European Union side events

CARBON4MINERALS

6 December 2023

Energy-intensive industries: Innovative technologies toward climate neutrality

Carbon4Minerals, Liesbeth Horckmans, VITO

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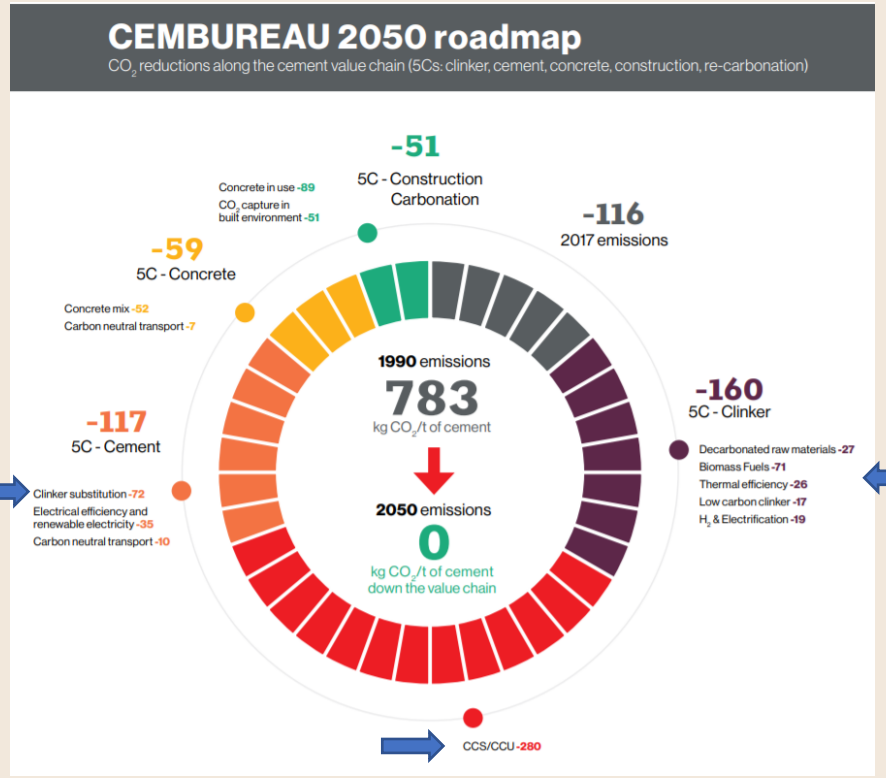
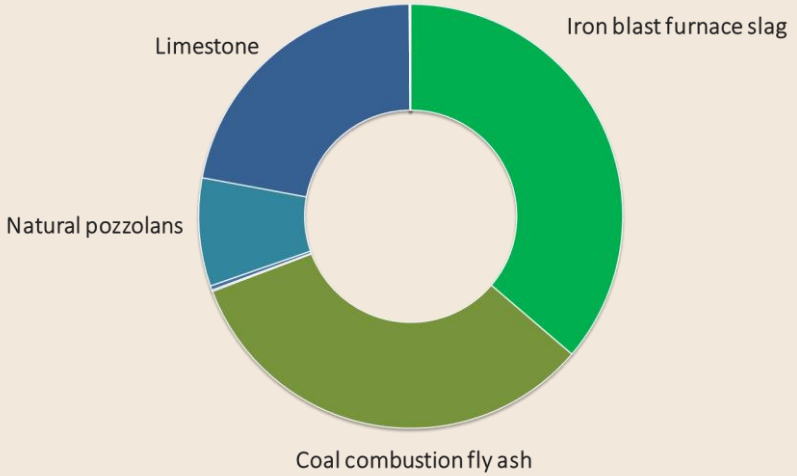
Decarbonisation of cement industry



CEMBUREAU 2050 Roadmap,
https://lowcarboneconomy.cembureau.eu/

Supplementary Cementitious Materials (SCM) use 2016

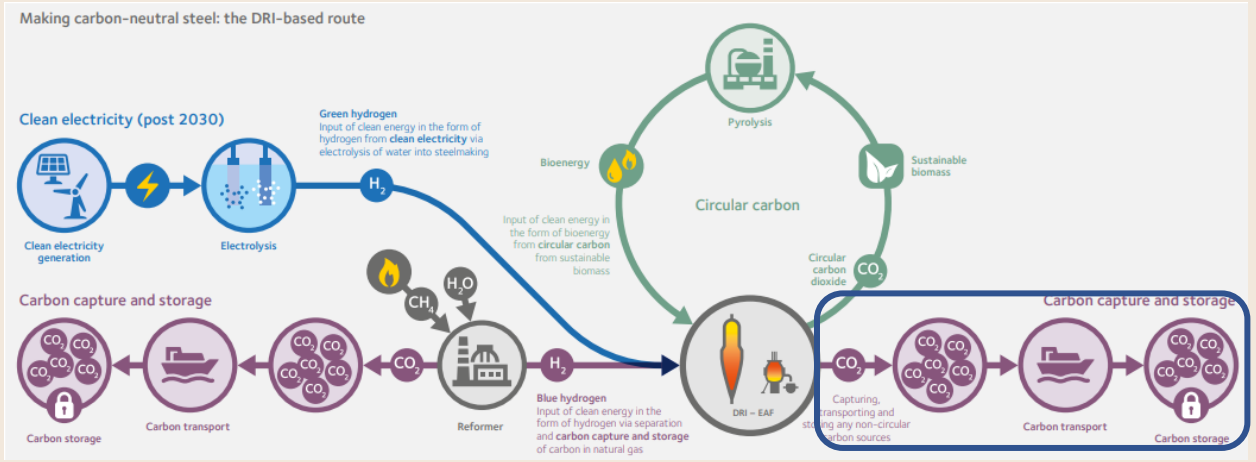


Total: 900 Mt/y; 75% clinker in cement; 2050 target: 65% clinker

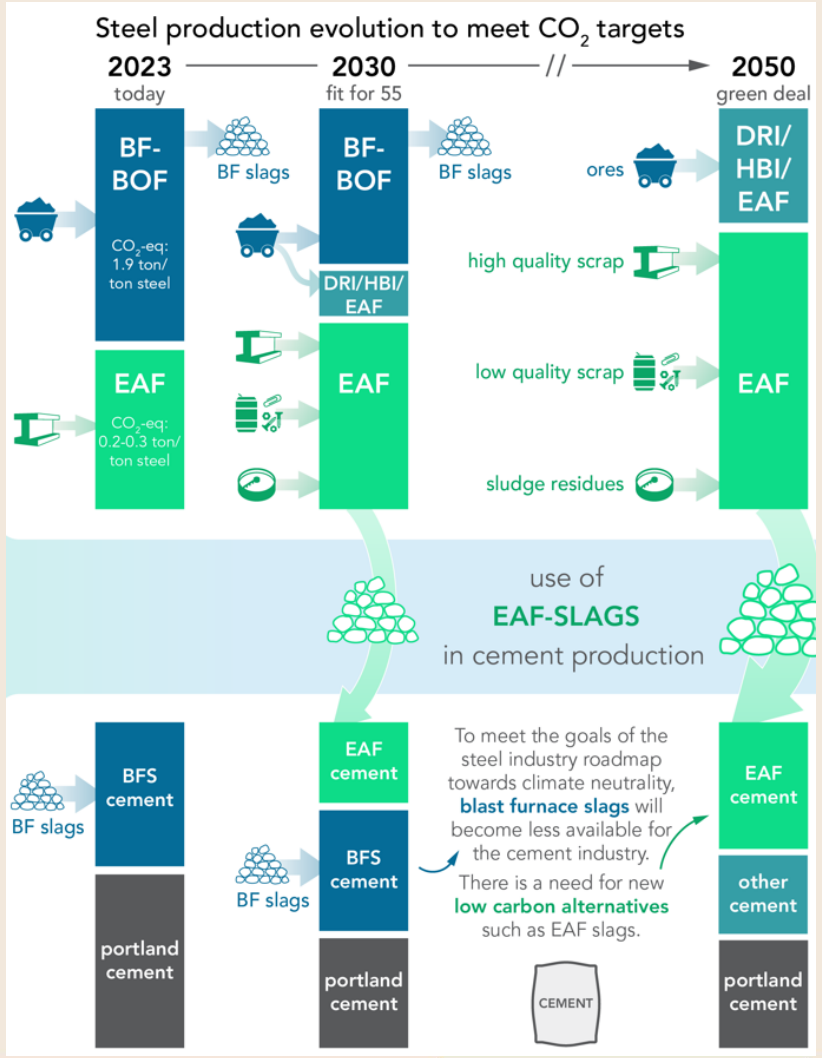
- Cement industry responsible for 6-8% of global GHG emissions, Portland clinker has high CO_2 impact (0.89 t CO_2/ton clinker)
- Alternative materials (SCMs) with lower CO_2 emissions needed to reduce clinker content but traditional SCMs fully used and in decline
- Costly CCU/CCS to close the gap

Decarbonisation of steel industry

- **Steel industry moving towards electrification**
  - Reduction of blast furnace (BF) slags (common SCM)
  - Increase of other steel slags (BOF, EAF)
- CCU/S to fill the gap



https://corporate.arcelormittal.com/sustainability/climate-action-in-europe



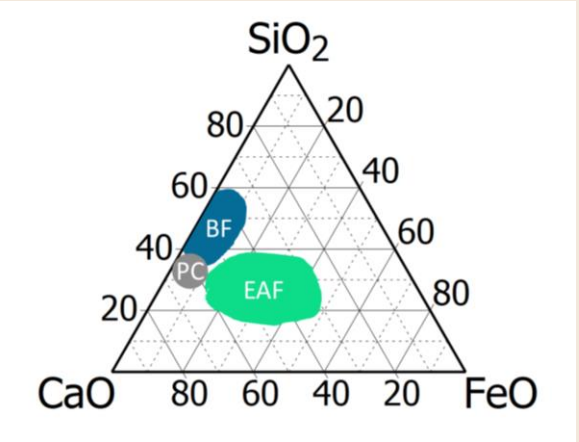
Carbonation as pre-treatment for SCMs

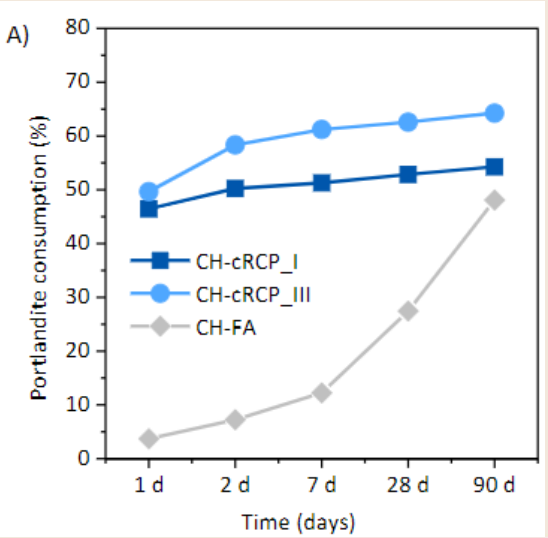
- EAF/BOF slags need treatment to ensure good technical properties:
  - Reduce free lime (CaO) content to avoid expansion & pop-outs
  - Increase reactivity to create sufficient strength

- Carbonation as possible treatment
  - $Ca_2SiO_4 + 2CO_2 \rightarrow 2CaCO_3 + SiO_2$ (amorphous)

    Limestone filler Reactive pozzolan
  - $CaO + CO_2 \rightarrow CaCO_3$

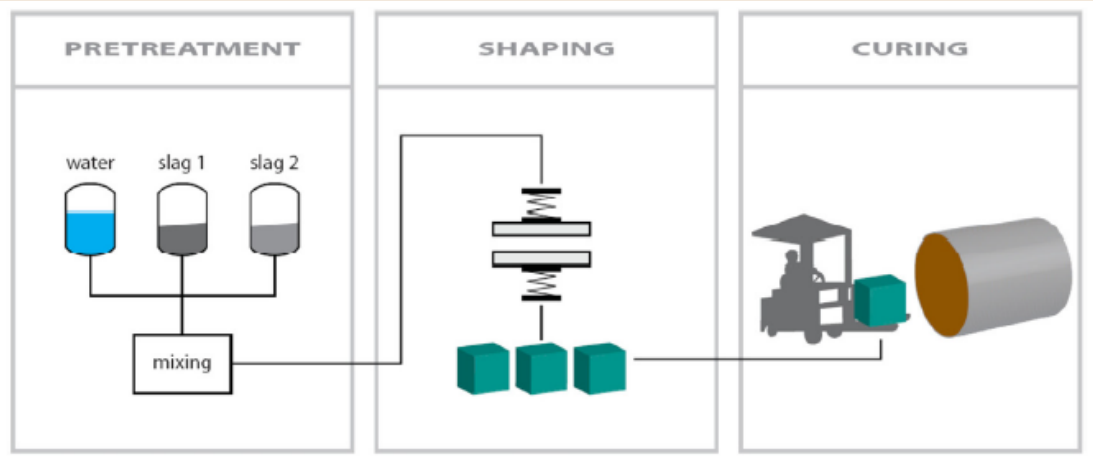
    Limestone filler





Portlandite consumption of carbonated recycled cement paste by Zajac et al. (2021), RILEM Technical Letters 6:53-60.

Carbonation to fully replace cement



Quaghebeur et al. (2015), Frontiers in Energy Research

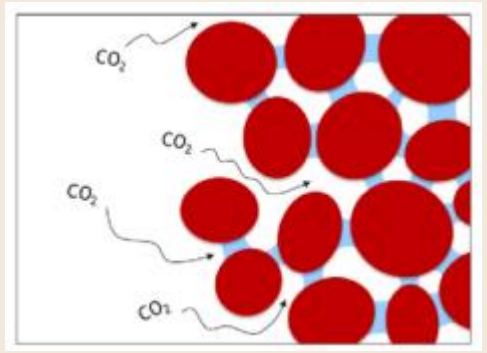
Stapsteen demonstration project Ghent, Belgium

Orbix pilot facility in Farciennes, orbix.be

$Ca_2SiO_4 + 2CO_2 \rightarrow 2CaCO_3 + SiO_2$ (amorphous)

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

Limestone binder



Nielsen et al. 2019

vandersanden.com, expected 2024

vito orbix MATERIALS - TECHNOLOGIES - SERVICES

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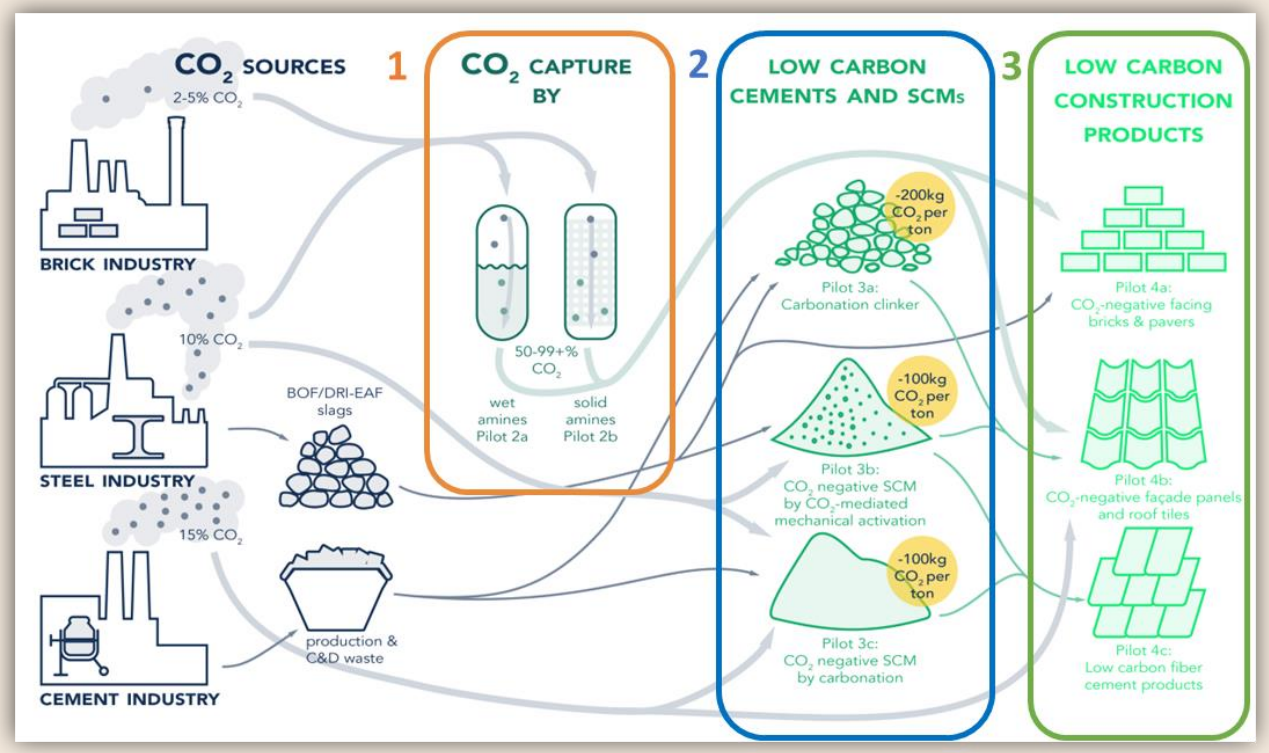
Concept

Reduce CO_2-emissions by **use of CO_2** from **industrial flue gases** to produce **innovative low-carbon binders and construction materials,** from industrial **waste streams**

Potential to reduce EU CO_2 emissions by 46 Mt/y

Start: January 2023
End: December 2026



Funded by the European Union

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1. (Post-combustion) CO_2 capture

State-of-art liquid amine absorption:

- High cost, high regeneration energy
- Corrosion, stability issue
- Large installations, economy of scale

1) 3rd generation bi-phasic solvent for liquid absorption

- Lower cost, lower regeneration temperature
- Reduced solvent degradation
- Pilot TRL 7 (10 kt CO_2/y)

2) Solid absorption with structured sorbents

- 30-50% energy reduction
- Tailored to small/medium volume
- Pilot TRL 6-7 (1 kg CO_2/h)

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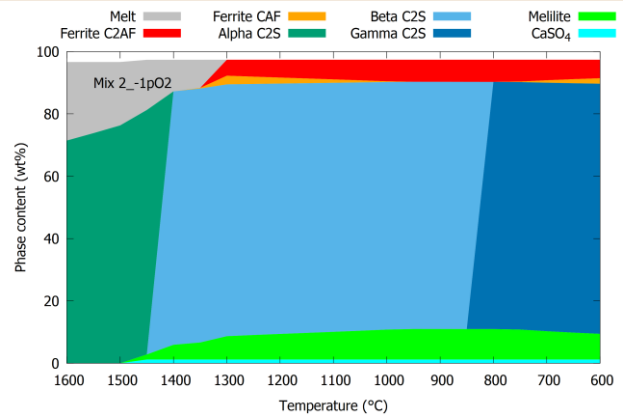
2. Low carbon cements and SCMs

Carbonation clinker

Uptake 200 kg CO_2/ton

TRL 6 demo, 1 ton/day



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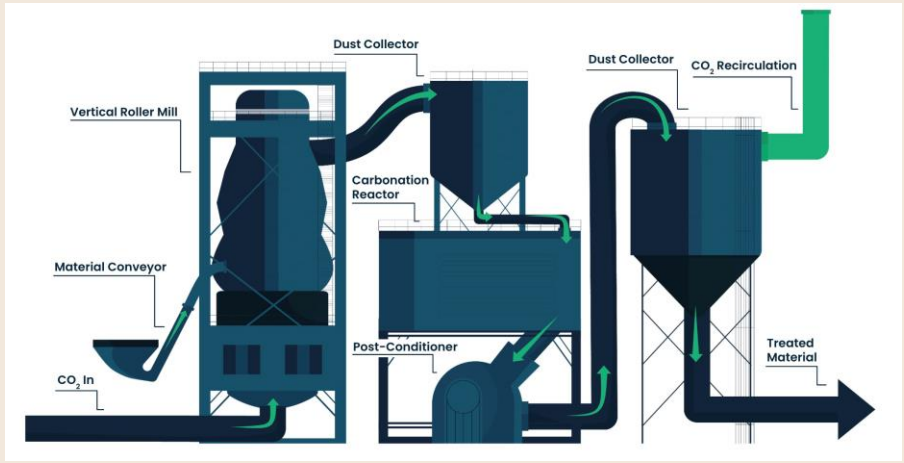
SCM by carbonation

Uptake 100 kg CO_2/ton

From steel slags

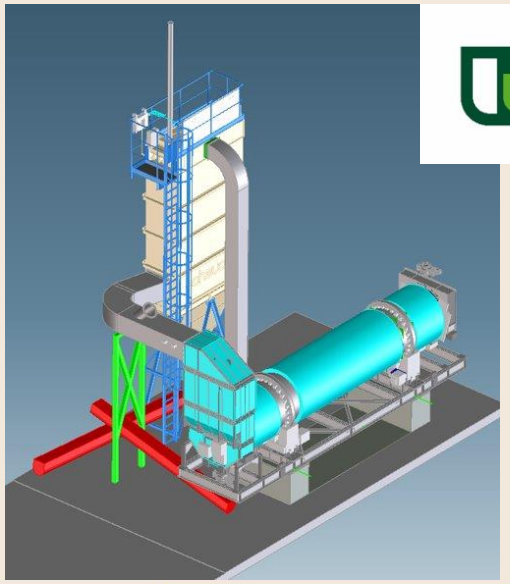
250 – 1,000kg / day pilot TRL 7

carbon upcycling



From Recycled Concrete Paste

1 ton/day pilot TRL 7

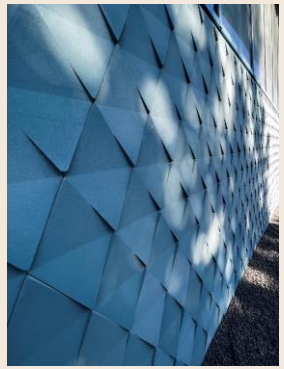


Heidelberg Materials

3. Mineral carbonation products

- Expand raw materials and products using flue gas CO_2
  - Carbonated bricks & pavers from steel slags

    TRL 7-8 production (500-2000 tonnes)



  - Precast (wet-shaped) carbonation products

    TRL 6-7 production (~500 kg)

    Using carbonation clinker & SCMs

    Façade/roof panels, fiber cement products

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Durability testing & validation of standard test methods to facilitate market uptake

THANK YOU!

Contact us: liesbeth.horckmans@vito.be

www.carbon4minerals.eu

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