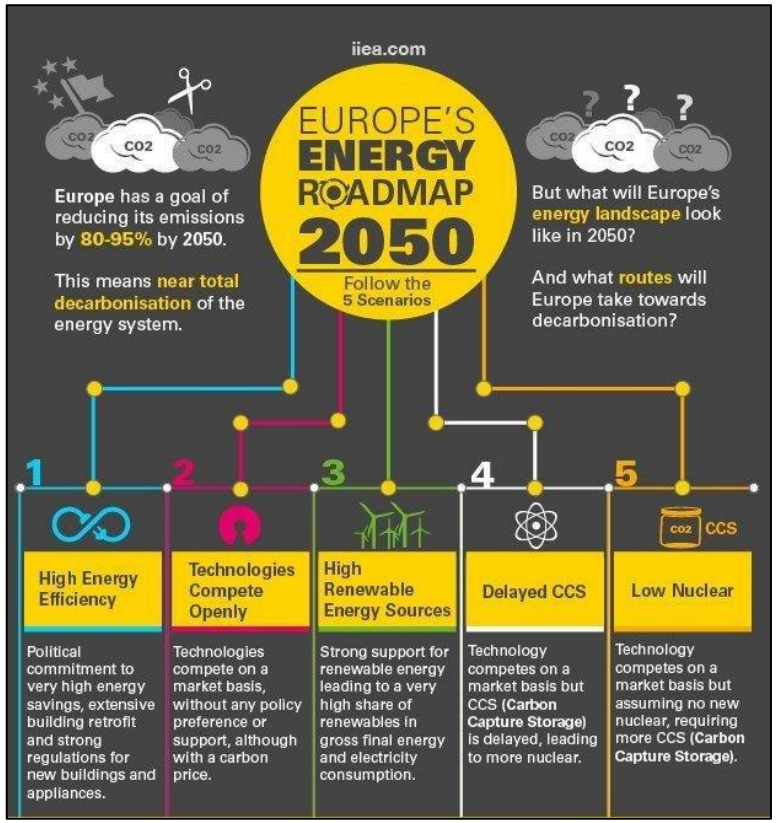

# Materials for Building and Construction

MateriNex Launch Event – 18/06/2024

/imagine “Antwerp in 2050”

/imagine “Antwerp in 2050 built with green and sustainable building materials using green energy”

# Fortunately, Europe agrees





Climate Action

**Roadmap for moving to a competitive low carbon economy in 2050**

## The EU Green Deal

The European Green Deal is about **improving the well-being of people**. Making Europe climate-neutral and protecting our natural habitat will be good for people, planet and economy. No one will be left behind.

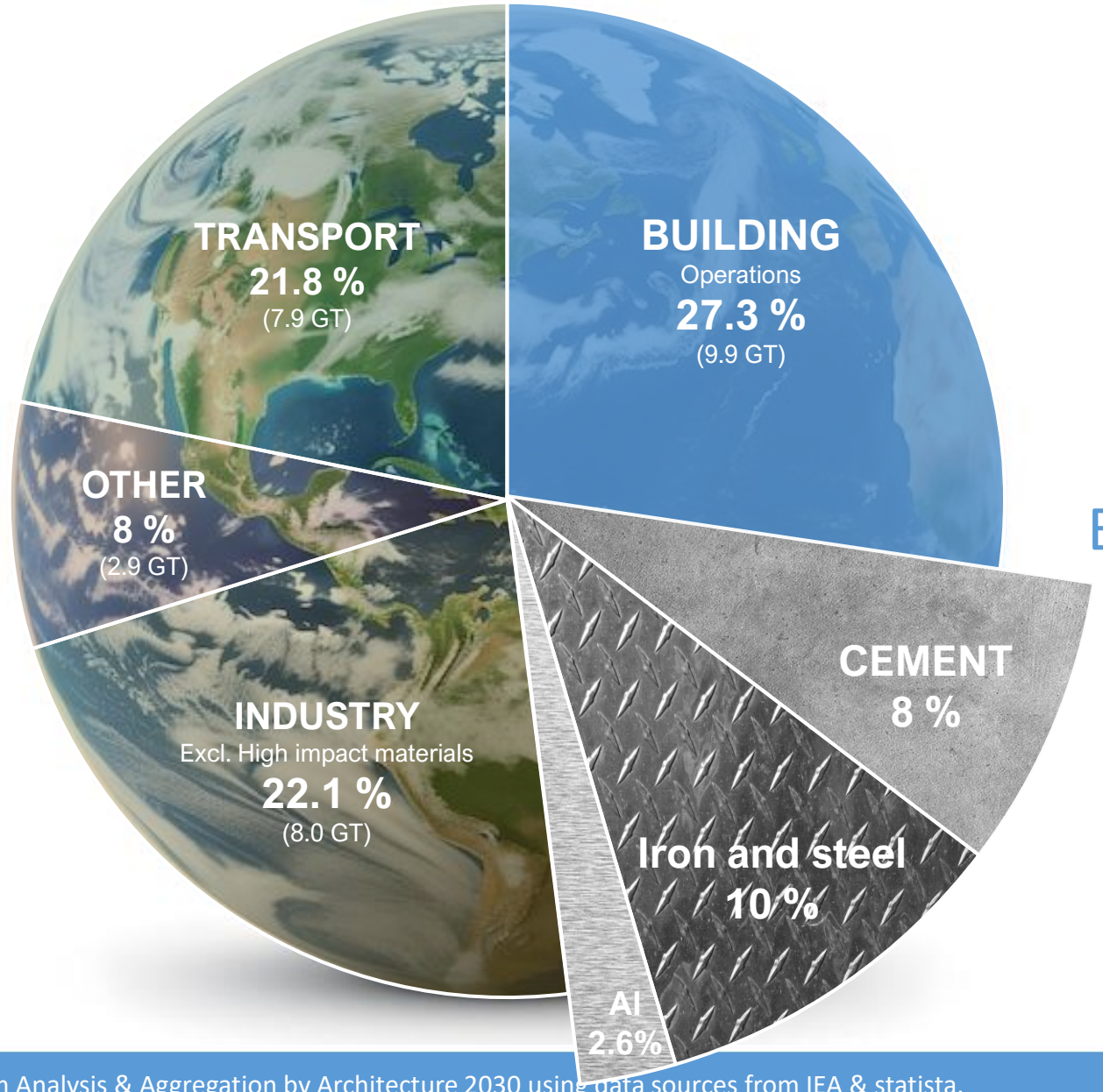
**The EU will:**

- Become climate-neutral by 2050
- Protect human life, animals and plants, by cutting pollution
- Help companies become world leaders in clean products and technologies
- Help ensure a just and inclusive transition



RESOURCEFULL

# Total annual global $CO_2$ emissions per sector




BUILT ENVIRONMENT 42%

MATERIALS 21%



Adapted from Analysis & Aggregation by Architecture 2030 using data sources from IEA & statista.

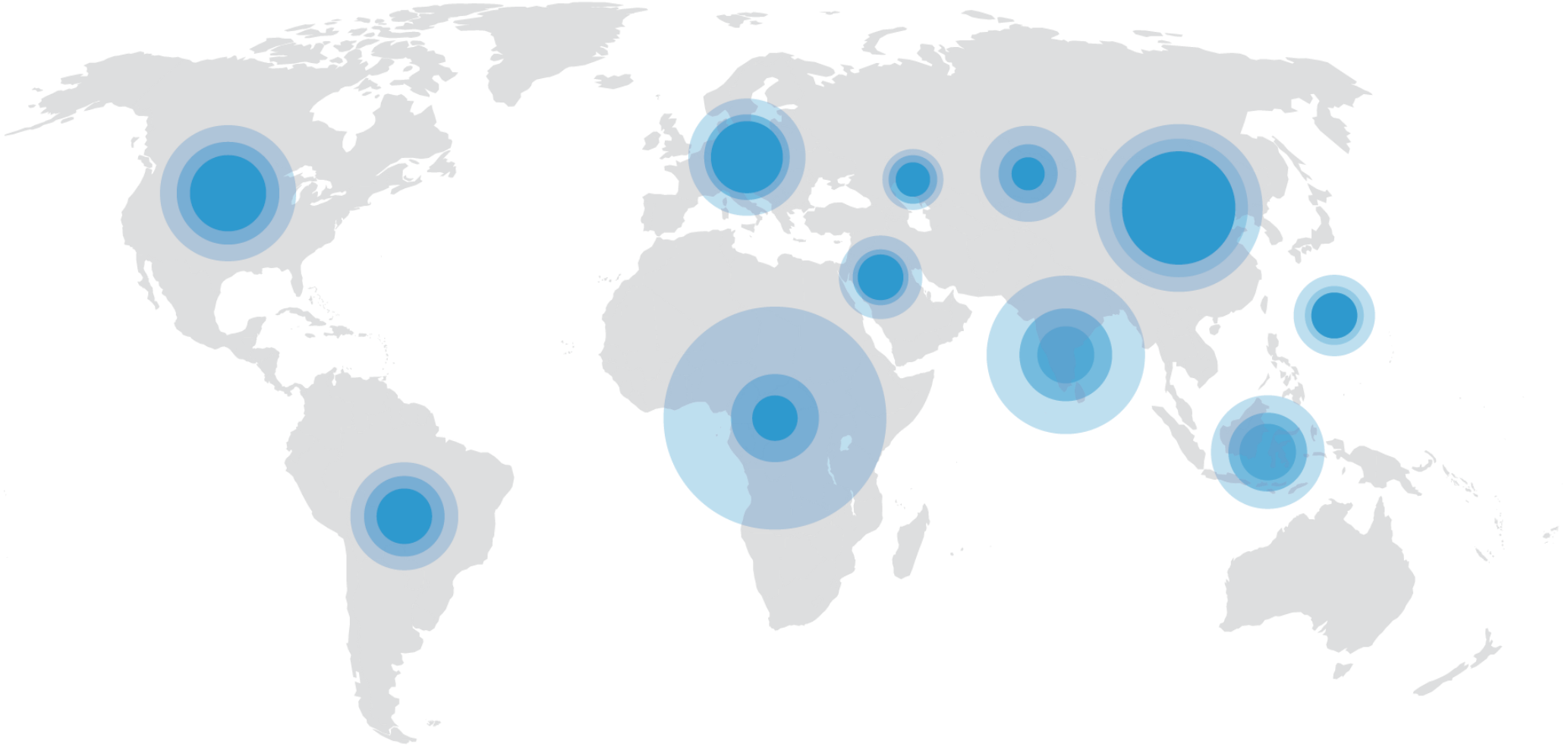
RESOURCEFULL

# EU construction sector environmental impacts at a glance



https://ecostandard.org/news_events/its-time-to-green-the-construction-sector/

# Global building floor area is expected to **double** by 2060.





RESOURCEFULL

# Construction sector:
# From environmental challenge to climate solution.

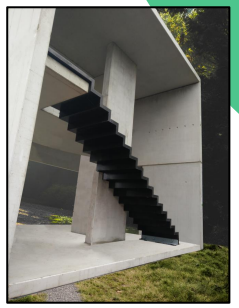
vito MATERINEX


LOW CARBON CONSTRUCTION

ENABLERS

- Tools
- Digitalization
- Regulation

RESOURCE EFFIENCY



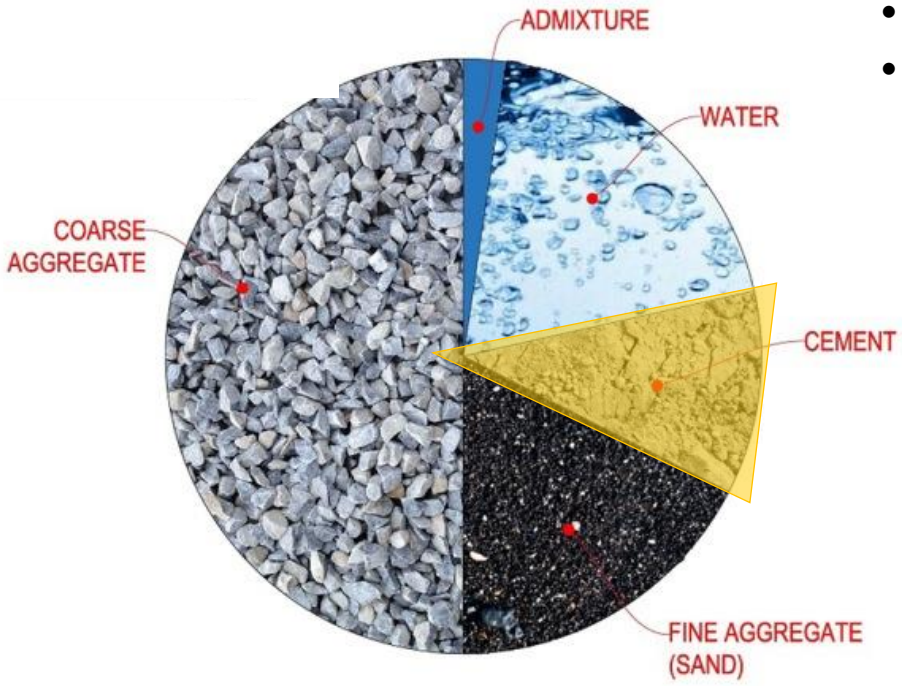


RESOURCEFULL


Enabling low impact building materials,
shoulder to shoulder with our customers.

# Concrete: the most used building material in the world

# What is concrete?




- Cement reacts with water to a strong, durable, binder
- Can be made with local, abundant, cheap materials
- Compatibel with steel
- Reacts at room temperature

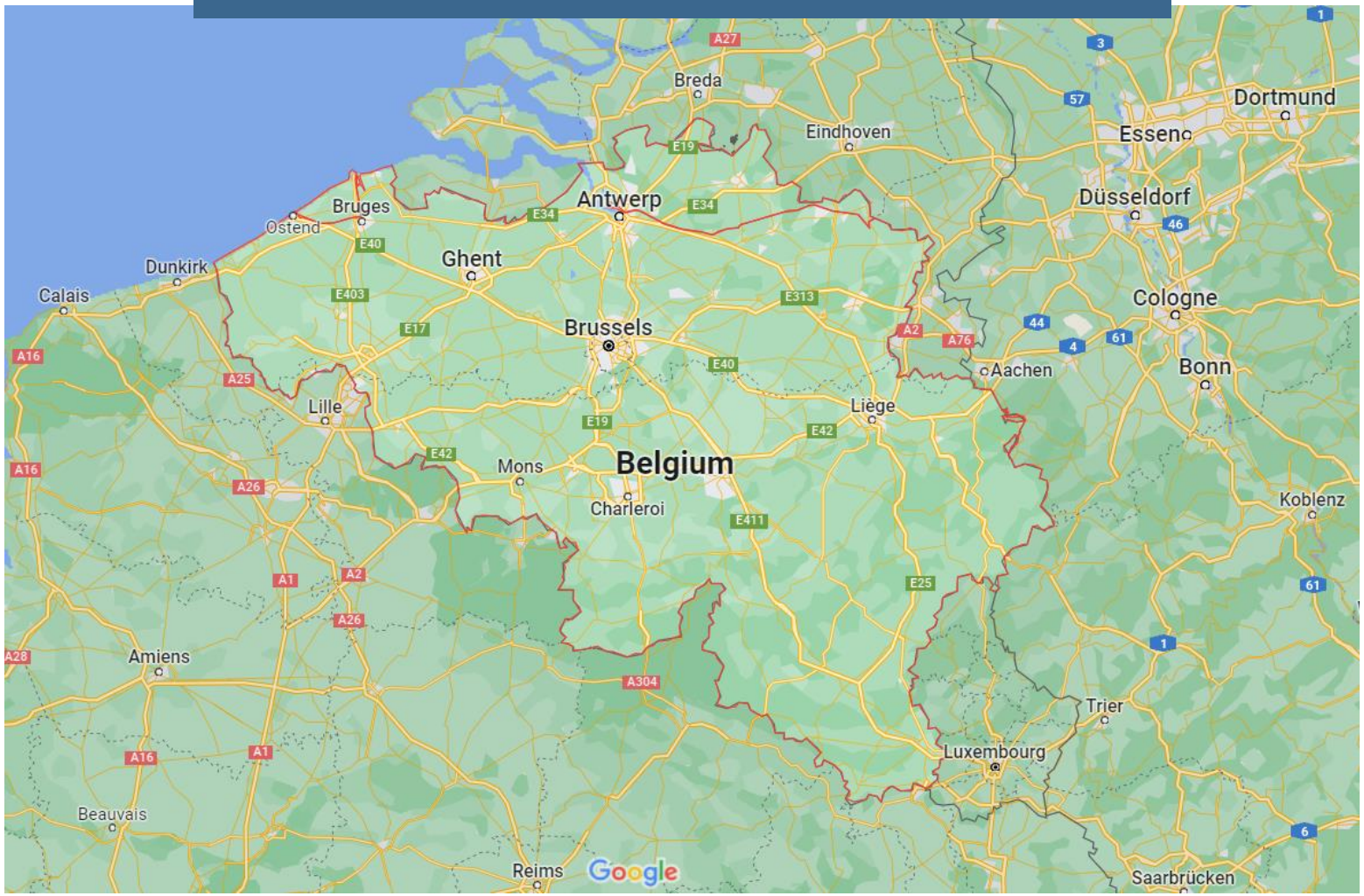
Most used construction material in the world

**12.500.000.000** $m^3$ per year



RESOURCEFULL

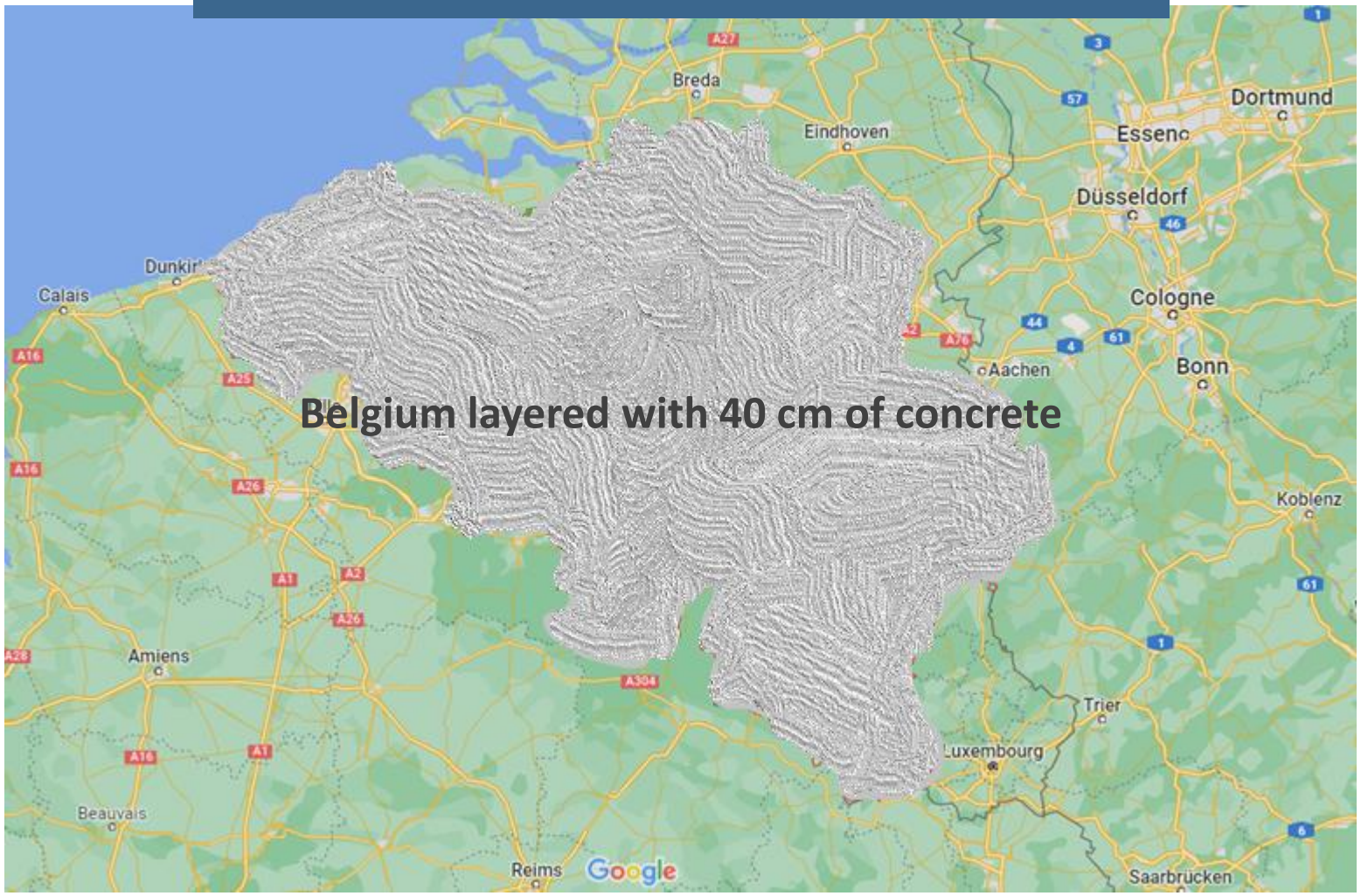
# **12.500.000.000** m³ per year






RESOURCEFULL

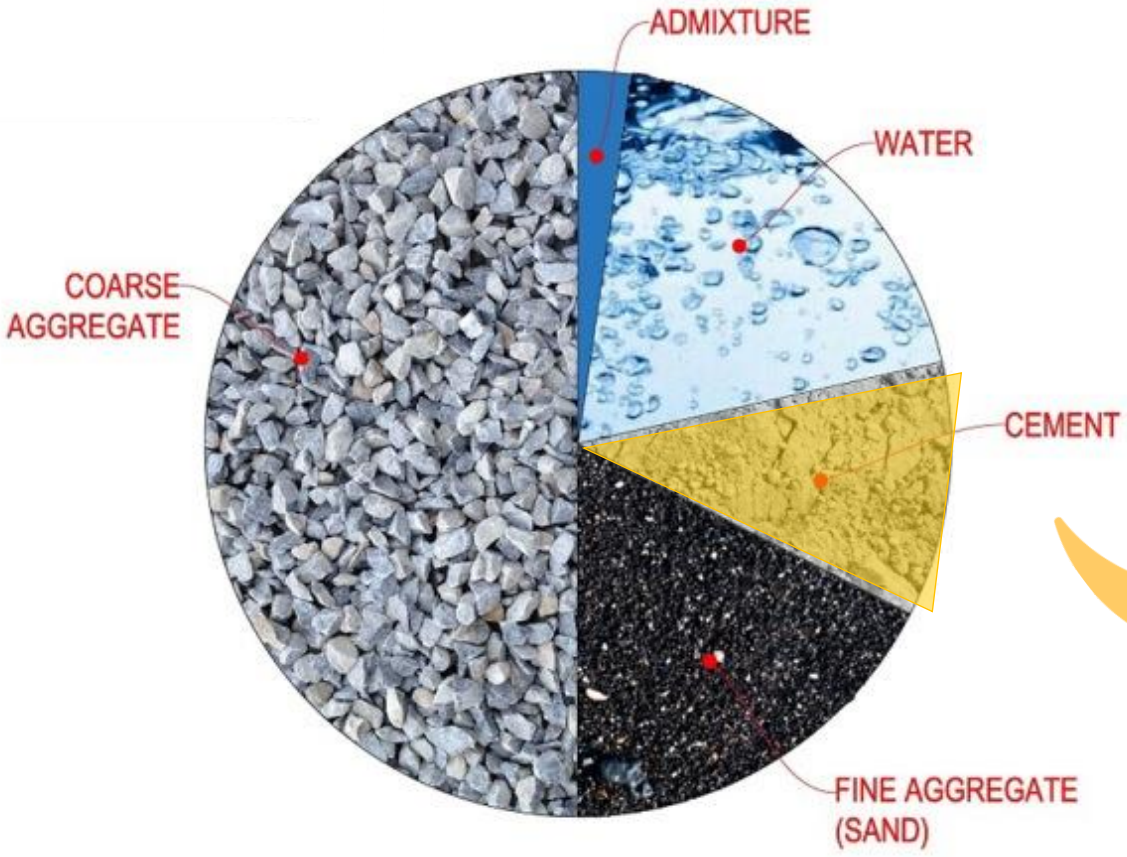
# **12.500.000.000** $m^3$ per year






RESOURCEFULL

# Concrete ⟷ Cement





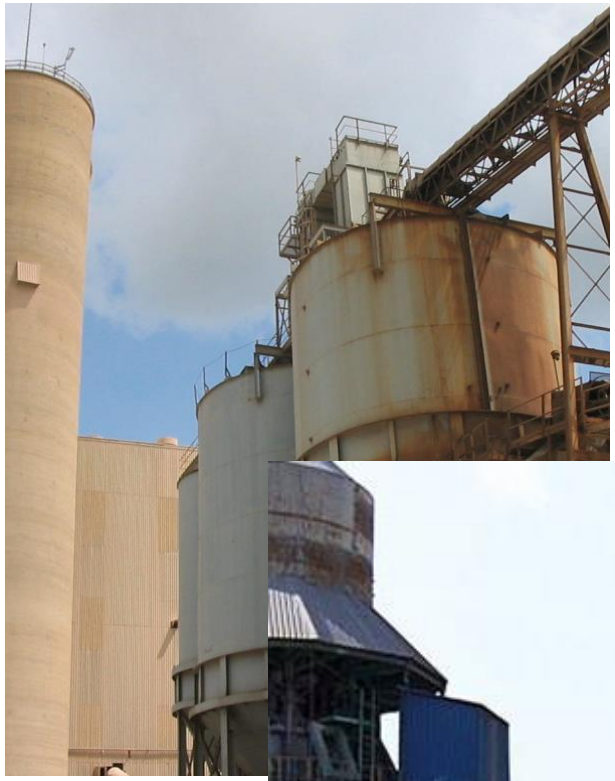
8% of worldwide CO2 emissions

Cement is responsible for >90% of the carbon footprint of concrete



RESOURCEFULL

# CEMENT Production Process

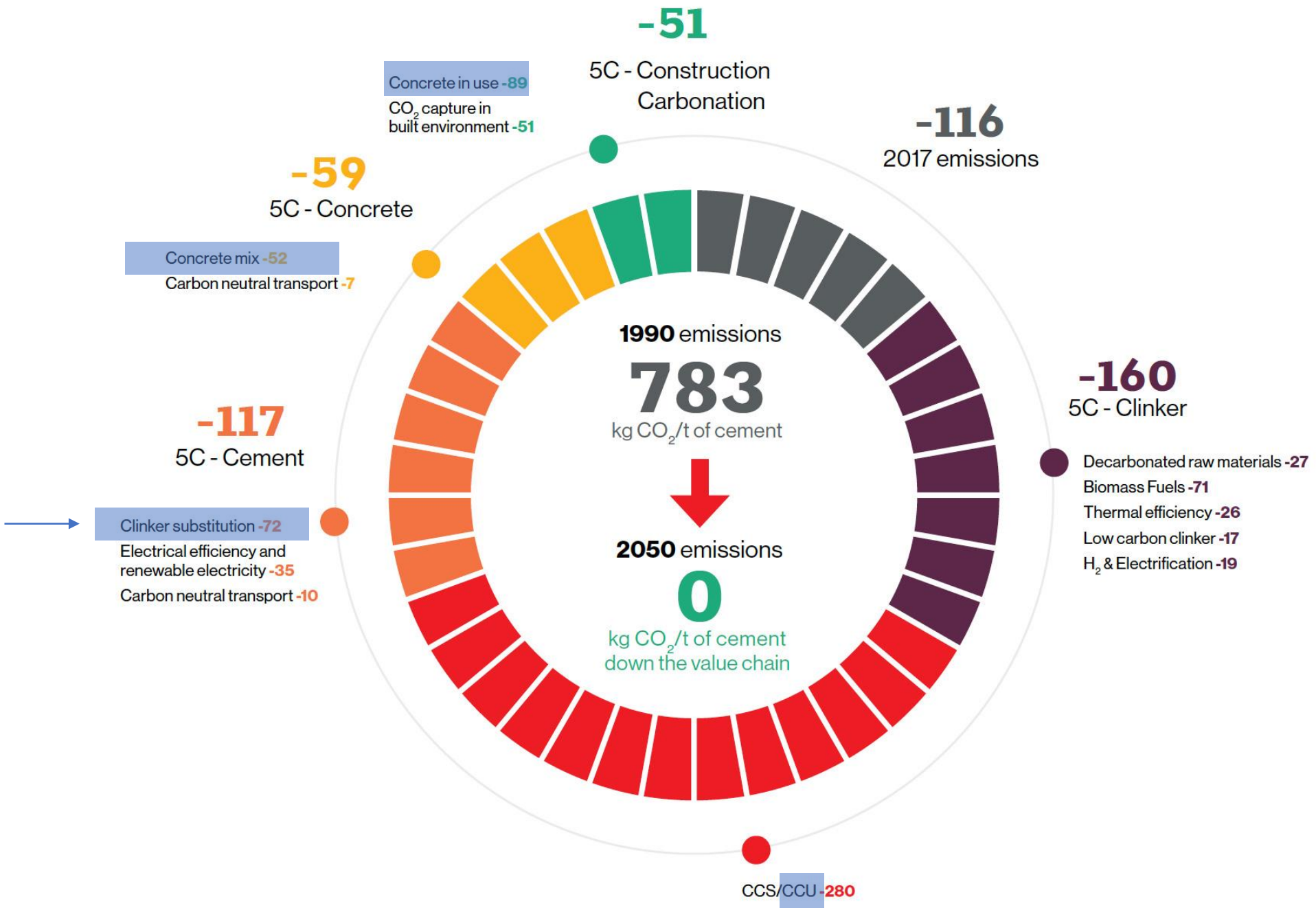




A **highly energy intensive** process, producing roughly 0,9 ton of $CO_2$ per 1 ton of clinker produced.

**4.1 billion ton** of cement is being produced each year, resulting in a contribution of **8-10%** of worldwide **$CO_2$ emissions**.



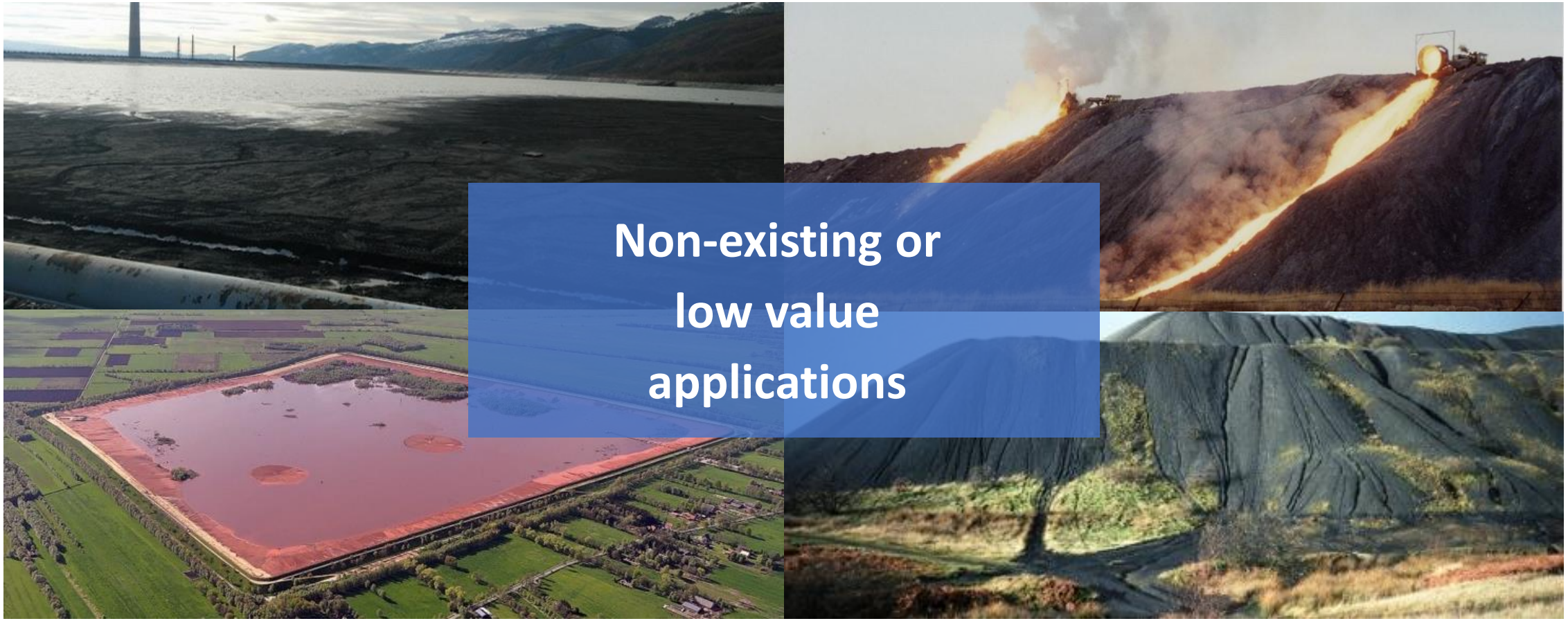
RESOURCEFULL






RESOURCEFULL

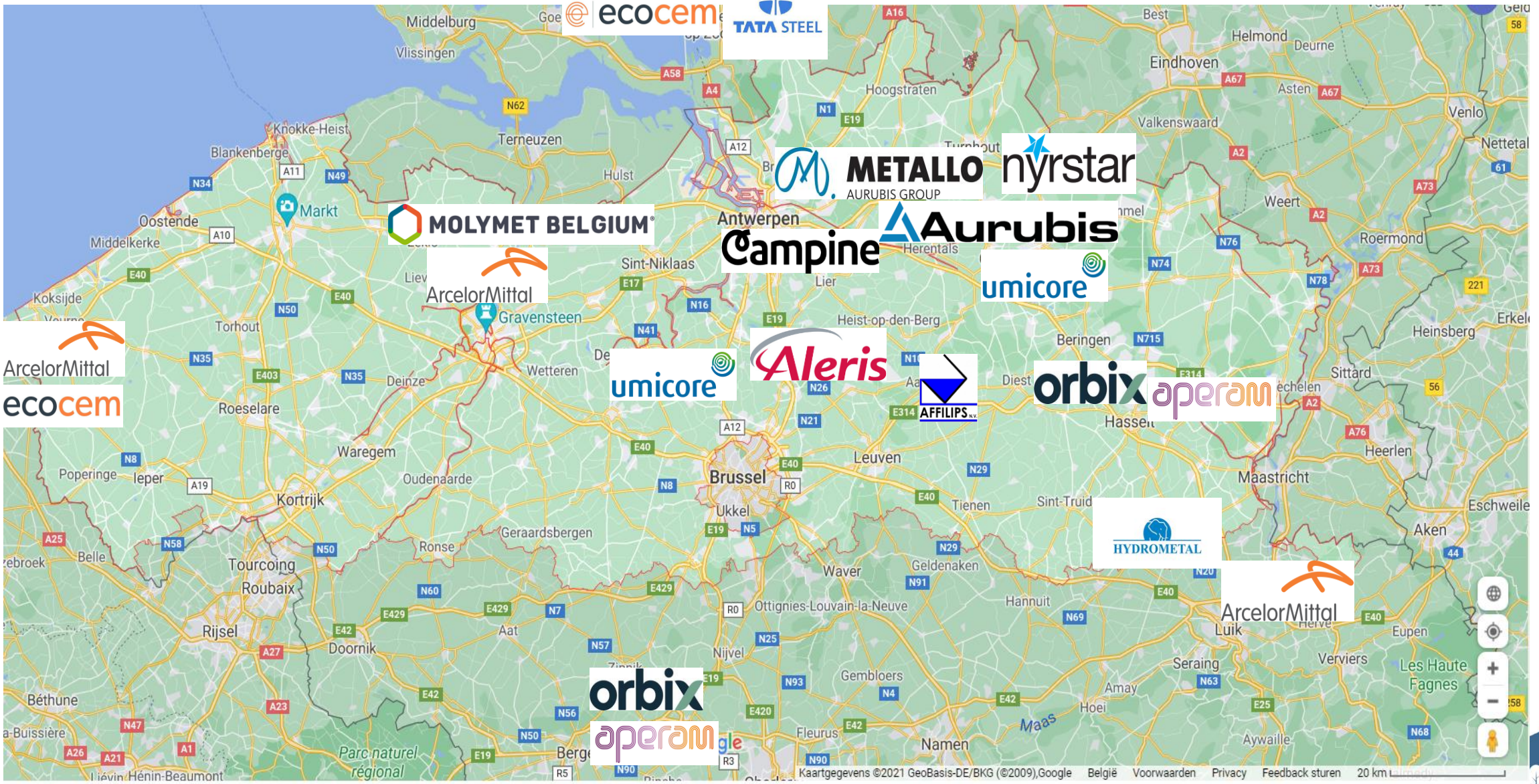
# Metallurgical residue waste piles






RESOURCEFULL

# Metallurgical slags from our **Flanders Metals Valley**: ferrous & non-ferrous industries






RESOURCEFULL

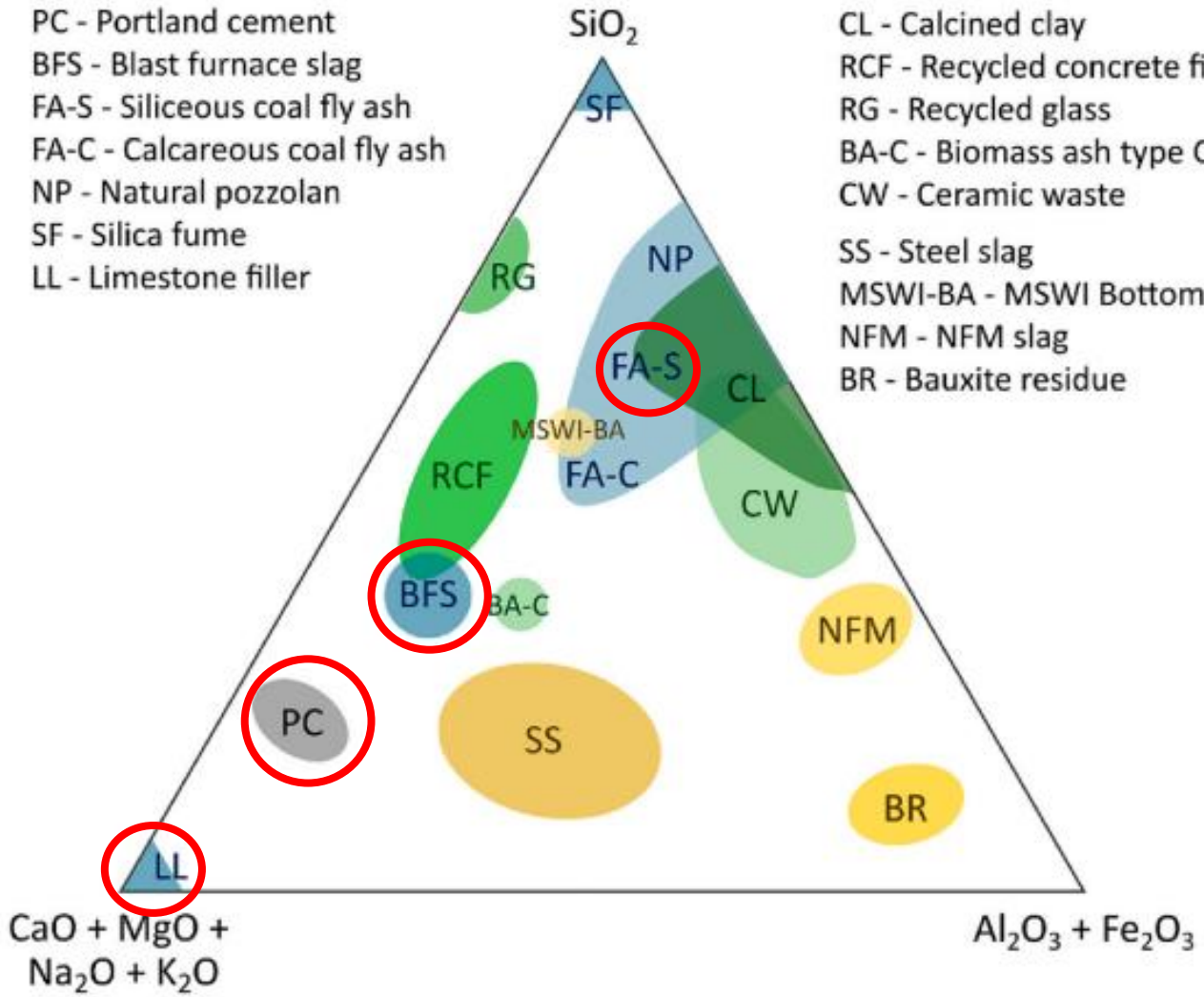



**Fig. 1.** The chemical composition ranges of common, emerging and future SCMs in a ternary diagram of (earth)alkalis–silica–alumina/iron oxide (in wt%). NFM stands for "non-ferrous metallurgical", MSWI for "municipal solid waste incineration". Commonly used SCMs and fillers are in green shades and emerging SCM sources are in yellow shades. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

# Connecting industries towards low impact building materials

**Metal industry**

Solving the waste problem

**Europe & world**

Less primary raw materials

$CO_2$ reduction of construction industry

**Construction industry**

Low footprint products



RESOURCEFULL

# Your engineering partner for low carbon concrete

## Pre-treatment and analysis

Chemical analysis
Mineral analysis
Crushing/grinding
Sizing and seperation
Thermal processing

## Binder development

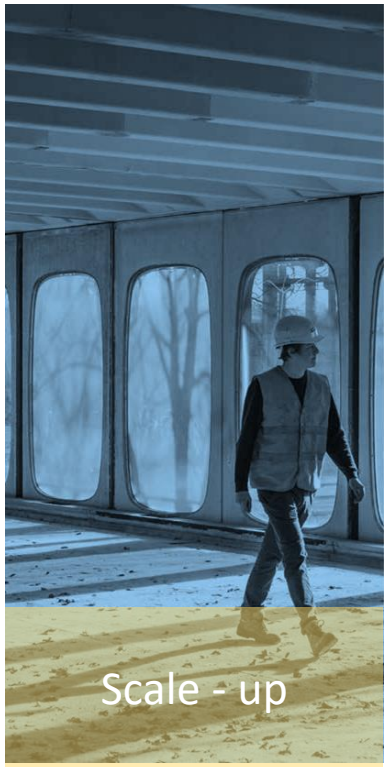
Alkali activation
Cement replacement
Acid activation
Carbonatation
Mg-cement
Ceramics


## Product development

3D-printing mortar
Acid resistant mortar
Floor screed
Ready-mix concrete
UHPC
Bricks

## Performance testing

Aggregate testing
Workability
Strength testing
Freeze-Thaw
Carbonatation

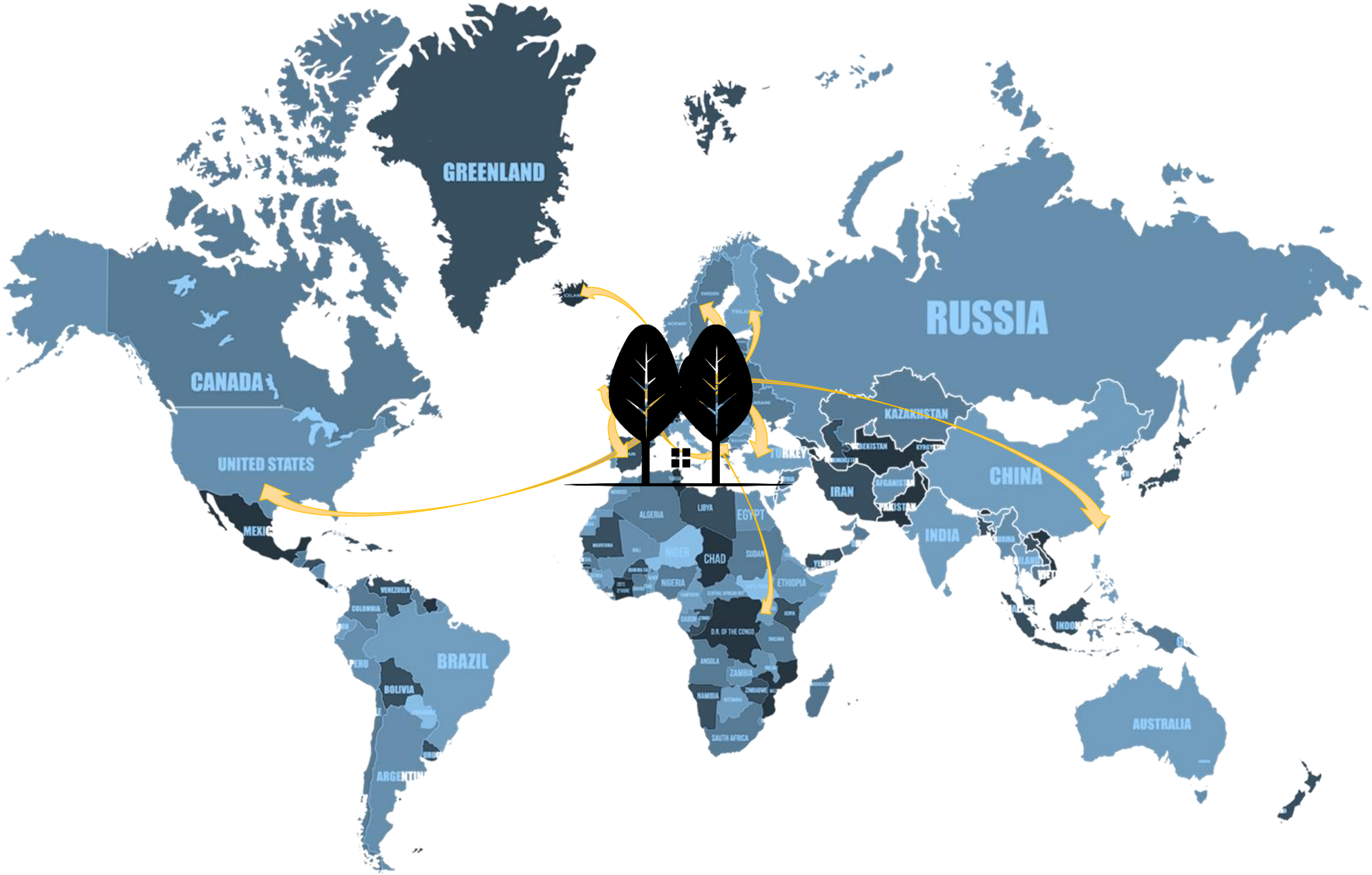


## Scale - up

Industrial implementation
LCA
Waste legislation
Building legislation



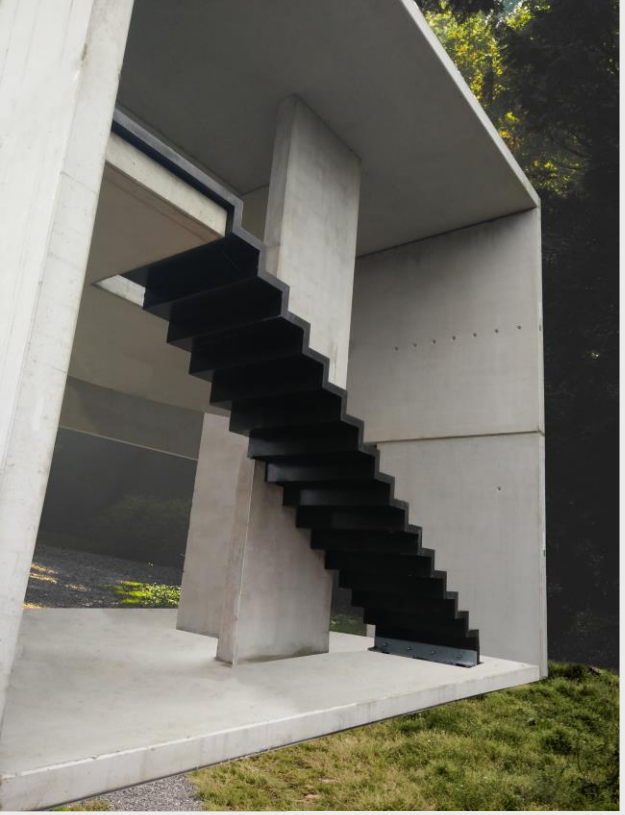
RESOURCEFULL

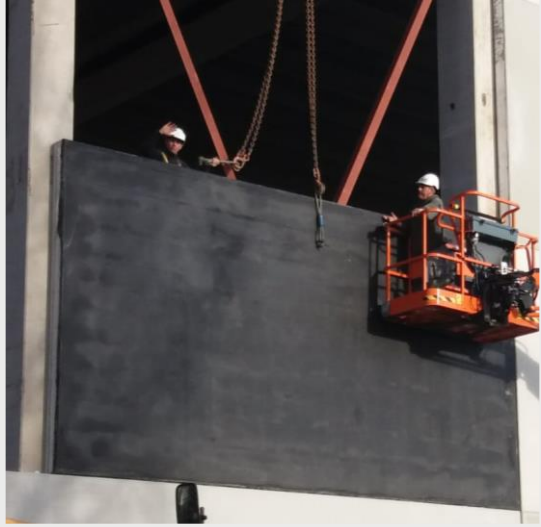


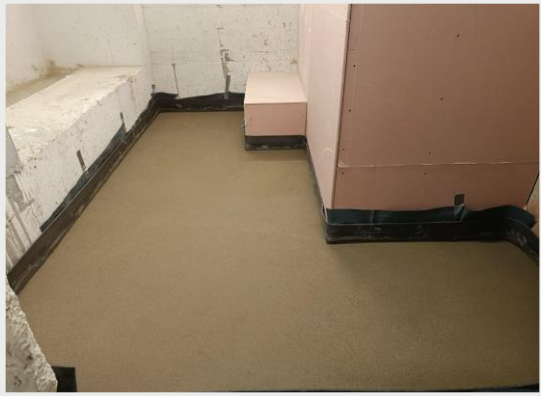



RESOURCEFULL

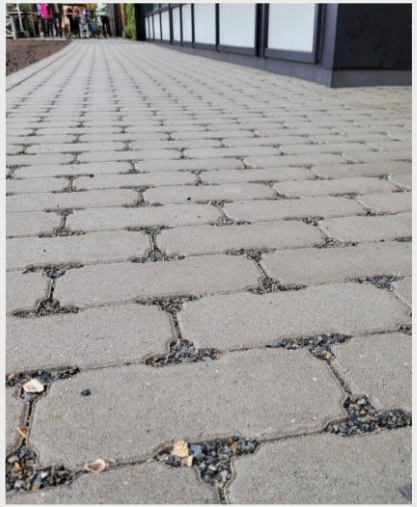
Innovating in the lab,
while implementing in the field,
for solutions with impact








RESOURCEFULL




ACLAGRO

# From slag to floor

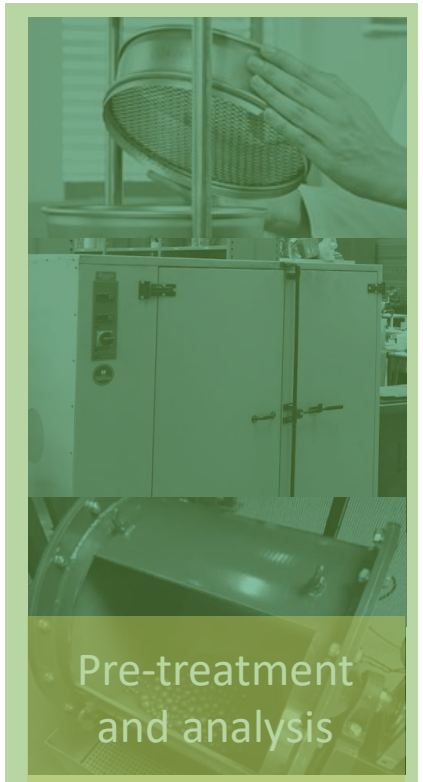


RESOURCEFULL

The following slides contain the combined results from the VLAIO funded projects: Plasmat, Supermex, DUSC, TOGETHER, URBCON

and continued bilateral collaborations.

# Your engineering partner for low carbon concrete



## Pre-treatment and analysis

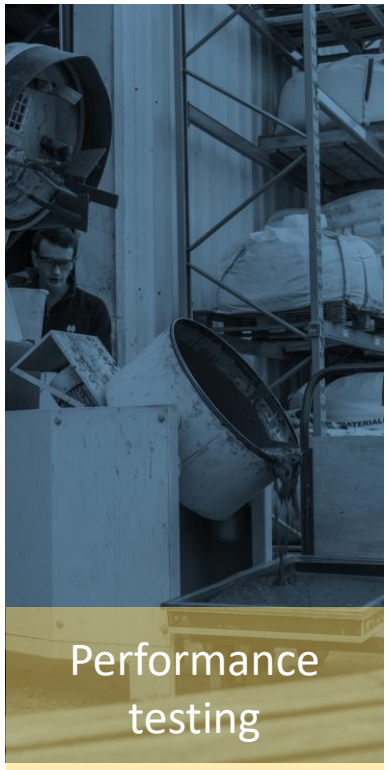
Chemical analysis
Mineral analysis
Crushing/grinding
Sizing and seperation
Thermal processing

## Binder development

Alkali activation
Cement replacement
Acid activation
Carbonatation
Mg-cement
Ceramics

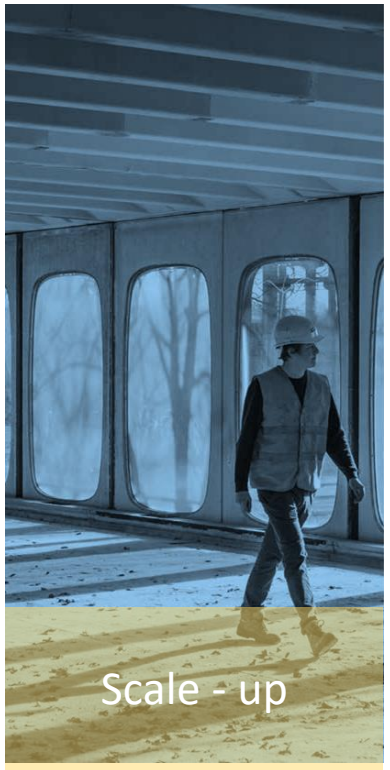

## Product development

3D-printing mortar
Acid resistant mortar
Floor screed
Ready-mix concrete
UHPC
Bricks



## Performance testing

Aggregate testing
Workability
Strength testing
Freeze-Thaw
Carbonatation



## Scale - up

Industrial implementation
LCA
Waste legislation
Building legislation



RESOURCEFULL

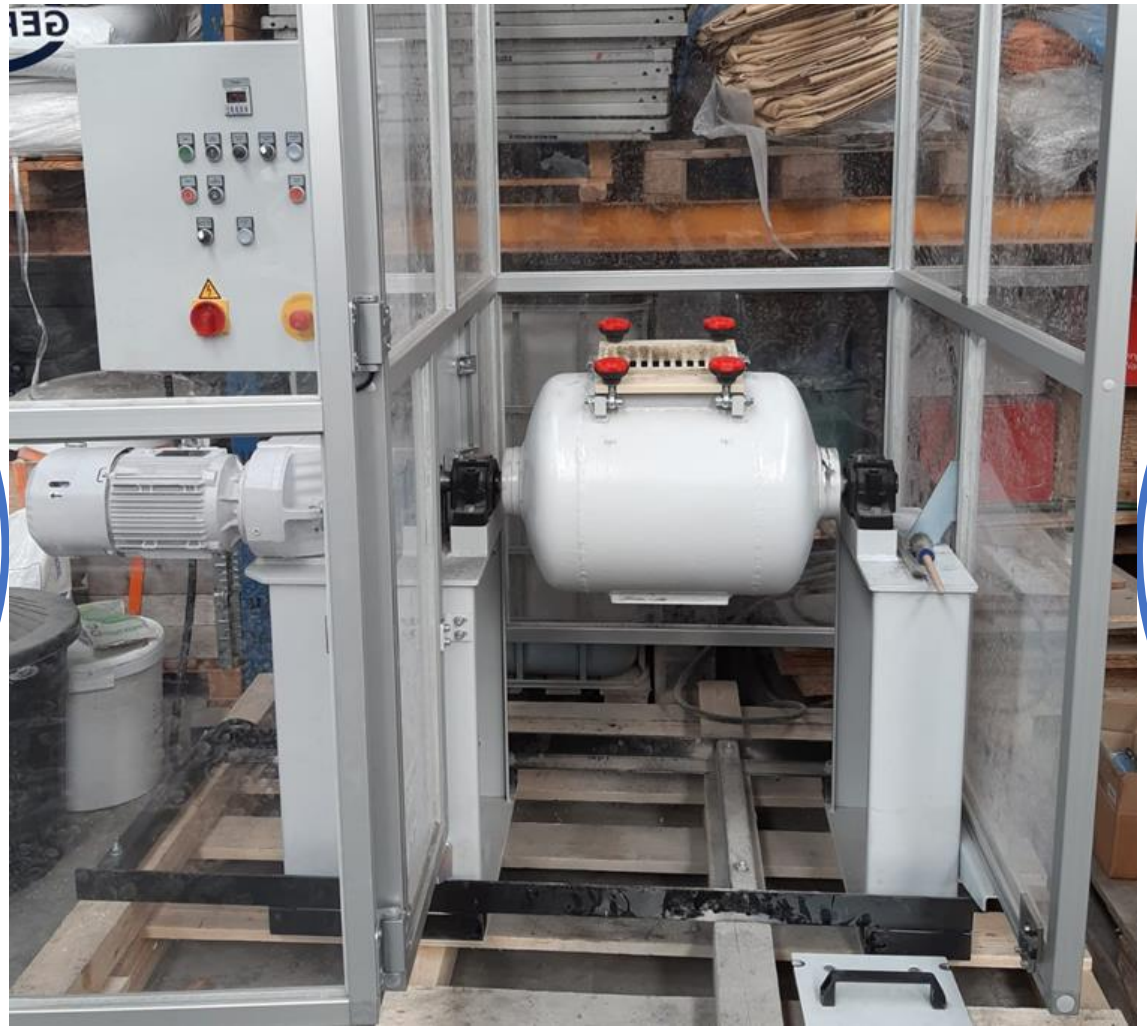
# High temperature modification & water granulation of copper slags



RESOURCEFULL

# Millability

Water granulated slak



Ground Granulated Slag



RESOURCEFULL

# Your engineering partner for low carbon concrete

## Pre-treatment and analysis

Chemical analysis
Mineral analysis
Crushing/grinding
Sizing and seperation
Thermal processing

## Binder development

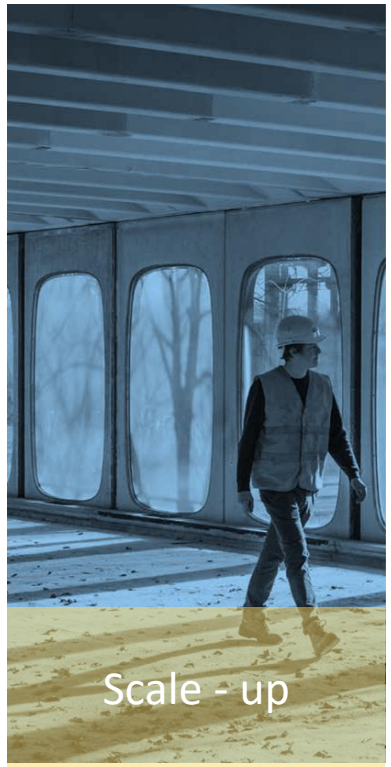
Alkali activation
Cement replacement
Acid activation
Carbonatation
Mg-cement
Ceramics


## Product development

3D-printing mortar
Acid resistant mortar
Floor screed
Ready-mix concrete
UHPC
Bricks

## Performance testing

Aggregate testing
Workability
Strength testing
Freeze-Thaw
Carbonatation



## Scale - up

Industrial implementation
LCA
Waste legislation
Building legislation



RESOURCEFULL

# Your engineering partner for low carbon concrete

## Pre-treatment and analysis

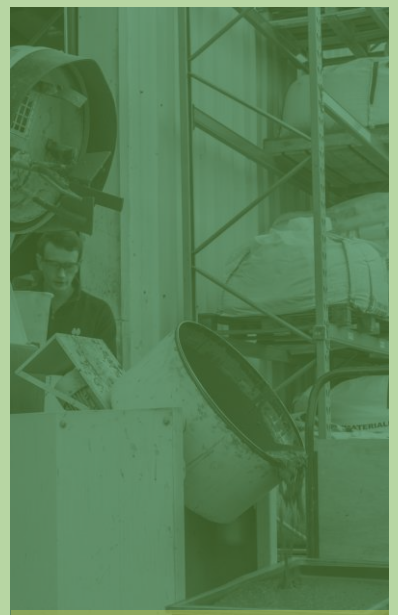
Chemical analysis
Mineral analysis
Crushing/grinding
Sizing and seperation
Thermal processing

## Binder development

Alkali activation
Cement replacement
Acid activation
Carbonatation
Mg-cement
Ceramics


## Product development

3D-printing mortar
Acid resistant mortar
Floor screed
Ready-mix concrete
UHPC
Bricks



## Performance testing

Aggregate testing
Workability
Strength testing
Freeze-Thaw
Carbonatation

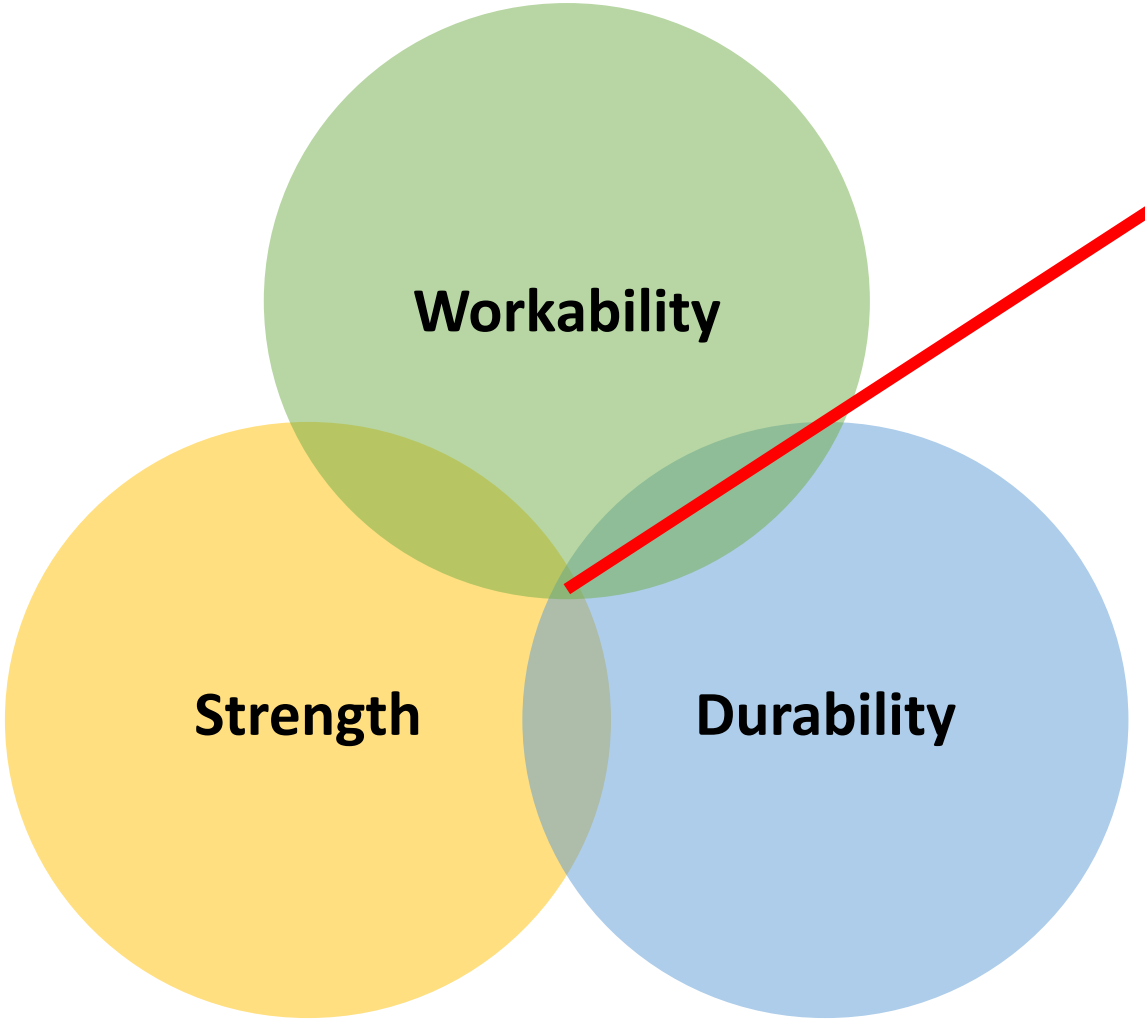
## Scale - up

Industrial implementation
LCA
Waste legislation
Building legislation



RESOURCEFULL

# Holy trinity of concrete theology

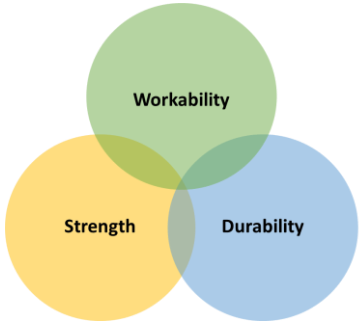



**Good concrete is here**



*credits to Geert De Schutter

RESOURCEFULL

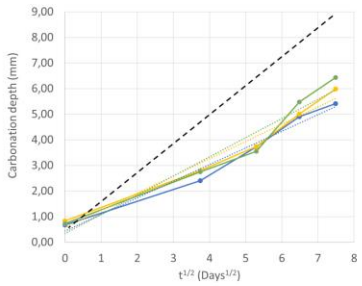



| Test | standard | status | |
|---|---|---|---|
| Slump stability | EN 12350-2 | Done | Fresh properties |
| Fresh density | EN 12350-6 | Done | |
| Air content | EN 12350-7 | Done | |
| Compressive strength | EN 12390-3 | Done | Mechanical properties |
| Flexural strength | EN 12390-5 | Done | |
| Splitting tensile strength | EN 12390-6 | Done | |
| Elastic modulus | EN 12390-13 | Done | |
| Chloride Migration | NT Build 492 | Done | Durability properties |
| Carbonation | EN 12390-12 | Done | |
| Water absorption | | Done | |
| Freeze and thaw - salt | EN 12390-9 | Done | |
| Reinforcement corrosion | | Ongoing | |
| Creep and shrinkage | EN 12390-17 | Ongoing | Structural Properties |
| Pull out (steel rebars) | EN 10080 | Done | |
| Flexural  strength - slab | Labo Magnel | Done | |
| Shear capacity - slab | Labo Magnel | Done | |



RESOURCEFULL

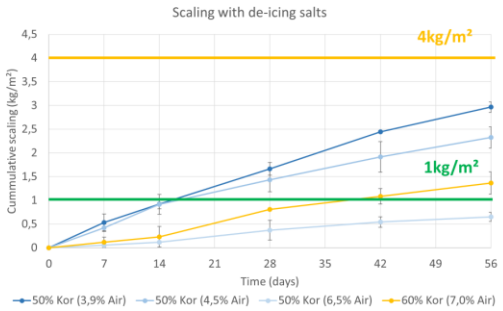
## Carbonation resistance




- Hybride mixtures have equal resistance to carbonation as CEM III/A



## Freeze-thaw resistance with de-icing salts



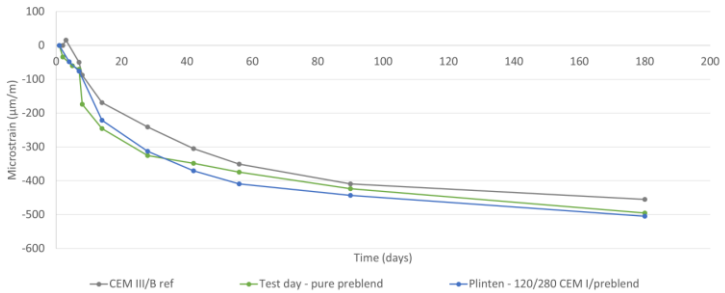

- Sufficient air is required to have < 1kg/m²
- Even sample with 60% Koranel (only 24% CEM I) behave rather good in F/T
- **Possible to have excellent F/T with 50% KOR 45 in C30/37 class = EE4**



# Structural properties



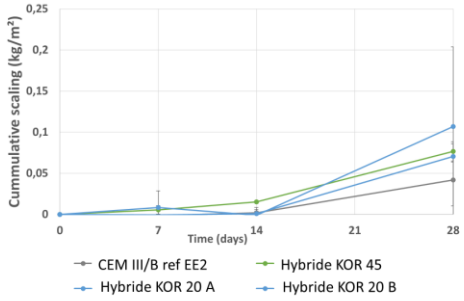
## Shrinkage behaviour




- Concrete shrinkage EE2 should stay below 570 µm/m at 90D -> no problem



## Freeze-thaw resistance without de-icing salts

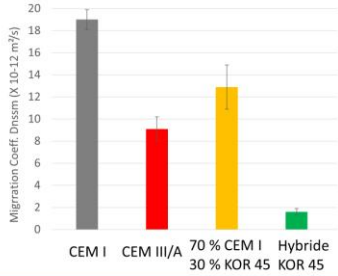


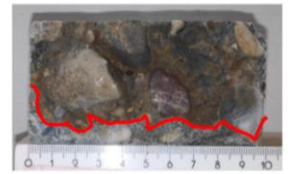

- All samples are below the limit for EE3



## Chloride migration

- Evaluation of resistance to Cl-migration (NT-Build 492):
- Hybride mixtures have lower chloride migration coëfficient



$$D_{nssm} = \frac{RT}{zFE} \cdot \frac{x_d - \alpha\sqrt{x_d}}{t}$$

where:

$$E = \frac{U-2}{L}$$

$$\alpha = 2\sqrt{\frac{RT}{zFE}} \cdot \mathrm{erf}^{-1}\left(1 - \frac{2c_d}{c_0}\right)$$

# Your engineering partner for low carbon concrete

## Pre-treatment and analysis

Chemical analysis
Mineral analysis
Crushing/grinding
Sizing and seperation
Thermal processing

## Binder development

Alkali activation
Cement replacement
Acid activation
Carbonatation
Mg-cement
Ceramics


## Product development

3D-printing mortar
Acid resistant mortar
Floor screed
Ready-mix concrete
UHPC
Bricks

## Performance testing

Aggregate testing
Workability
Strength testing
Freeze-Thaw
Carbonatation

## Scale - up

Industrial implementation
LCA
Waste legislation
Building legislation



RESOURCEFULL

# Let’s get this party started

# Pilot testing at industrial facilities

# Pilot trials at industrial facilities


31
SCHWING
Stetter

# Pilot trials at industrial facilities




41




42

# Ready for the real deal




RESOURCEFULL

# Ready for the real deal



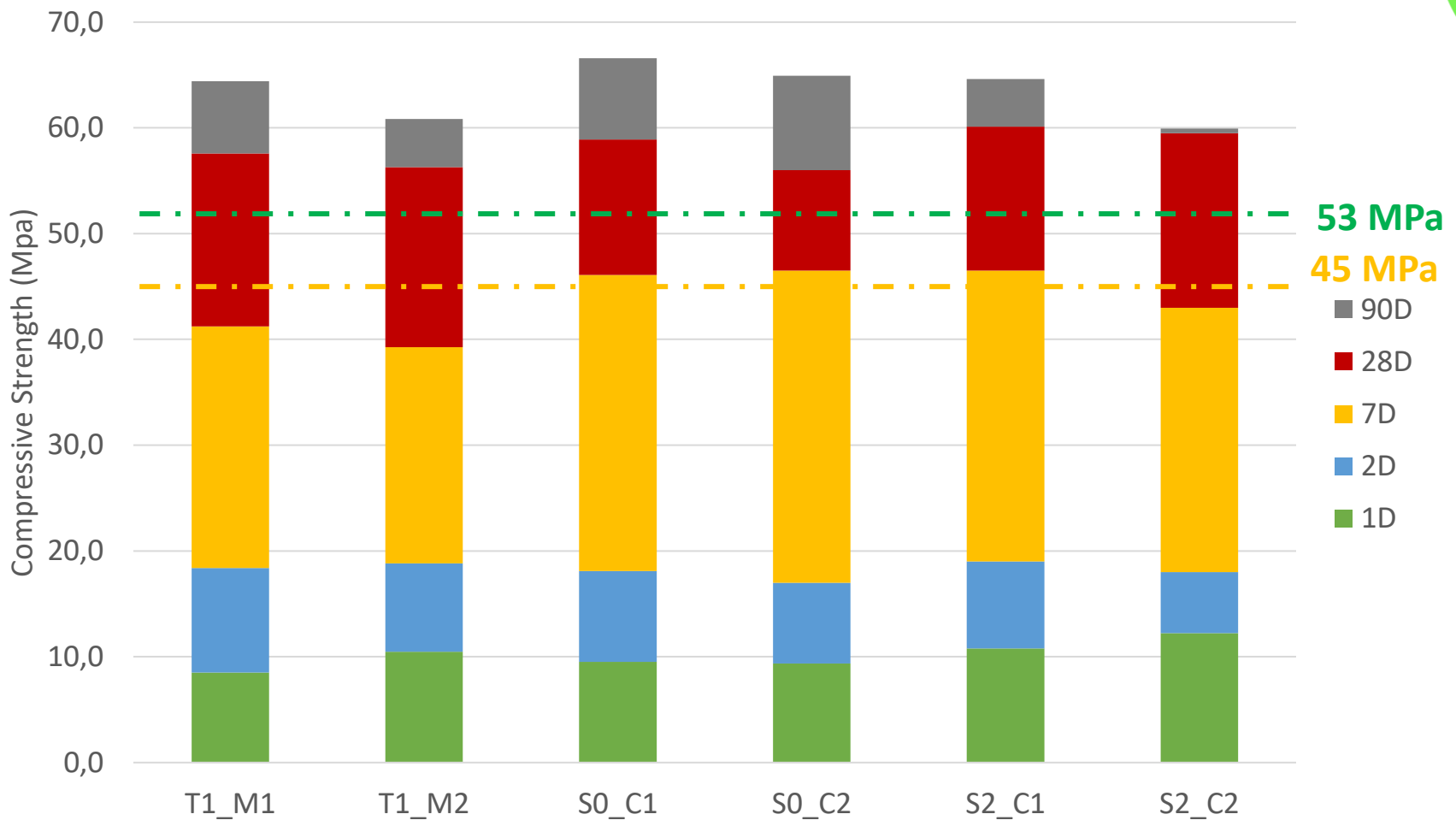

RESOURCEFULL

# Ready mix concrete based on copper slag

# Ready mix concrete based on copper slag

# Continuous sampling to compare industrial to laboratory results

# Property tracking per concrete truck



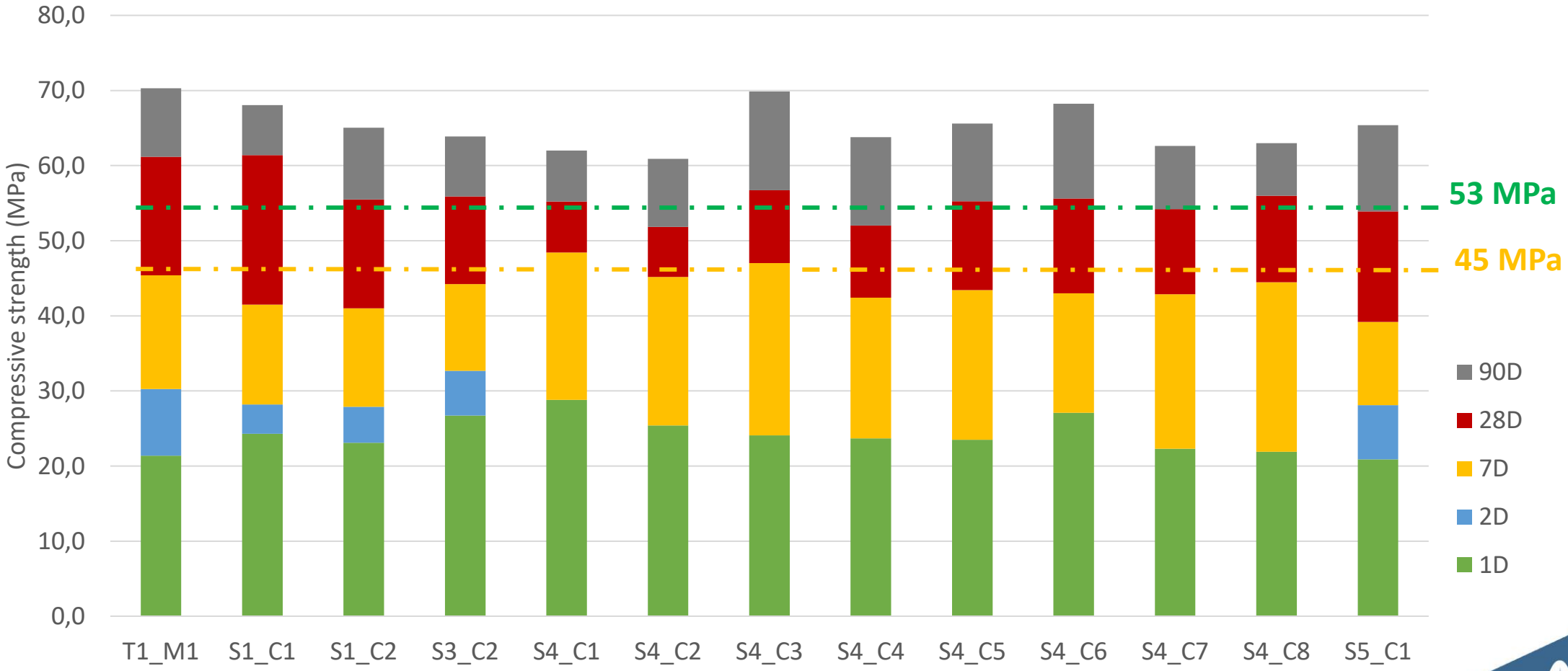



RESOURCEFULL

# Ready-mix concrete based on copper slag for flooring

# Ready-mix concrete based on copper slag for flooring

# Property tracking per concrete truck






RESOURCEFULL

# Continued with an even larger installation last week…

# Continued with an even larger installation last week…

# Let’s talk about how we can build a green future, together!

RESOURCEFULL

RESOURCEFULL

ResourceFull
Rozenstraat 5A
9810 Eke
Belgium

www.resourcefull.eu

Lukas Arnout
lukas.arnout@resourcefull.eu

Wouter Crijns
wouter.crijns@resourcefull.eu

Thomas Lapauw
thomas.lapauw@resourcefull.eu

**Building a green future, together**