

C²inCO₂

Calcium Carbonation for industrial use of CO₂

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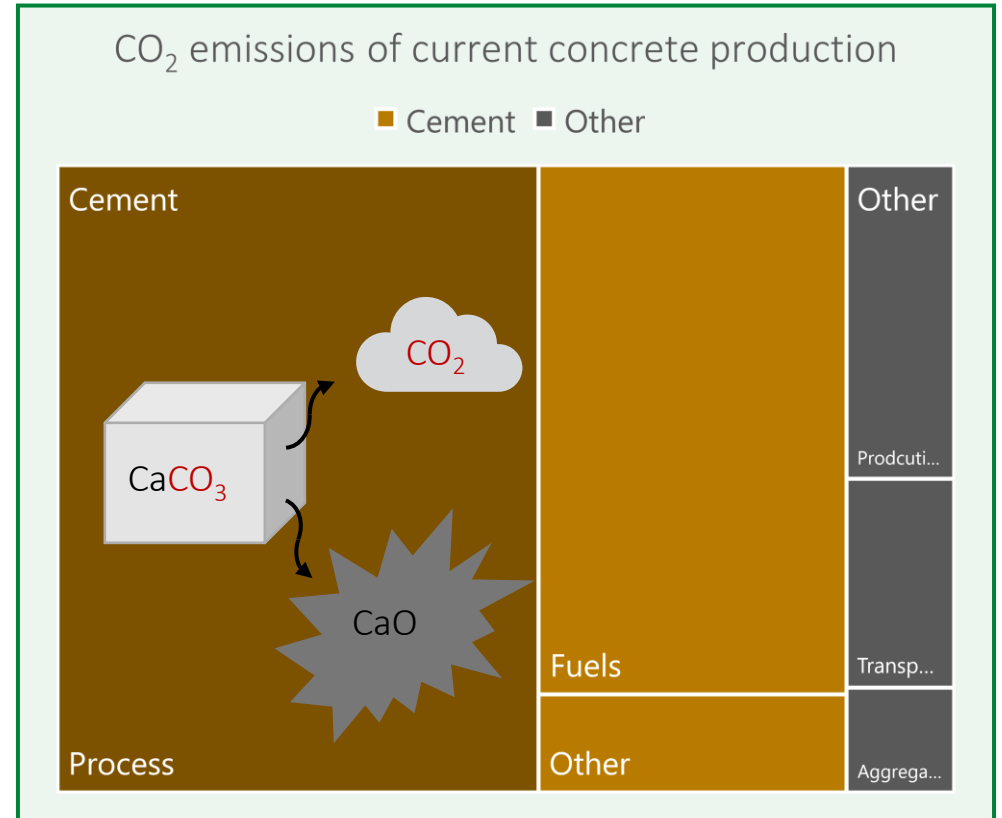
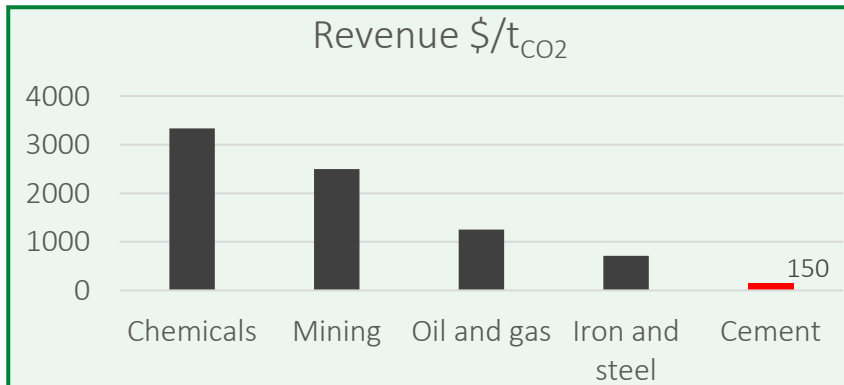
Our goal is to realize
carbon neutral concrete
by 2050 at the latest.



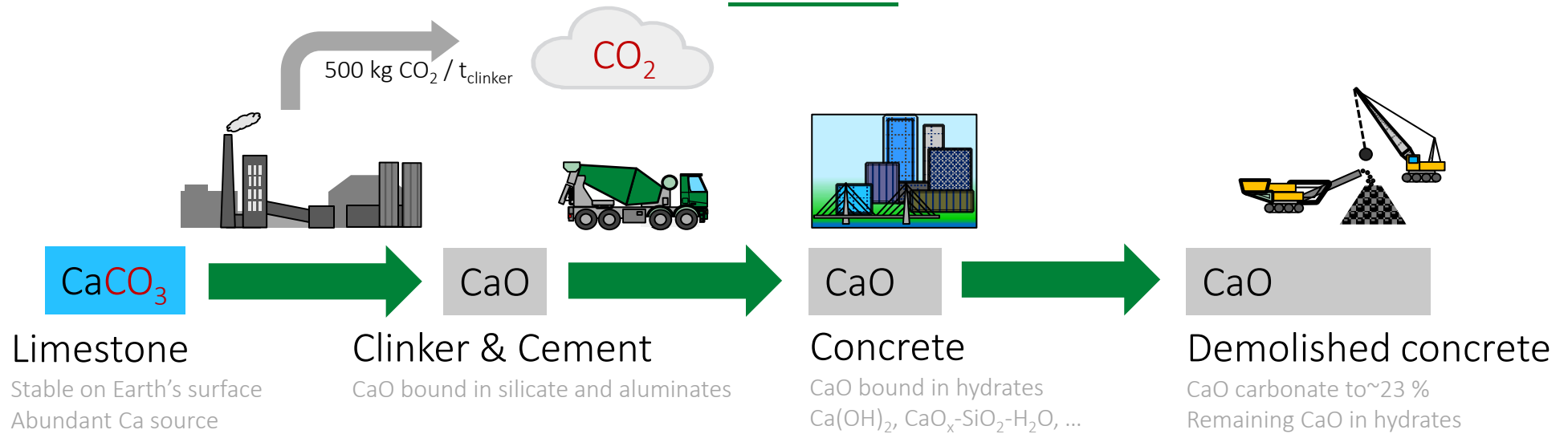
CARBON
NEUTRAL

Huge economical and technical challenges to reduce CO₂ emissions

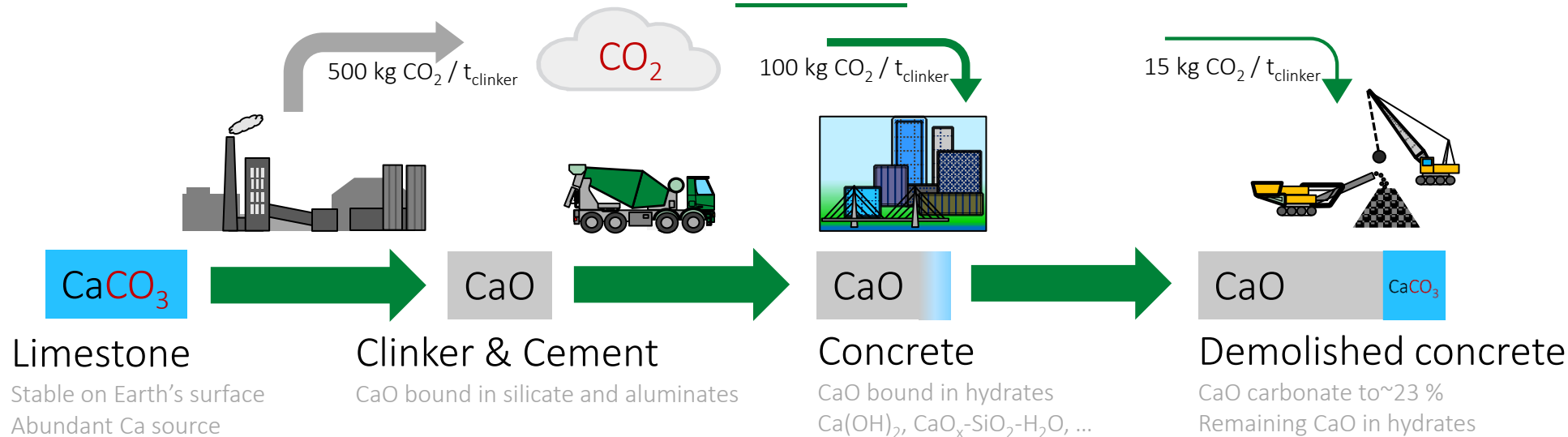
- Most of concrete CO₂ emissions originate from cement, resp. clinker production
- About 500 kg CO₂/t_{clinker} originates from limestone (=process emissions)
- Process emission cannot be avoided at scale for reasonable costs



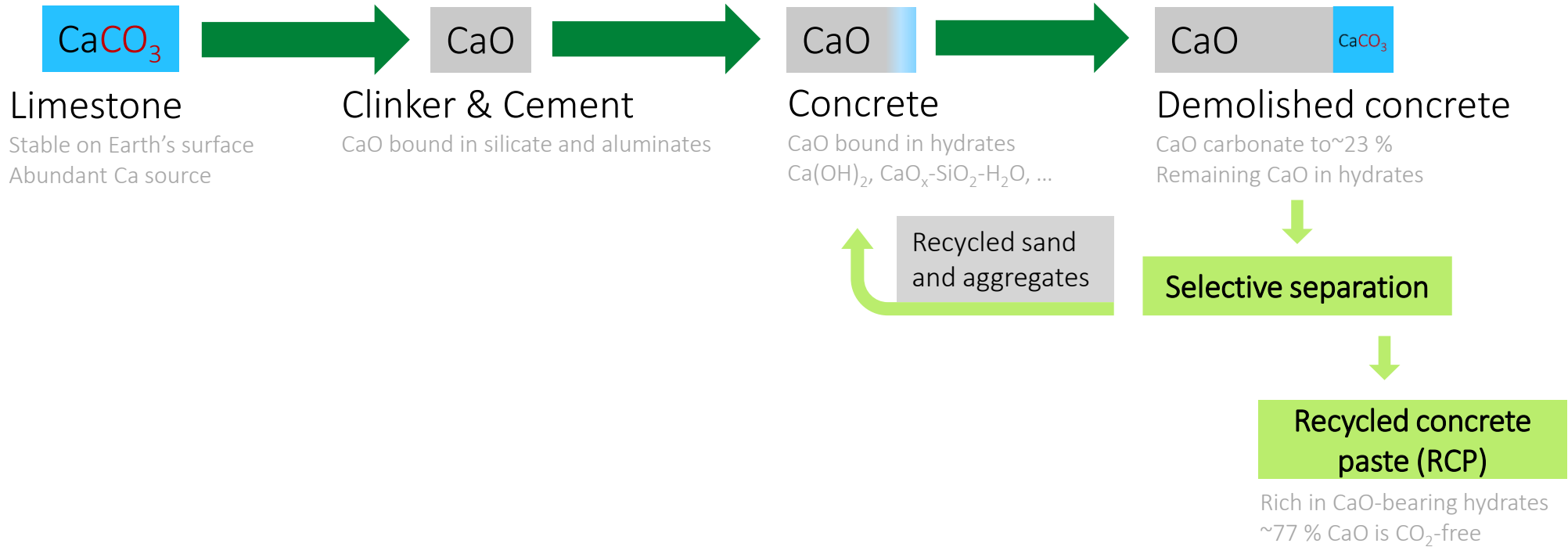
Concrete at end of its service life is a large source of decarbonated CaO



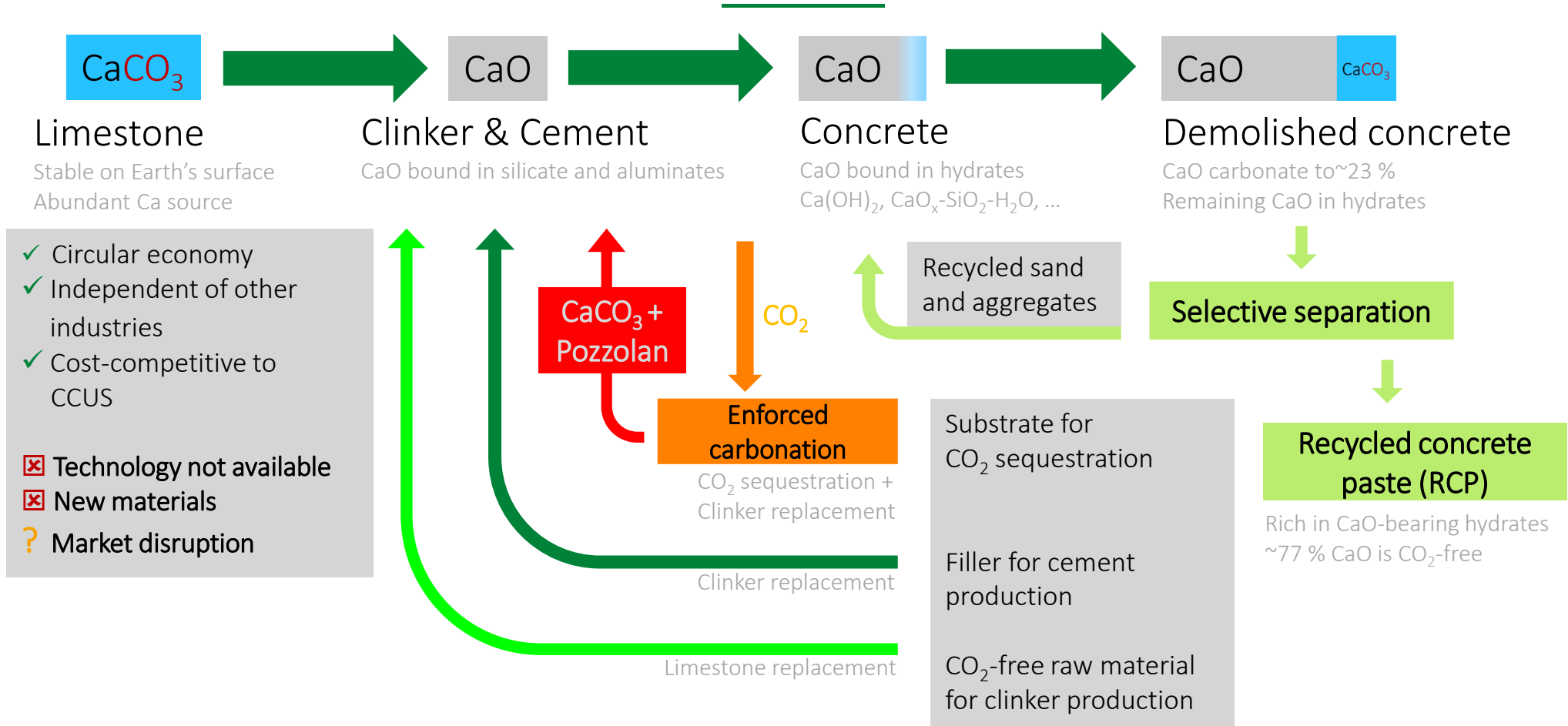
CaO in concrete spontaneously binds CO₂ when in contact with air



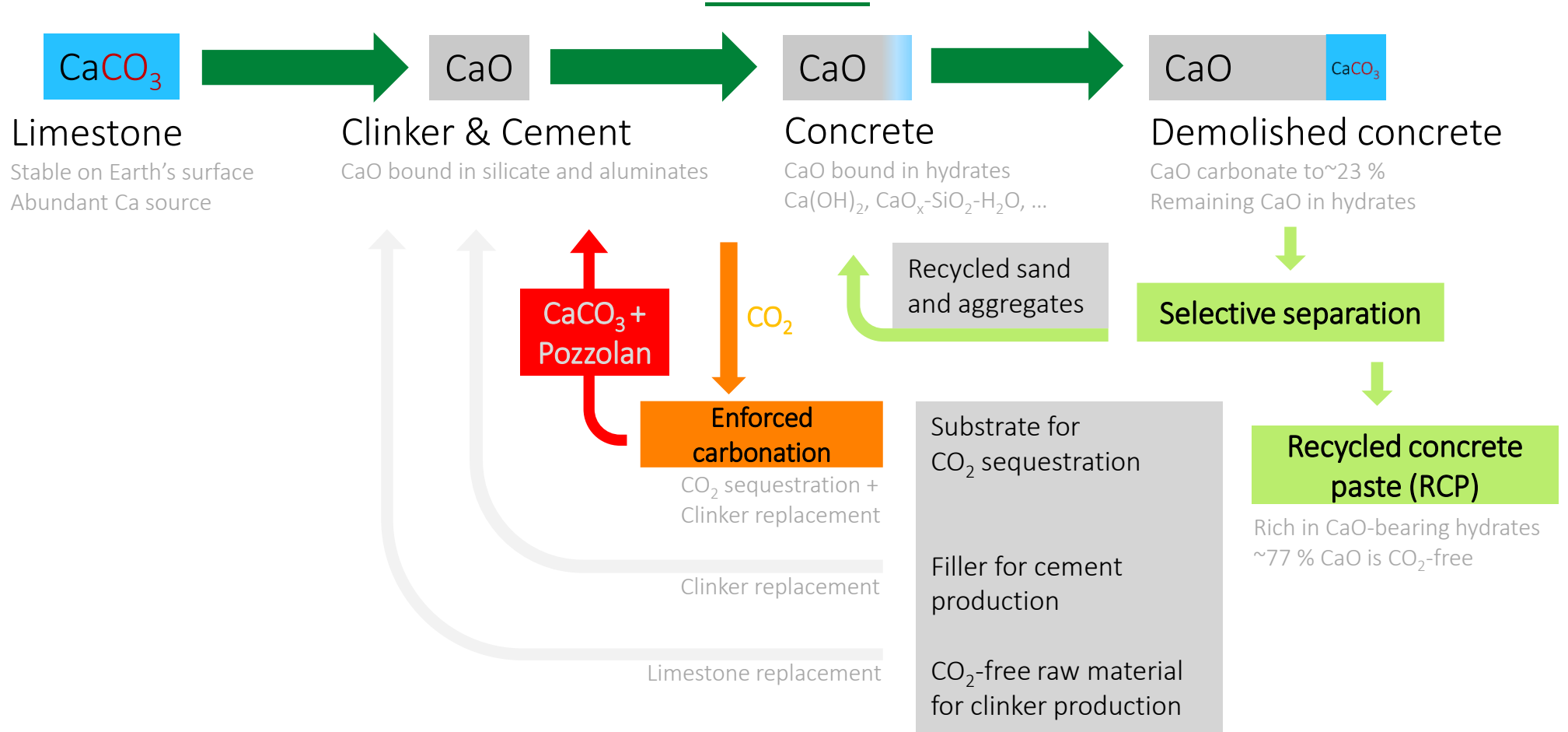
About 80 % of CaO remains available for CO₂ reduction



Recycled concrete paste can be used in clinker and cement production



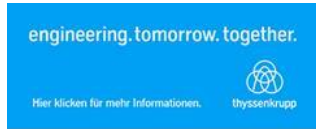
Recycled concrete paste can be used in clinker and cement production



C²inCO₂ = largest project in the call – 6 M€

HEIDELBERGCEMENT

Coordinator, materials, trials



Carbonation
Combined processes



Separation



Admixture technology
(associate partner)



Materials' performance

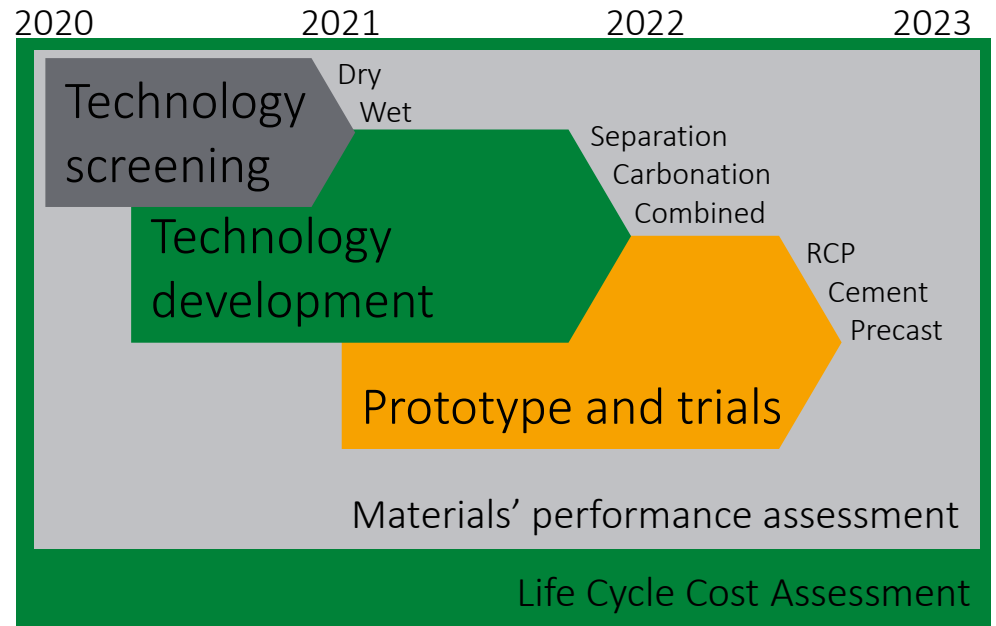


Separation, design integration



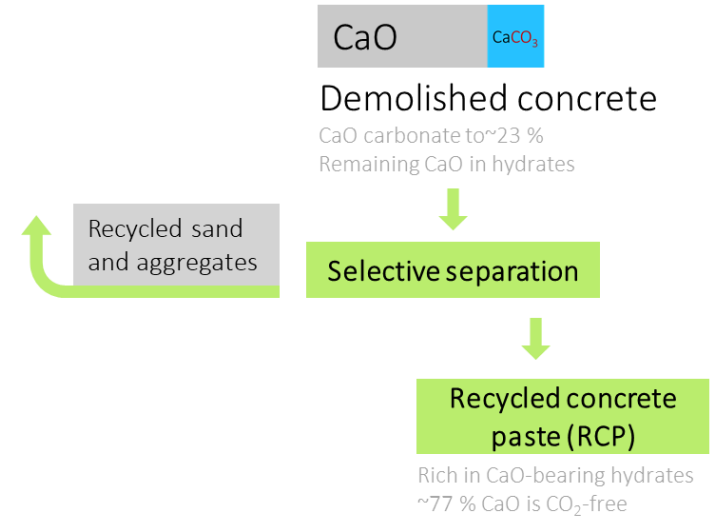
LCCA

Project kicked-off in February 2020, runs until Q1 2023



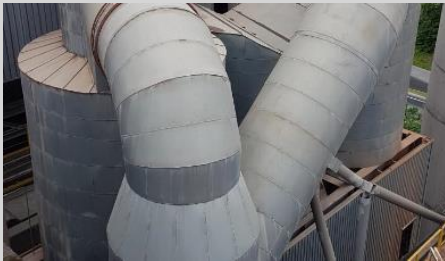
Selective separation

- ✓ **Mechanical treatment with low energy demand suitable**
→ Low-pressure attrition-driven in-bed comminution highly effective
- ✓ **RCP yield of up to 80 % and purity of up to 80 % possible**
- ✓ **Removing RCP improves quality of recycled aggregates and sand**
→ RA and RS can replacement of up to 100 % without changing mix design and compromising concrete workability and strength
- ▶ **Further technology developments in C²inCO₂**
 - VRM by Loesche
 - HPGR by tkIS
 - Separation and sorting by AMR RWTH
 - VSI pilot in Berlin by HC
- ▶ **Assessment of recycled sands for concrete production planned at Uni Weimar**



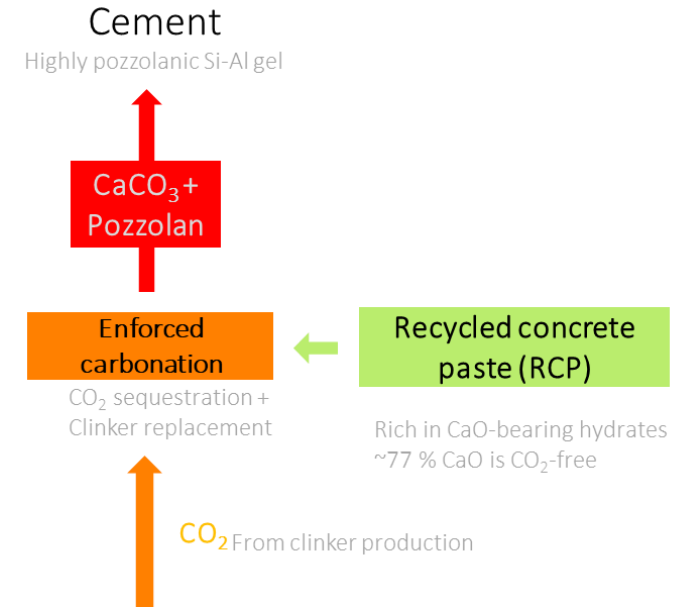
Enforced carbonation = Carbon Capture and Utilization using RCP

- ✓ Thermodynamically feasible CO₂ mineralization into calcite
 - Fast kinetics, exothermic, ambient pressure and T suitable
 - 80 % of process emissions mineralized in 30 minutes
- ✓ Robust to reaction and material conditions
 - Raw kiln gas can be directly used
 - Demonstrated at full scale in HC plant in Brevik



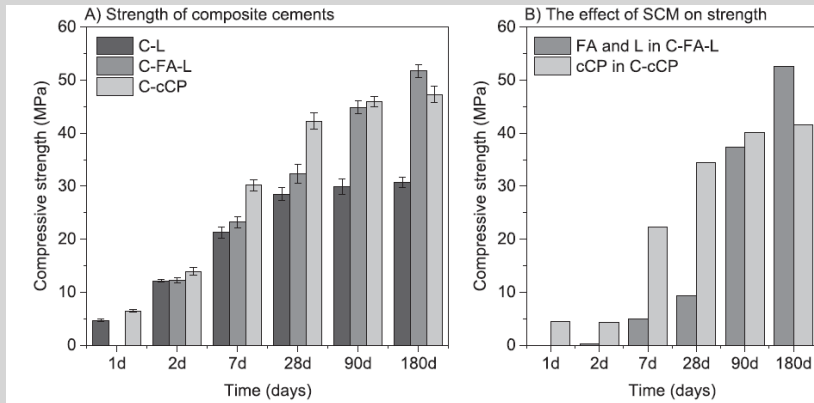
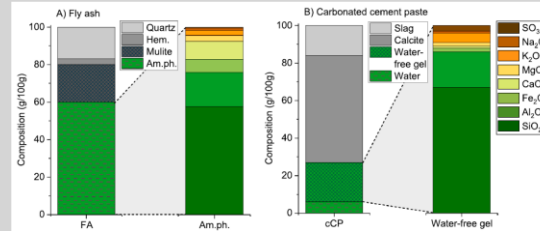
<https://blog.heidelbergcement.com/en/ccu-brevik-norcem-recycled-concrete>

- ▶ Mobile technology and combined selective separation/carbonation technology under development in C²inCO₂ (tkIS, AMR RWTH, Loesche)

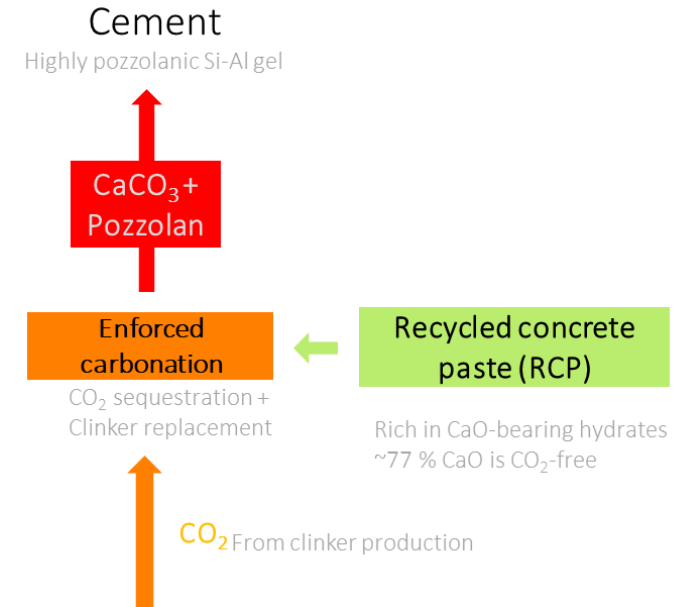


Enforced carbonation = Carbon Capture and Utilization using RCP

- ✓ Si-Al gel formed is a suitable pozzolan
 - Chemically similar to siliceous FA glass
 - Well known reaction products
- ✓ Gel-like structure with high surface area
 - Reaction kinetics similar to silica fume
 - Contributes to strength already at 1 day

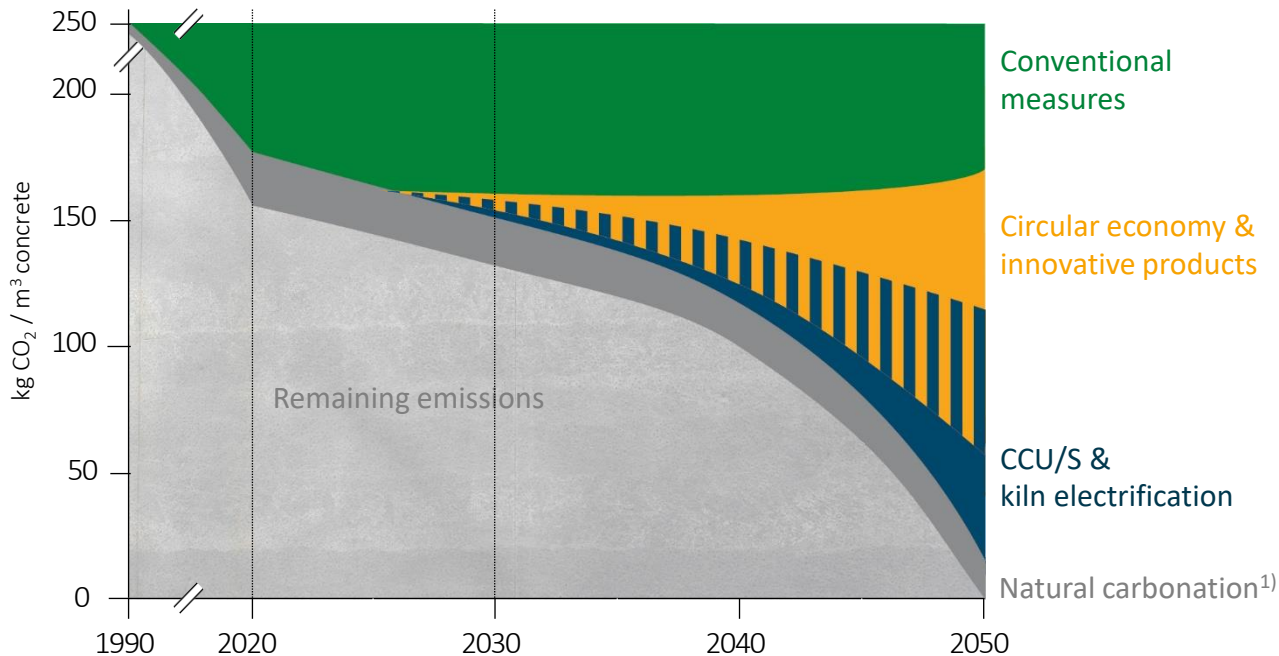


- Hydration studies and cement development running at Uni Weimar & supported by Sika



C²inCO₂ is an important foundation of decarbonization plans

Our approach to carbon neutrality



Circular economy & innovative products

- Recycled materials ([recycled aggregates](#), [recycled concrete paste as raw material](#))
- Alternative cementitious materials (e.g. calcined clay, [carbonated recycled concrete paste](#))
- Low carbon clinker types (example: Ternocem, CSA)
- Low carbon cement types (example: MultiComponentCement – CEMII/C-M)

CCU/S & kiln electrification

- Carbon Capture & Usage (high protein animal feed, manufacture of fuels, [carbonates](#) and chemicals)
- Carbon Capture & Storage (amine scrubbing, Oxyfuel technology, LEILAC)
- Hydrogen & kiln electrification projects

1) Natural carbonation is the absorption of CO₂ from the atmosphere during the lifetime of a concrete construction

BMBF funded project C²inCO₂

Key technologies

- Advanced concrete recycling
- Concrete enforced carbonation
- Novel concrete products utilizing resulting materials

Main objectives

- Develop Carbon Capture and Utilization technology based on enforced carbonation of demolished concrete and re-use of recycled aggregates, sand and carbonated concrete paste in concrete and cement production, respectively
- Demonstrate applicability at industrial scale and evaluate its LCA/LCCA

Funding

- Total project budget: 5.85 Mio. €
- Total max. BMBF contribution: 3.17 Mio. €
- HC project budget: 1.90 Mio. €
- HC max. BMBF contribution: 0.74 Mio. €

Time frame

- Project duration: 36 months
- Start: February 2020
- End: January 2023

Project partners

HEIDELBERGCEMENT — Coordinator, materials, trials —



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Admixture technology
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Materials' performance



Separation, design integration



LCCA

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MATERIAL
TO BUILD OUR FUTURE

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