INDUSTRIAL RESIDUE ACTIVATION FOR SUSTAINABLE CEMENT PRODUCTION

EXPLORING THE USE OF PROCESSED BAUXITE AS A SUSTAINABLE SUPPLEMENTARY CEMENTITIOUS MATERIAL: INSIGHTS FROM THE E REACTIV PROJECT

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CORALIS Webinar, January 21st, 2025

The research leading to these results has been performed within the ReActiv project and received funding from the European Community's Horizon 2020 Programme (H2020/2014-2020) under grant agreement n° 958208.

EU REACTIV PROJECT AT A GLANCE

Project Information

ReActiv

Grant agreement ID: 958208

DOI

10.3030/958208

EC signature date

28 September 2020

Start date

1 November 2020

End date

30 April 2025

Funded under

INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Advanced manufacturing and processing

Total cost

€ 10 455 975,36

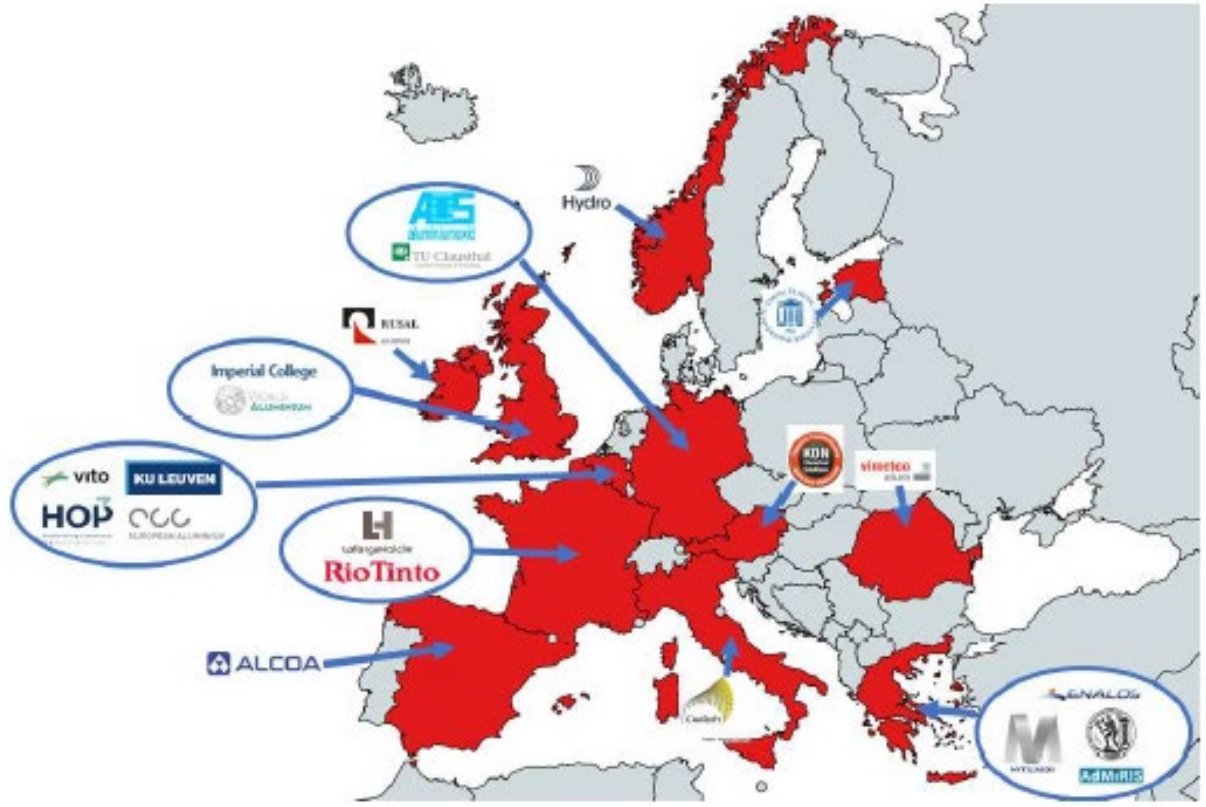
EU contribution

€ 8 807 929,38

Coordinated by

HOLCIM INNOVATION CENTER SAS

France



A consortium, consisted by a multinational cement industry, all key alumina players across Europe, and other high-level partners (academia, SMEs, Associations), which brings together the expertise required to successfully achieve the project's objectives.

EU REACTIV PROJECT: LOW CO_2 FOOTPRINT & REDUCED WASTES

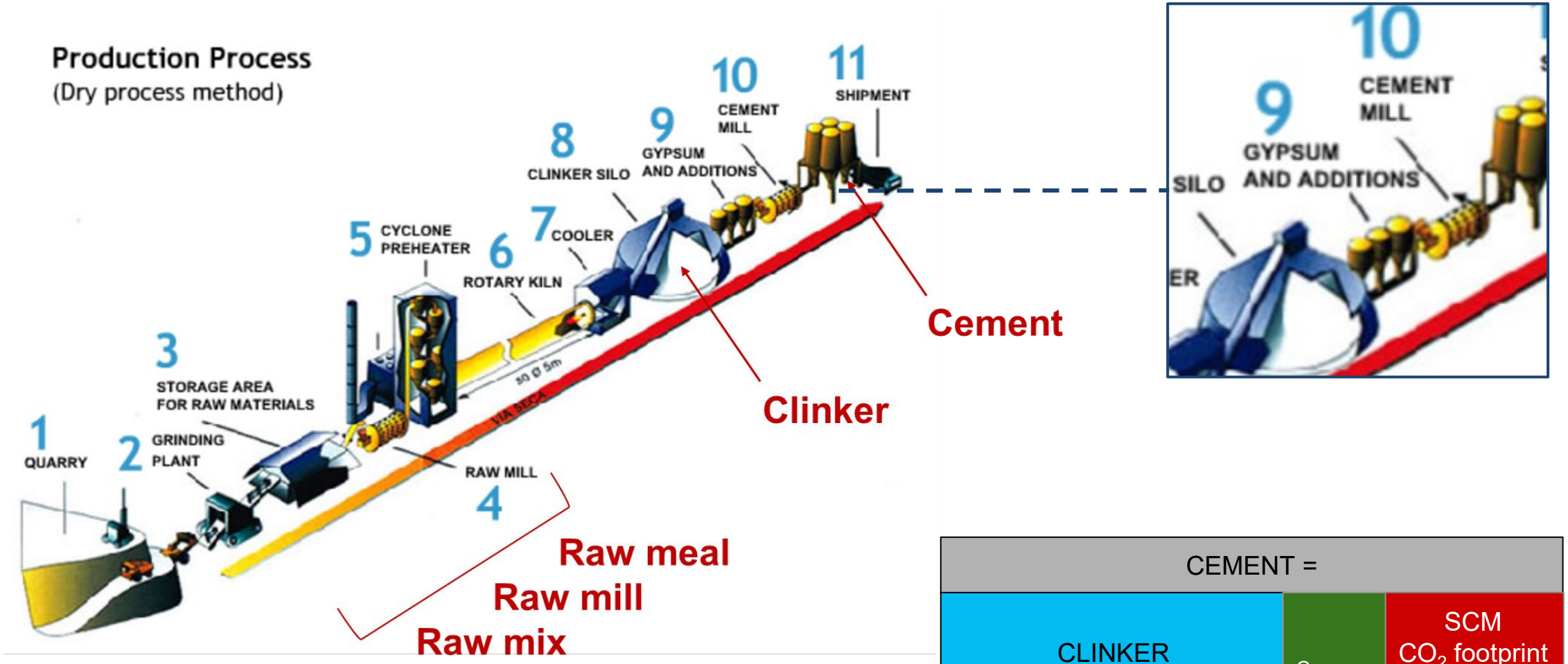
Objective

The project aims to demonstrate:

- The **conversion of Processed Bauxite into a new Supplementary Cementitious Material** (SCM) suitable for cement applications

- **Substituting up to 30 wt. % of clinker** in cement production, thereby highlighting a sustainable and resource-efficient approach.

CEMENT PRODUCTION

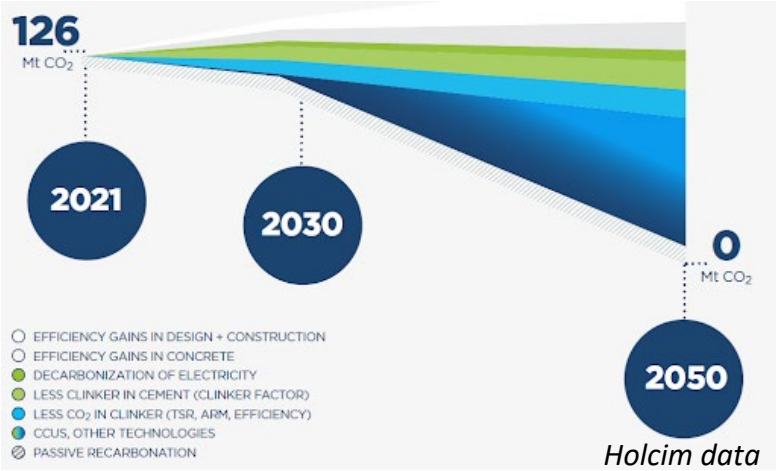


CEMENT =		
CLINKER CO_2 footprint = 800 kg/ton	Gypsum	SCM CO_2 footprint = 0-200 kg/ton

CHALLENGE OF THE CEMENT INDUSTRY

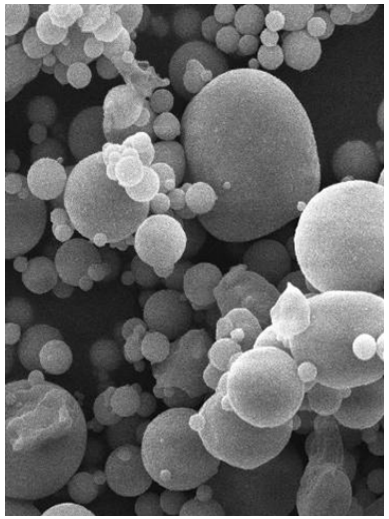
DECARBONIZATION : A MAJOR CHALLENGE FOR THE CEMENT INDUSTRY

SUPPLEMENTARY CEMENTITIOUS MATERIAL (SCM): A PILLAR OF THE STRATEGY TO REDUCE CO2 EMISSIONS



Holcim data

CURRENT SCM'S ARE BECOMING SCARCER AND SCARCER



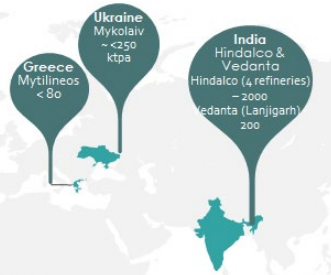
NEW TYPES OF SCM'S REQUIRED

CHALLENGE OF THE ALUMINA INDUSTRY

ALUMINA PRODUCTION GENERATES ON AVERAGE 1.23 TON OF PROCESSED BAUXITE PER TON OF ALUMINA

MAINLY LANDFILLED

LOW CIRCULARITY – ONLY 3-4 % VALORIZED IN CLINKER PRODUCTION

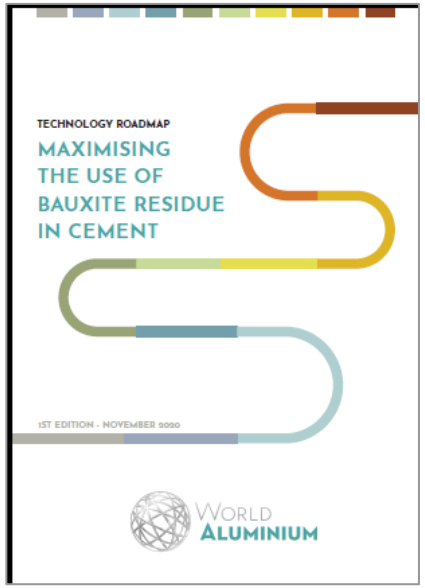


6 mio TONS/Y PRODUCED IN EUROPE

160 mio TONS/y PRODUCED WORLDWIDE

+ EXISTING DEPOSITS

VALORIZATION OF PROCESSED BAUXITE



HOW BOTH INDUSTRIES CAN FIND SYNERGIES ?

Alumina industry

REDUCE WASTE

&

LOWER CO_2 FOOTPRINT

Cement industry

Alumina industry

REACTIVE MATERIAL (Secondary Cementitious Material)

&

PRODUCTION OF LOW CO_2 CEMENTS

Cement industry

CHALLENGING PERFORMANCES TO ACHIEVE

SAFE TO USE
BY CUSTOMERS

GOOD TECHNICAL
PERFORMANCES
Reactivity, Rheology

ENVIRONMENTALLY
&
ECONOMICALLY VIABLE

3 TRANSFORMATION ROUTES INVESTIGATED TO PRODUCE A REACTIVE SCM

WP3 800°C — Co-calcined BR & kaolinite clays

Production in c… rotary kiln

Metlen Energy & Metals

vito

Calcination pilot installed in Metlen plant (Greece)

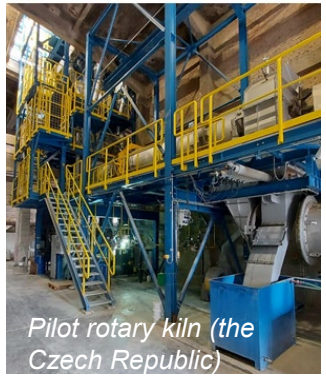
WP4 1250°C — Vitrified Bauxite Residue

Bauxite residue corrected by limestone & silica addition, and C

KU LEUVEN

HOLCIM

TECHNOPARK KRALUPY



Pilot rotary kiln (the Czech Republic)

WP5 1500°C — Smelted Bauxite Residue

Melt demixion between a metallic slag and an oxidized one

Metlen Energy & Metals

Electric Arc Furnace pilot installed in Metlen plant (Greece)

PROTOCOL OF EVALUATION OF NEW MICs AT HOLCIM

28 types of analyses and characterizations for each MIC

Health & Safety checks

- Radioactivity level
- Presence of asbestos, respirable silica or TiO_2
- Presence and level of heavy metals classifying the product as CMR
- Initial soluble Cr^{6+} content

-> an internal MSDS is established for each product

Analyses

- Chemistry (XRF, f CaO, Alk., Cl, S, insol.)
- Mineralogy (XRD)
- Particle Size Distribution
- Heat of hydration

-> as requested by CEN TR 16912 in order to prepare the standardization dossier

Performances

- Grindability
- Workability & admixture compatibility
- Setting time
- Mechanical Strength

-> as requested by CEN TR 16912 in order to prepare the standardization dossier

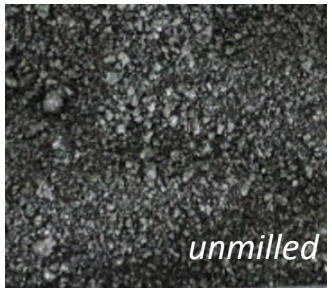
HEALTH & SAFETY EVALUATION OF OUR 3 SCM IS DONE

1st Major milestone on the way to market

WP3 Co-calcined Processed Bauxite

- Radioactivity ☑
- Soluble chromium VI ☑
- Vanadium: oxidized form ☑
- SiO_2, TiO_2 crystalline phases ☑

WP4 Vitrified Processed Bauxite



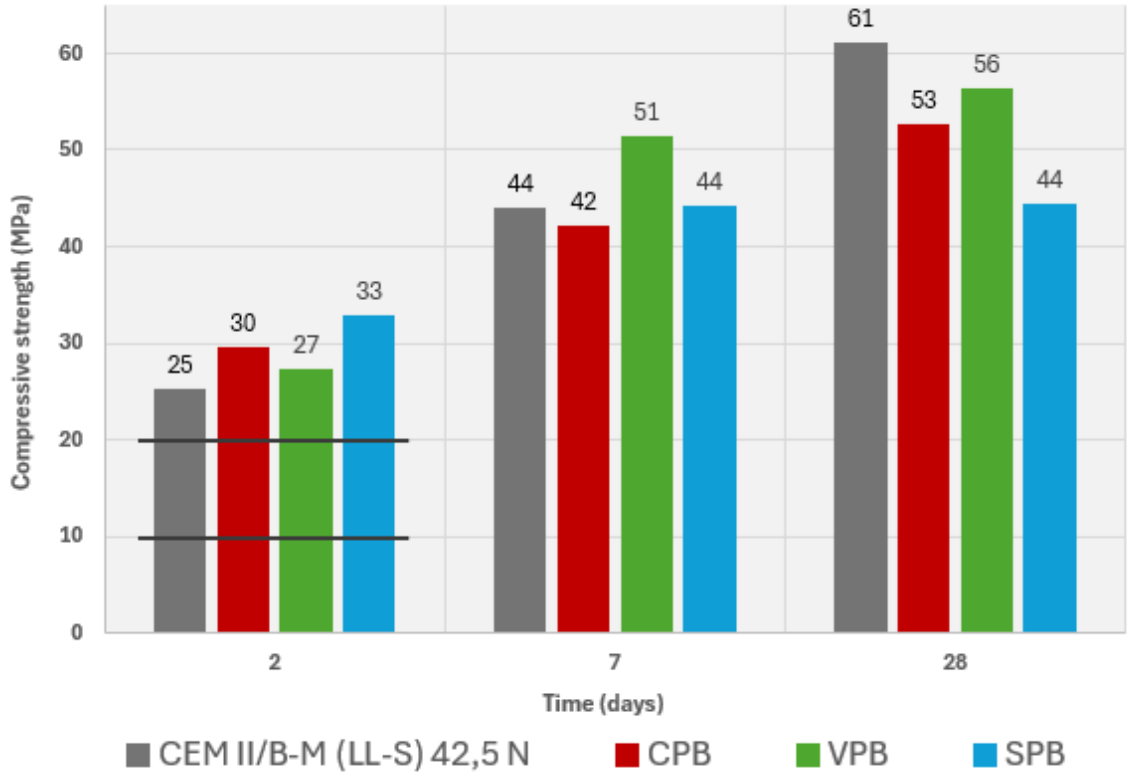
- Radioactivity ☑
- Soluble chromium VI ☑
- Vanadium: reduced form ☑
- SiO_2, TiO_2 in amorphous form ☑

WP5 Smelted Processed Bauxite

- Radioactivity ☑
- Soluble chromium VI ☑
- Vanadium: reduced form ☑
- SiO_2, TiO_2 in amorphous form ☑

ALL TESTED PERFORMANCES COMPLIANT WITH EN 197-1 SPECIFICATIONS

Performances in line with 'most used' cement class for ready-mix concrete applications



Blended cements # 70% CEM I + 30 % PB

All tested performances in line with requirements

- CS above 197-1 specifications for 42.5 N&R ☑
- Setting time within EN 197-1 specs ☑
- Good admixtures compatibility ☑
- Good workability with/without admixture compensation ☑
- Grindability performance compared to GGBFS ☑
- The 3 Processed Bauxites show high early strengths ☑

-> 2nd Major milestone on the way to market

THE 5 TONS OF CO-CALCINED PROCESSED BAUXITE PRODUCED AND TESTED AT REAL SCALE

The production at Metlen Energy & Metals in Greece

- Achieved good performances confirmed the results obtained from lab experiments

The demonstrator in HOLCIM INNOVATION CENTER

- 300 liters of concrete
- 1 slab & 1 wall
- Testing samples for c

☑

vito Metlen Energy & Metals

INITIATING THE STANDARDIZATION

A technical pre-dossier shared with EU SUSTACEM project

➢ **Setting up a dedicated Task Force**

HOP3 · HOLCIM · INTERNATIONAL ALUMINIUM · European Aluminium

➢ **Supported by the ReActiv technology providers / relevant partners**

vito · KU LEUVEN · RWTH AACHEN UNIVERSITY · IMPERIAL · UNIVERSITY OF TARTU

➢ **And the European alumina players**

Alcoa · aluminiumoxid · AUGHINISH ALUMINA · Hydro · Metlen Energy & Metals · vimetco alum · RioTinto

- A technical dossier in line with CEN TR 16912 was ready in the end of August.
- It aims to standardise ReActiv SCMs as primary constituent for **CEM II/A** and **CEM II/B**.

BAUXITE RESIDUES AS A REACTIVE SCM

The route is straight but the slope is steep

Bauxite residue not usable as SCM in cement

2020

Bauxite residue usable as SCM in cement

End of

2025

Normalized as main component

Economically & CO_2 viable solution / market acceptance

Bauxite residue based SCM cement on the market

REACTIV CONSORTIUM

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Thank you

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