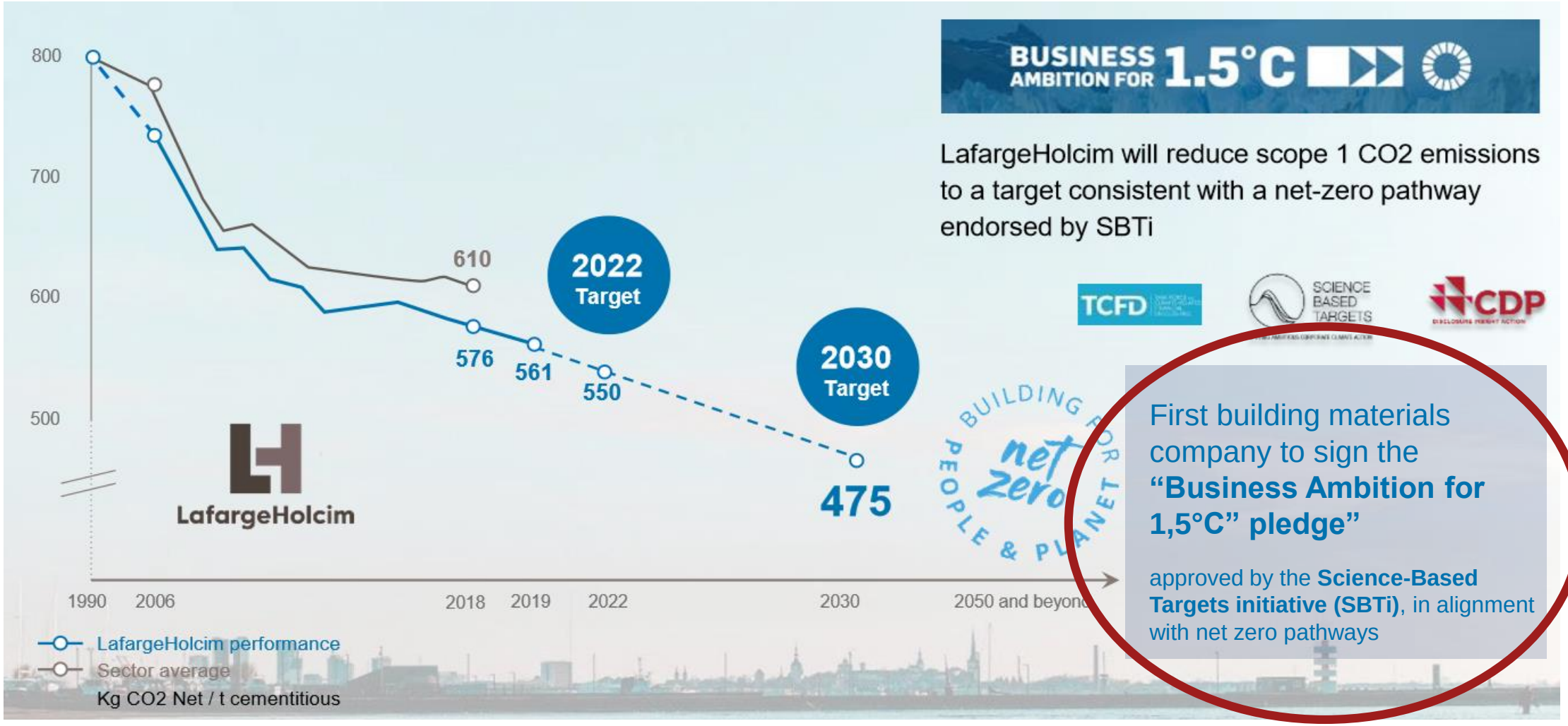
Quellen: VDZ Congress 2018, Limestone and Calcined Clay Concrete, K. Scrivener, 2017 École polytechnique fédérale de Lausanne (EPFL)in UNEP Report

Hochrechnung für 2017: Cementitious > 35.000 Mt/year

Concrete can only marginally be replaced by alternative building materials!

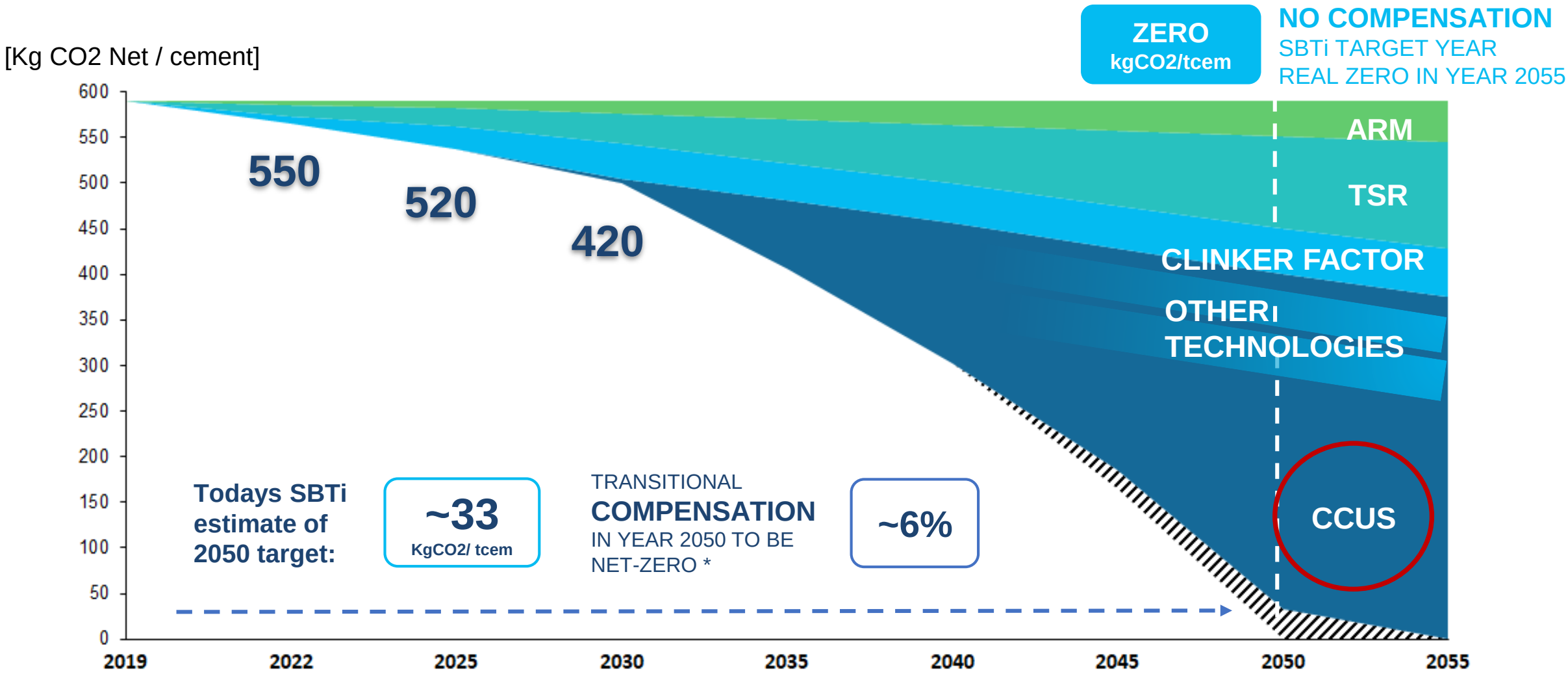
3. Approach von Holcim zur Erreichung des „Net-Zero-Targets“

Shaping our Net Zero Roadmap – Key Role as Global Leader



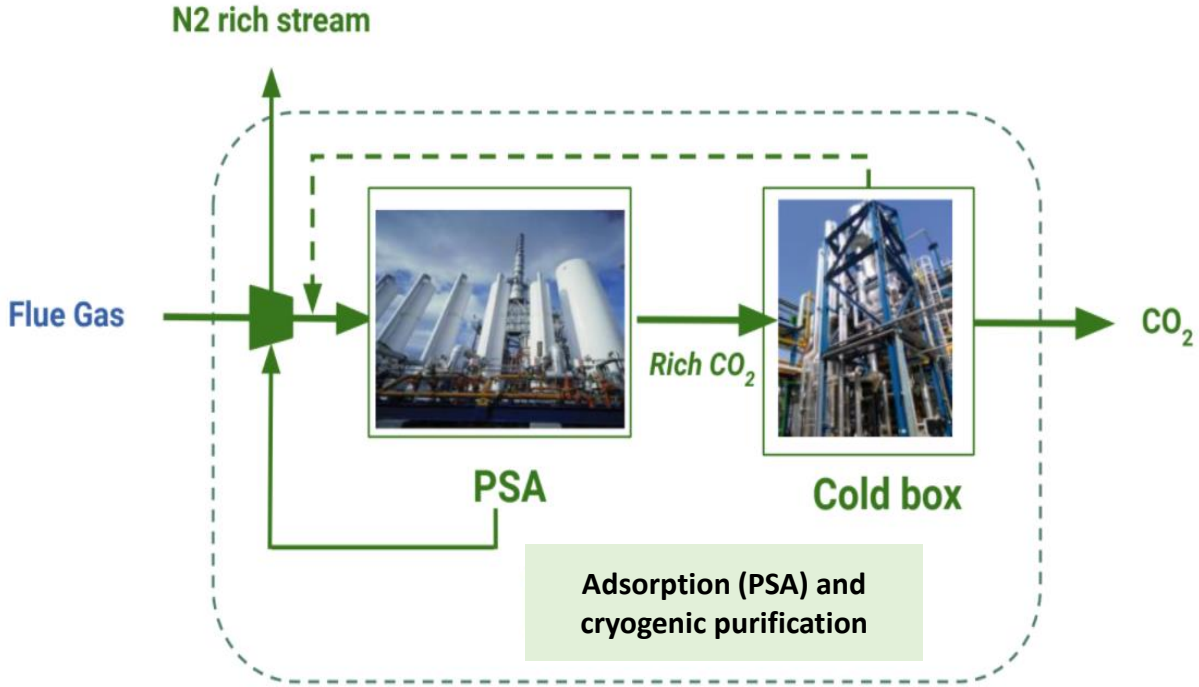
CCUS IS A MUST TO ACHIEVE OUR NET-ZERO PLEDGE BEYOND 2030
yet we need lighthouse projects before 2030

C2PAT

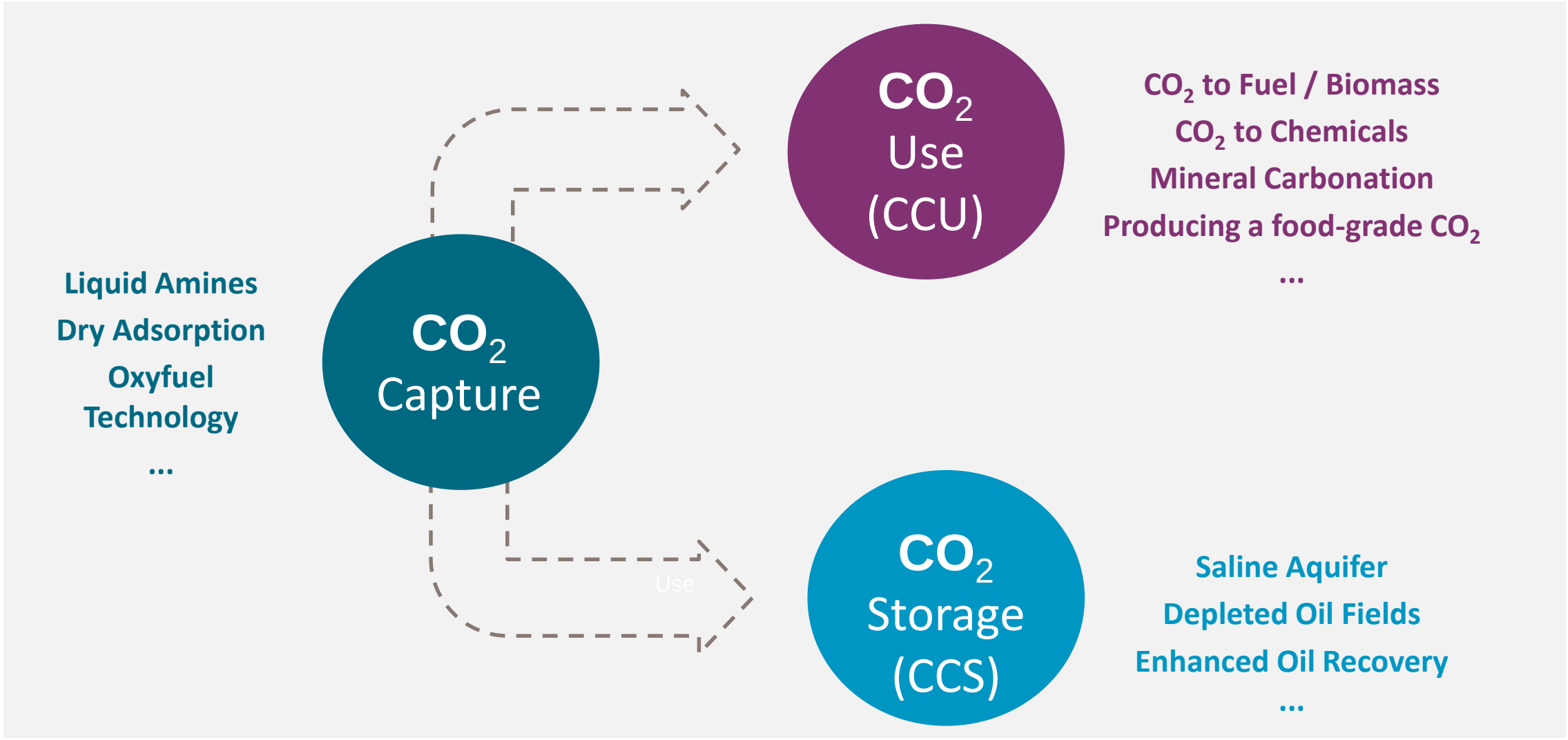


4. CCU oder CCS ?

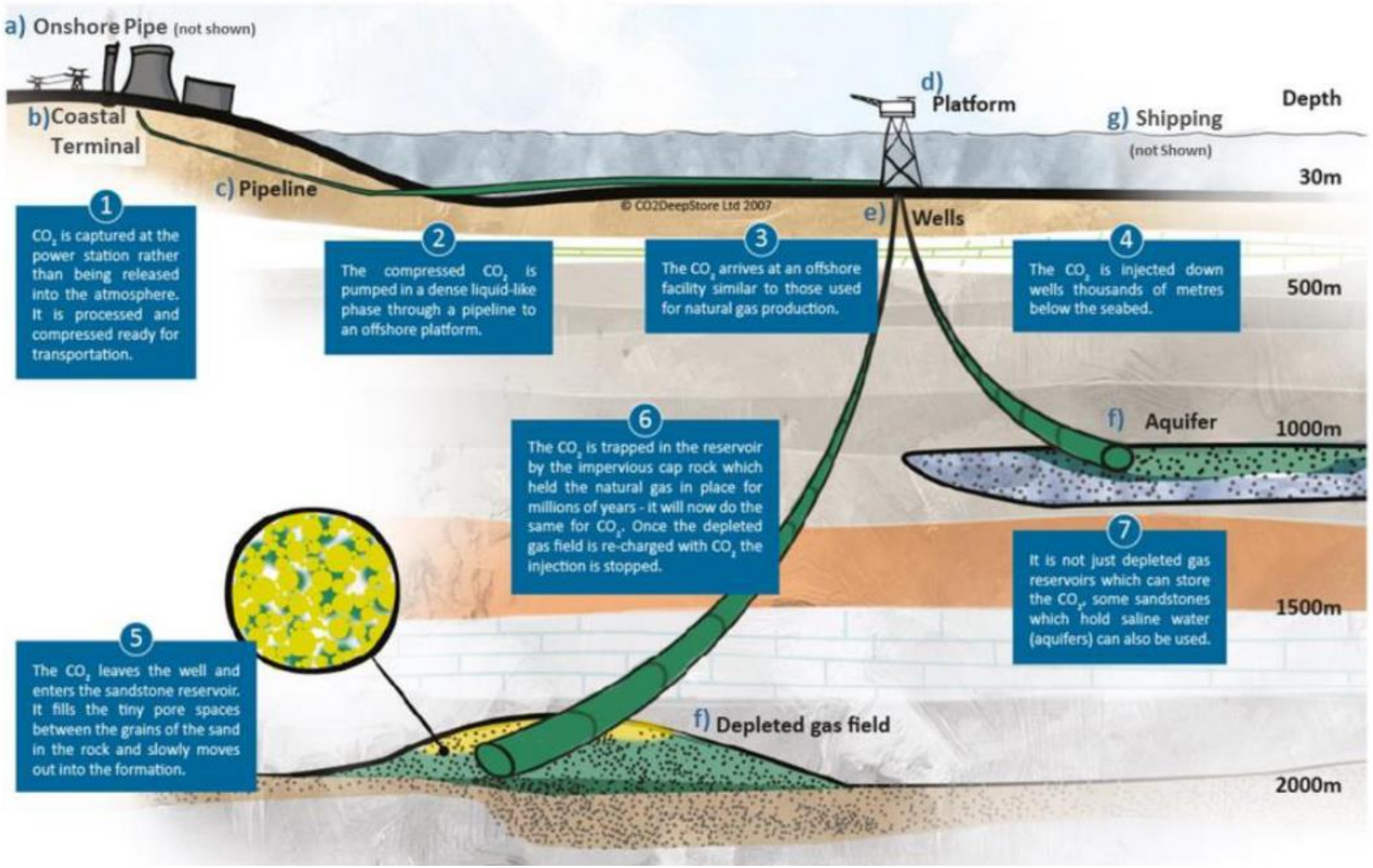
Carbon Capture Technology – Beispiel „PSA/Cryogenic“



Solutions: “Carbon Capture-Utilization” and “-Sequestration”

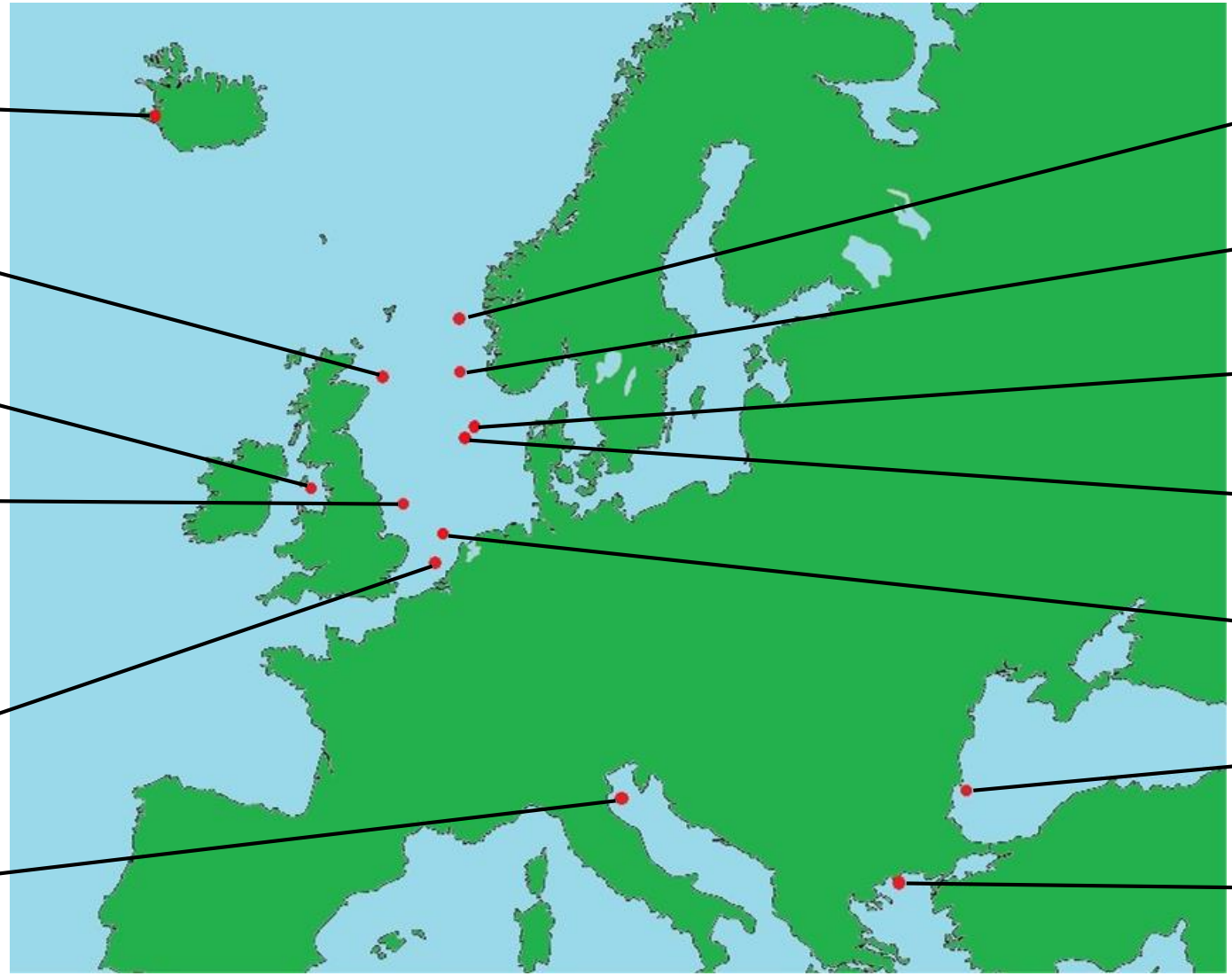


CCS



Source: ETI, 'Strategic UK CCS Storage Appraisal' [Online].
Available: https://www.eti.co.uk/programmes/carbon-capture-storage/strategic-uk-ccs-storage-appraisal

Overview of European CO2 Storage Sites (non exhaustive)
Number of offshore storage options in Europe is increasing with upcoming years



Coda, Iceland
300 ktpa - 3 Mtpa
2026-2031

Acorn, UK
300 ktpa-3 Mtpa
2024-2026

Hynet, UK
10 Mtpa
Late 2020s

ECC, UK
4-27 Mtpa
2026 and beyond

Porthos, Netherlands
2.5 Mtpa
2024/2025

Aramis, Netherlands
2.5-8 Mtpa
2026-2030

Ravenna, Italy
4-10 Mtpa
2027-2030s

Northern Lights, Norway
5-10+ Mtpa
2024-2030s

Stella Maris, Norway
10 Mtpa
2026

Greensand, Denmark
1.5-8 Mtpa
2025-2030

Bifrost, Denmark
3 Mtpa
2028

L10, Netherlands
5 Mtpa
2026

Galata, Bulgaria
800 ktpa+
2028?

Prinos, Greece
750 ktpa
Late 2020s

5. C2PAT – Carbon2Product Austria

Carbon2Product Austria – “C2PAT”

Rationale:

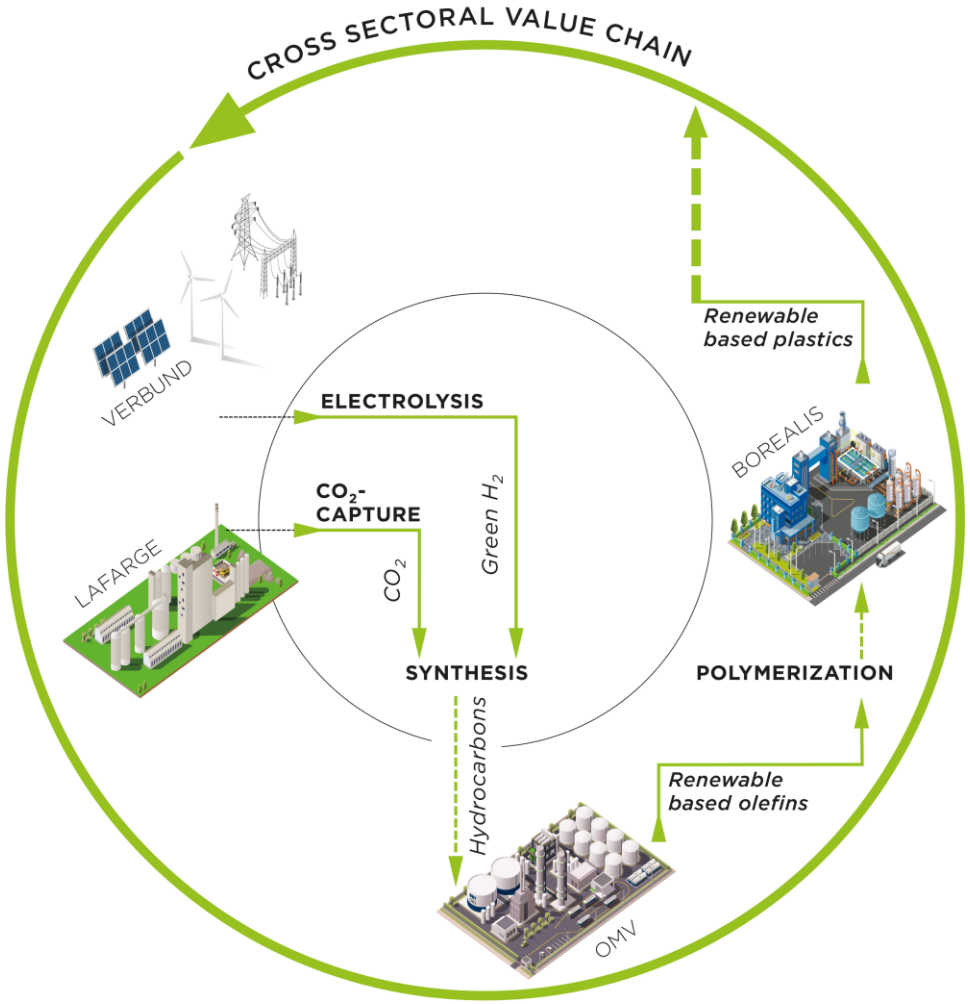
- To prove the feasibility of **transforming the CO2** captured from the flue gas of a cement plant **into renewable based Plastics**

Objective:

- **Installation of a set of full scale technologies in order to turn 750 kt CO2/y to 200 kt plastics/y (2029)**
- **“Cross-Sectoral Value Chain” Approach:** consortium with OMV (Refinery), VERBUND (Green Electricity) and BOREALIS (Plastics).

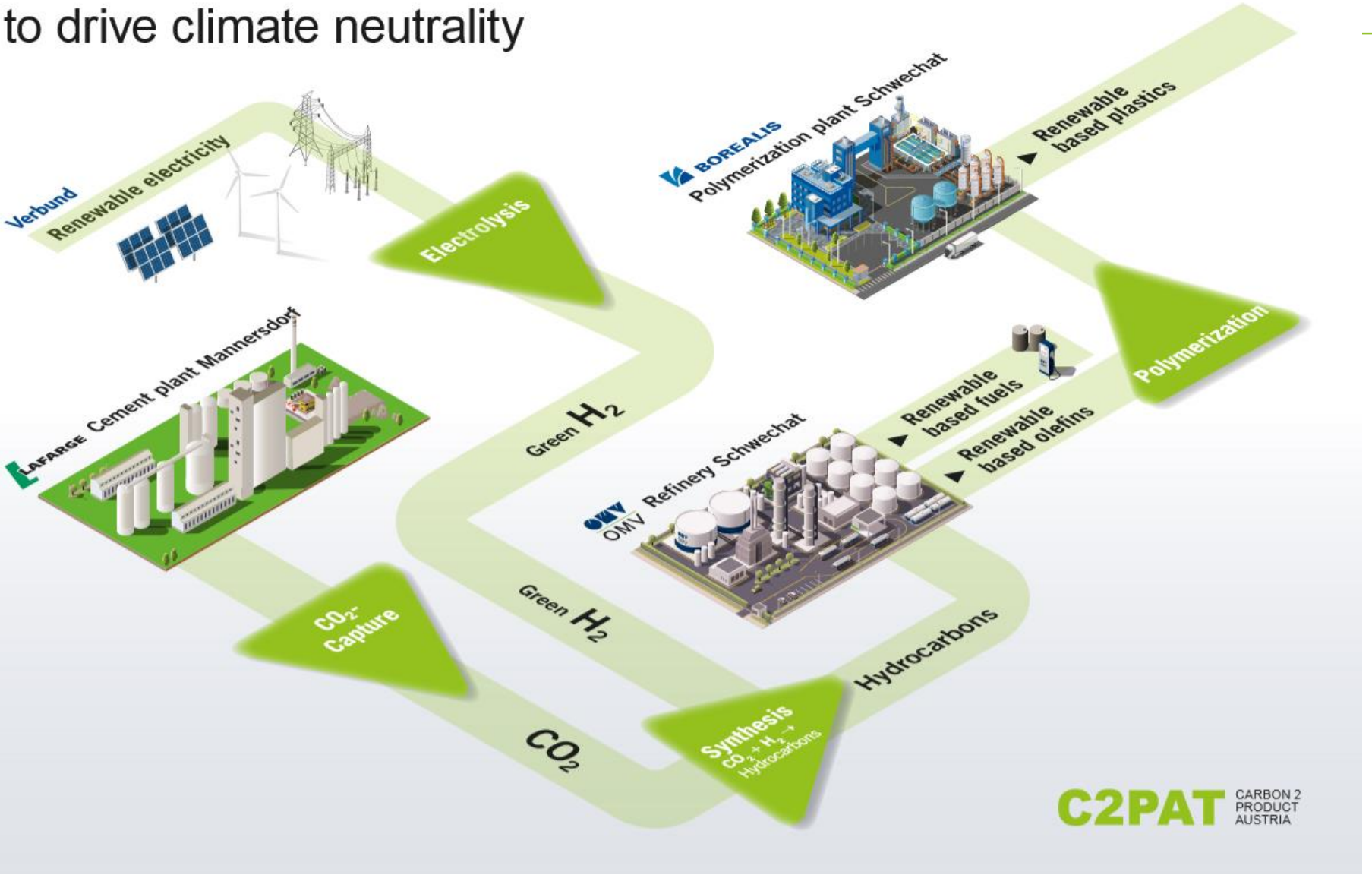
Key Enabler:

- **Austrian’s Flagship Project for the Decarbonation of the Industry** (scale-up potential to other plants and other industries)
- **MDF plant is well located**, very close to OMV’s Refinery (OMV) and to Borealis’ Petrochemical operations. VERBUND is the leader of Green-Power in Austria



Cross sectoral value chain

to drive climate neutrality



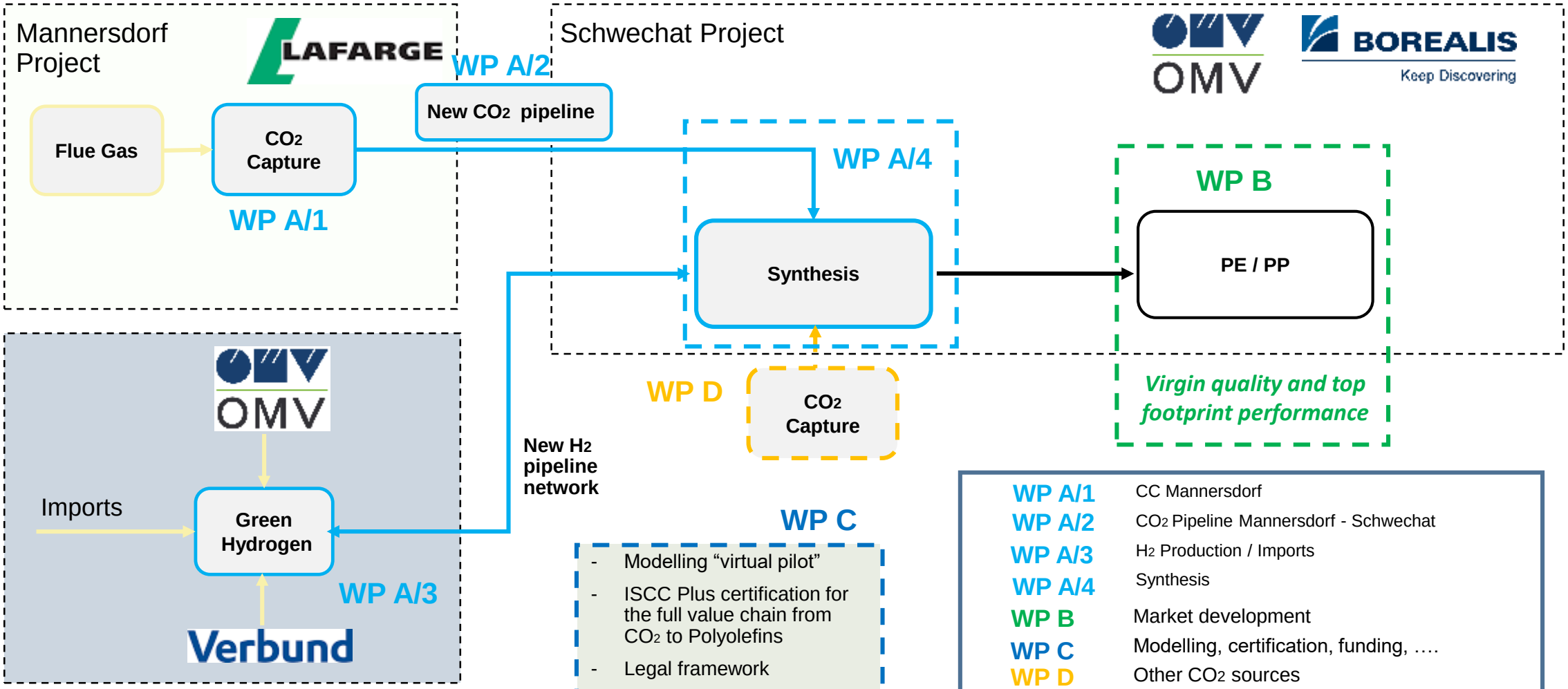
“Carbon2ProductAustria” (C2PAT) - From CO2 to Feedstock

1. **CO_2** from Cement Plant	**$CaCO_3 \rightarrow CaO + CO_2$**
2. **Green Hydrogen** through Water Electrolysis	**$H_2O \rightarrow H_2 + ½O_2$**
3. Production of **renewable based Hydrocarbons**, such as Olefins (plastics)	**$CO_2 + 3H_2 \rightarrow CH_3OH + H_2O$**

- **CO2 is not just a greenhouse gas that we have to reduce**
- **It is also a valuable raw material from which we can produce synthetic fuels and feedstock for the chemical industry, e.g. Polypropylene**

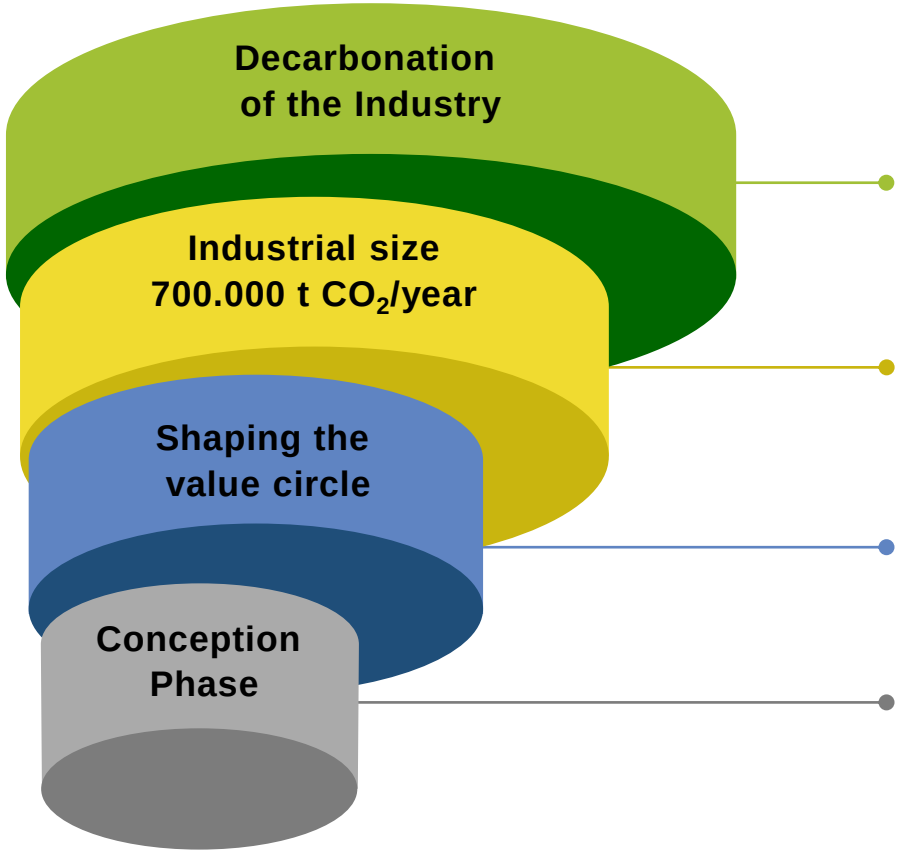
Direct upscale in several technology packages

The ‘industrial-scale demonstration’: **from 750.000 tons CO_2 p.a. & 100.000 t/a H_2 to ~ 200.000 tons Polyolefins p.a.**



Source: C2PAT GmbH & Co KG

Our way towards a CO2 neutral industry transformation



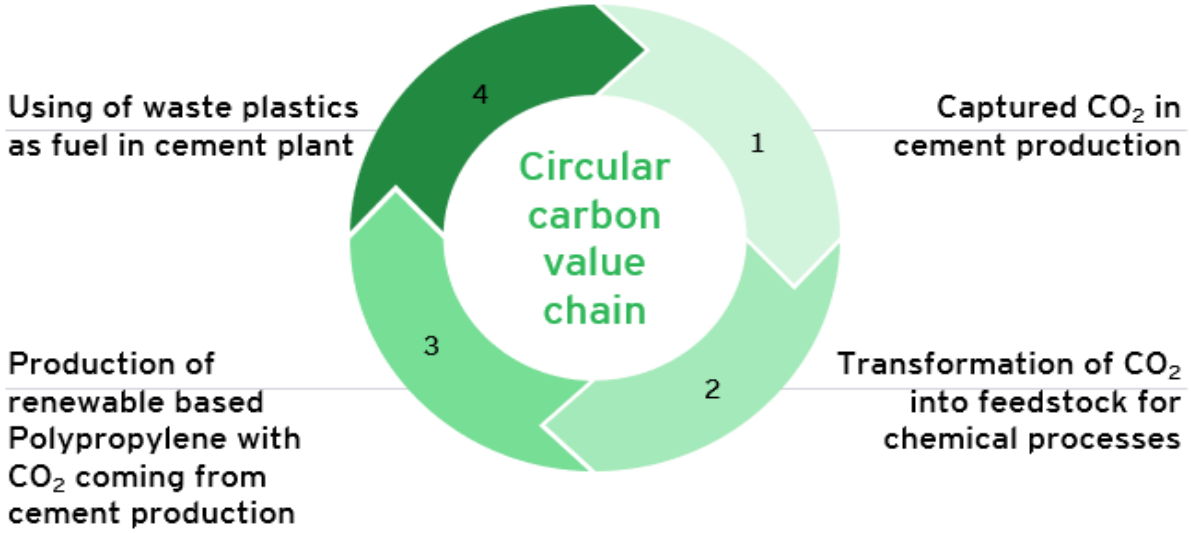
Transformation of the industry
C2PAT as a blueprint for the transformation of industry towards a climate-neutral economy in Austria, in Europe and at global level

'world-scale plant' defined by > 700,000 t CO2
Erection and operation of a world-scale plant converting more than 700,000 tons of CO2 per year into renewable based products (e.g. chemicals and plastics)

"Modelling" of the Value Circle
Shape the different technologies for a sustainable cooperation of the different sectors

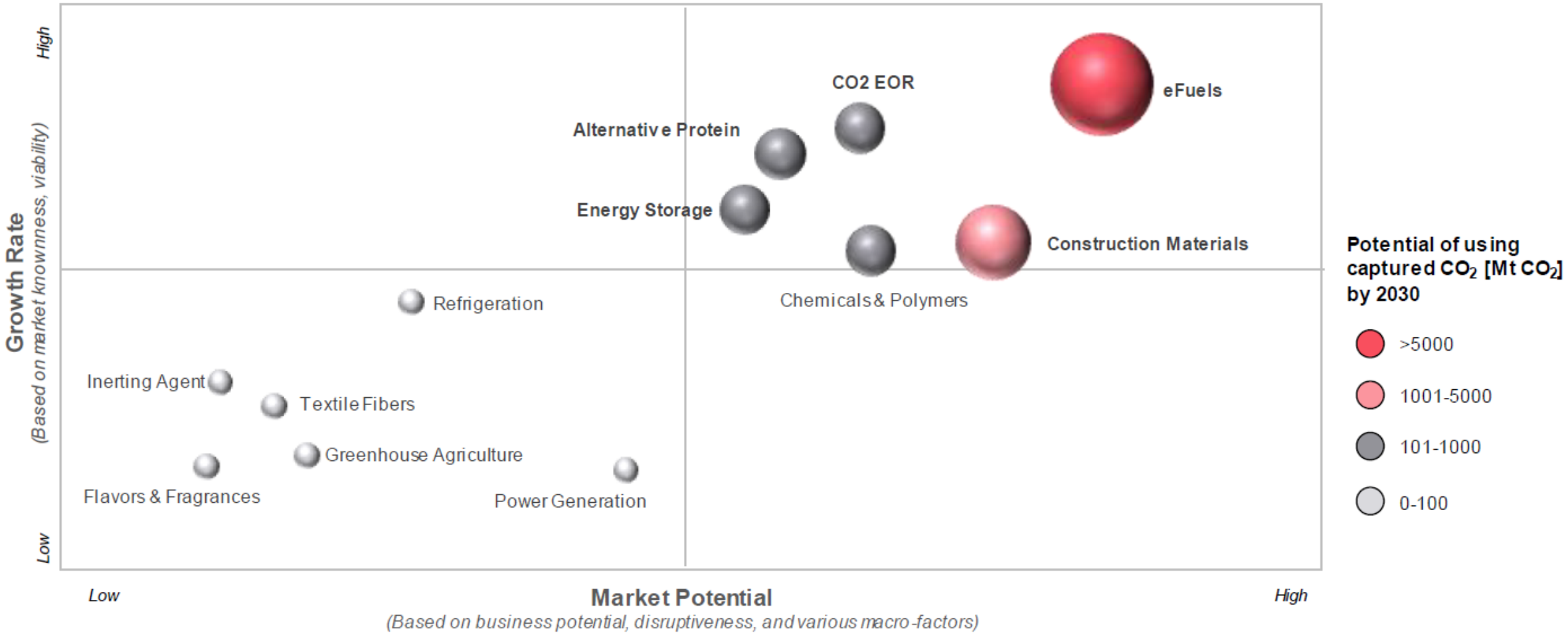
'Critical Pathway'
Concept development and analysis of the critical pathway towards the realization of the full-scale plant

Circular Carbon Value Chain – keeping CO2 in the loop



- Clinker burning process at **1450°C**
- Mannersdorf Plant:
  up to **90% Alternative Fuels** used to replace Fossil Fuels
- **100.000 t/a RDF**
  (Residual Derived Fuel)
- RDF: around **50% processed Plastic waste**

CO2 as an Asset – Future Potential: 2030



Source: FutureBridge.com

6. Warum geht das alles nicht schneller?

Key issues for a climate neutral economy

- **REGULATORY STABILITY**
  - Enormous investments need a sound business case
- **ENABLING THE CREATION OF MARKETS FOR RENEWABLE BASED PRODUCTS**
  - Regulatory incentives to create market demand (standards, public procurement, …)
- **FUNDING**
  - Support for the development and scaling up of breakthrough technologies (incl. demo units)
- **ACCESS TO RENEWABLE ENERGY**
  - Accelerate permitting processes and enable competiveness
  - Build infrastructure for transport and storage

100€/t CO2: angemessener CO2-Preis?

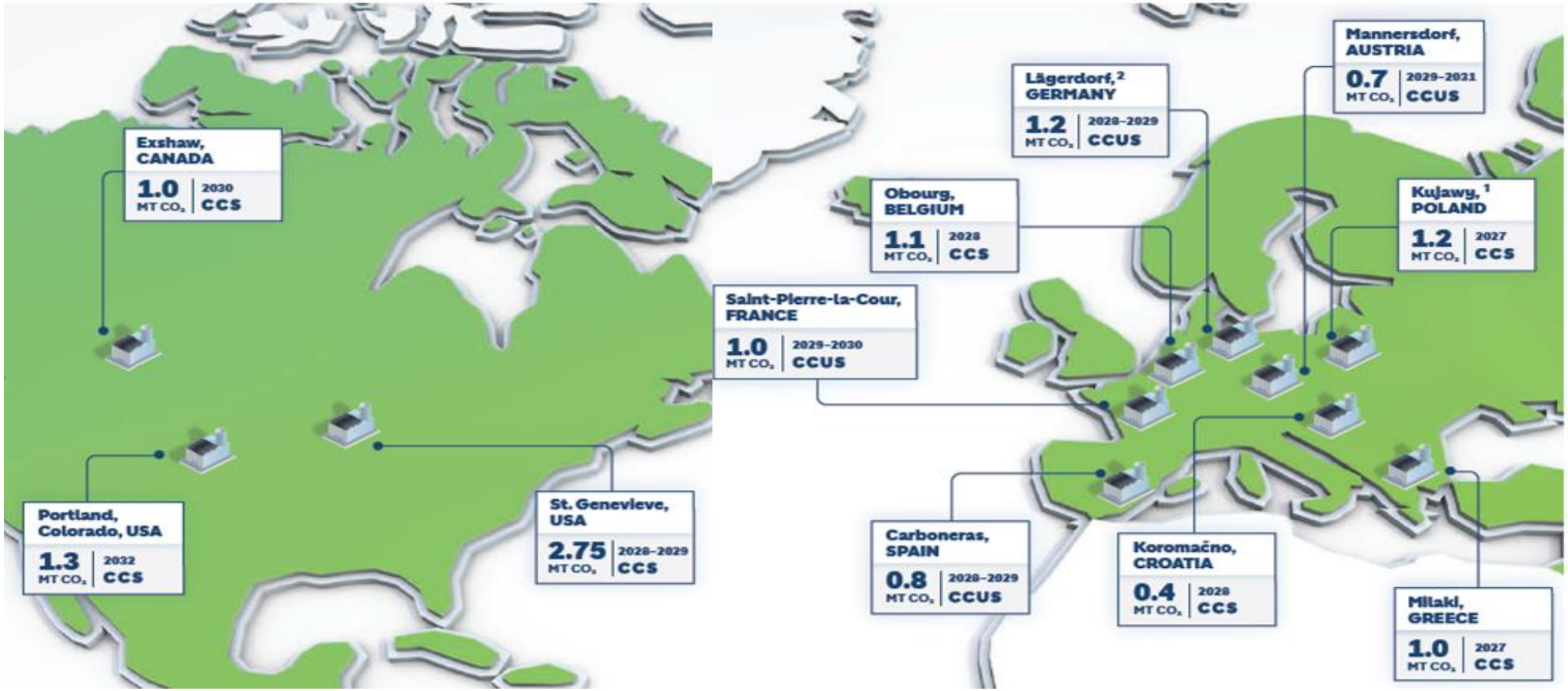
CO_2 Preisentwicklung
01.01.2019 – 14.09.2022

7. Wo wird in CCU/CCS investiert?

OVER 50 CCUS PROJECTS

CHF 2 BILLION CAPEX BY 2030 TO CAPTURE MORE THAN 5M TONS OF CO2/YEAR

11 FLAGSHIP PROJECTS TO START CAPTURING +5 MT CO2 BEFORE 2030
From storage and utilization, including mineralization and carbonation

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