HeidelbergCement's engagement and projects in recarbonation of concrete

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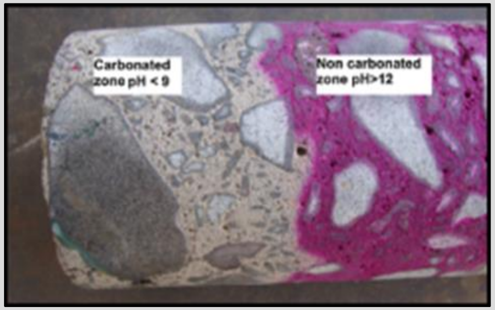
CO2Value Europe, 19 September 2019



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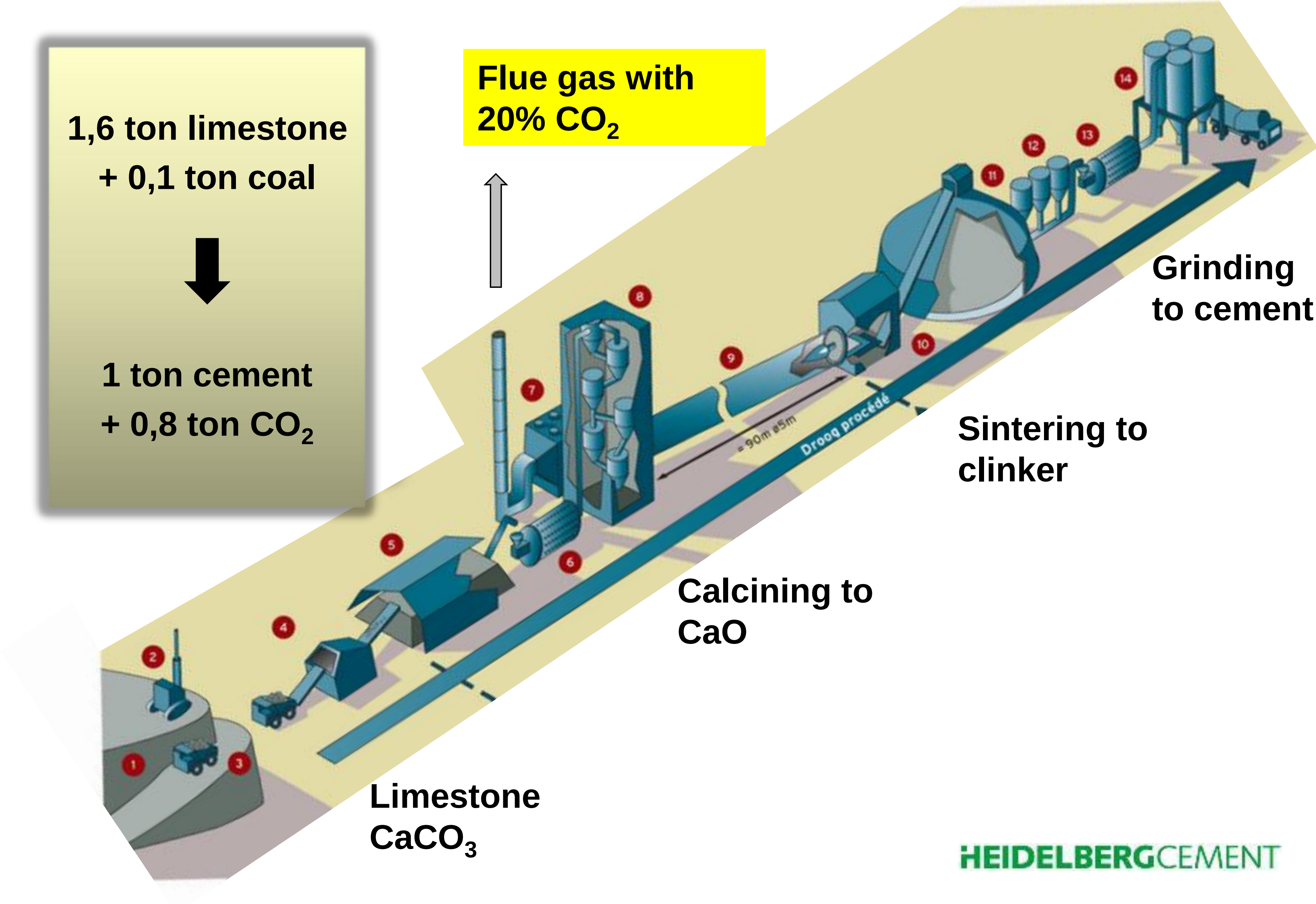
Cement manufacturing explained in 1 minute

1,6 ton limestone
+ 0,1 ton coal

1 ton cement
+ 0,8 ton CO_2

Flue gas with 20% CO_2



Limestone $CaCO_3$

Calcining to CaO

Sintering to clinker

Grinding to cement

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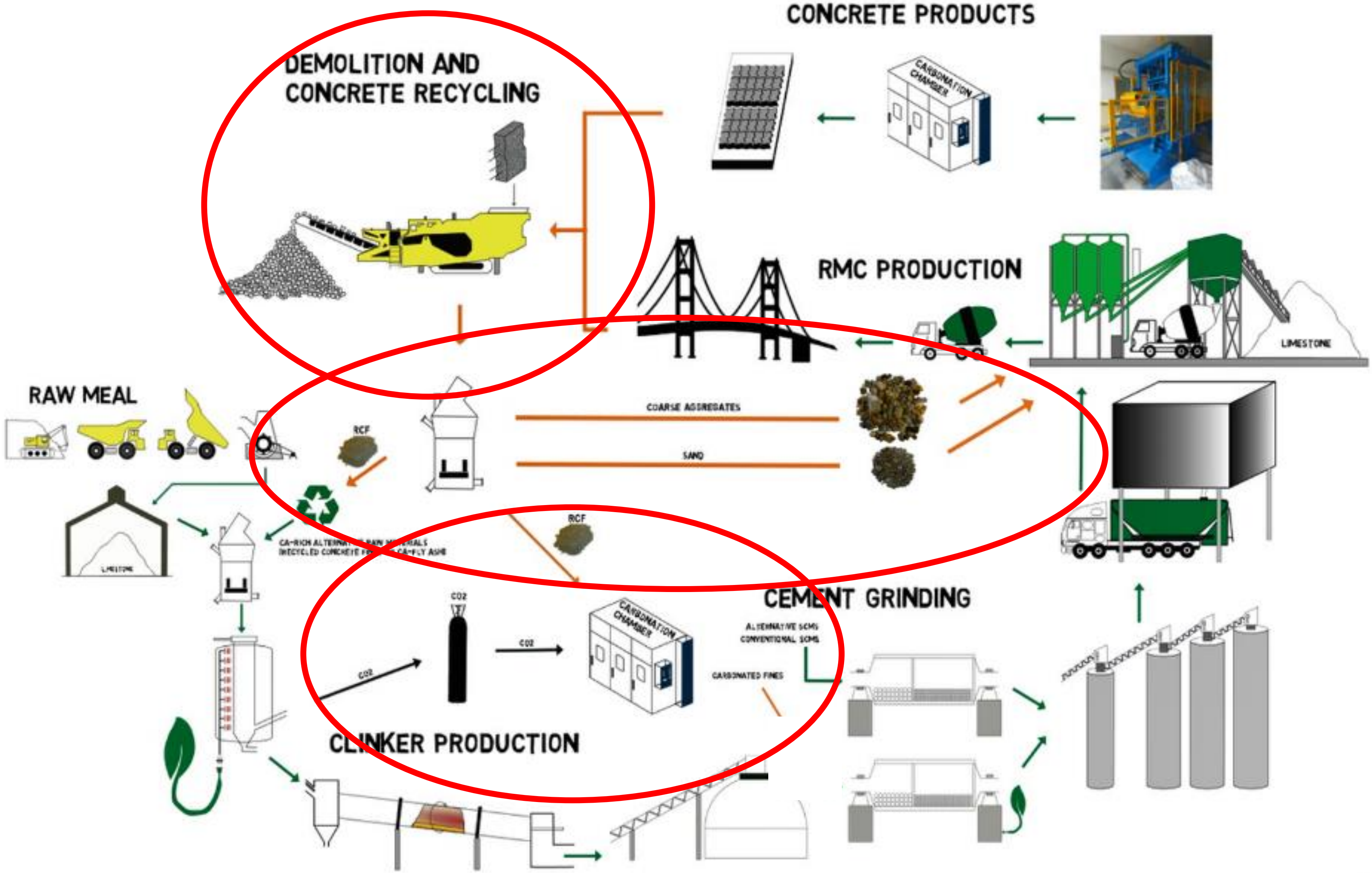
HeidelbergCement Vision 2050



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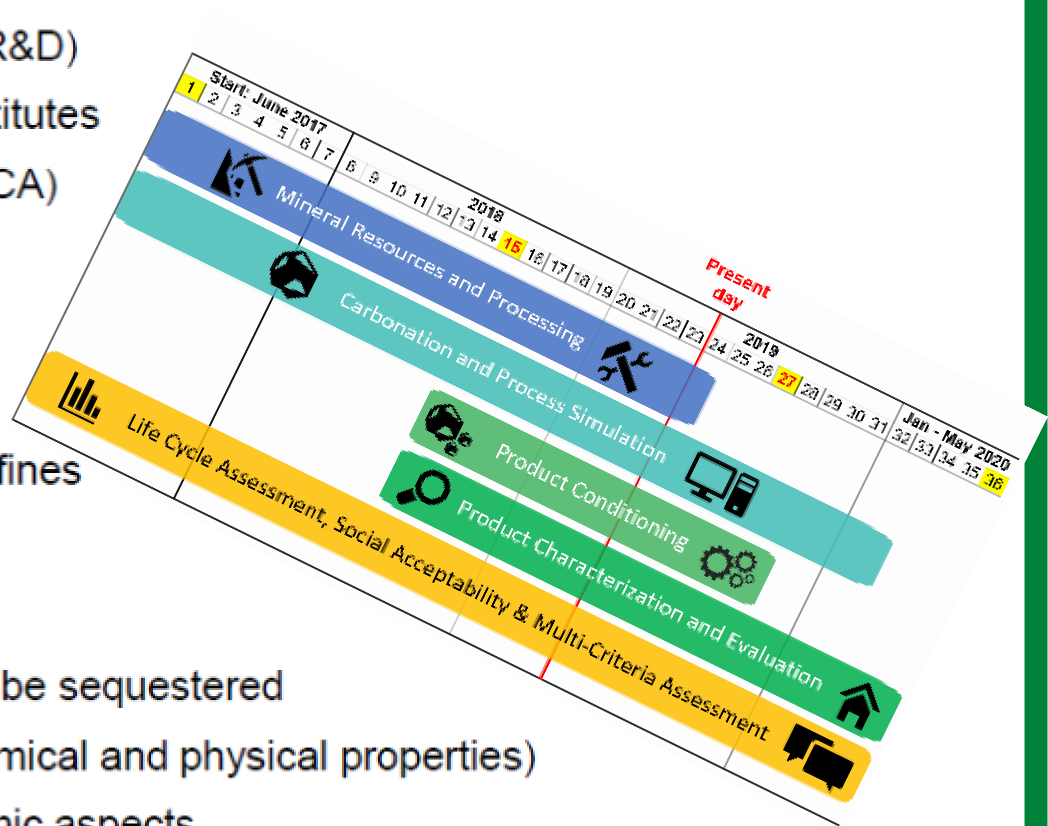
Using natural minerals and by-products for carbonation: CO2MIN

- BMBF-funded program (3 m€) with next project partners
  - HeidelbergCement (HTC Global R&D)
  - RWTH Aachen present with 5 institutes
  - IASS Potsdam (Stakeholders + LCA)



- Minerals to be investigated:
  - Natural: basalt, olivine
  - By-products: steel-slag, concrete fines

- Focus points:
  - How much and how fast can CO_2 be sequestered
  - Value of generated products (chemical and physical properties)
  - Energy-balance, LCA and economic aspects

Re-carbonation in concrete

Theoretical re-carbonation quantity

Material	CO_2^{theor} (kg/kg)
Quick lime	0.785
CEM I	0.5
CEM I fully hydrated	0.35
Slag (typical)	0.3

Max CO_2 uptake linked to CaO + MgO % in material

CEM I maximum binds **0.5 kg CO_2/kg cement**

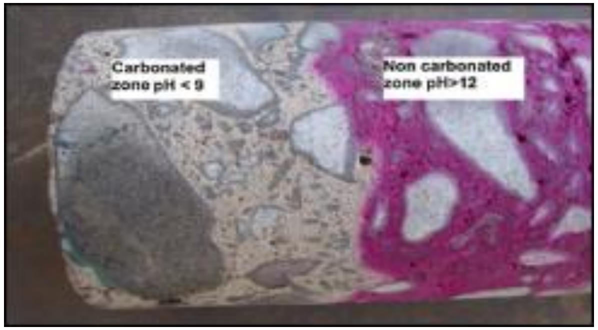
This equals to all CO_2 released by limestone during calcination!

Re-carbonation speed in mm/year$^{0.5}$

Concrete strength (cylinder=	< 15 MPa	15 to 20 MPa
Parameters	Value of k-factor, in mm/ye	
Civil engineering structures		
Exposed to rain		2,7
Sheltered from rain		6,6
In ground [a]		1,1
Buildings		
Outdoor		
Exposed to rain	5,5	2,7
Sheltered from rain	11	6,6
Indoor in dry climate [c]		
With cover [b]	11,6	6,9
Without	16,5	9,9

Carbonation penetration 'only' 1-16 mm/year$^{0.5}$ at:

- atmospheric conditions (P, T, humidity)
- ambient air: 0.04% CO_2



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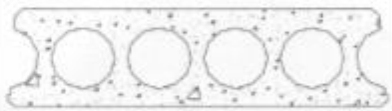
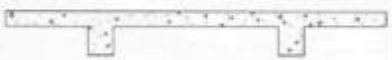
Re-carbonation in fresh concrete

Quantitative example: NL – hollow floor structures

Vloerproducten	Woningbouw (overspanning 5-6 m.)	Overige (kantoren etc.) (overspanning 6-14 m.)
Breedplaatvloer 	5,5	0,5
Kanaalplaatvloer 	2,5	2,0
Ribben vloer 	1,0	1,0
Combinatievloer 	1,5	0,1
Diversen	0,2	0,9
TOTAAL	10,7	4,5

Tabel 5.1. De markt van prefabvloeren (in $m^2 \times 10^6$), gemiddelde over de periode 1995 – 2000; Ref. [22].

Market size hollow floor NL

- 4.5 million m^2 floor / year
- 4% of cement use in NL

Re-carbonation potential

- “Canal”-floor 36%
- Massive floor 5%

NL impact potential: - 1.5% !

Re-carbonation in fresh concrete

- **Objective**:

  Investigate potential of accelerating re-carbonation of cement in concrete by design optimization and curing casted concrete products in a CO_2-rich atmosphere.

- **Key success factors**
  - Performance of concrete product during its lifetime
  - Analyse largest benefit towards climate change
    - Natural carbonation during lifetime
    - Accelerated carbonation at production in workshop
  - Adapt product design to CO_2-uptake potential
  - Collaboration in the supply chain

- **Unique aspects for CCU**
  - Applying known technologies and equipment
  - Existing markets, no regulation barriers
  - Limited need for (green) electricity

Recarbonation of concrete fines: what is needed ?

- **Technology**
  - Energy-efficient crushing/separation
  - Start-ups are active
  - Large equipment manufacturers are also focussing on it

- **Logistics**
  - Transport from fines to the cementplant
  - Or transport of CO2 to recycling site

- **Regulation**
  - Ban on landfilling of concrete
  - Promote complete recycling including the concrete fines

CO_2 a challenge and an opportunity…..

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