Utilization of Recycled Materials (CDM) in the Cement Industry

HOLCIM DEUTSCHLAND

Dr. Thorsten Haase and Dr.-Ing. Kaleb Yared, August 2023

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MOTIVATION & HINTERGRUND
Earth Overshoot Day

High time for circular economy!

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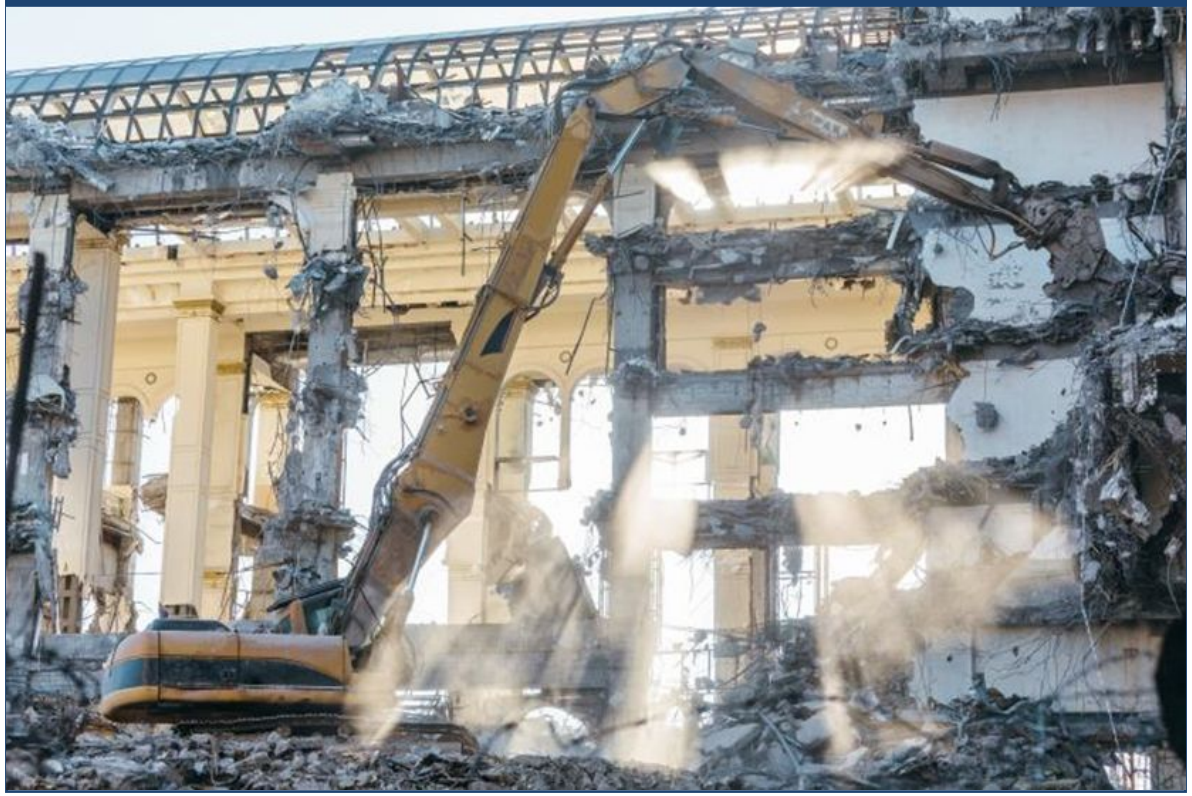
Alternative Raw Material Sources

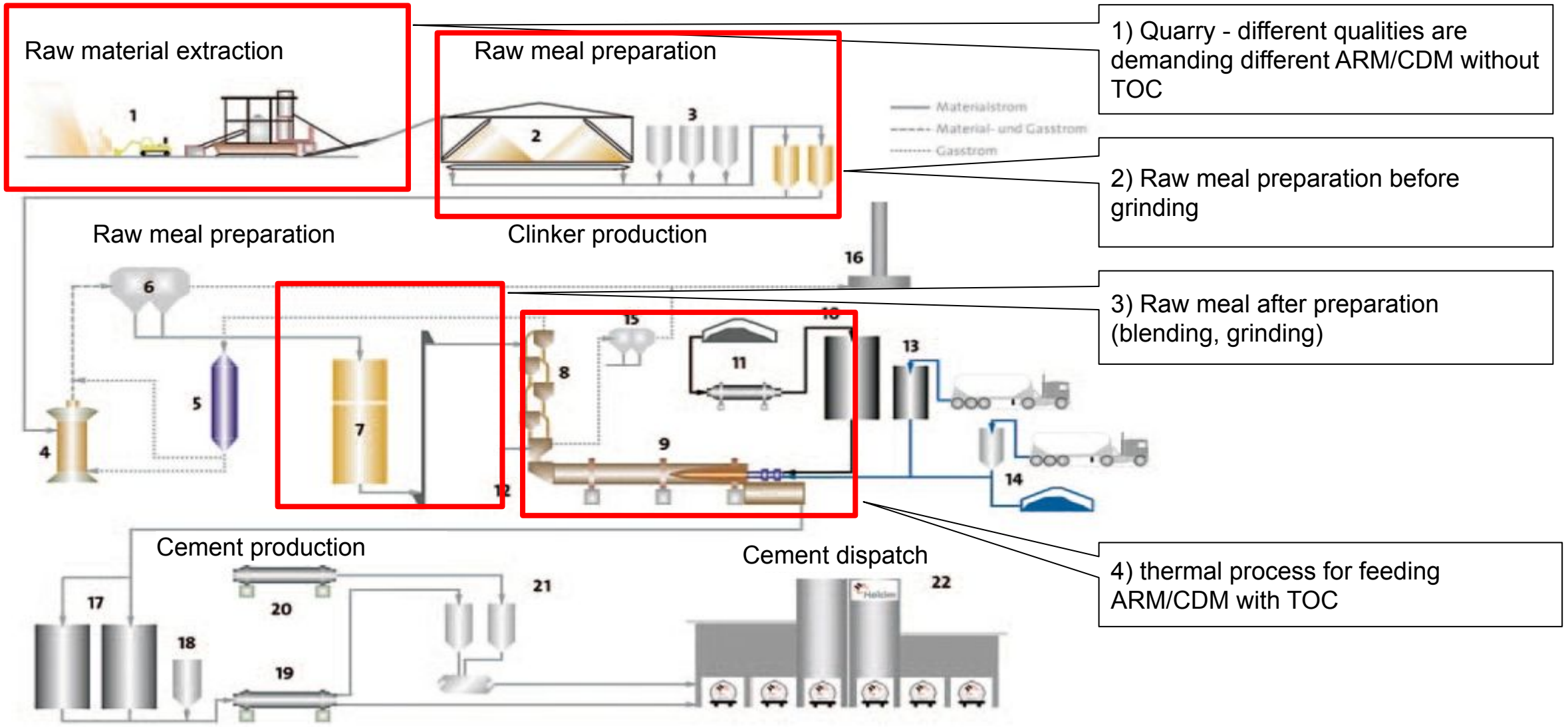
Quarry 1.0

Quarry 4.0



CDM / ARM in Clinker Production

Possible Feed of CDM / ARM into the Clinker Production Process



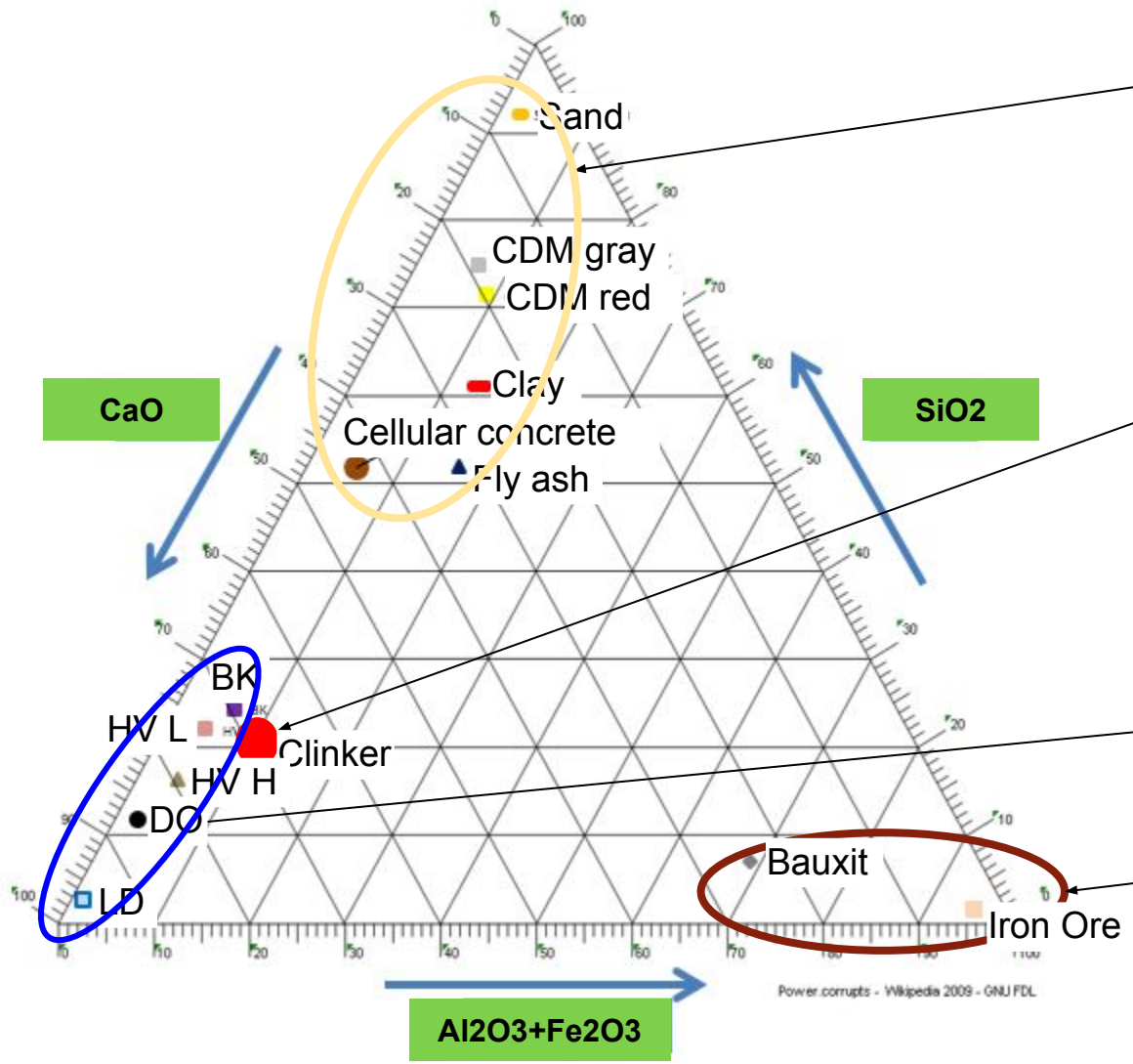
1) Quarry - different qualities are demanding different ARM/CDM without TOC

2) Raw meal preparation before grinding

3) Raw meal after preparation (blending, grinding)

4) thermal process for feeding ARM/CDM with TOC

Tertiary Diagram for the Clinker Chemistry
Quarry Material Dictate Quantity and Quality of Correctives



Siliceous correctives

Typical main composition of clinker	
CaO	~70 %
SiO_2	~21%
Al_2O_3	~6%
Fe_2O_3	~3%

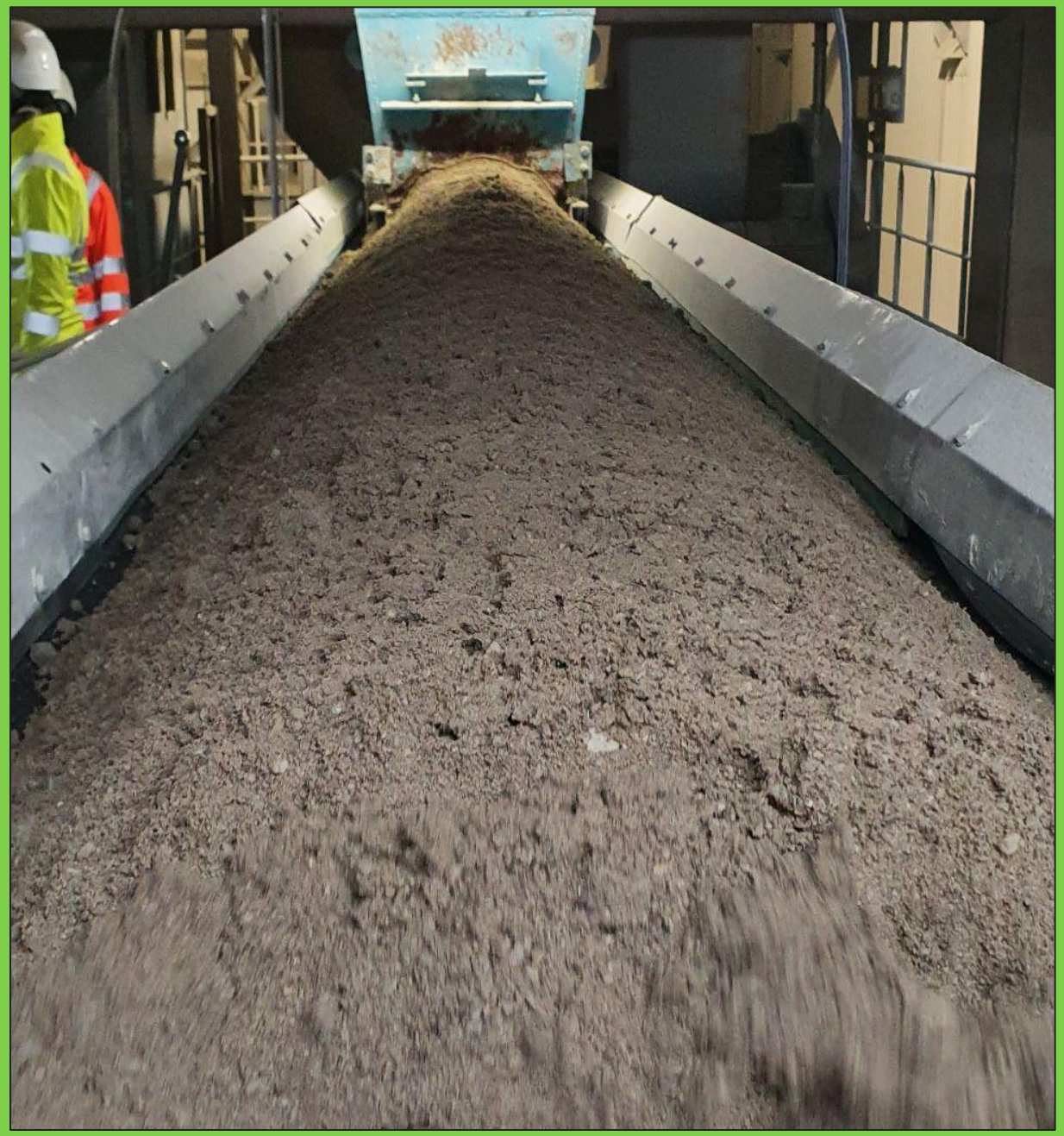
Different limestones / marls from cement plant quarry

Aluminuous/ferrous correctives

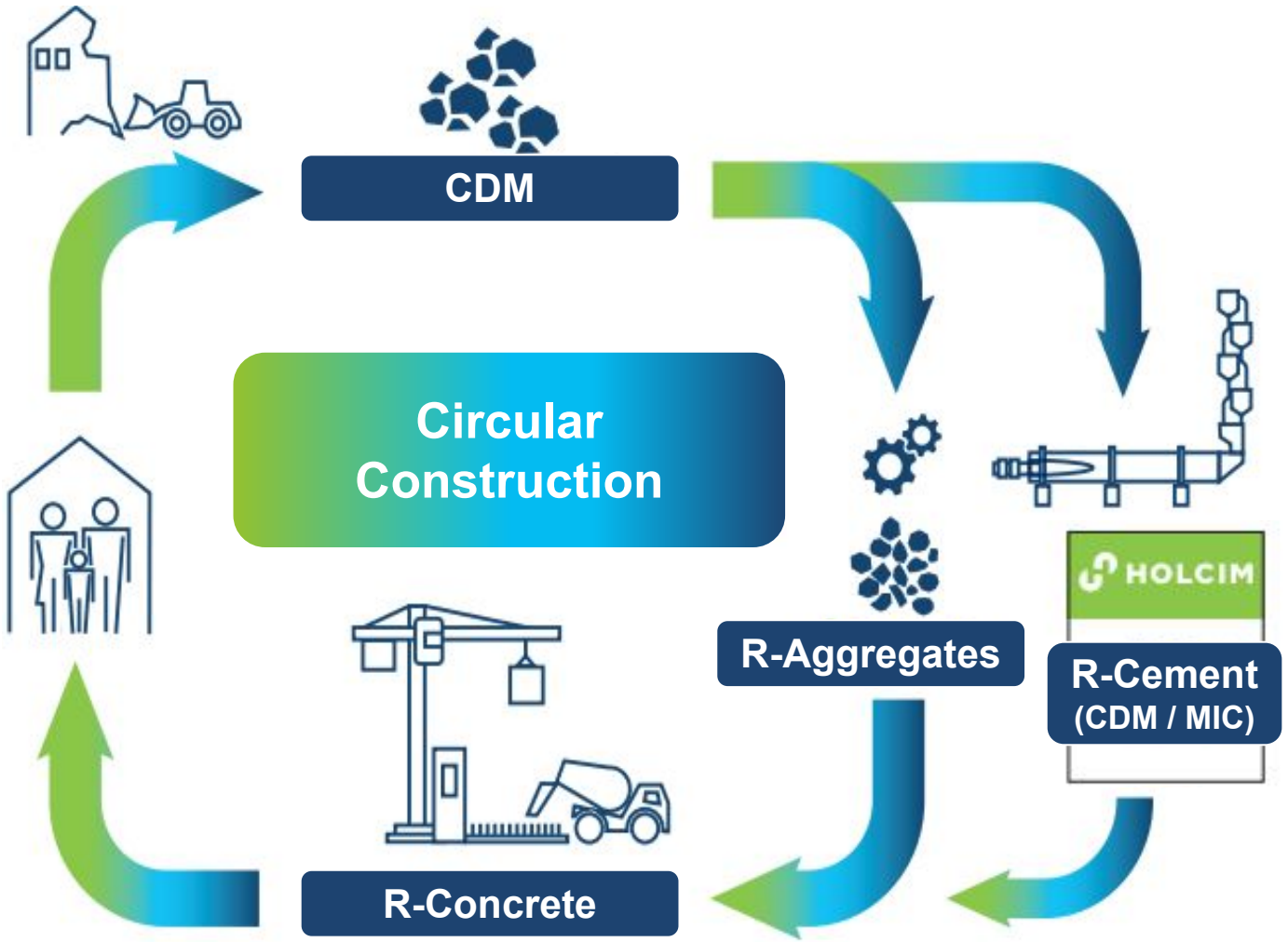
Co-processing CDM / ARM in Clinker Production

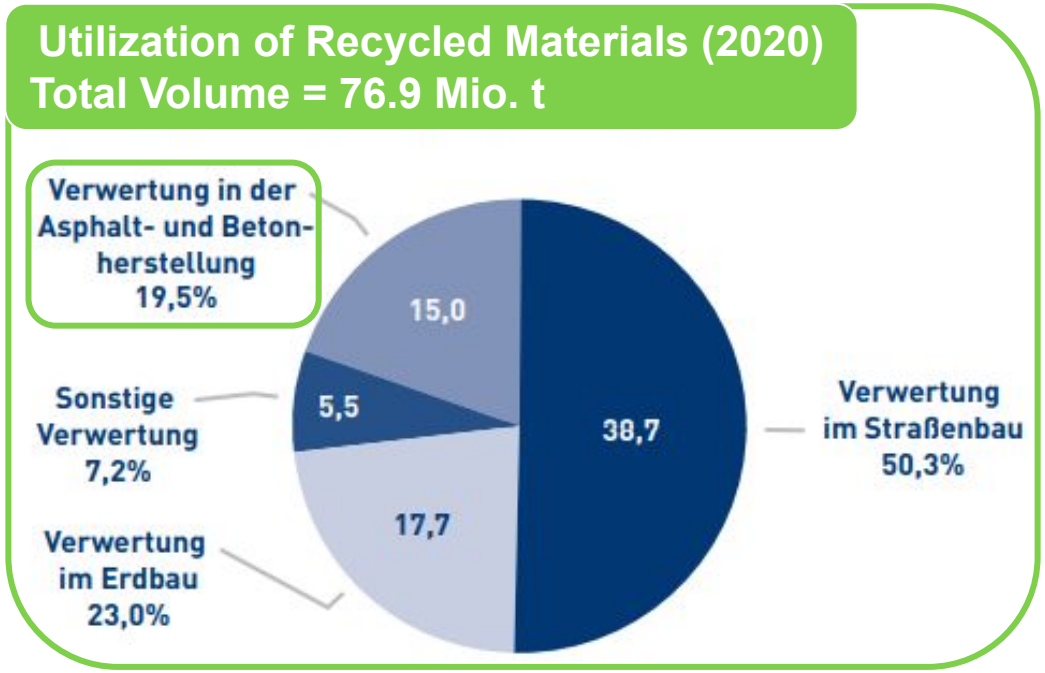
- **Pre-processing**
  - Sorting, crushing
- **Quality control and assurance**
  - Chemical composition meeting clinker chemistry
  - Grain size
- **Process stability**
  - moisture
  - chloride
  - sulfur
- **Storage and feeding (investments)**
  - continuity in volume and quality

CDM / MIC as Main Constituent in Cement Production



Circularity (Up-cycling) in the Cement and Concrete Industry





Source: Mineralische Bauabfälle Monitoring 2020

Recycled Aggregates in Concrete
Material Compositions (M.-%) and Types

Material Compositions[1)]		Type 1	Type 2
Rc + Ru	Concrete, Aggregate	≥ 90	≥ 70
Rb	Brick	≤ 10	≤ 30
Ra	Asphalt	≤ 1	≤ 1
X + Rg	Rest Materials	≤ 1	≤ 2
FL		≤ 2	≤ 2

[1)] DIN EN 12620, Table 1 (excerpt)

Only RC-Aggregates > 2 mm are allowed to be used in concrete!

What to do with the RC-Sand ≤ 2 mm?

Recycled Materials as MIC in Cement
R-Cement Production Concept

CDM Processing @Recycling Centers

Drying and Grinding @Cement Plant

R-Cement Production @Cement Plant

DEUTSCHE NORM *Entwurf* Juni 202

DIN EN 197-6

DIN

ICS 91.100.10

Einsprüche bis 2022-07-20

Entwurf

Zement –
Teil 6: Zement mit rezyklierten Baustoffen;
Deutsche und Englische Fassung prEN 197-6:2022

Cement –
Part 6: Cement with recycled building materials;
German and English version prEN 197-6:2022

Ciment –
Partie 6: Ciment avec des matériaux de construction recyclés;
Version allemande et anglaise prEN 197-6:2022

Recycled Materials as MIC in Cement
prEN 197-6 cement with recycled concrete fines

Definition Recycled MIC

- Selected and processed mineralic material
- Production in a recycling facility producing recycled aggregates for concrete

Requirements of Recycled MIC

- TOC-Content ≤ 0,8 M.-%
- Methylene blue ≤ 1,2 g/100g
- SO3-Content ≤ 2,0 M.-%

Constituents and Compositions

Main types	Notation of the products (types of cement)		Composition (percentage by mass) [a]											
			Main constituents											Minor additional constituents
			Clinker	Recycled concrete fines	Blast-furnace slag	Silica fume	Pozzolana		Fly ash		Burnt shale	Limestone		
							natural	natural calcined	siliceous	calcareous				
	Type name	Type notation	K	F	S	D [b]	P	Q	V	W	T	L [c]	LL [c]	
CEM II	Portland-recycled-fines cement	CEM II/A-F	80–94	6–20	—	—	—	—	—	—	—	—	—	0–5
		CEM II/B-F	65–79	21–35	—	—	—	—	—	—	—	—	—	0–5
	Portland-composite cement [d]	CEM II/A-M	80–88	6–14	←---------- 6–14 ----------→									0–5
		CEM II/B-M	65–79	6–29	←---------- 6–29 ----------→									0–5
		CEM II/C-M	50–64	6–20	←---------- 16–44 ----------→									0–5
CEM VI	Composite cement	CEM VI	35–49	6–20	31–59	—	—	—	—	—	—	—	—	0–5

[a] The values in the table refer to the sum of the main and minor additional constituents.
[b] In case of the use of silica fume, the proportion of silica fume is limited to 6 % to 10 % by mass.
[c] In case of the use of limestone, the proportion of the sum of limestone and recycled concrete fines (sum of L, LL and F) is limited to 35 % by mass.
[d] The number of main constituents other than clinker is limited to two and these main constituents shall be declared by designation of the cement (for examples, see Clause 6). In case of the use of both F and (L or LL) in the composition, the number of main constituents other than clinker is limited to three and these main constituents shall be declared by designation of the cement.

Recycled Materials as MIC in Cement
Challenges to Urgent Adoption

Germany

A special technical approval (abZ) is required for R-Cements for usage in concrete:

- For each cement type
- For each cement plant

ECOCycle®

Switzerland

Susteno
- the resource saving cement

- Cement type nach SIA 2049: CEM II/C-M (T-F) 42,5 N
- Approved for all exposure classes
- RC-MIC composition of Type 2

SUSTENO 4

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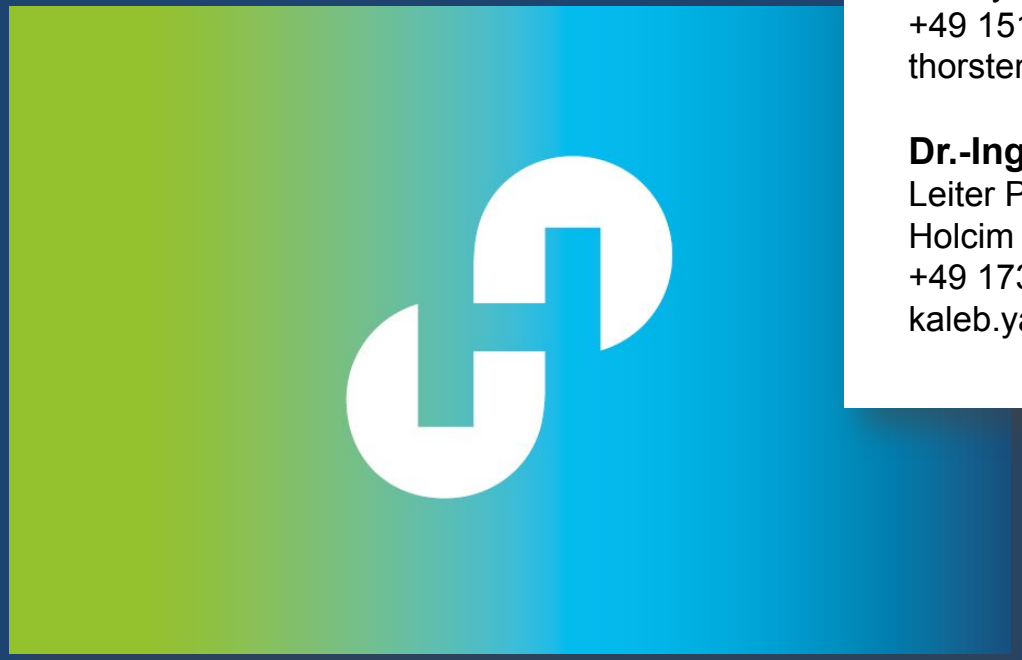
IN KONTAKT BLEIBEN



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