

The EPFL logo is displayed in a bold, red, sans-serif font.

Also part of :



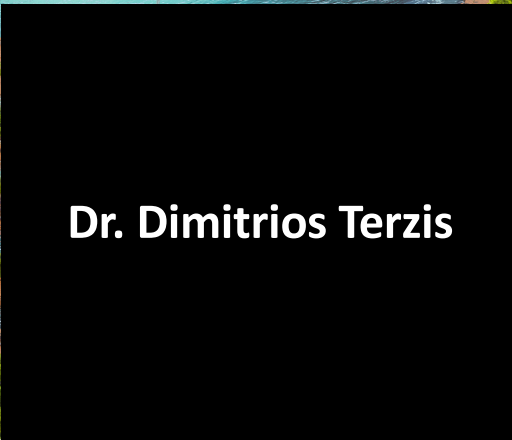
sia

Schweizerischer Ingenieur- und Architektenverein
Société suisse des ingénieurs et des architectes
Società svizzera degli ingegneri e degli architetti
Swiss society of engineers and architects

 Dimitrios Terzis

The background of the slide is an aerial photograph of a city waterfront. On the left, a dense cluster of modern skyscrapers rises from the shore. A curved promenade with green trees and walkways separates the city from a large body of water. Several sailboats are visible on the water, and a small harbor area with more boats is visible in the distance. The water is a vibrant blue-green color.

Innovation for construction & the environment

A solid black rectangular box is positioned in the lower-middle section of the slide, serving as a background for the speaker's name.

Dr. Dimitrios Terzis

24/09/2024

Today's class

- The role of regulations in sustainable construction
- Life cycle assessment
- Sustainalytics
- Another example from the Swiss innovation ecosystem

The role of regulations in sustainable construction



The role of regulations in sustainable construction

MINERGIE

The role of regulations in sustainable construction



59 mio m²

de surface de référence
énergétique (SRE)



51'302

bâtiments certifiés
Minergie en Suisse

Le nombre effectif de catégories de bâtiments est évalué. Un projet avec
plusieurs affectations peut donc être décompté plusieurs fois.

The role of regulations in sustainable construction

62,6 mia

de kWh d'énergie et

11,24 mio

de tonnes de CO₂ ont été économisés au cours des 21 dernières années grâce aux constructions Minergie au lieu des exigences légales minimales.

The role of regulations in sustainable construction

39'000

personnes ont suivi une formation depuis 1998.

441'000

personnes travaillent, étudient ou passent leur temps libre dans un bâtiment Minergie.

The role of regulations in sustainable construction

× MINERGIE®

59 mio m²

de surface de référence
énergétique (SRE)



5775

Minergie-P

1083

Minergie-A

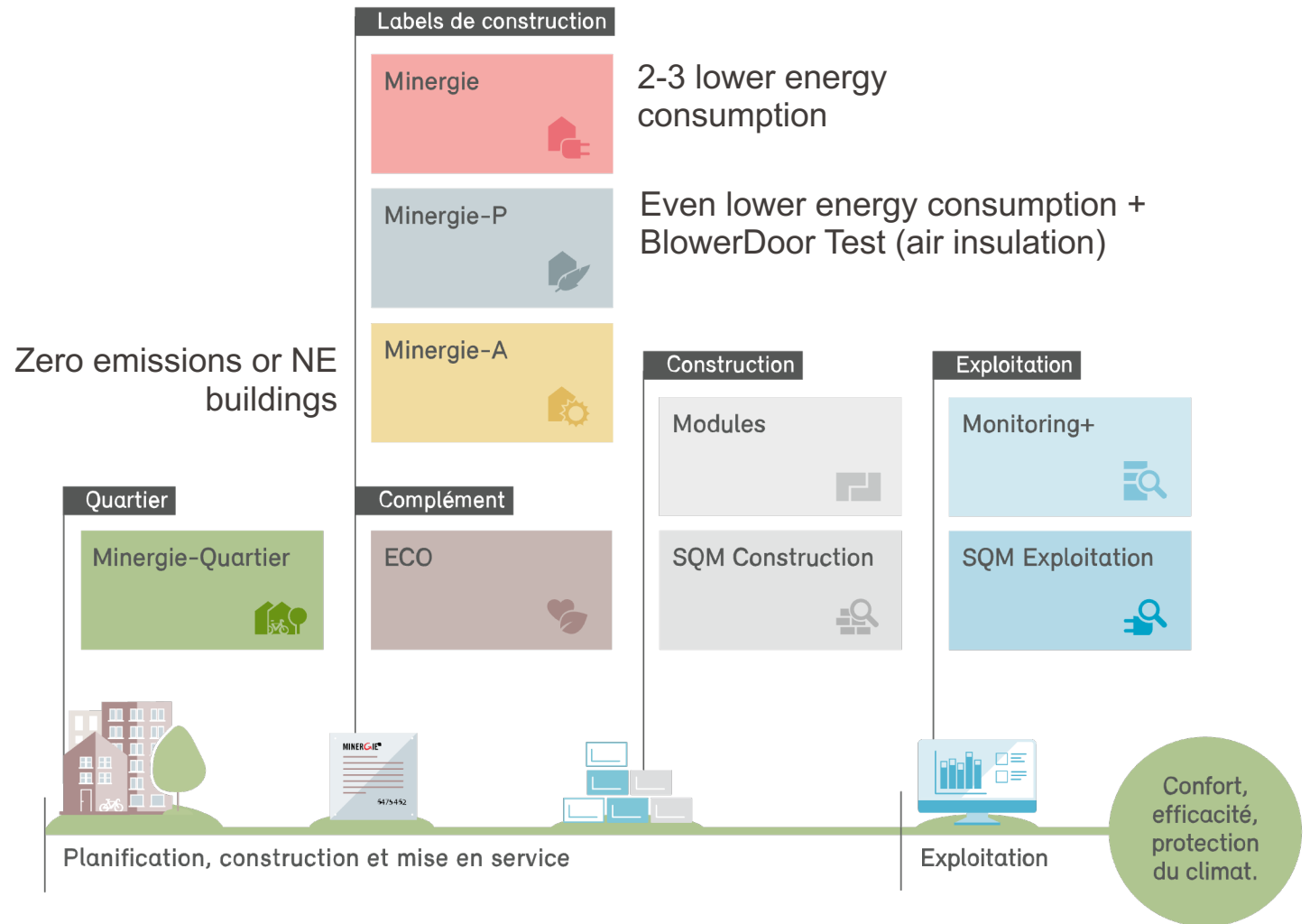
1817

avec le complément ECO

19

avec le complément
SQM Construction

The role of regulations in sustainable construction



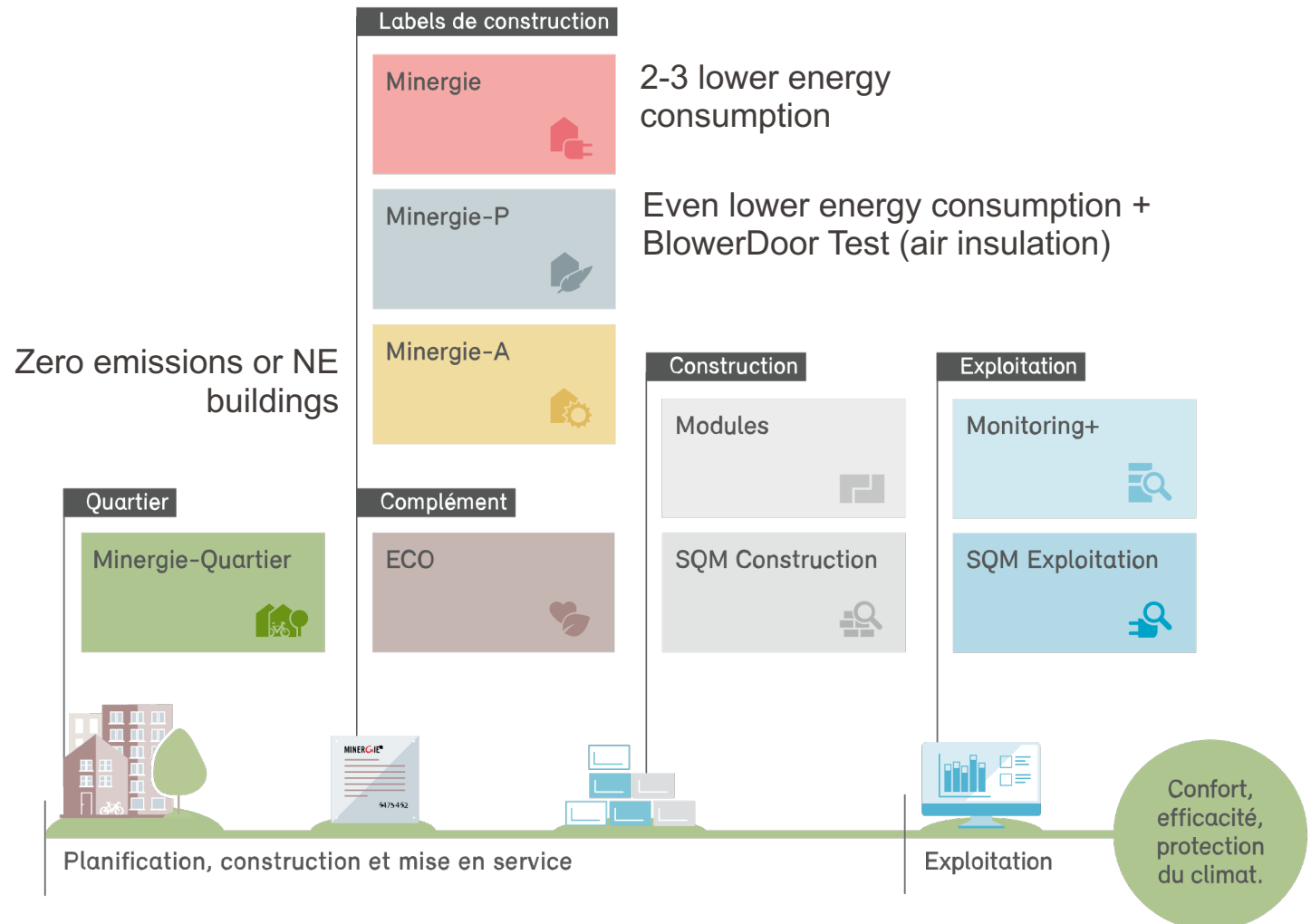
The role of regulations in sustainable construction

Certification with the ECO supplement

The ECO supplement, combined with one of the three Minergie standards, makes it possible to obtain a particularly healthy, circular and ecological building. For this, it is particularly important to have a flexible building concept, to carefully choose materials and to pay great attention to themes such as water and biodiversity.

SQM Construction is a “Minergie Quality System” which provides for the control and documentation of the implementation of all relevant construction elements to comply with Minergie requirements and thus ensures the definitive certification of the building. This allows construction defects to be avoided.

Monitoring+ and SQM Exploitation are products that allow planned and calculated energy indices to be compared to those measured. These products make it possible to detect malfunctions in technical installations and ensure that energy consumption and loads are as low as possible during operation.



The role of regulations in sustainable construction

× MINERGIE®

59 mio m²

de surface de référence
énergétique (SRE)



5775

Minergie-P

1083

Minergie-A

1817

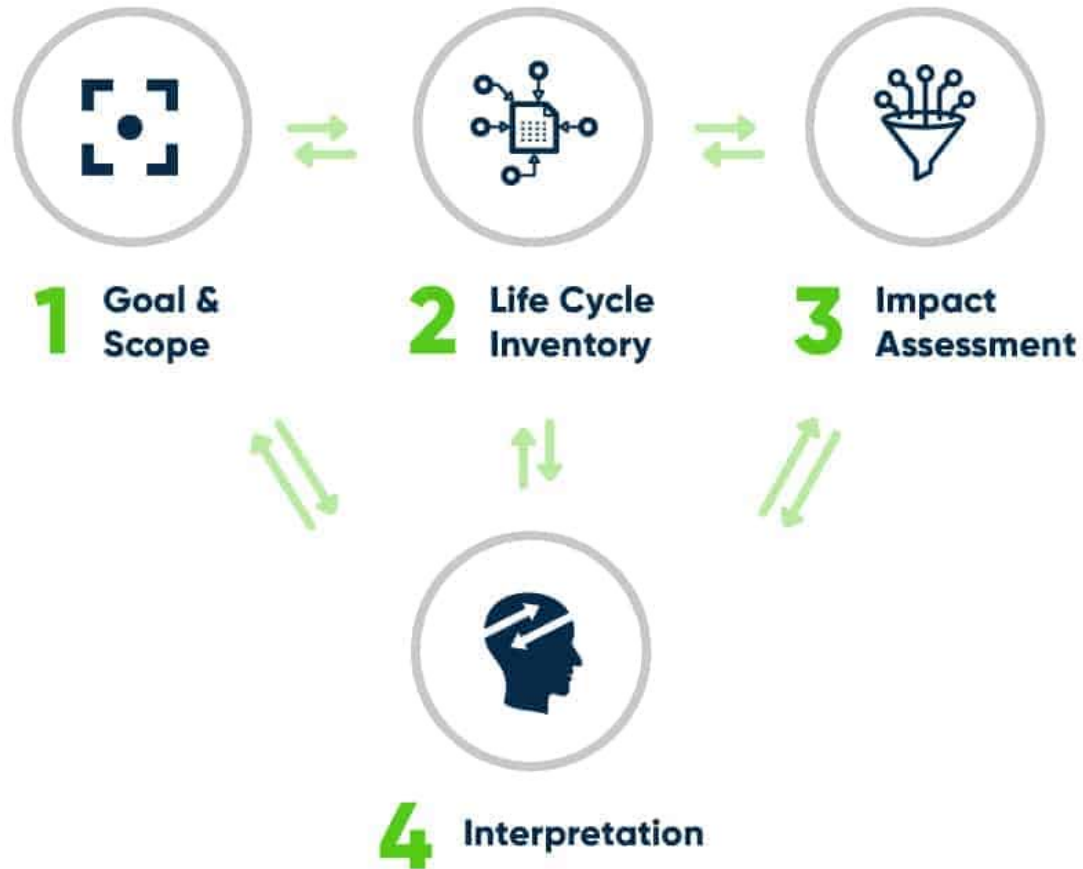
avec le complément ECO

19

avec le complément
SQM Construction

The role of regulations in sustainable construction

- New materials
- New energy grids (for e.g. district heating networks)
- New business models (for e.g. materials which are leased/rented)
- New data collection and reporting systems
- New design approaches



LCA vs. LCI vs. LCIA

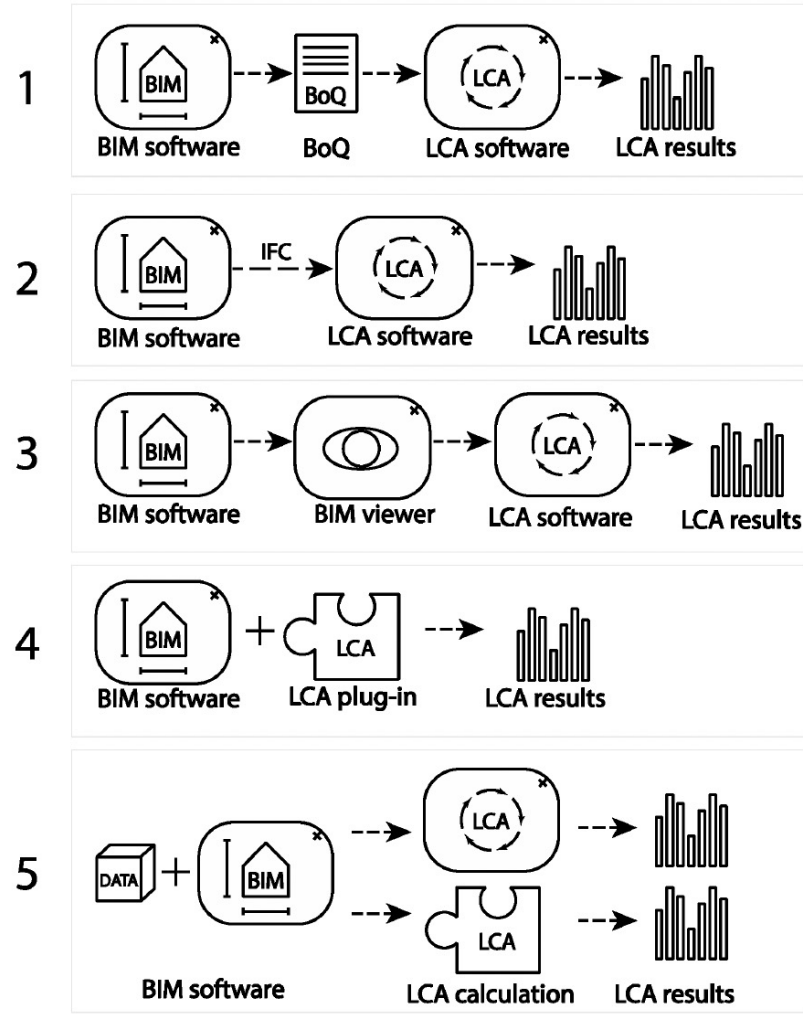
LCA Stands for Life Cycle Assessment. LCA is the scientific method to calculate the environmental footprint of a product. Expressed in 15+ environmental impact categories.

LCIA Stands for Life Cycle Impact Assessment. The LCIA is phase 3 of the four phases of performing an LCA. It's where the impact assessment takes place.

LCI Stands for Life Cycle Inventory, which is phase 2 of the four phases of performing an LCA. In this phase, we collect the input data (BOM, energy usage, etc.) that are assessed in phase 3.



LCA decision making design



BIM and LCA integration: A systematic literature review

T Potrč Obrecht, M Röck, E Hoxha, A Passer - Sustainability, 2020 - mdpi.com

To foster sustainable development, the environmental impacts of the construction sector need to be reduced substantially. Life cycle assessment (LCA) is the established methodology for the quantification of environmental impacts, and therefore has been increasingly applied to assess the environmental performance of buildings. By coupling LCAs with digital design tools, eg, building information modeling (BIM), the identification of environmental hotspots and their mitigation is possible during the design process. The ...

☆ Save Cite Cited by 145 Related articles All 12 versions

Figure 2: Most common BIM-LCA integration types [8]

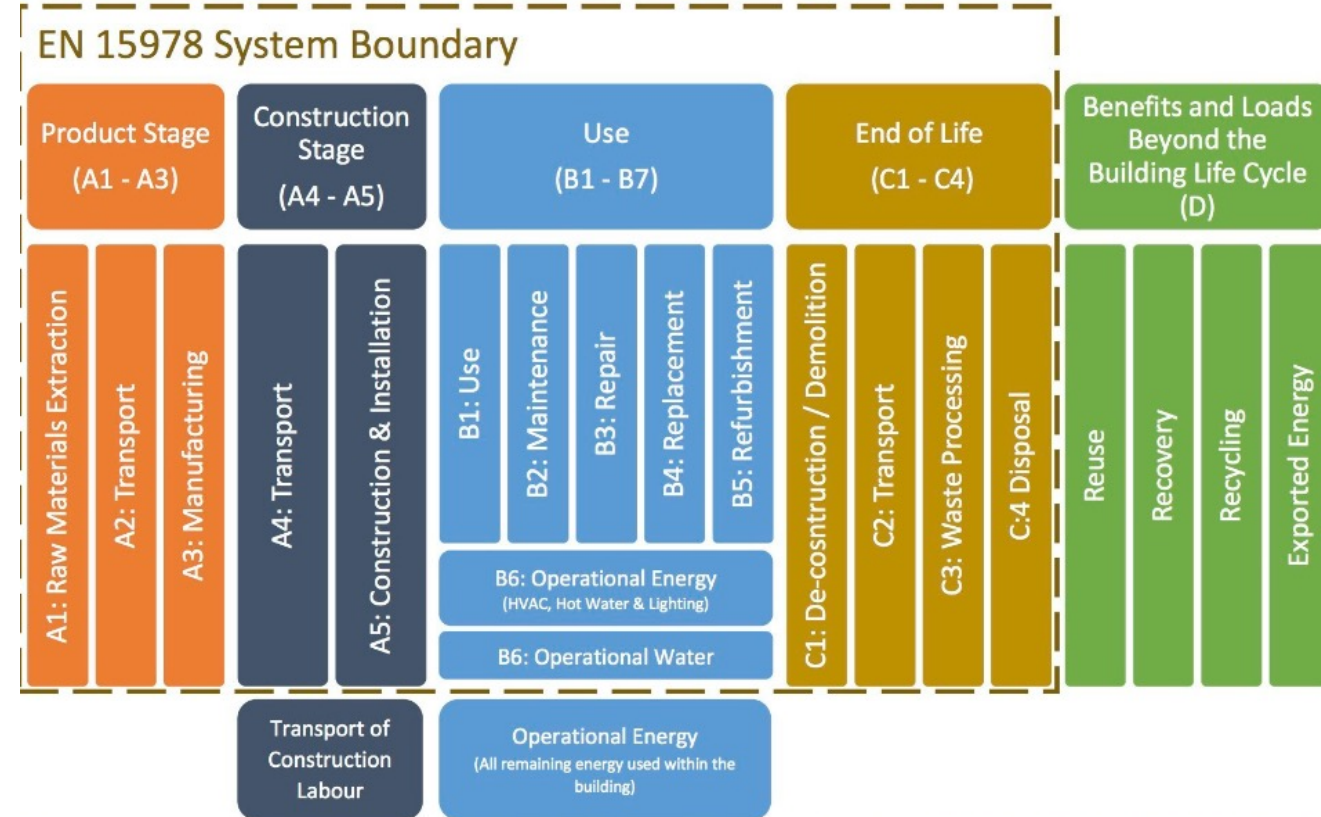


Performing accurate LCAs for the construction industry using BIM models

A past year's project presentation
12/12/2022

- Introduction
- I. Literature review
 - 1. Current solutions overview
 - 2. Use cases
- II. Innovation and impact creation
 - 1. Room for innovation
 - 2. Value creation
 - 3. Potential risks
 - 4. SWOT
- III. Conclusion

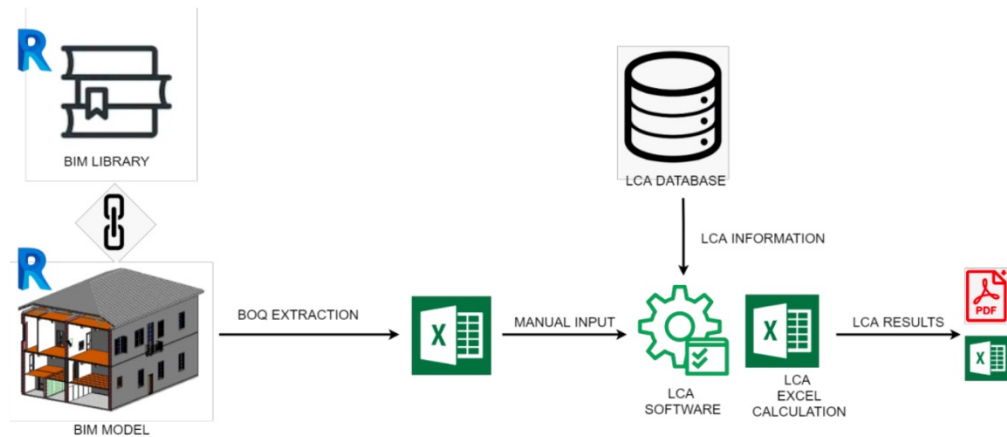
- Impact of the building sector:
 - 32% of global resource consumption and 40% of energy consumption
 - 22% of hazardous wastes in Europe
- The LCA tool
 - A set methodology
 - But :
 - Scope not well defined
 - Lack of automated methods (Excel files, by hand calculations ..)
 - Connection with BIM models



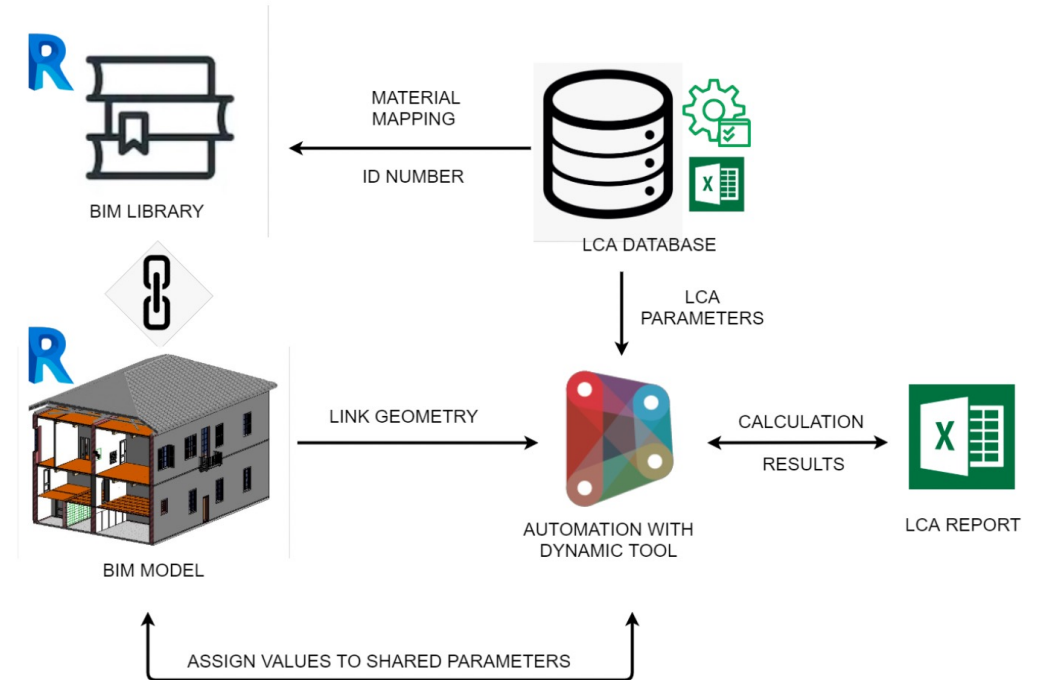
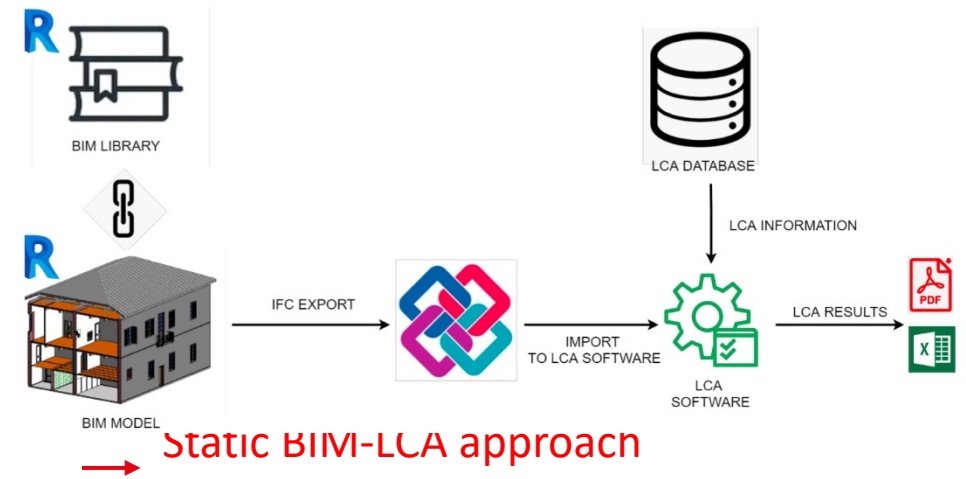
I. Literature review

1. Current solutions overview

→ Template including environmental data about building material



→ Conventional extraction from BIM to LCA software



→ Dynamic method: Plug-in

1. Use cases

a) Direct LCA databases into BIM

- Integrated BIM-LCA workflow
- Swiss context (LOD, LCA, and cost-planning databases)
- Connects LCA database to cost-planning structure
- Create a new LCA database per element
- Links newly created LCA database to a BIM model



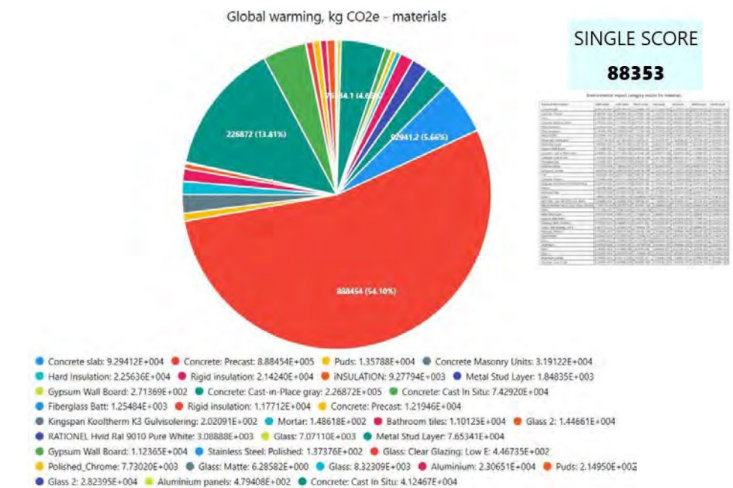
LCA Database										
LOD	Pre-LOD	LOD100	LOD200							
Building Phase	1 Strategic Briefing	2 Preliminary Studies	3 Project							
Database	eBKP-H					LCA Values				LCA Benchmarks
	Main group	Element group	Element	Element material	Sub-Element	Unit	Grey Energy (MJ)	GHG (kg CO ₂ eq)	USP (P/L)	SIA2032/ETH Zurich
	C Building construction	C2 Wall construction	C22 Interior wall construction			m ² year	12.19	1.24	1541.81	m ² year 12.60 1.16 48.00
			C22 001 Interior wall construction concrete			m ² year	11.01	1.15	1401.21	m ² year 11.00 0.90 45.00
			C22 001 Concrete bearing up to K32, raw 20 cm, B 90 kg/m ³			m ² year	12.40	1.37	2009.67	m ² year 11.00 0.90 45.00
			C22 001 Concrete bearing over K32, raw 20 cm, B 105 kg/m ³			m ² year	11.05	1.20	1781.00	
			C22 001 Concrete bearing over K32, raw 20 cm, B 105 kg/m ³			m ² year	11.73	1.30	1902.00	
			C22 001 Concrete bearing over K32, raw 25 cm, B 105 kg/m ³			m ² year	14.41	1.60	2346.00	
			C22 002 Interior wall construction masonry			m ² year	9.63	0.93	792.75	m ² year 11.00 0.90 45.00
			C22 002 Bearing masonry, BN 15cm			m ² year	6.83	0.60	475.00	
			C22 002 Bearing masonry, KS 15cm			m ² year	5.50	0.60	529.00	
			C22 002 Masonry bearing double shell, sound-absorbing, BN 15cm, SD 4cm, BN 15cm			m ² year	14.43	1.30	1029.00	
			C22 002 Masonry bearing double shell, KS 15cm, SD 4cm, KS 15cm			m ² year	11.76	1.20	1138.00	

Source : Aliakbar Kamari, Bartłomiej Marek Kotula, and Carl Peter Leslie Schultz. A BIM-based LCA tool for sustainable building design during the early design stage. *Smart and Sustainable Built Environment*, 11(2):217–244, July 2022.

1. Use cases

b) Plug-in Solution

- Early design stage to target critical building elements + alternatives comparison
- Plug-in integrated into BIM software
- Automatically calculate LCA :
 - takes automatically every element and associates them with the LCA database
 - Graphical and numerical results

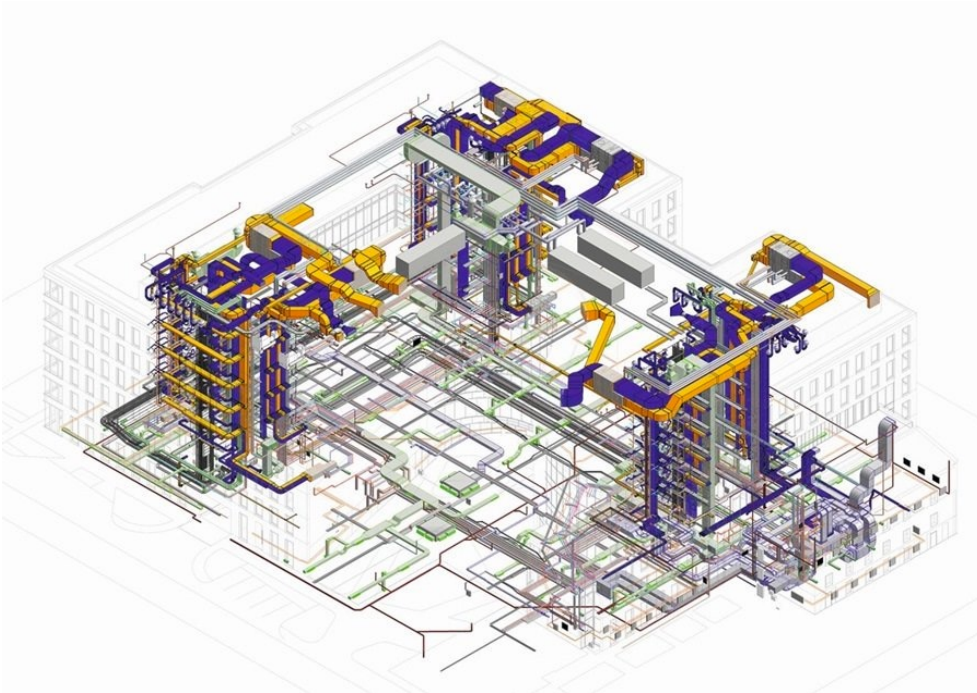


Source : Anita Naneva, Marcella Bonanomi, Alexander Hollberg, Guillaume Habert, and Daniel Hall. *Integrated BIM-Based LCA for the Entire Building Process Using an Existing Structure for Cost Estimation in the Swiss Context*. page 18, 2020.

II. Innovation and impact creation

1. Room for innovation

- Inaccurate BIM models



Source:
https://www.google.ch/url?sa=i&url=https%3A%2F%2Fskills4future.mk%2Fpublic-call-for-interested-applicants-for-trainings-for-bim%2F&psig=AOvVaw2w3YuJgxhcV4ZAW_qhKZjt&ust=1670502823563000&source=images&cd=vfe&ved=0CA0QjRxqFwoTCKDexrrG5_sCFQAAAAAdAAAAABAI

- Detailing Product and Construction stages



Source:
https://www.google.ch/url?sa=i&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D864ZX6n8Kcs&psig=AOvVaw1gwGvynknjdlAxlT_5ptp&ust=1670503116681000&source=images&cd=vfe&ved=0CA0QjRxqFwoTCPIq5KnD5_sCFQAAAAAdAAAAABA3

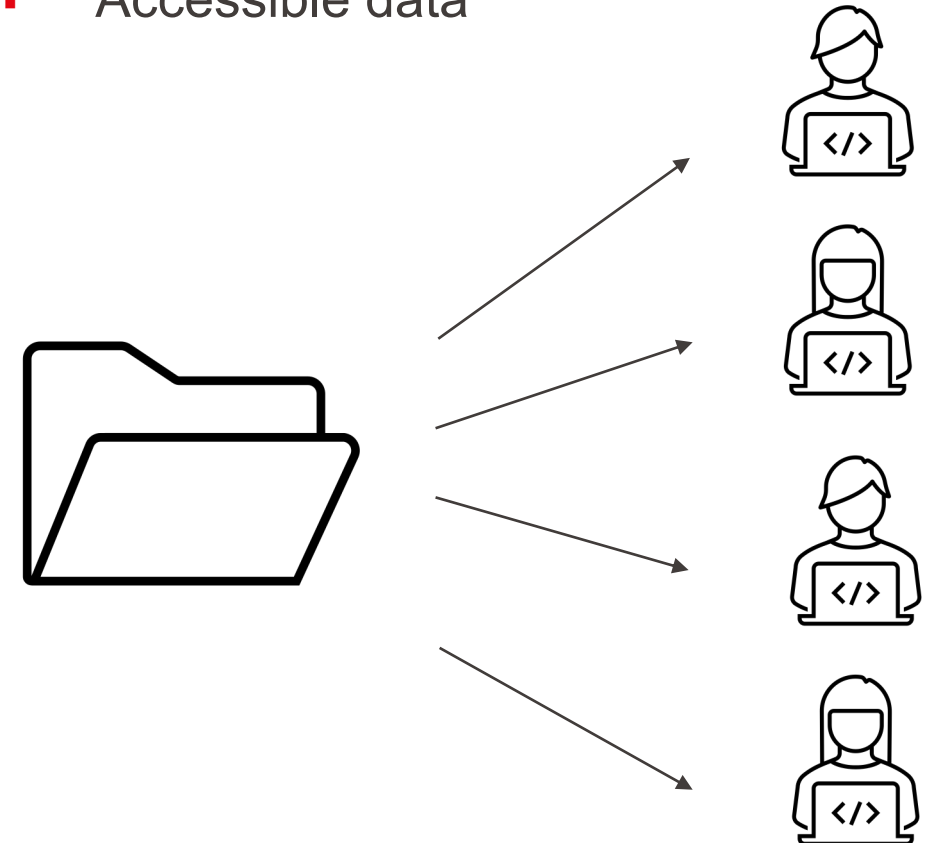
II. Innovation and impact creation

1. Room for innovation

- LCA computations mainly for buildings



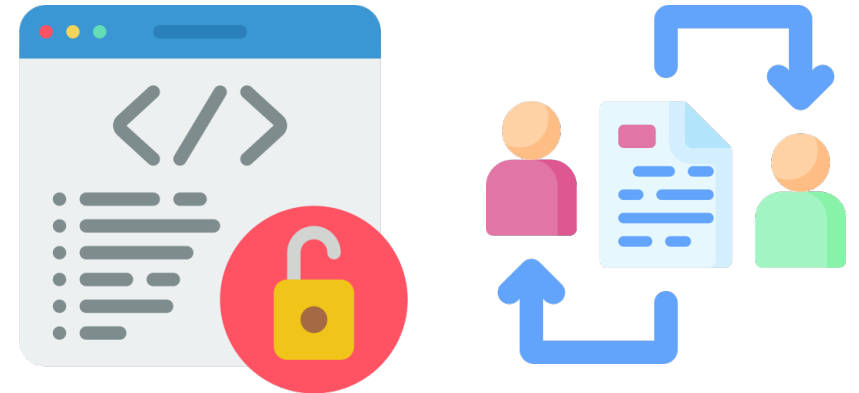
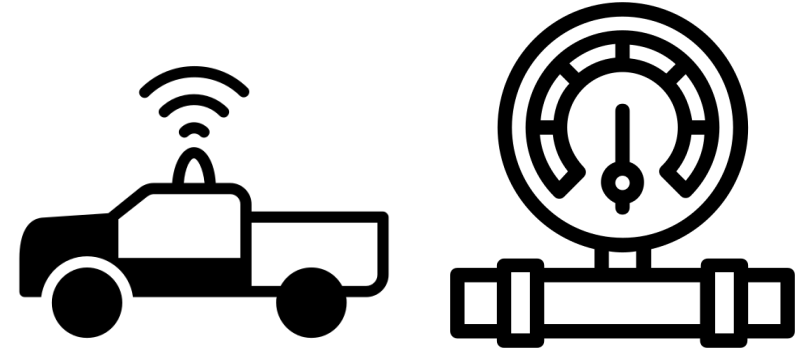
- Accessible data



II. Innovation and impact creation

2. Value creation

- **Monitoring and App:**
 - Transport of materials, people
 - On-site energy consumption
 - Consumption of construction machines
- Use for other types of construction than buildings
- **Open-source database containing the results of LCAs**
 - Buildings and other construction
 - Great value to construction companies, to the industry, and the scientific construction field as a whole
 - Serve as an example
 - Transform LCA from a methodology to a tool



II. Innovation and impact creation

3. Potential risks

a) Companies unwillingness to use monitoring tools

- Need to be planned ahead
- Trained engineers or architects needed
- Increase the cost of an LCA
- Return on investment not guaranteed in the short term
- Necessary measure on a building site?



b) Companies' unwillingness to share their data

- Willingness to use an open-source format?
- Data is valuable (paid for, reproducible)
- Data can be sensitive
- No financial incentives to share it

A red rectangular label with a white border, containing the words 'TOP SECRET' in bold, red, serif capital letters. This label is used to denote highly sensitive information that is restricted to a small number of people.

2. SWOT Analysis

Strengths:

- More accurate LCAs
- Better understanding of global impact reduction levers
- Possibility to compare design alternatives
- Avoidance of manual data re-entry

Weaknesses:

- Convince people
- Lack of process standardization and lack of precise LCA databases
- Privacy issues

Opportunities:

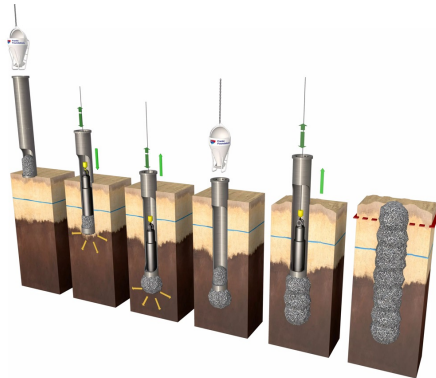
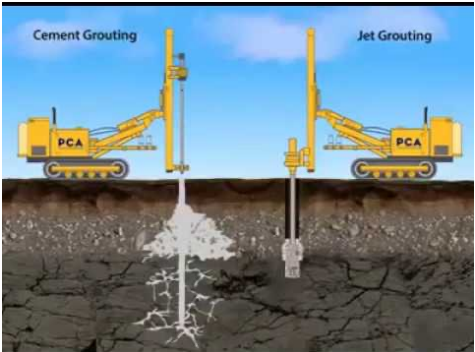
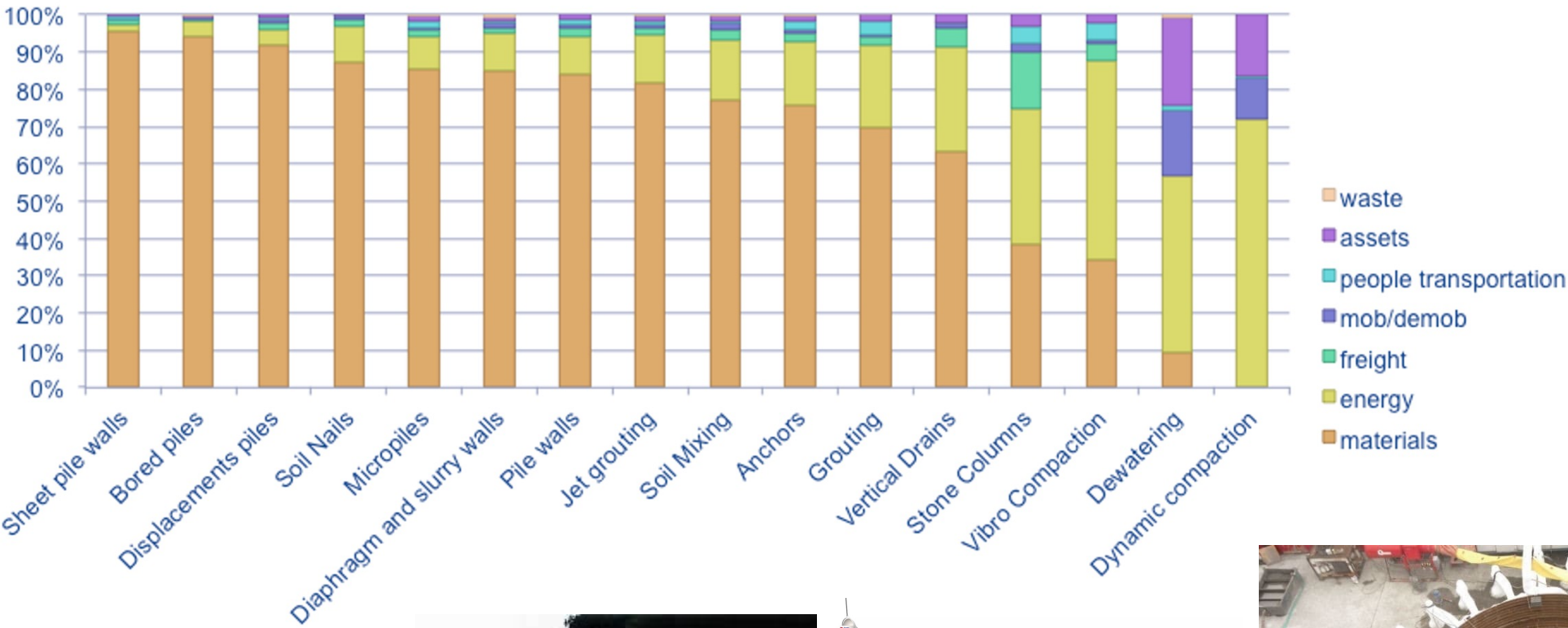
- Valuable database creation
- Easier carbon footprint assessment
- Demand increase for automatical accurate LCAs calculation
- Environmental impact reduction of the construction industry

Threats:

- No support from large companies
- Refusal from various stakeholders
- Supplementary fees for companies



Emission breakdown : Average results (based on samples studied to develop the methodology)



Cement Production Process

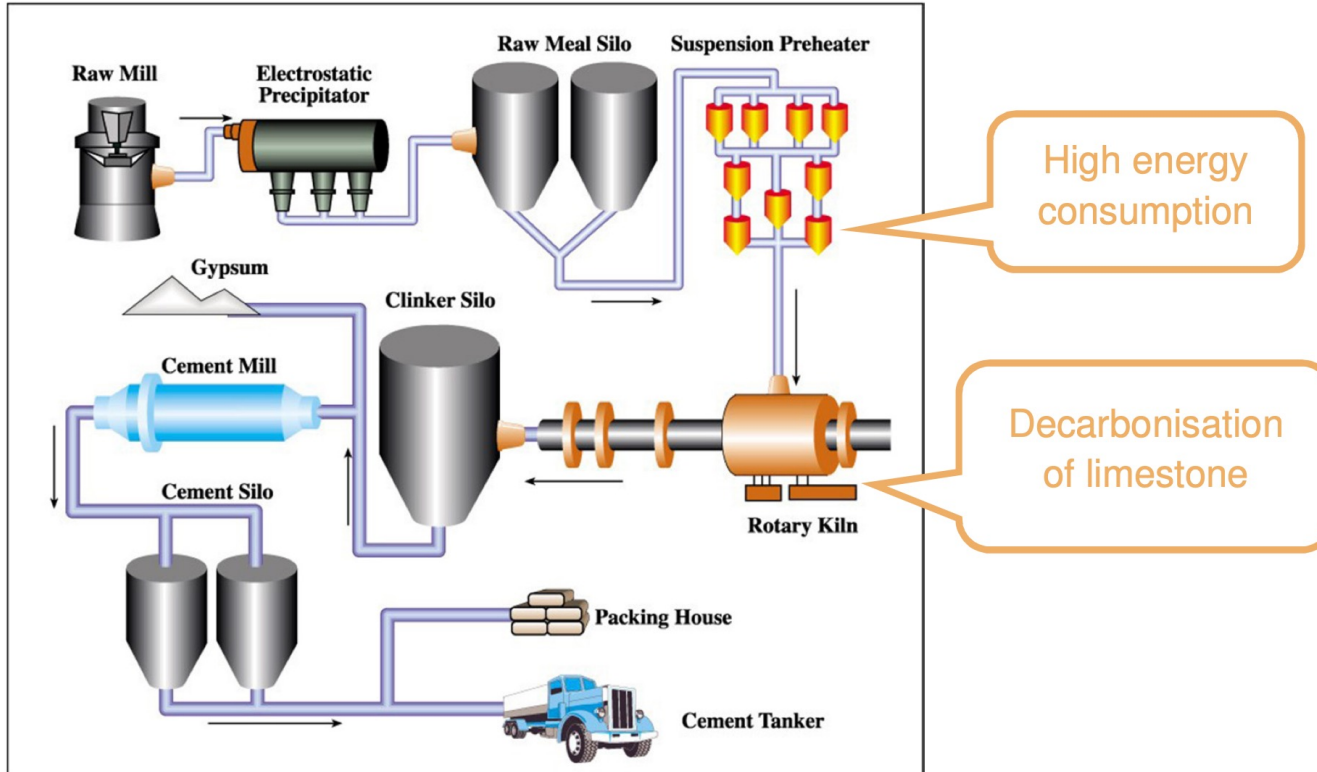
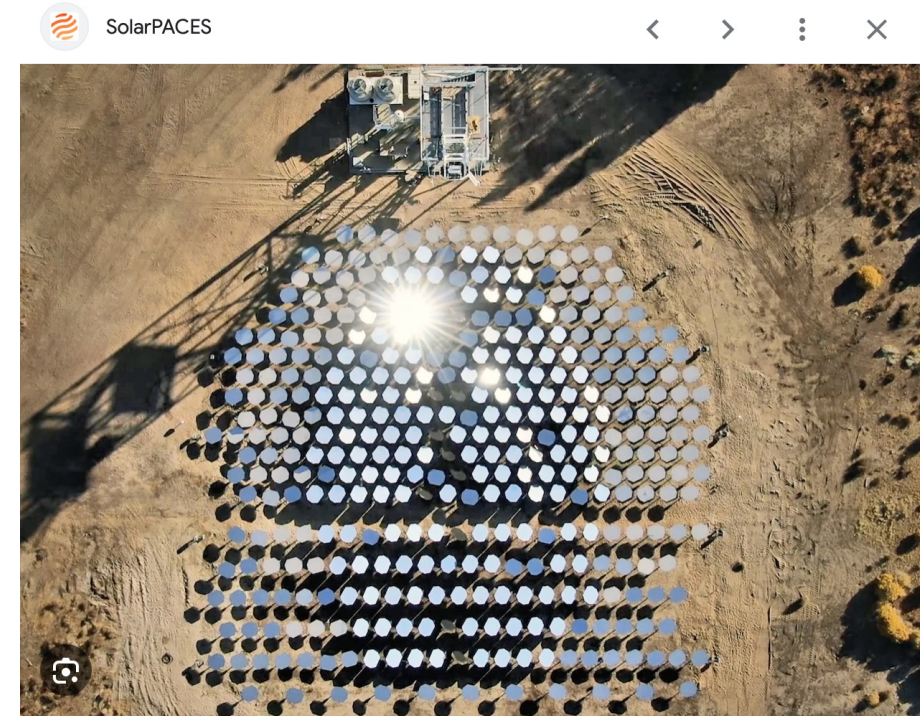


Figure 9: cement production process



Bill Gates Funds A Second Concentrated Solar Thermal Startup:
Heliogen - SolarPACES

[Visit](#)

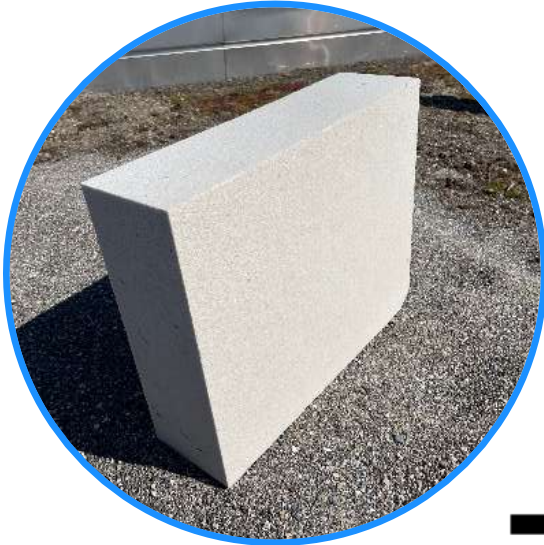
Constructing Cities and the Sustainable Development Goals (SDGs)





Scope: Technological innovation and real world

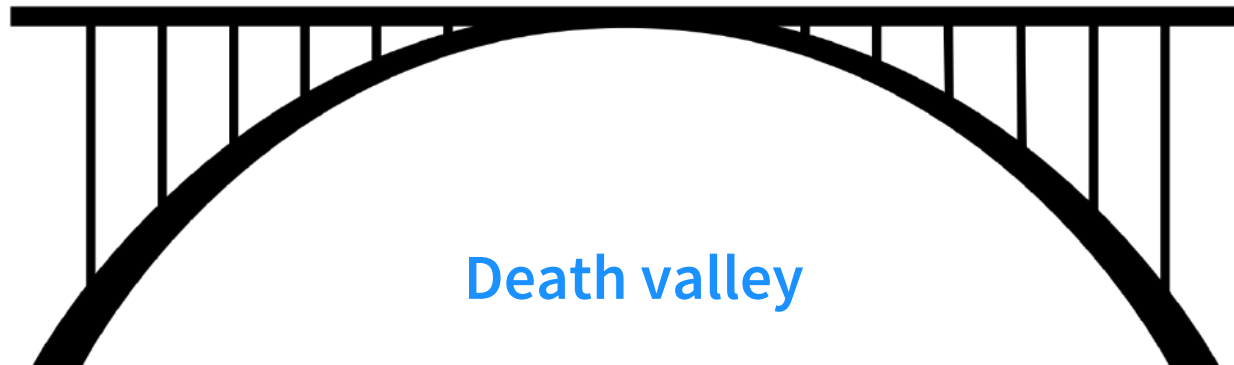
Materials Science



e.g.



Market



Death valley

Background



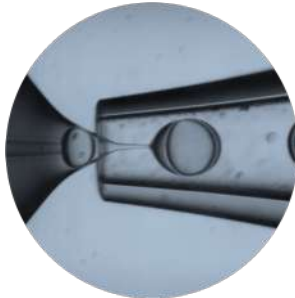
Asphalt crack
healing

Given topic



Bilayer
Microcapsules

Accident



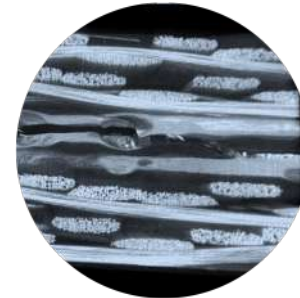
Microfluidics

Fun



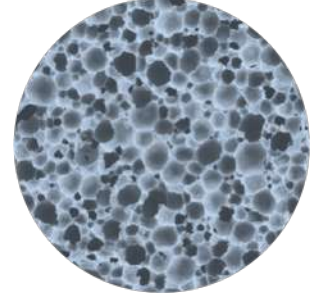
Ultra-shiny
Chocolate

Time to kill



Self-healing
Composites

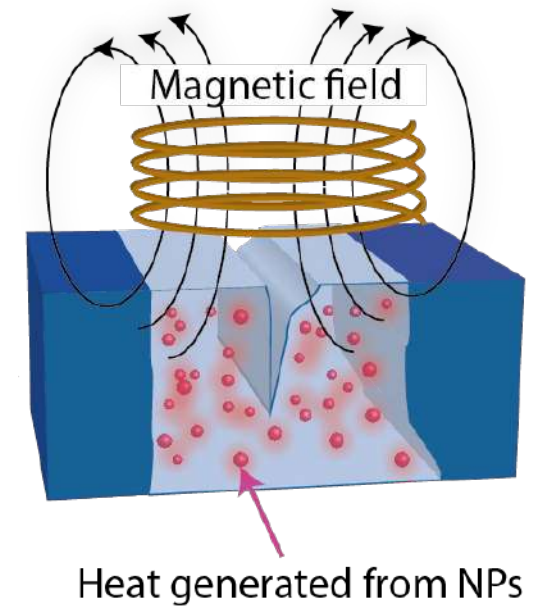
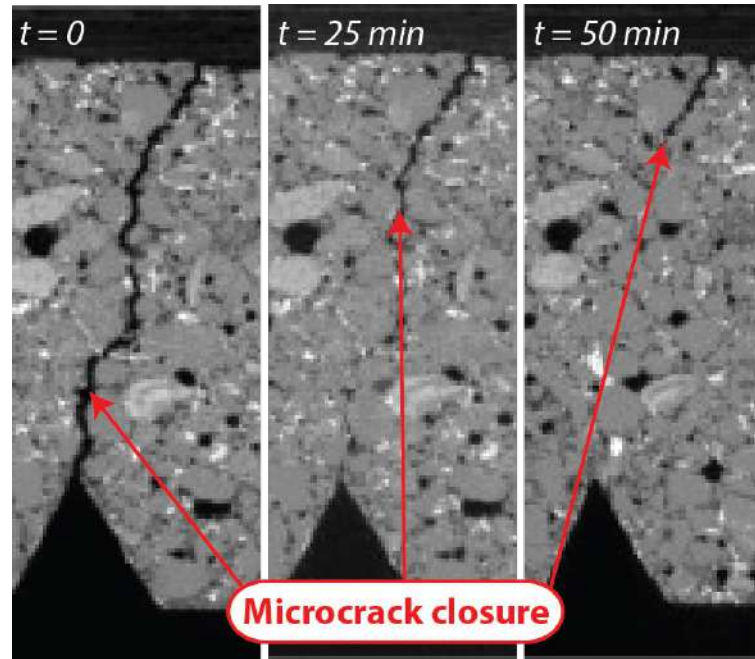
Given topic



Mineral foams

Impact

Asphalt crack healing



Under [combined conditions](#), microcracks can be closed [autonomously](#).

Asphalt crack healing – Follow-up



150+ media coverage

1 Patent



Neue Zürcher Zeitung



Ultra-shiny chocolate

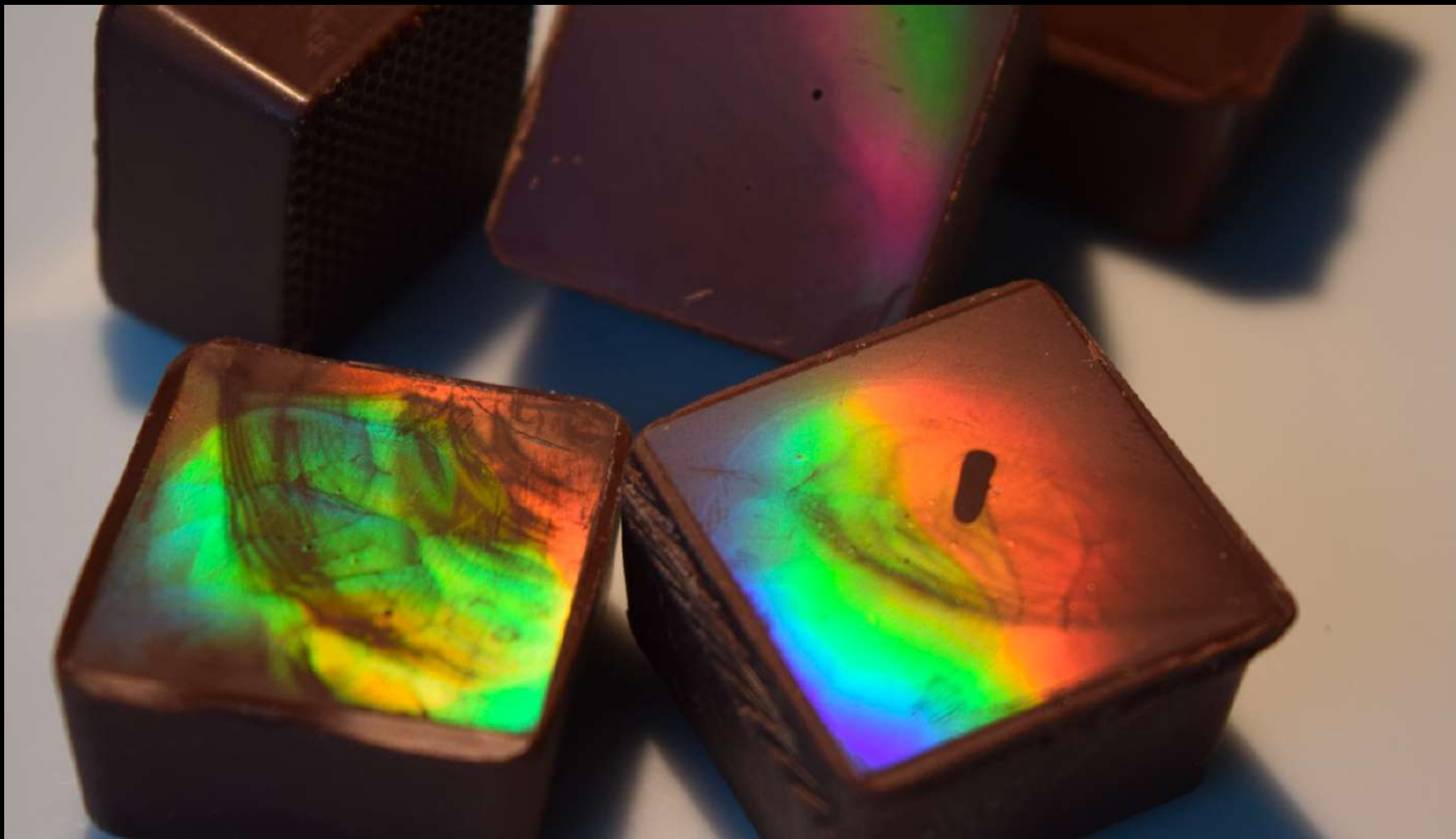


We love Chocolate!

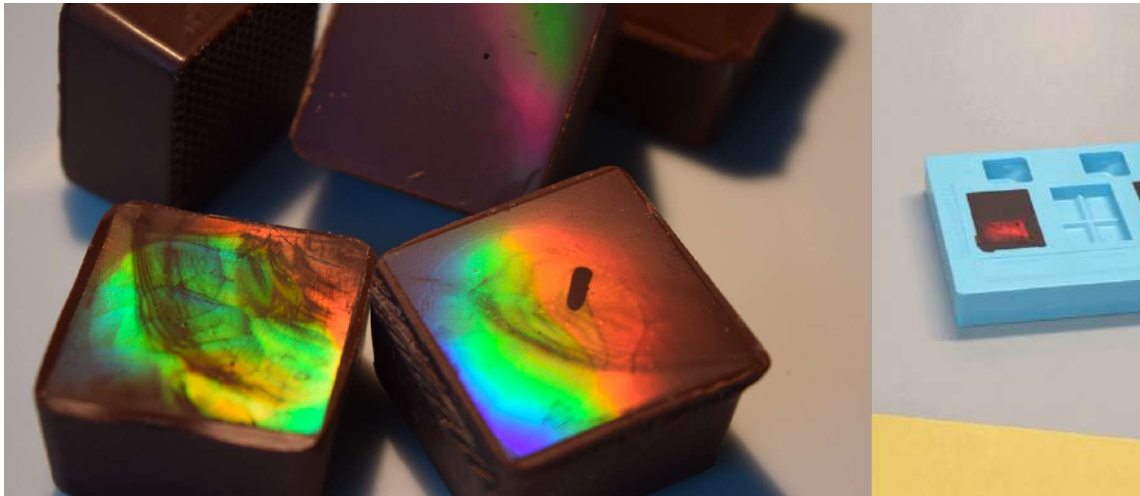


We love Butterflies!



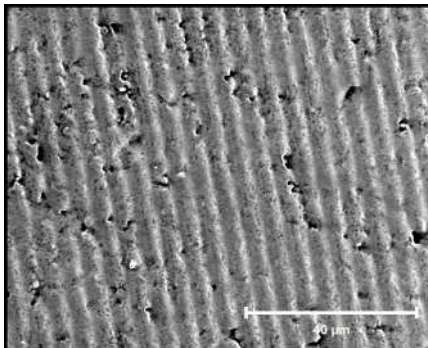
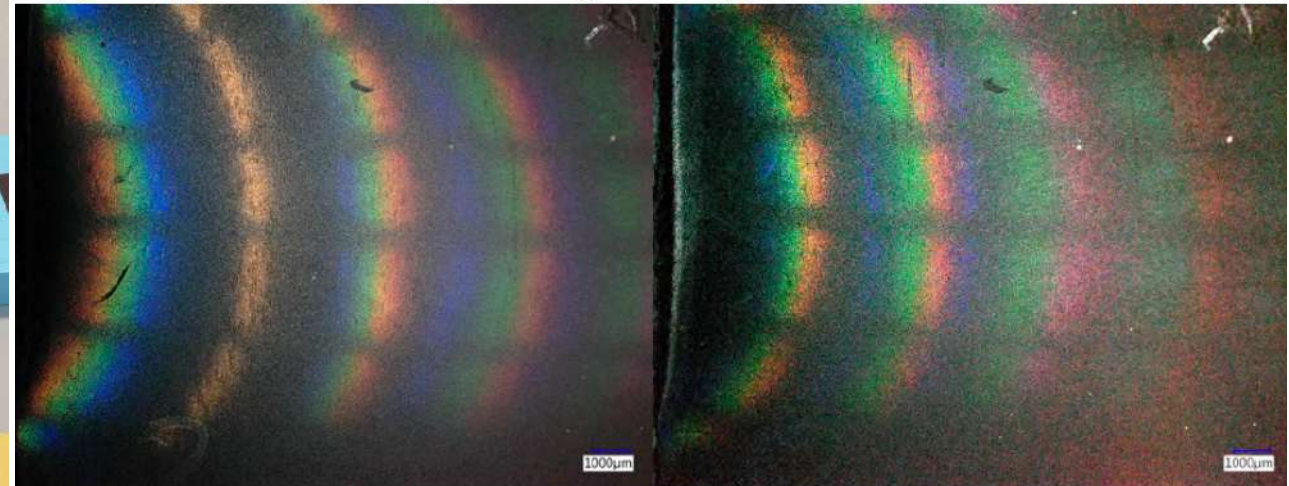


Ultra-shiny chocolate

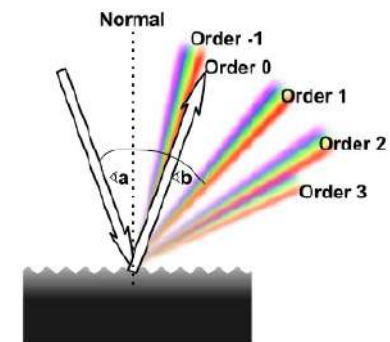


Order:

-1 0 1 2 3 1 2 3 4



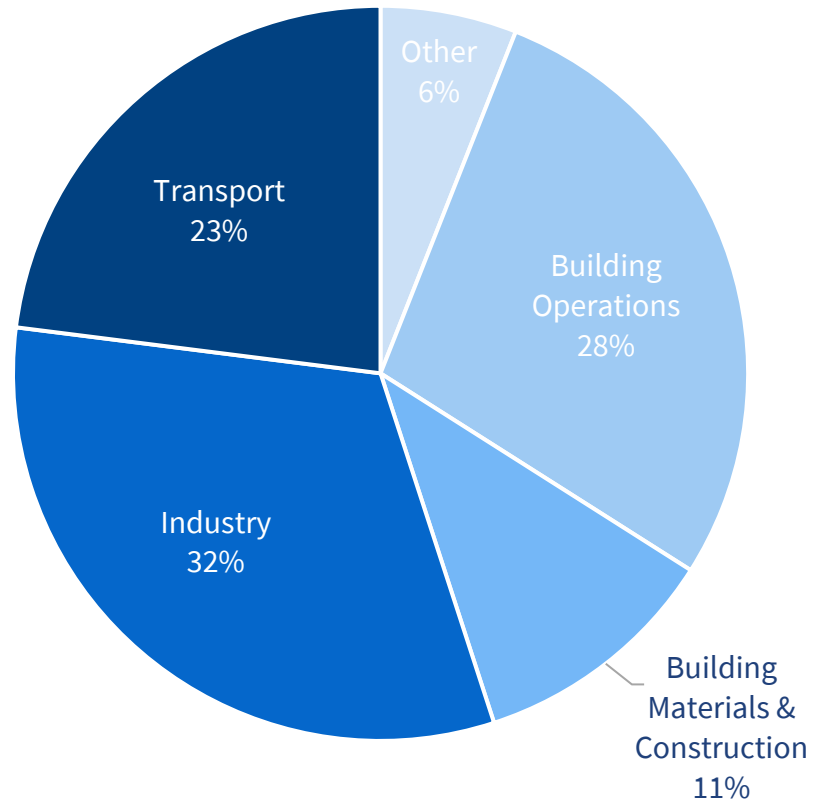
-14°



-22°

Problem: Building Environmental Impact

Global GHG emissions



New Buildings Institute

36%

World greenhouse
gases emissions

40%

World energy
consumption

Problem: Building Environmental Impact

Population

1970

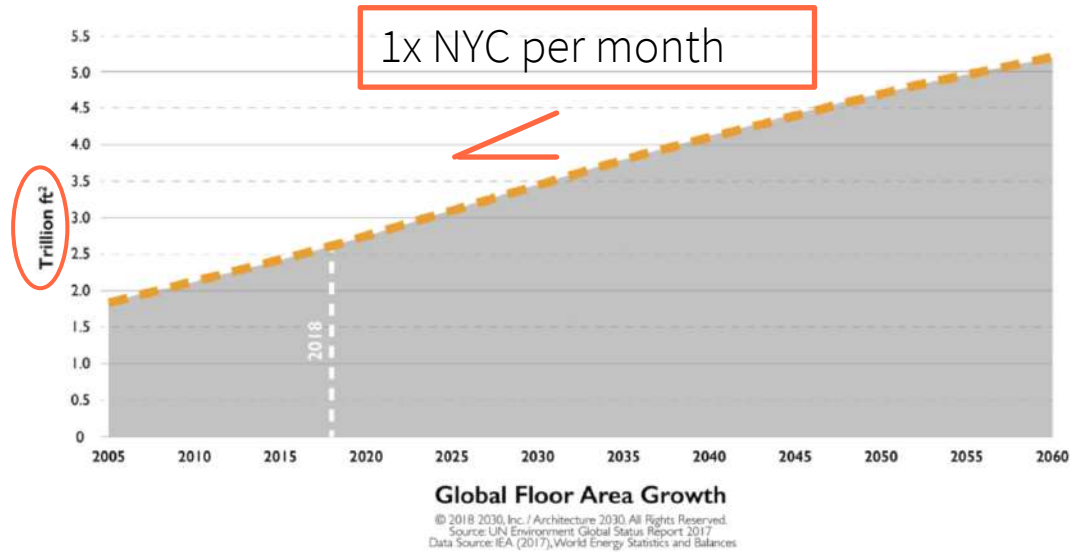


2x

Today



Building stock area



Concept of Sustainable Circular Economy

Sustainability: the ability to exist constantly - optimized process

Circular Economy: economic system aimed at eliminating waste and the continual use of resources

10 circularity strategies

R0: refuse
R1: rethink
R2: reduce
R3: re-use
R4: repair

R5: refurbish
R6: re-manufacture
R7: repurpose
R8: recycle
R9: recover

Potting et al., 2016

Circular Economy in Construction



Guggenheim Museum, Bilbao



Markthal, Rotterdam



Blur expo02, Yverdon-les-Bains



MAXXI, Rome



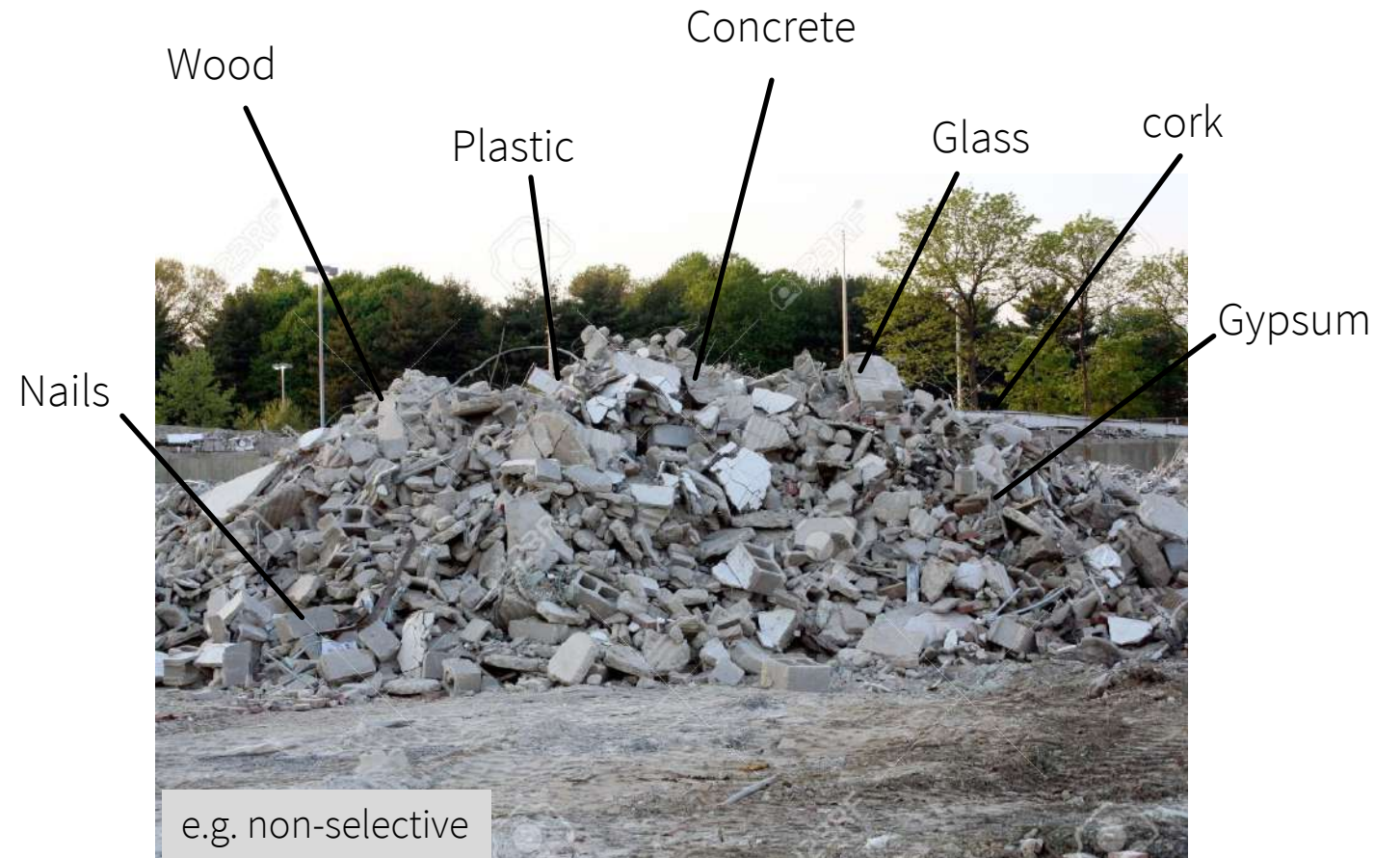
Assembly

Disassembly

Dismantling



Buildings are patchy composites



Selective vs non-selective

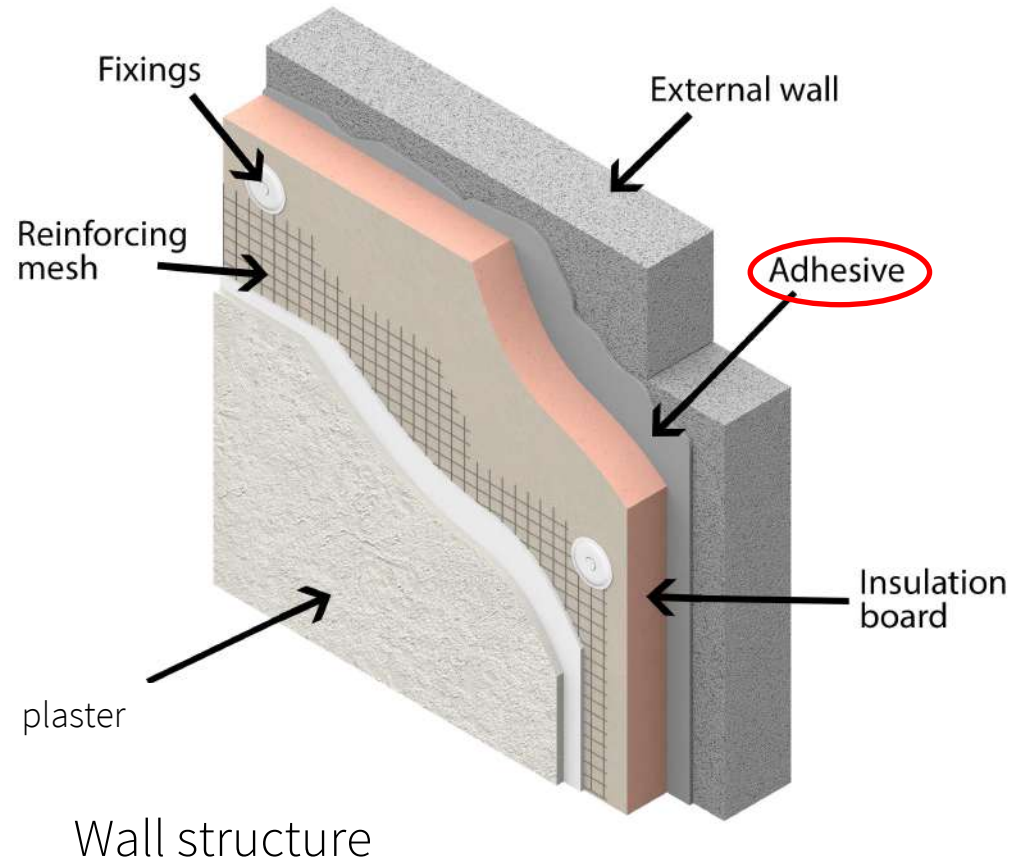
The background image shows a demolition site. A yellow Hyundai excavator is positioned on a pile of rubble and debris in the foreground. In the background, a large, multi-story brick building is being demolished, with many windows missing and structural damage visible. The sky is overcast and grey. A circular logo with the text 'FenX' is in the top right corner.

1.5%

The current share
of insulation
materials recycled
in Switzerland*

*M. Wiprächtiger, et al., Resources, Conservation & Recycling 154 (2020) 104631

Dismantling



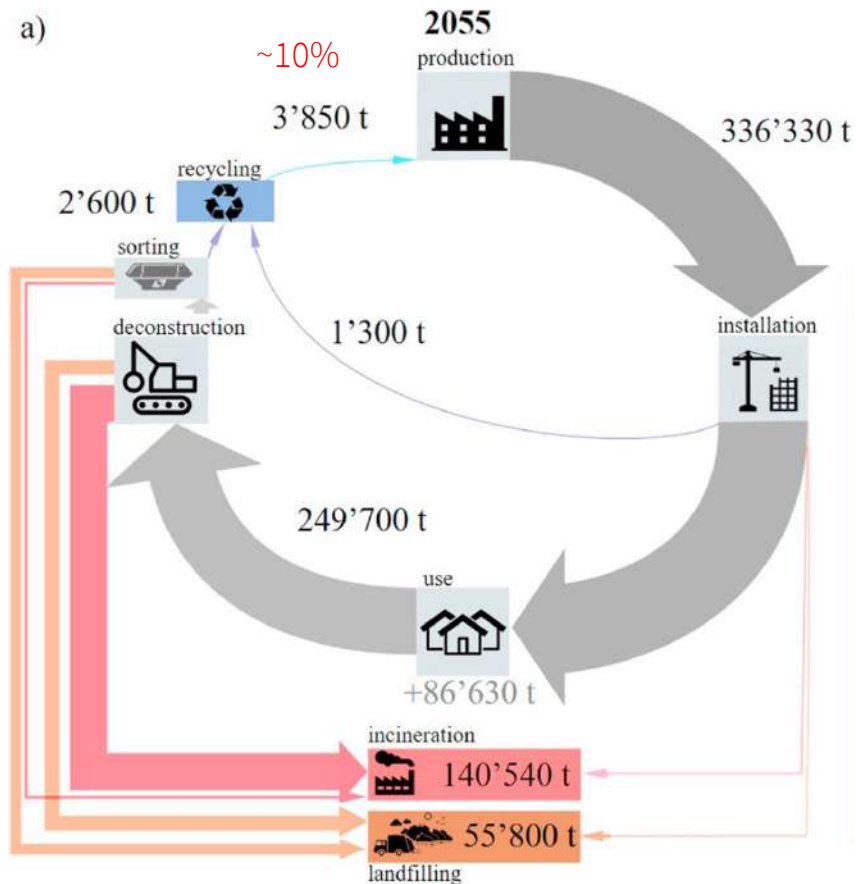
Problems

Lack of reversed logistics

Contaminations
(e.g. bituminous glues, HBCD)

Strategy for impact reduction

Baseline



Screwing vs gluing

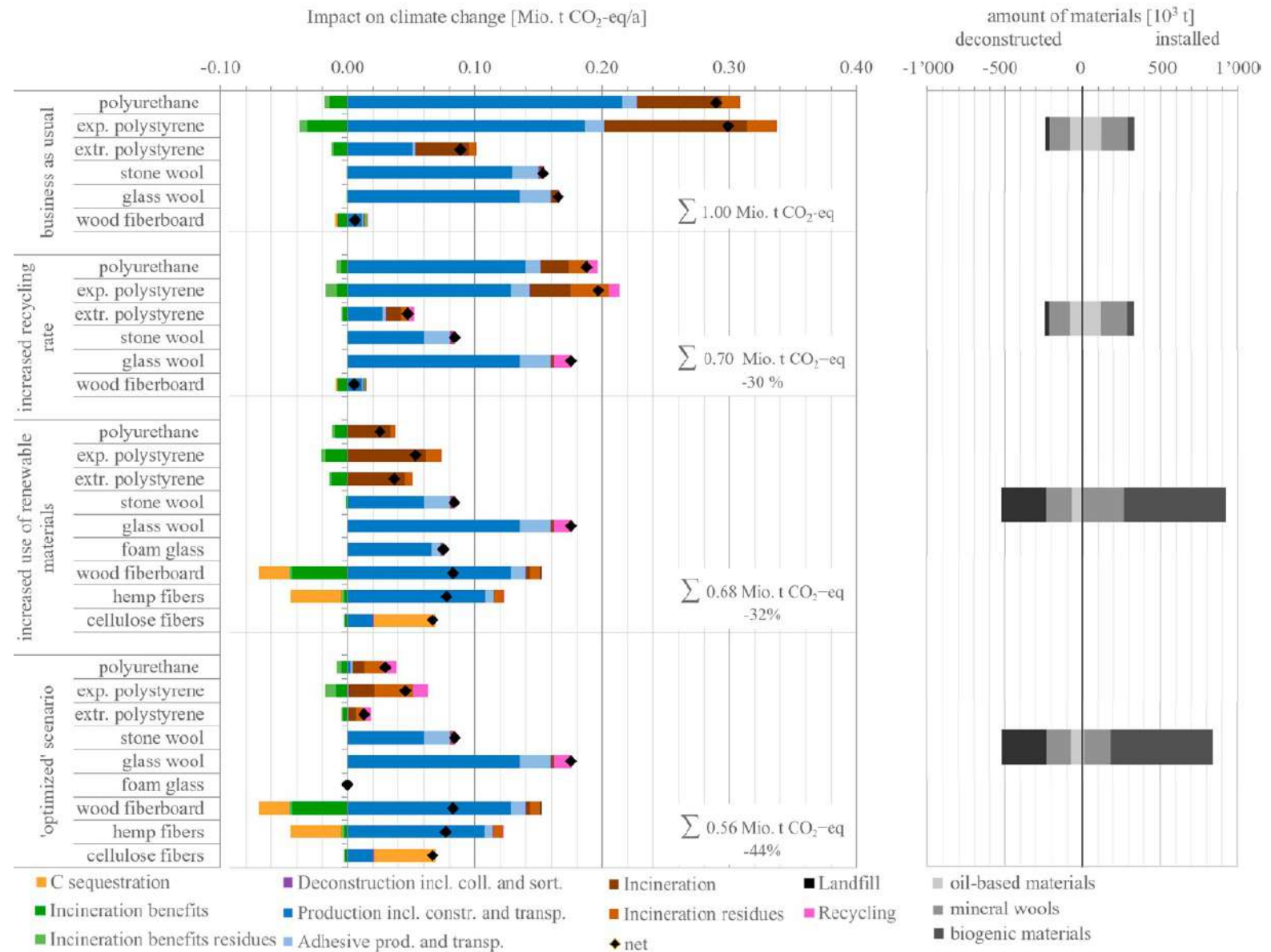
Selective deconstruction

Baseline

A

B

A + B



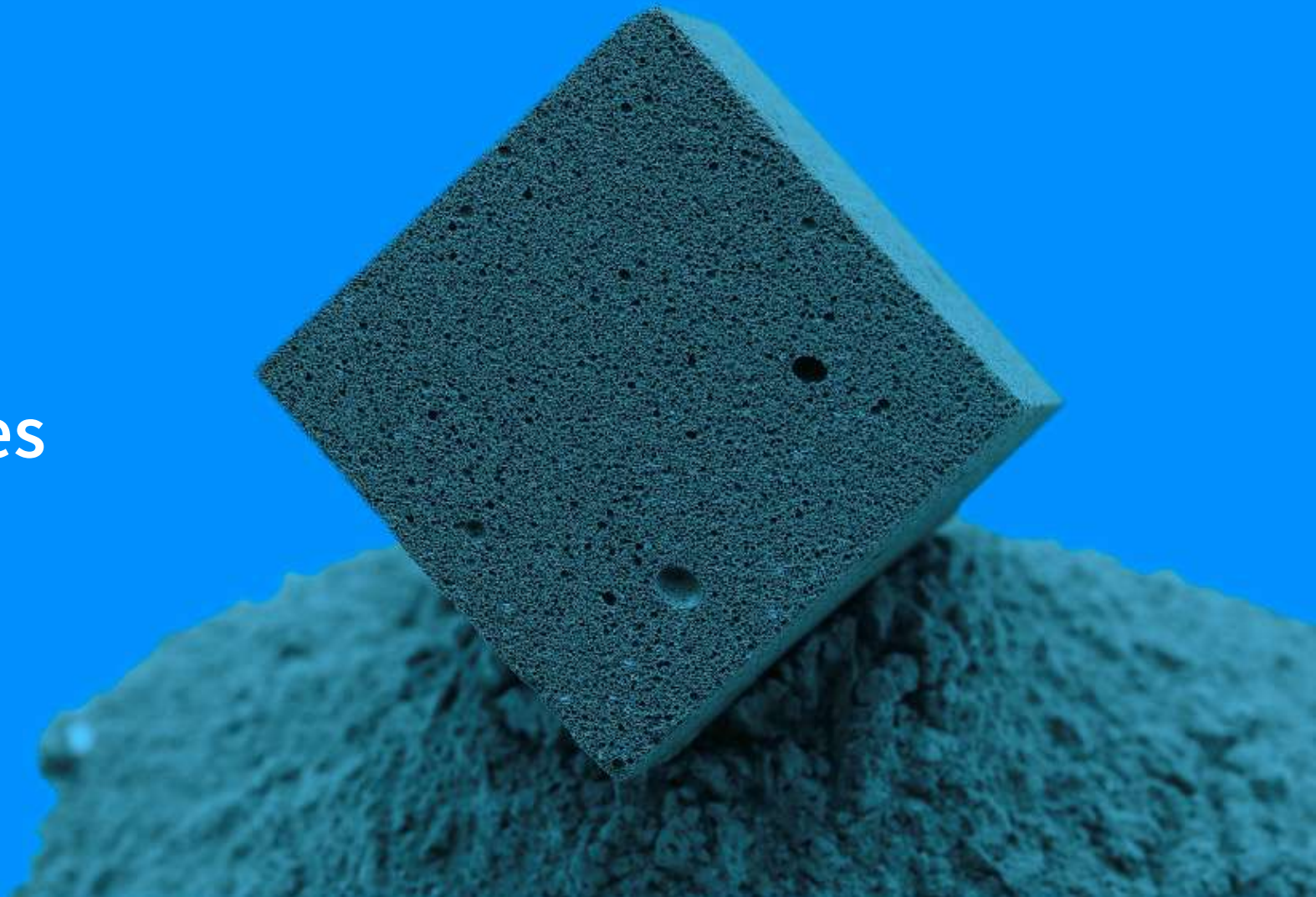
CH based numbers

How can Construction become more sustainable?

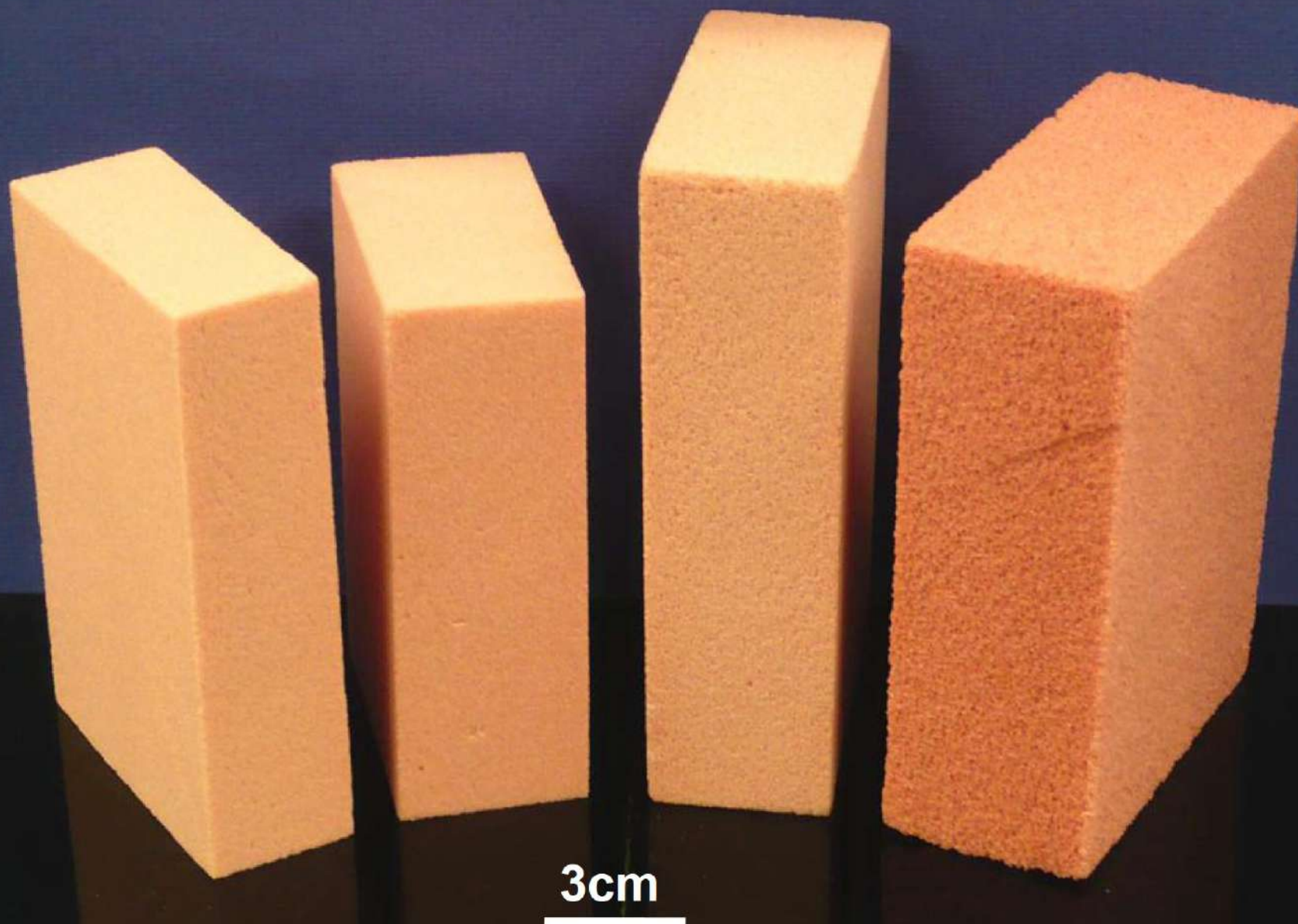
- Recycling in Construction is too costly (logistics + contamination between materials)
- Increasing recycling rates + use low-carbon materials could reduce Swiss CO₂ emissions by 44% by 2050
- New construction materials must be low-carbon + "easy-to-recycle"

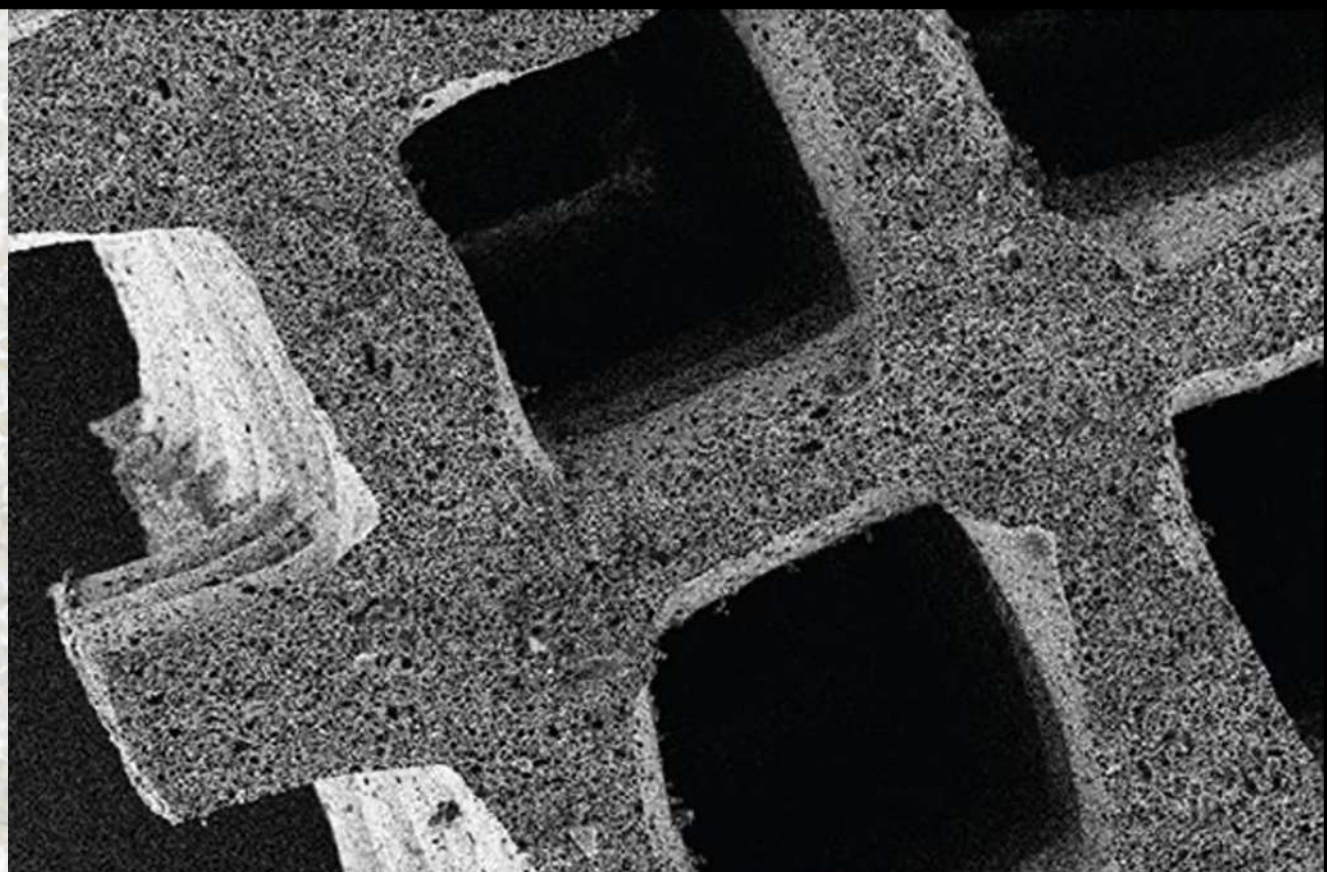
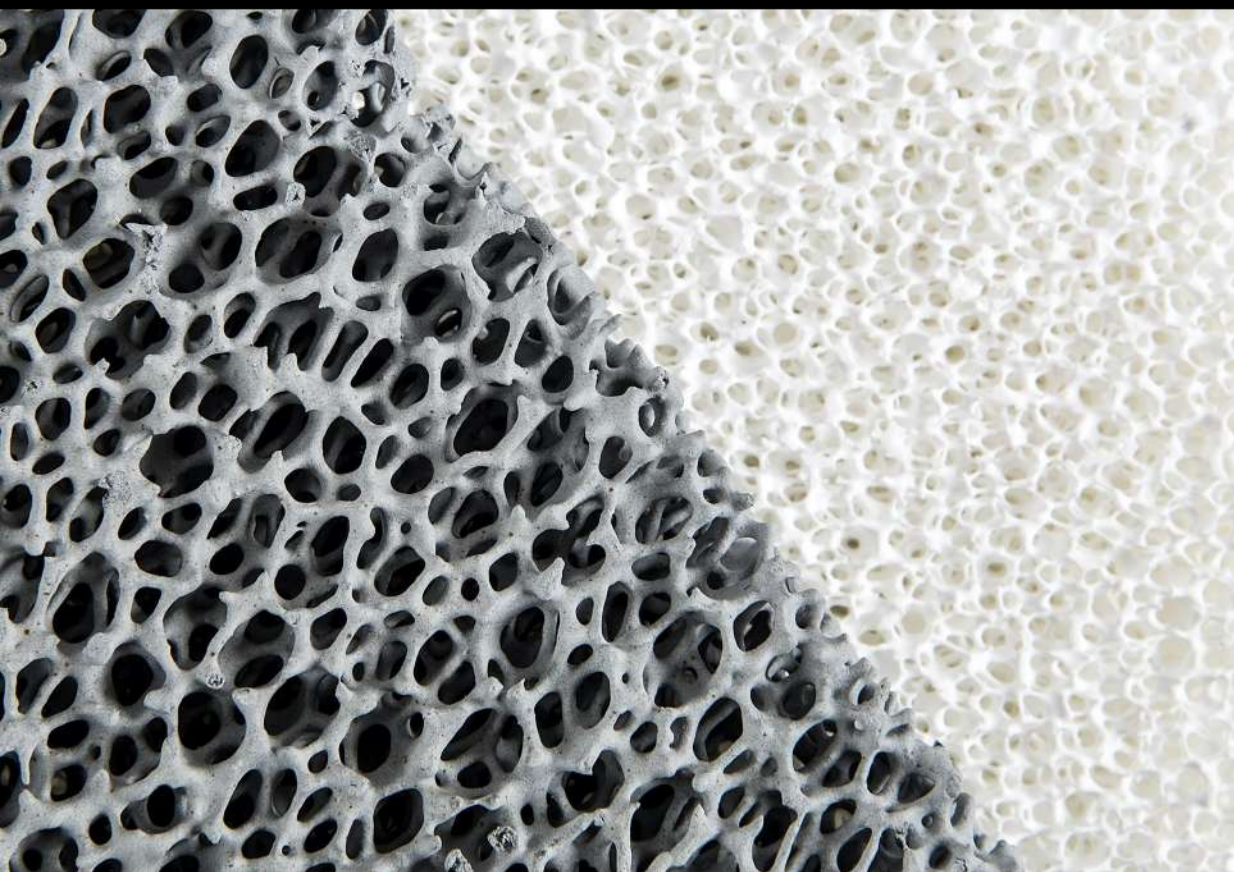
FenX

Insulation
Reborn from Ashes

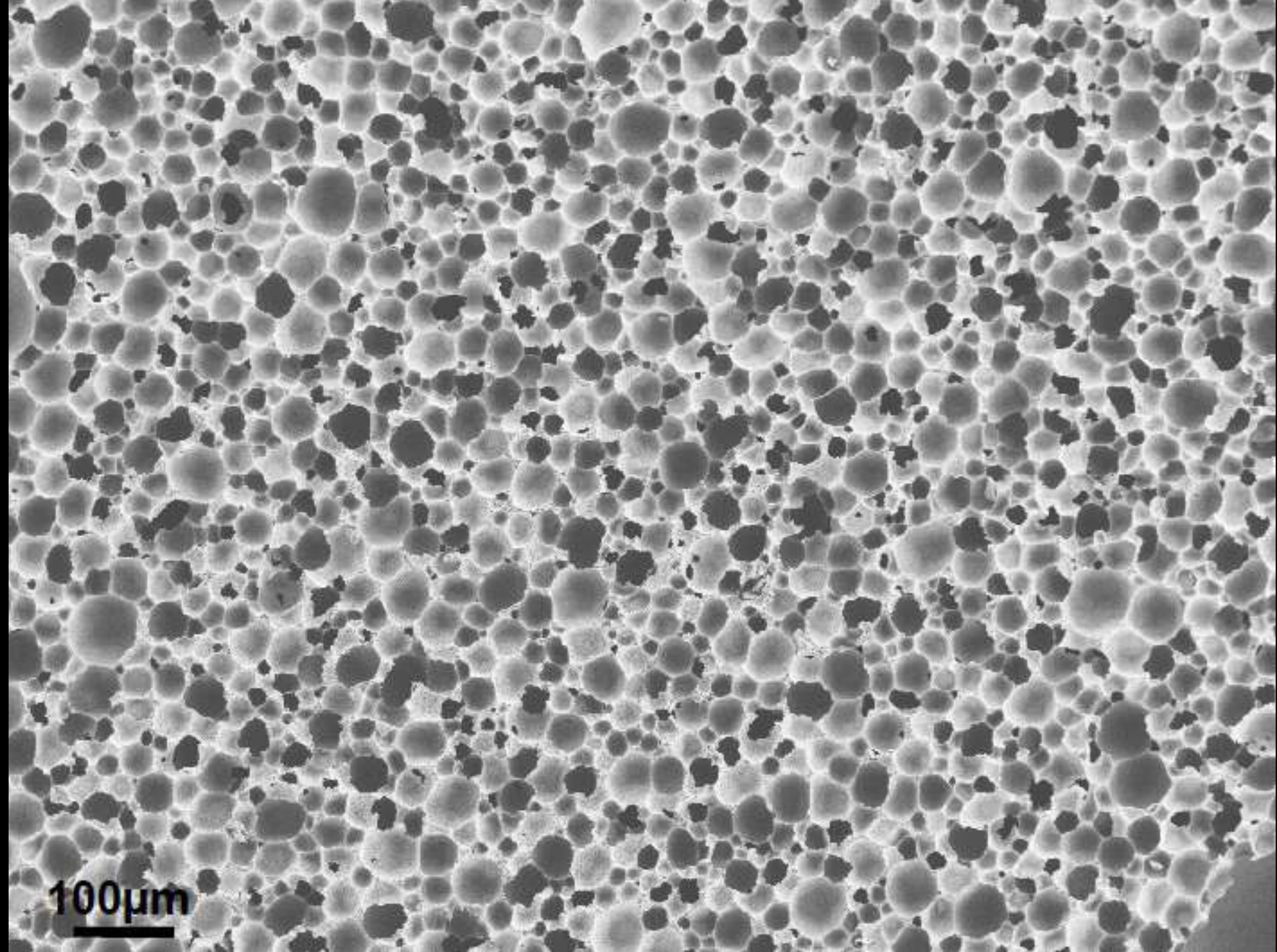


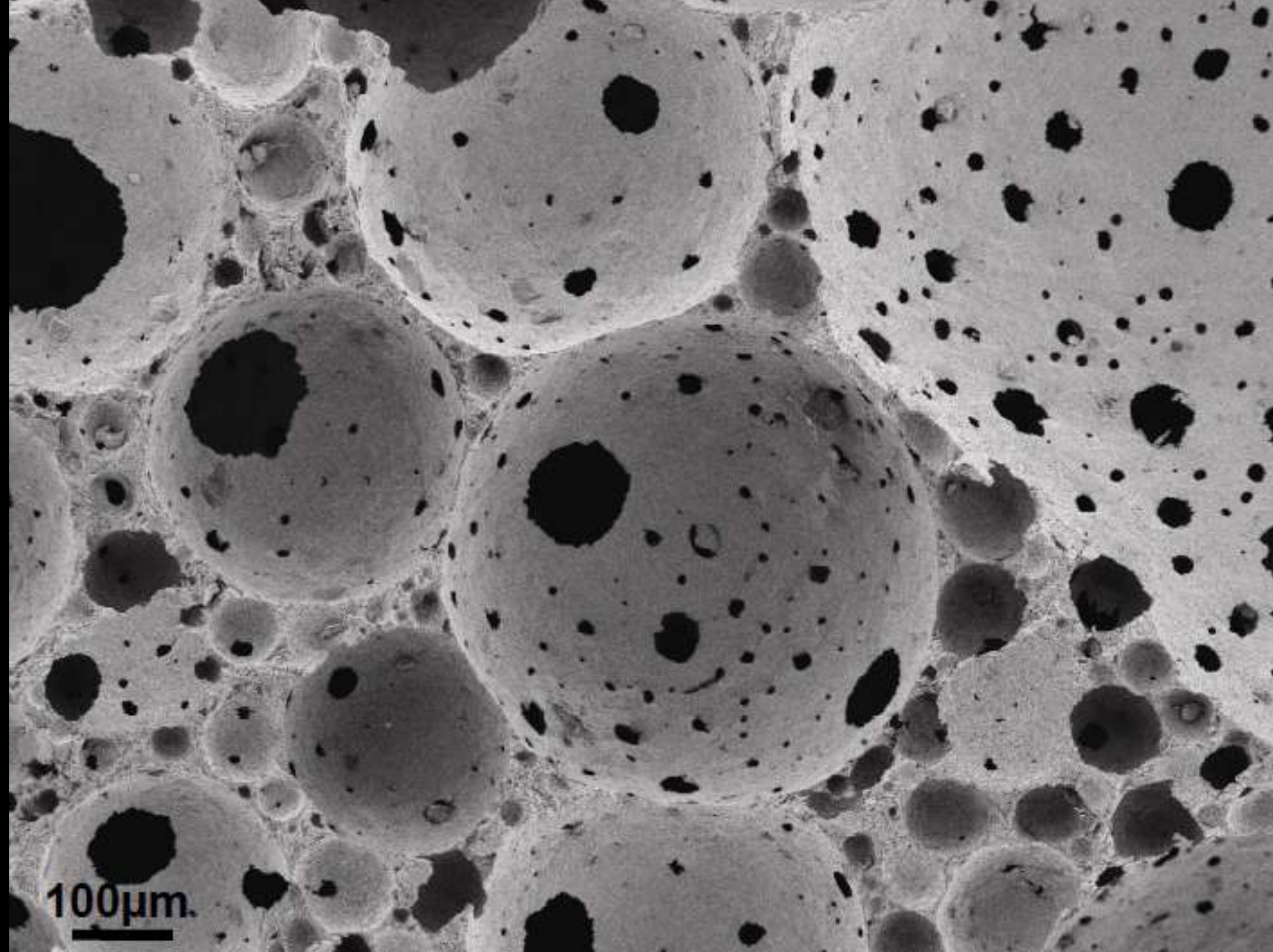
In 2009 at ETH Zürich...

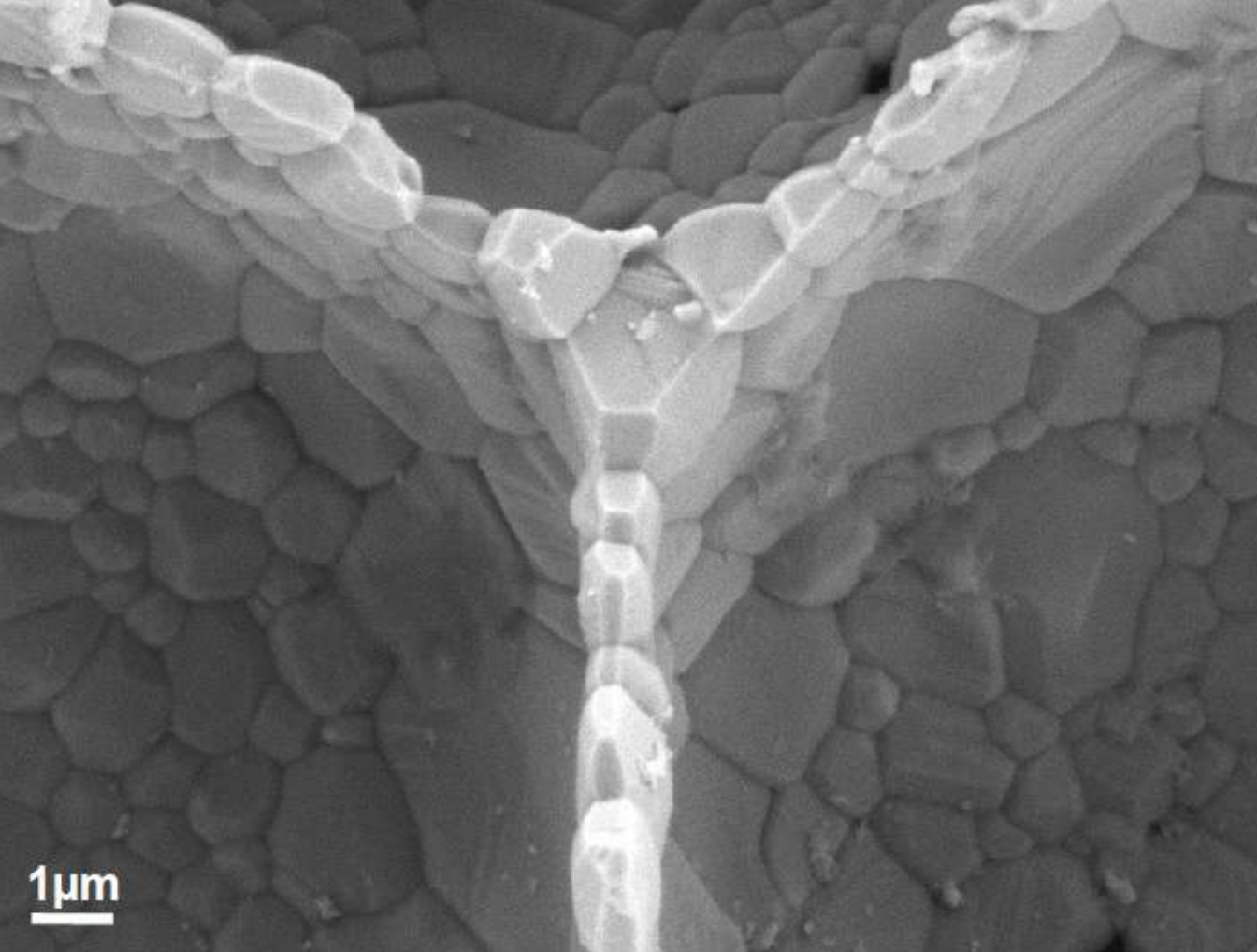




Development of ultra-light ceramic foams







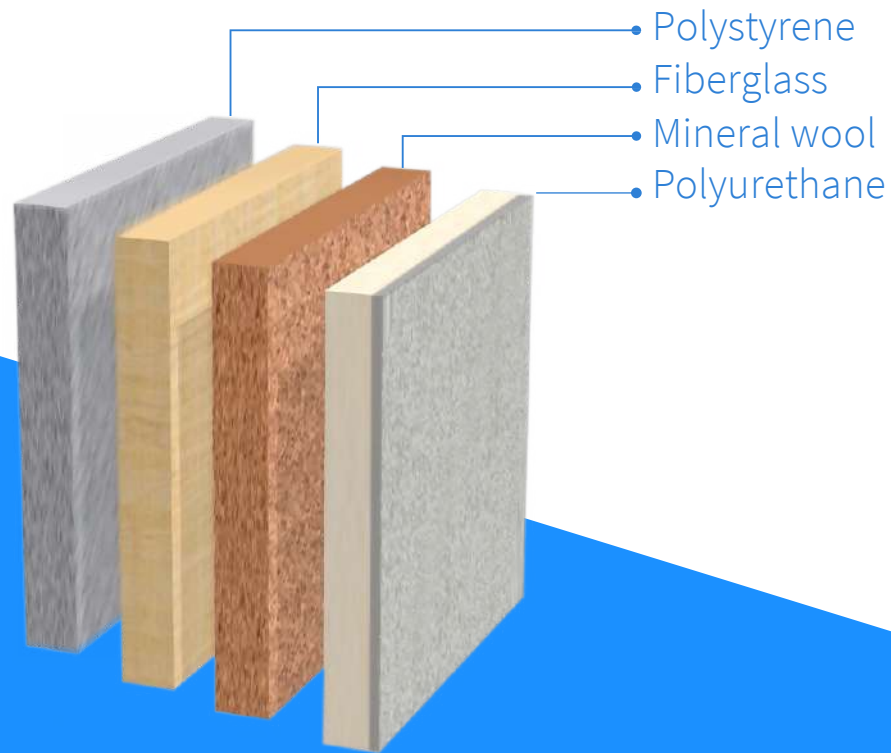
Applications

- high-temperature thermal insulation
- filters for molten metals, exhaust gases
- catalyst carriers
- bone grafts
- lightweight materials
- ...

High-impact application is building thermal insulation but:

- Expensive
- High carbon footprint

Thermal Insulation Market



Global building

thermal insulation market
CHF 22.4 billion (per year)



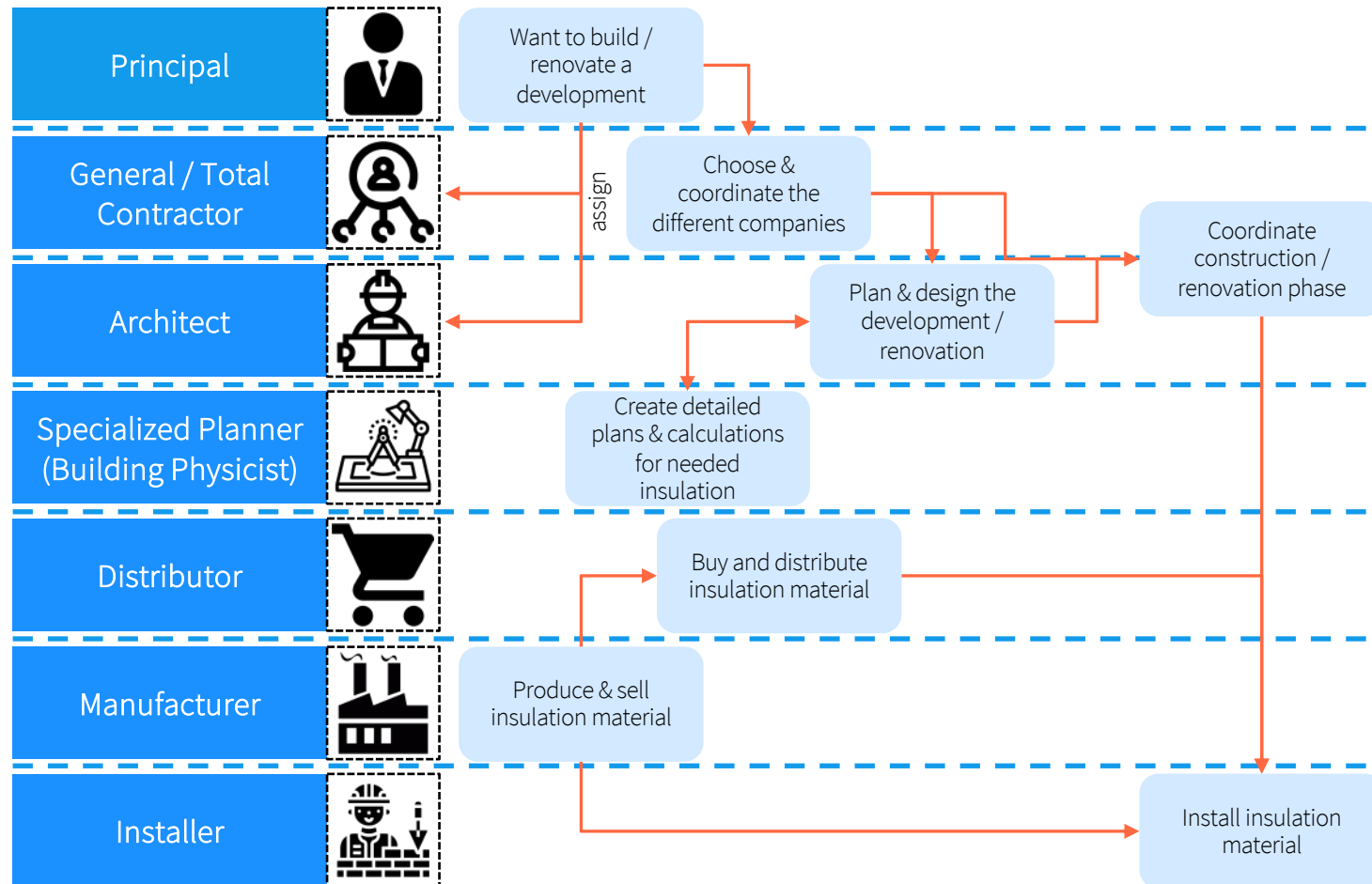
Swiss building

thermal insulation market
CHF 600 million (per year)

Customers

Real Estate developers, Constructors,
Project Planners, Architects, Installers

Market Players



OUR SOLUTION

MINERAL FOAM FROM WASTE



Excavated Materials



Waste from Excavated Materials



Expansion of FenX foam from waste

We use Swiss Mineral Waste Nr.1 = Excavation Materials

THE GREENEST NONFLAMMABLE INSULATION

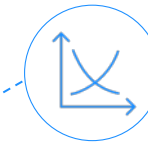
FenX



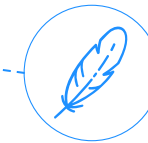
Very low carbon footprint



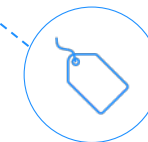
Nonflammable (A1/RF1 certified)



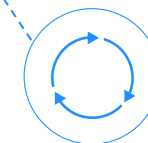
Remarkable insulation



Very light



Priced competitively



Fully and easily recyclable

confidential

Today, recycling possible with 10 different waste

Examples

FenX



Excavated materials



Rice husk ash



Metal slags



Coal fly ash



Construction & Demolition Waste

Business Model

