Circular concrete: A myth or a reality?

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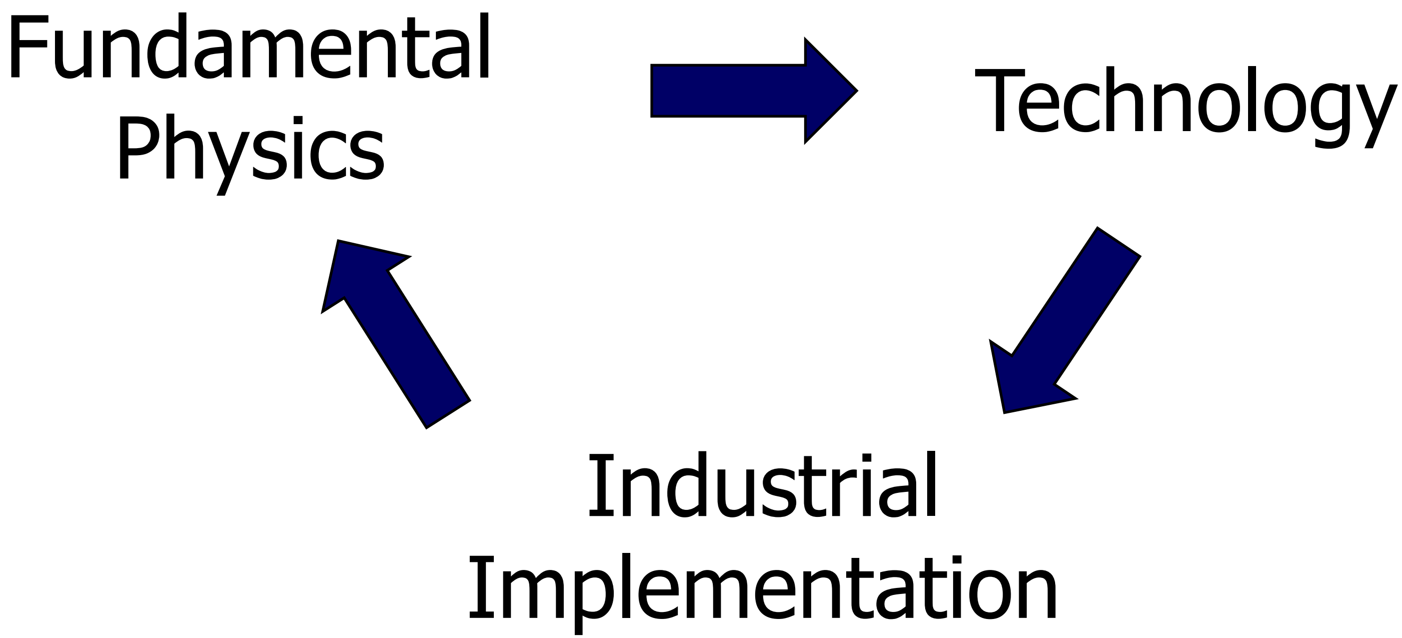
Resources & Recycling

Mission statement

Support the raw material supply of Europe by innovations in recycling

Resources & Recycling



Group Spinoffs

Company spinoffs over the last 6 years

ReSteel: Separation of Steel-Copper scrap (CSM)

INASHCO: Metals recovery from MSWI bottom ash (ADR)

URBAN MINING DELFT: Plastics sorting (MDS)

C2CA: Concrete recycling (ADR + HAS)

Introduction

The Resource Challenges:

- Use of building materials leads to massive global resource extraction
- Concrete accounts for the main share
- Cement industry contributes 5% to global CO_2 emissions, unavoidable of which 3% not energy related
- Steel industry contributes 5%, partly also non-energy related

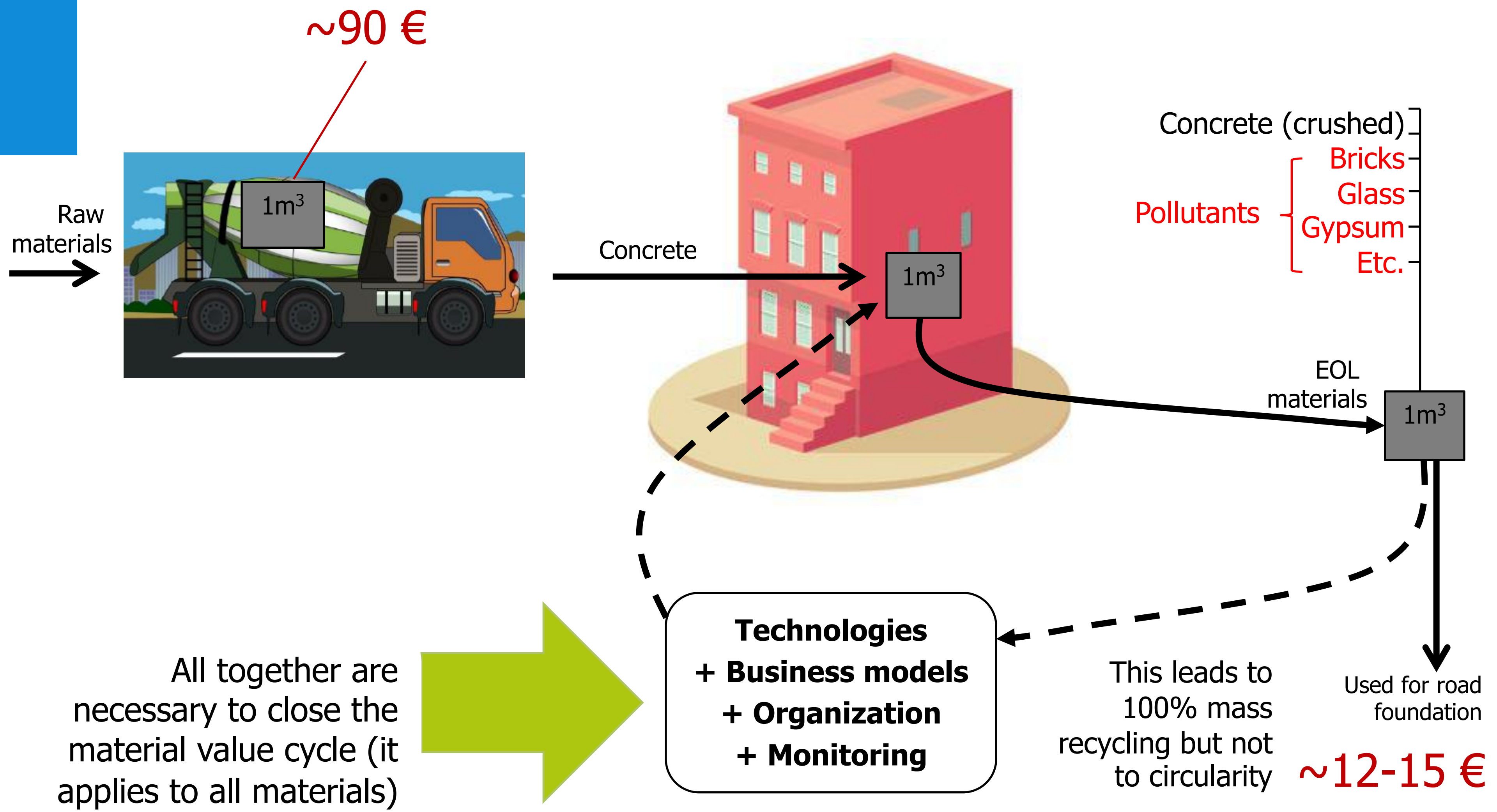
Introduction

The Waste Challenges:

- C&DW (construction and demolition waste) increases exponentially
- End-of-life (EoL) concrete represents 60-70% of C&DW
- High potential for recycling, but largely downcycled
- EU generates 461 Mt/yr CDW (Construction and Demolition Waste), make it the largest waste stream, if landfilled, would cover 75% of the Dutch land
- EU Waste Framework Directive (2008) target: "by 2020, the preparing for reuse, recycling and other material recovery, including backfilling … shall be increased to a minimum of **70 %** by weight."

Implementing Circular Economy

To implement CE it is necessary to close the material value cycle



Technologies for concrete recycling

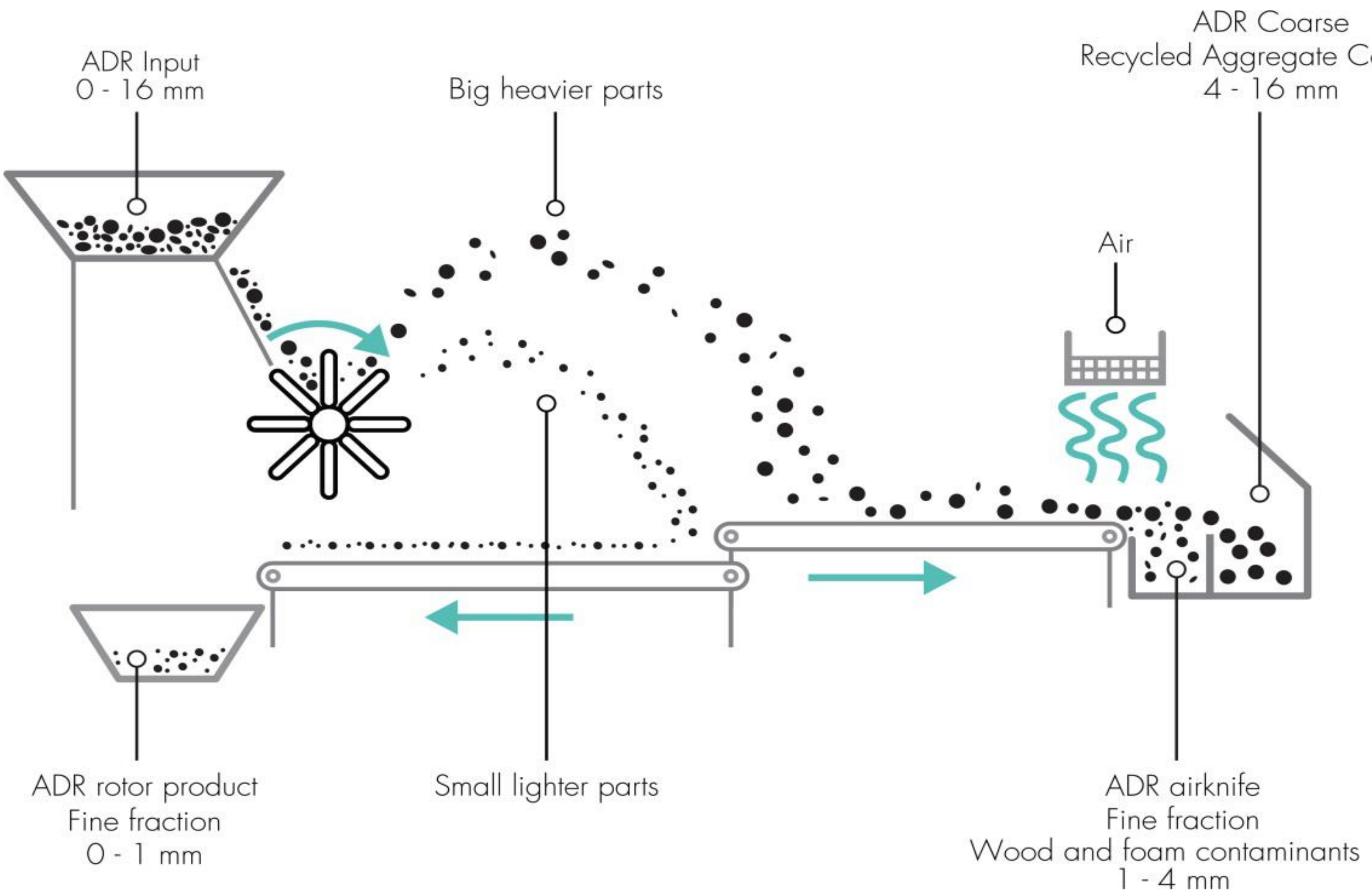
- **ADR** (Advanced Dry Recovery)
- **HAS** (Heating Air Classification System)
- **LIBS** (Laser Induced Breakdown Spectroscopy)

Three large European funded projects in the field:

- C2CA — SEVENTH FRAMEWORK PROGRAMME
- HISER — HORIZON 2020 THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION
- VEEP — HORIZON 2020 THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION

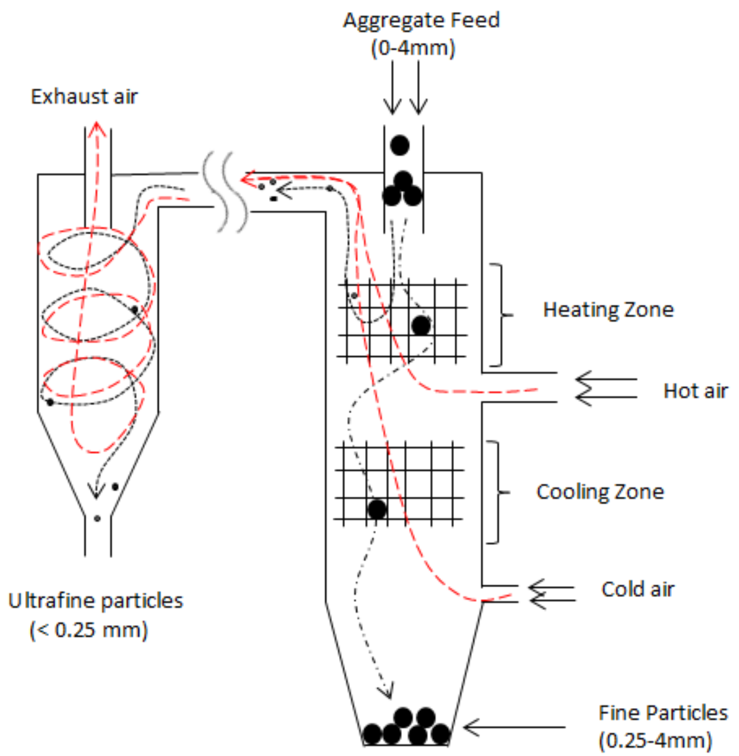
ADR (Advanced Dry Recovery)

ADR technology to separate crushed concrete coarse from fines



HAS (Heating Air Classification System)

Thermal-mechanical treatment of 0-4 mm fraction

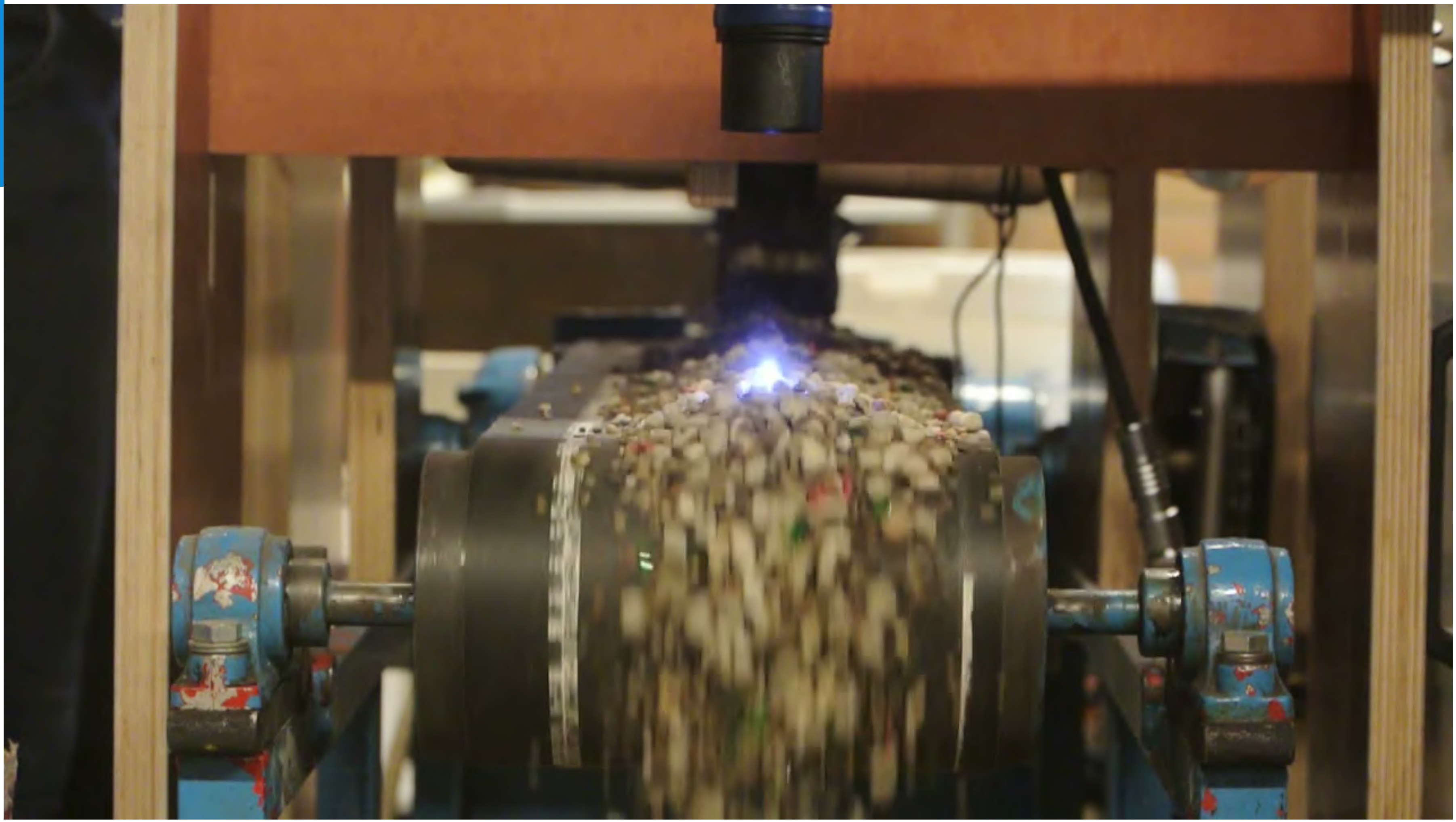


Sketch of HAS design and working principle.

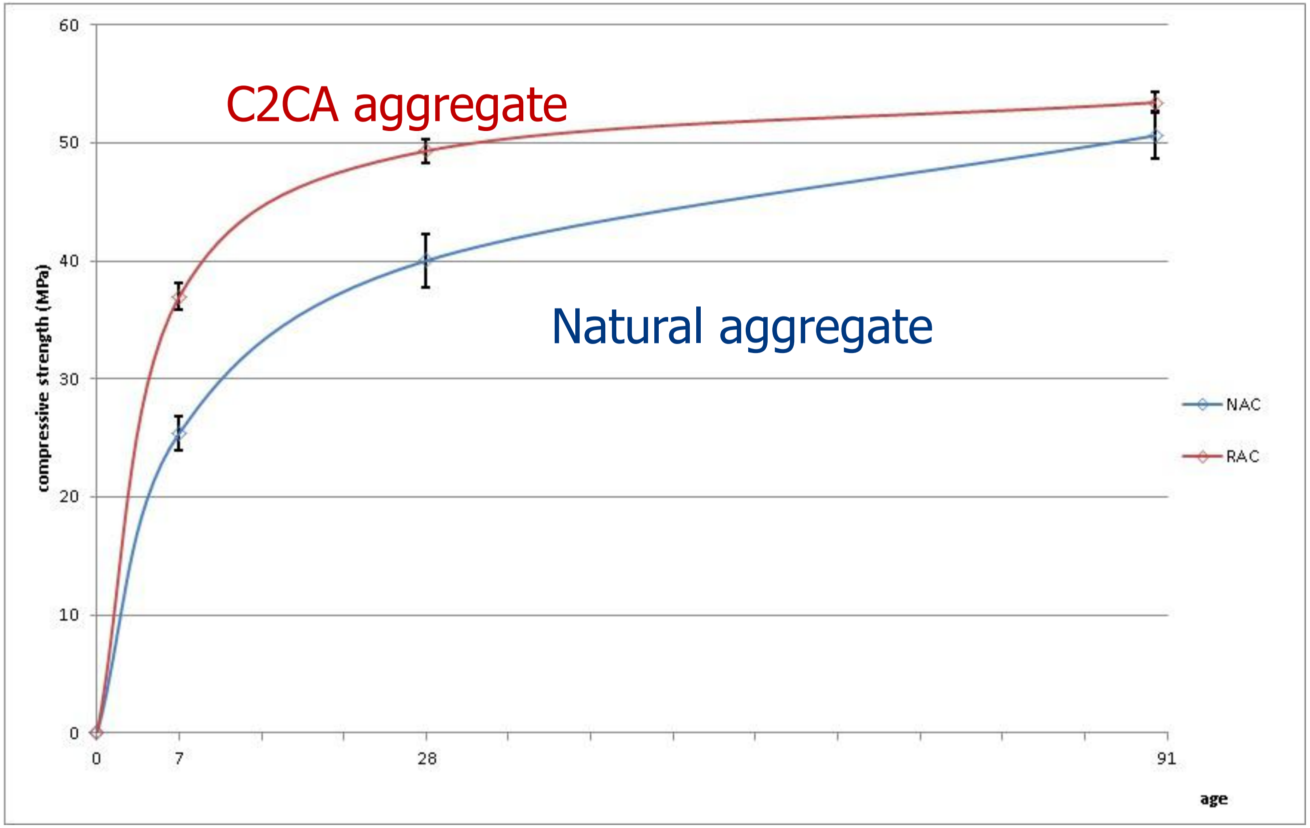
Heating of the 0-4 mm and milling to concentrate more cement into the 0-0,250mm fraction

ADR & HAS

LIBS (Laser Induced Breakdown Spectroscopy)



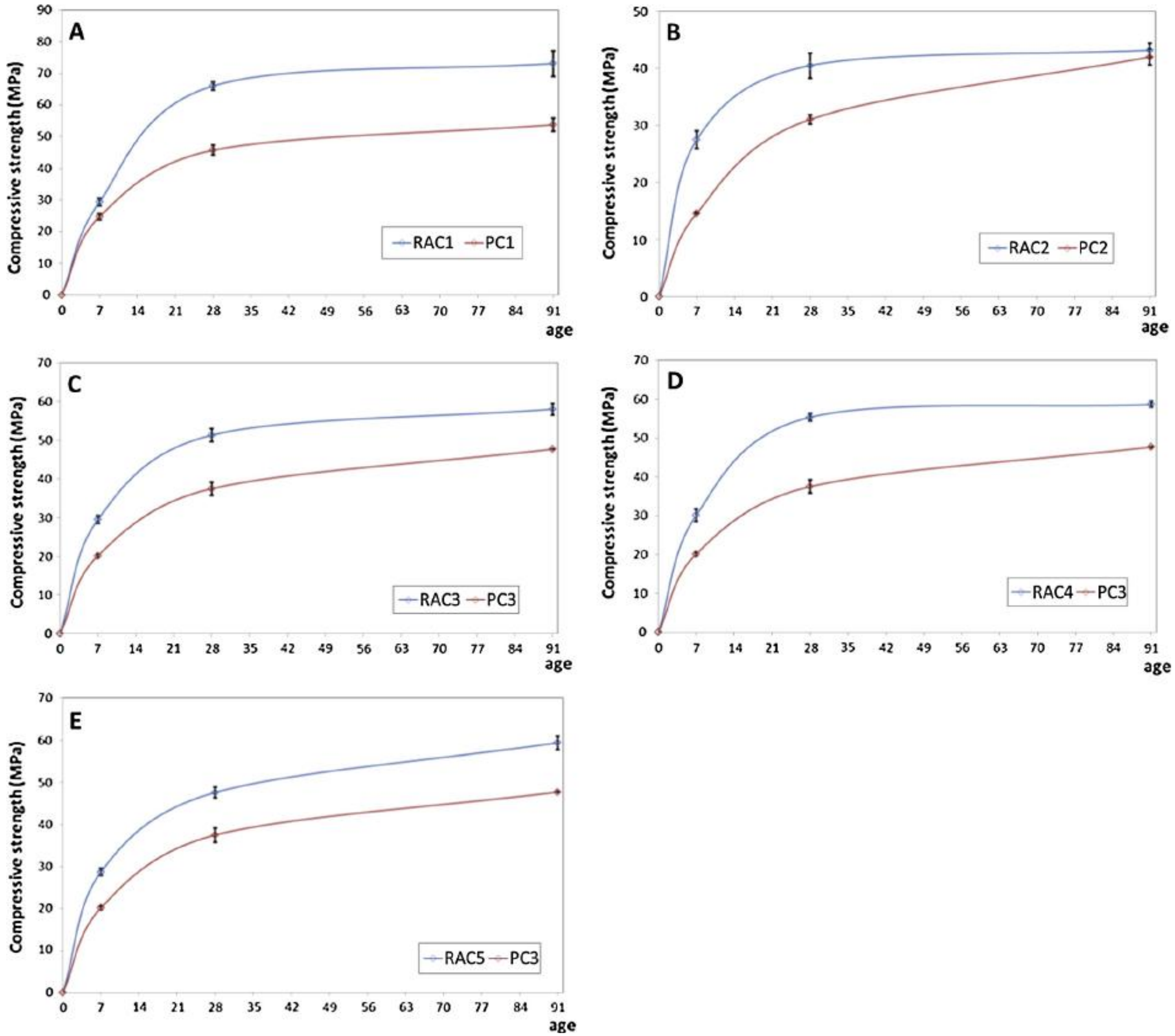
Main result from ADR recycled coarse:



Using recycled aggregates concrete achieves higher early strength

Product quality from ADR recycled coarse:

Strength development faster for recycled aggregates



Composition of fines out of HAS is comparable with limestone

Oxides	ADR fines directly used in C2CA trial	FF (0-0.125 mm) resulted from heating and grinding	Example Clay	65% $CaCO_3$ (marl) Limestone-low quality	95% $CaCO_3$ Limestone-high quality
SiO_2	75.49	41.2	67.30	21.80	2.83
Al_2O_3	4.57	6.42	9.00	5.48	0.69
TiO_2	0.23	0.41	-	0.26	0.03
MnO	0.13	0.13	-	0.03	0.03
Fe_2O_3	1.64	2.97	4.30	1.86	0.28
CaO	11.24	35.16	7.30	36.60	53.00
MgO	1.23	1.79	2.00	0.87	0.61
K_2O	0.85	0.78	1.20	0.97	0.13
Na_2O	0.43	-	1.40	0.13	0.04
SO_3	0.78	1.75	0.30	0.56	0.04
P_2O_5	0.07	-	-	0.08	0.06
LOI	9.03	9.13	7.20	30.88	41.90

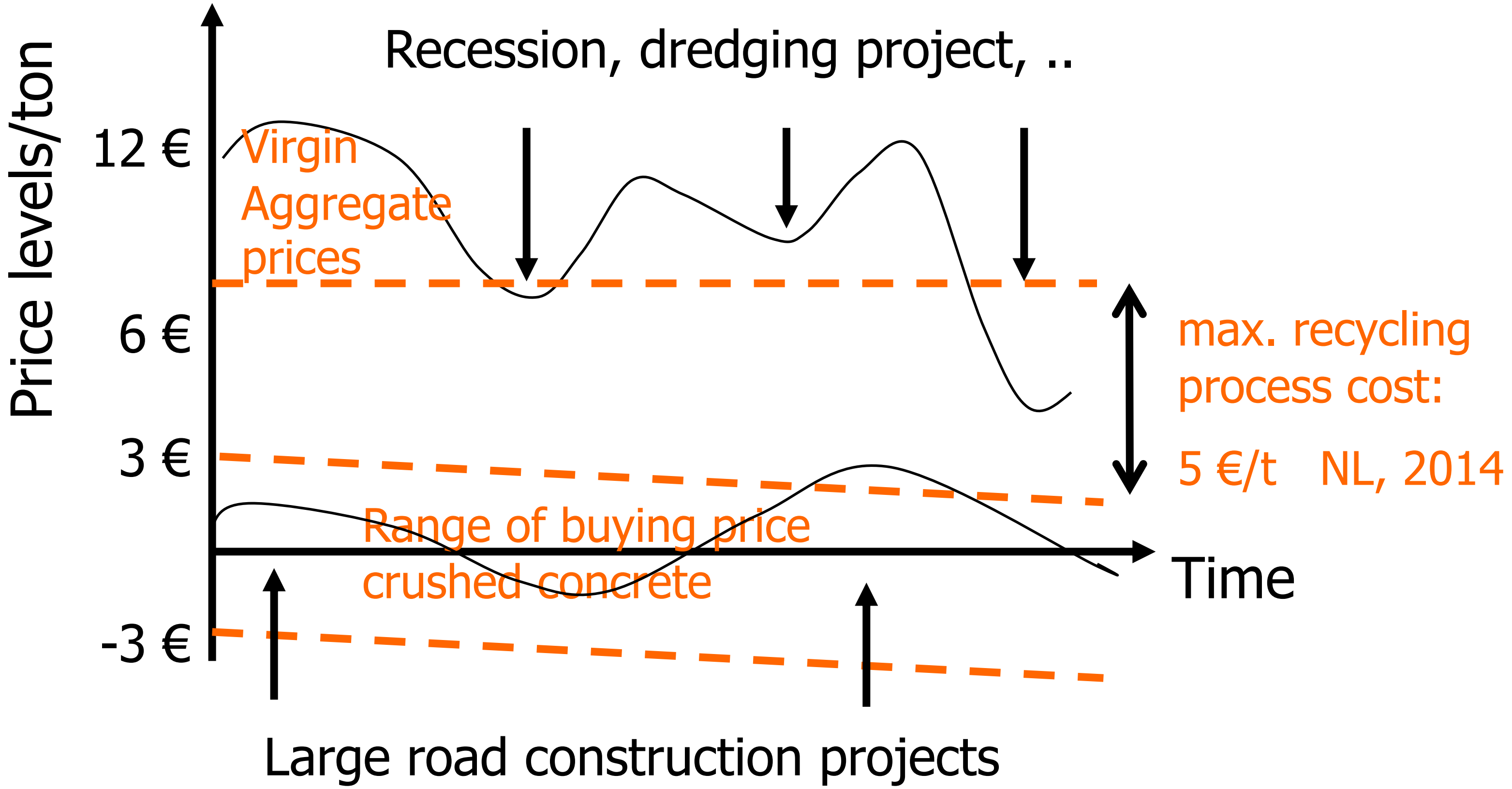
So: technologies are available.

Is cost-effective technology enough to

make the transition to circularity?

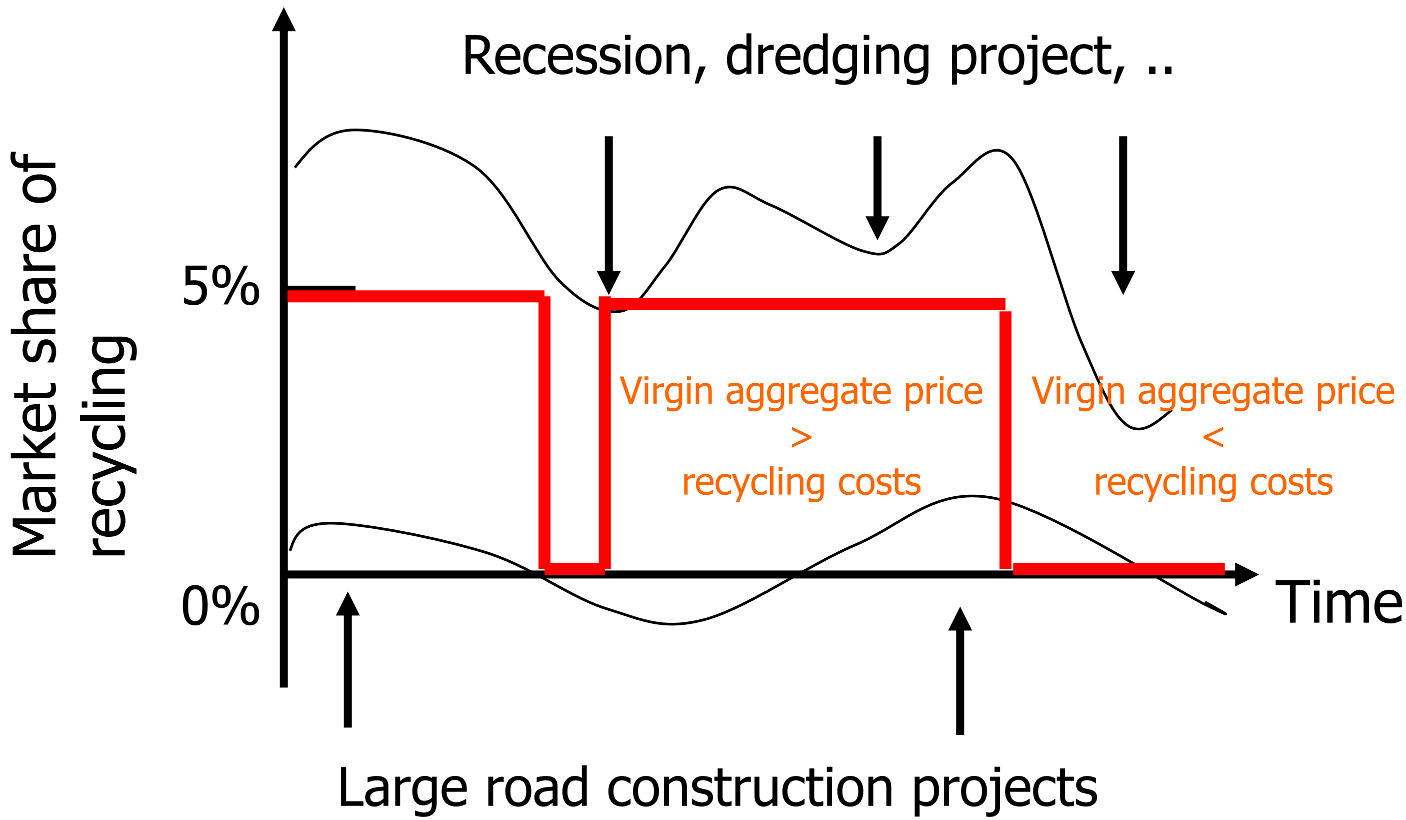
Transition requires more …

Investment in new technology must be secure



Transition requires more …

No investment in new technology while market share for recycled aggregates fluctuates by 100%



Transition requires more …

NL Covenant of all parties in the chain

Dutch enterprises in concrete chain commit to minimum of X% recycle aggregate in new concrete
->

- Different recycling options will compete on quality and price
- Average costs of transition to circularity are negligible
- Initial investors in new technology have small but finite market

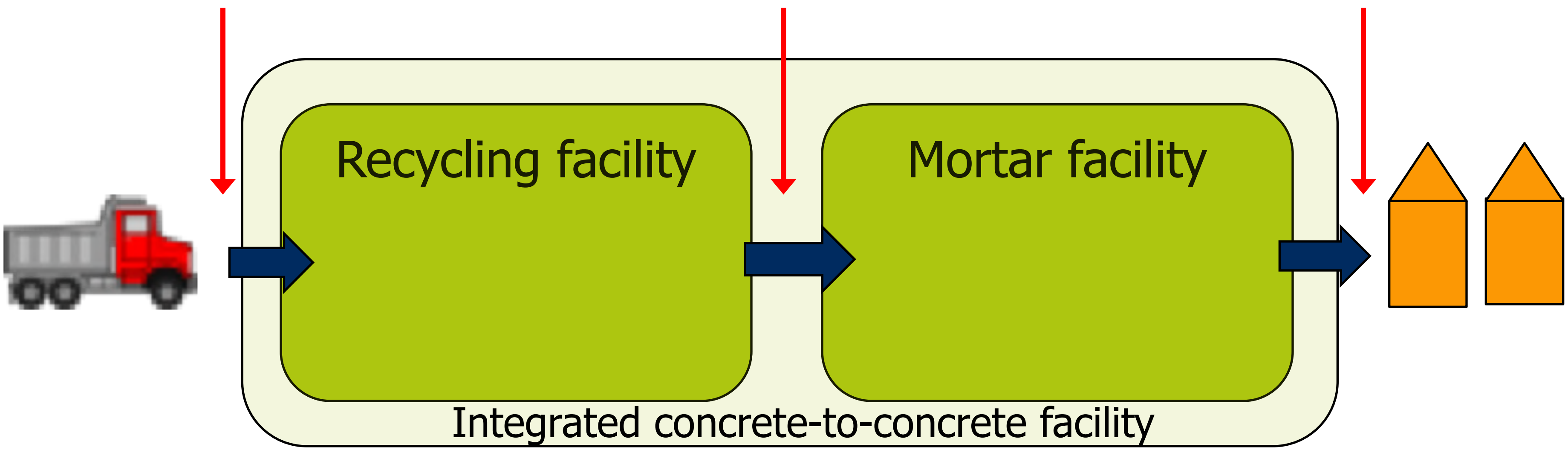
Transition requires more …

Tight quality control needed to control risks

Quality of EOL (Visual)

Quality of recycle aggregate (LIBS)

Guarantee (RMix Producer)



Risk of failure

~5€/ton

~15-100€/ton

~500€/ton

Engage industrial partners to shorten the value chain

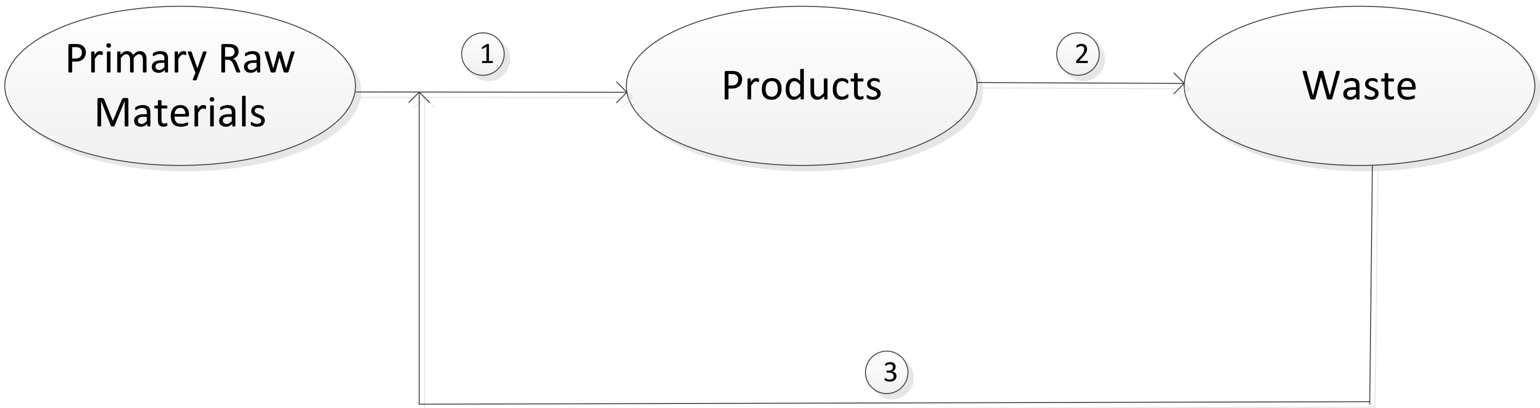
Monitoring

- **Quantify Circularity** for Innovation
- Develop **indexes** to be used by decision makers from government and industry

"Contribute to decouple Economic Growth from Material Input"

Circular Economy Index

Key performance parameter for innovation



1. Resource efficiency of production
2. Resource efficiency of collection
3. Resource efficiency of recycling

Policy makers still lack an effective indicator for stimulating the recycling industry

$$Recycling\ rate = \frac{Mass\ separated\ from\ waste\ streams}{Mass\ collected}$$

$$CEI = \frac{Recycled\ material\ value}{Virgin\ material\ value}$$

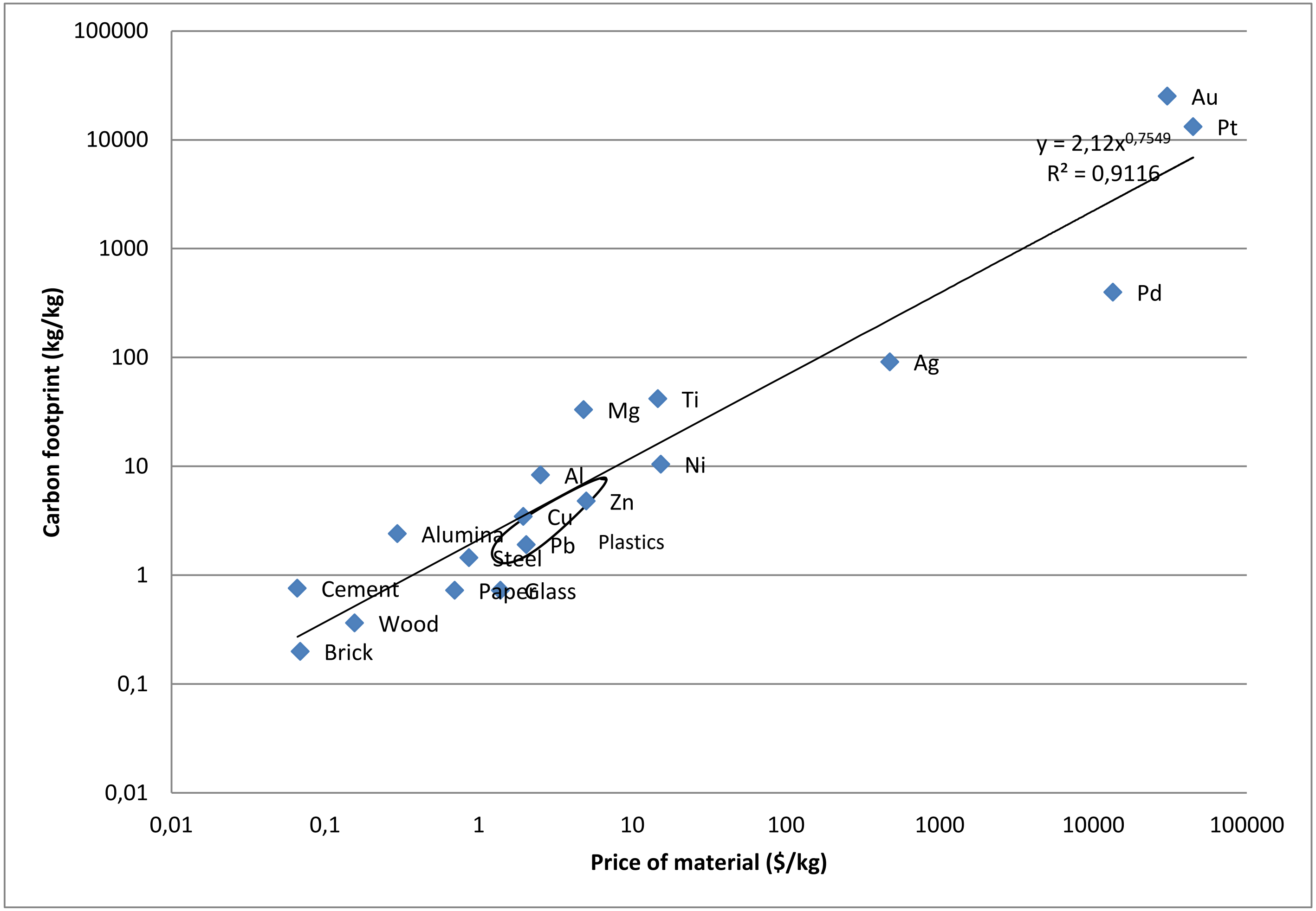
Circular Economy Index

Materials	Steel	Plastics	Al	Cu
Mass (kg)	600	130	50	20

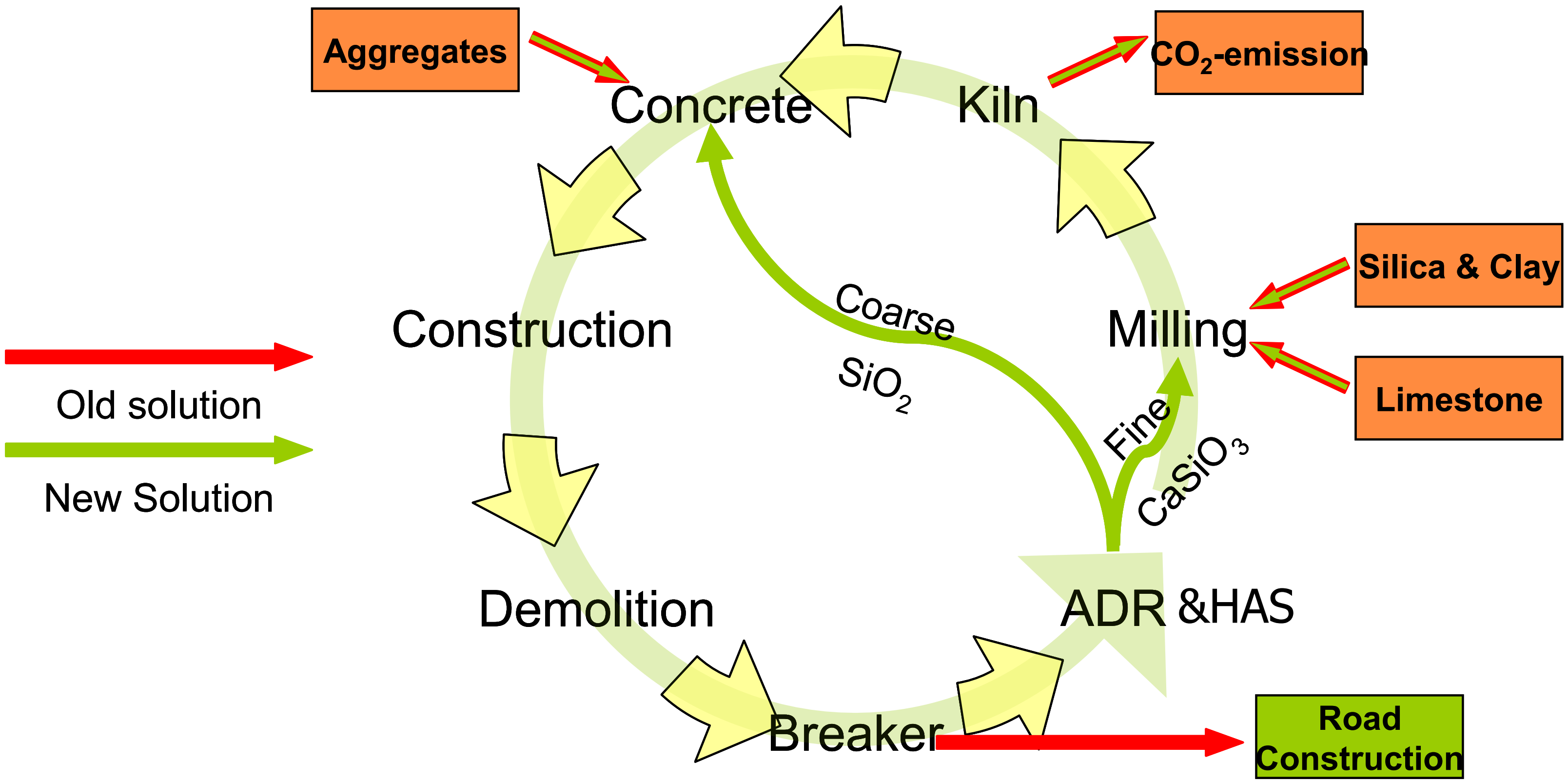
Three scenarios can be envisaged:

1. Use of standard technology to extract 620 kg of steel contaminated by Cu from the ASR.
2. Use of advanced technology to extract 130 kg plastics plus 50 kg Al from the ASR.
3. Use of advanced technology to separate steel from Cu.

Circular Economy Index



C2CA Process



Old route and proposed novel closed cycle for recycling of concrete to cement and aggregate (C2CA).

Thank you

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