Interreg
North-West Europe
SeRaMCo
European Regional Development Fund
EUROPEAN UNION

Welcome

to the first

SeRaMCo Webinar

Secondary Raw

Materials for Concrete

Precast Products

22 June 2020
10:30-12:00 CEST

Interreg North-West Europe SeRaMCo
European Regional Development Fund

Programme

10:30	Welcome	Christian GLOCK, University of Kaiserslautern
10:35	Concrete and the challenge of a low-carbon, sustainable and circular construction: Will precast concrete still be used in 2050?	Alessio RIMOLDI, BIBM
10:45	The influence of the crushing production process on the quality of recycled aggregates	Julien HUBERT, University of Liège
10:55	Availability of recycled material: • Characterization of the building stock in Luxembourg • Assessment of concrete volumes • Availability of the future mineral waste stock based on stochastic scenarios	Lorenc BOGOVIKU, University of Luxembourg

Interreg North-West Europe SeRaMCo
European Regional Development Fund

Programme

11:05	Development of innovative concrete mixtures: • High water demand of the recycled aggregates and the regulating effect of the superplasticizer ACE in a mixture. • Effect of the particle size distribution on the workability of concrete. • Development of medium to high strength concrete with recycled aggregates	Gaël Gelen CHEWE NGAPEYA, University of Luxembourg
11:15	Concrete containing recycled aggregates from unknown origin – Development of new concrete mixes for structural precast elements and pavement blocks	Anja TUSCH, University of Kaiserslautern
11:25	Closed-loop supply chain of construction and demolition wastes: Towards a circular economy in French regions	Nacef TAZI, Cerema
11:35	Discussion, questions & answers	All
11:55	Wrap-up	Christian GLOCK, University of Kaiserslautern
12:00	End	

Interreg North-West Europe
EUROPEAN UNION
SeRaMCo
European Regional Development Fund

Concrete and the challenge of a low carbon, sustainable and circular construction

Will precast concrete still be used in 2050?

Think Concrete, Go Precast
bibm

Alessio RIMOLDI
Secretary General

Webinar
22nd June 2020

Construction 2050

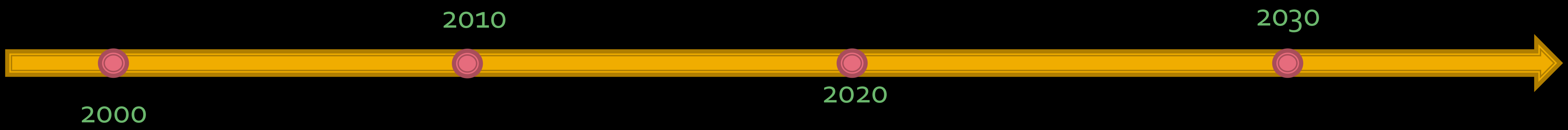
- Energy efficient

Construction 2050

- Sustainable
- Energy efficient

Construction 2050

- Low carbon
- Sustainable
- Circular



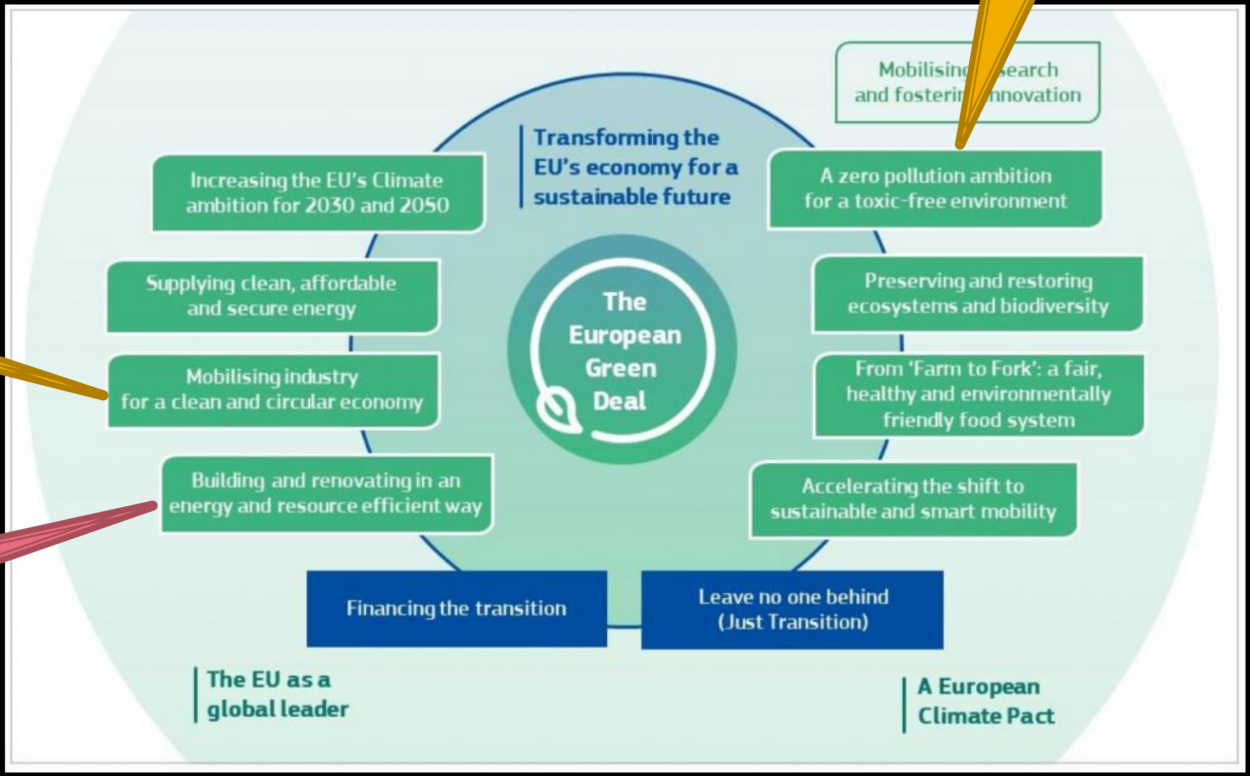
Construction 2050

- ??

Construction 2050

- Low carbon
- Sustainable
- Circular

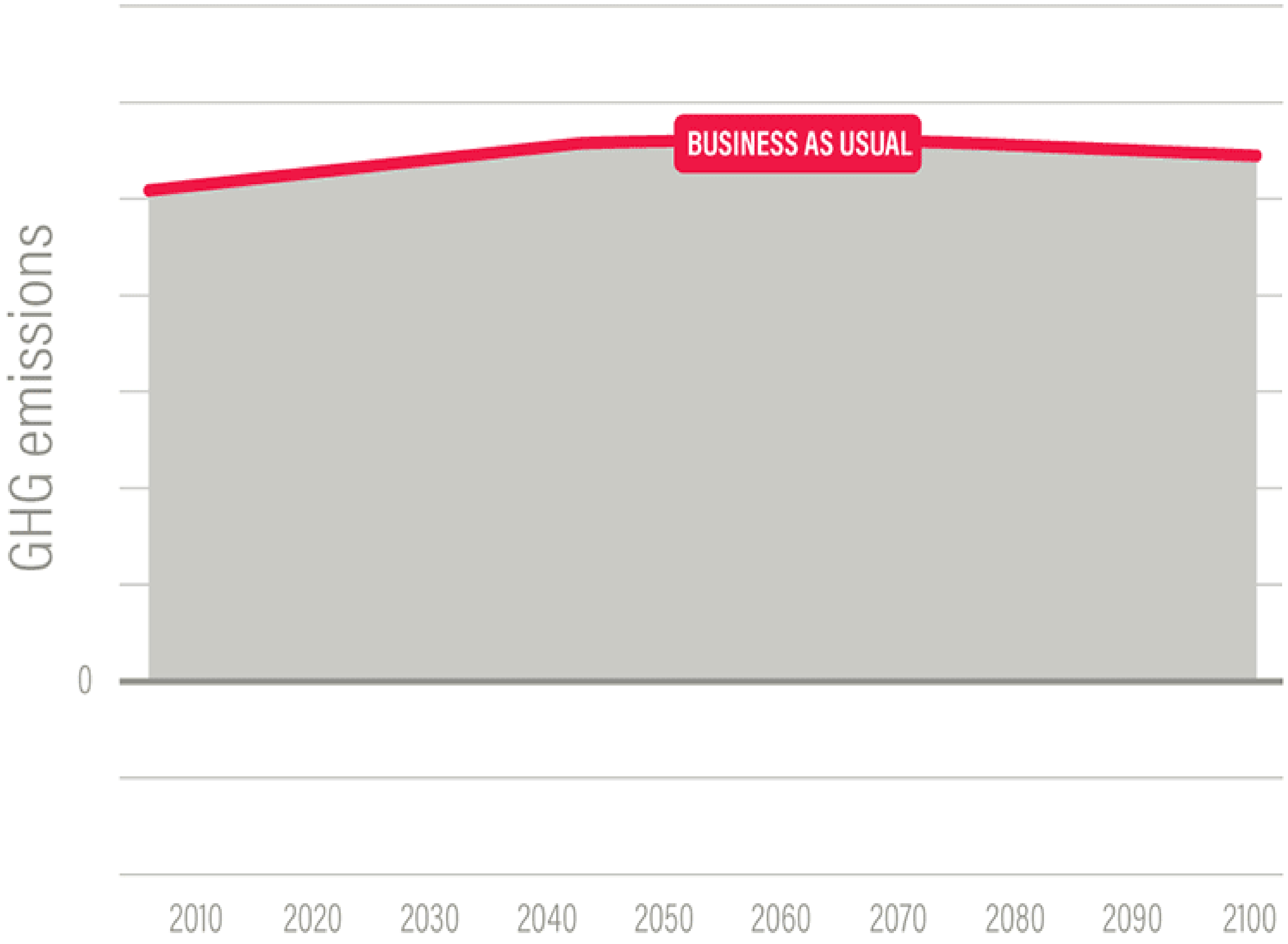
Green Deal



Zero pollution

Clean and circular economy

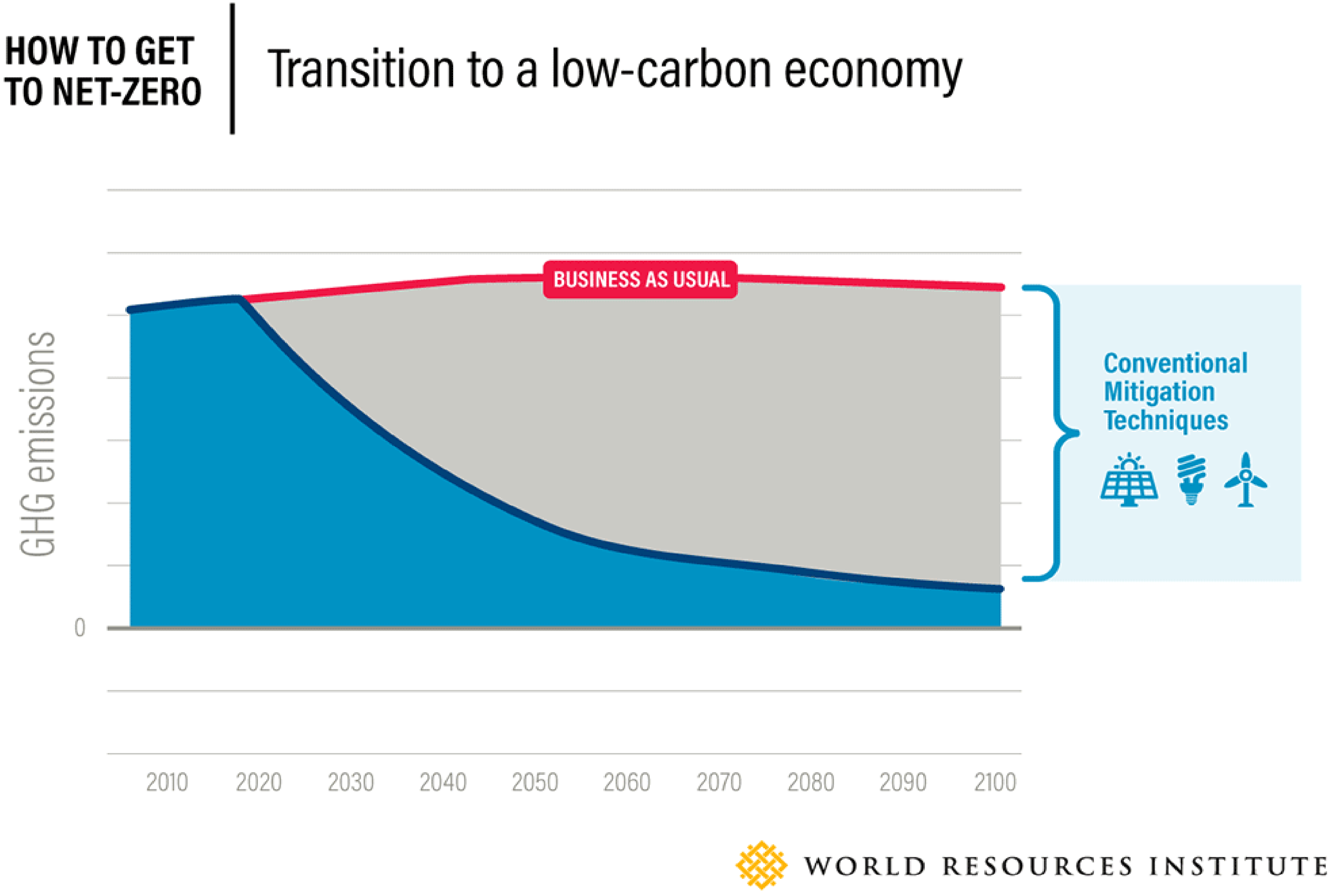
Building in energy/resource efficient way



WORLD RESOURCES INSTITUTE

- Low carbon

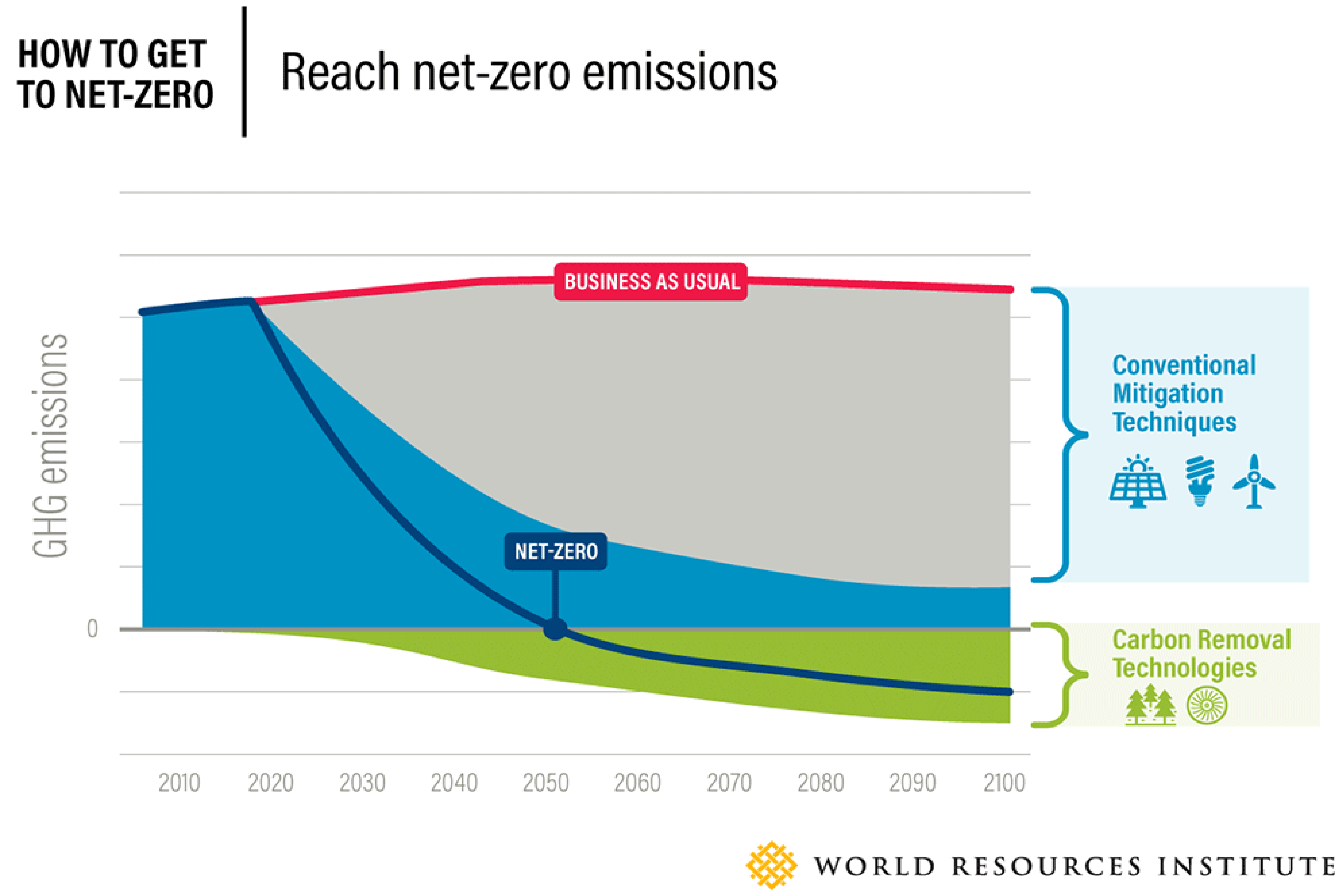
o. business as usual



- Low carbon

1. Mitigation

+



- Low carbon

+

2. Removal

= Net Zero
In 2050

- Low carbon - Mitigation

Designers

Optimisation

High-strength concrete

Digitalisation

Raw materials

Cement
- Energy
- Material/process

Aggregates
- Recycled
- Artificial

Precast manufacturers

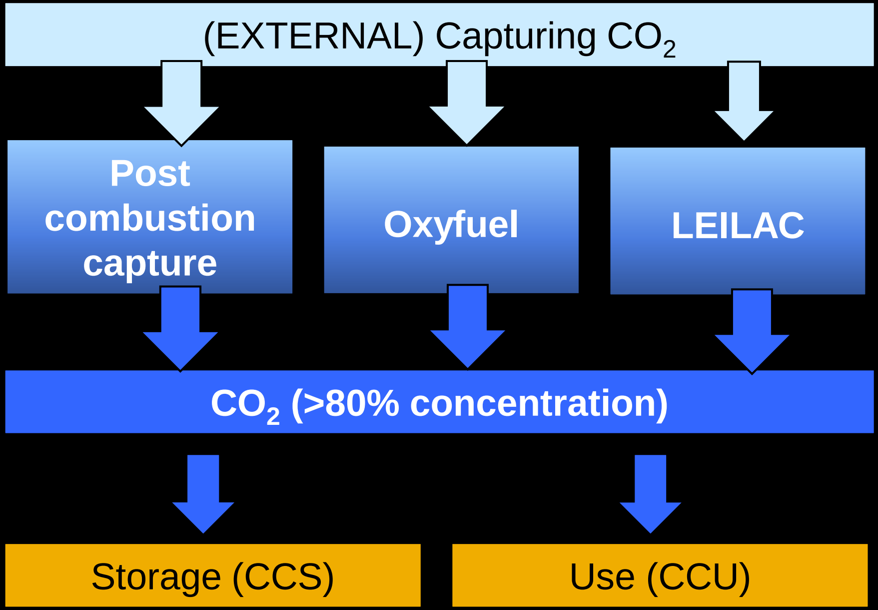
Circularity
- Long service life
- Easy maintenance and repair
- Easy disassembly

Innovation

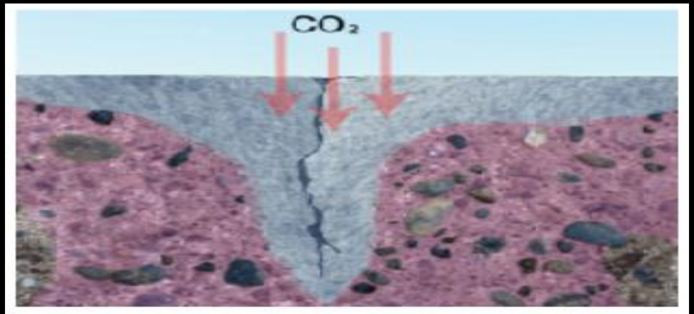
Society

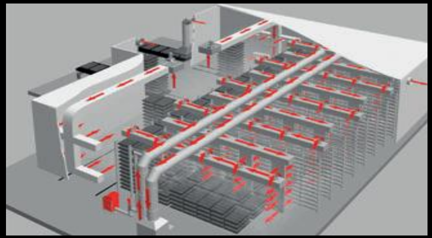
Concrete benefits
- Energy efficiency
- Adaptation to CC
- Healthy and safe places
- Value to local economy

• Low carbon - Removal



(INTERNAL) Carbonation



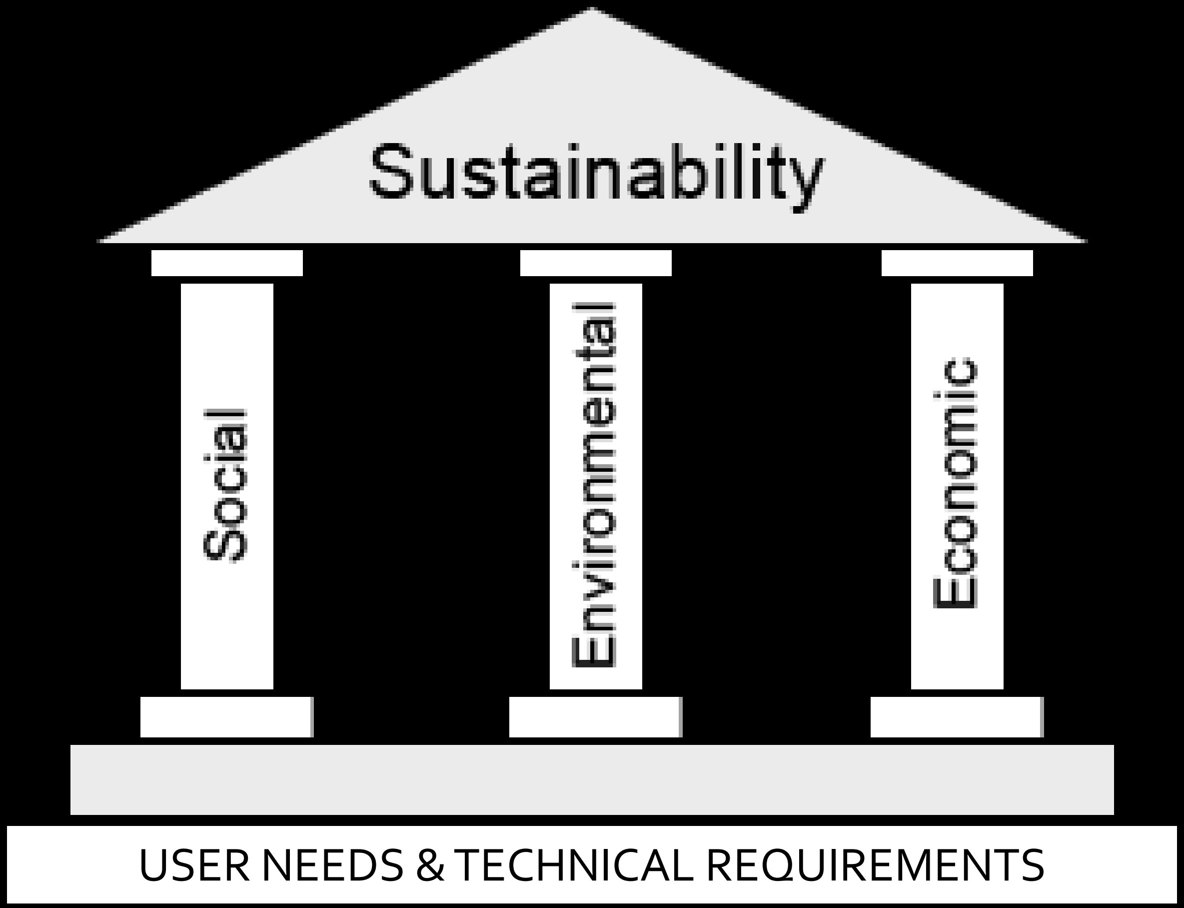


- Curing of pre-cast concrete with CO_2

- Sequestration during lifetime of construction

- Recycled concrete fines recarbonate with CO_2

- Sustainable



HOLISTIC

Construction work

Whole life cycle

Concrete

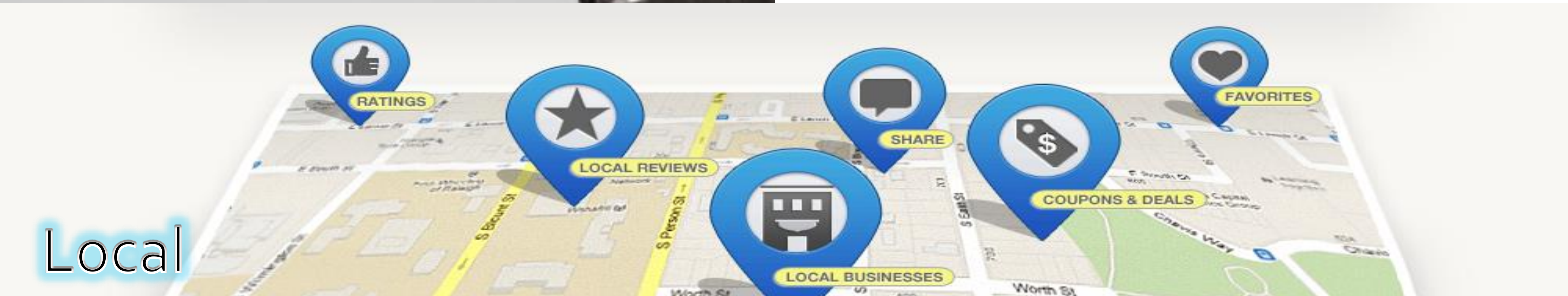
- High quality
- Long service life
- Fire safety
- Versatility
- Healthy
- Affordable
- Aesthetic
- Thermal comfort
- Acoustic comfort

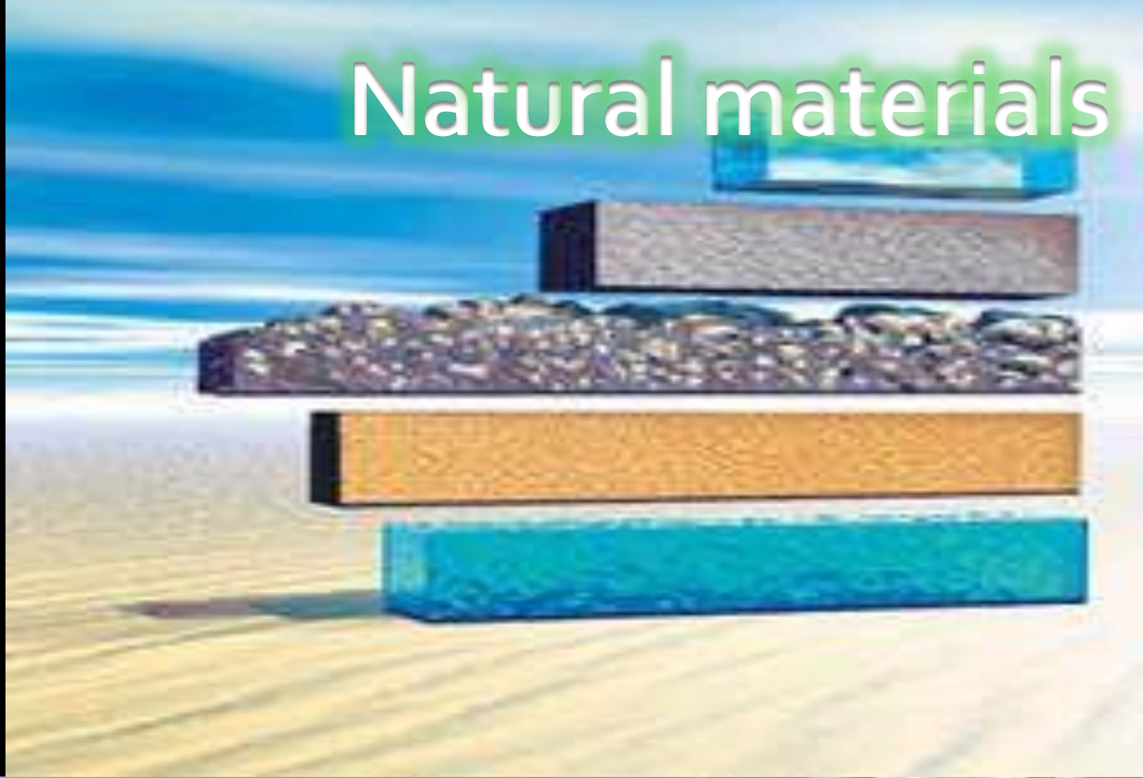

Respond to societal challenges
Healthy & Comfortable
Social
Safe and resilient

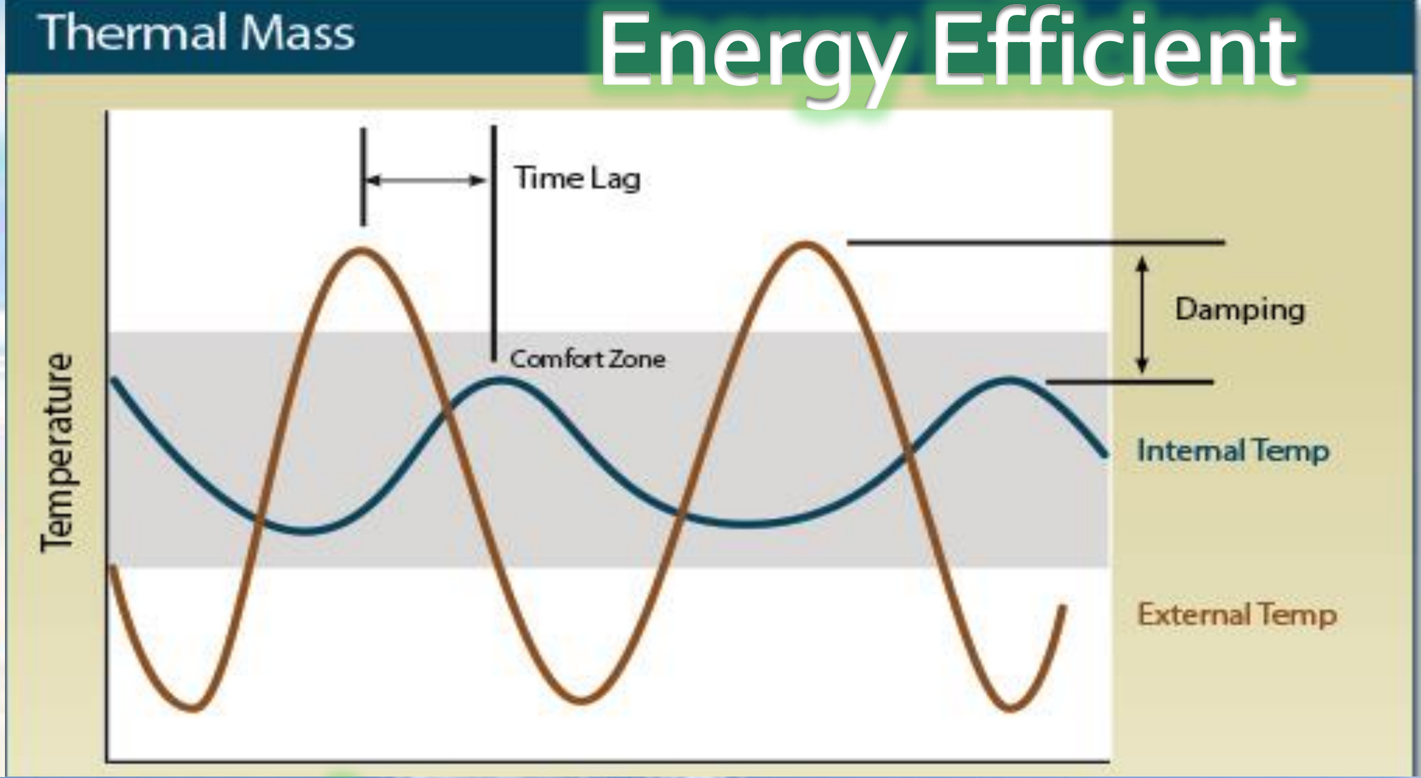

Growth


Value for money

Economy

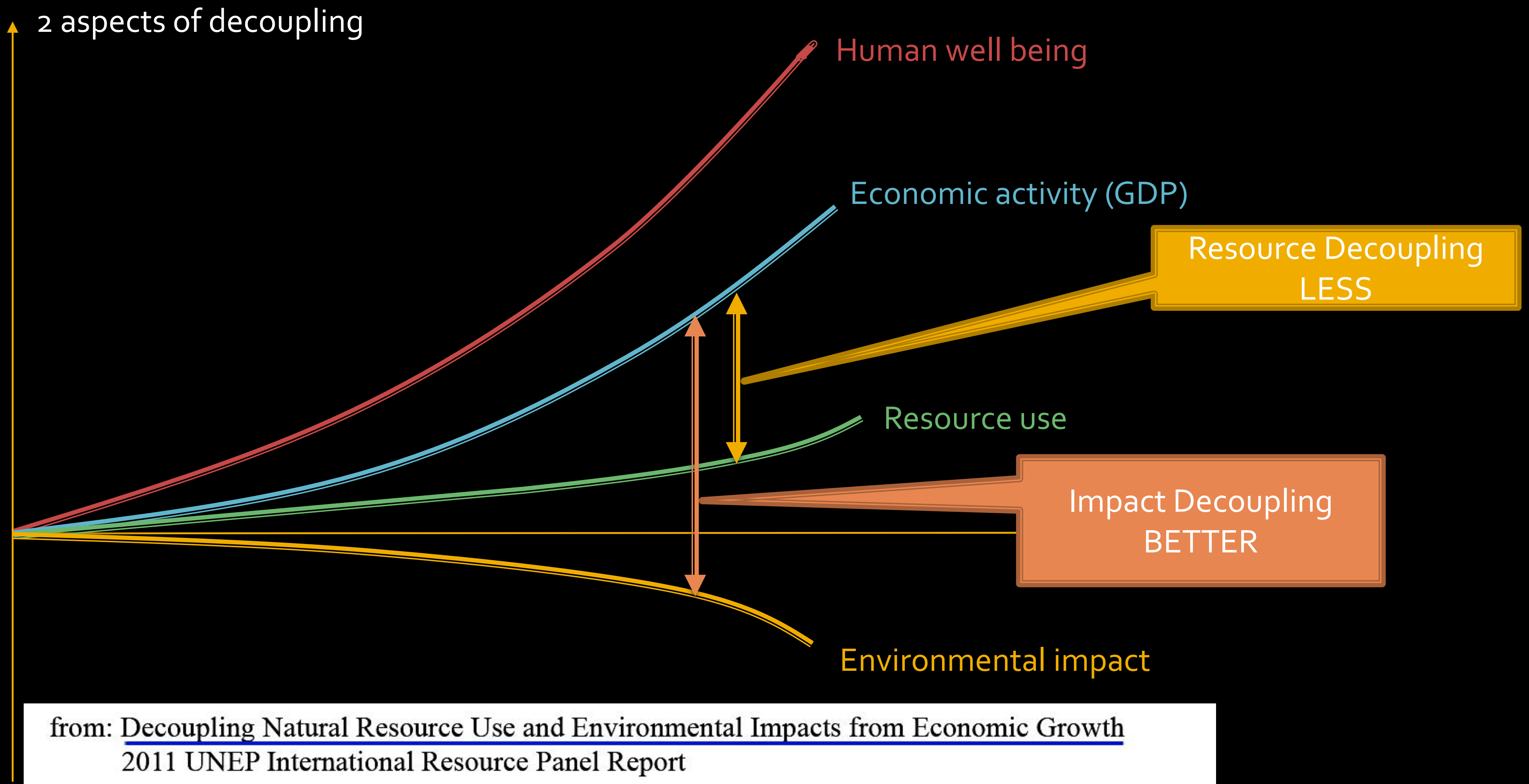

RATINGS
LOCAL REVIEWS
SHARE
FAVORITES
COUPONS & DEALS
LOCAL BUSINESSES
Local


Natural materials


Thermal Mass
Energy Efficient
Time Lag
Damping
Comfort Zone
Temperature
Internal Temp
External Temp


Environment
Climate resilient

- Circular – decoupling economic growth from resource use



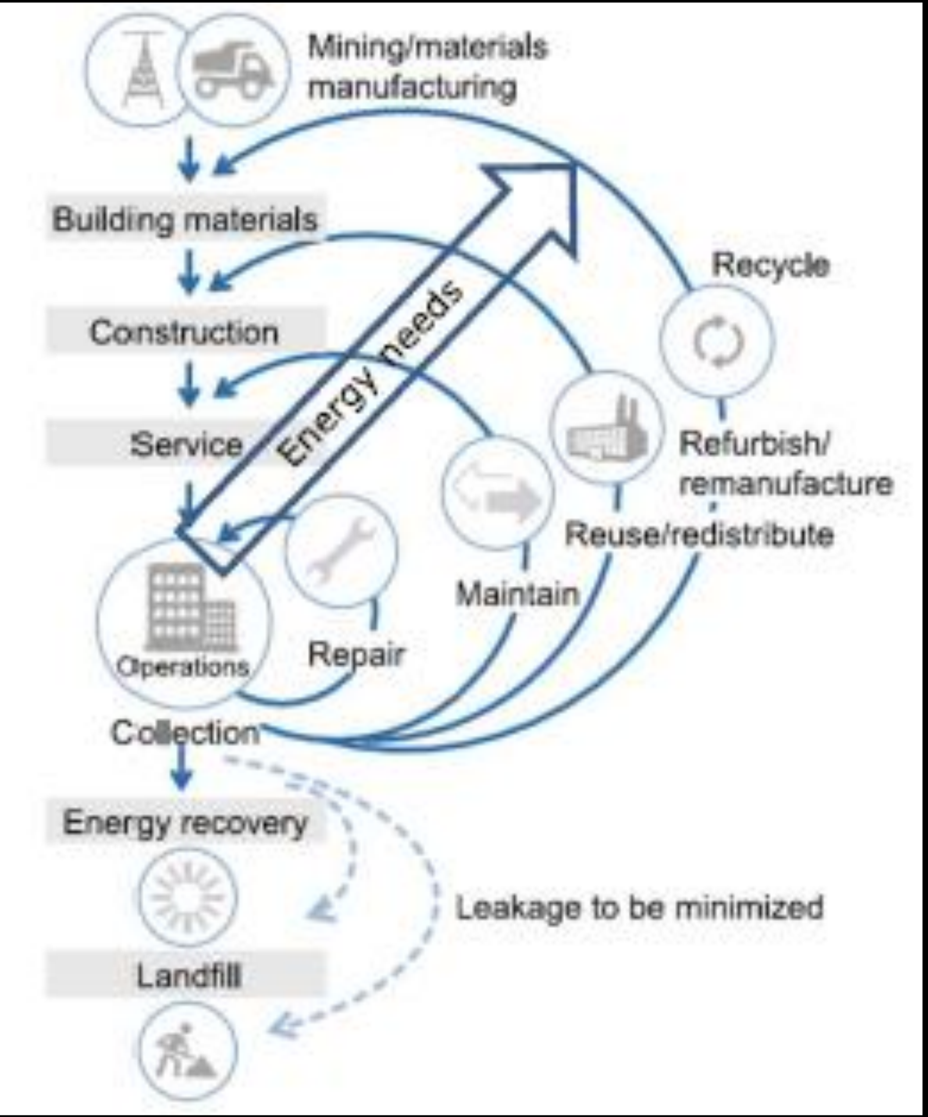
from: Decoupling Natural Resource Use and Environmental Impacts from Economic Growth
2011 UNEP International Resource Panel Report

- # Circular in construction

MINIMISE

Energy / Material

Material



Ensure a service life as long as possible

Favour internal processes with lower energy

- Repair
- Maintain

Avoid “exiting”

- Re-use
- Recycle

Circular Economy

MINIMIZATION AND PREVENTION

Most favored

Average

Least favored

Circular Economy

MINIMIZATION AND PREVENTION

Durability

Easy maintenance and repair

New Concretes

Circular Economy

REUSE

STRUCTURE
REUSE

PRODUCT
REUSE

Circular Economy

GEOTECHNICAL WORKS

RECYCLING

RECYCLED AGGREGATES

- Conclusion

PRECAST provides **solutions** to the challenges of construction 2050

- Low-carbon
- Sustainable
- Circular

- Fire resistance
- Adapting to climate change
- Affordable
- Thermal comfort
- Resilient

PRECAST provides **solutions** to other societal challenges

- Conclusion

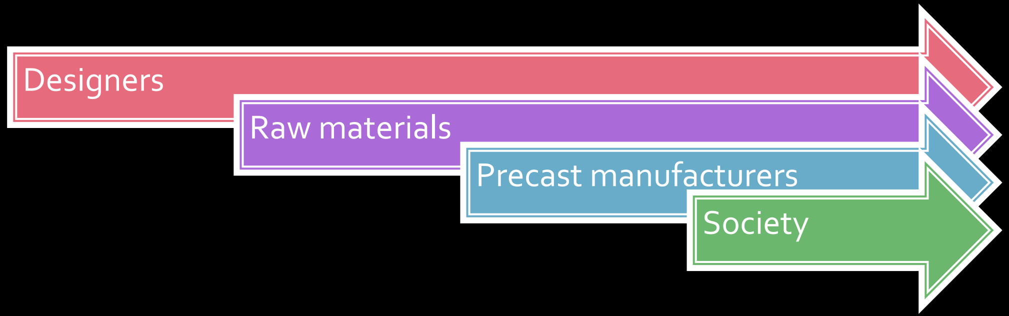
PRECAST
will be the
backbone
for a transition to
Construction 2050

Not an obstacle

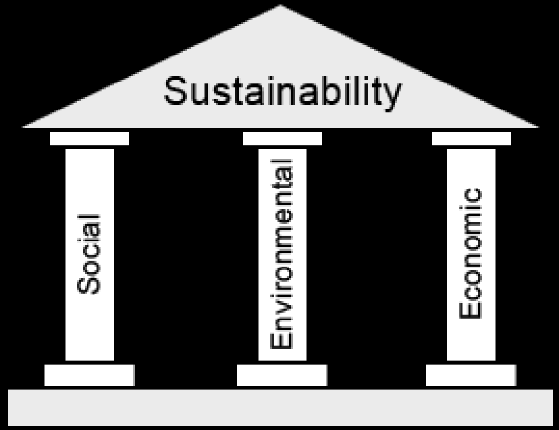
- Conclusion

Providing that the precast industry

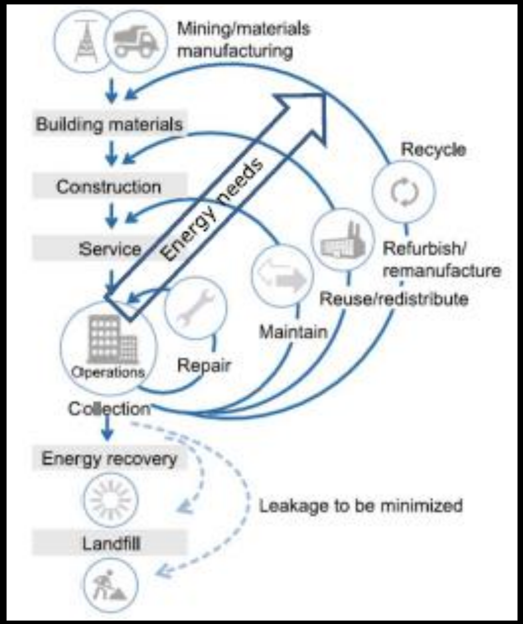
1. Engages in a transition towards low-carbon together with stakeholders



2. Keeps on manufacturing with sustainability in mind



3. Fully embraces circular economy principles



Interreg North-West Europe SeRaMCo
European Regional Development Fund

Thank you for attention.

Secondary Raw Materials for Concrete precast products

Please visit us
www.nweurope.eu/seramco

https://twitter.com/seramconwe

https://www.linkedin.com/company/seramco

Alessio RIMOLDI
ar@bibm.eu

Recycled aggregates properties – Influence of the crushing method

SeRaMCo Webinar

22nd of June 2020

J.Hubert, Z. Zhao, F. Michel & L. Courard (ULiege)

Summary of the presentation

- Materials and methods
  - Crushing methods
  - Concrete compositions
- Results
  - Grain size distribution
  - Morphology of the aggregates
  - Cement paste content
  - Water absorption
- Energy consumption study

Materials and methods

Crushing methods

→ Production of 0/25

Impact crusher

Set at 6,5 kW (40% of maximum power)

Jaw crusher

Jaw crusher set at a 22 mm opening

Materials and methods

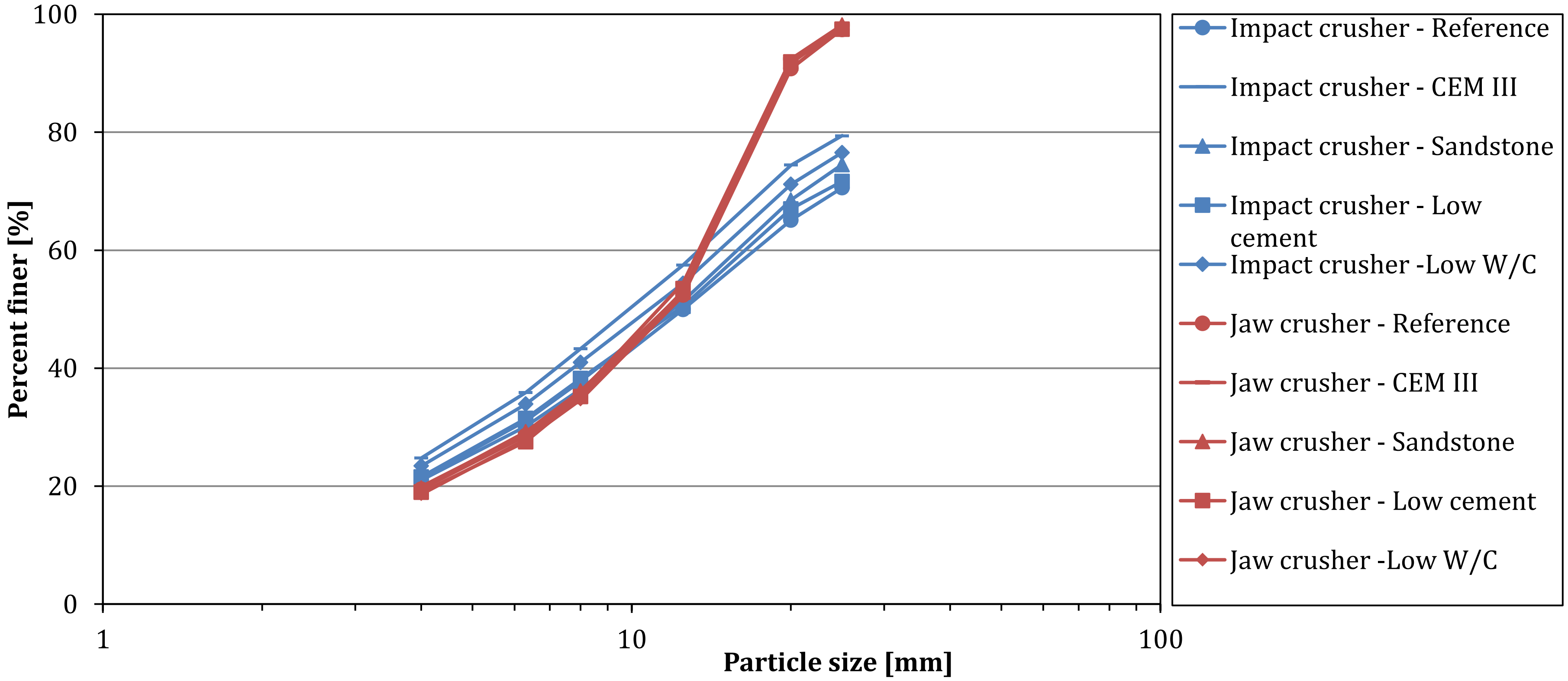
Concrete compositions

	1.0	1.1	1.2	2	3
Name	Reference	CEMIII	Sandstone	Low Cement	Low W/C
Aggregates type	Limestone	Limestone	**Sandstone**	Limestone	Limestone
Cement type	CEMI 52.5	**CEMIII 52.5**	CEMI 52.5	CEMI 52.5	CEMI 52.5
Cement quantity (kg/m^3)	400	400	400	**320**	452
Cement paste volume (dm^3/m^3)	351	358	351	**282**	351
W/C	0.56	0.56	0.56	0.56	**0.46**

Results

Grain size distribution

The jaw crusher produces aggregates with a more constrained grain size range

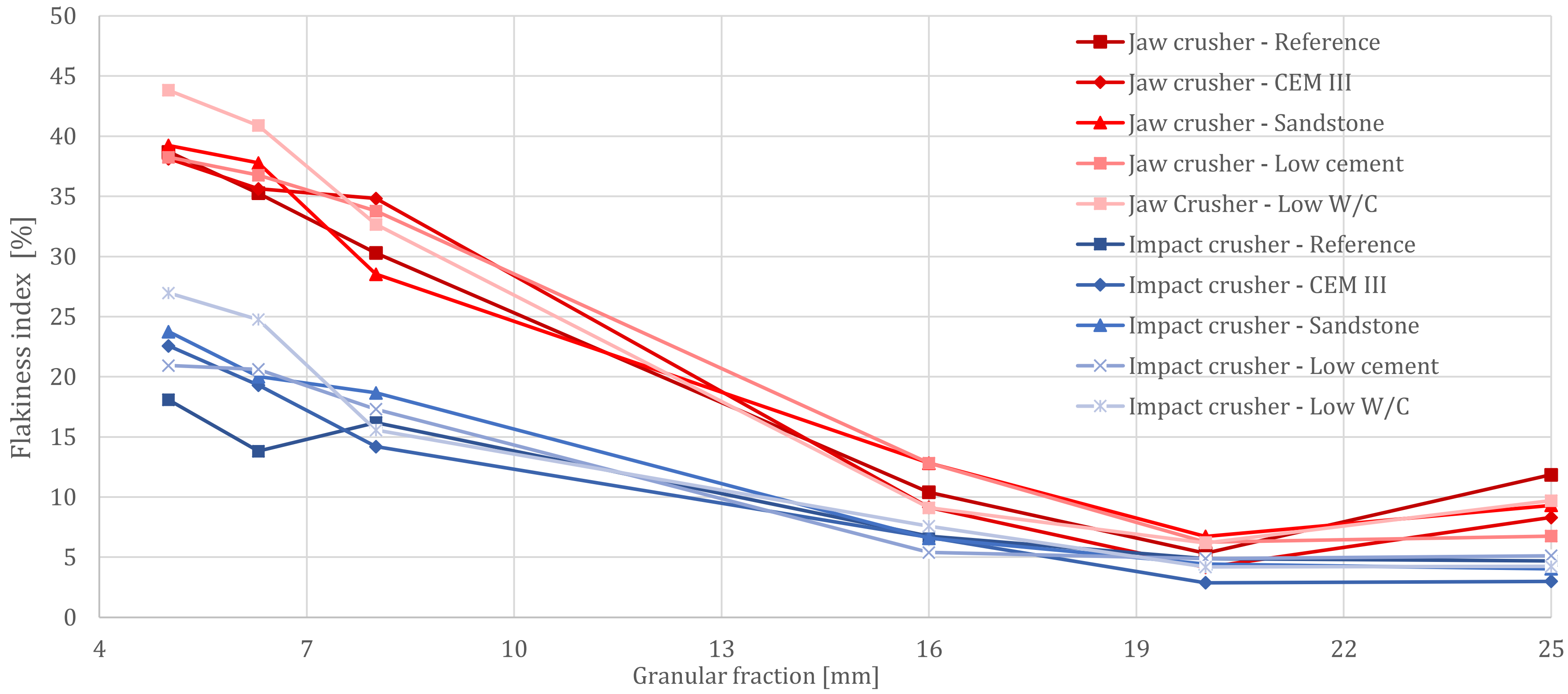


Results

Morphology

The flakiness index decreases with increasing granular fraction and the jaw crusher produces flakier aggregates

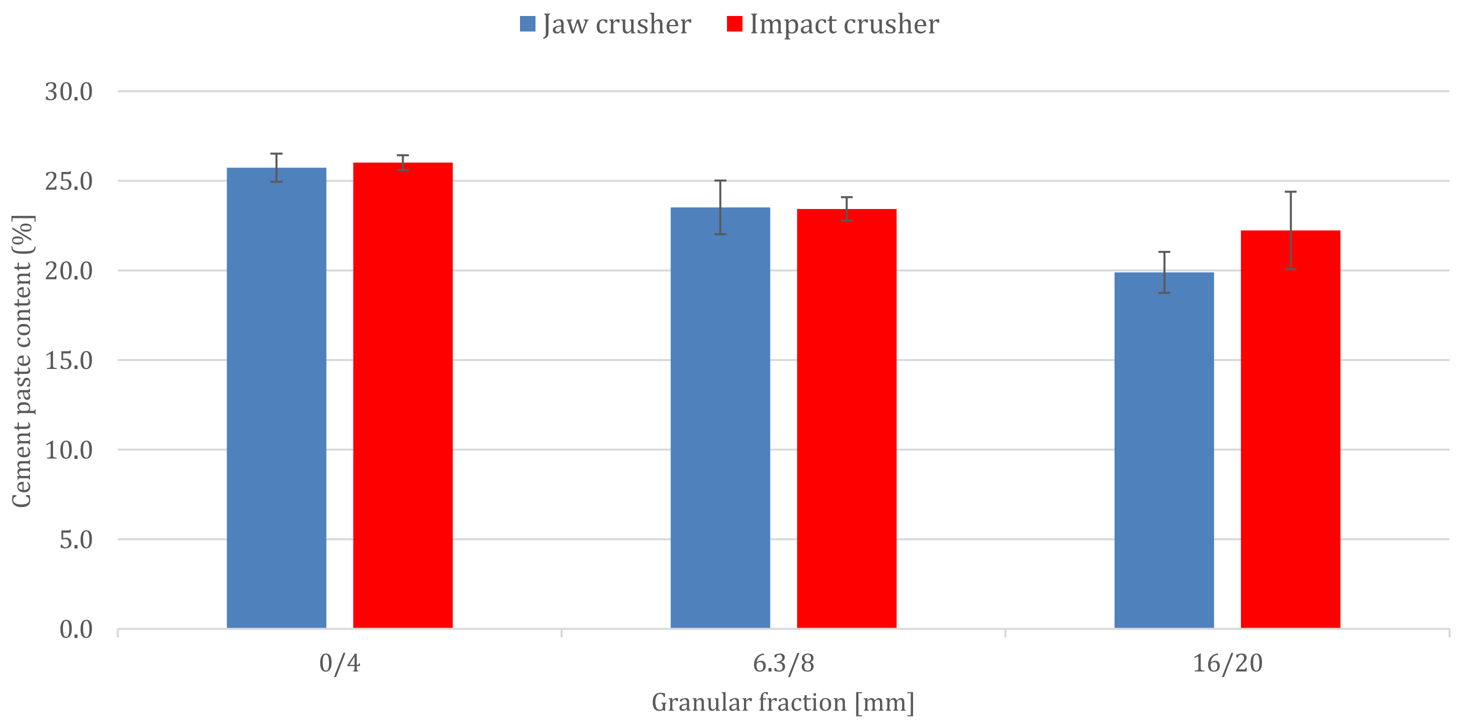
No influence of the concrete composition in the investigated range



Results

Cement paste content

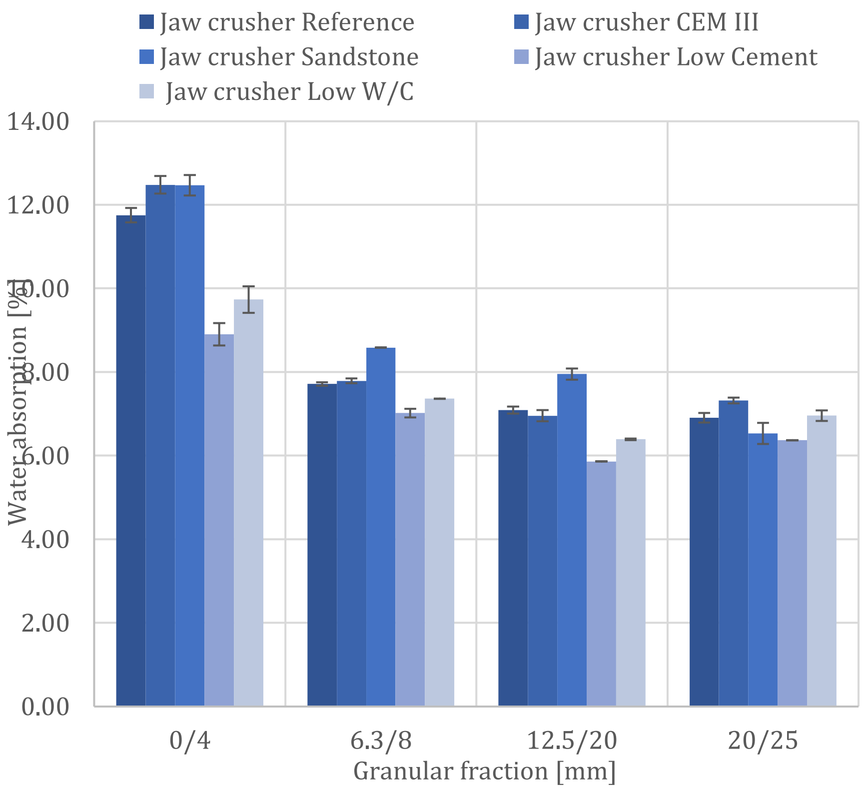
Decrease in cement paste content with increasing granular fraction
No influence of the crushing method

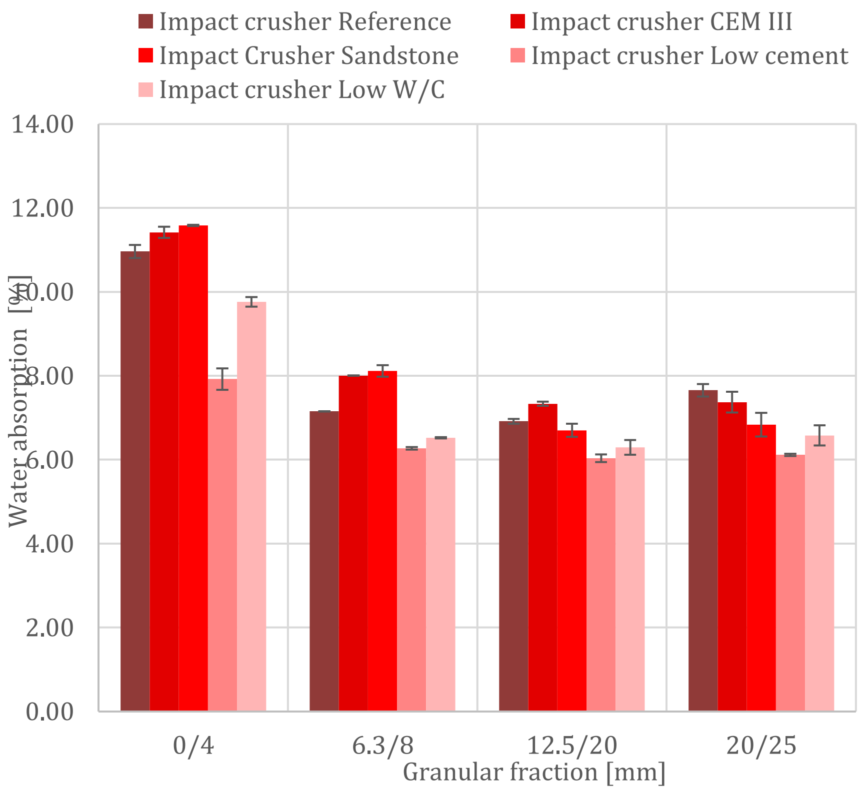


Results

Water absorption

Decrease in water absorption with increasing granular fraction

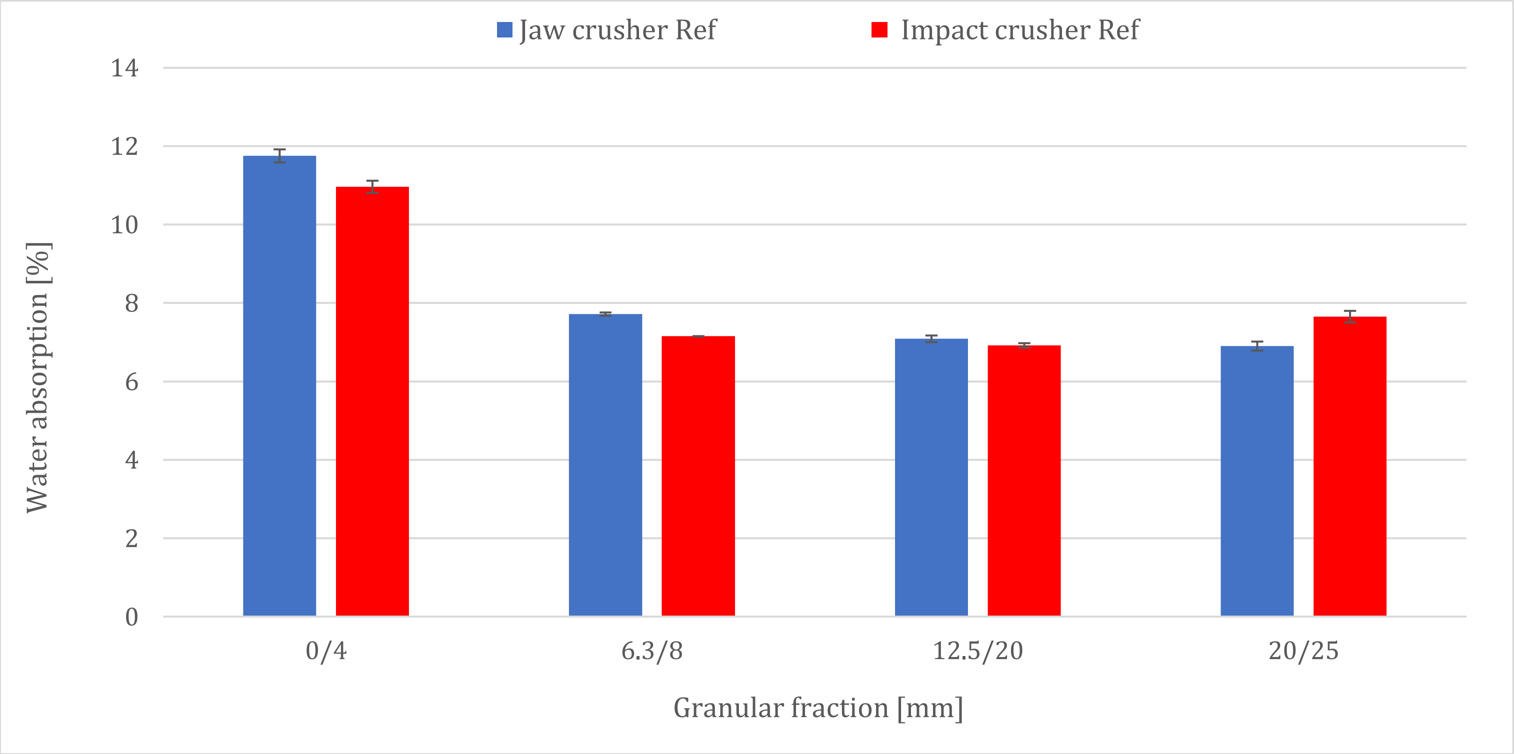




Results

Water absorption

No significant influence of the crushing method on the water absorption of the recycled aggregates (for all tested composition)



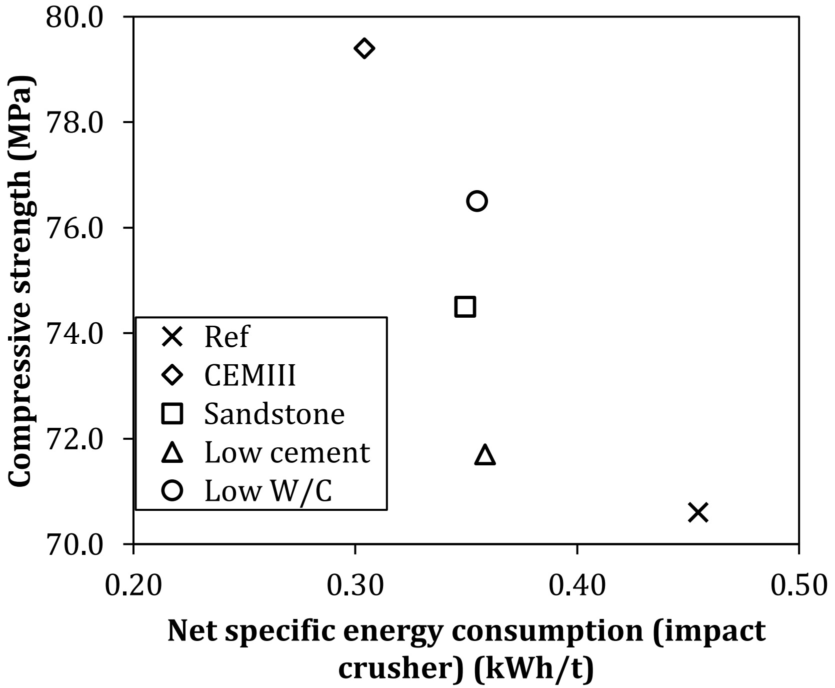
Energy consumption study

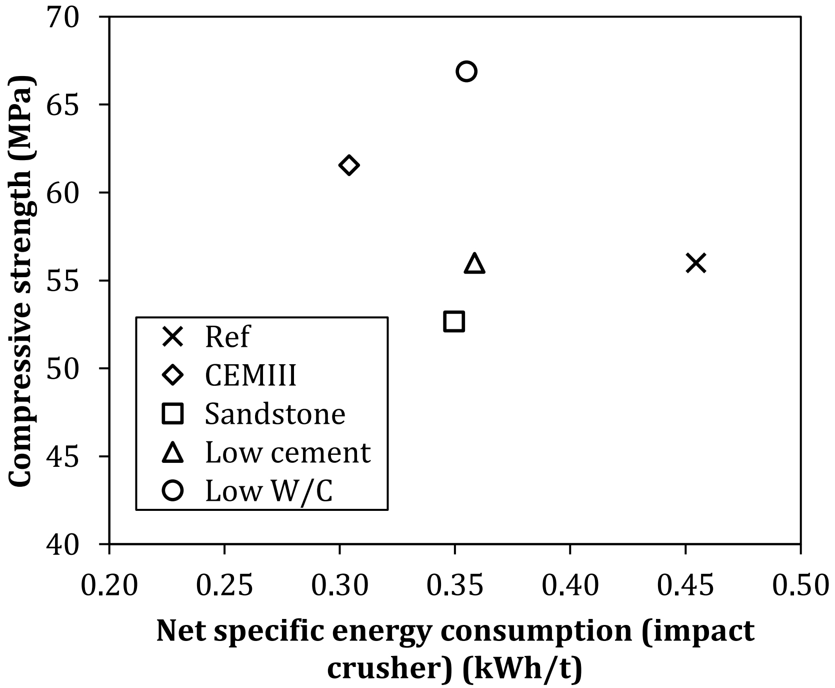
	Jaw crusher	Impact crusher
(a) Running power (kW)	1,8-2,0	6,5-6,6
(b) Mean net power (kW)	1,9-2,1	0,5-0,8
(c) Mean crushing duration (s)	200	252
(d) Crushed mass of material per hour (t/h)	2,0-2,3	1,6-1,7
(e) Net specific energy consumption (kWh/t) **(b/d)**	0,9-1,0	0,30-0,50
(f) Total specific energy consumption (kWh/t) **((a+b)/d)**	1,8-1,9	4,1-4,5
(g) Percentage of energy consumed for crushing **(=b/(a+b))**	~50	~10

Crushing specific energy analysis

No correlation between jaw crusher specific energy consumption and impact crusher specific energy consumption

No correlation between specific energy consumption and compressive strength





Conclusion

	Impact crusher	Jaw crusher
Aggregates geometry	More spherical	-
Grain size distribution	-	More constrained
Fine content	-	Less fine content
Cement paste content	No influence	No influence
Water absorption	No influence	No influence
Energy consumption	-	Less consuming
Crushing duration	-	Shorter

Thank you for your attention

The work was carried out thanks to the financial support of the European Commission in the framework of the **Interreg NWE SeRaMCo project**

UNIVERSITÉ DU LUXEMBOURG

UNIVERSITY OF LUXEMBOURG
Department of Engineering

Recycled Aggregates Concrete

Dr. Gael CHEWE NGAPEYA
Prof. Dr.-Ing. Danièle Waldmann

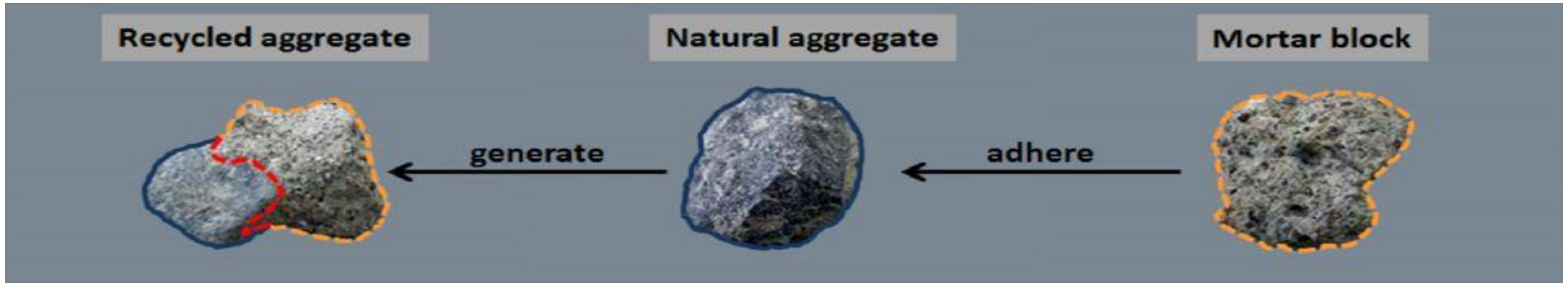
Luxembourg, June 2020

High water demand of RAC

Old mortar attached: the main differences between the properties of recycled aggregates and natural aggregates

Density, Porosity, Crushing index

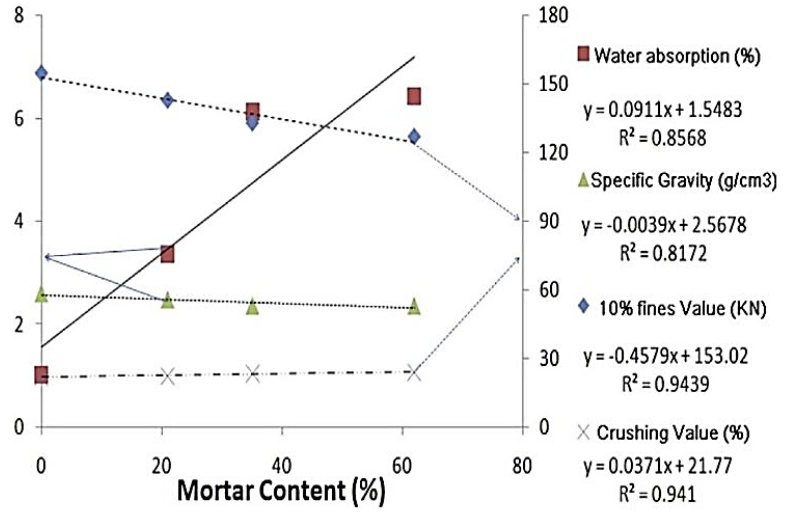
Interfacial Transition zone (ITZ)



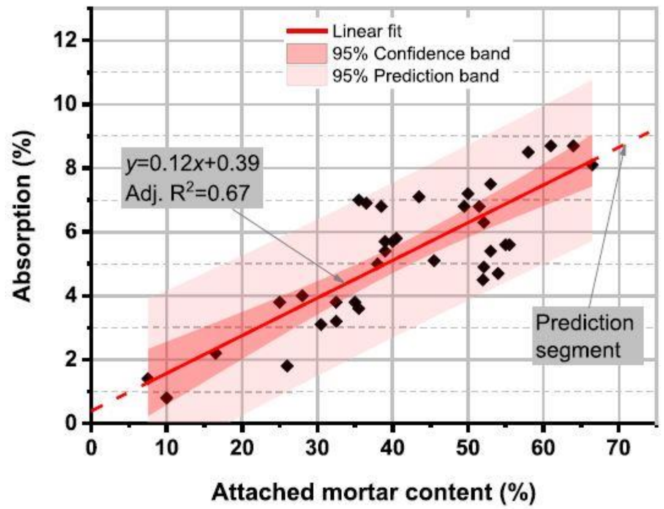
[1] T. Yoshikane, Present status of recycling waste cement concrete in Japan, Private Communication Research Laboratory Taiyu Kensetsu Co Ltd, Japan, 1988

High water demand of RAC

- The **higher the mortar content** is, the **higher the porosity** of RA, and the **higher the water absorption.**
- The **water absorption of RA** is **2.3 to 4.6 times higher** than that of **natural aggregate**, irrespective of the original concrete strength. [3,4]
- The high **water demand of RA** leads to **a reduction of the workability** of RA concrete.
- The high **water demand of RA** leads to **a reduction of the workability** of RA concrete.



[2] Z.H. Duan, C.S. Poon, Properties of recycled aggregate concrete made with recycled aggregates with different amounts of old adhered mortars, Materials and Design 58 (2014) 19-29



[5] Guoliang Bai, Chao Zhu, Chao Liu, Biao Liu, An evaluation of the recycled aggregate characteristics and the recycled aggregate concrete mechanical properties, Constr. Buil. Mat. 240 (2020) 117978

[3] T.C. Hansen, N. Henrik, Strength of recycled concrete made from crushed concrete coarse aggregate, Concr. Int. 5 (1) (1983) 79-83
[4] S.R. Suryawanshi, B. Singh, P. Bhargava, Characterization of recycled aggregate concrete, Adv. Struct. Eng (2015) 1813-1822.

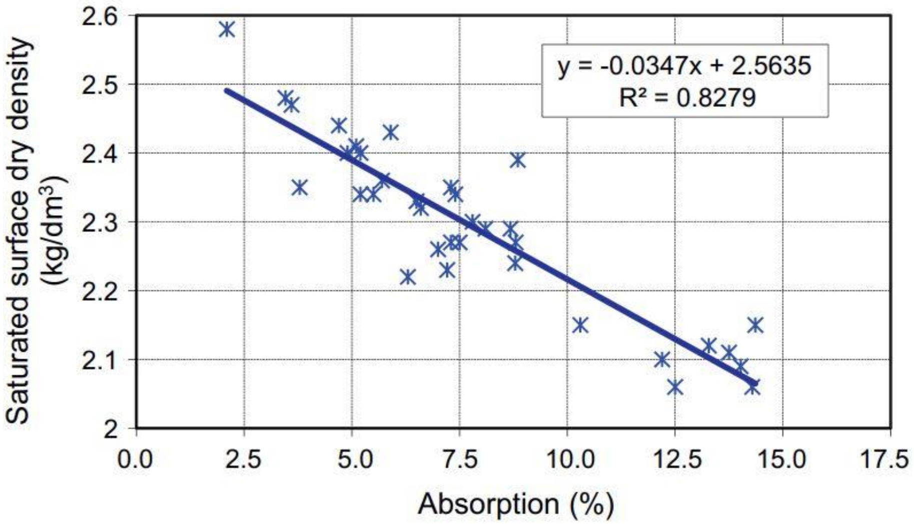
Particle size distribution and workability of concrete

- The **adhered mortar content** increases with the **decrease** in the **aggregate size.**

As the RA gradually crumbles → Cement mortar accumulates in fines RA → Density of recycled fine aggregate decreases

- A proportion of **more than 20% recycled fine aggregate** results in a **large reduction of the workability**, a phenomenon linked to the saturated surface dry-density of RA.

- The **saturated surface dry density decreases** with the **absorption**, i.e. with the adhered mortar content, i.e. with the particle size distribution.

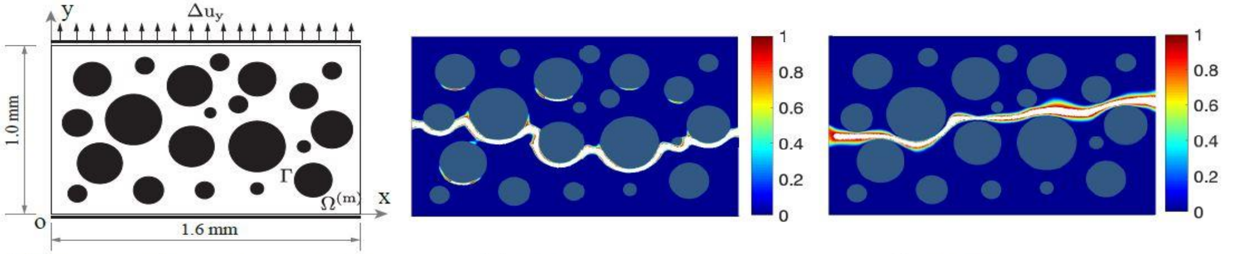


[6] F. Agrela et al., Limiting properties in the characterisation of mixed recycled aggregates for use in the manufacture of concrete

Development of medium to high strength concrete

- The interfacial transition zone strongly impact the performance of RA concrete

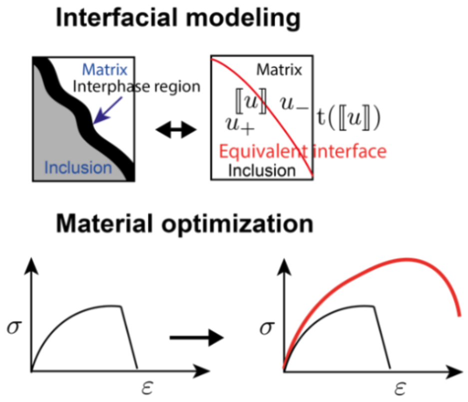
Soft interface provides a **major interfacial cracking mode**, while **stiff interface** induces a **main bulk cracking behavior.**



(a) Geometry/boundary conditions (b) Soft interphase (c) Stiff interphase

[...] Simulation of the early-age behaviors of recycled concrete by using a phase field model. A high risk of cracking is noted [22, 23]

- An enhancement of the ITZ performance results in an improvement of the compressive strength of RA concrete.



The ITZ enhancement could be achieved by:

1- A two stage mixing approach for improving the micro structure of old adhered mortar.
2- A separation of adhered mortar or a treatment with a polymer solution

Development of medium to high strength concrete

Mixing procedure

- Improve the microstructure of old mortar
- Enhance the performance of the ITZ by producing a thin layer of cement slurry on RA.

Aggregates + total binder (cement + fillers) — 30 sec
½ of free water — 30 sec
60 sec of mix
½ of free water + superplasticizer — 30 sec
60 sec of mix
Edges scraped
120 sec of mix
Fresh concrete

Development of medium to high strength concrete

- It is already known that the **concrete compressive strength decreases** with the **increase of the replacement rate of NA** with **recycled ones**, irrespective of aggregate type.

Low performance of the **Interfacial Transition Zone**
Low bonding between **old attached mortars** and the **fresh mortar paste**

High-Strength Concrete

Micro-silica ~ 2% of the binder weight
Superplasticizer ~ 3 % of the binder weight
Binder to aggregate ratio ~ 1:3.6
Water to binder ratio w/b ~ 0.35
Particle size skeleton reconstructed

$f_{c,28} = 58.5\ MPa$

$E = 29500\ MPa$

SeRaMCo

Developed concretes using 100% of recycled aggregates from known origin

Self-Compacting Concrete

Master air ~ 0.15% of the binder weight
Superplasticizer ~ 1.5 % of the binder weight
Binder to aggregate ratio ~ 1:3.1
Water to binder ratio w/b ~ 0.35
Particle size skeleton reconstructed

$f_{c,28} = 32.4\ MPa$

$E = 6700\ MPa$

Open Structure Concrete

Micro-silica ~ 2% of the binder weight
Binder to aggregate ratio ~ 1:2.9
Water to binder ratio w/b ~ 0.35
Particle size skeleton reconstructed

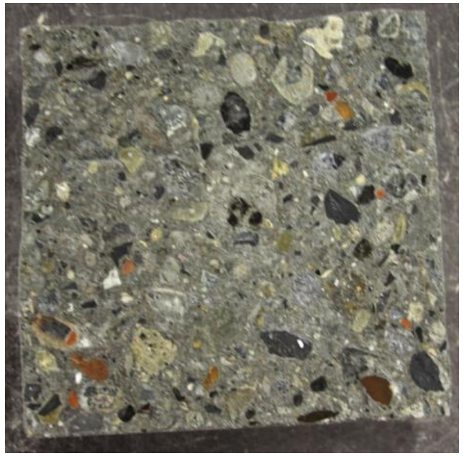
$f_{c,28} = 5.7\ MPa$

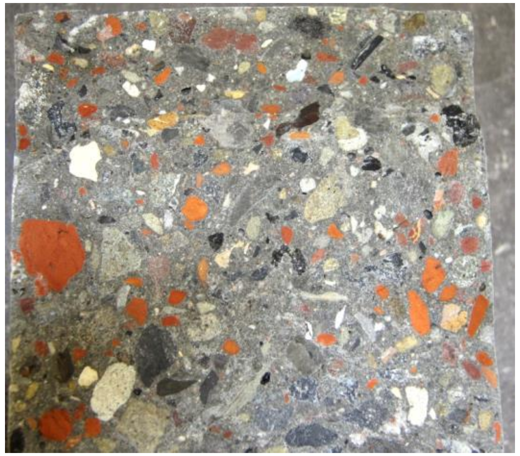
$E = 1500\ MPa$

Villmools Merci!

Concrete containing recycled aggregates from unknown origin

Development of new mixes for structural precast elements and pavement blocks





Anja Tusch

FWB
Fachgebiet Werkstoffe im Bauwesen

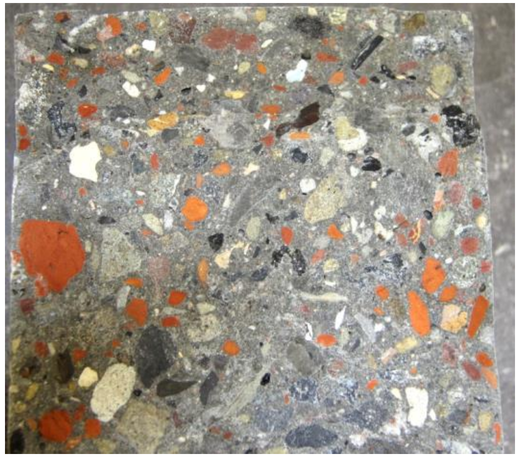
Interreg North-West Europe SeRaMCo
European Union
European Regional Development Fund

Aim

Development of different new concrete mixes containing recycled aggregates from unknown origin

Recycled aggregates

Concrete



Challenges

Production of concrete containing recycled aggregates from unknown origin causes some challenges:

Aggregates

- Great variety of the materials
- Great variety of the properties

Fresh concrete

- Workability due to the higher waterabsorption

Hardened concrete

- Strength
- Deformation behaviour
- Durability

Concrete mixtures for SeRaMCo

- Mixture for the production of structural elements
- Mixture for the production of non-structural elements
- Rammed concrete
- Salty concrete

Used aggregates

Crushed concrete

Type A (except R_a)

WA24: 4–5 %

Density: 2.3 kg/dm³

Fractions: 2-6 mm, 6-14 mm, 14-22 mm

Mixed aggregates

Type B (except R_a)

WA24: 6-9 %

Density: 2.2 kg/dm³

Fractions: 2-6 mm, 6-14 mm, 14-22 mm

Mixture for the production of structural elements

Mixture for the production of non-structural elements/ Pavement

Structural elements

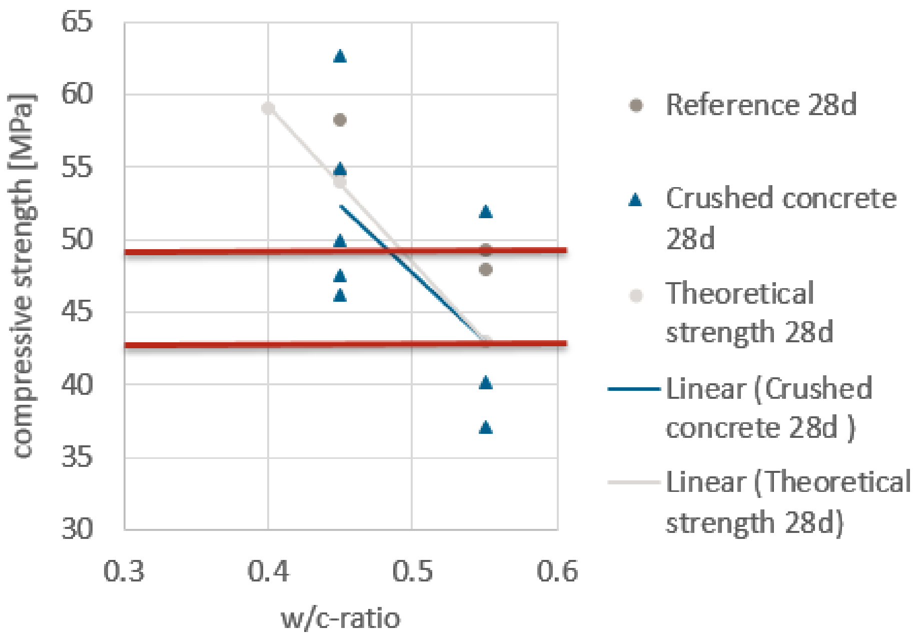
Starting point: Development of a concrete mixture, which can be used for different structural elements

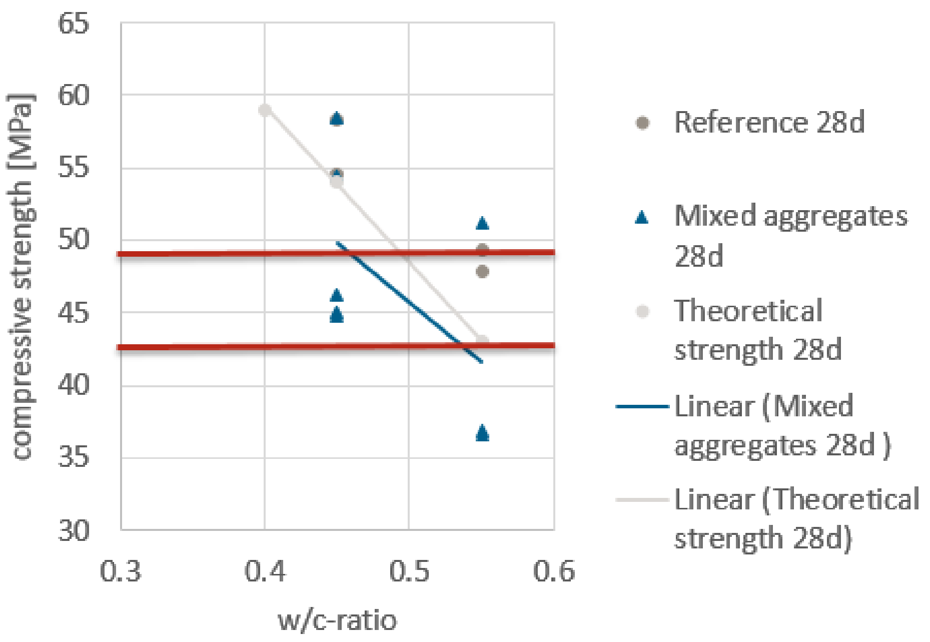
Challenge: The products are not known yet and the mixture has to be very variably

Planned test procedure:

- Design a mixture which is able to match C 30/37 by using a standard CEM I 42.5 and recycled aggregates
- Using two different w/c ratios for the concreting of the mixture → w/c: 0.45; 0.55
- Verify the results by using different cements → CEM II 42.5; CEM I 52.5

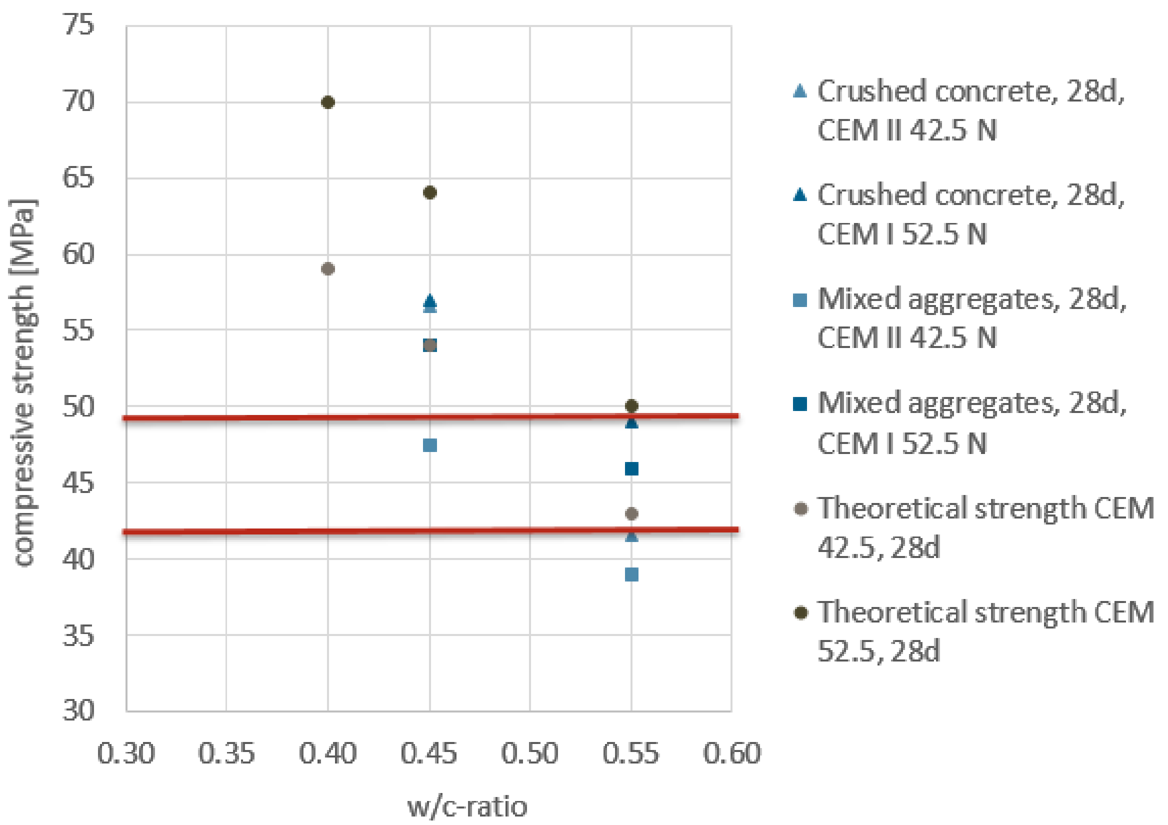
Results test series 1:





The variations of the w/c ratio results in a scattering of the compressive strength

Results test series 2:



Concrete mixtures

Mixture for the production of structural elements

Mixture for the production of non-structural elements/ Pavement

Development of the concrete mix for non-structural elements / paving blocks

Requirements:

- Slump 0 (earth-moist concrete)
- High early age strength
- The resulting concrete has to fulfill the standards of EN 1338

Challenge: Properties of the product depend on the mixture as well as on the used process technology

Development of the concrete mix for non-structural elements / paving blocks

Test procedure:

Step 1

- Determination of a well graded grain composition with a suitable cement amount and an optimum water content
- Analogous to the determination of the proctor density

Step 2

- Determine the properties of the resulting concrete mixture
- Is it able to fulfill the requirements?

Step 3

- Optimization if needed
- Addition of additives if needed

Step 4

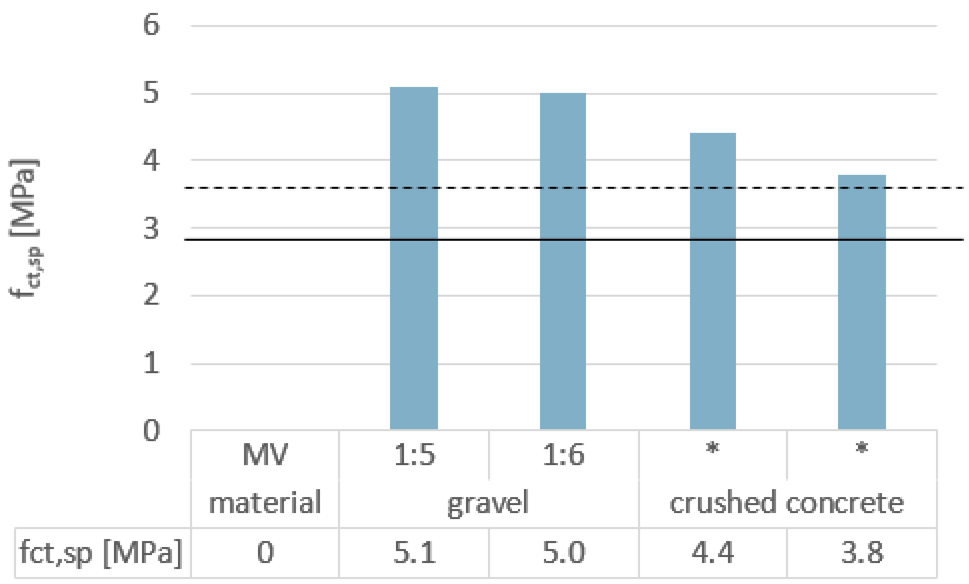
- Testing the mixture directly in the production line
- Optimization of the mixture in combination with the production process





Development of the concrete mix for non-structural elements / paving blocks

First results



Procedure to find a suitable mixture:

- Selection of aggregates
- Determination of average cement content (corresponds to mixing ratio)
- Determination of the optimum water content in the test
- Preparation of samples and determination of strength (applying strength by cement content)
- Calculation of the mixture composition from the ingredients

Development of the concrete mix for non-structural elements / paving blocks

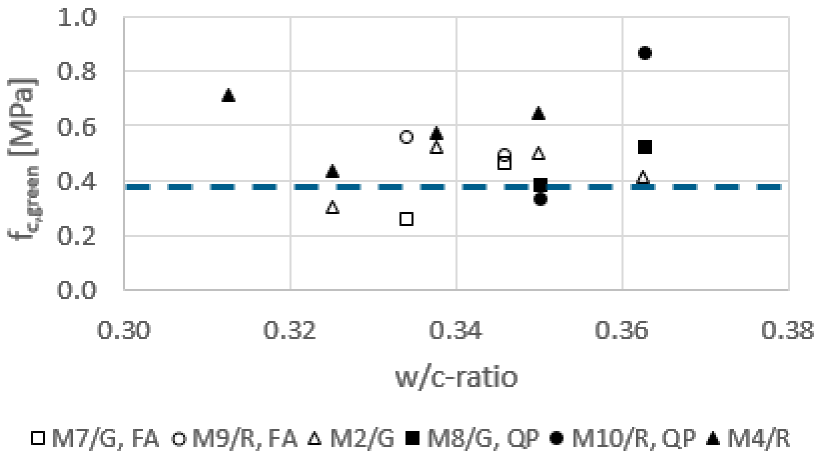
Results green strength

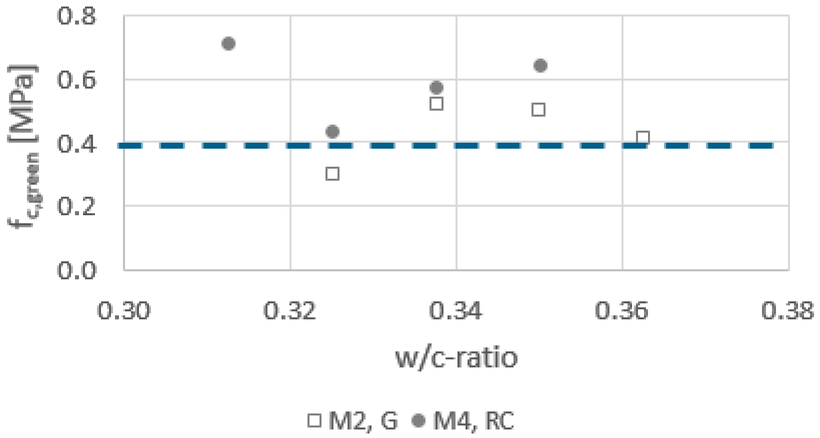
Parameter	Influence
Water content	Most important (optimum = W_{opt})
Concrete composition (cement content and specific surface!)	Increasing with increasing cement content and specific surface
Grading curve of aggregates	Minor influence
Admixtures/additives	Depends on individual case (mixing ratio, added amount)
Compaction energy	Important

Development of the concrete mix for non-structural elements / paving blocks

Results green strength

Mix	Mixing ratio	W	C	FA	QP	Aggregates
1	1:6	x	x	0	0	Gravel
2	1:5	x	x	0	0	Crushed concrete
3	1:6	x	x	0	0	Gravel
4	1:5	x	x	0	0	Crushed concrete
5	1:5	x	x	x	0	Gravel
6	1:5	x	x	0	x	Gravel
7	1:5	x	x	x	0	Gravel
8	1:5	x	x	0	x	Gravel
9	1:5	x	x	x	0	Crushed concrete
10	1:5	x	x	0	x	Crushed concrete





FACHGEBIET WERKSTOFFE IM BAUWESEN

Interreg North-West Europe SeRaMCo

European Regional Development Fund

EUROPEAN UNION

Thank you for your attention!

Centre d’étude et d’expertise sur les risques,
l’environnement, la mobilité et l’aménagement

Closed-loop supply-chain of construction and demolition wastes: Towards circular economy in French regions

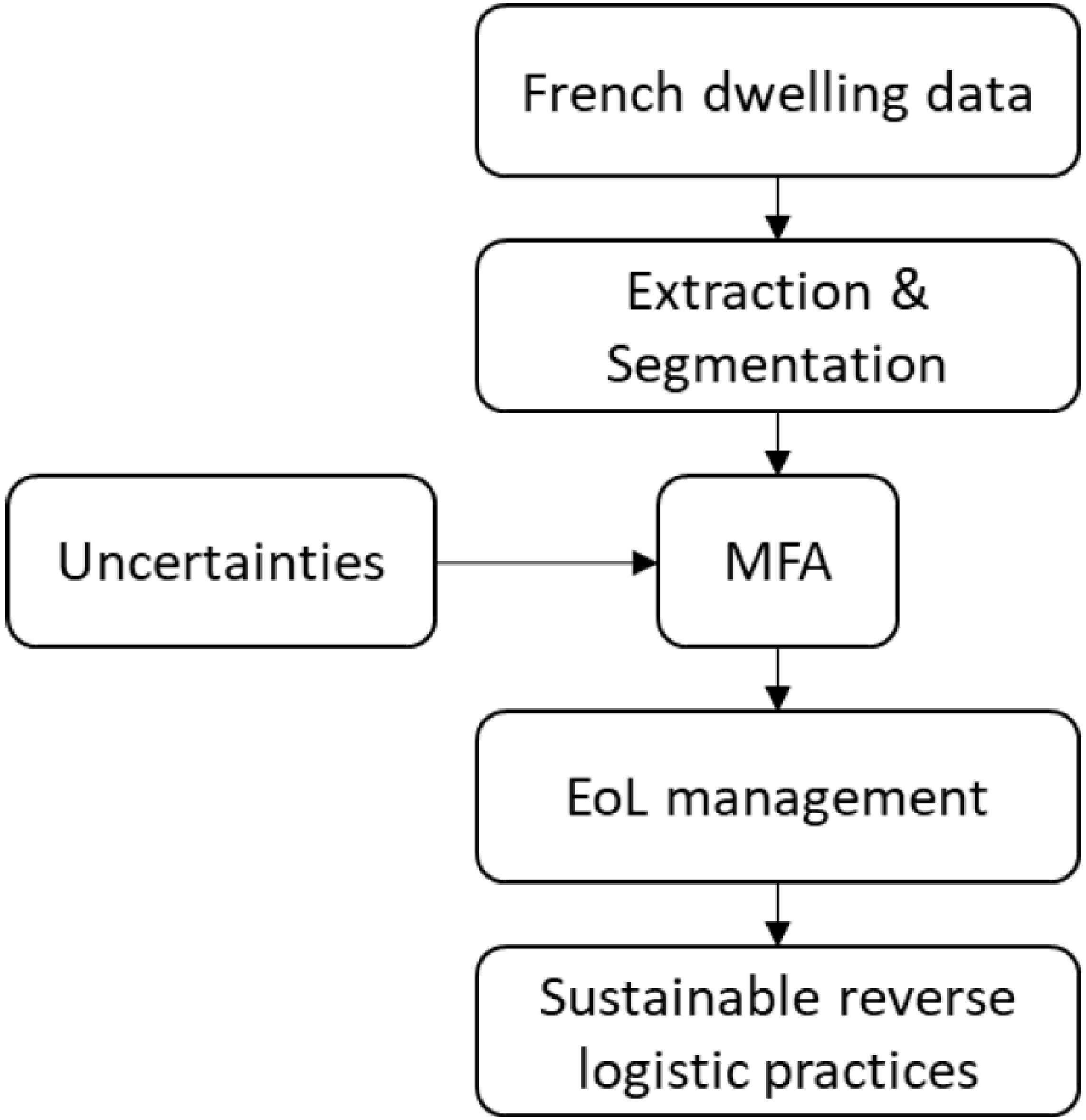
N. TAZI, R. IDIR and A. BEN FRAJ

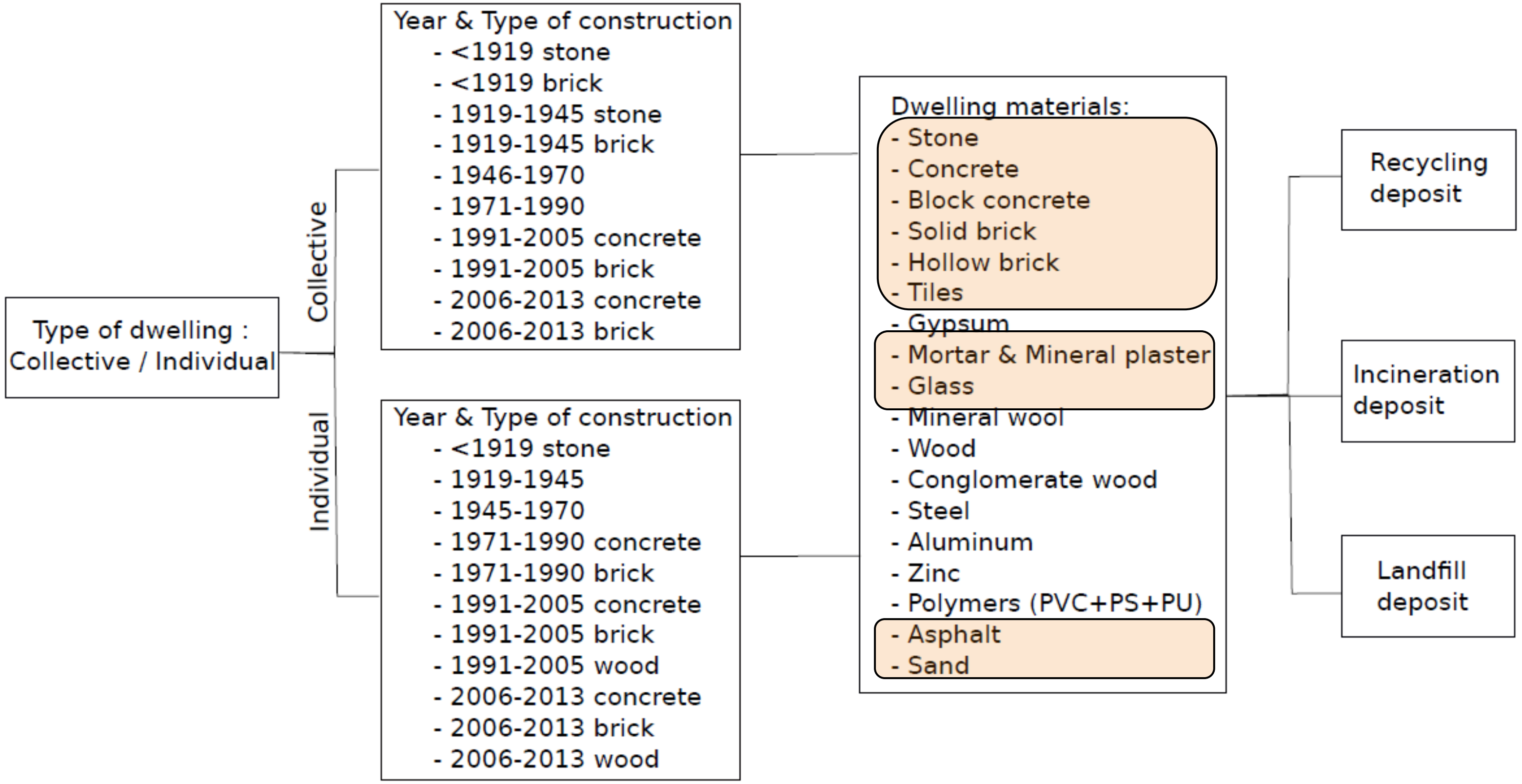
June, 22

- The necessity to handle inert wastes from dwellings construction and demolition
- Methods
- Results in nutshell
- Conclusions and perspectives

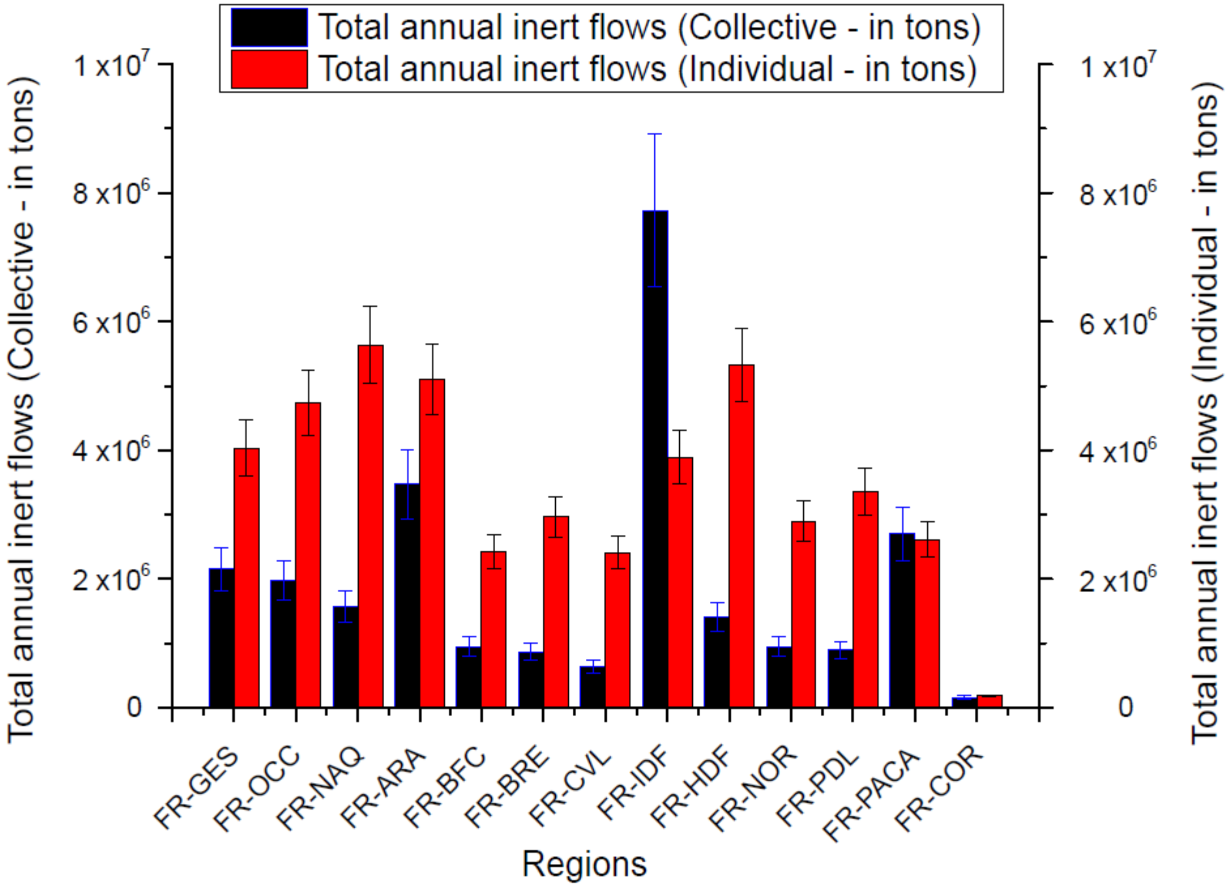
- Assess the ability of a region to reach a sustainable reverse logistic model in the construction and demolition sector
- Stock deposit
- Assessment of inert wastes from dwelling stock
- Avoided resource indicator

Model Framework

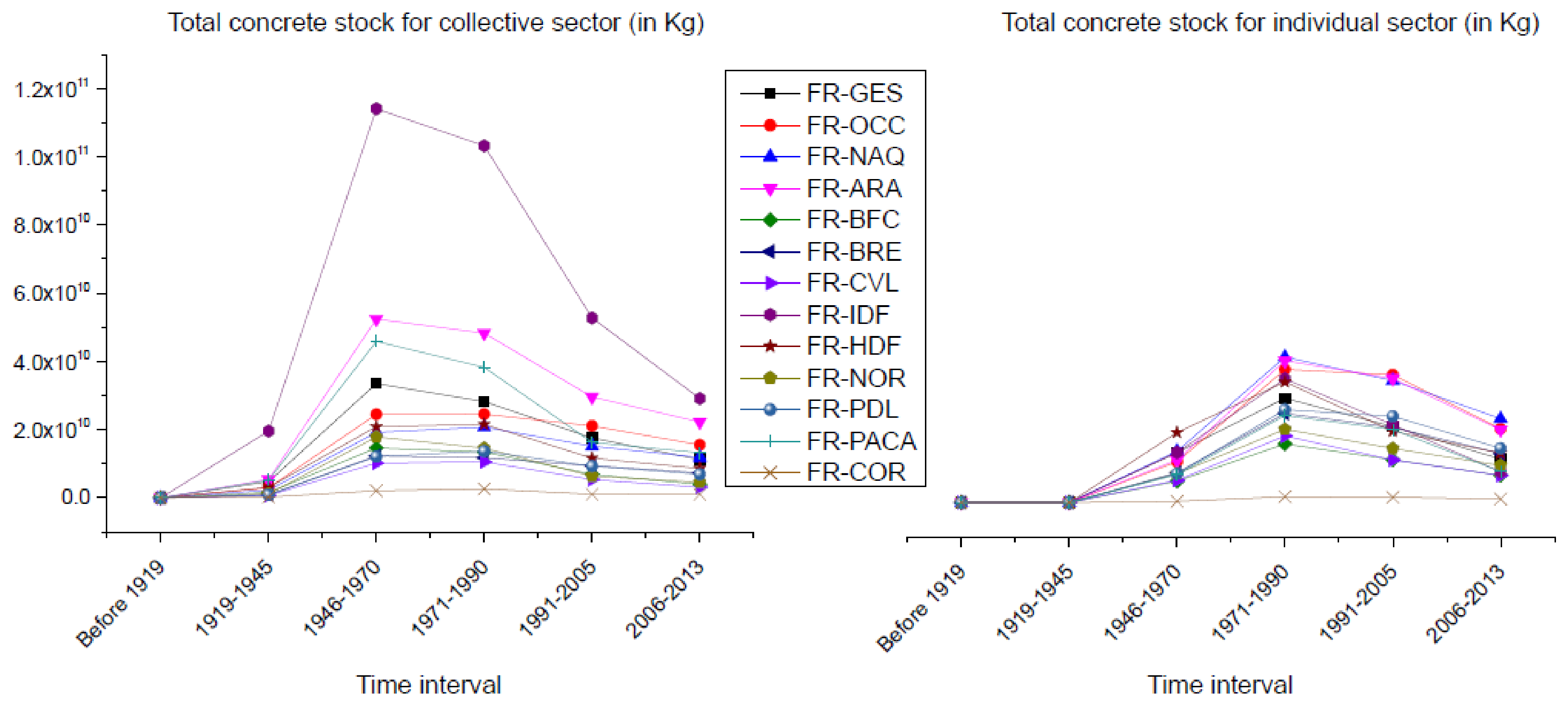




Model framework



Annual flows from inert wastes



Chronological concrete flows generated in French regions from collective (left) and individual (right) dwellings

Interreg North-West Europe SeRaMCo

Cerema

- Annual recycled inert wastes (regional)

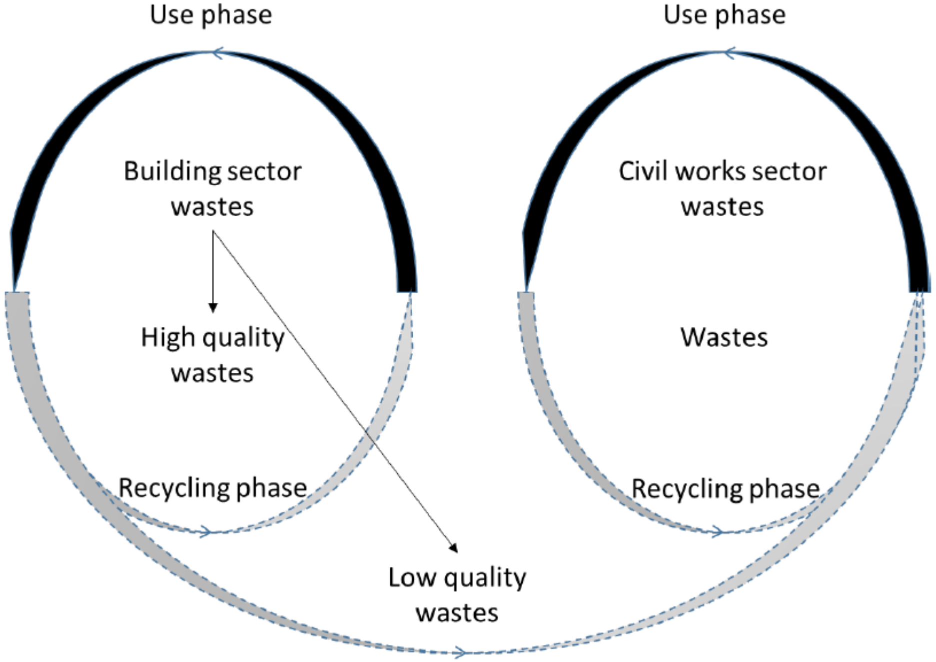
Vs.

- Regional natural resource depletion (NA)

Sustainability criterion

Interreg North-West Europe SeRaMCo
Cerema

- Towards circular economy in the construction sector (locks and opportunities)
- MCDA of recycling processes of CDW
- Environmental assessment of the reverse logistic process



Interreg North-West Europe SeRaMCo
European Regional Development Fund
Cerema


THANK YOU
MERCI
GRACIAS
DANKE
TERIMA KASIH
DANKESCHÖN
TACK
TAK
DANK U
KÖSZÖNÖM
OBRIGADO
GRAZIE
СПАСИБО
MERCI
DANKESCHÖN
DANKE
شكرا لك
GRACIAS
ĎAKUJEM
DZIĘKUJĘ
ΣΑΣ ΕΥΧΑΡΙΣΤΩ
DANK U
DANKESCHÖN
תודה
LOGOTYPE
MERCI
ORGANIZATION
THANK YOU
OBRIGADO
GRATIAS TIBI
TAKK
KÖSZÖNÖM
ÞAKKA ÞÉR
GRAZIE
KIITOS
OBRIGADO
TEŞEKKÜR EDERIM
ありがとう
GRATIAS

Cerema

Centre d’étude et d’expertise sur les risques, l’environnement, la mobilité et l’aménagement

Interreg North-West Europe SeRaMCo European Regional Development Fund

Closed-loop supply-chain of construction and demolition wastes: Towards circular economy in French regions

Nacef TAZI : nacef.tazi@cerema.fr
Rachida IDIR : rachida.idir@cerema.fr
Amor BEN FRAJ: amor.ben-fraj@cerema.fr

Discussion, questions & answers

Interreg North-West Europe SeRaMCo
European Regional Development Fund
EUROPEAN UNION

Save the date:

SeRaMCo Final Conference "Precast Concrete in the Circular Economy”

15-16 February 2021

University of Kaiserslautern, Germany

Interreg North-West Europe SeRaMCo
European Regional Development Fund

Thank you for your attention.

We hope to see you again at our next webinar!

Follow us on:

Twitter and LinkedIn