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Also part of :

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Swiss society of engineers and architects

Innovation for construction & the environment

Dr. Dimitrios Terzis

23/09/2025

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

Dr. Dimitrios Terzis

The role of regulations in sustainable construction

Dr. Dimitrios Terzis

MINERGIE

Dr. Dimitrios Terzis

The role of regulations in sustainable construction

× MINERGIE®

59 mio m^2

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.

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The role of regulations in sustainable construction

62,6 mia

de kWh d'énergie et

11,24 mio

de tonnes de CO_2 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 m^2

de surface de référence énergétique (SRE)

5775

Minergie-P

1083

Minergie-A

1817

avec le complément ECO

19

avec le complément SQM Construction

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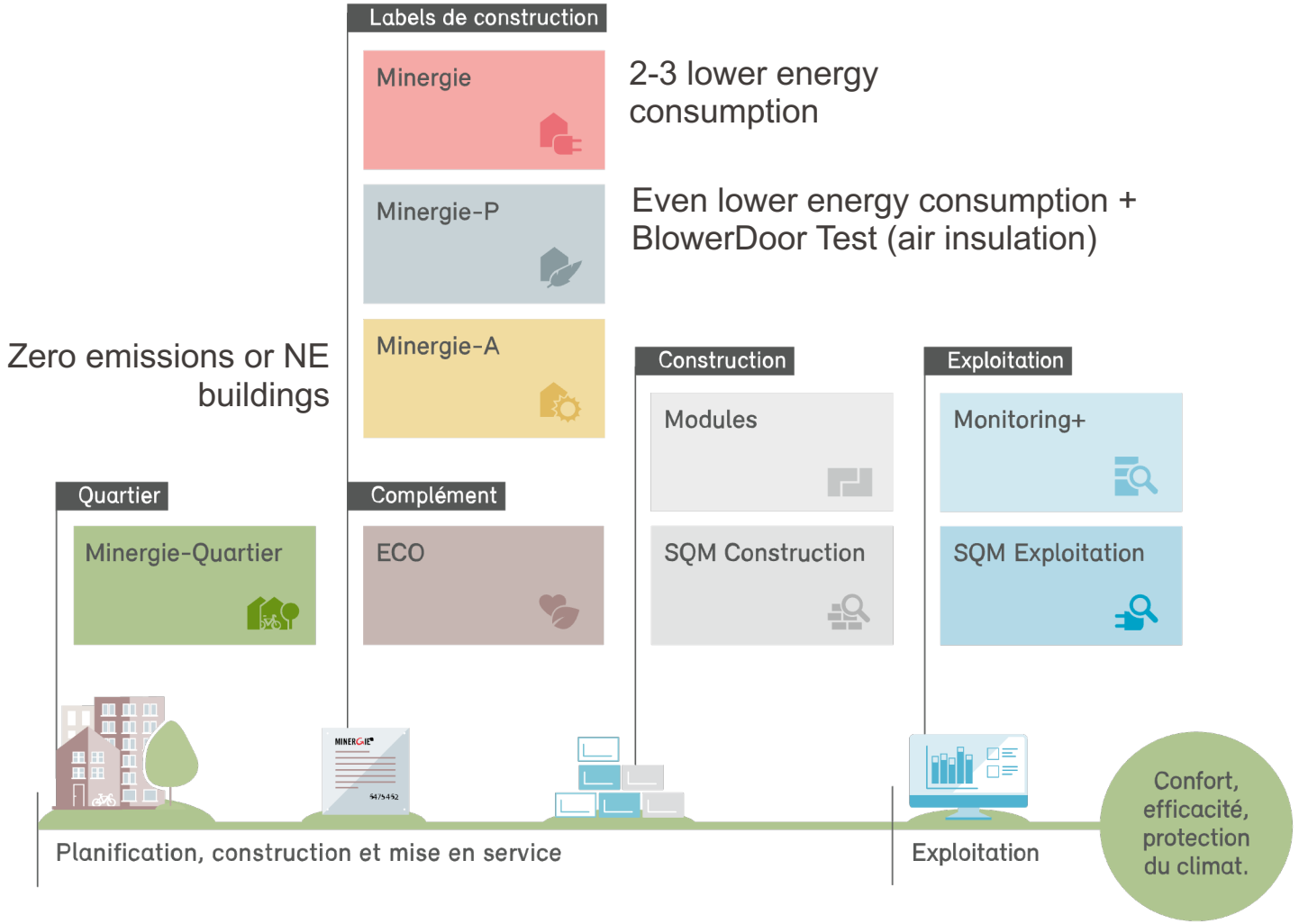
The role of regulations in sustainable construction



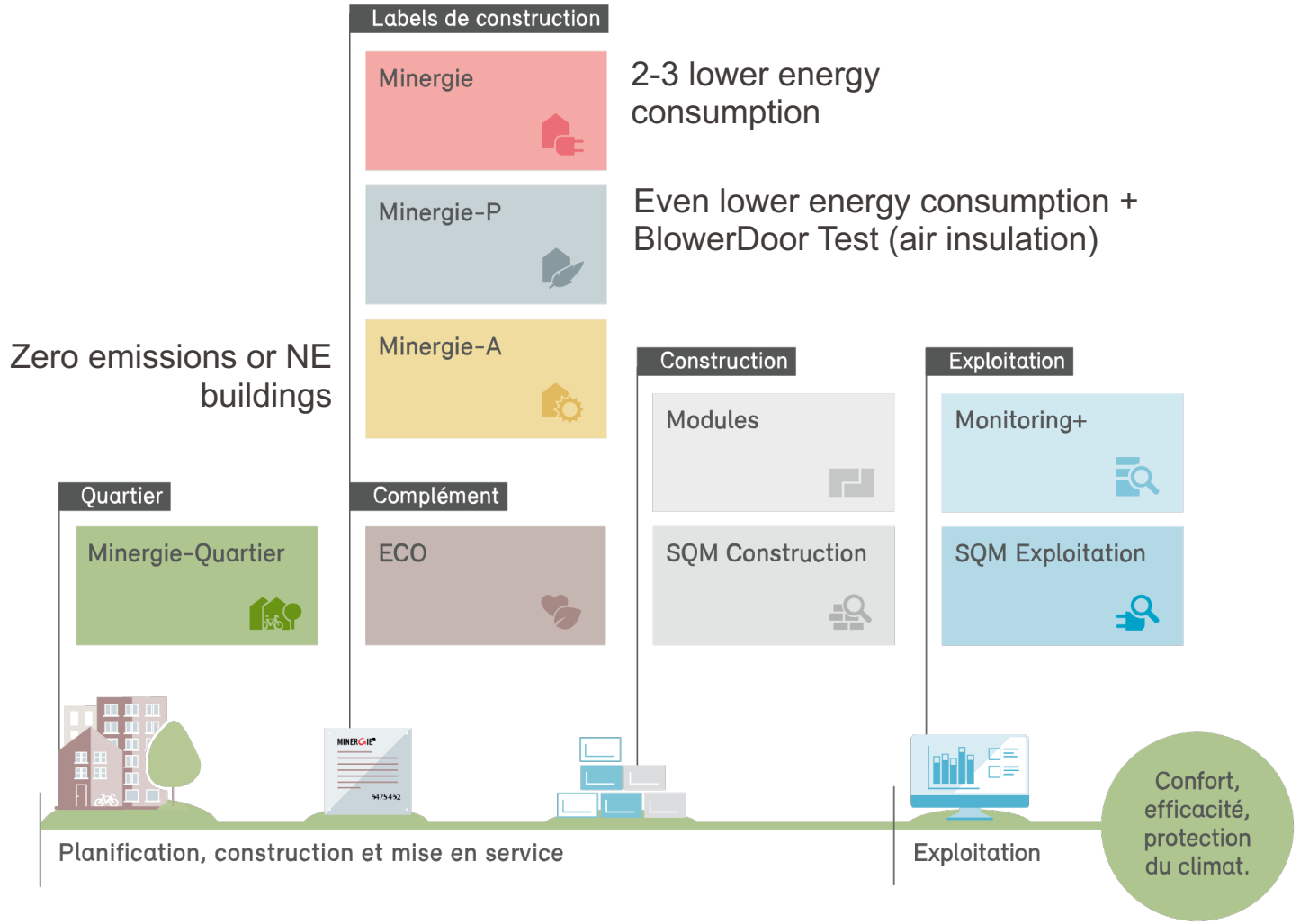
The role of regulations in sustainable construction

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.



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The role of regulations in sustainable construction

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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

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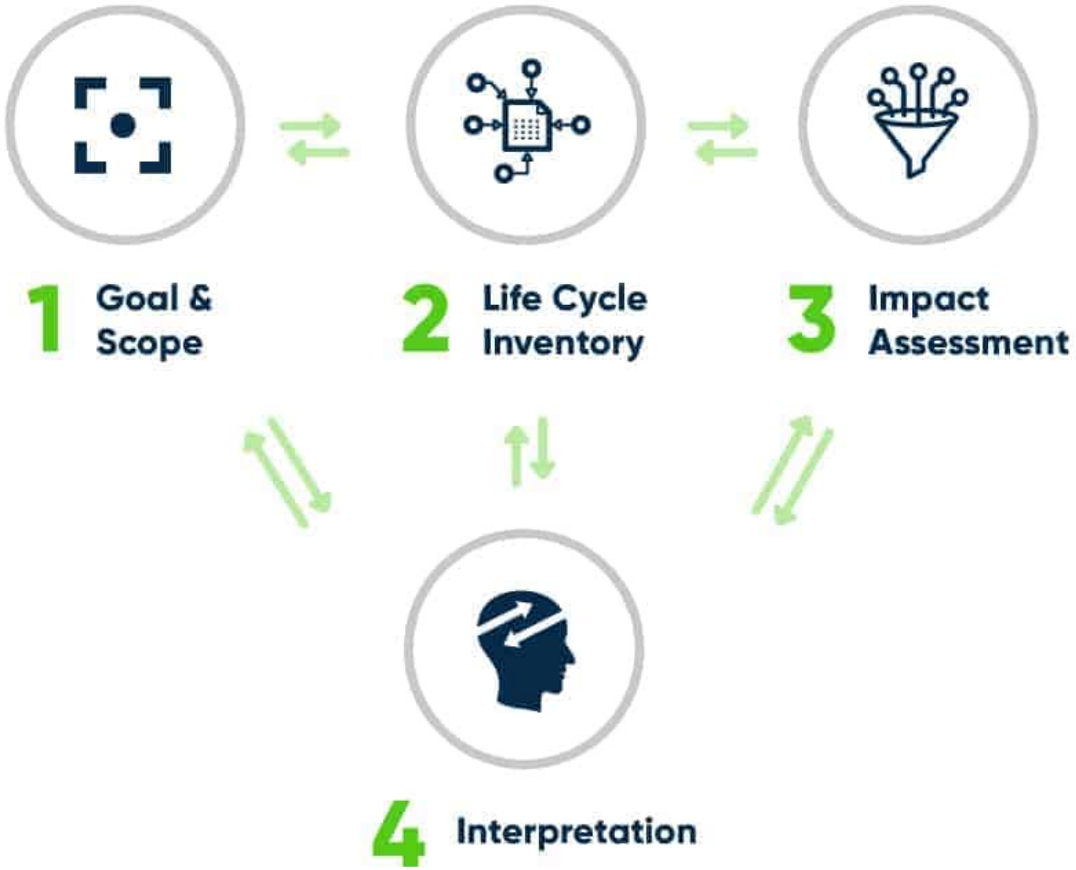


LCA vs. LCI vs. LCIA

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.

Ecochain

LCA decesion making design

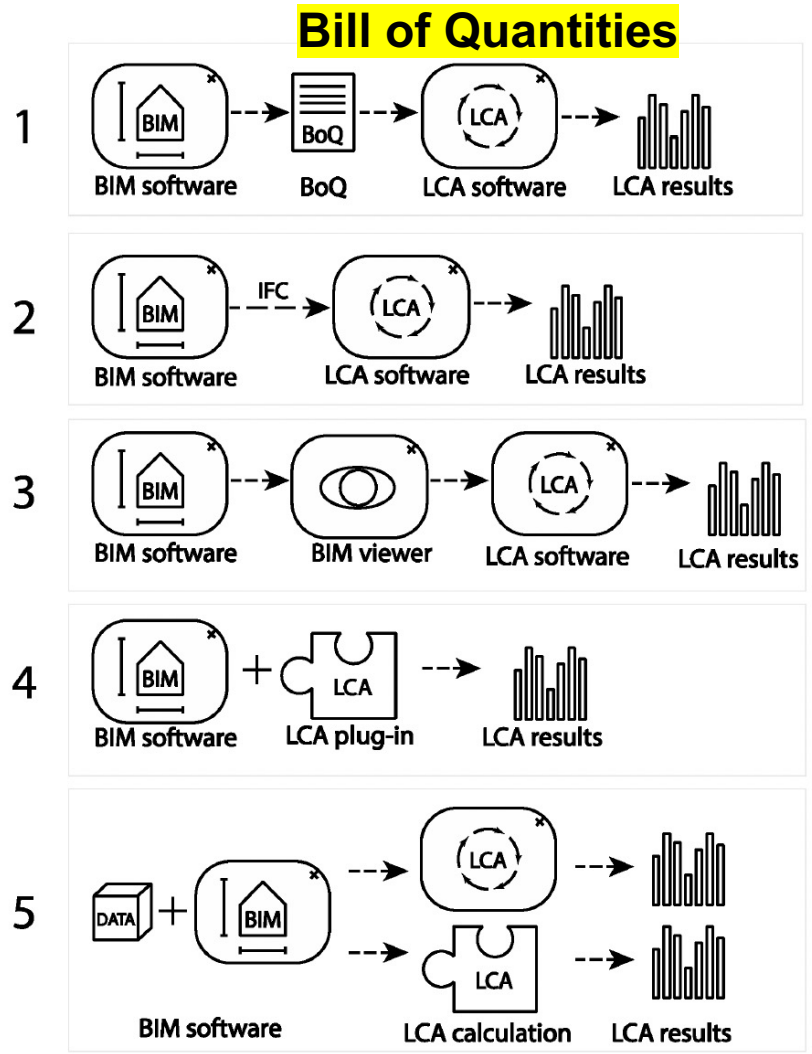


Figure 2: Most common BIM-LCA integration types [8]

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 99 Cite Cited by 145 Related articles All 12 versions »

Performing accurate LCAs for the construction industry using BIM models

A past year's project presentation

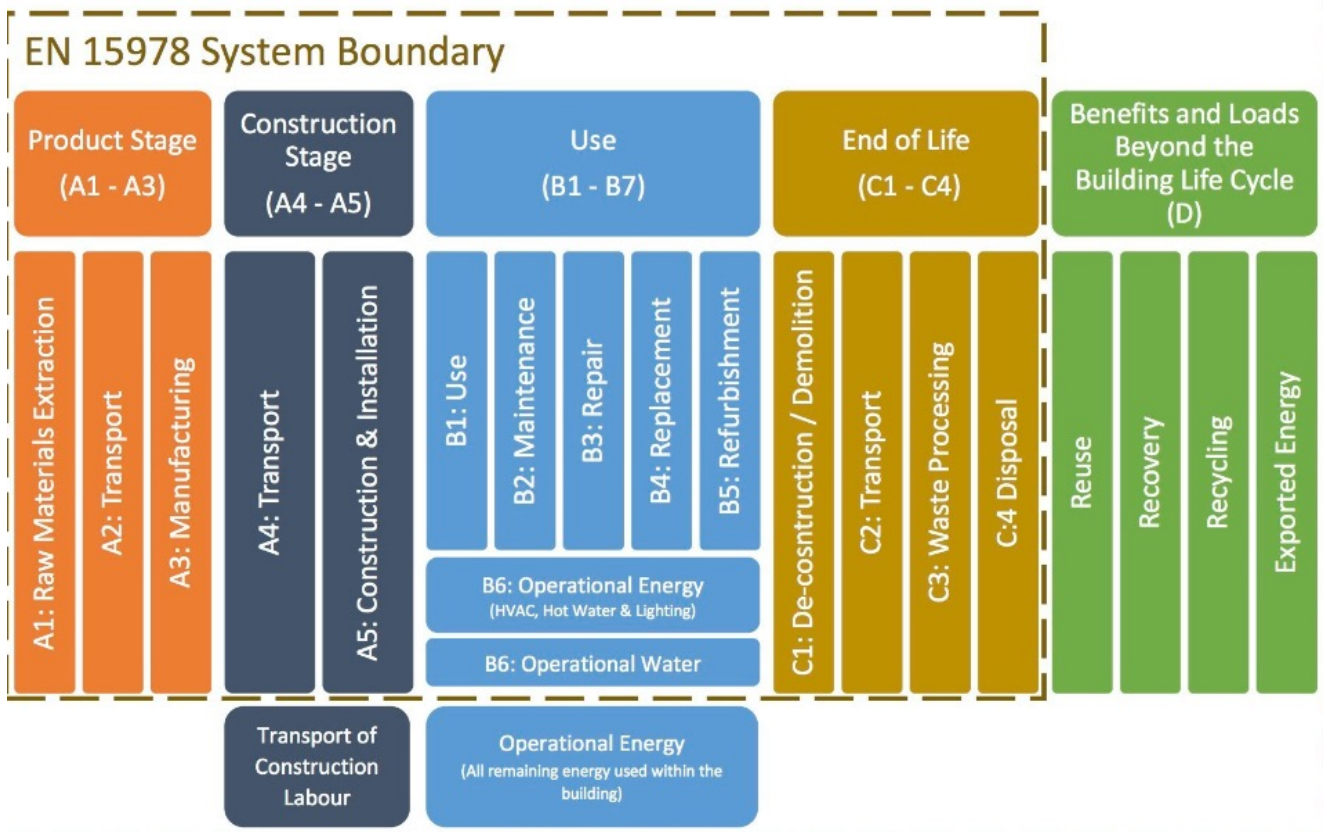
12/12/2022

Table of contents

Introduction

- 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

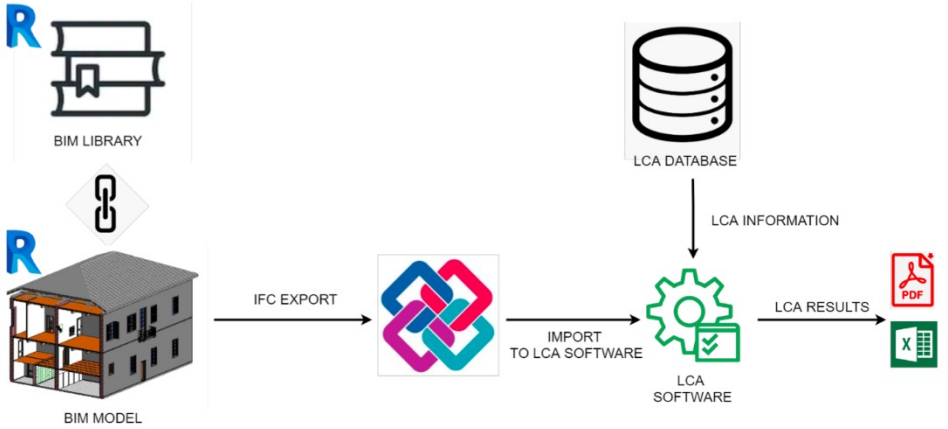


Source: En 15978 - sustainability of construction works - assessment of environmental performance of buildings - calculation method. November 2011

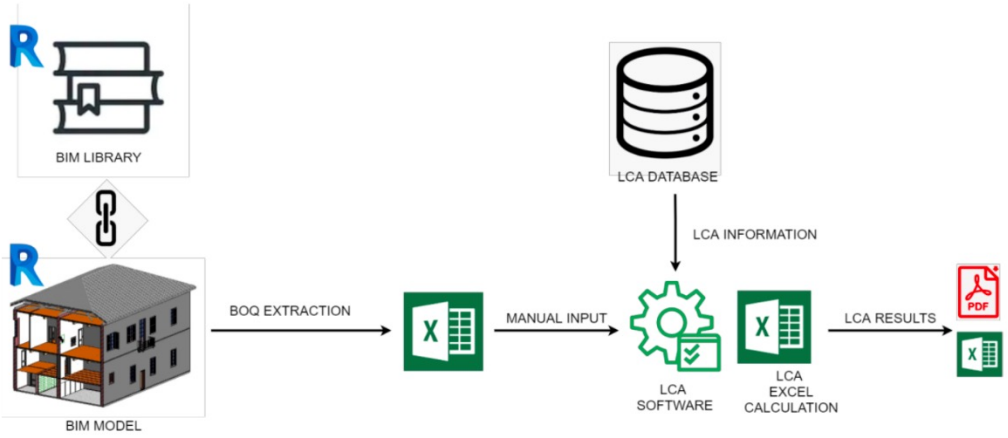
I. Literature review

1. Current solutions overview

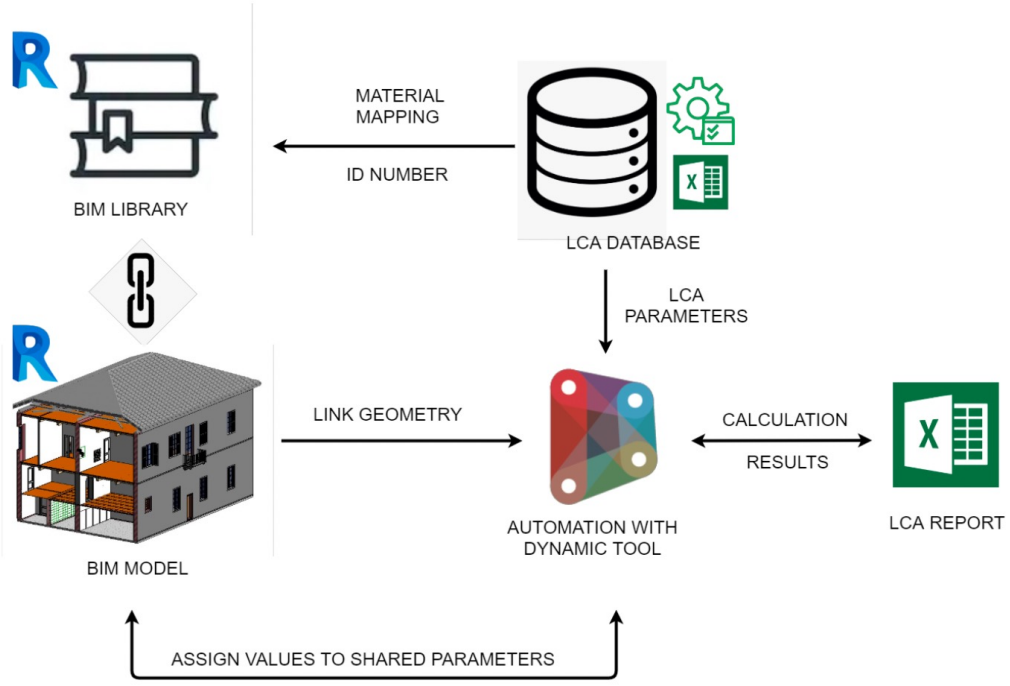
→ Template including environmental data about building material



→ Static BIM-LCA approach



→ Conventional extraction from BIM to LCA software



→ Dynamic method: Plug-in

Source: *ORJOLA BRAHOLLI. Automated procedures for LCA analysis on a BIM project, Politecnico Di Milano, 2019.*

I. Literature review

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								
										LCA Values			LCA Benchmarks			
Database	eBKP-H						Bauteilkatalog				SIA2032/ETH Zurich			
	Main group	Element group	Element	Element material	Sub-Element		Unit	Grey Energy (MJ)	GHG (kg CO_2-eq)	UBP (PL)	Unit	Grey Energy (MJ)	GHG (kg CO_2-eq)	RFL
	C Building construction	C2 Wall construction					m2 year	12.19	1.24	1541.81	m2 year	12.60	1.16	48.00
			C22 Interior wall construction				m2 year	11.01	1.15	1401.21	m2 year	11.00	0.90	45.00
				C22 001 Interior wall construction concrete			m2 year	12.40	1.37	2009.67	m2 year	11.00	0.90	45.00
					C22 001 Concrete bearing up to K32, raw 20 cm, B 90 kg/m3		m2 year	11.05	1.20	1781.00				
					C22 001 Concrete bearing over K32, raw 20 cm, B 105 kg/m3		m2 year	11.73	1.30	1902.00				
					C22 001 Concrete bearing over K32, raw 25 cm, B 105 kg/m3		m2 year	14.41	1.60	2346.00				
				C22 002 Interior wall construction masonry			m2 year	9.63	0.93	792.75	m2 year	11.00	0.90	45.00
					C22 002 Bearing masonry, BN 15cm		m2 year	6.83	0.60	475.00				
					C22 002 Bearing masonry, KS 15cm		m2 year	5.50	0.60	529.00				
					C22 002 Masonry bearing double shell, sound-absorbing, BN 15cm, SD 4cm, BN 15cm		m2 year	14.43	1.30	1029.00				
					C22 002 Masonry bearing double shell, KS 15cm, SD 4cm, KS 15cm		m2 year	11.76	1.20	1138.00				

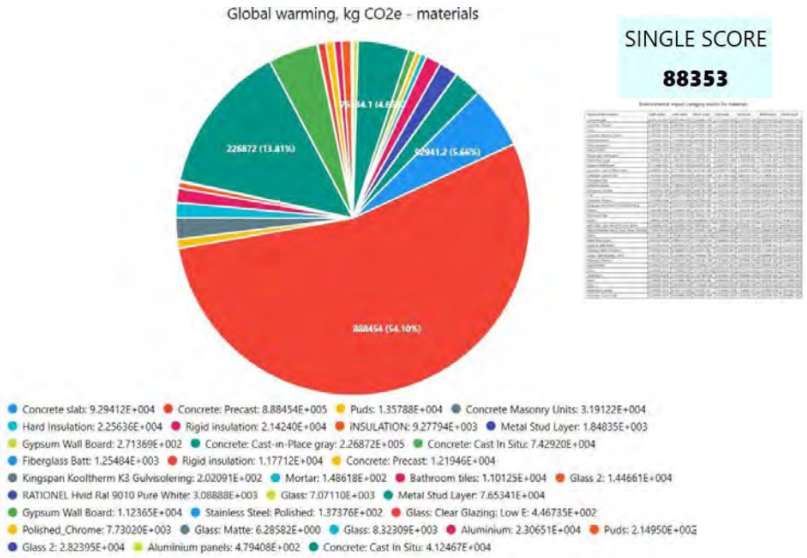
- Source : *Aliakbar Kamari, Bartlomiej Marek Kotula, and Carl Peter Leslie Schultz. A BIM-based LCA tool for sustainable building design during the early design stage. Smart and Sustainable Built Environment, 11(2):217–244, July 2022.*

I. Literature review

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

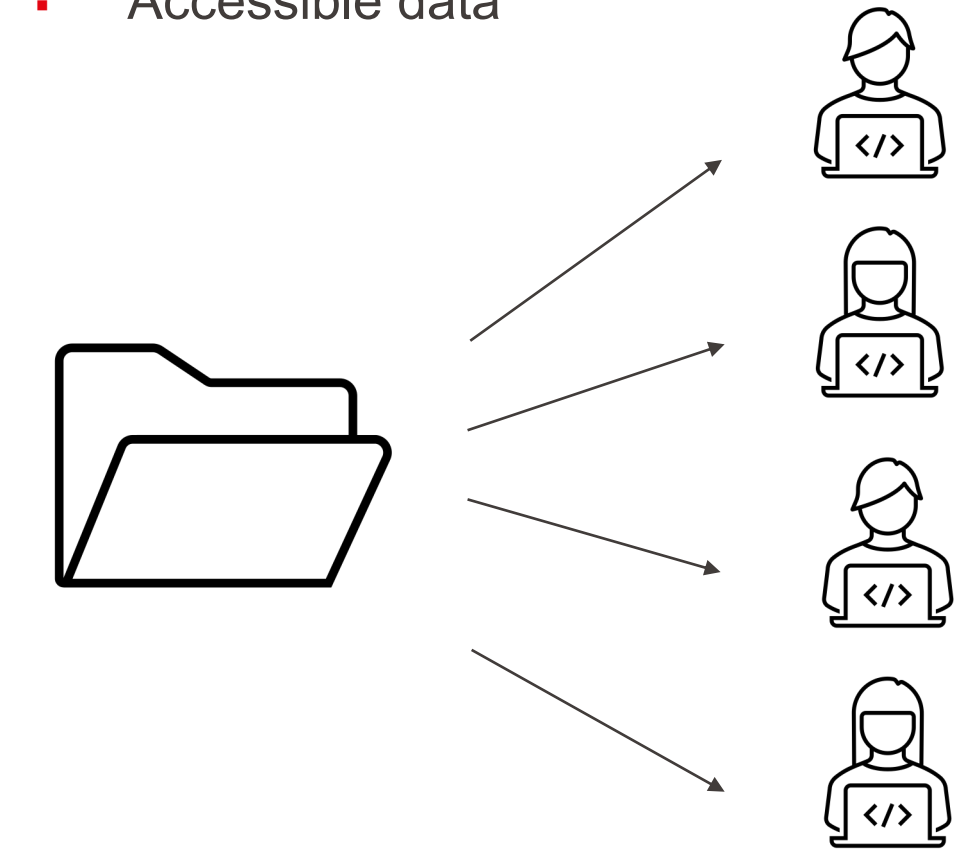
Source:
https://www.google.ch/url?sa=i&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3D864ZX6n8Kcs&psig=AOvVaw1gwGvynknjdleAxIt_5ptp&ust=1670503116681000&source=images&cd=vfe&ved=0CA0QjRxqFwoTCPiq5KnD5_sCFQAAAAAdAAAAABA3

II. Innovation and impact creation

1. Room for innovation

- LCA computations mainly for buildings

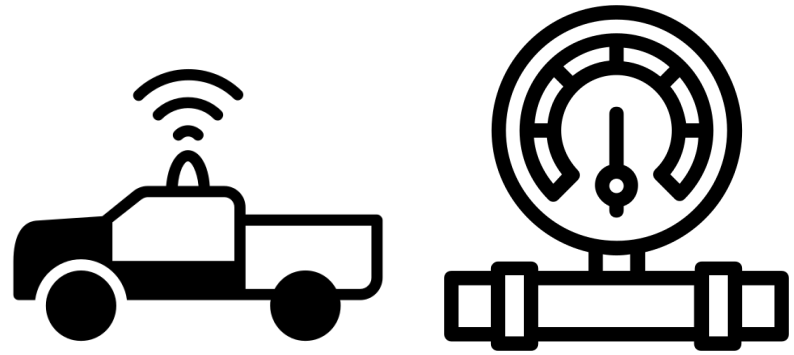
- Accessible data



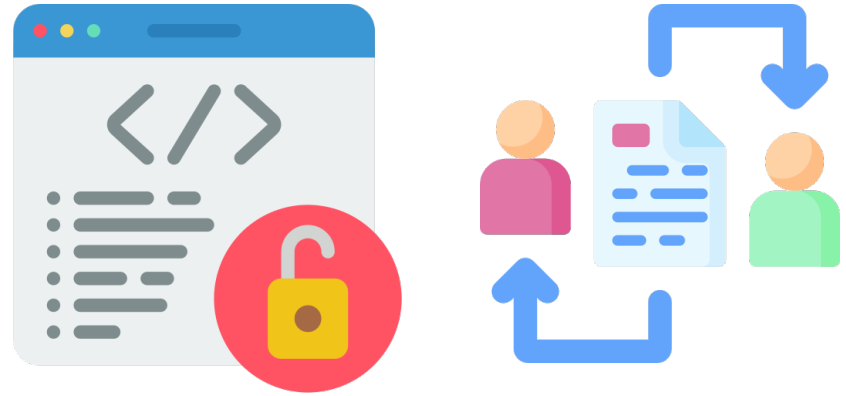
II. Innovation and impact creation

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

II. Innovation and impact creation

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

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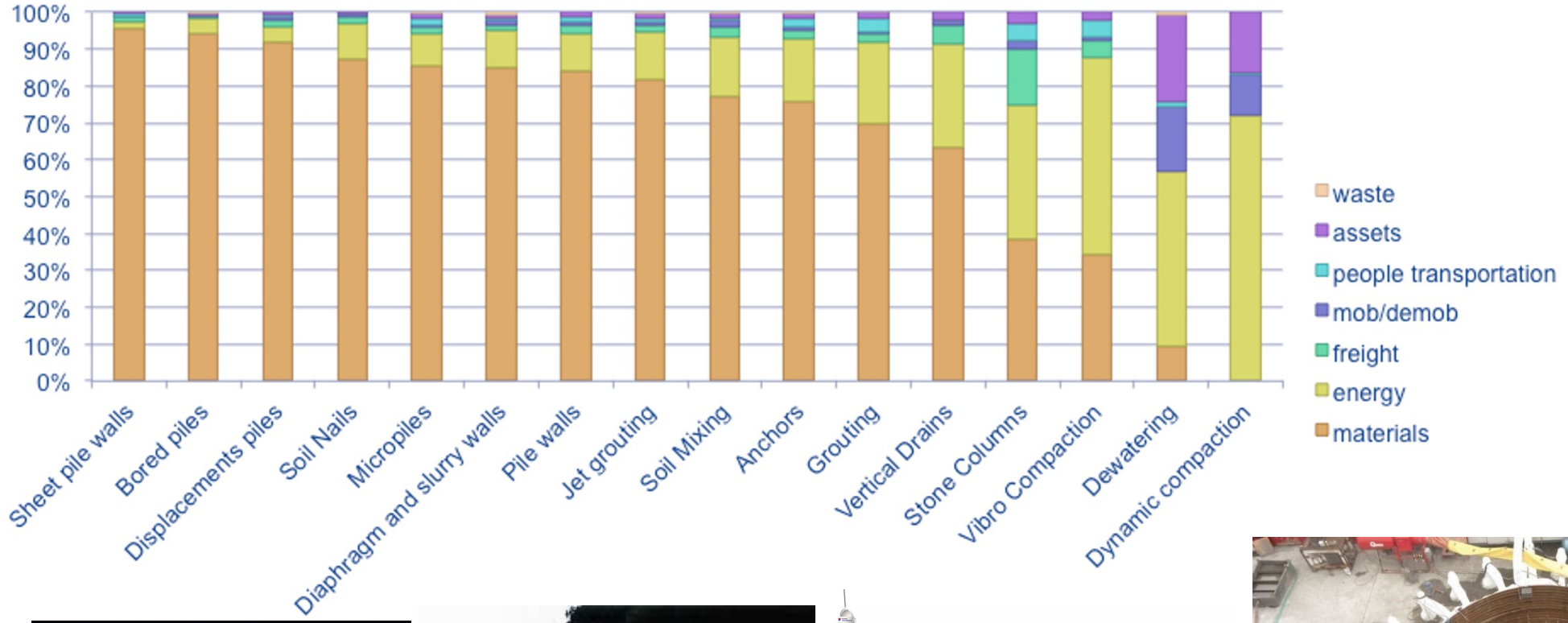
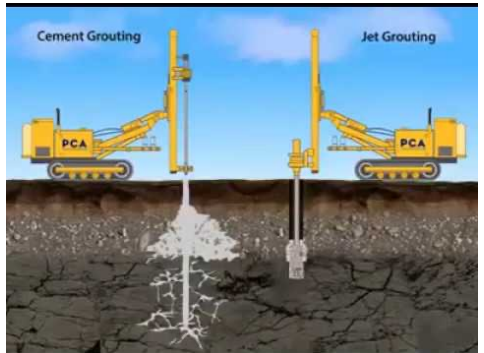
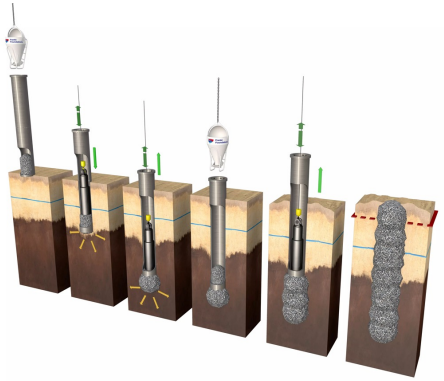
BoQ: Bill of Quantities

EFFC/DFI Carbon Calculator

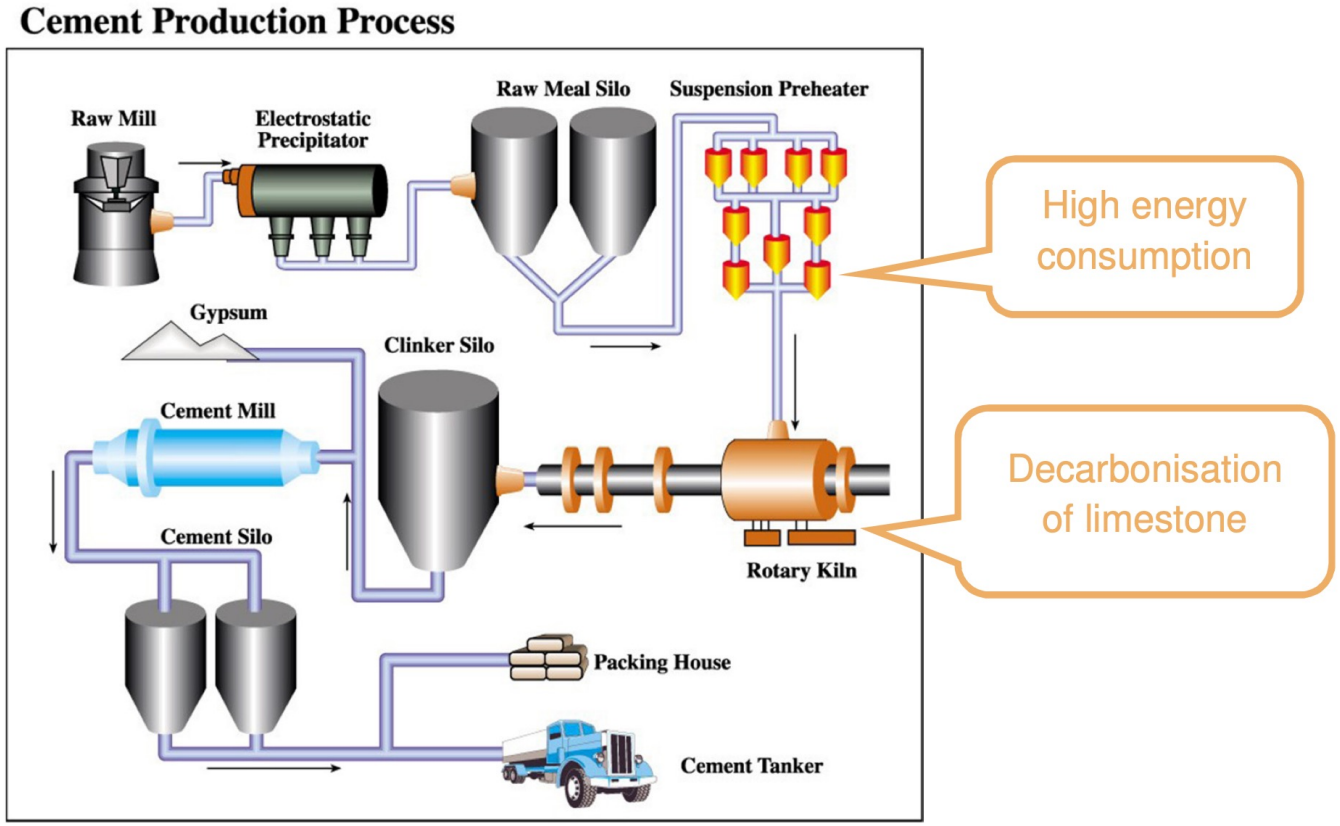
Emission breakdown : Average results (based on samples studied to develop the methodology)







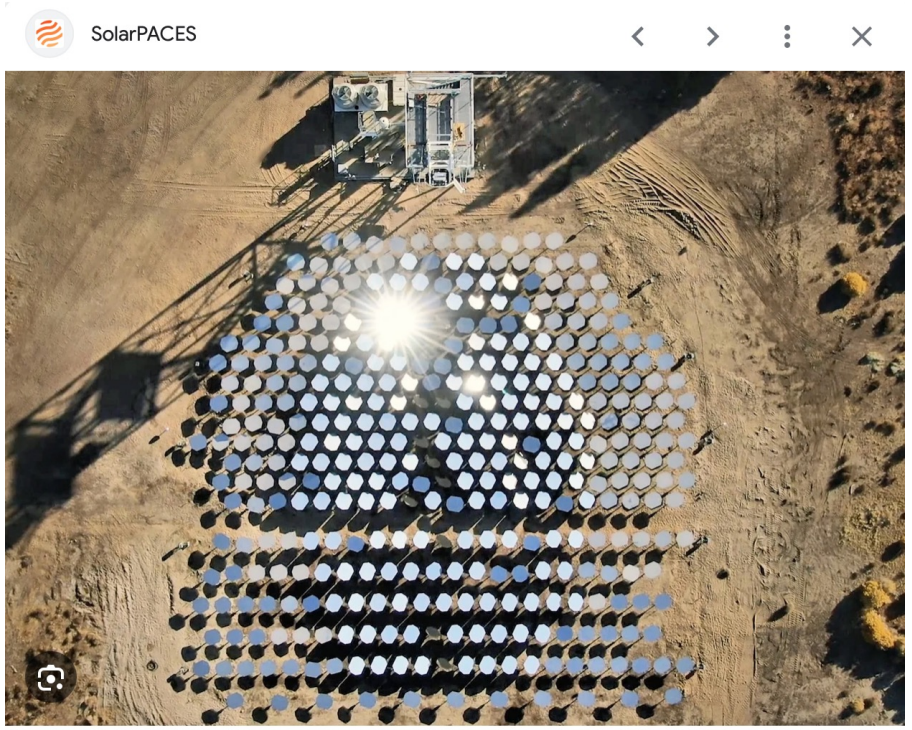
Decarbonization and energy consumption



High energy consumption

Decarbonisation of limestone

Figure 9: cement production process



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

Visit

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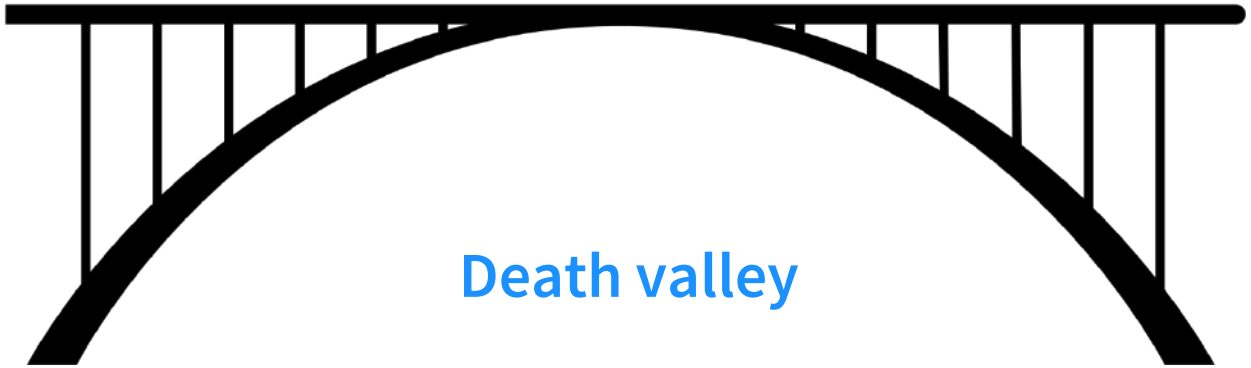
Environmental footprint beyond LCA

Scope: Technological innovation and real world

Materials Science

e.g.

FenX



Death valley

Market

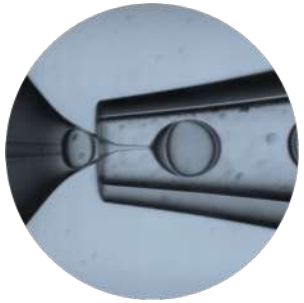
Background

Asphalt crack healing

Given topic

Bilayer Microcapsules

Accident

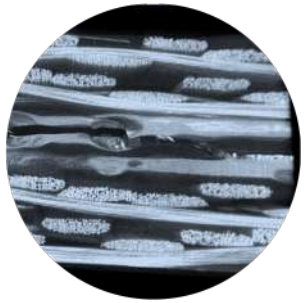


Microfluidics

Fun

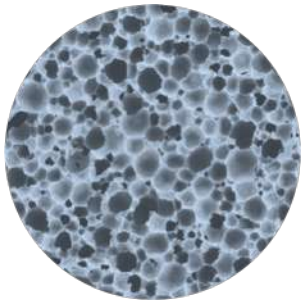
Ultra-shiny Chocolate

Time to kill



Self-healing Composites

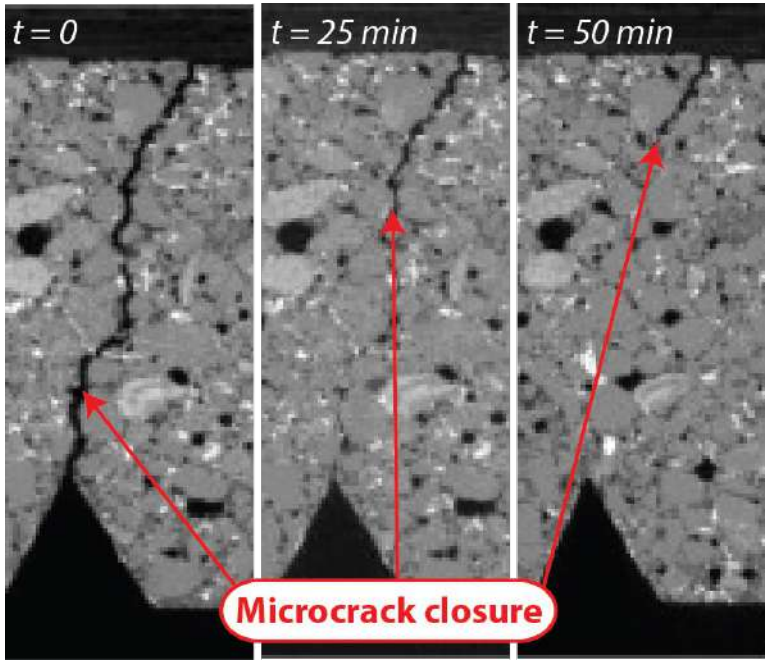
Given topic

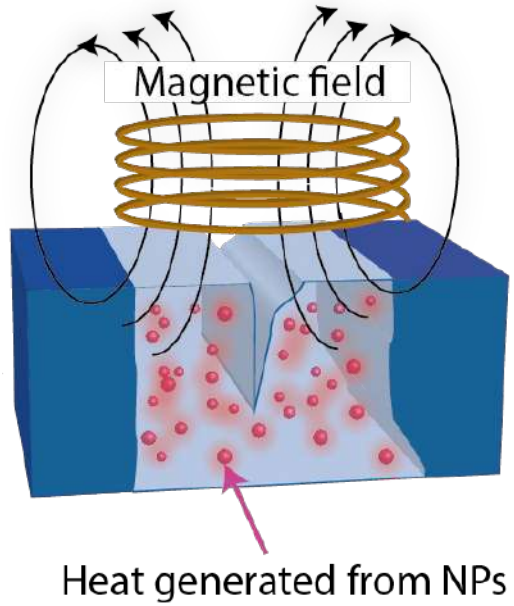


Mineral foams

Impact

Asphalt crack healing





Under combined conditions, microcracks can be closed autonomously.

Asphalt crack healing – Follow-up

The Economist

VICE

Neue Zürcher Zeitung

20 minutes

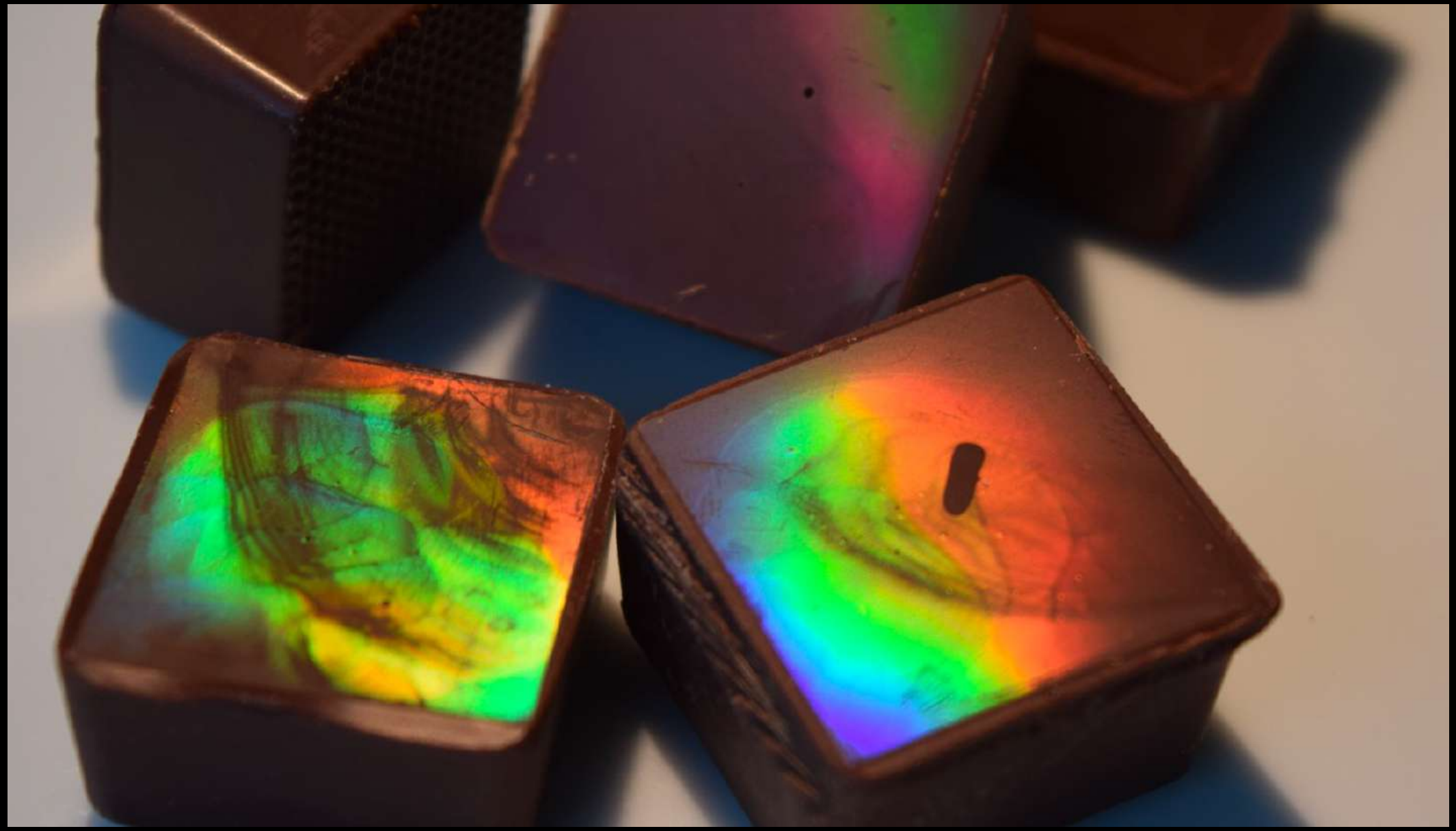
150+ media coverage

1 Patent

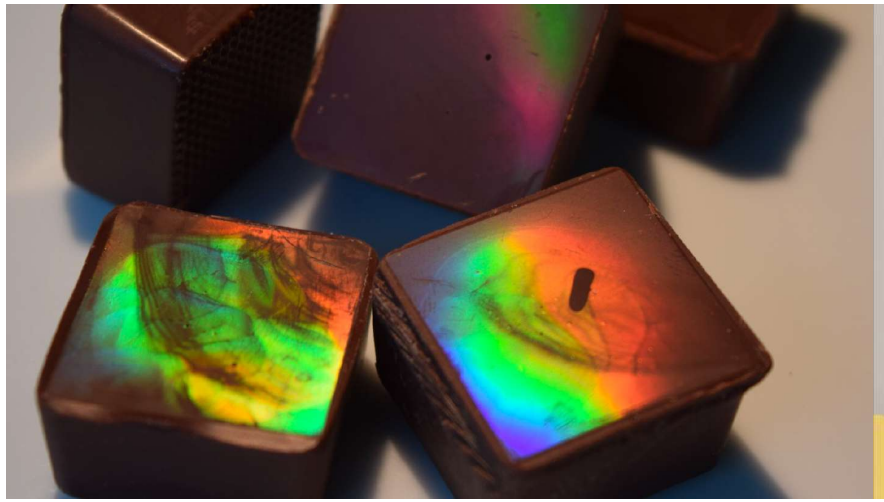
Ultra-shiny chocolate

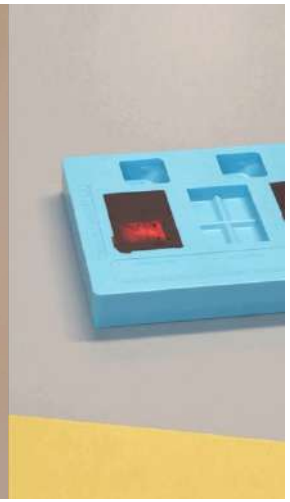
We love Chocolate!

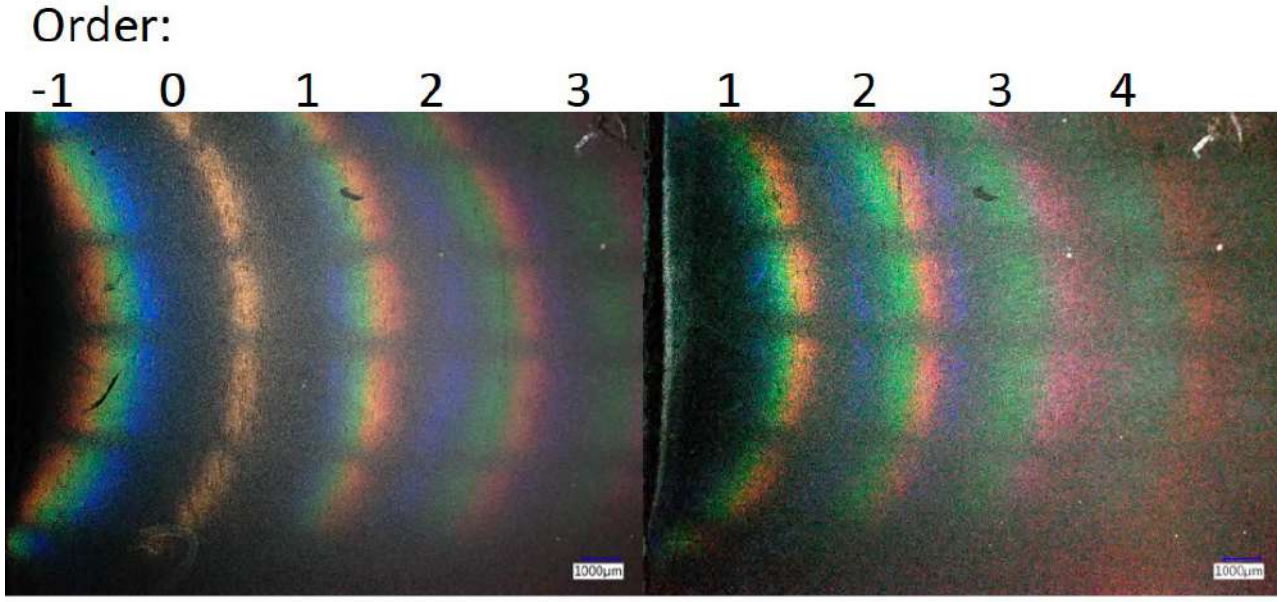
We love Butterflies!

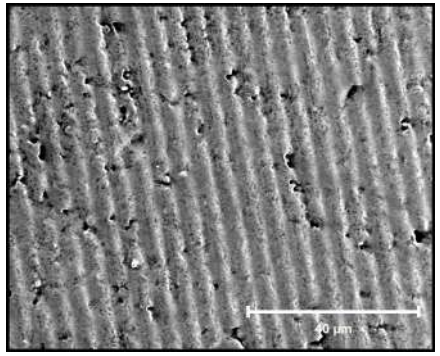


Ultra-shiny chocolate

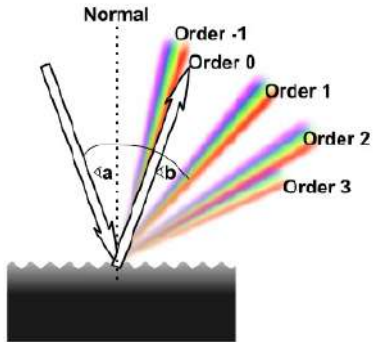








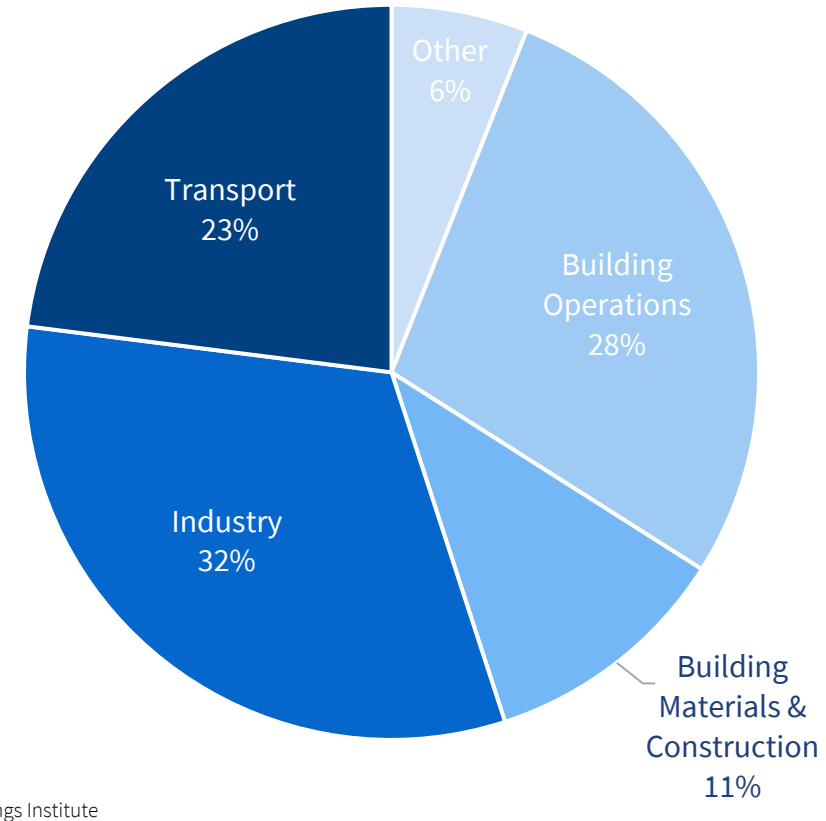
-14°



-22°

Problem: Building Environmental Impact

Global GHG emissions



New Buildings Institute

36%

World greenhouse gases emissions

40%

World energy consumption

Problem: Building Environmental Impact

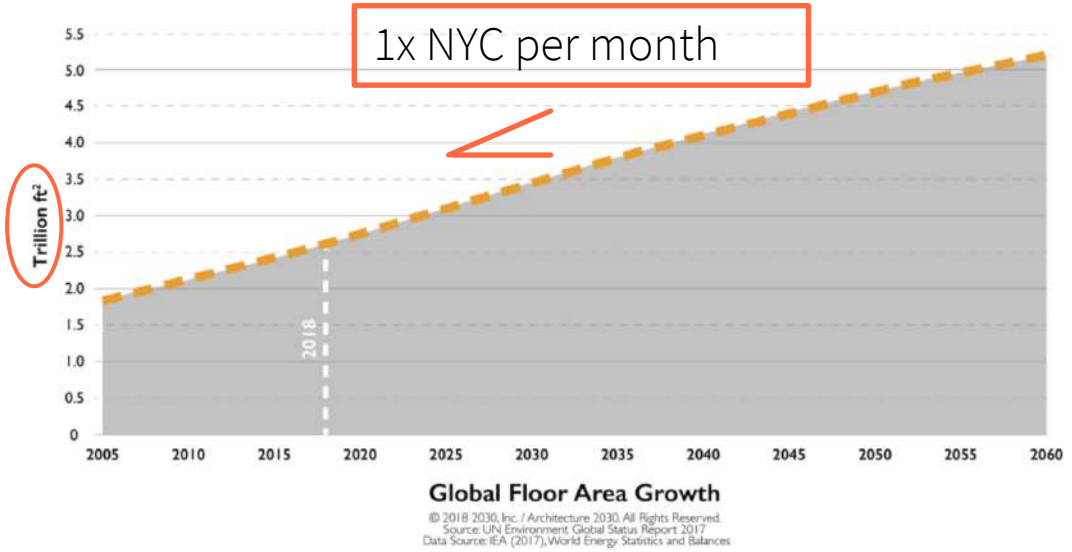
Population

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

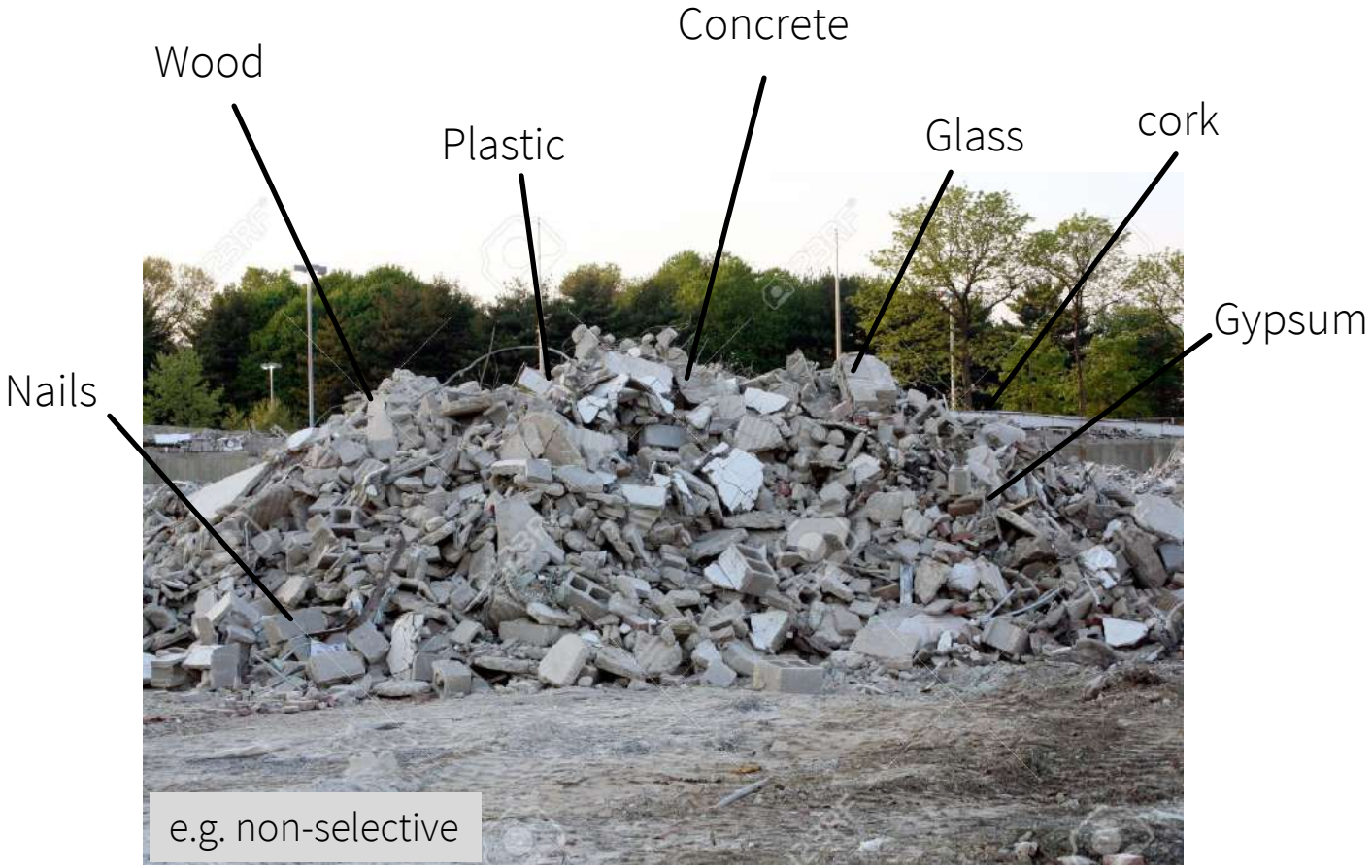
MAXXI, Rome

Assembly

Disassembly

Dismantling

Buildings are patchy composites



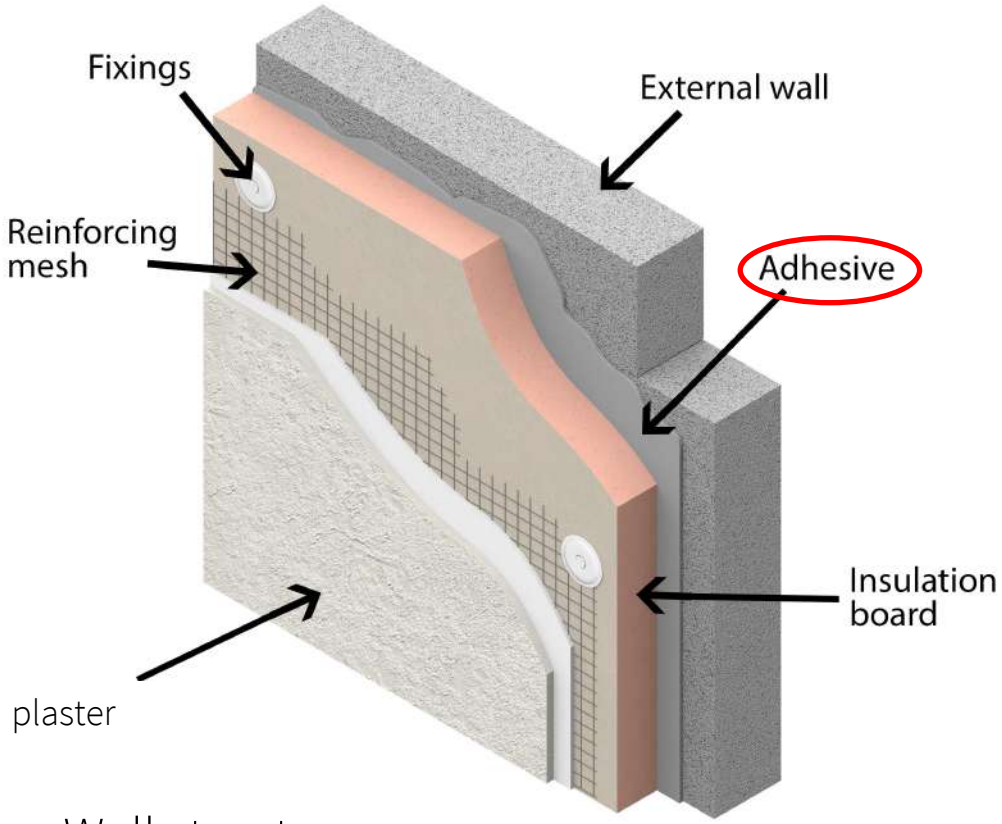
Selective vs non-selective

1.5%

The current share of insulation materials recycled in Switzerland*

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

Dismantling



Wall structure

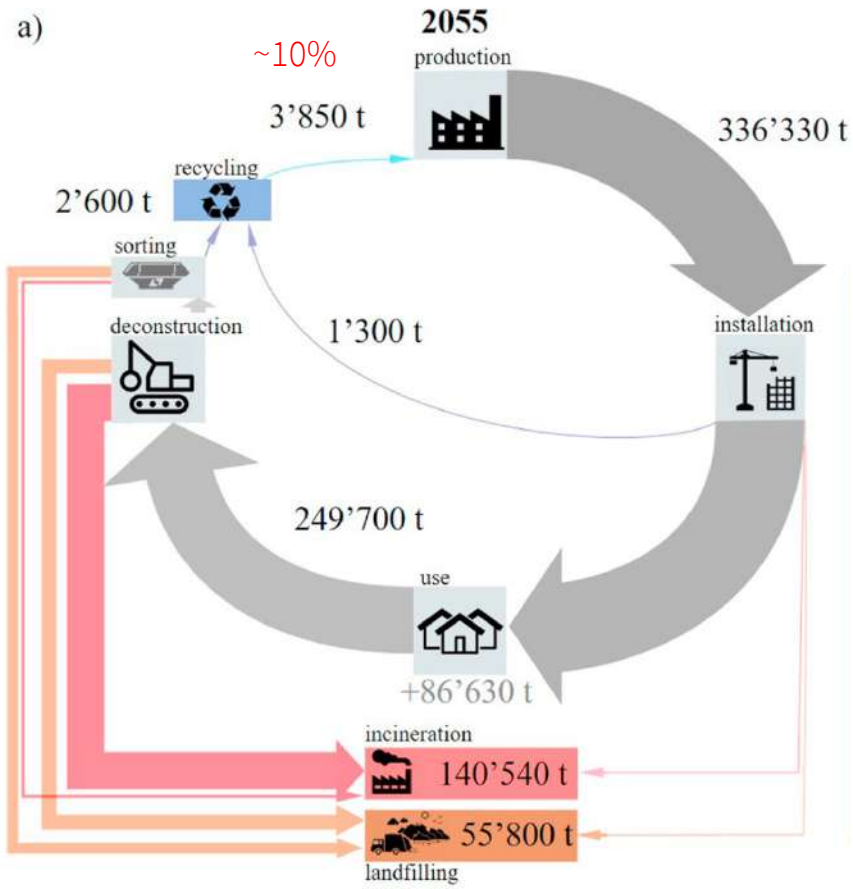
Problems

Lack of reversed logistics

Contaminations
(e.g. bituminous glues, HBCD)

Strategy for impact reduction

Baseline



Screwing vs gluing

Selective deconstruction

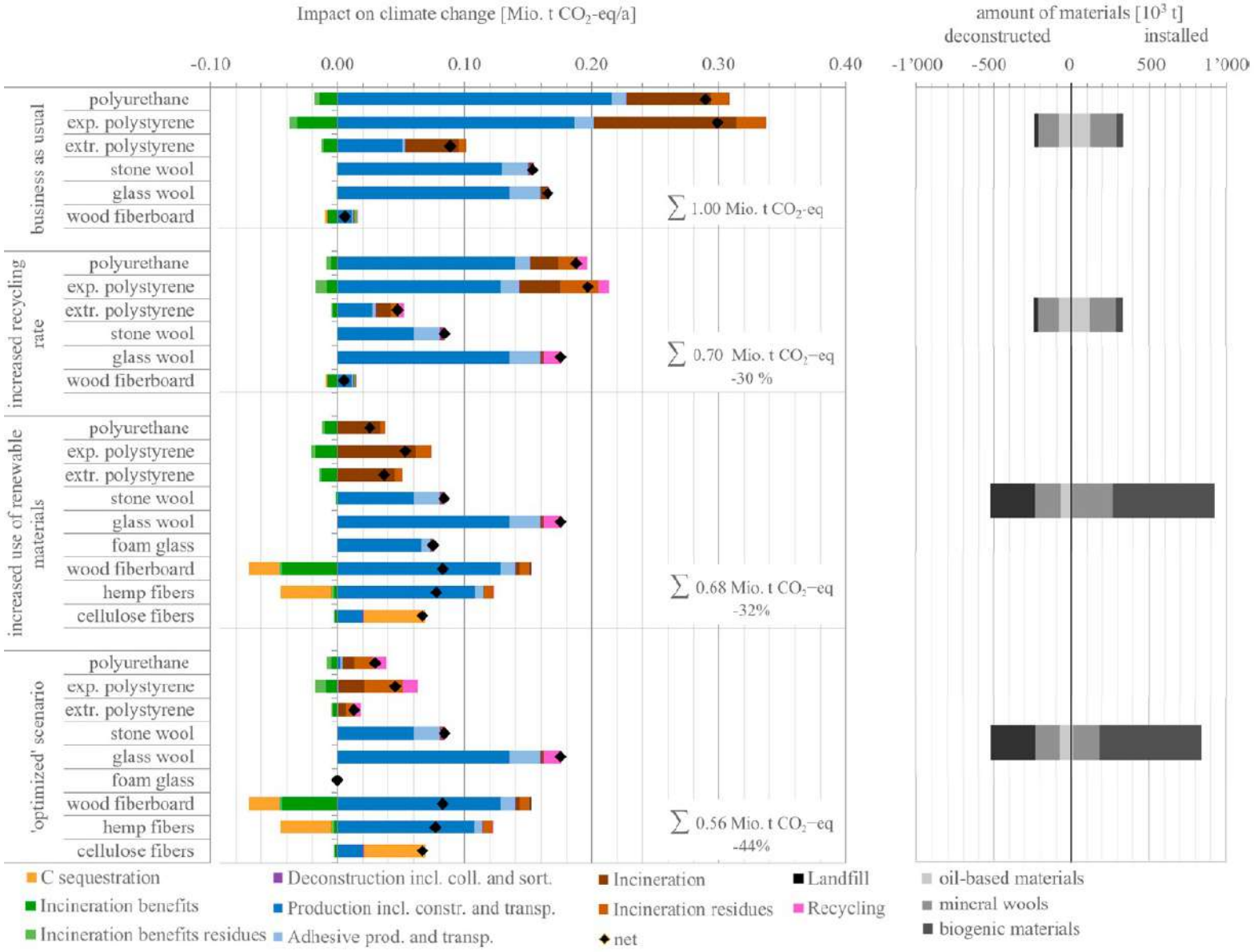
Wiprächtiger et al., Resources, conservation & recycling, 2020

Baseline

A

B

A + B



CH based numbers

Wiprächtiger et al., Resources, conservation & recycling, 2020

How can Construction become more sustainable?

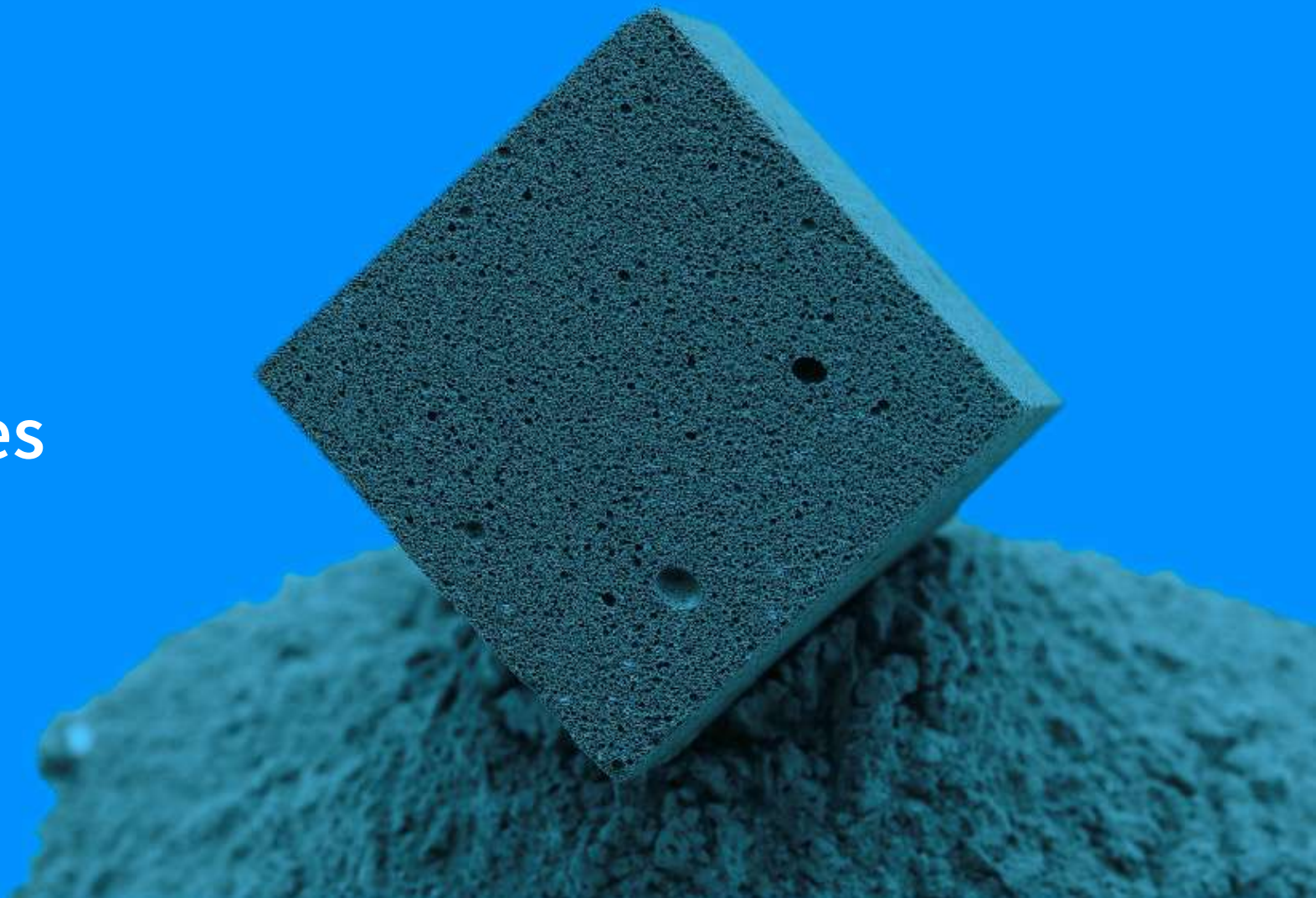
- Recycling in Construction is too costly (logistics + contamination between materials)
- Increasing recycling rates + use low-carbon materials could reduce Swiss CO_2 emissions by 44% by 2050

- New construction materials must be low-carbon + ”easy-to-recycle”

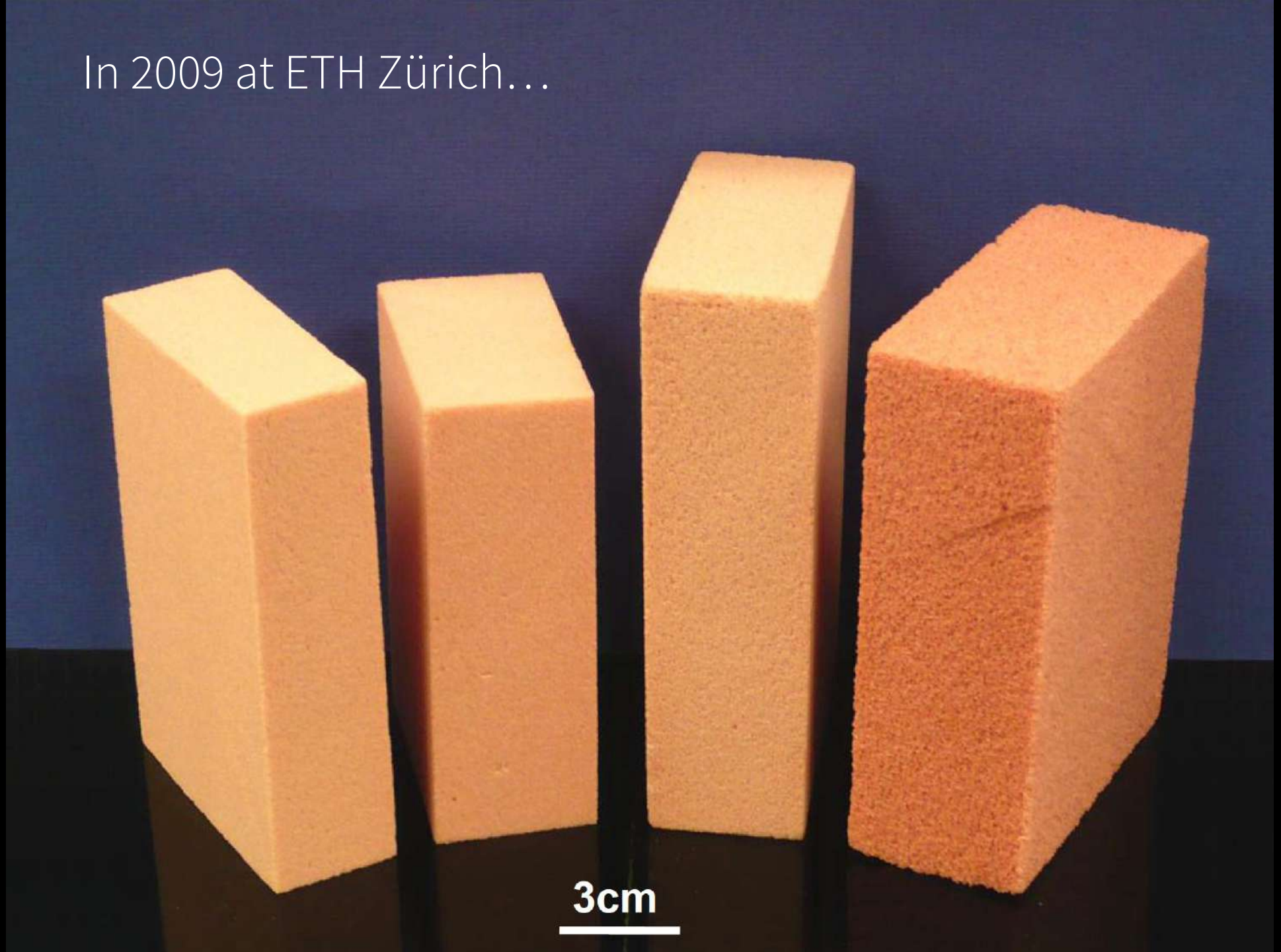
Spinoff
ETH zürich

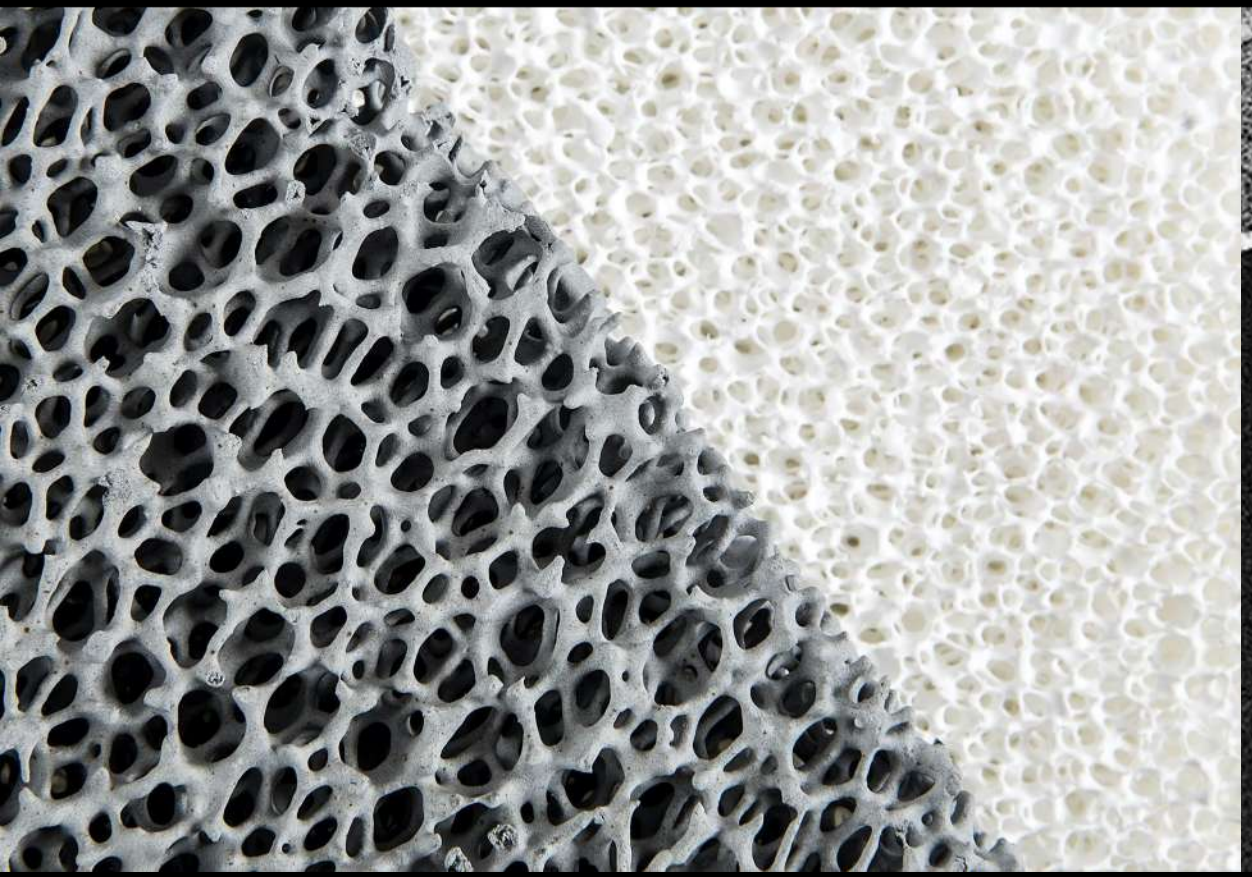
FenX

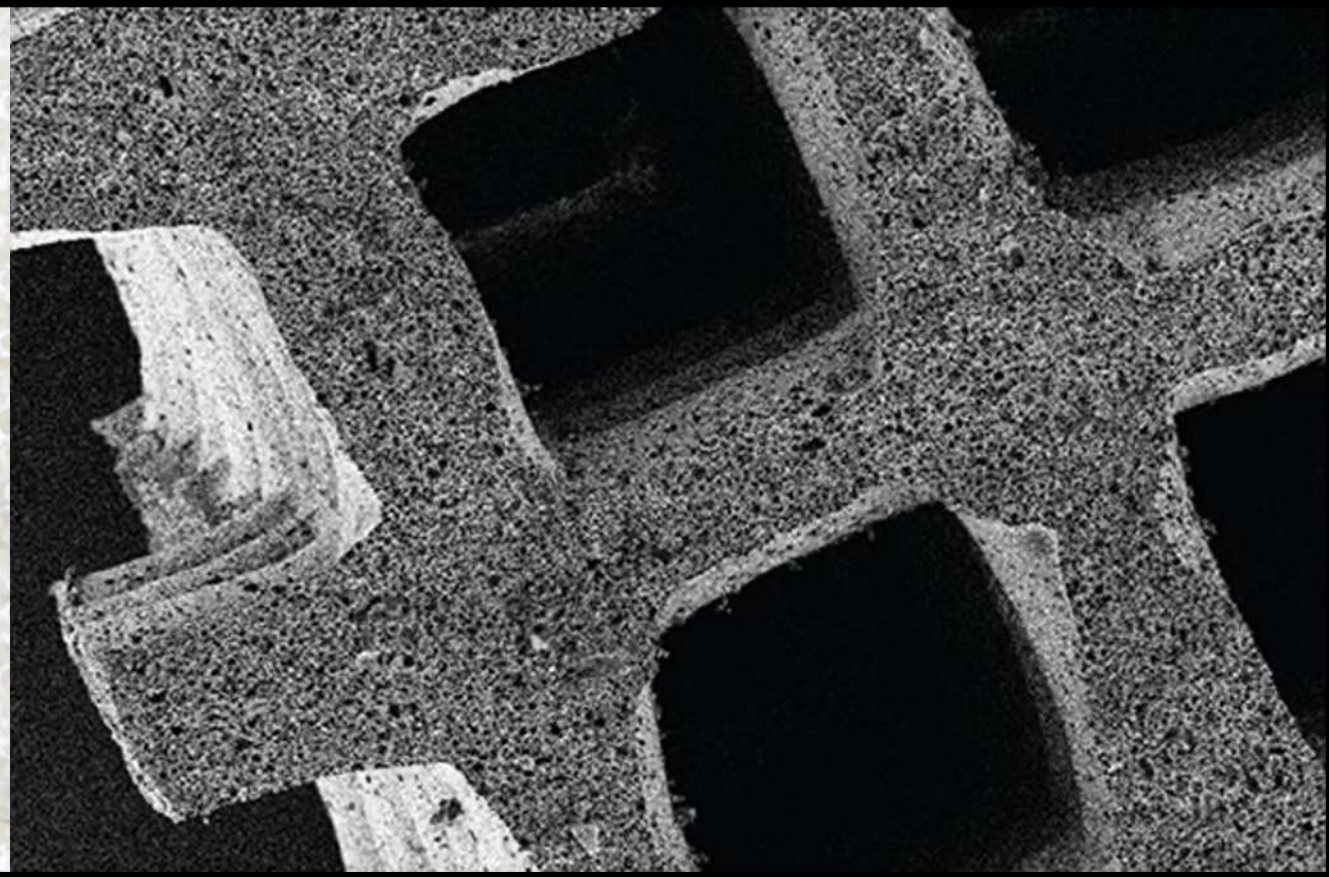
Insulation
Reborn from Ashes



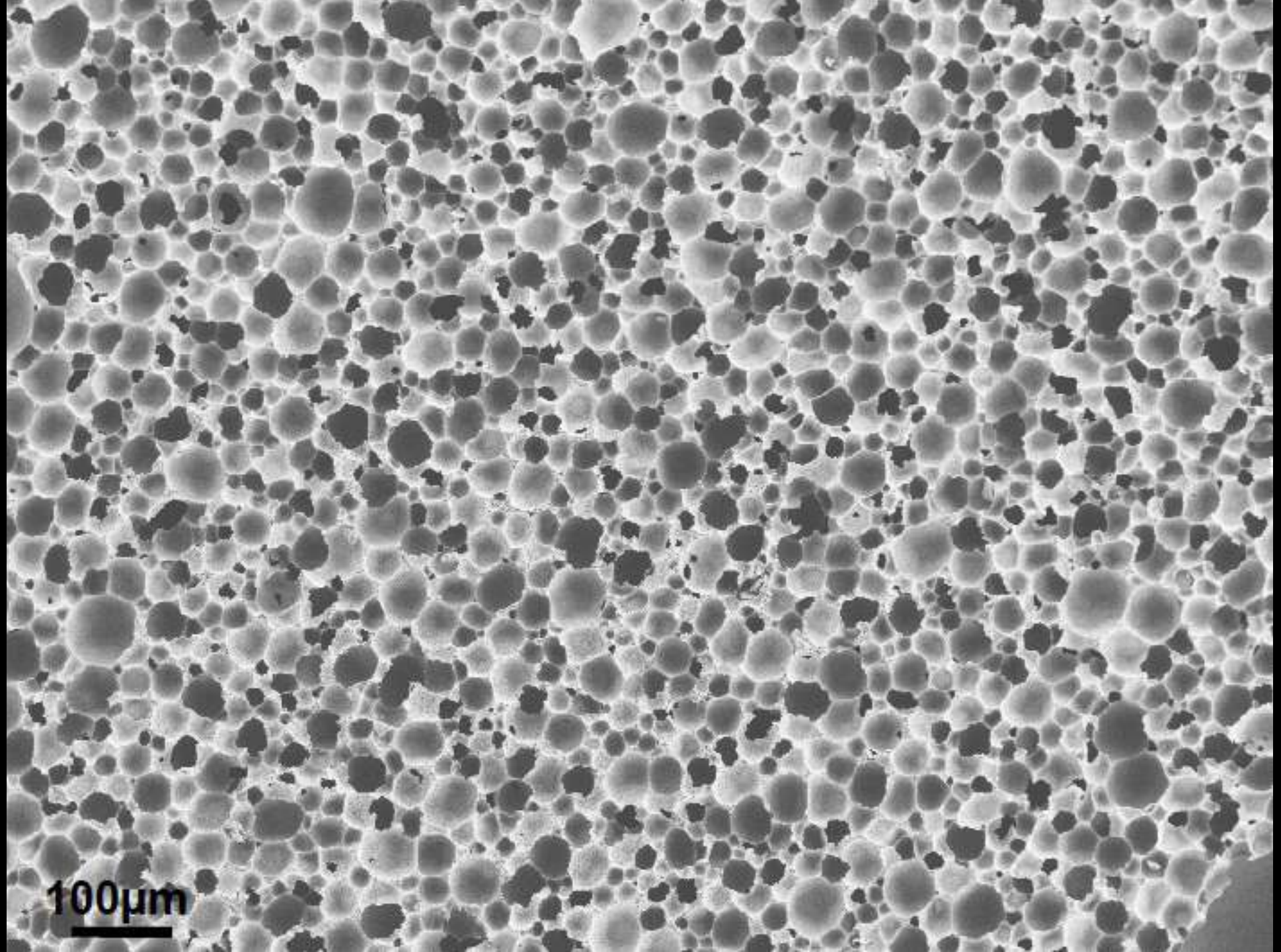
In 2009 at ETH Zürich…

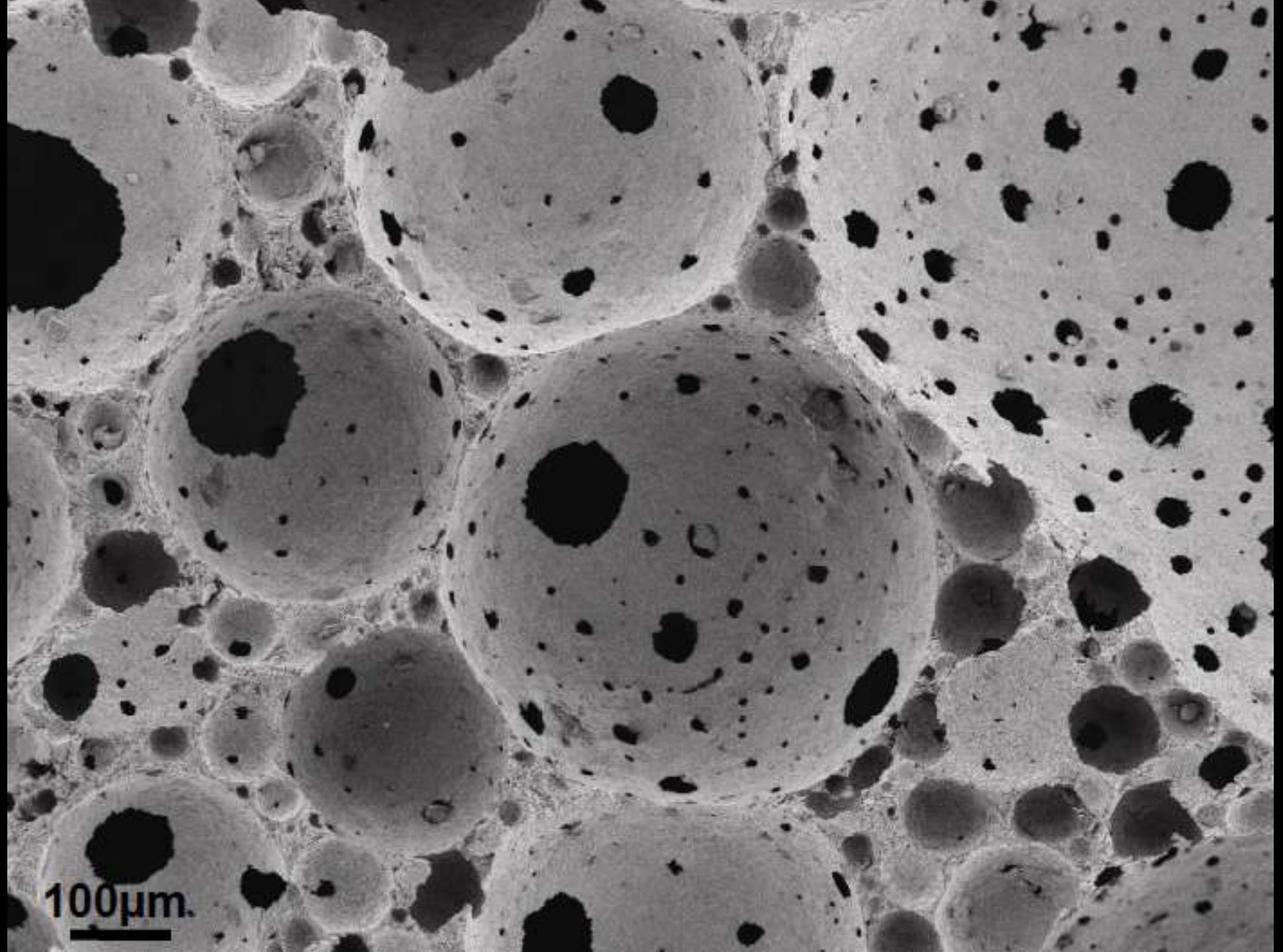


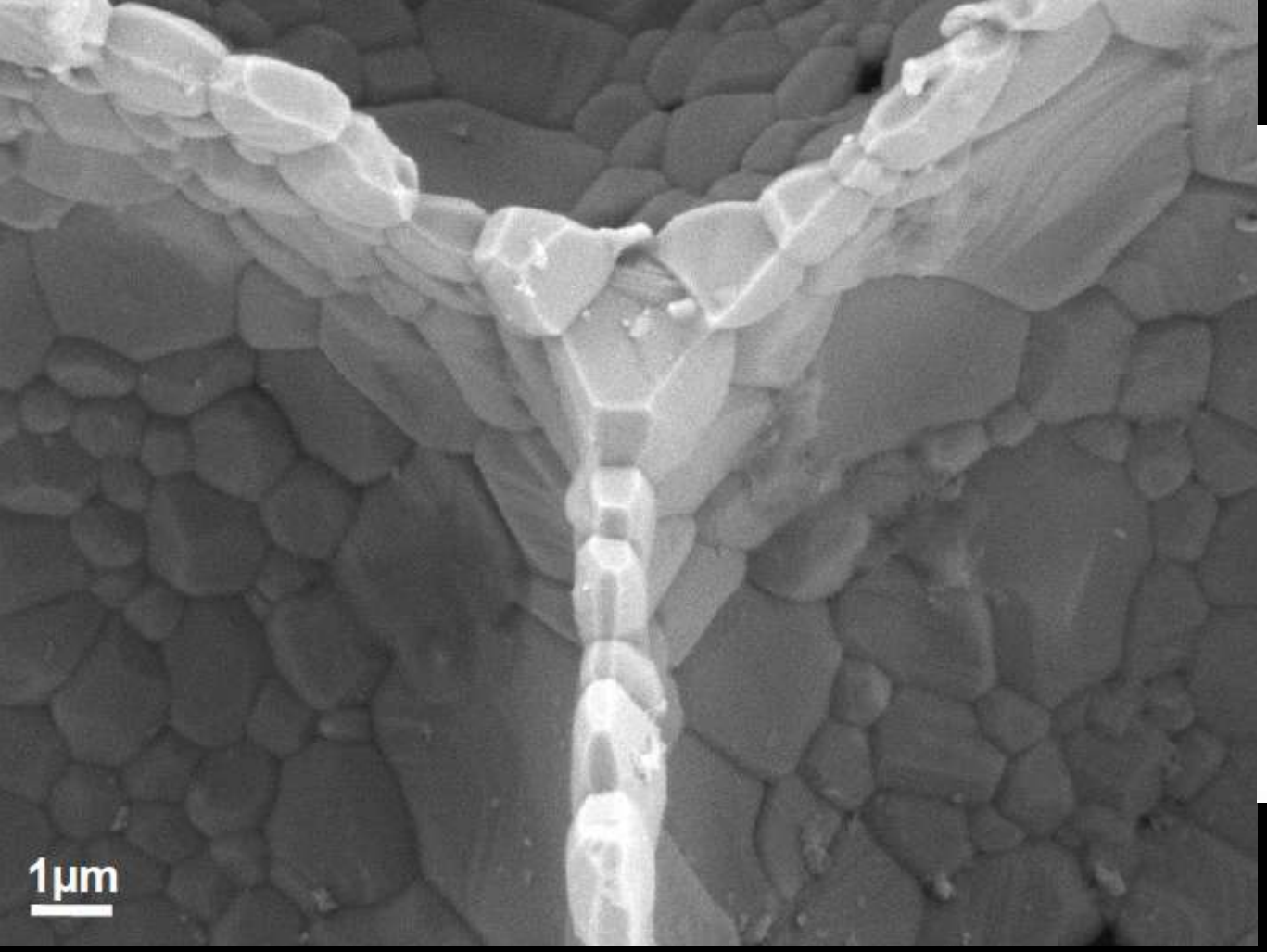




Development of ultra-light ceramic foams


100µm


100µm.



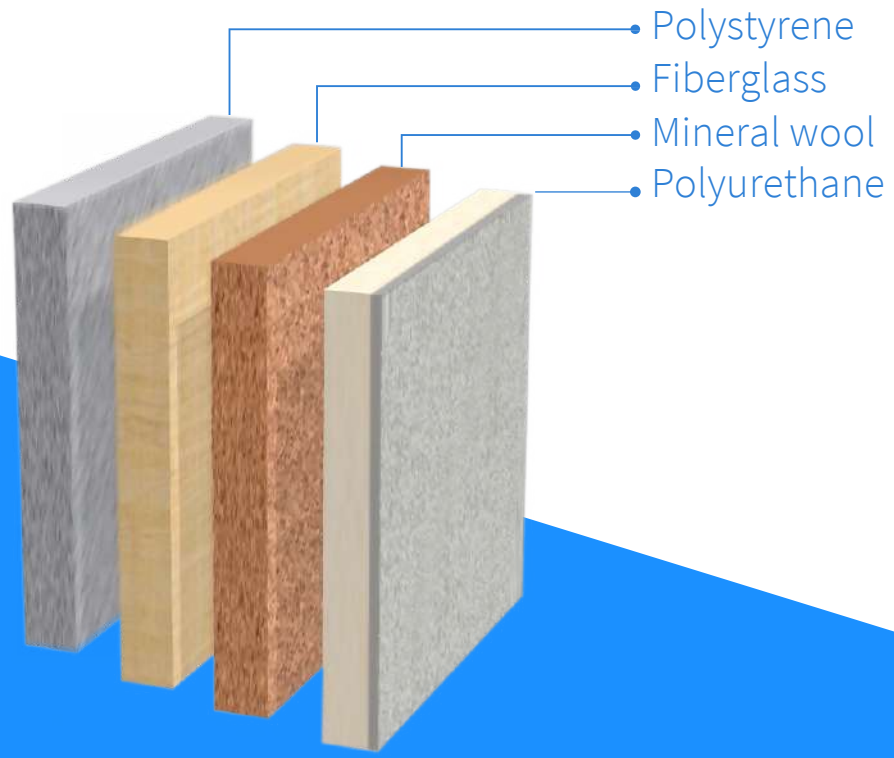
Applications

- 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)

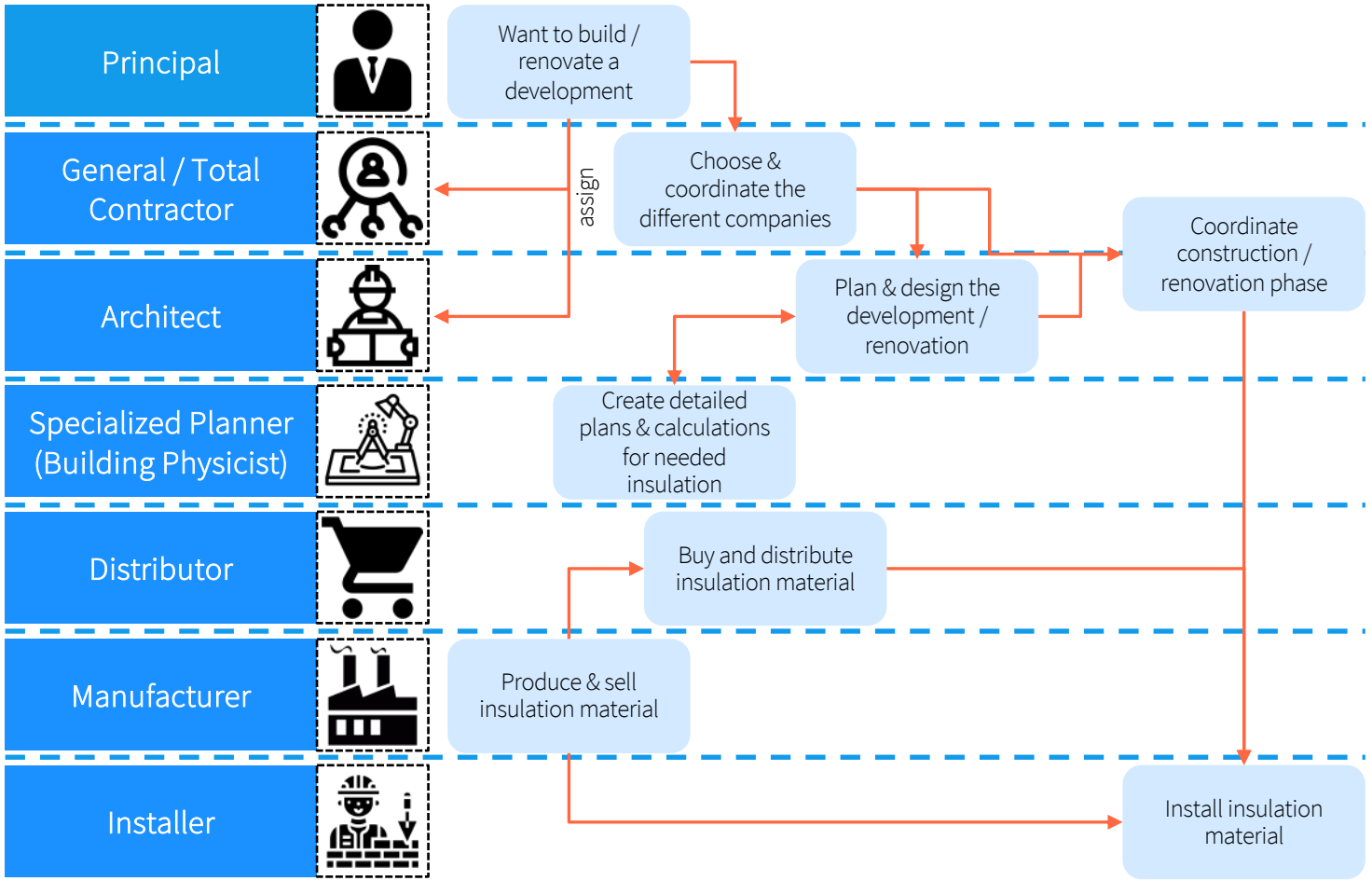
Swiss building

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

Patent pending

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

- Very low carbon footprint
- Nonflammable (A1/RF1 certified)
- Remarkable insulation
- Very light
- Priced competitively
- Fully and easily recyclable

Today, recycling possible with 10 different waste

Examples

- Excavated materials
- Rice husk ash
- Metal slags
- Coal fly ash
- Construction& Demolition Waste

Business Model