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Di Maio, Francesco; Rem, Peter; Lotfi, Somi; Bakker, Maarten; Xia, Han; Hu, Mingming

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Recycling of End of Life Concrete to New Concrete

Francesco Di Maio¹, Peter Rem¹ Somayeh Lotfi¹,
Maarten Bakker¹, Han Xia¹, Mingming Hu²,

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Key Factors affecting the industry:

➤ Political influence

- Growing demand to improve resource efficiency
- Growing demand of high quality secondary raw materials

➤ Environmental

- Growing demand for green waste management technologies
- Policy and regulations concerning pollution and land use

➤ Social

- Growing demand of high quality secondary raw materials

➤ Economic

- Wastes are increasingly seen as resources to be exploited rather than a burden
- Capital demand

Recycling potential in EU

- 2.3 bn tons of concrete is annually produced in EU
- 380 M tons of end-of-life concrete is generated in EU
- 47% average recycling rate of C&DW in EU
- Only 2.2 % of the concrete produced in NL contains RCA
- Decreasing demand for road foundation materials

Construction and Demolition Waste = C&DW
Recycled Concrete Aggregates = RCA
Data of 2014

C2CA solution

End
of
Life
Concrete

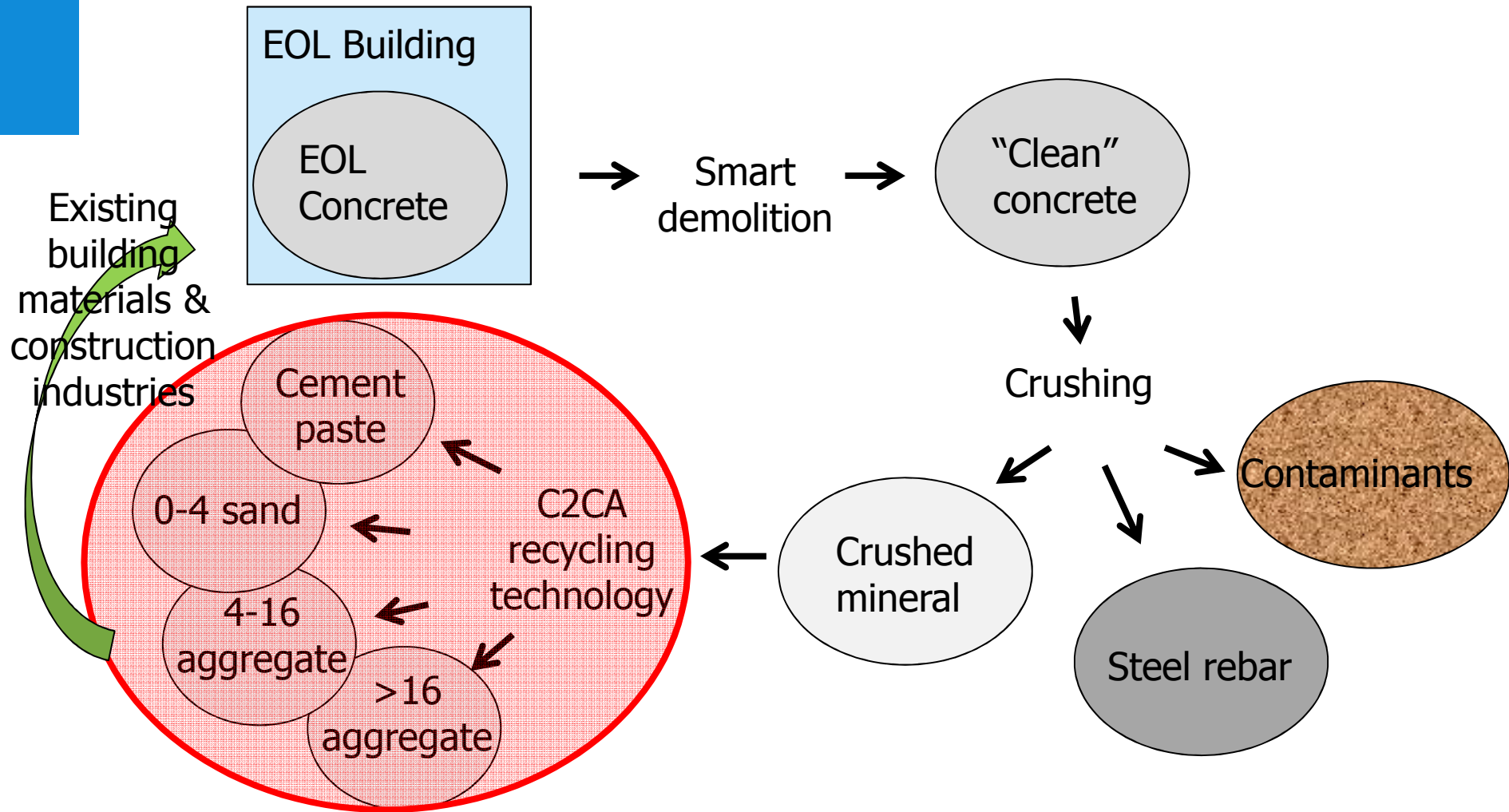
To

Cement
&
Clean
Aggregates

Strukton - Theo Pouw - Heidelberg Cement - Holcim - DV - Laser 2000 – Inashco - TU Delft – La Sapienza Roma - AGH University - FORTH - BSC – Leiden University - TU Denmark

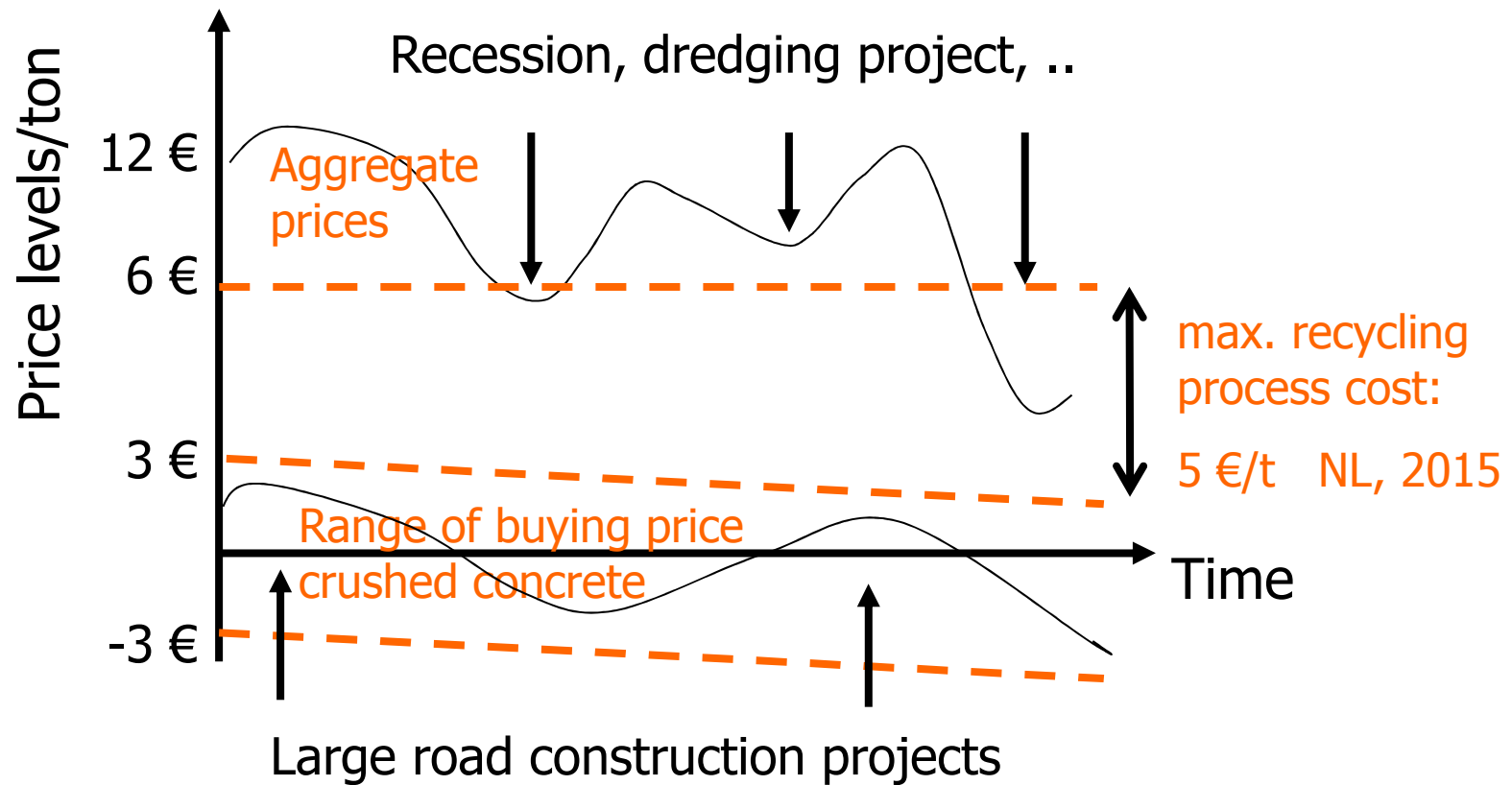
Overall view of C2CA Technology

Smart demolition, Crushing, High-quality products



Economy

Essential to minimize process cost



Is concrete-to-concrete possible?

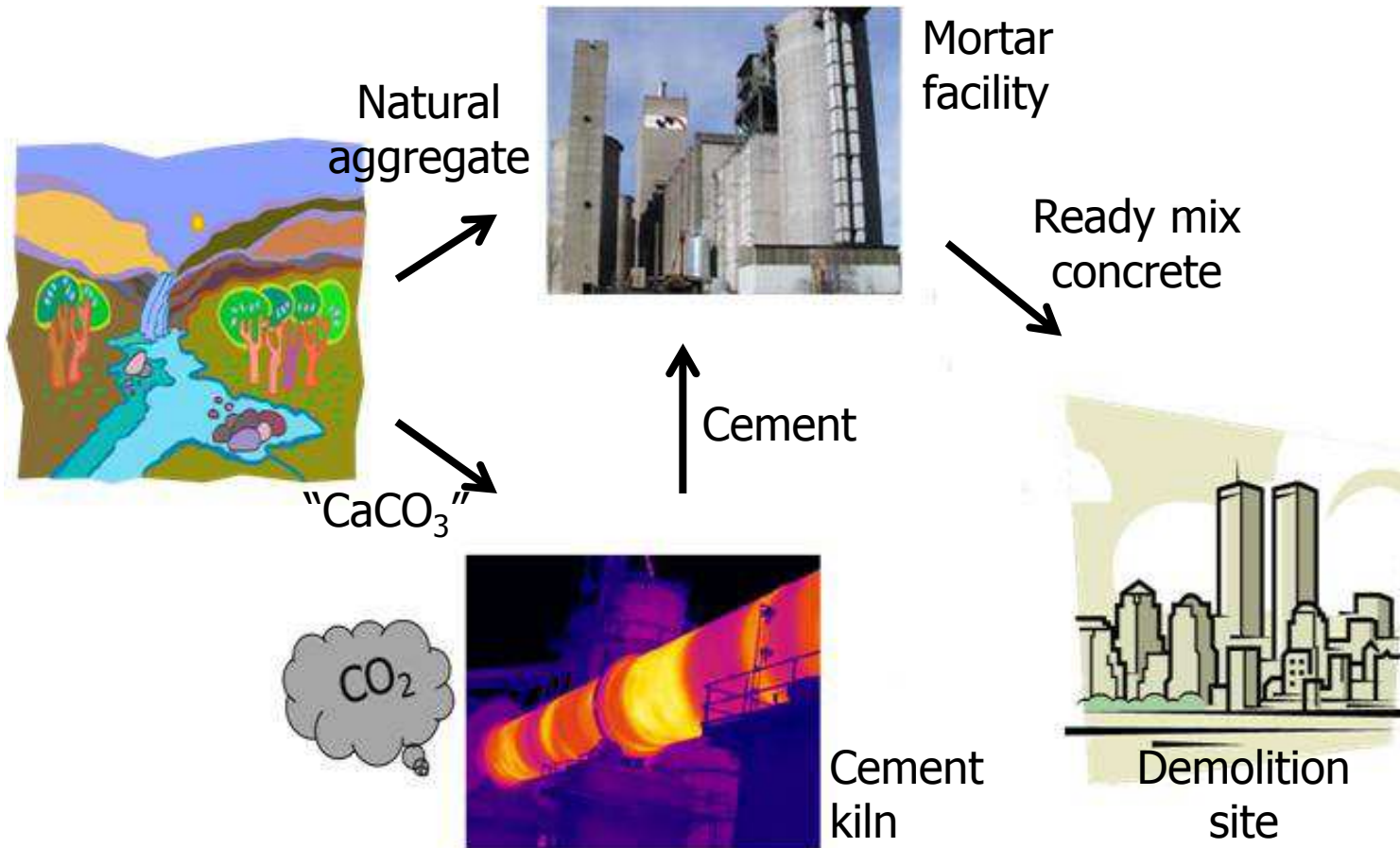
Economy pushes innovations on technology and business models

Business model:

- Avoid/minimize transfer of ownership/trading fees
- Avoid transport (both number and distance)
- Create transparency about quality

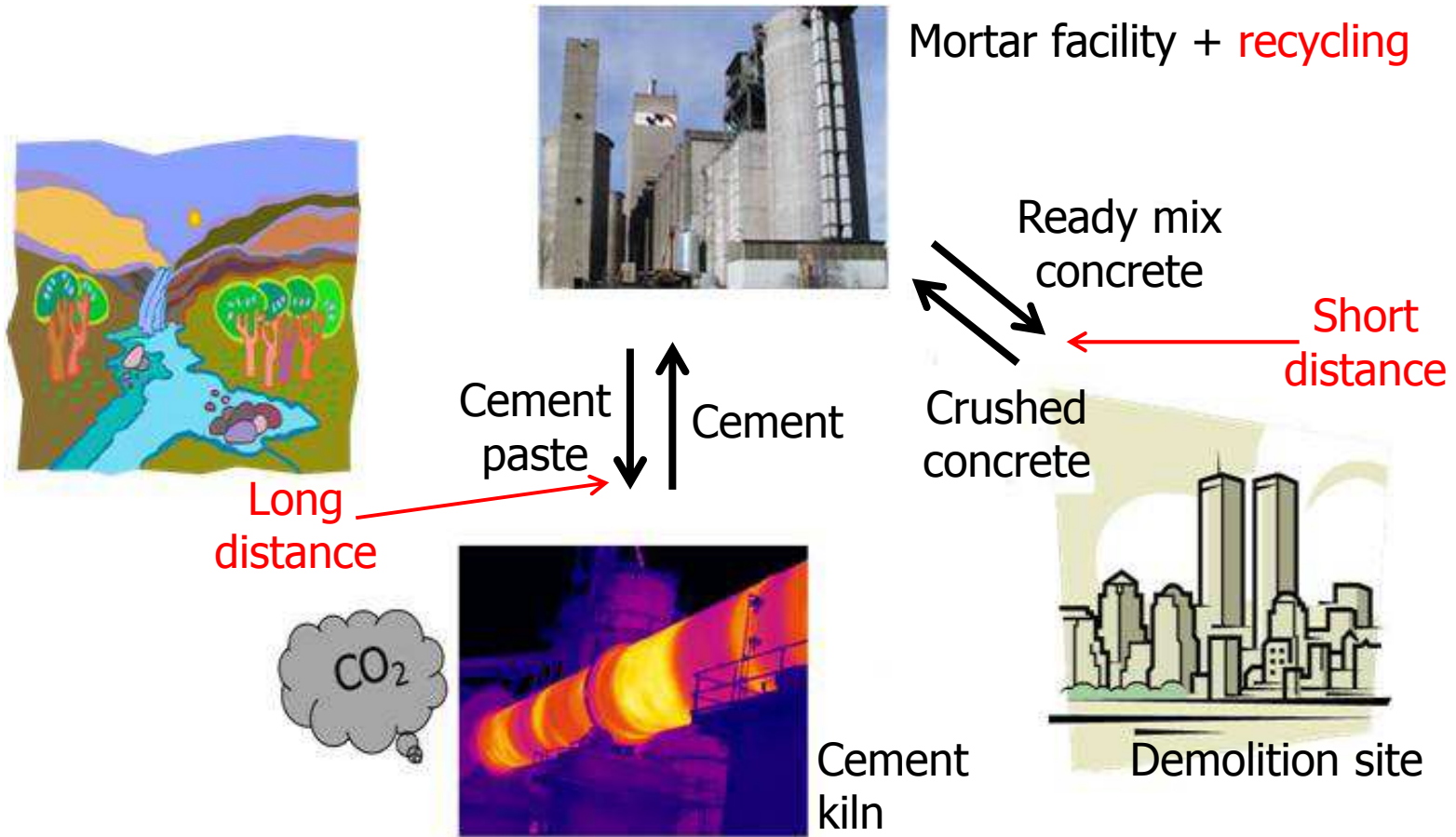
Is concrete-to-concrete possible?

Avoid transport: primary raw materials base case



Is concrete-to-concrete possible?

Avoid transport: Recycling at mortar facility



Is concrete-to-concrete possible?

Recycling at mortar facility, high-Ca cement paste

- Recycling at the mortar facility has favorable **economy of scale** wrt demolition sites and leads to **minimal transport and material transfer**
- **Minimal trading fee** based on trust relation demolition company – mortar facility or based on on-line quality control
- High-Ca cement paste product needed to **minimize transport over long distances**

Is concrete-to-concrete possible?

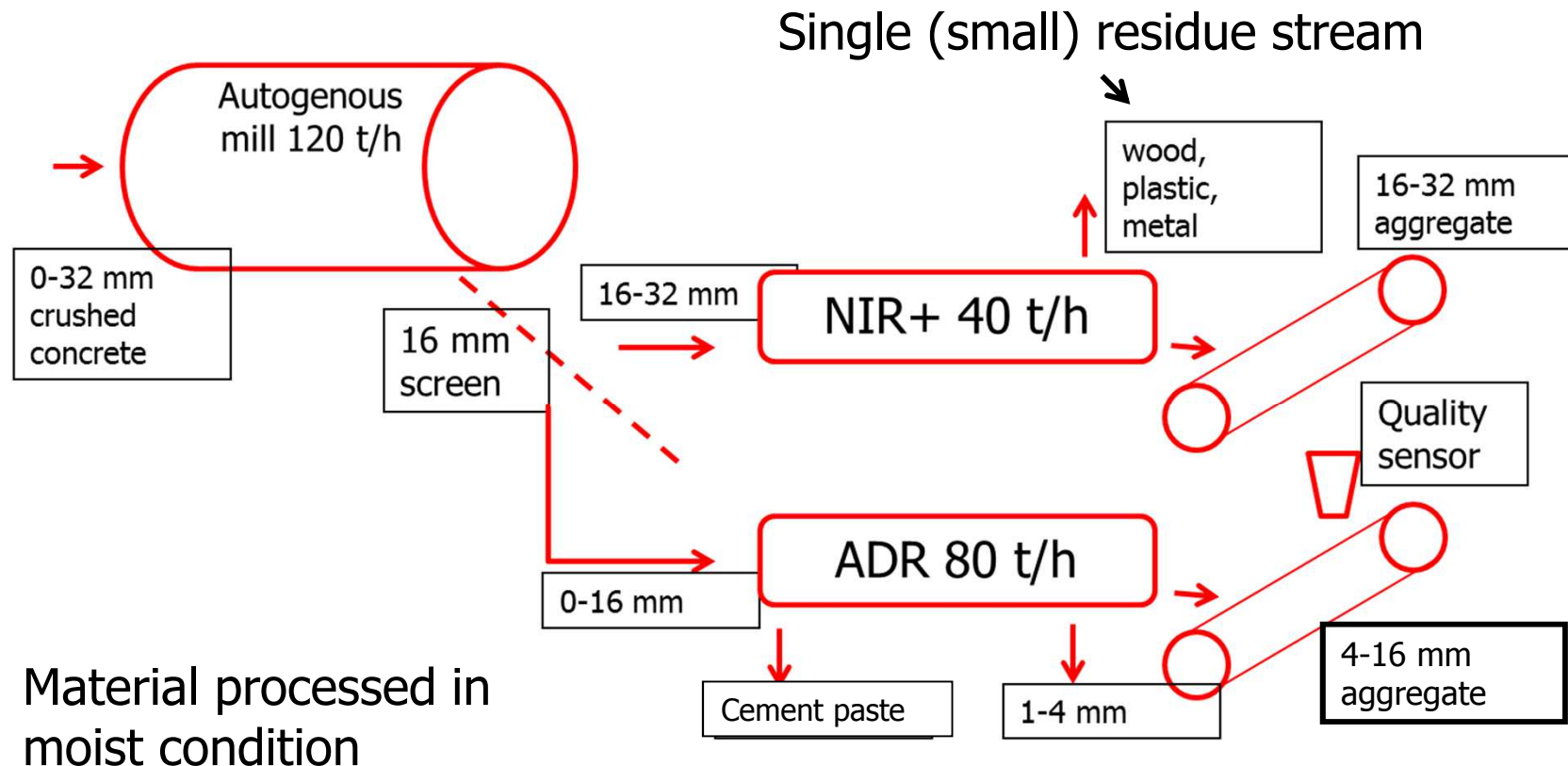
Constraints on technology and business model

Technology:

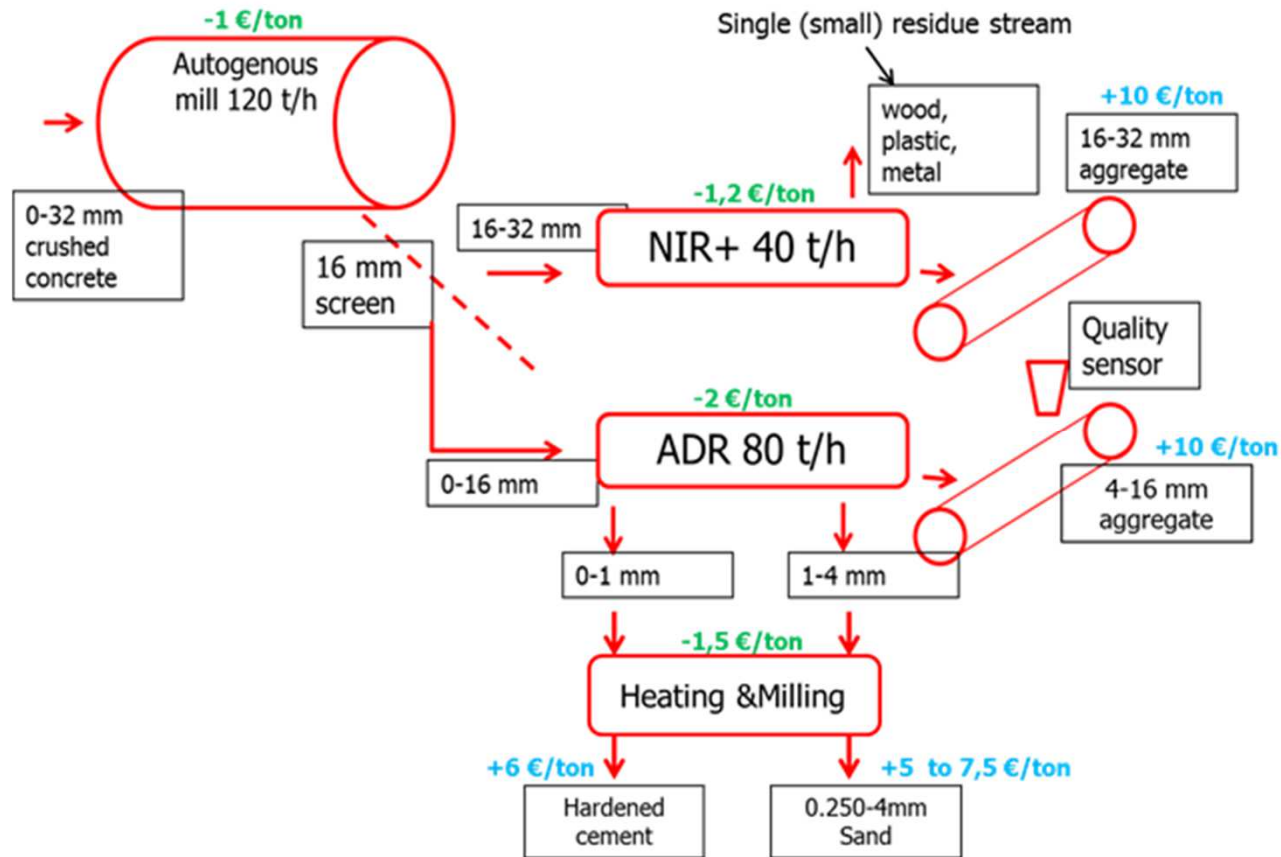
- Only cheap unit processes (0.5 – 2 €/ton)
- No residues (land fill costs are prohibitive in NL)
- High-quality products: better than natural wherever possible

C2CA recycling process

Process flow sheet: only cheap unit processes



C2CA process costs



Why use NIR sorter on >16 mm?

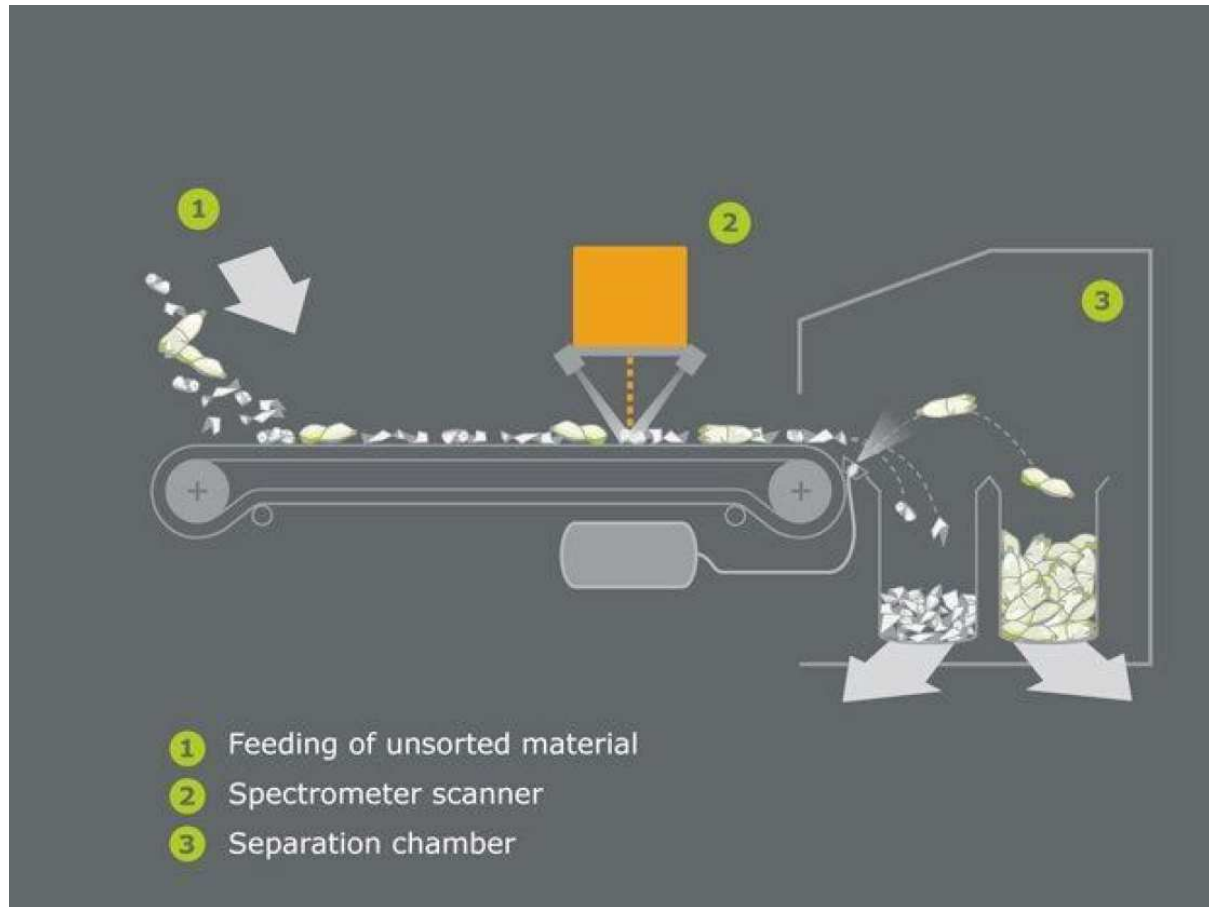
Wood, metal and plastic contaminants



+16 mm has varying levels of wood, plastics and metal contaminants



Tests NIR (near infrared) sensor



Principle of TITECH autosort

Tests NIR (near infrared) sensor

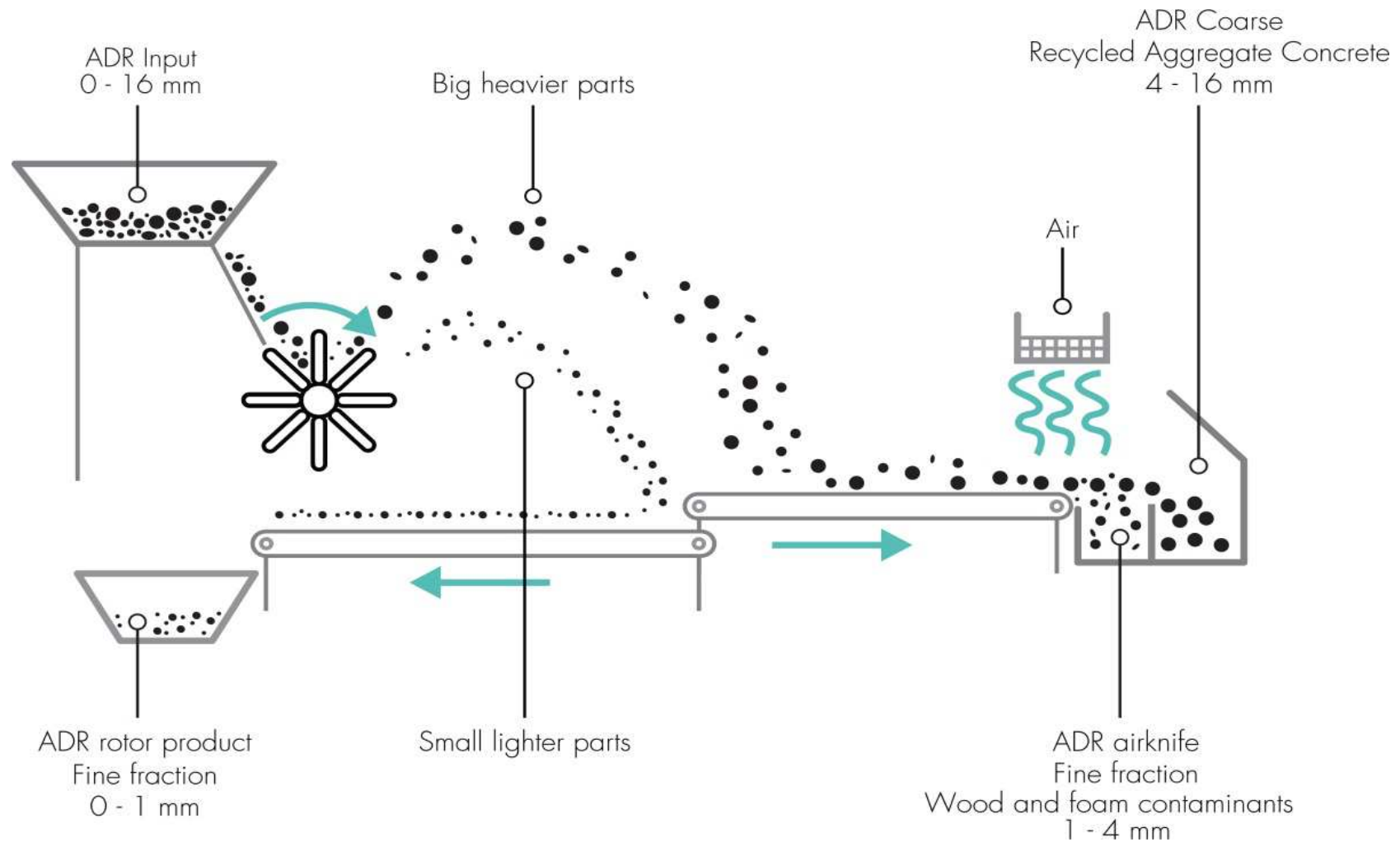
NIR
Sensor





Ejected contaminants
after NIR sorting

Why ADR treatment?



Why ADR treatment?



Products from crushed concrete by ADR: coarse (left) and fine (right)

Why ADR treatment?

Separation and thermal-mechanical treatment
of contaminated 0-4 mm fraction





Challenge the future



Industrial demonstration (120 t/h)
When: on June 10, 2016
Where: Hoorn, The Netherlands





Location C2CA (HOORN)

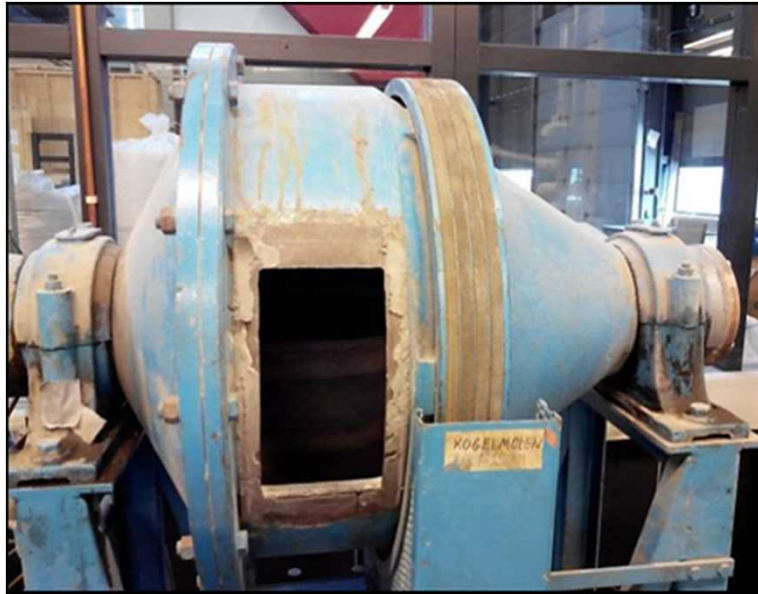
C2CA

Mebin

STRUKTON
GRONDSTOFFEN /
OOMS PRODUCTEN

Thermal-mechanical treatment of 0-4 mm fraction

- ✓ Heating of the 0-4 mm and milling to concentrate more cement into the 0-0,250mm fraction



Lab scale ball-mill



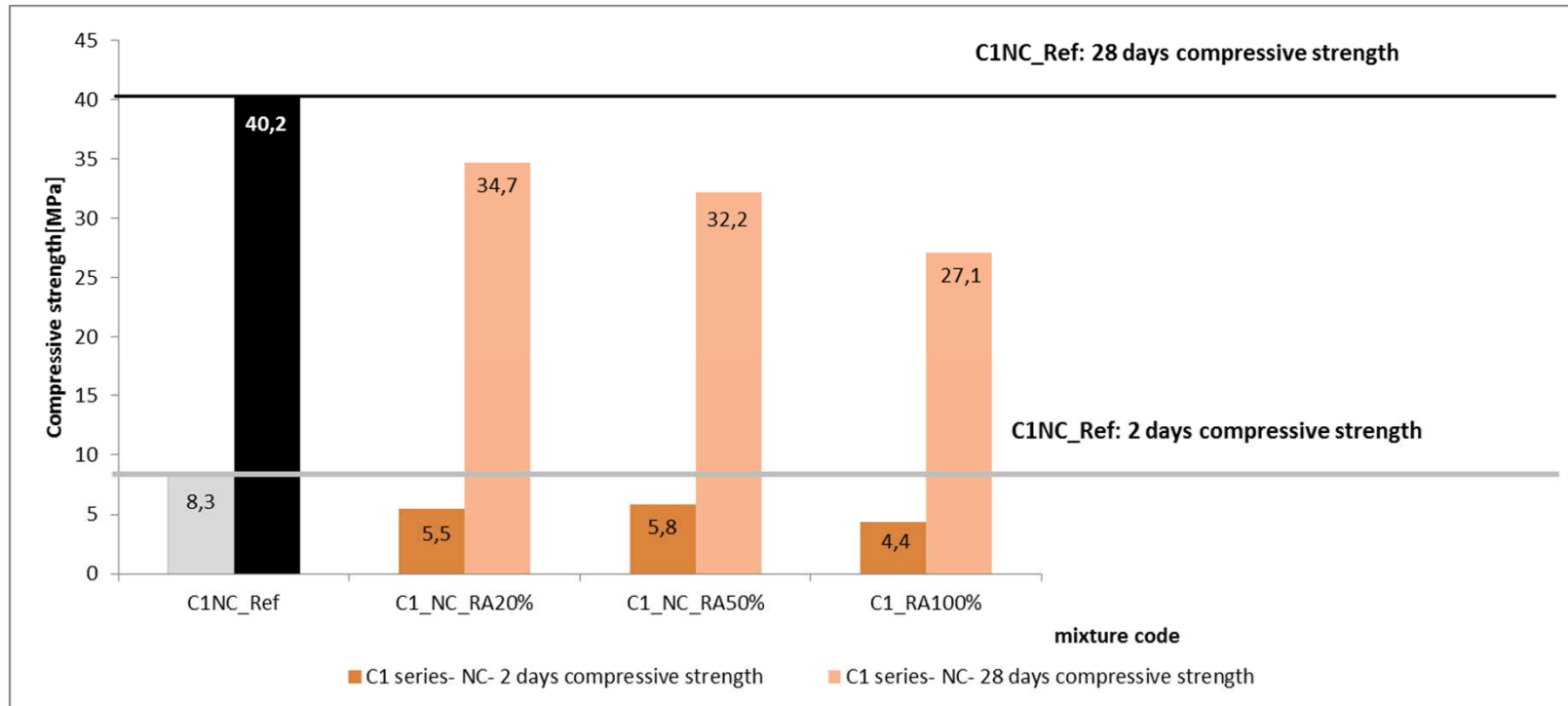
Product quality

Can we achieve equal or better results than with natural raw materials?

Options that would add value:

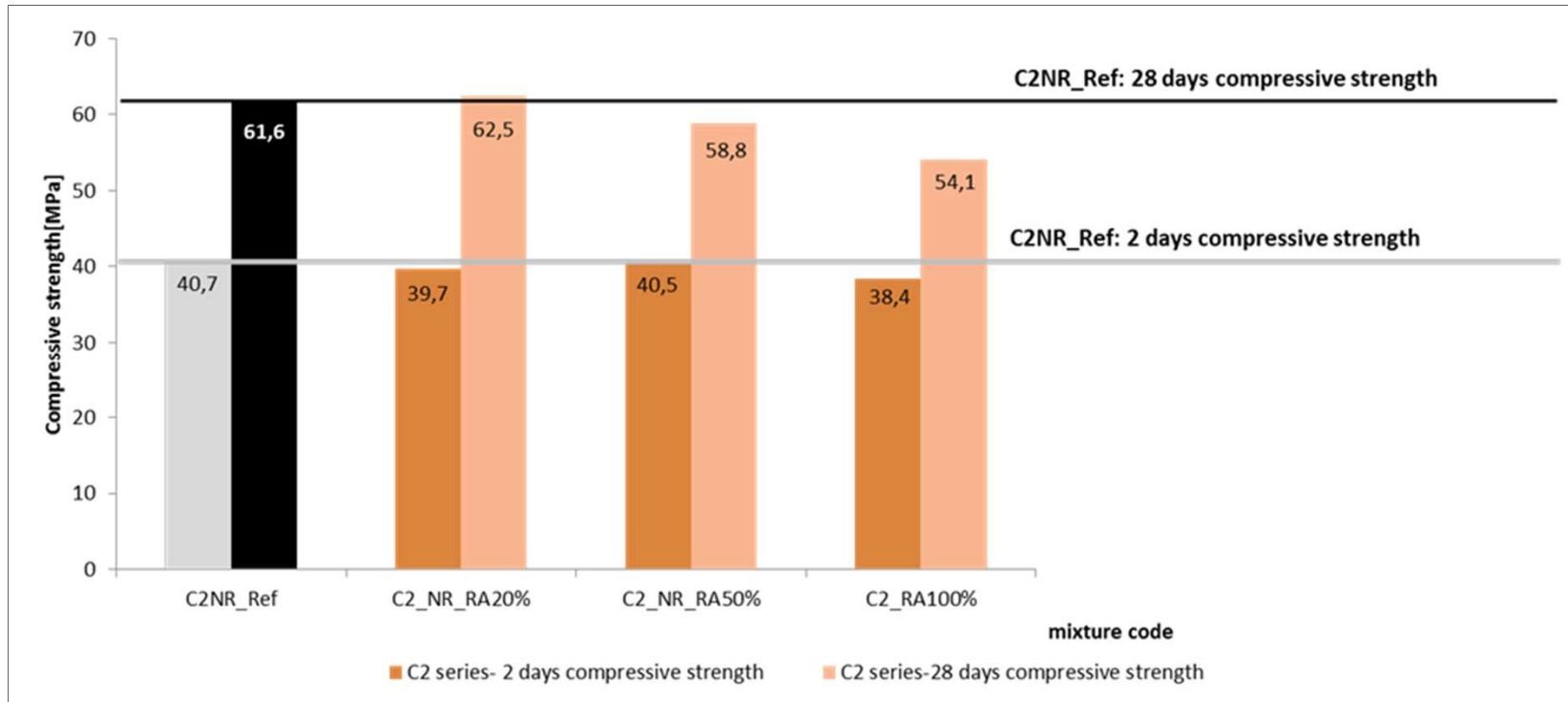
- Recycled aggregate: higher strength; faster strength; more durable
- Cement: Calcium Silicates (old cement paste) can be used in the cement kiln to reduce CO₂ emissions; Calcium Silicates can be used in low-temperature cements

Product quality: C2CA aggregate



Compressive strength after 2 and 28 days, reference sample with 100% natural aggregates in comparison with concrete samples with 20%, 50% and 100% substitution of recycled aggregates: trials by Holcim

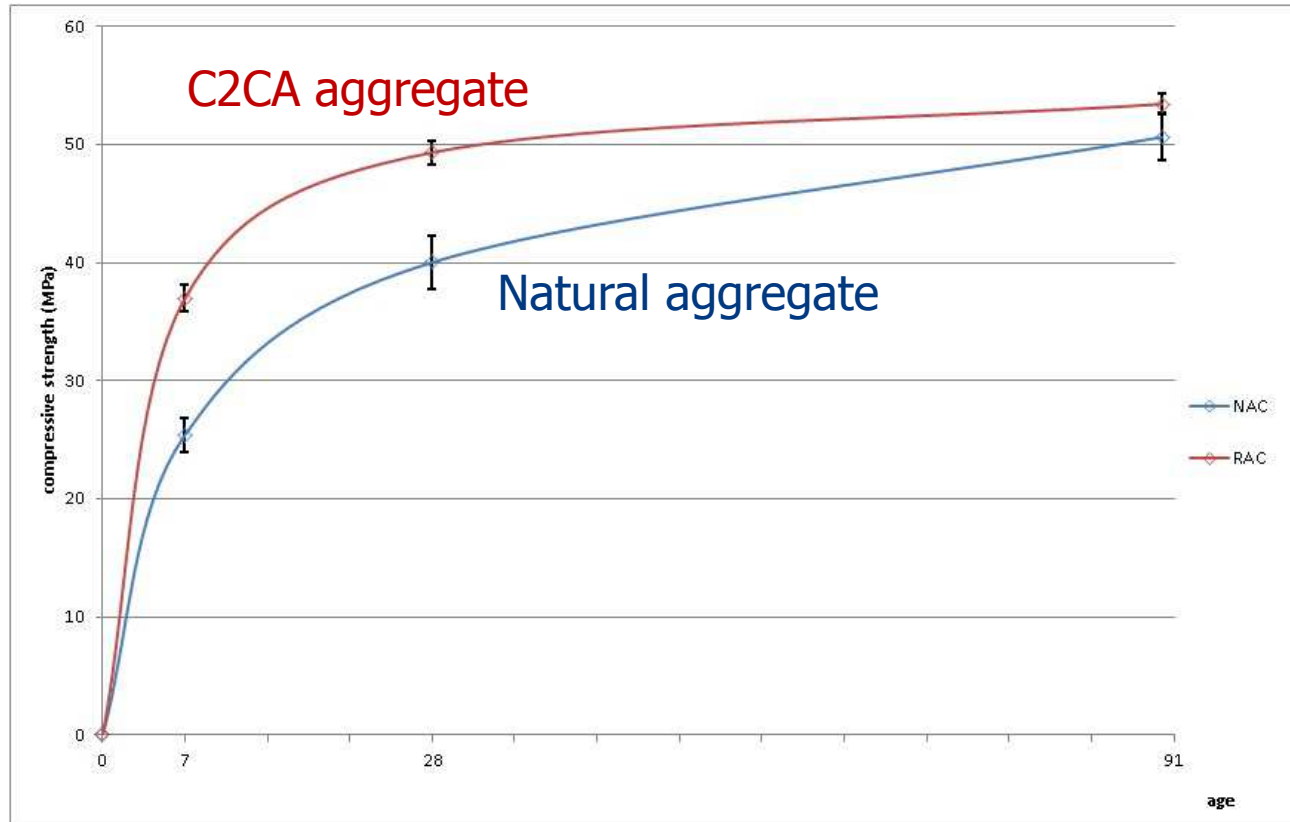
Product quality: C2CA aggregate



Compressive strength after 2 and 28 days, reference sample with 100% natural aggregates in comparison with concrete samples with 20%, 50% and 100% substitution of recycled aggregates: trials by Heidelberg

Product quality: C2CA aggregate

Strength development much faster for recycled aggr.



Comparison between compressive strength of concrete with 100% of natural aggregate (—) with concrete with 100% of recycled aggregates (—) at different ages: trials by AGH University

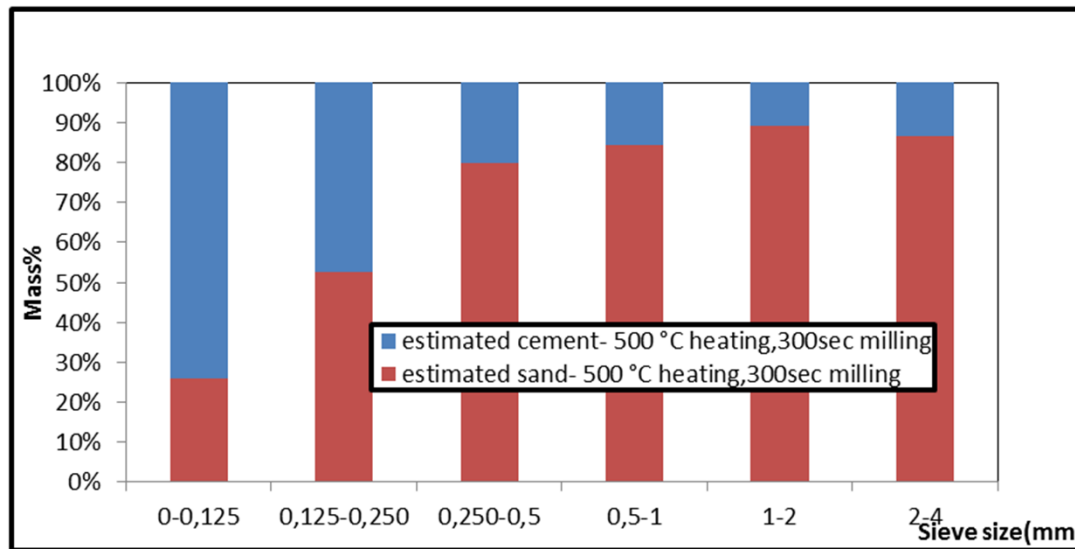
Product quality: C2CA aggregate

Concrete quality depends strongly on production process, not just on raw materials

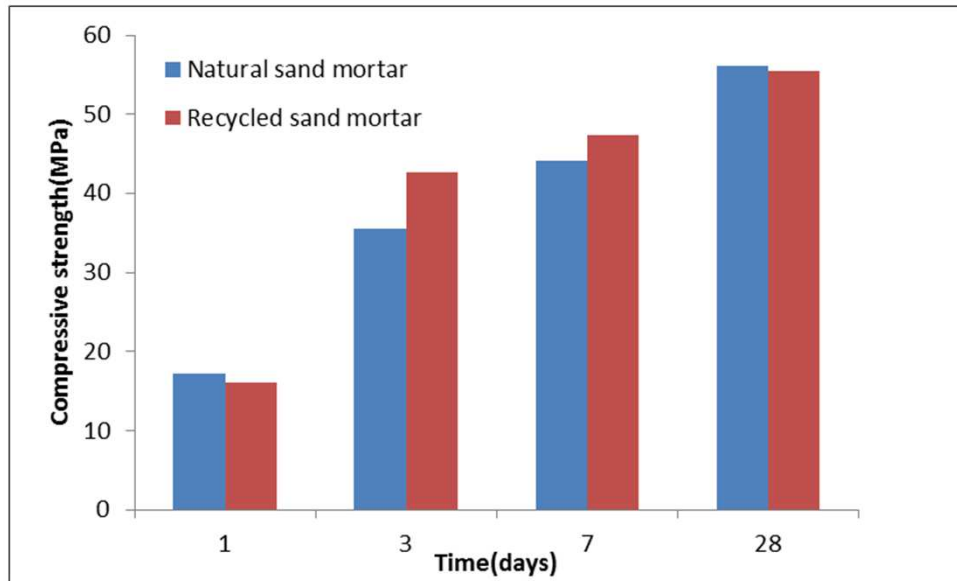
Conclusions:

- Recycled aggregate can provide strength development essentially beyond that reached with natural aggregate, using the same amount of cement
- Procedure for making concrete from recycled aggregate is different, akin to procedures used with light aggregate
- Key is in high-level understanding of concrete production process

Cement paste produced from 0-4mm



Compressive strength test 0-4 mm sand



Results of the compressive strength test of mortar samples
Comparison with natural confirms the quality of the recycled sand

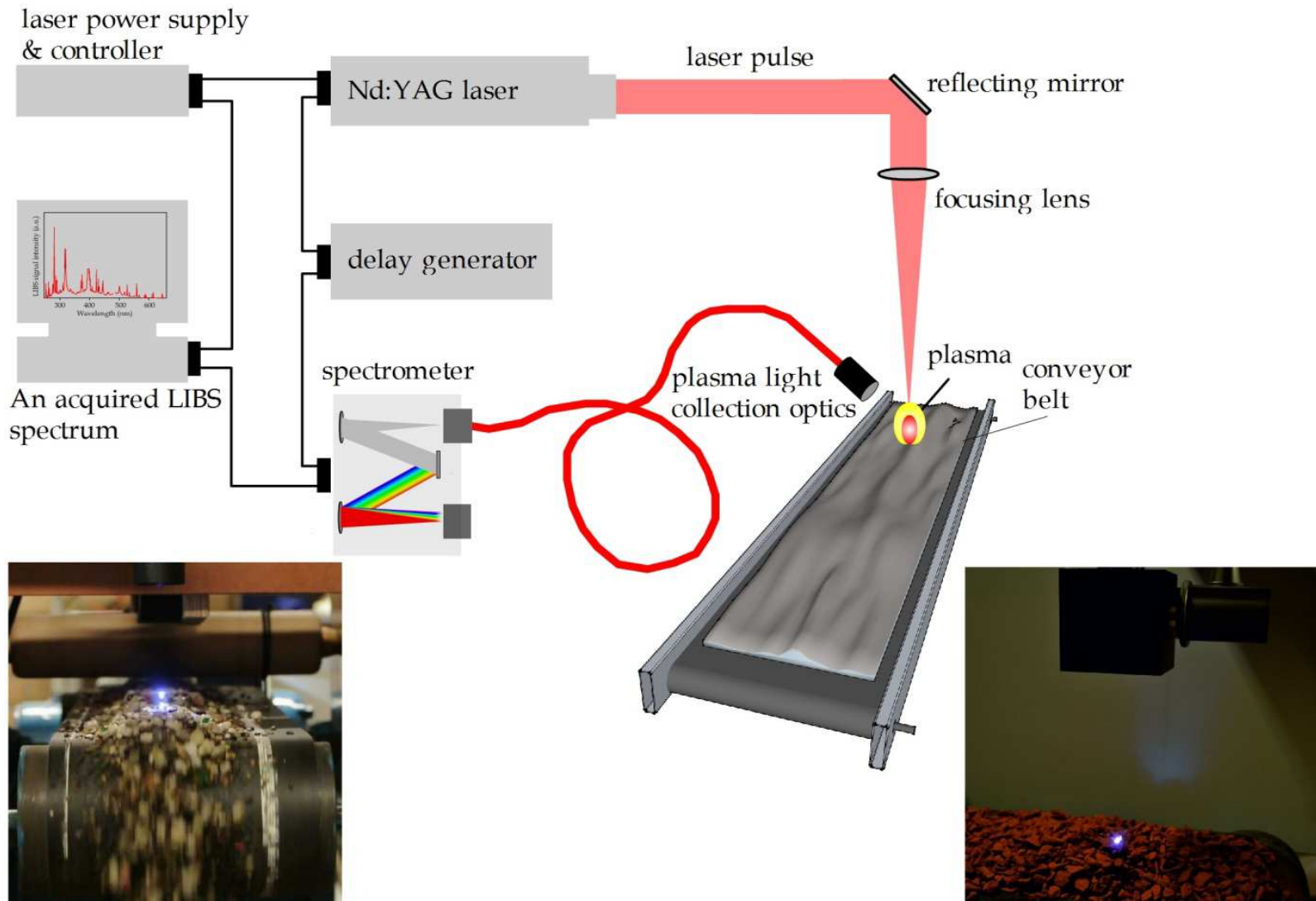
Product quality

Can we achieve equal or better results than with natural raw materials?

Conclusions:

- Recycled aggregate: faster strength; not stronger, not more durable
- Cement: Calcium Silicates (C2CA: 50% of old cement paste) can be used in the cement kiln to reduce CO₂ emissions;
- Calcium Silicates can be used in low-temperature cements (indication from the market)

LIBS Quality Assessment



HISER Project



Holistic Innovative Solutions for an Efficient Recycling and Recovery of Valuable Raw Materials from Complex Construction and Demolition Waste (HISER) project is co-financed in the framework of the biggest EU Research and Innovation Programme - Horizon 2020.

HISER project is an answer to European challenges that have been identified in the construction and demolition sector such as:

- the need to move towards highly efficient paradigms of recovery of valuable raw materials in priority waste streams within the EU28,
- the need for progress in novel recycling technologies for complex Construction and Demolition Waste,
- the need for novel solutions stimulating selective sorting at source of materials arising from demolition and refurbishment works.

HISER objectives

The **main objective of HISER** is to develop and demonstrate novel cost-effective holistic solutions (technological and non-technological) to increase the recovery rates from increasingly complex Construction and Demolition Wastes (C&DW), according to the principles of circular economy approach throughout the whole value chain in the construction sector.

The following **solutions are proposed** within the project:

- harmonized procedures, supplemented by an intelligent tool and systems for traceability of the supply chain, for highly-efficient sorting at source in demolition and refurbishment works,
- advanced sorting and recycling technologies with automated quality control for the production of high purity raw materials from complex C&DW,
- development of optimized construction products (such as low embodied energy cements, green concretes, bricks, gypsum plasters and gypsum plasterboards or extruded composites) with higher rates of recycled materials.

Thank you

Francesco Di Maio

Email address: f.dimaio@tudelft.nl

www.C2CA.eu

www.hiserproject.eu

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