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Innovation for construction & the environment

Dr. Dimitrios Terzis

16/09/2025

Today's class

- The path to net-zero
- An example of a NET (CO_2 Mineralization in demolished aggregates)
- Cement-free concrete & valorizing excavation waste

+Brief examples for your projects

Dr. Dimitrios Terzis

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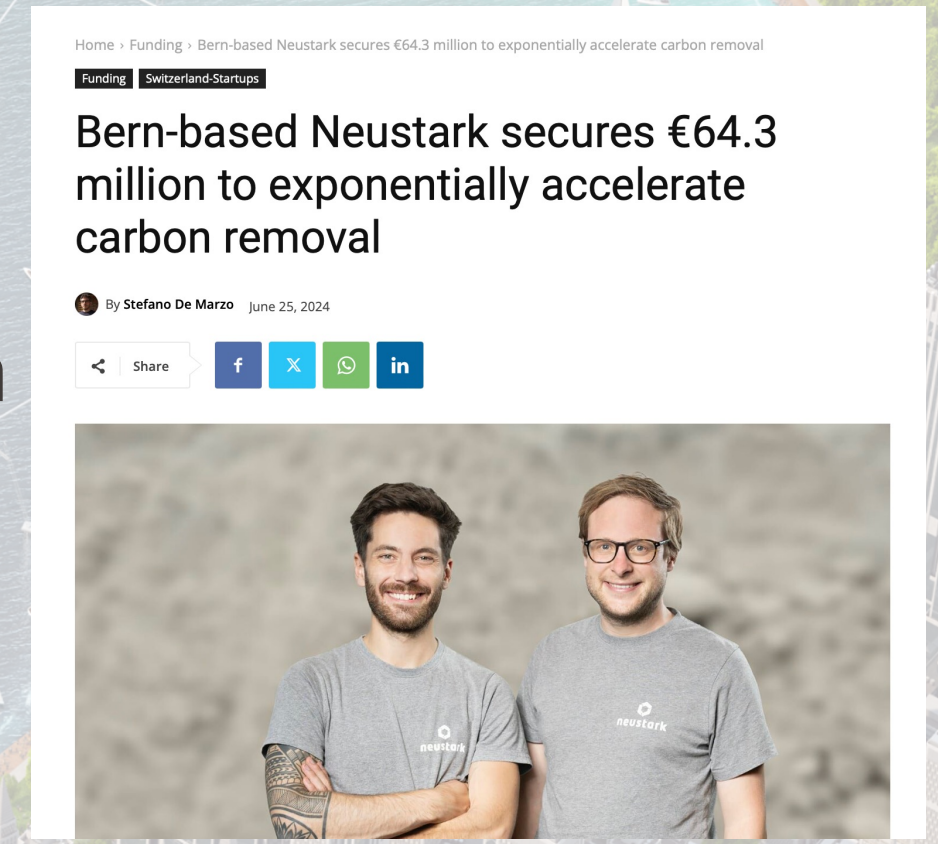

Home › Funding › Bern-based Neustark secures €64.3 million to exponentially accelerate carbon removal

Funding Switzerland-Startups

Bern-based Neustark secures €64.3 million to exponentially accelerate carbon removal

By Stefano De Marzo June 25, 2024

Share

https://www.eu-startups.com/2024/06/bern-based-neustark-secures-e64-3-million-to-exponentially-accelerate-carbon-removal/

+Brief examples for your projects

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PRESSEPORTAL

20.08.2024 – 09:00

Holcim (Schweiz) AG

Strategic partnership between ETH Spin-off Oxara, KIBAG and Holcim to decarbonise concrete and binders

https://www.presseportal.ch/de/pm/100002508/100922198

+Brief examples for your projects

The construction & building sectors are responsible for:

Dr. Dimitrios Terzis

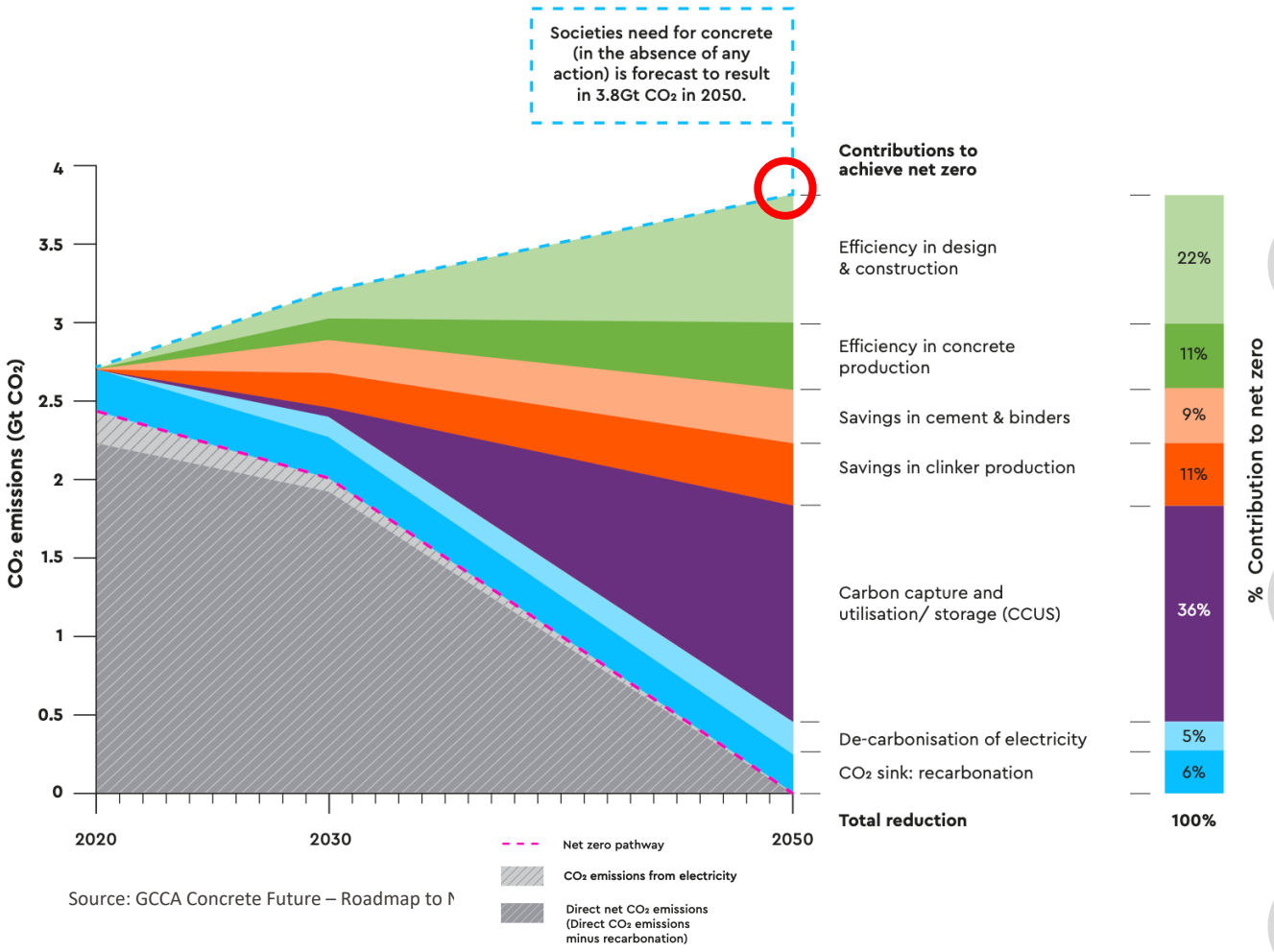
50% of all natural resources depletion by volume

36% of GHG emissions (source: WEF)

1st sector contributing to GDP and its growth

Source: U.K. Green Building Council

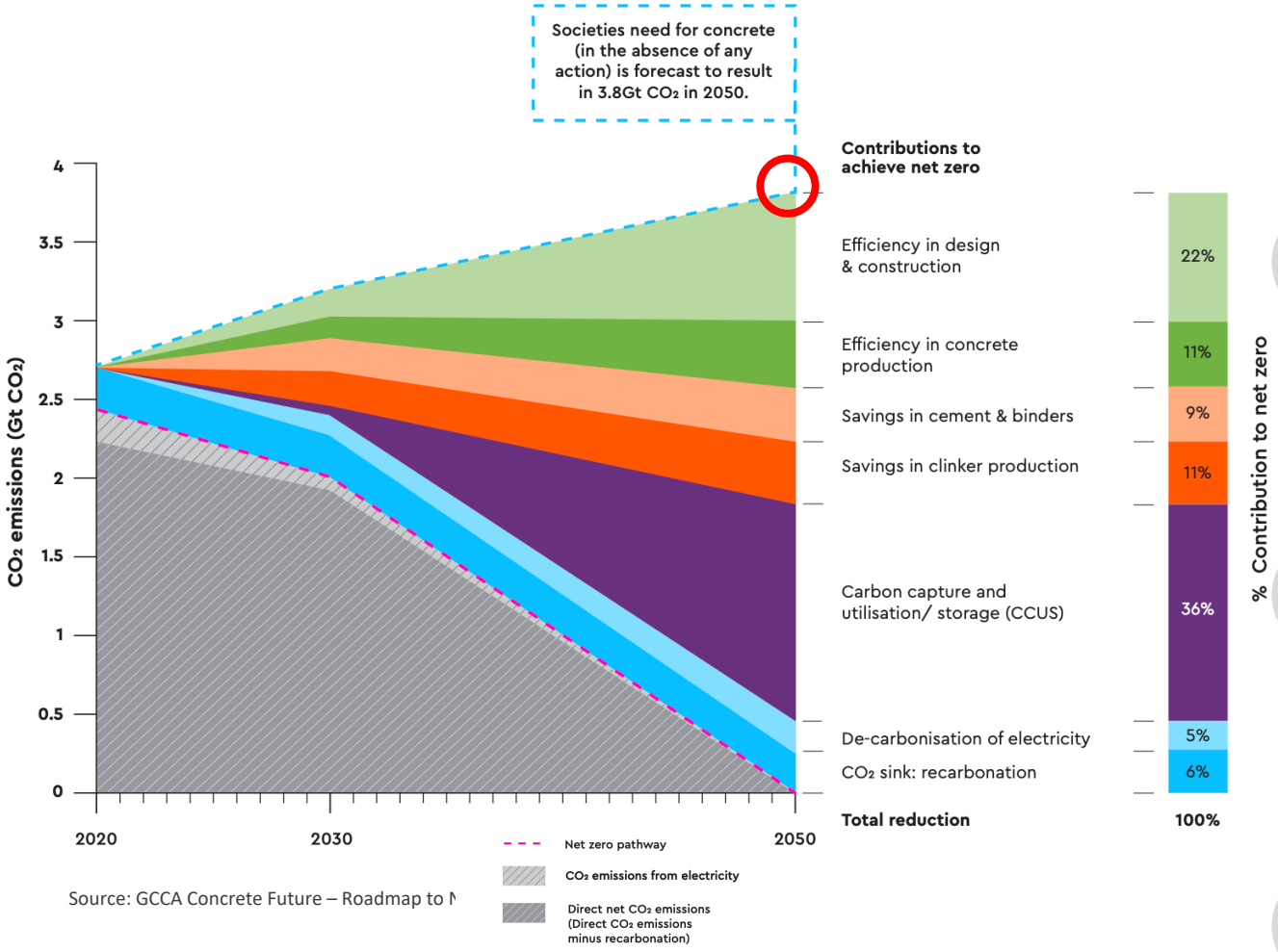
A take on Green businesses in the construction sector



Source: GCCA Concrete Future – Roadmap to N

A take on Green businesses in the construction sector

1. There exists a path to **net-zero**



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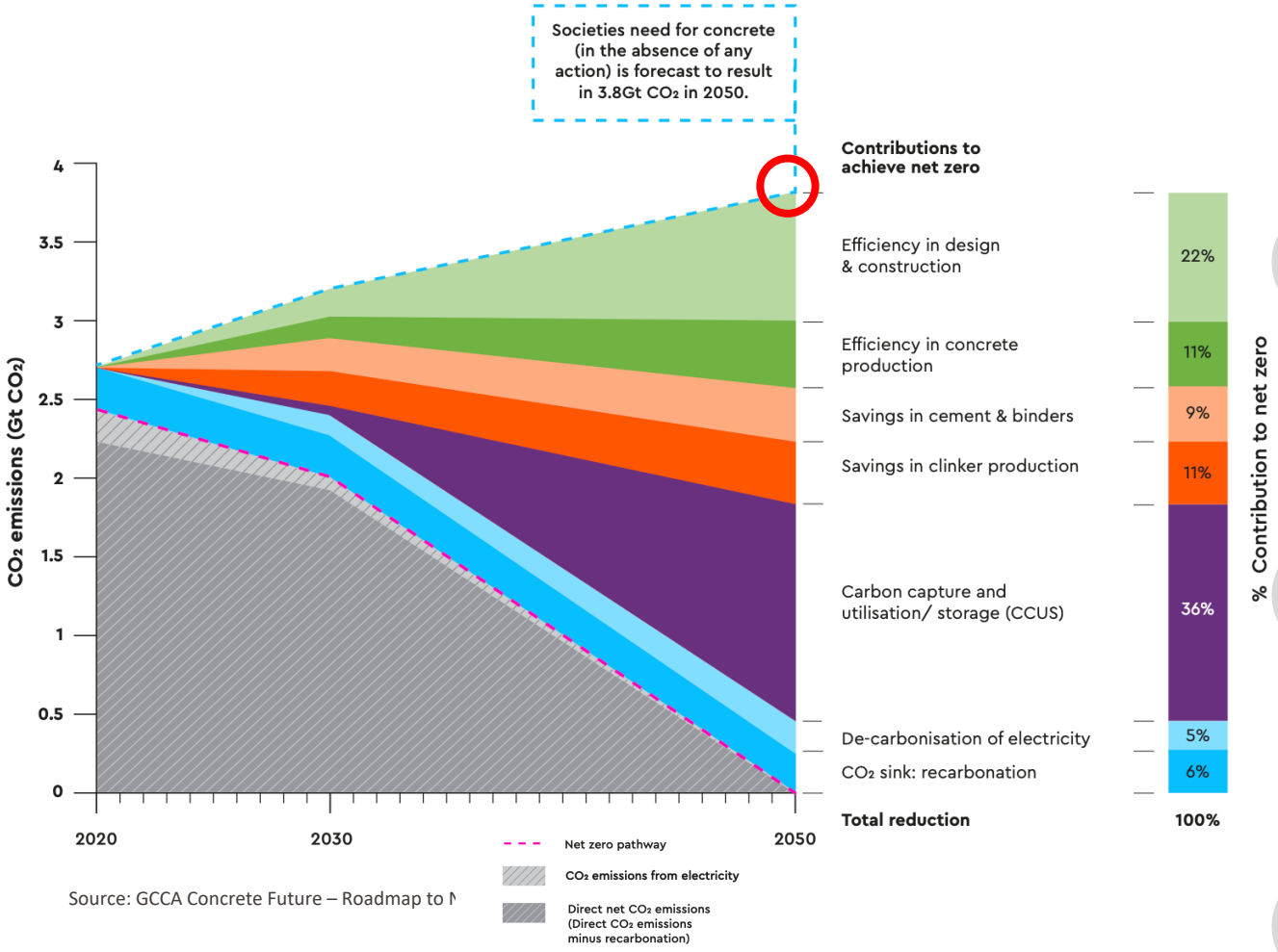

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1. There exists a path to **net-zero**

2. Carbon **credits** have been under a lot of scrutiny.

   *Cutting emissions at **source**, through materials innovation.*

Our take on defining sustainability in construction via 4 questions

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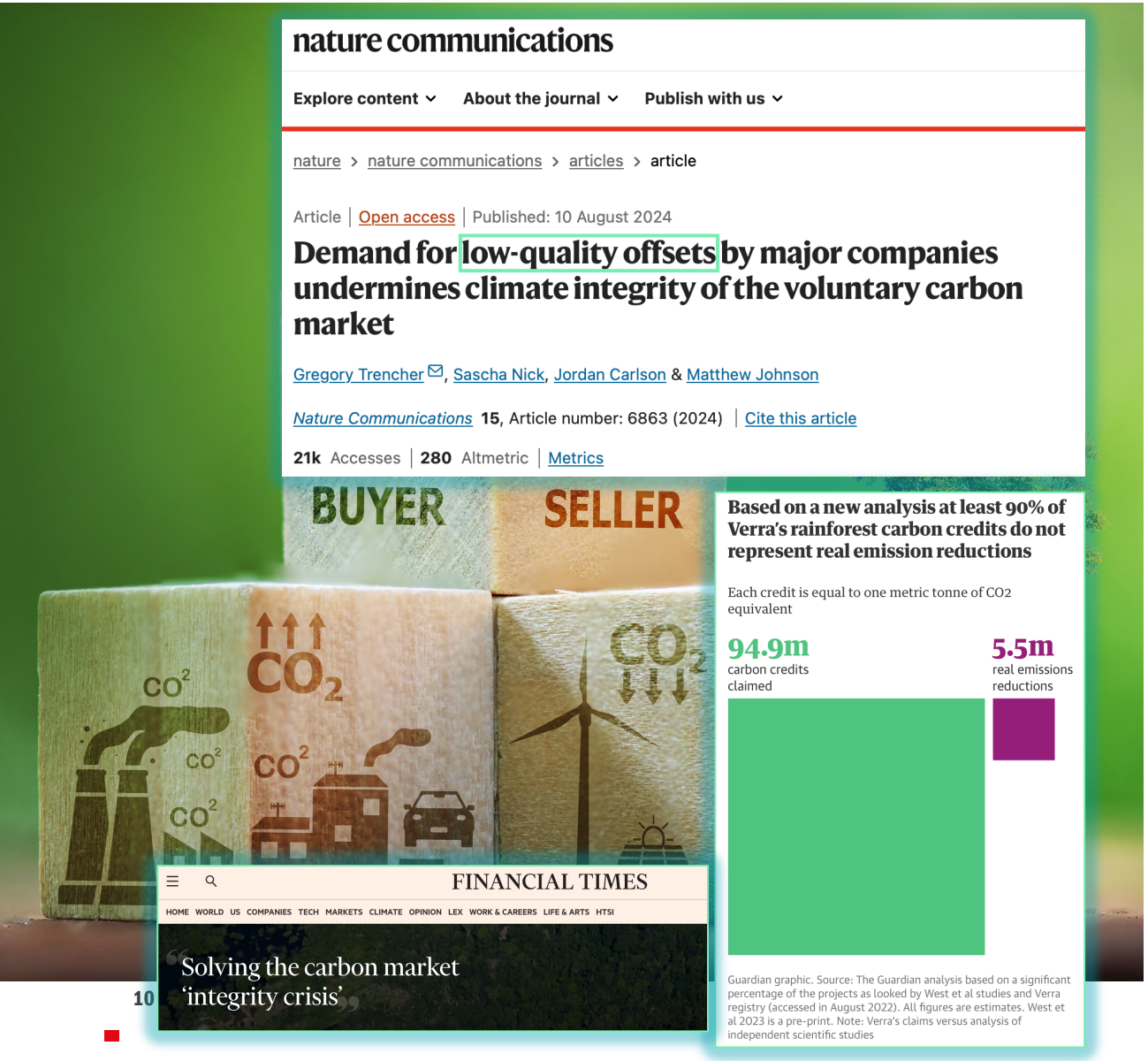

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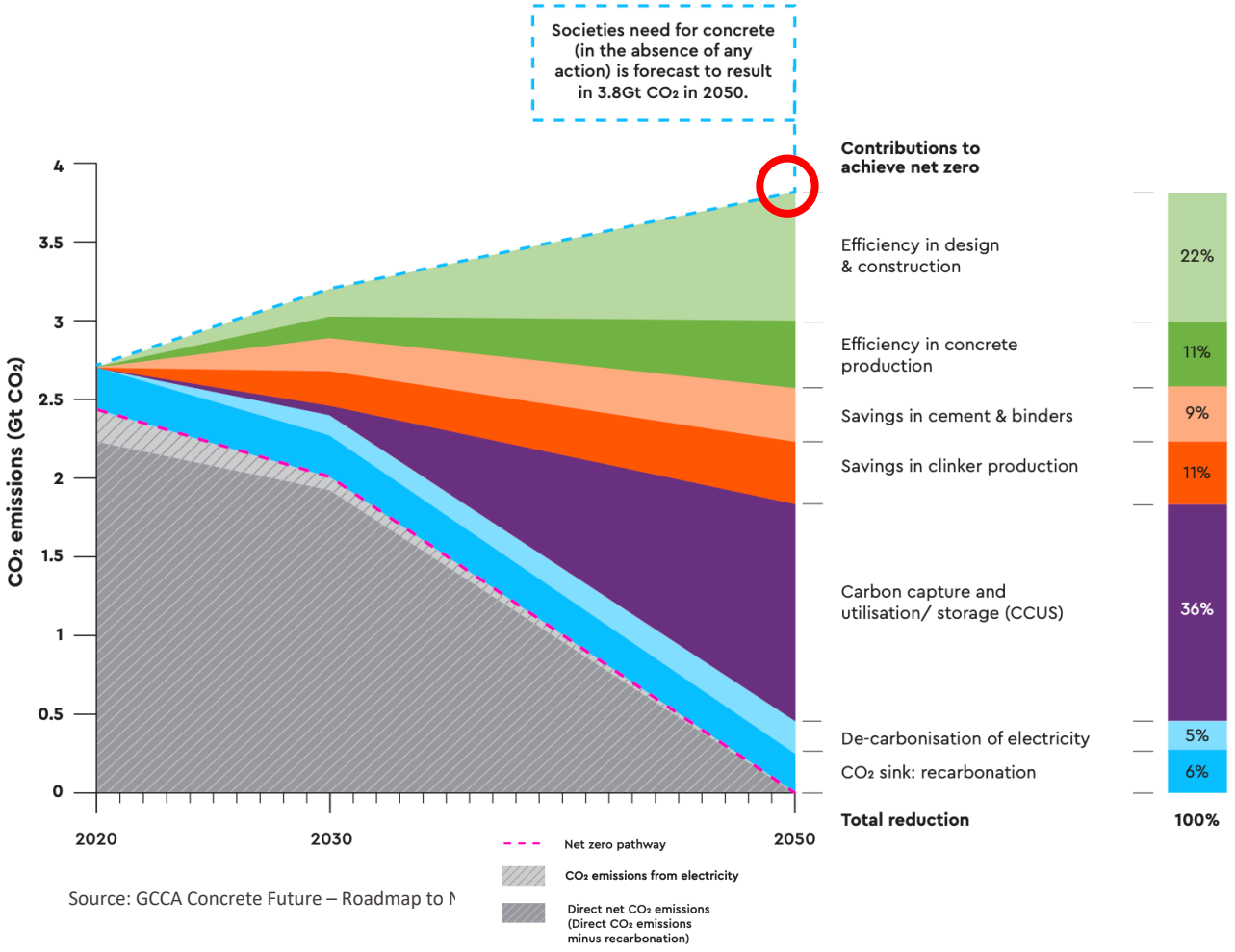

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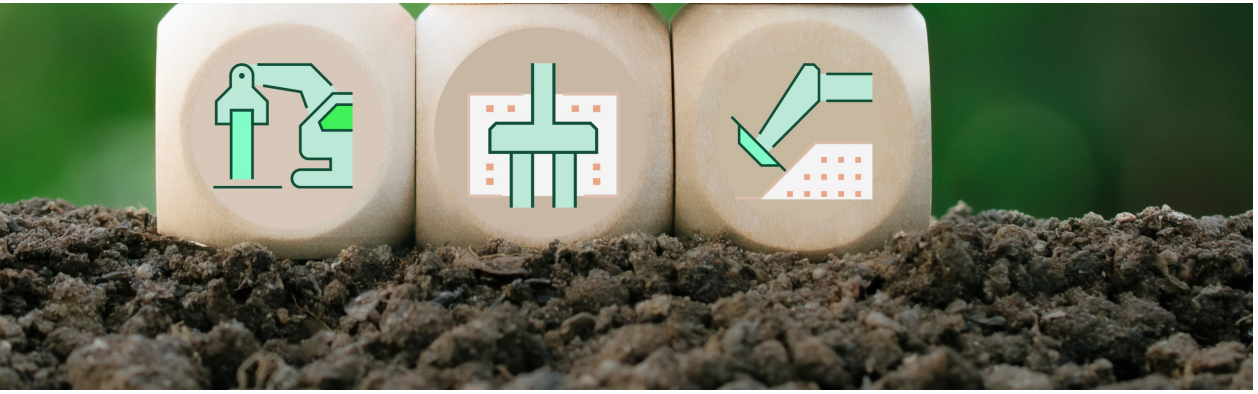
A take on Green businesses in the construction sector



"***Chemical grouts*** *typically make groundwater* ***highly alkaline,*** *which can have a negative impact on soil. Older mixes, which are increasingly prohibited, also contain* ***harmful alumina and other heavy metals***"

KELLER

Paul Pandrea, European Technical Director,
KELLER. March 2021

1. There exists a path to **net-zero**

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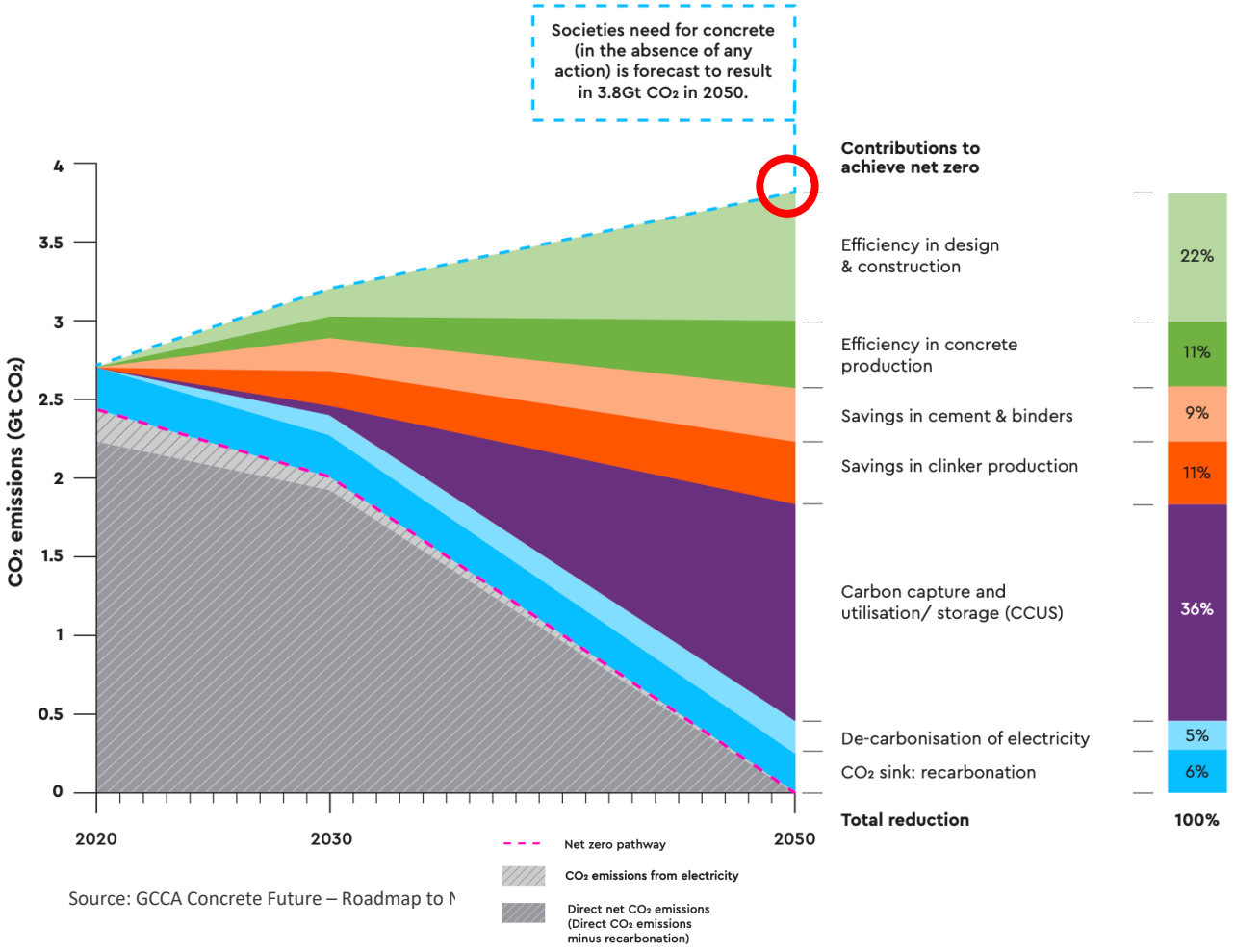
4. 2025 offers a **defining moment** for climate tech in constructon

A take on Green businesses in the construction sector



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4. 2025 offers a **defining moment** for climate tech in constructon

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Office for the Environment FOEN

Factsheet

Long-term climate strategy

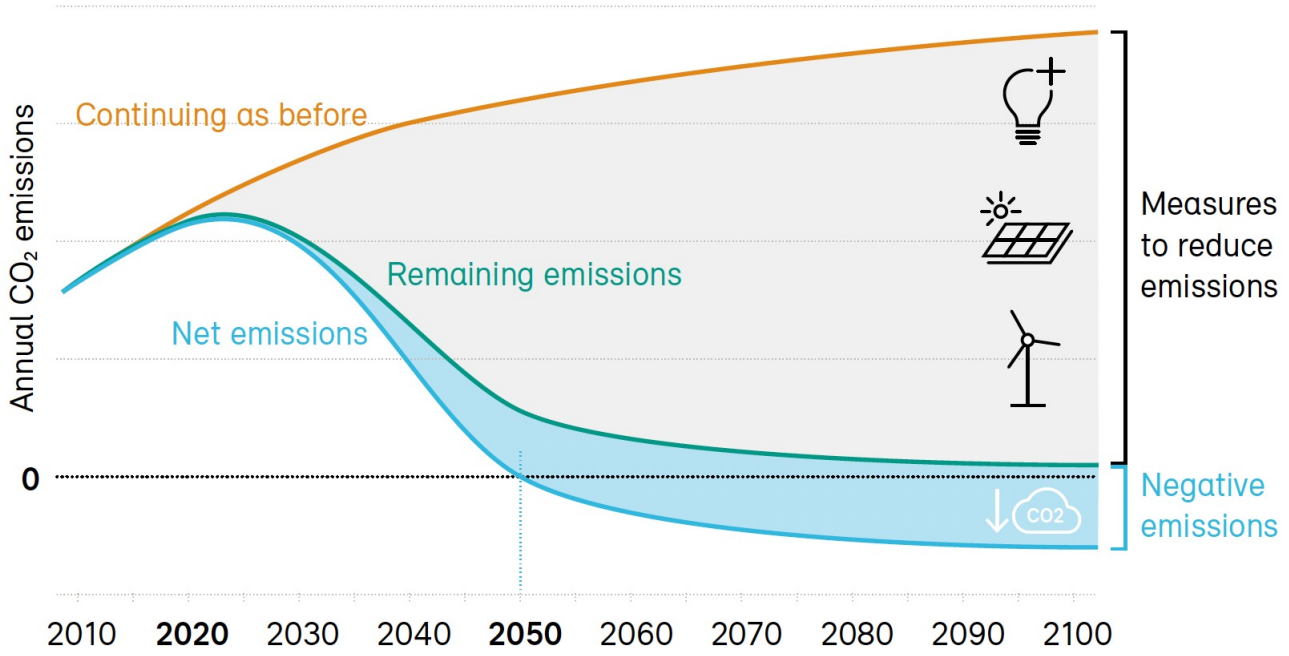
> *On 28 August 2019, the Federal Council adopted a net-zero target. Switzerland aims to reduce its net greenhouse gas emissions to zero by the year 2050.*

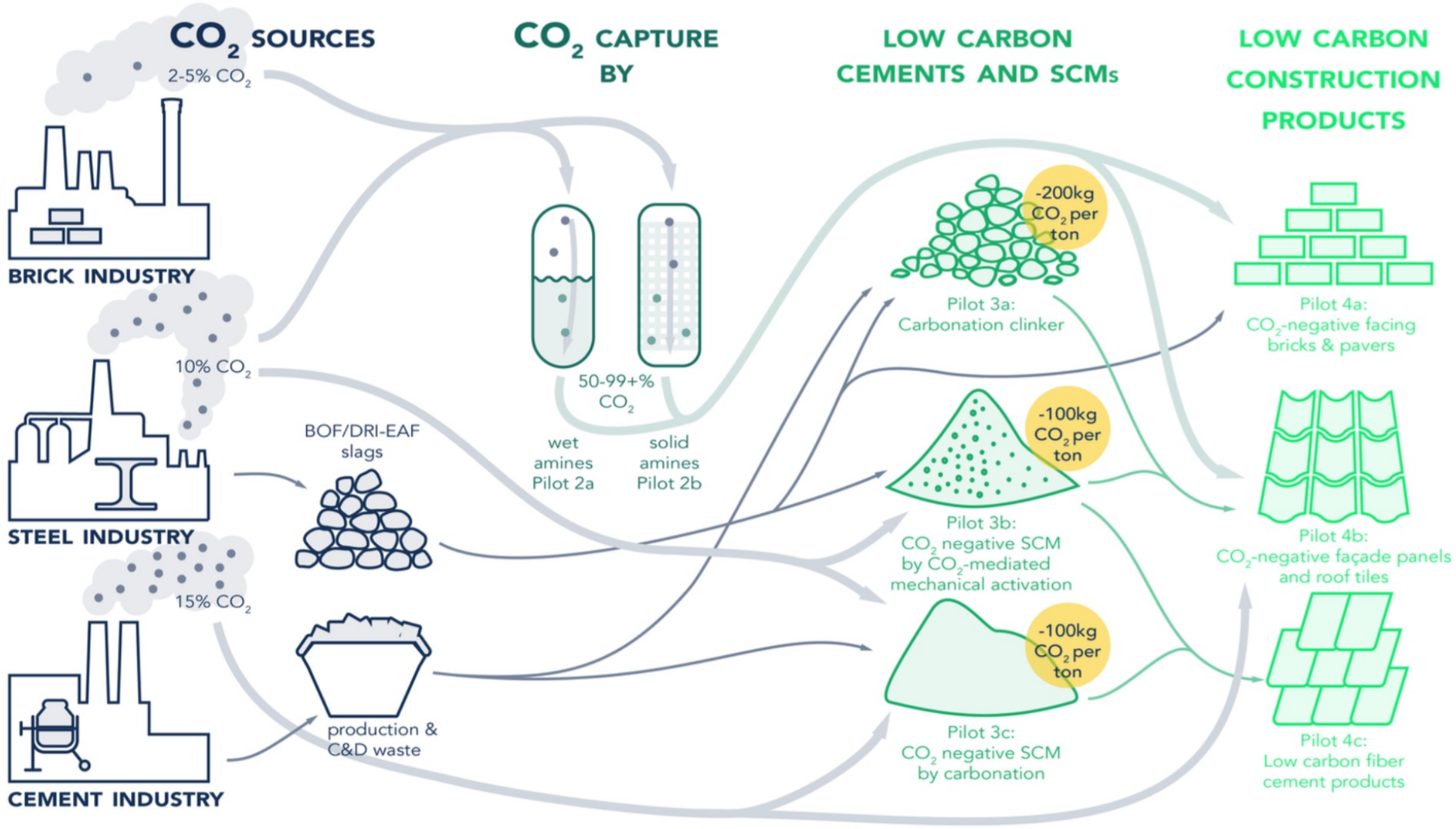
> *On 27 January 2021, the Federal Council adopted its Long-Term Climate Strategy. In ten strategic principles, it sets the guidelines for Switzerland's long-term climate policy. The Long-Term Climate Strategy also sets targets for each sector and shows possible developments up to the year 2050.*

> *Remaining emissions that are difficult to avoid must be offset by so-called negative emission technologies. The Long-Term Climate Strategy shows needs that may arise in this area.*

Achieving the net zero target by 2050

To achieve net zero, avoidable emissions must be eliminated and emissions that are difficult to avoid must be offset by negative emission technologies (NET) that permanently remove CO_2 from the air. Net zero is only an interim target.

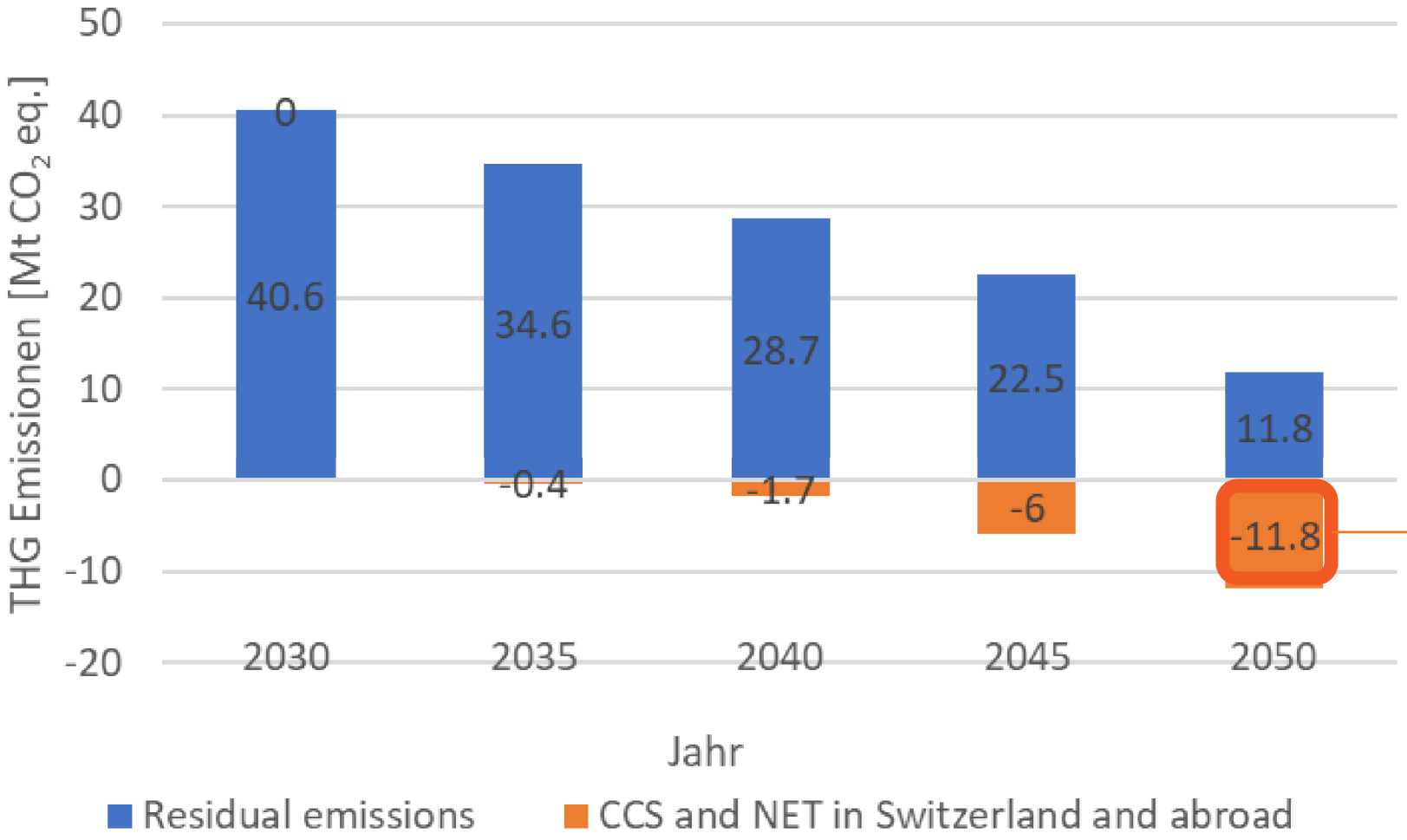


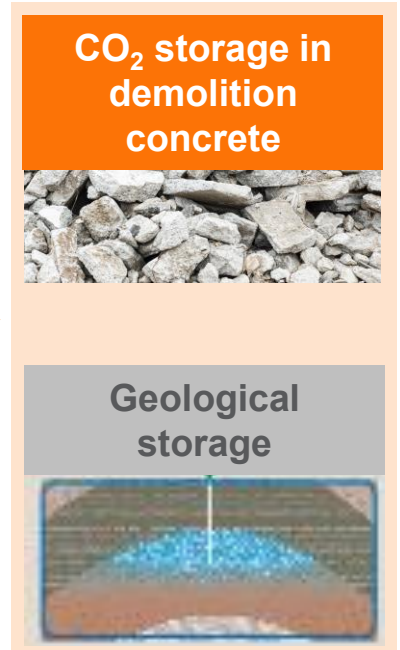


https://www.carbon4minerals.eu


neustark™
building on CO_2

SWISS CO_2 REDUCTION PATHWAY



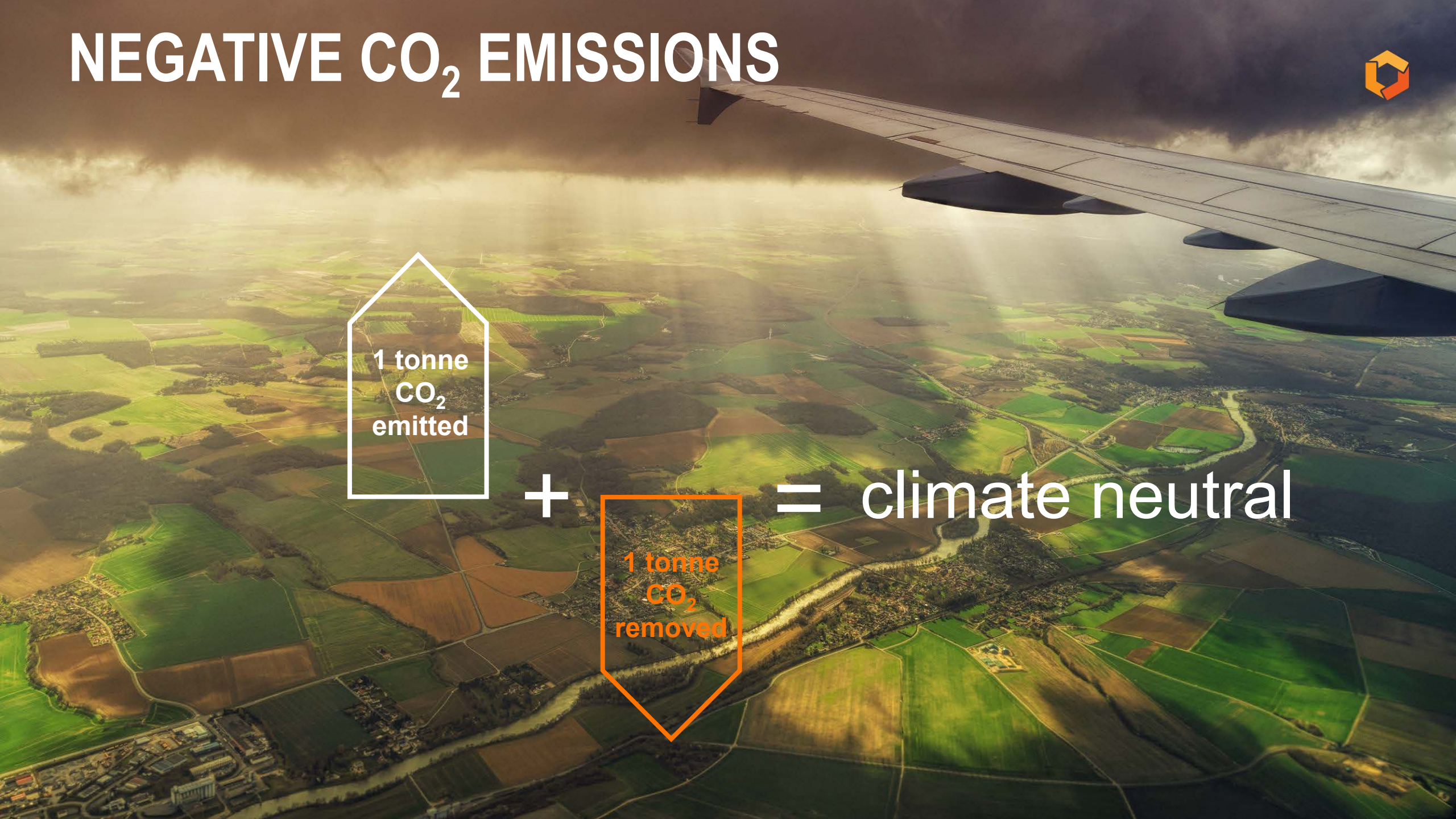


Quelle: Switzerlands's long-term climate strategy (BAFU 2021)

SINK – DEMOLITION CONCRETE

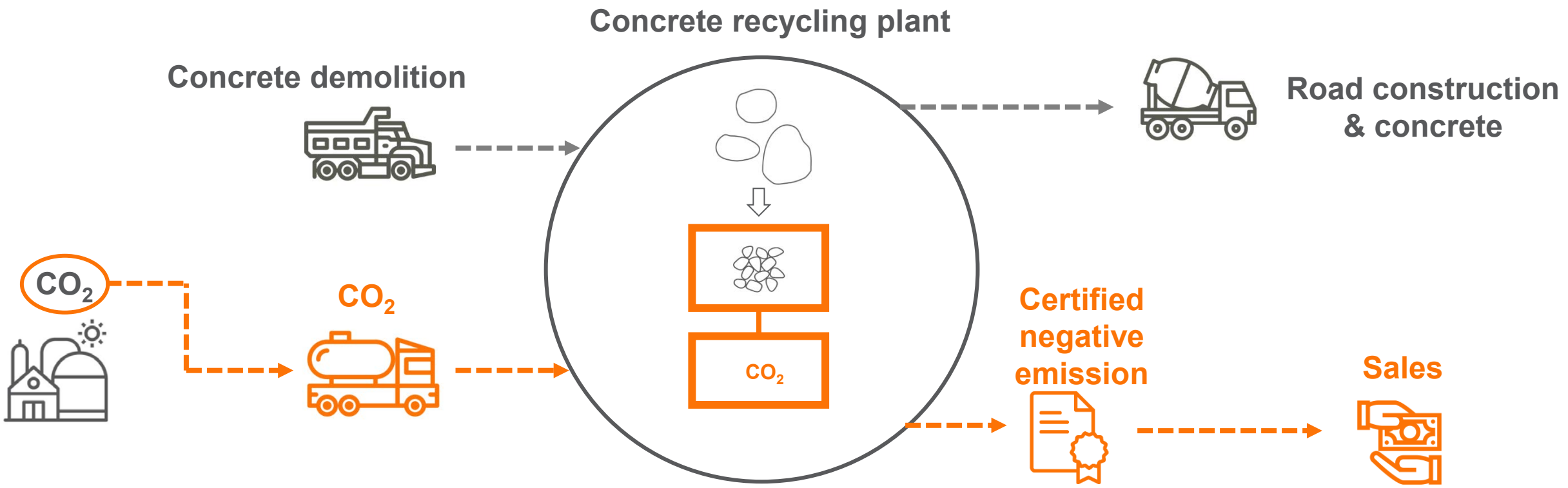
1. Capability to fix 60 kg CO_2 / t
2. Abundant
3. Concrete recycling industry

NEGATIVE CO_2 EMISSIONS



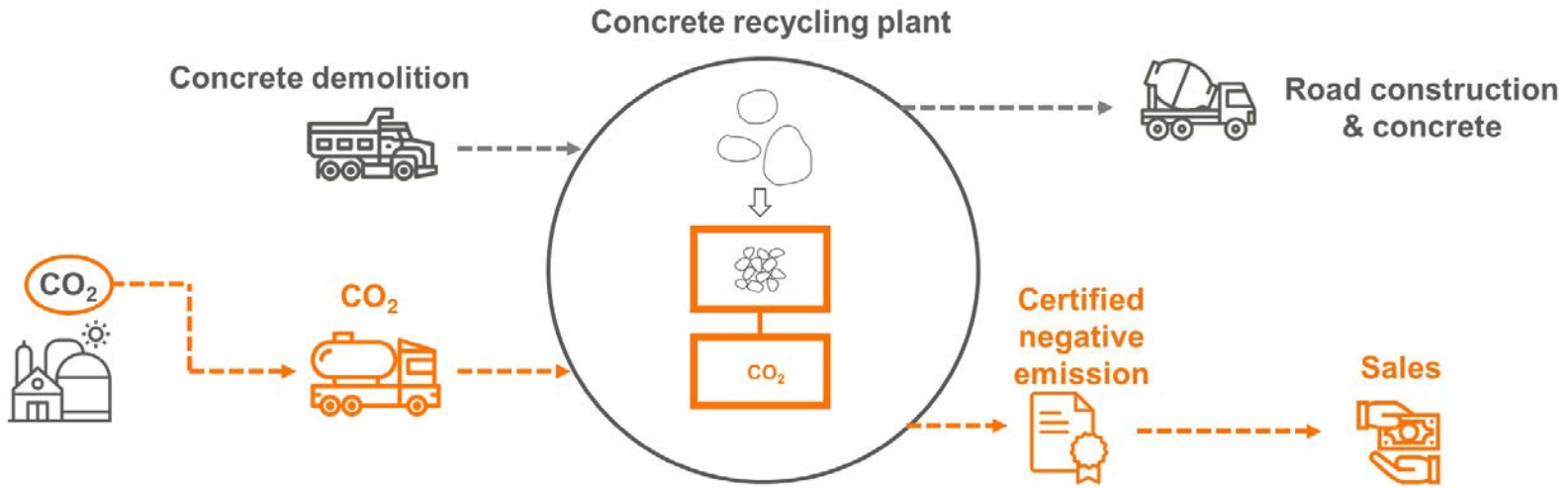
1. Neustark’s negative emission value chain

NEUSTARK VALUE CHAIN



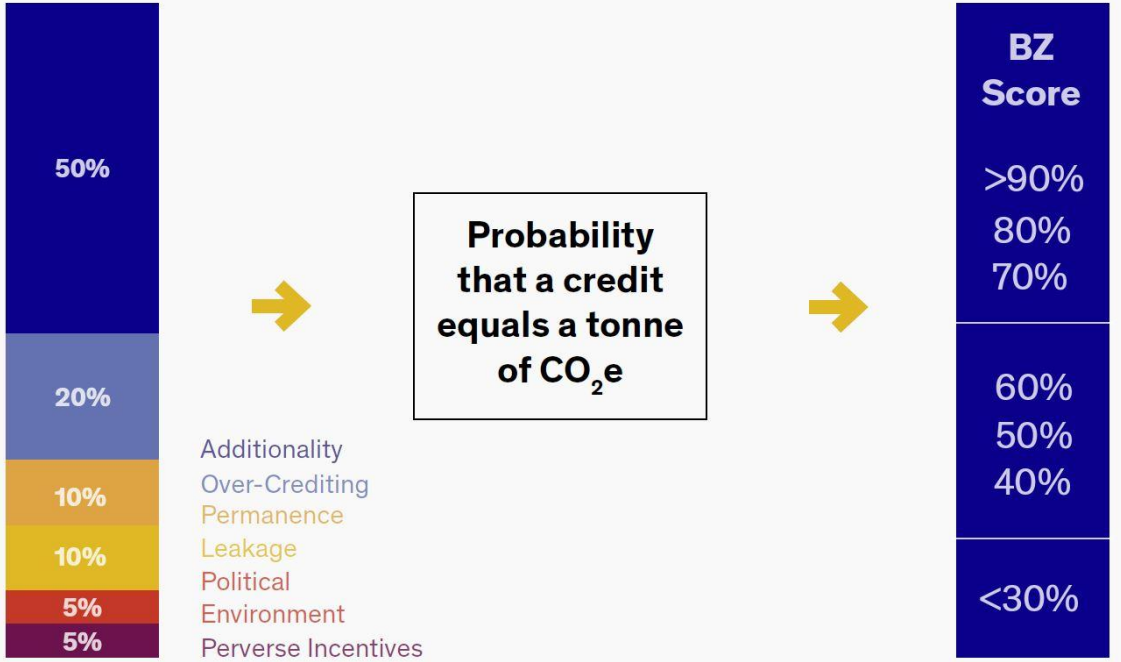
MOBILE PILOT PLANT

2. Products


Concrete recycling plant
Concrete demolition
Road construction & concrete
CO_2
CO_2
CO_2
Certified negative emission
Sales

CERTIFIED NEGATIVE EMISSION

Risk factor	Importance	Explanation
Additionally	Critical	To truly be an 'offset' the carbon avoided or stored must only have occured due to the creation of the project and purchase of the credit.
Over-crediting	Primary	The total Greenhouse Gas (GHG) removal or avoidance is critical for assessing the probability that a credit achieves a tonne of CO_2e. The accuracy of baselines strongly determines how much GHG is offset.
Permanence/ enforceability		Nature-based carbon credits risk trend reversal within the committed project timeframe. The probability of delivery also requires assessment.
Leakage		Likelihood that local or national activities increase emissions.
Perserve Incentives	Secondary	Minimising the extent to which behaviours are aligned with the desired carbon or conservation outcomes drives offset quality.
Political Environment		Local, national and international conditions & legislation can have significant, if less direct, bearing on offset quality.

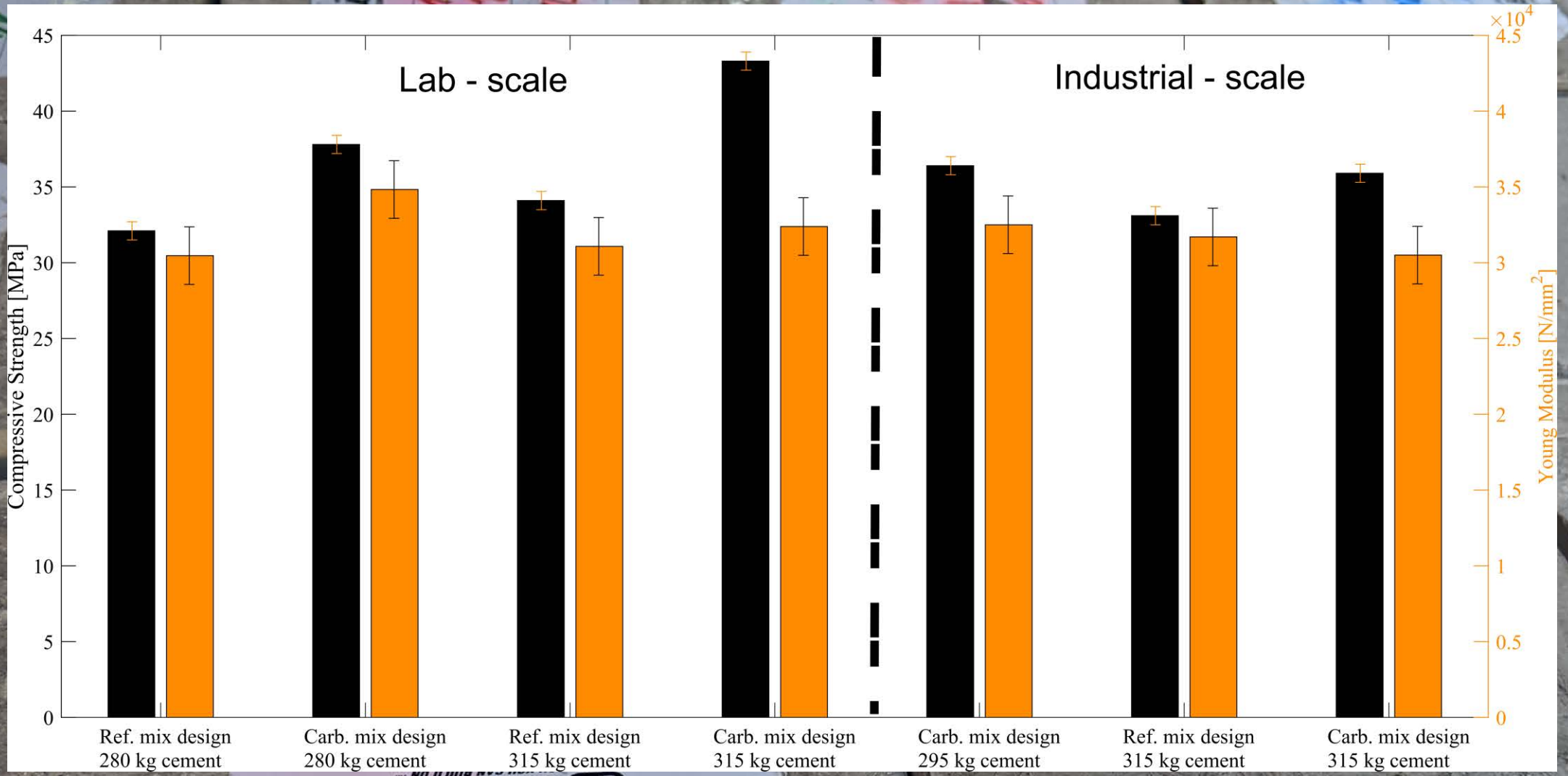


Source: BeZero Carbon Ratings: Methodology White Paper

Carbonated Concrete Aggregate

1. Recycling concrete (> 25% secondary material according to Merkblatt 2030)
2. Material for road construction

MATERIAL TESTS



PRIMARY SCHOOL KLEEFELD, BERN

Hochbau
Stadt Bern

frischbeton
rubigen

CO2 NEUTRAL

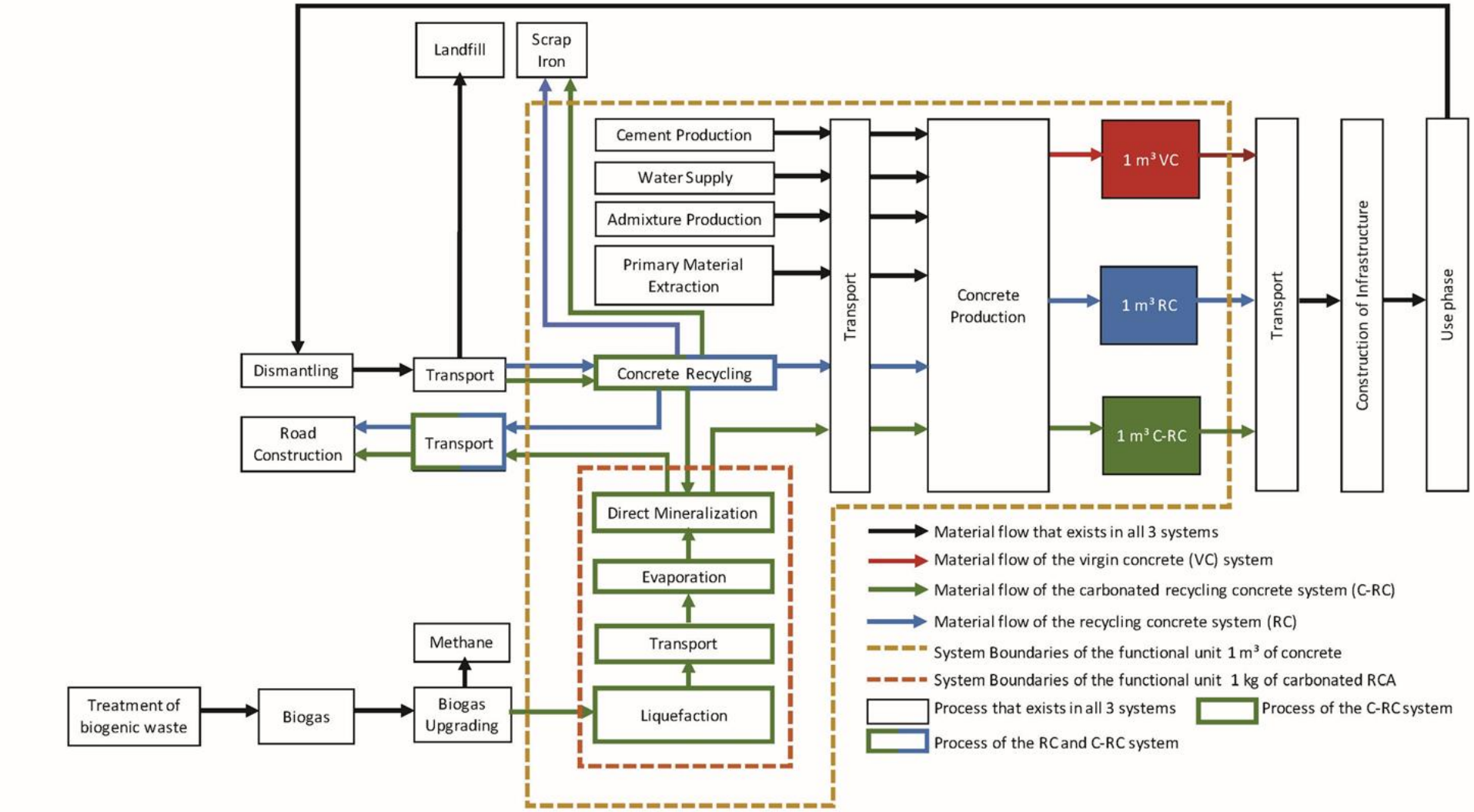
KÄSTLI

3. Environmental performance

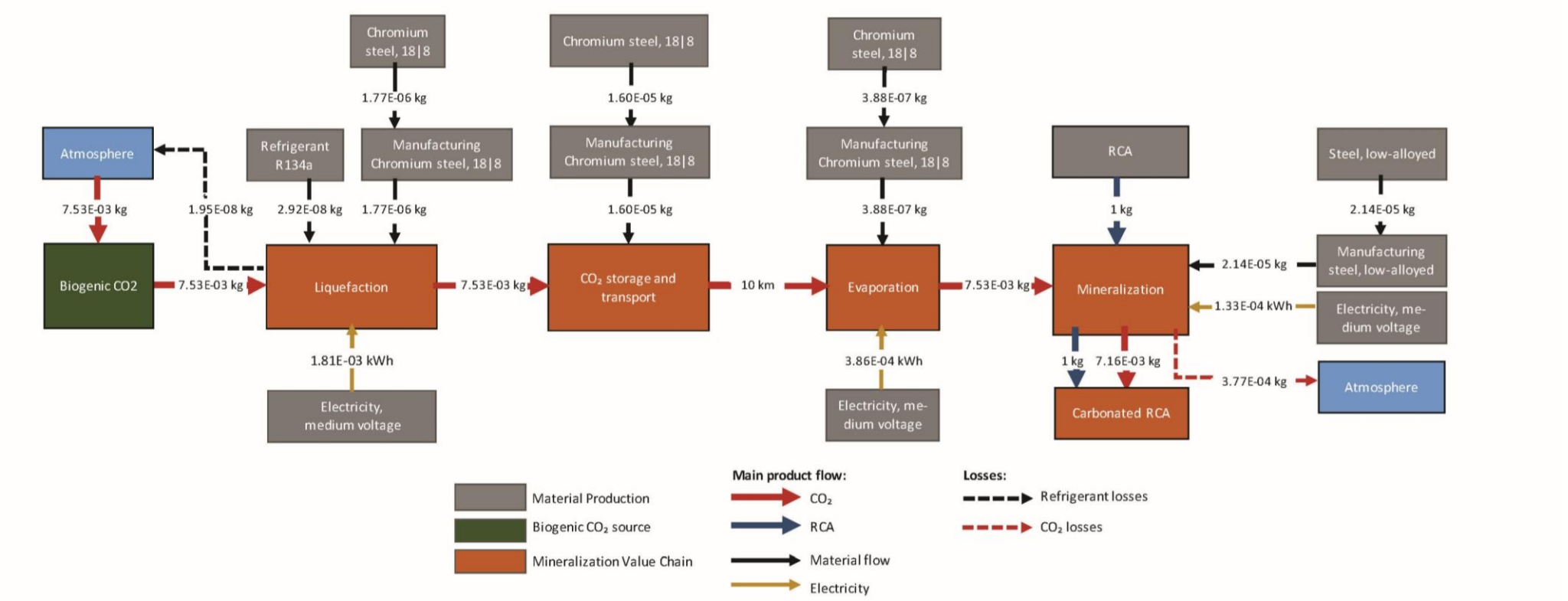
LCA OF THE VALUE CHAIN

1. Goal and Scope
2. Definition of the system boundaries and functional unit
3. Life Cycle Inventory
4. Results and Discussion

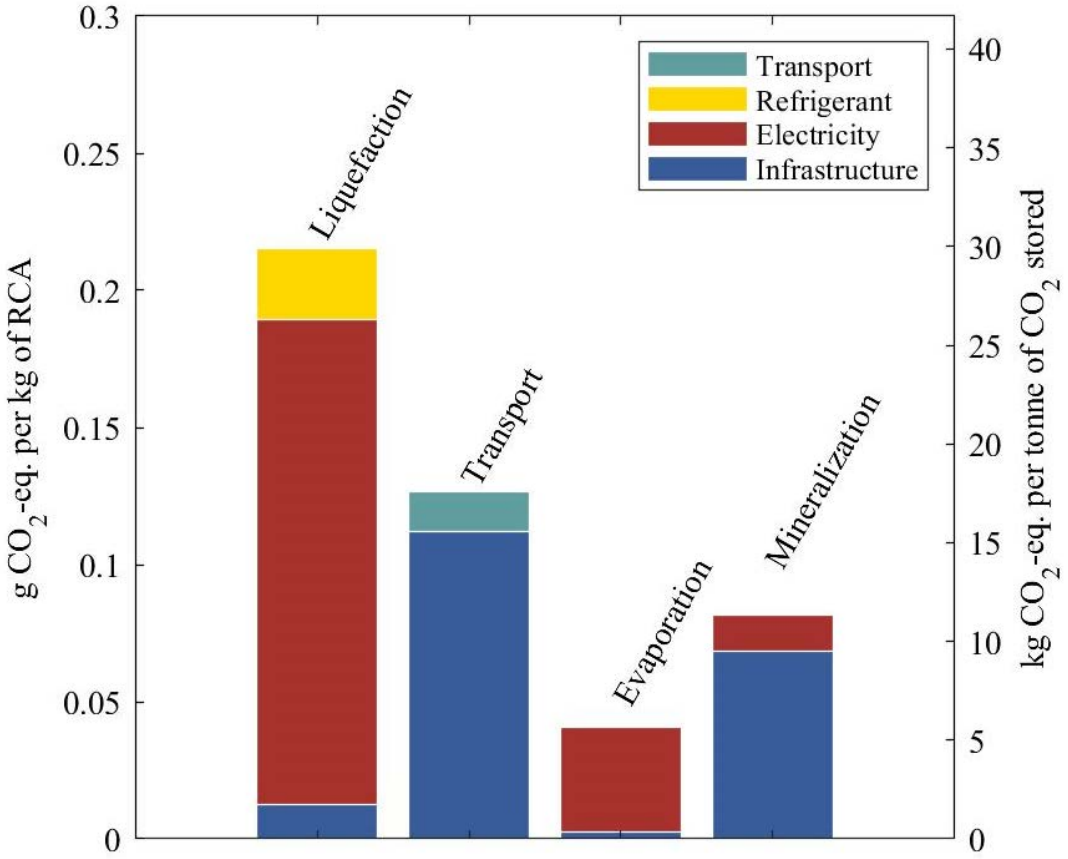
1. System boundaries and functional unit

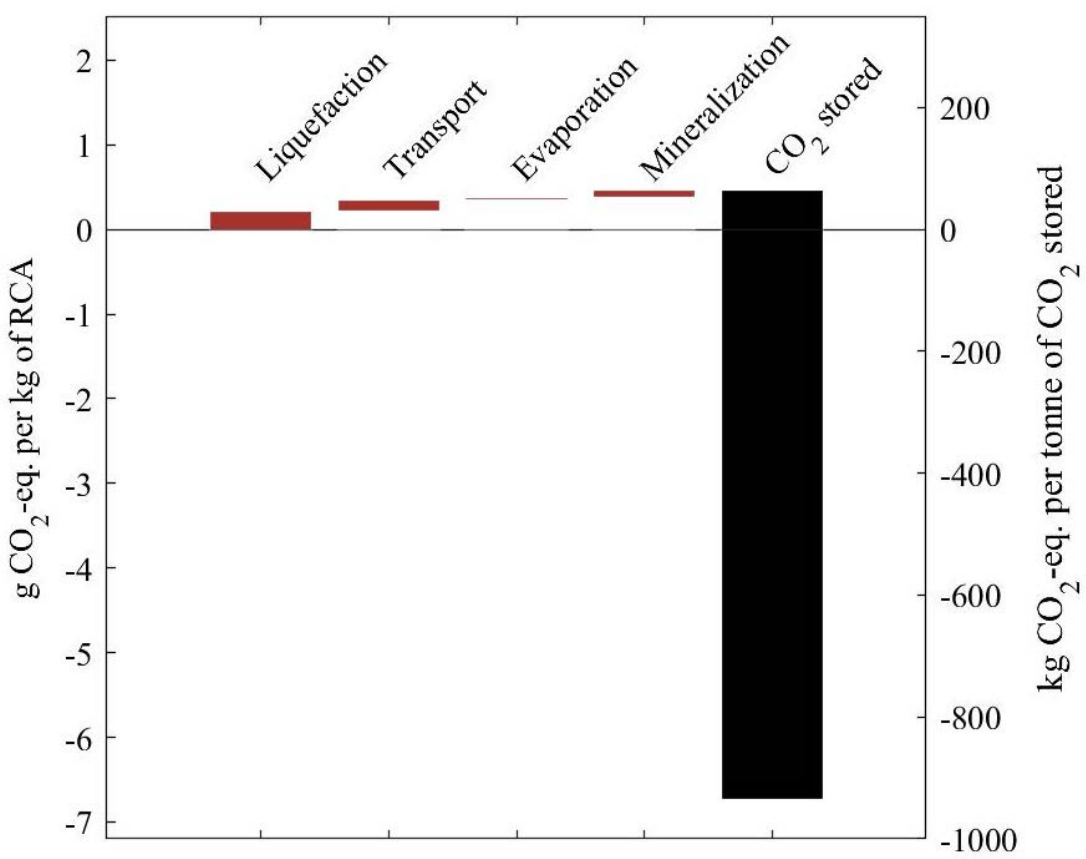


2. LCI of the negative emission value chain

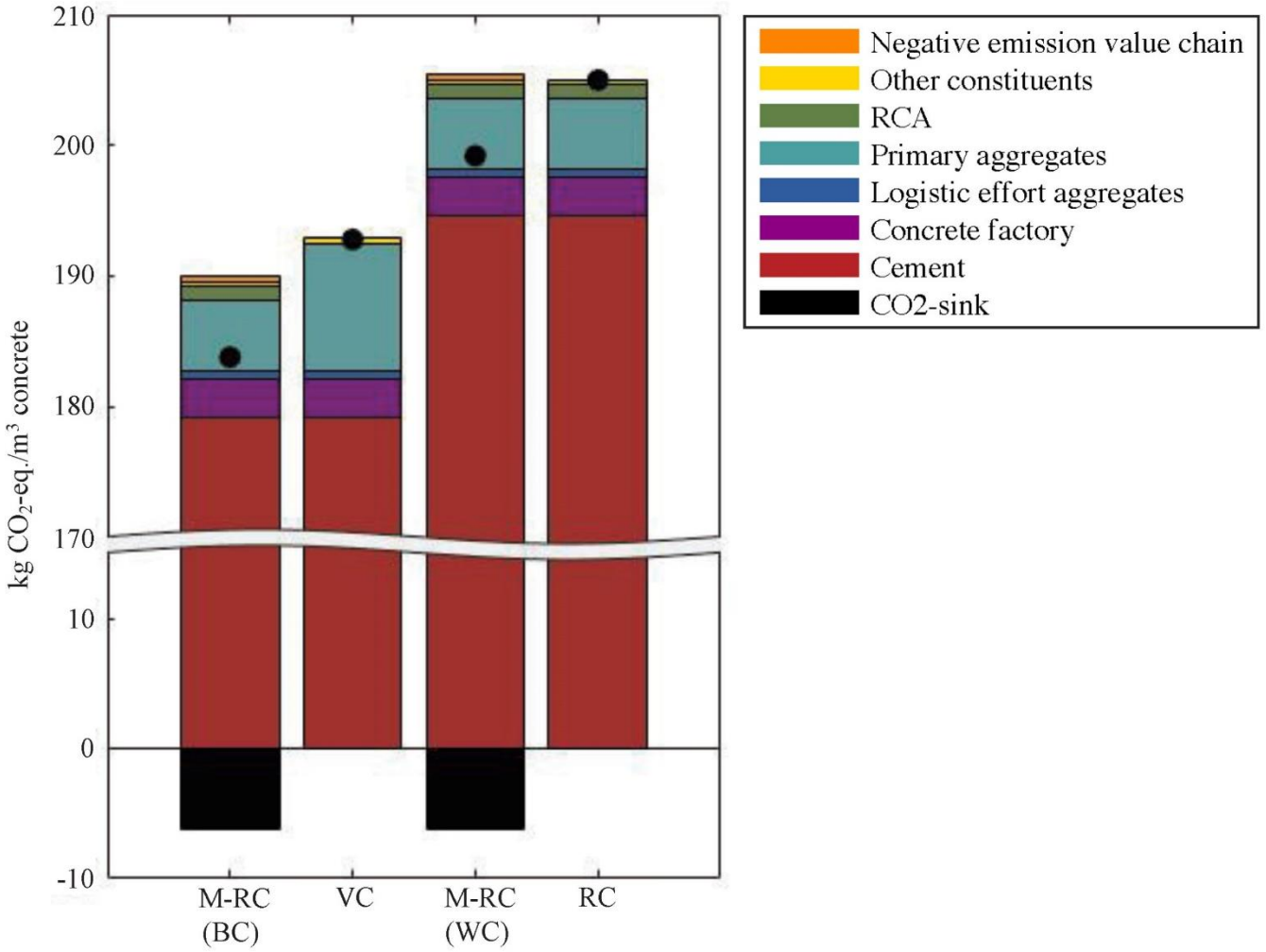


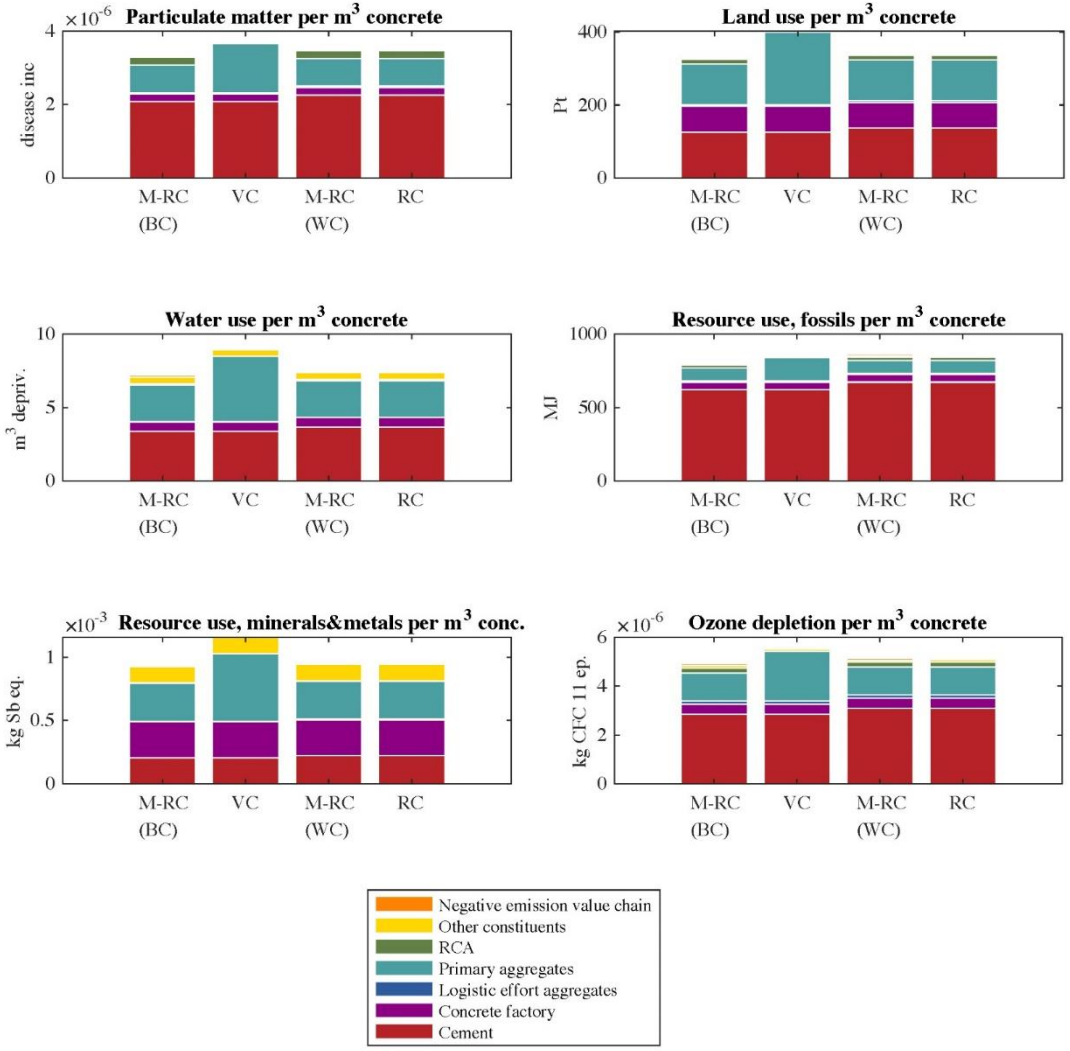
3. Results: Process- vs. Negative Emissions





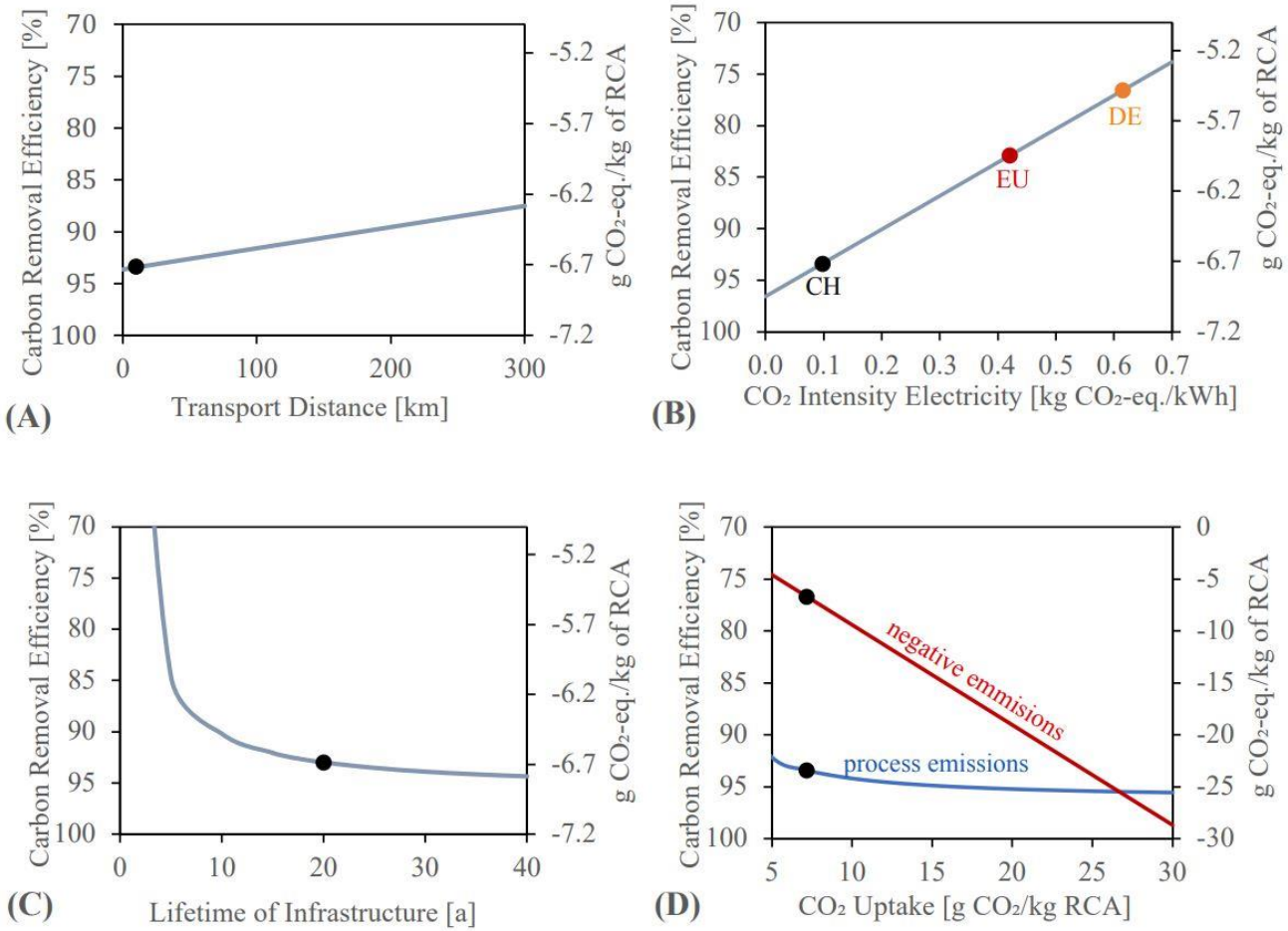
3. Results: 1 m^3 concrete





RC – concrete only better – if cement demand not increased!

4. Sensitivity Analysis



1. The carbon removal efficiency shows a low sensitivity towards the transport distance, infrastructure lifetime and CO_2 uptake.

2. The CO_2 intensity of the electricity mix has a significant impact on the amount of negative emissions.

3. However, even with a German electricity mix, the technology has carbon removal efficiencies exceeding 75%

4. Further developments

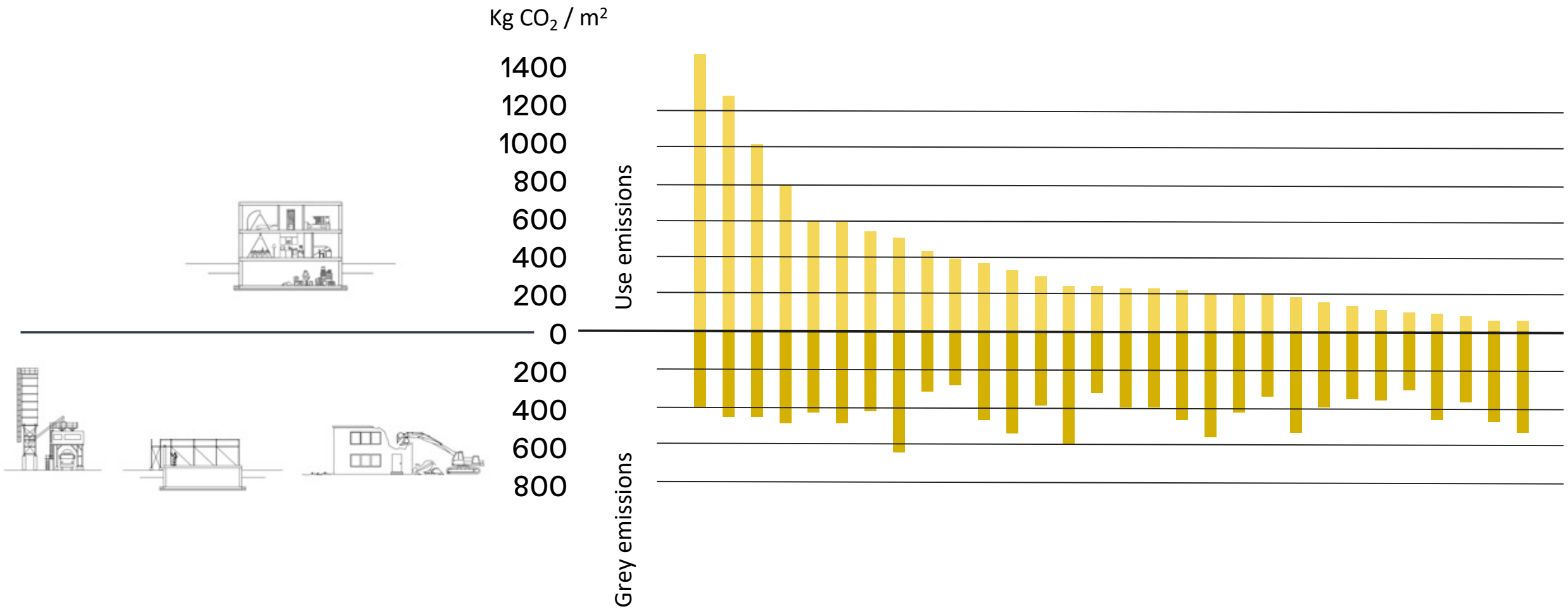
Flue gas capture and mineralization technology

Conclusion

1. To reach climate neutrality, Switzerland has to capture and store 12 Mt CO2 per year in 2025
2. Demolition concrete can store a substantial part of these emissions in a save and permanent way.
3. The neustark value chain delivers as a product negative emissions – which can reduce the footprint of construction materials already today.
4. The quality of a carbon sink is characterized by a number of criteria, most importantly additionality, overcrediting and permanence.
5. The resulting material can be used as a gravel and sand substitute in road construction or concrete
6. The LCA shows that the value chain removes 20 times more CO2 than it emits
7. An environmental assessment should be conducted to decide if the product should be used in concrete or road construction. Recycling can even increase the environmental footprint!

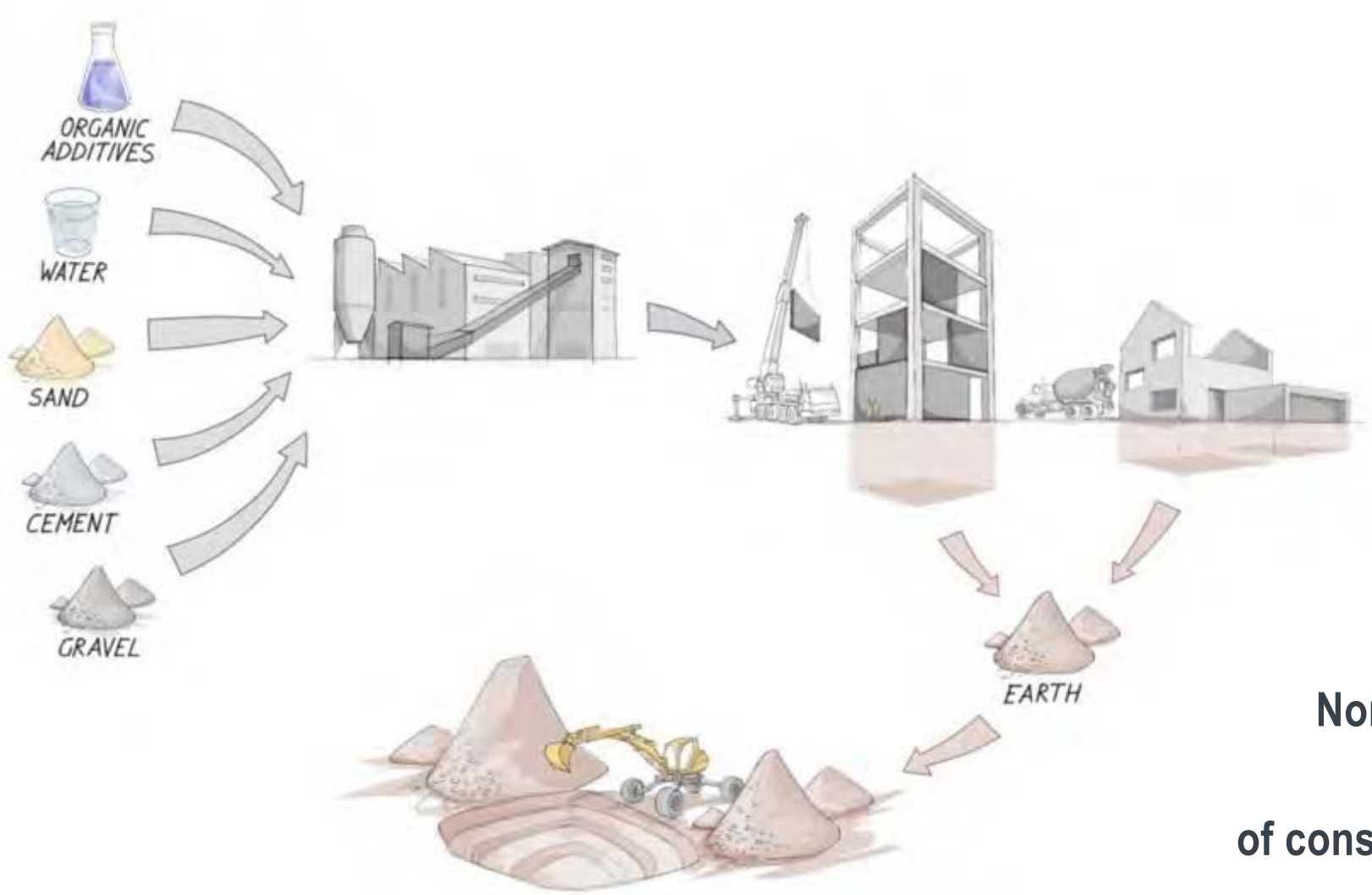
Building the future of housing using cement-free, clay-based products

CO_2 emissions of buildings



Quelle: Illustration adaptiert aus Bericht Klimapositives Bauen 2021, Daten: Hoxha et al., 2016

Conventional construction



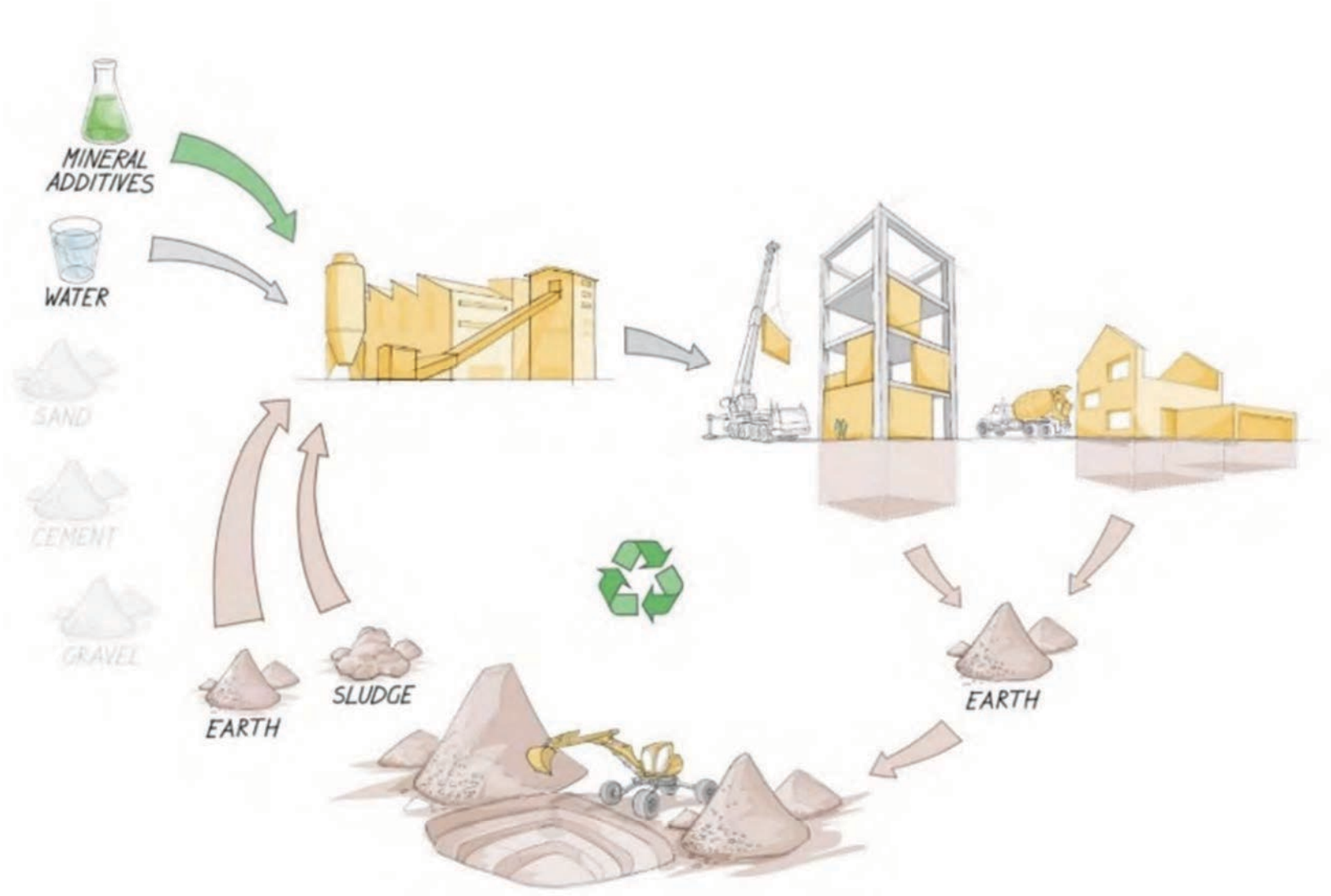
Cement industry:
~8%
of global CO_2 emission

Non-polluted earth:
76%
of construction waste in CH

Designer: Adam Kiryk

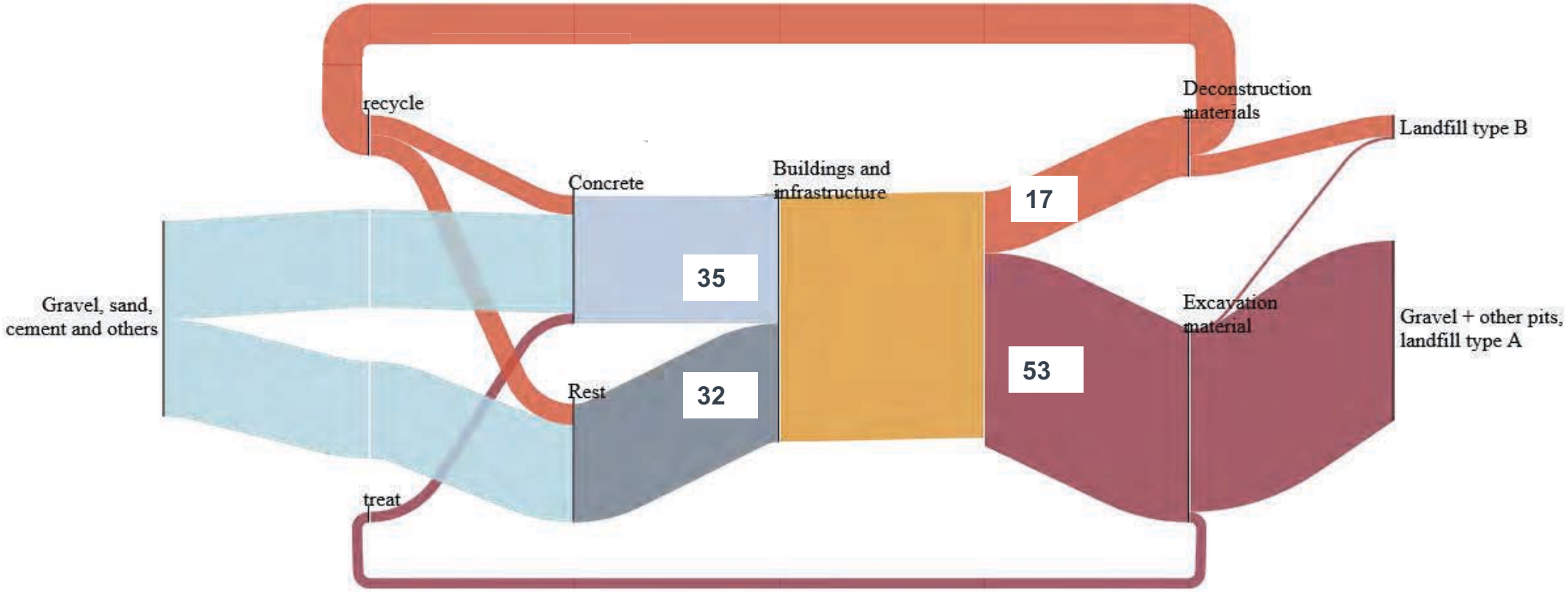

Non-polluted earth:
76%
of construction waste in CH

Earth-based construction



Designer: Adam Kiryk

Material cycle in Switzerland



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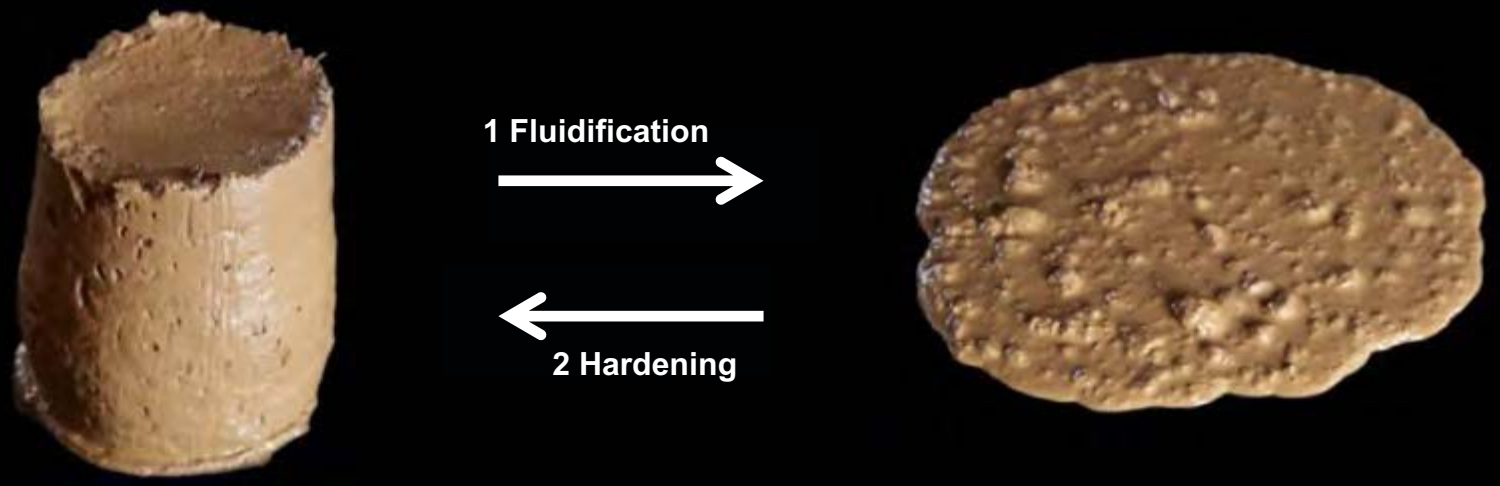

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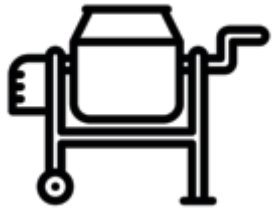
Crédits: Lucile Couvreur / amàco

Why pouring earth?



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2

Historical buildings

Earth as a building material

>1/3 of mankind lives in raw earth shelters

Chan Chan, archaeological site, Peru. © CraTERRE

Shibam, Yemen

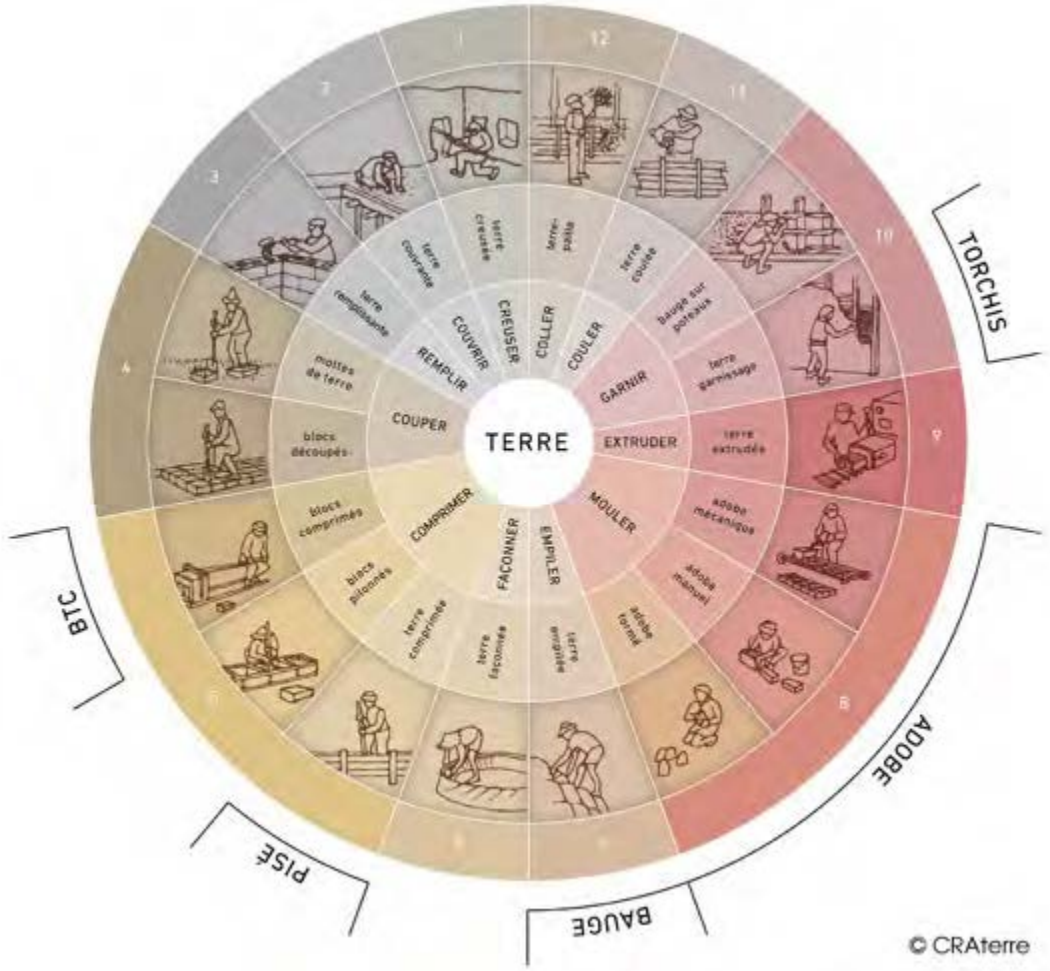
Djenné, Mali. © CraTERRE

Fortress of Bam, Iran. ©Hubert Guillaud

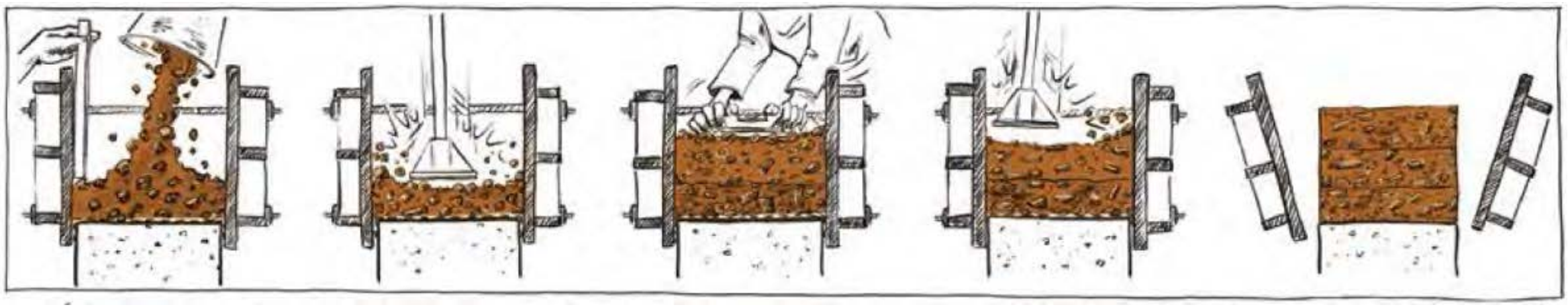
3

Traditional building techniques

Clay in construction



Rammed earth



Architecture en terre d’aujourd’hui – Les techniques de la terre crue, TERRA Award. Illustration Pauline Simon (creative commons BY+NC+ND)

Rammed earth

Ricola Kräuterzentrum, Laufen, Switzerland, Herzog & de Meuron, Martin Rauch

The Vaugirard castle, Champdieu, France, XVIIth century, rammed earth

Rammed earth

Clément Vergely architects, Diener&Diener Architekten, Nicolas Meunier, Lyon, France

Wattle and daub

Architecture en terre d'aujourd'hui – Les techniques de la terre crue, TERRA Award. Illustration Pauline Simon (creative commons BY+NC+ND)

Wattle and daub, Horyu-ji, Japan

Wattle and daub, Rennes, France

4

Innovative earth building

3D printing

© WASP

3D printing

(c) Gramazio Kohler Research – MAS Digital Fabrication in Architecture students - ETH Zurich

Egg Shell / clay formwork

Final Prototype

Final Prototype after clay eggshell removal

(c) Gramazio Kohler Research – MAS Digital Fabrication in Architecture students - ETH Zurich

(c) Gramazio Kohler Research – MAS Digital Fabrication in Architecture students - ETH Zurich

Compressed brick

(c) TERRABLOC

Poured earth concrete

Manom building, Architecture Millieux. *In* Béton d'Argile Environnemental, Couvreur M, Moevus-Dorvaux L, Cloquet B, Fontaine L, Anger R, Doat P.

Poured earth concrete

Manom building, Architecture Millieux. *In* Béton d'Argile Environnemental, Couvreur M, Moevus-Dorvaux L, Cloquet B, Fontaine L, Anger R, Doat P.

5

Earth, strength and rheology

6

Oxara’s material and projects

Strength development

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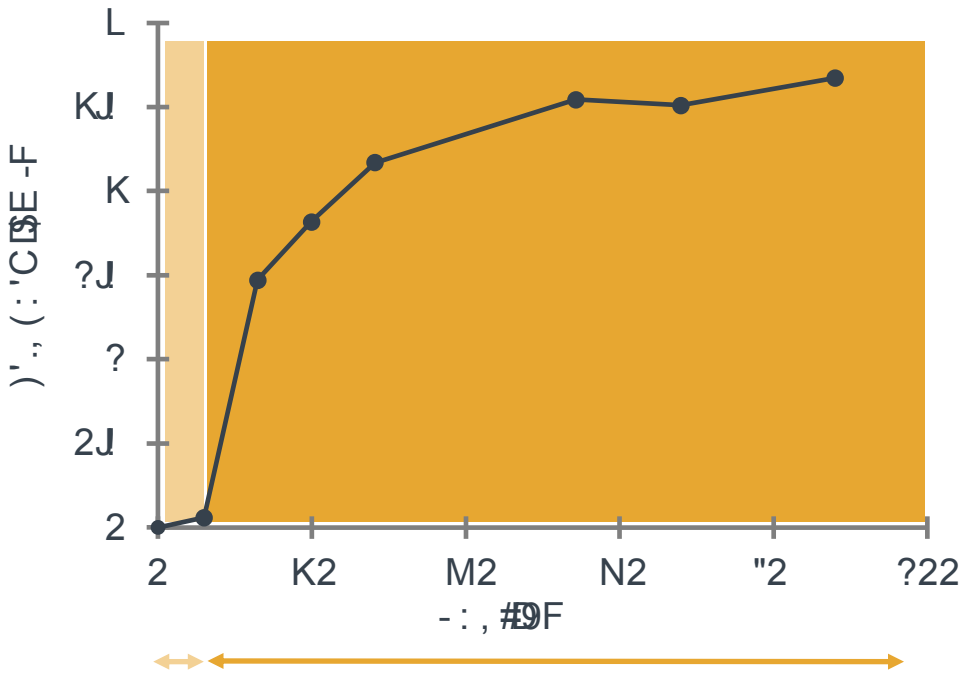
Cleancrete



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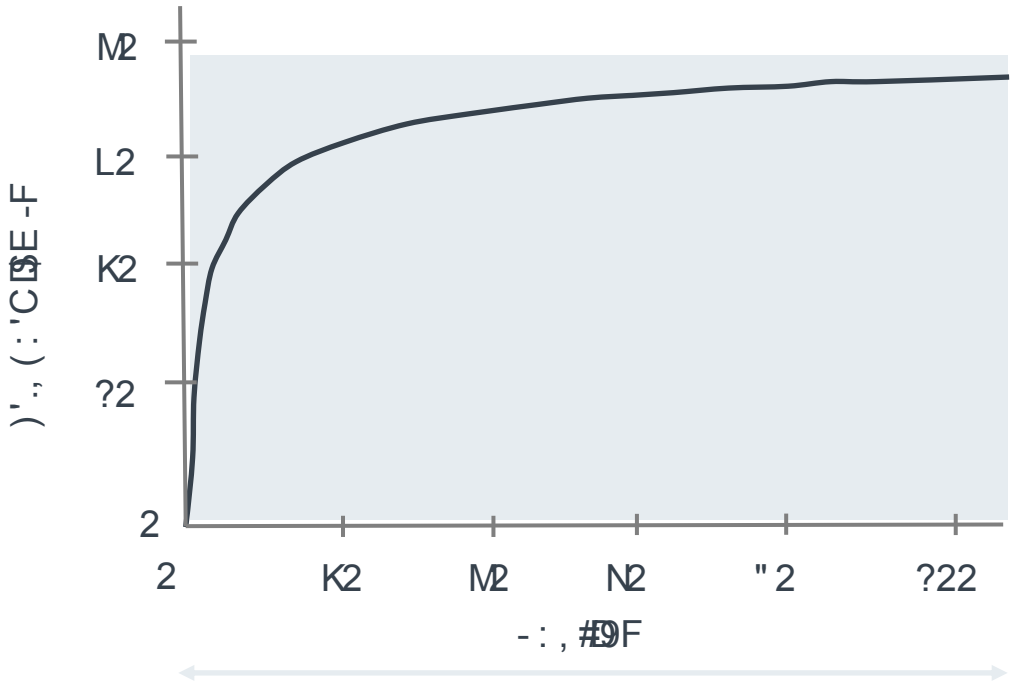
Standard concrete (C25/30)



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Towards load-bearing Cleancrete walls

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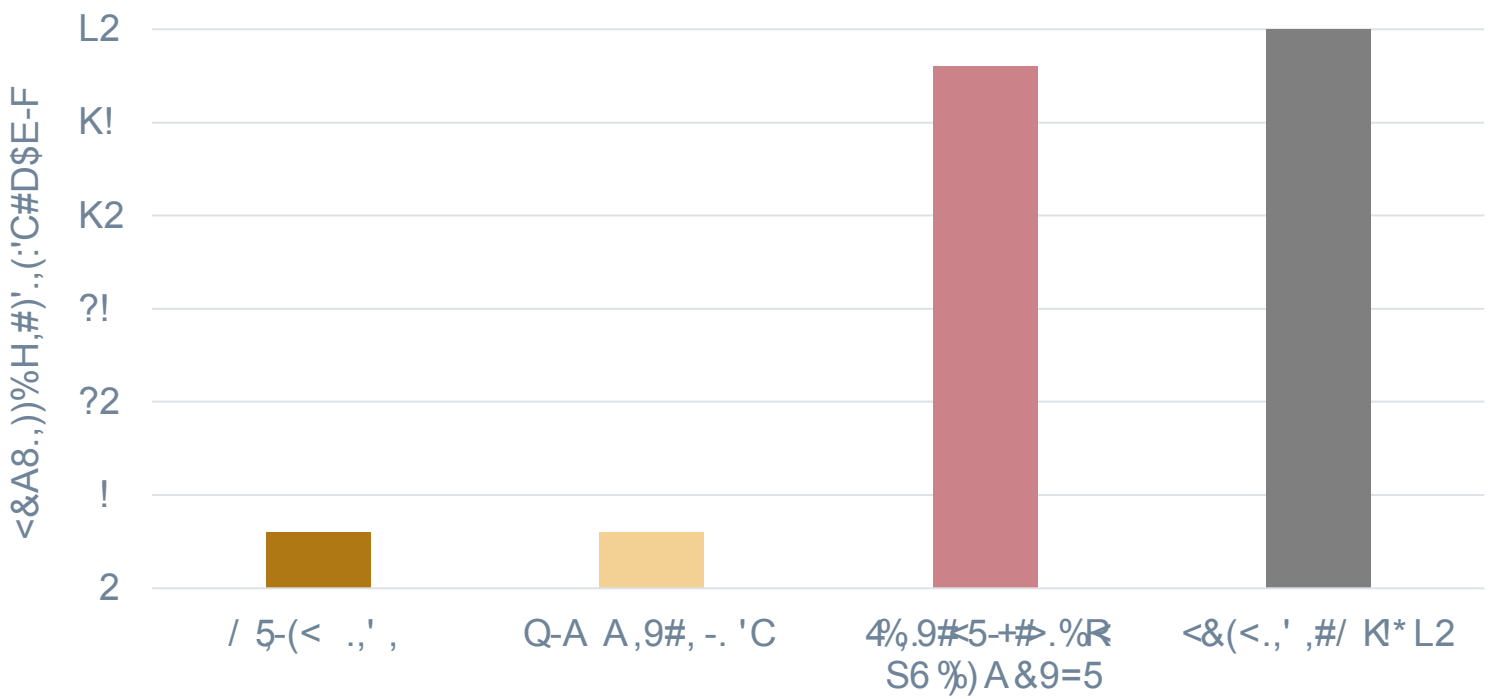

Material properties: Towards load-bearing Cleancrete walls

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Compressive Strength

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Seismic Test

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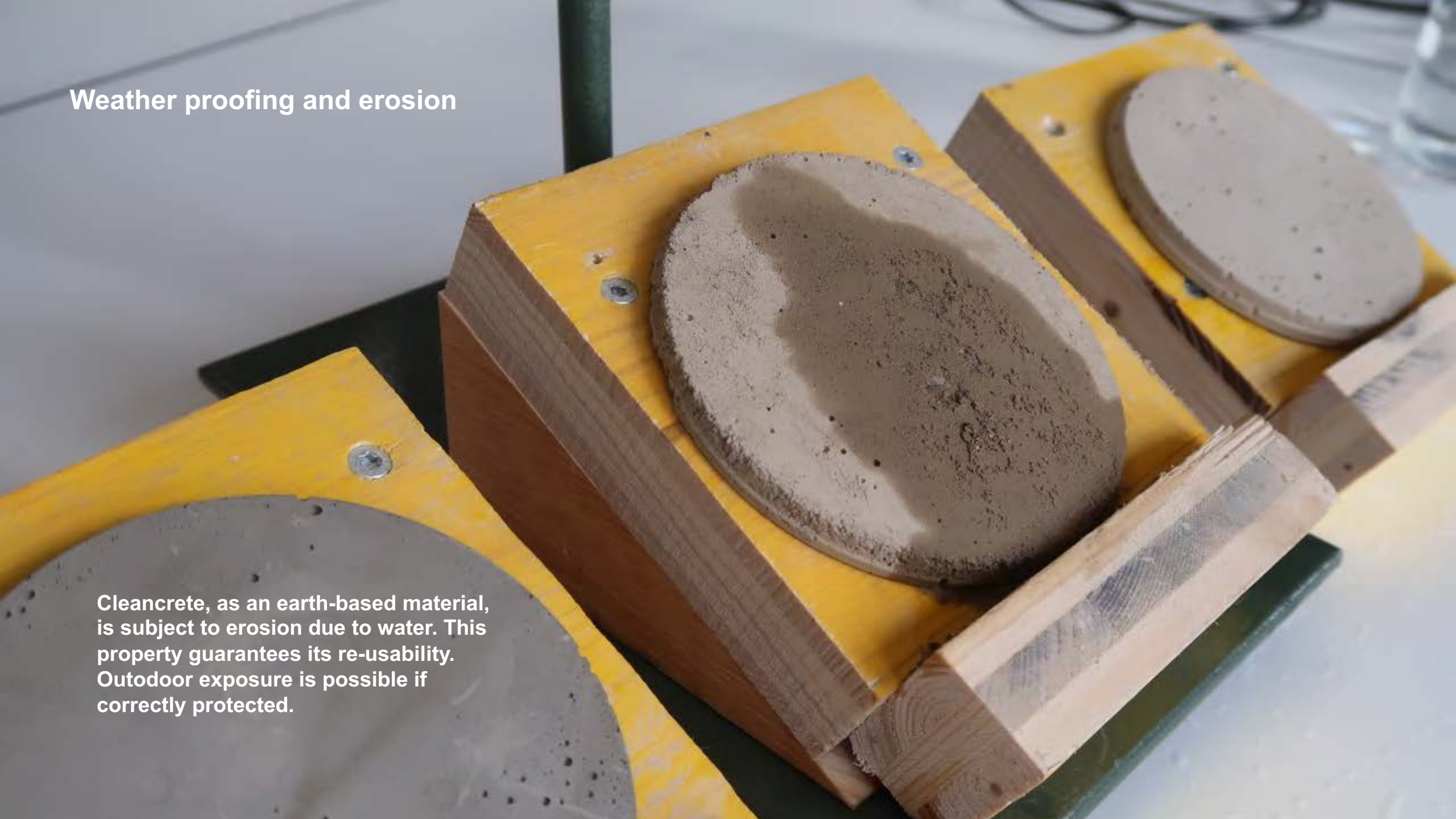
Weather proofing and erosion



Cleancrete, as an earth-based material, is subject to erosion due to water. This property guarantees its re-usability. Outodoor exposure is possible if correctly protected.

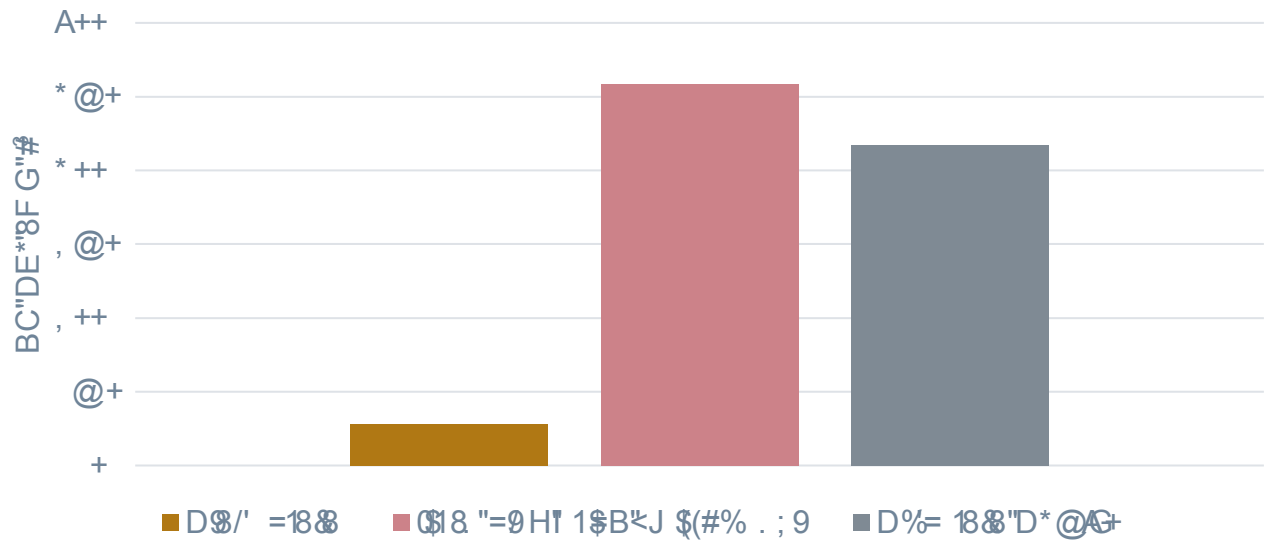
Re-usability

Cleancrete is fully reversible; since the strength comes from the clay particles, it can be easily destroyed and used again as another building element.

This element has been made from re-mixed material.

Cleancrete© Mesh Mould, Jomana Baddad & Indra Santosa, collaboration with GramazioKohler Research Group, 2020

Environmental properties of Cleancrete



Preliminary data concerning Cleancrete, calculated in the Zerostrat project funded by the Bundesamt für Energie (BFE). The project is led by INTEP in Collaboration with ETHZ Chair of Sustainable Construction.

Environmental impact of construction elements

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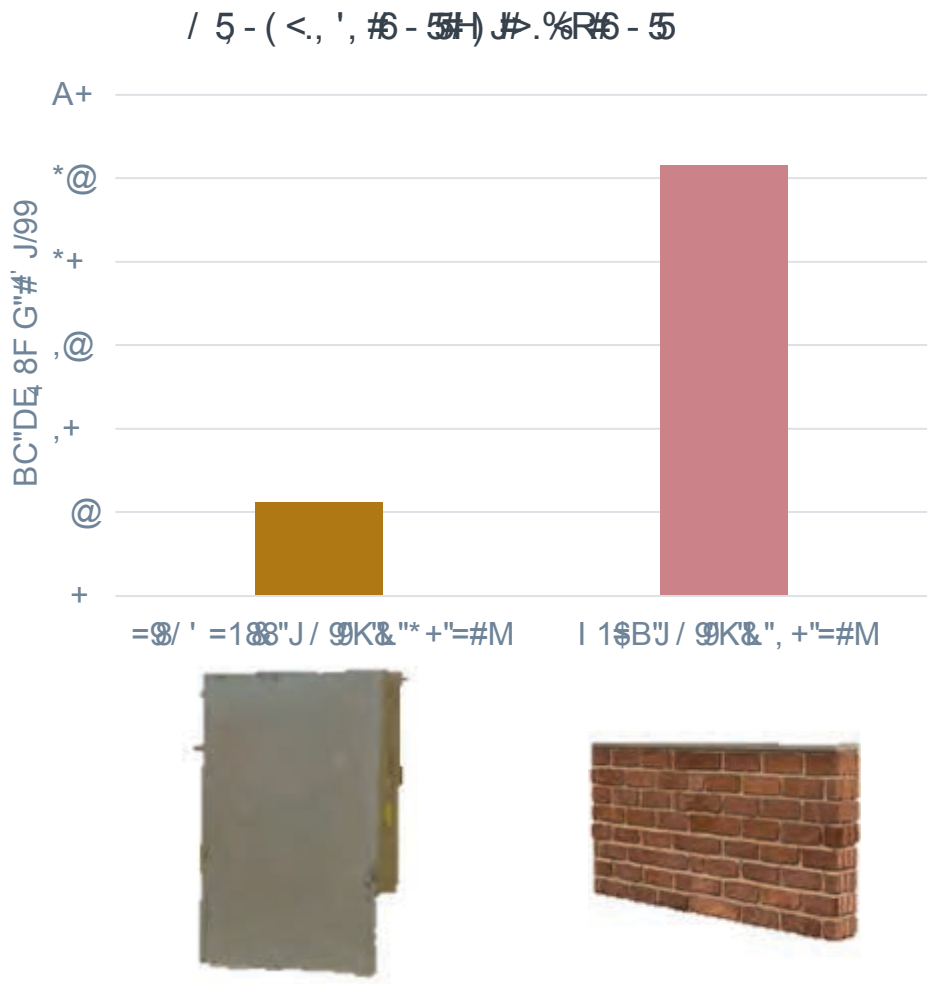

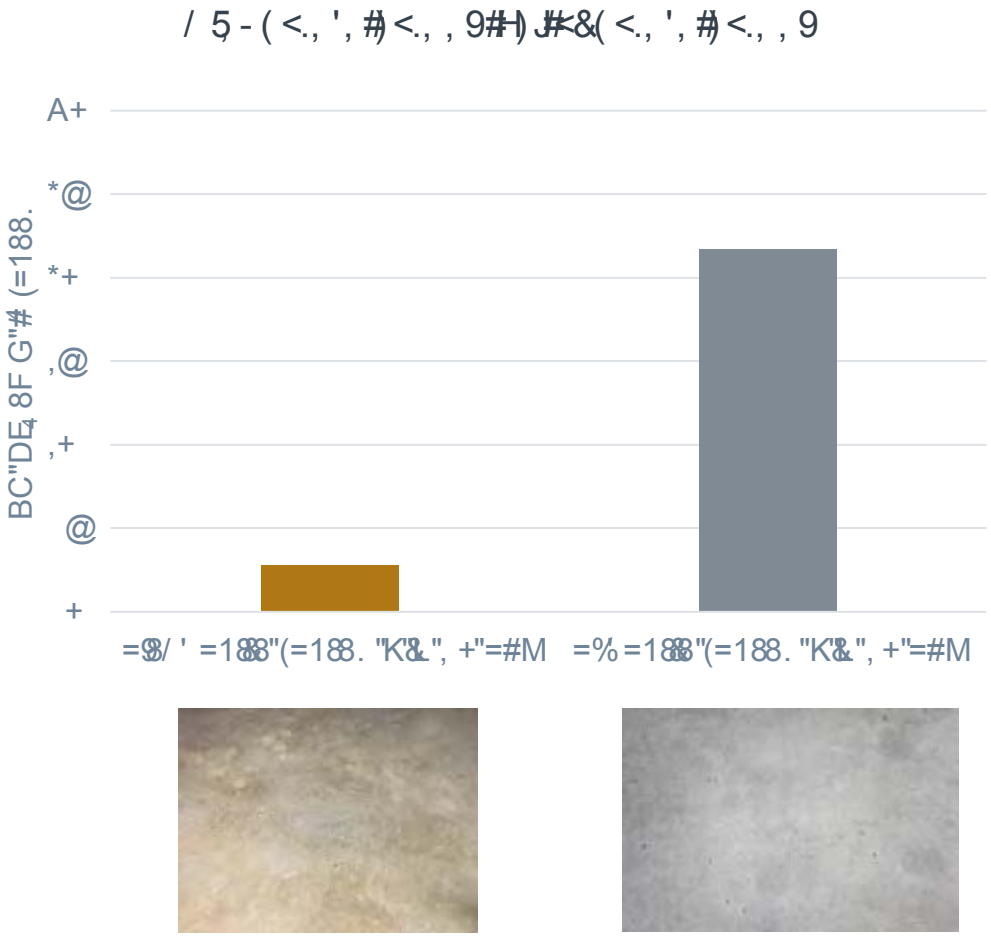

Projects implementation: completed & upcomming

A CEMENT – FREE BUILDING MATERIALS

Cleancrete floor in Zürich

Client: Kirche Auf der Egg @ Wollishofen
Architect: Gianluca Pedrini
Year: 2021 - 2022

Cleancrete furnitures in Zürich & Basel

Client: SBB
Designer: Ofsi
Year: 2021 - 2022

Cleancrete pavilion in Geneva

Client: Oxara & Marti Construction SA
Architect: Julien Chabanne
Year: 2021 -2022

Burkwil residential building in Meilen

Client: Burkwil Stiftung
Architect: Duplex Architekten
Year: 2022 - 2024

Foto: Gianluca De Pedrini

Wall textured

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Walls

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Walls

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Walls

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SBB Mobility Furniture

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SBB Mobility Furniture
P5(, .(- '%l, #) , #&43&=., 9#, - .'C

Thank you for your attention!