



## Workshop on Architecture Engineering Construction with Member States representatives

On 27 September 2022, [Franc Mouwen](#), the EIC Programme Manager (PM) for Architecture Engineering Construction (AEC), presented past, current and potential future EIC challenges under his umbrella to invited representatives from European Union Member States and Associated Countries. The virtual workshop was moderated by Keith Sequeira who opened the discussion by explaining the role of Programme Managers as EIC's in-house experts. The PMs work in their respective area of specialisation and support the European R&D&I ecosystem. The differences between the challenges prepared by the Programme Managers and the open calls were explained. Open calls represent the majority of the EIC funding. EIC Programme Managers design challenges around topics that the EIC considers strategic for Europe. Challenges are part of the work programme and described as part of Pathfinder, Transition and Accelerator calls.

Franc Mouwen started his presentation quoting President Von der Leyen from her opening speech of the European Innovation Council in 2021: "We, Europeans, face a paradox. We are excellent in making science with money. But we are not so good in making money out of science. The EIC is here to resolve this paradox". Also, PM Mouwen pointed out that even though AEC is one of the largest economic sectors in Europe and faces multiple major wicked problems, the sector also traditionally receives little scientific attention and (deep-tech) investments. PM Mouwen then gave an overview of the AEC sector and several key pathways for innovation towards the future using the metaphor of a metro map.

Decarbonisation and stagnant productivity is one of the largest challenges of the construction sector in Europe. Even though good progress is made in the area of reducing operational carbon emissions during the operational life of buildings with topics such as heating, ventilation, air conditioning, double glazing and insulation, reducing embedded carbon emissions (emitted during the fabrication of materials and buildings) remains hugely problematic.

Therefore, reduction of embedded carbon is in one of the main aims related to the 2023 draft challenge: "*Triad of computational design, digital fabrication and materials*". Two ideas for future challenges addressing reduction of embedded carbon were also discussed with the participants: "*Low and carbon negative materials (timber, 0-cement, bio)*" and "*The role of deep-tech in renovation, disassembly, re-use and recycling pathways*". This was followed by possible future challenges related to the reduction of operational carbon "*HVAC, insulation, glazing, integrated solar PV*" and "*SMART buildings, digitization*".

In the second part of his presentation, PM Mouwen introduced the “New European Bauhaus” as an important “heart and soul of the European Green Deal”. The New European Bauhaus puts the user at centre stage which is critical from an entrepreneurial perspective. PM Mouwen offered the thought that in the context of New European Bauhaus a challenge around “*Deep-tech for the experiential dimension of the future build environment*” has lots of potential.

PM Mouwen also asked the participants what could be the role of deep-tech and EIC in the important “European Renovation Wave”. This led to rich comments and discussion, and confirmed the importance to embrace this topic in future.

As a final remark, there was a fruitful discussion on the topic proposed by the Programme Manager on “Barriers for AEC innovation” regarding regulation, codes, standards, certifications, culture, complexity and time horizon, including the IP topic introduced as a question by a delegate.

The discussions on the different topics was enriched with questions and comments that not only expressed the current concerns on how to decrease the carbon emissions or gaining supply chain efficiencies and productivity gains, but also searching for new business models. Topics such as offsite modular and pre-fab construction were mentioned as well as a focus on renovation rather than new construction.

For any question to Programme Manager Franc Mouwen and past, current and future challenges, please reach out to [EISMEA-D.02@ec.europa.eu](mailto:EISMEA-D.02@ec.europa.eu).



# Backing visionary entrepreneurs

## The European Innovation Council

Meeting with Member States 27.09.2022

## Candidate topics for EIC Challenges in Architecture Engineering Construction

Franc Mouwen

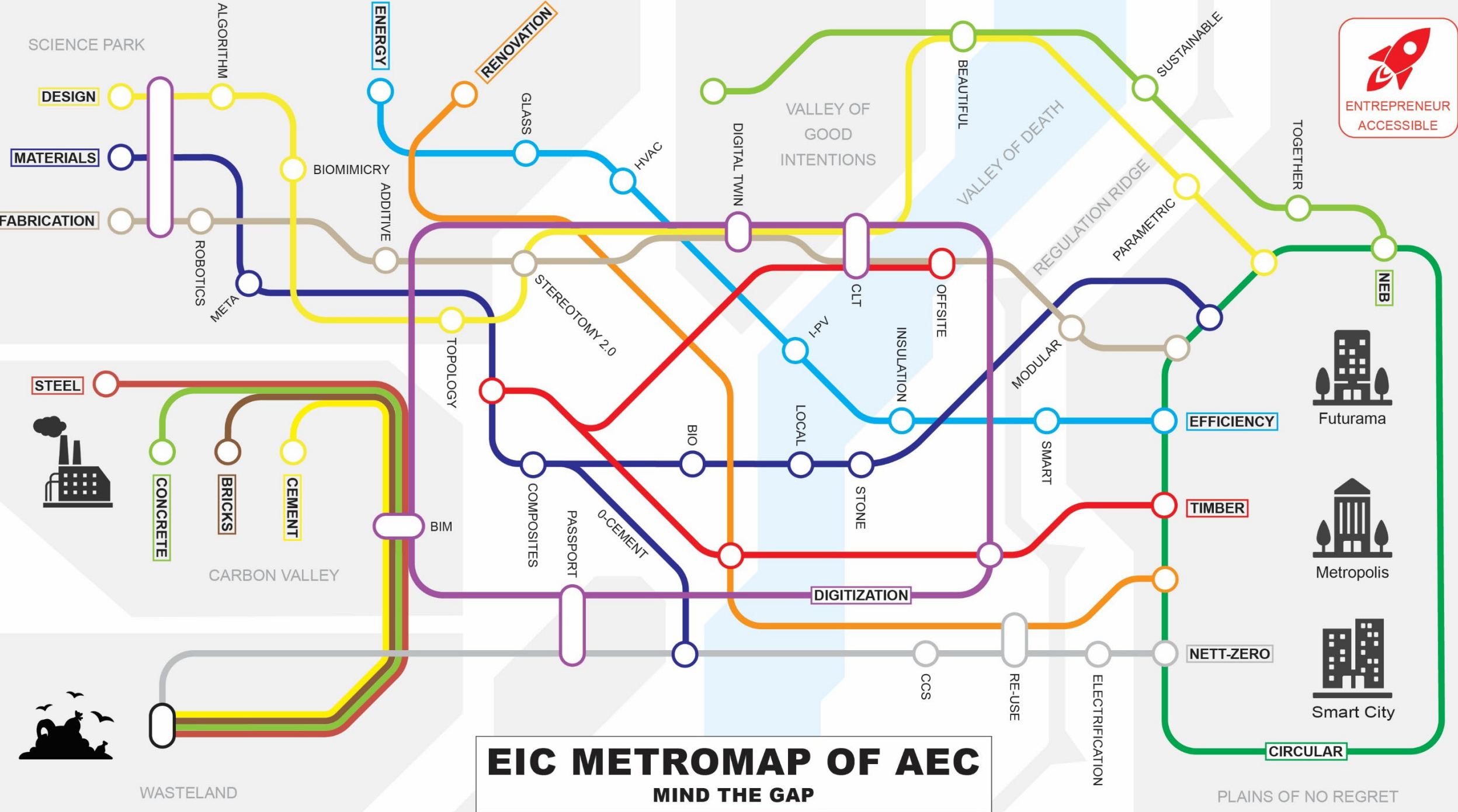
DISCLAIMER: The view expressed in this presentation is the sole responsibility of the Programme Manager and does not necessarily reflect the views of the European Commission



**Ursula von der Leyen**  
*President of the European Commission*

“... And we all know, Europe is a powerhouse in science. Our new Horizon research programme is the largest ever. But we also face a big paradox: We, Europeans, are excellent in making science with money. But we are not so good in making money out of science. And the new European Innovation Council is there to help resolve this paradox.” (18/03/2021)





# Green Deal: reduction of embedded carbon

# The EU faces a monumental task to decarbonize and modernize the construction sector within 30 years

- The EU committed to net-zero by 2050 by law
- Emissions of the construction sector are estimated at 5-12% of EU's total
- Also, the construction sector accounts for 50% of EU extracted material ...
- ... and construction and demolition waste accounts for over 35% of EU's waste

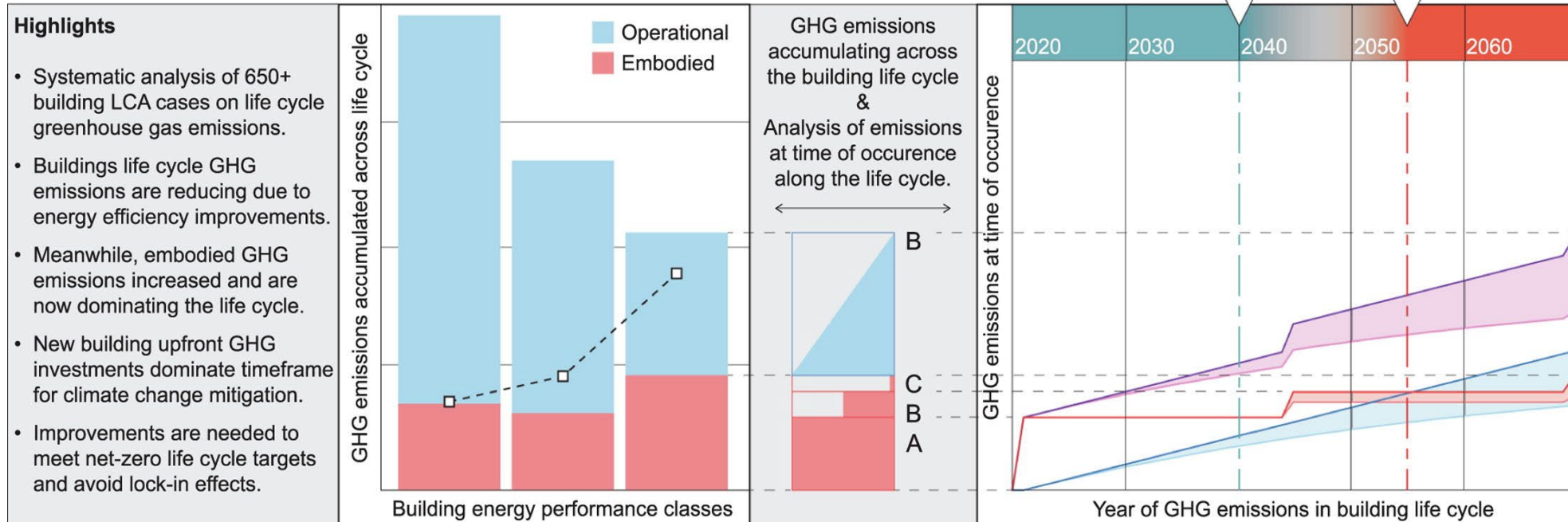
**Global context:** the world will add the equivalent of 1 New York City, per month, for the next 40 years:



# Fossil fuels ugly fossil sister is embodied in our buildings and a climate change mitigation challenge

## Embodied GHG emissions of buildings - the hidden challenge for effective climate change mitigation.

M. Röck et al., Applied Energy, 2019.



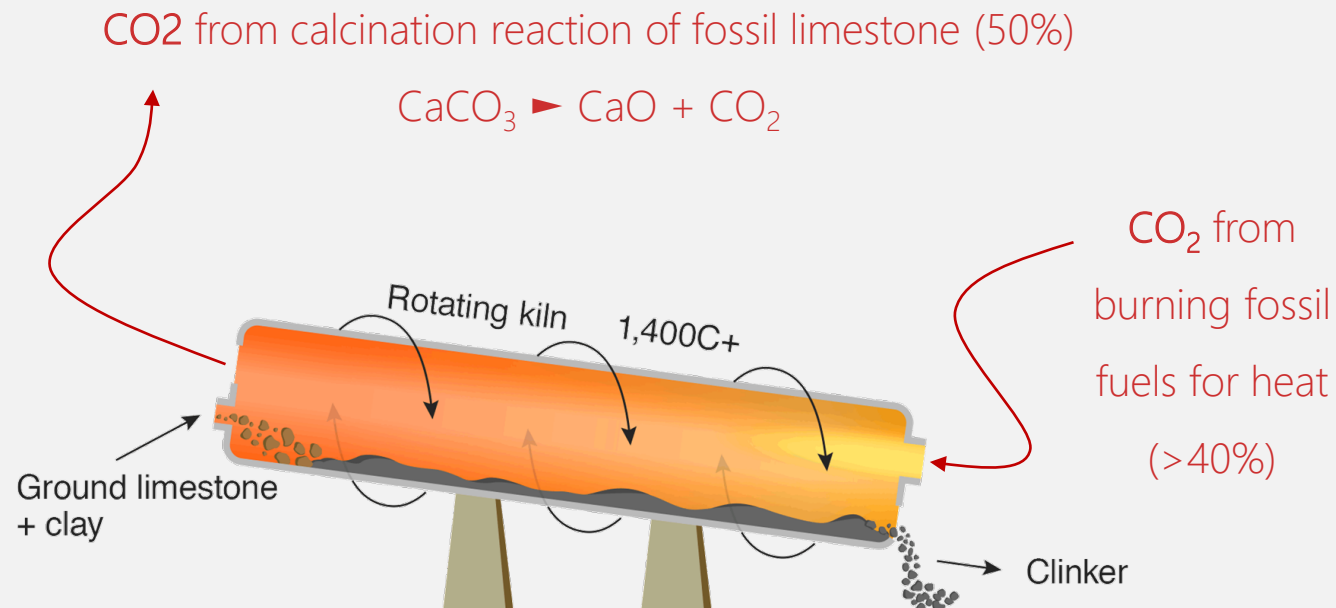


Problems to be solved: emissions from cement and steel and waste from demolished buildings, formwork



# The calcination of limestone at high temperatures is the major source of embodied carbon emissions

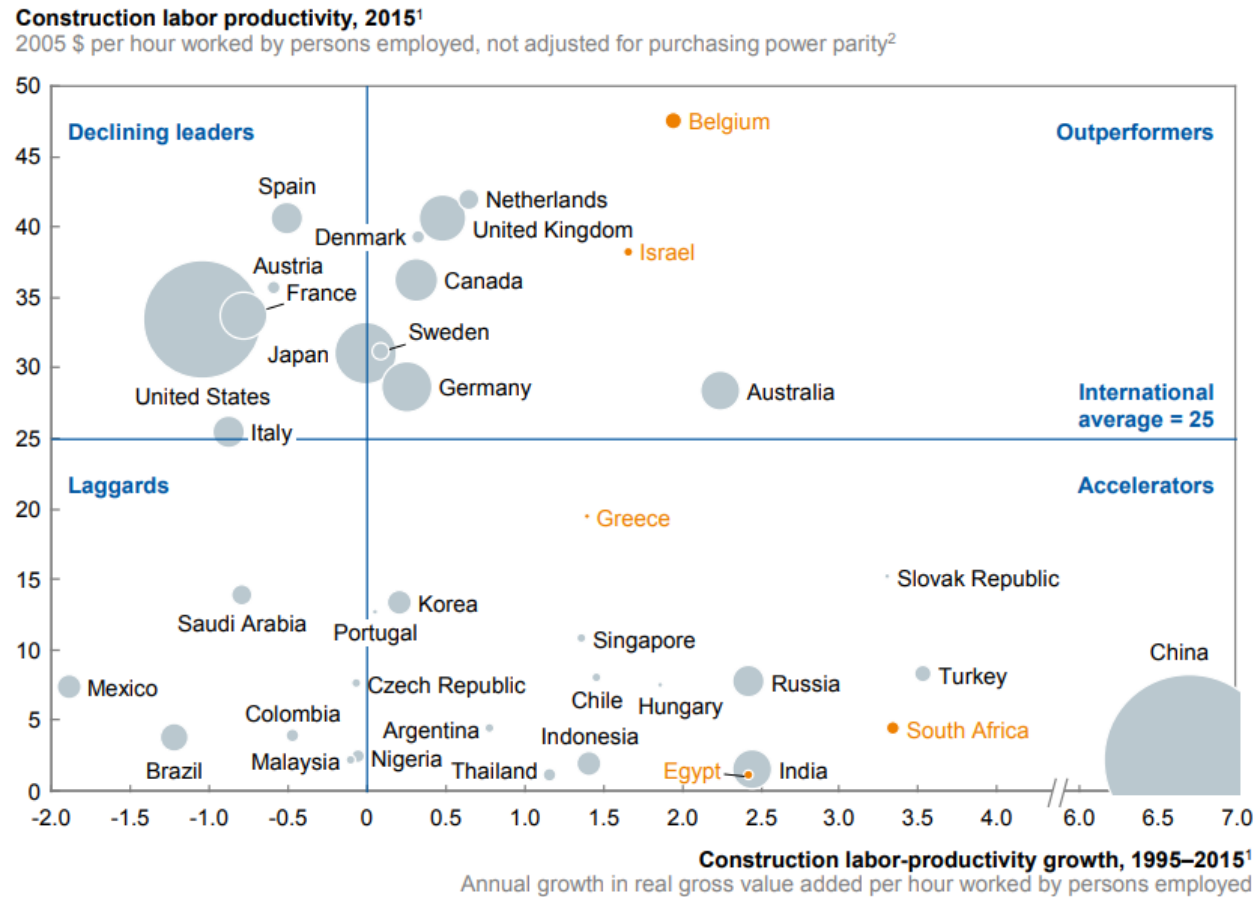
## The Problem



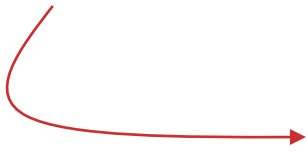
## Solutions

- Use alternatives to cement
- Use less materials, cement
- Bury the CO<sub>2</sub> (CCS)
- Upgrade to electric kilns
- Re-use materials

# Contrasting all other sectors, the construction sector faces lagging productivity, e/g due to low digitization



The absolute value of productivity



Increase or decrease of productivity over a period of 10 years



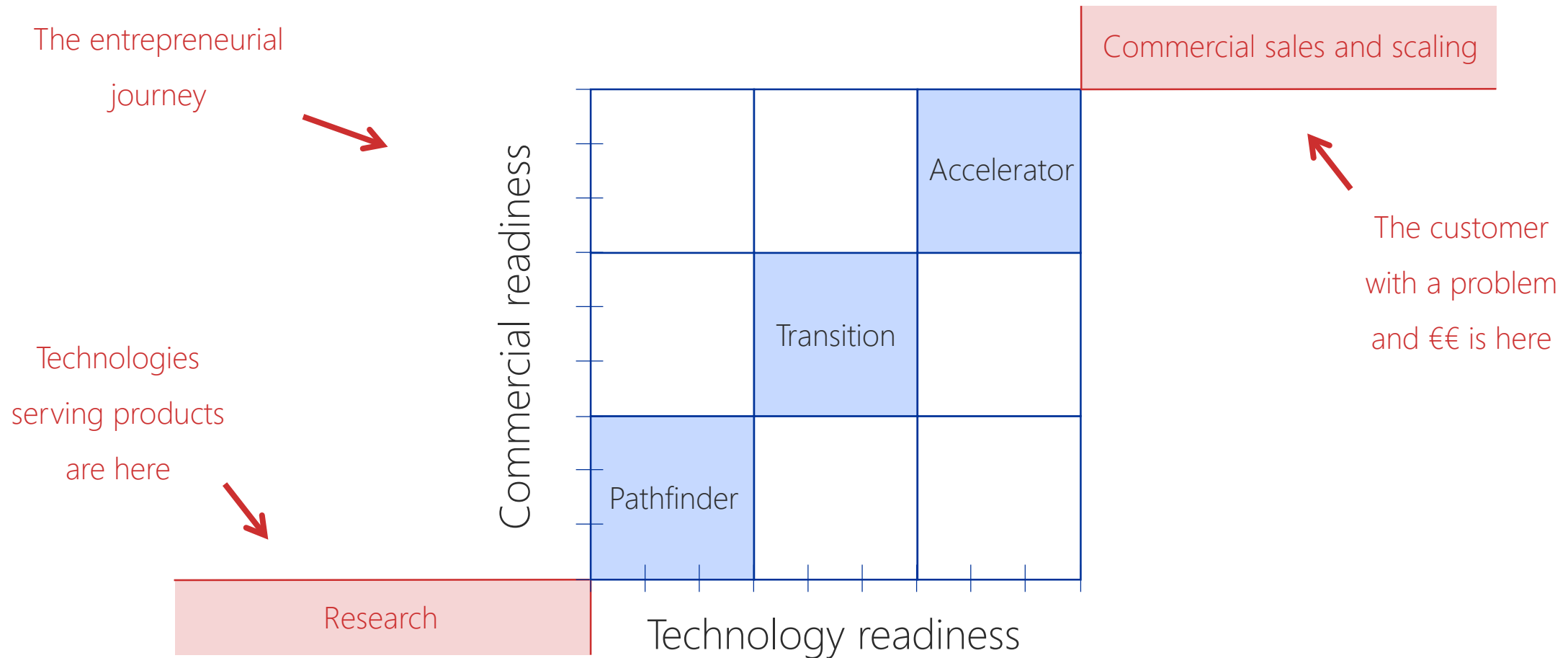
Source: McKinsey Global Institute, Reinventing construction: a route to higher productivity, 2017

Green Deal:  
reduction of embedded carbon

# Triad of computational design, digital fabrication and materials (2023 Challenges)

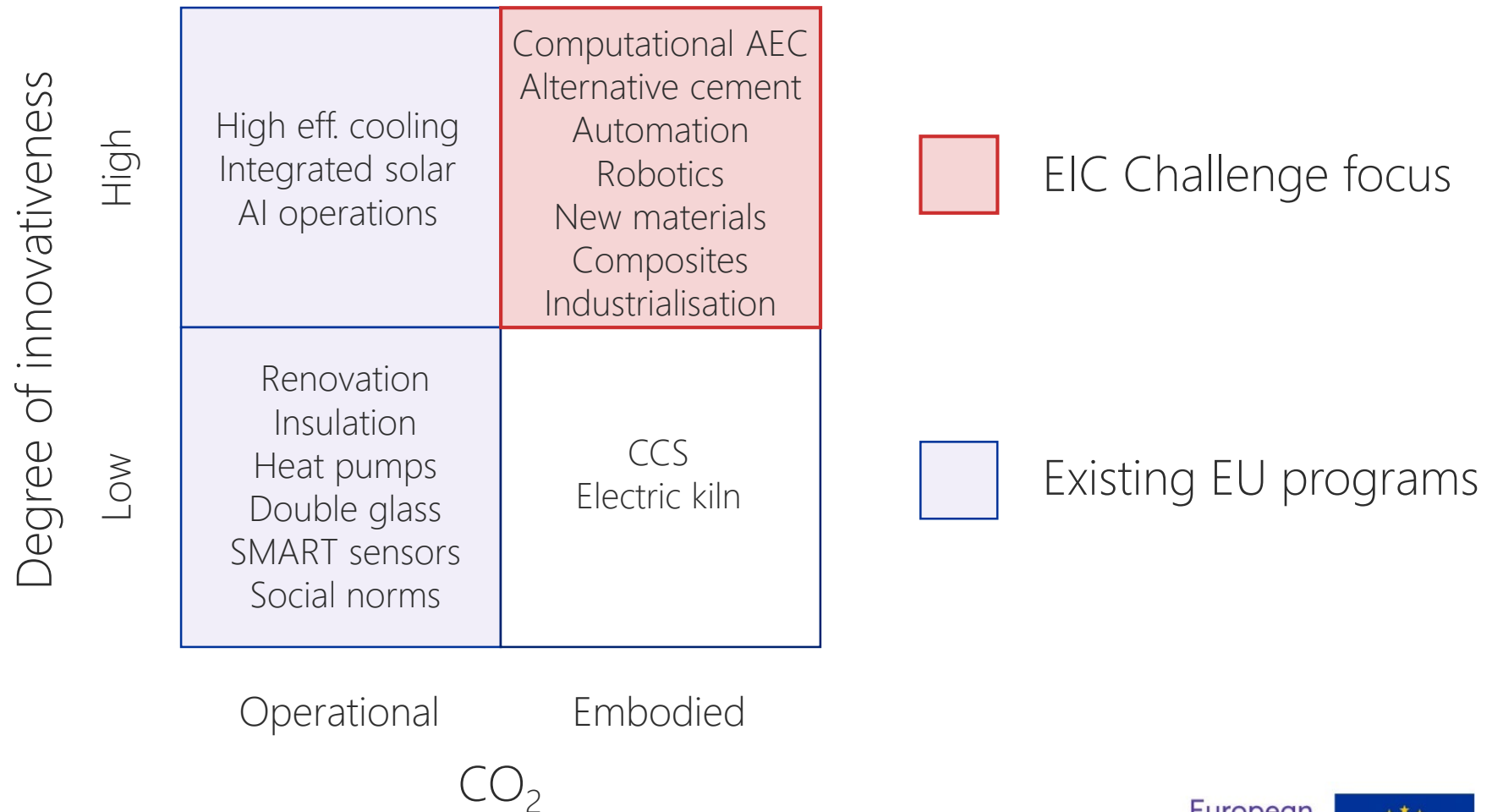


# Mind the gap: the type of challenges match the TRL and CRL of pathfinder, transition and accelerator.



# The EIC “AEC Challenges” aim to attack 2 problems: reducing embodied emissions, increasing productivity

The EIC Mission  
is to support  
deep-tech  
entrepreneurs

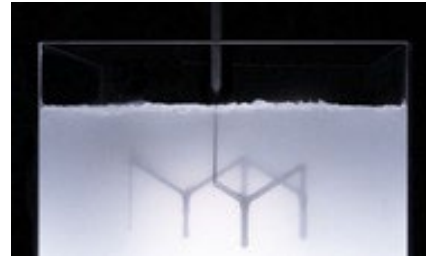


# The "EIC AEC Challenges" are rooted in European RTD across the value chain with commercial potential

Densified wood + composites



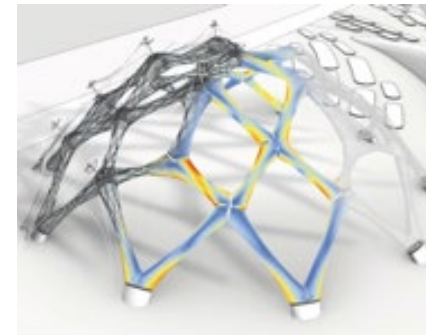
Suspended rapid concrete printing



Topology optimized concrete slab



Light weight AI computation



Segmented robotic CLT construction



Digital stereotomy local stone



Robotic fibre production



Moulded wood



Curved CLT timber



Biomimicry



Flexible robotic production



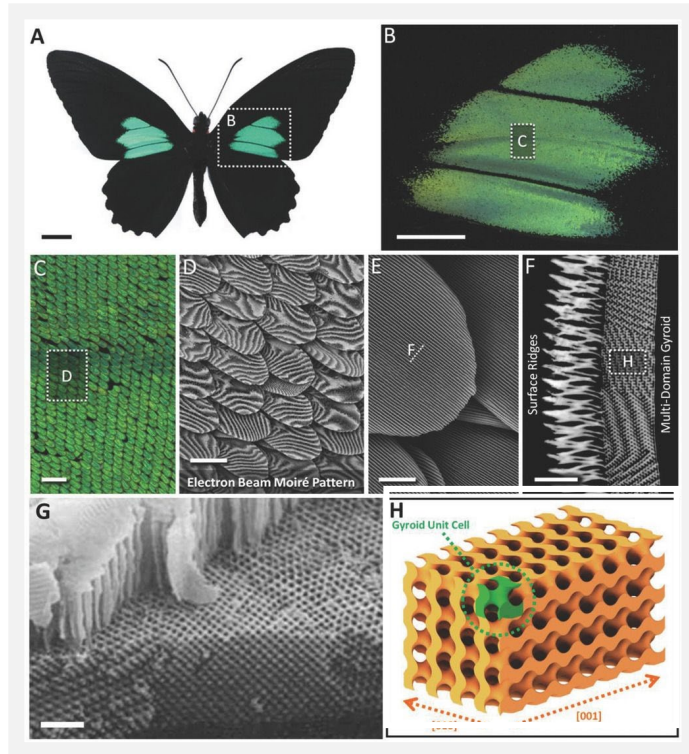
3D thin shell fabric - no formwork



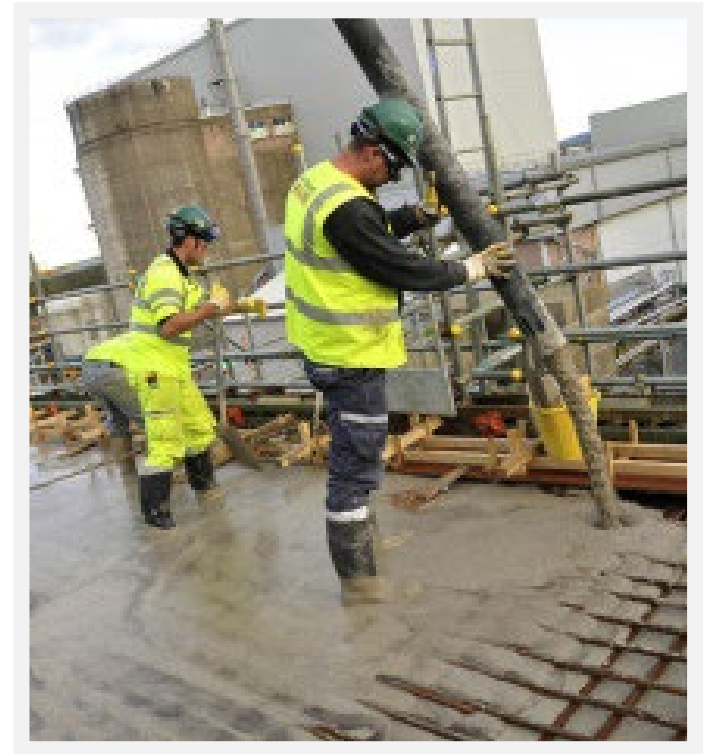
# Nature uses few materials in endless complex ways; humans many materials in simplistic, wasteful ways

Gyroids at nanoscale in butterfly wing

In-situ concrete pouring and formwork



Paradigm





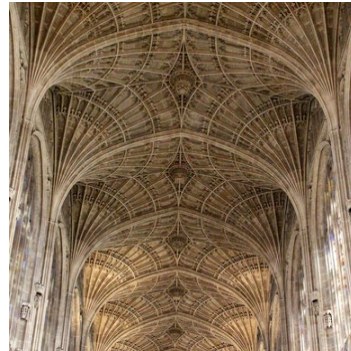
# Rooted in EU legacy, computational digital AEC\* offer pathways to use less and alternative materials

Once ...



Unreinforced  
concrete  
3D

Then ...



Stone  
stereotomy  
3D

Then ...



In-situ reinforced  
concrete  
2D+

... our logical digital future?



Computational design  
Digital meta-concrete  
3D+

\* AEC: Architecture Engineering Construction

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Disclaimer: This document presents draft ideas of the EIC work programme 2023. This draft has not been adopted or endorsed by the European Commission and may not in any circumstances be regarded as stating an official position of the Commission.

# AEC Challenges: deep chain digitalization to cut CO<sub>2</sub>, push productivity, drive experience and sustainability

Digital workflow of: Design ▷ Engineering ▷ Fabrication ▷ Assembly ▷ Operation ▷ Re-use

Challenge

## Under discussion

Scope

This Challenge aims to attract cutting-edge science and technologies that contribute to a deep digitization of the AEC value chain:

- **Computational design** scientific advances and new technologies that ultimately enable mass-adoption of parametric, generative and algorithmic design and physical simulation. The ultimate complexity of algorithmically designed objects may well approach the complexity of nature itself: biomimicry.
- **Alternative materials** enabled by computation, i.e. engineered, bio-, locally sourced, recycled, regenerative and meta-materials and alternatives to cement.
- **Digital fabrication** (3D print), industrialized manufacturing, assembly robotics.

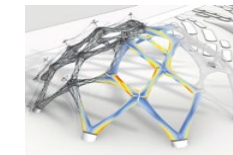
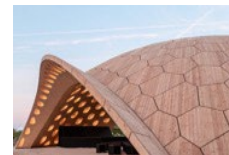
Objectives and impact

Objective is to transform the AEC sector into a **productive**, digitally enabled, **climate neutral sector**. Impacts include delivery of sustainable, inclusive and high quality building products in line with the **New European Bauhaus mission**.

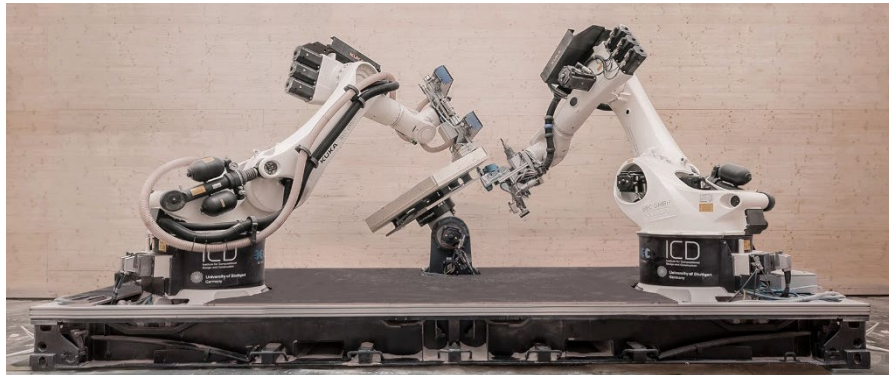
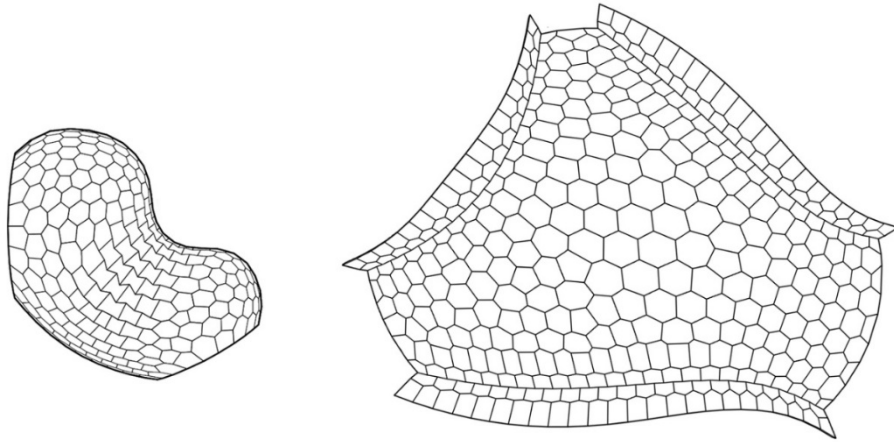
Rationale

Horizon Europe's Strategic Plan 2021-2024: "Making Europe the first **digitally enabled**, circular, **climate neutral** and **sustainable** economy through the **transformation** of its mobility, energy, **construction** and **production** systems."

Mood board



# “Buga Pavilion” is an example of generative design, robotic CLT\* fabrication, assembly and digital chain



\* CLT: Cross Laminated Timber

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“ We know that the construction sector can even be turned from a carbon source into a sink, if organic building materials like wood and smart technologies like AI are applied.

**Ursula von der Leyen**

President of the European Commission  
State of the Union address, 9 Sep 2021



In the mean  
time ...

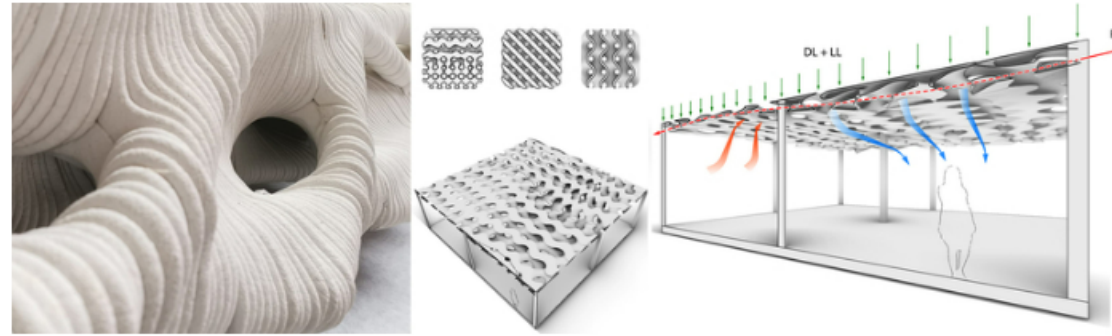
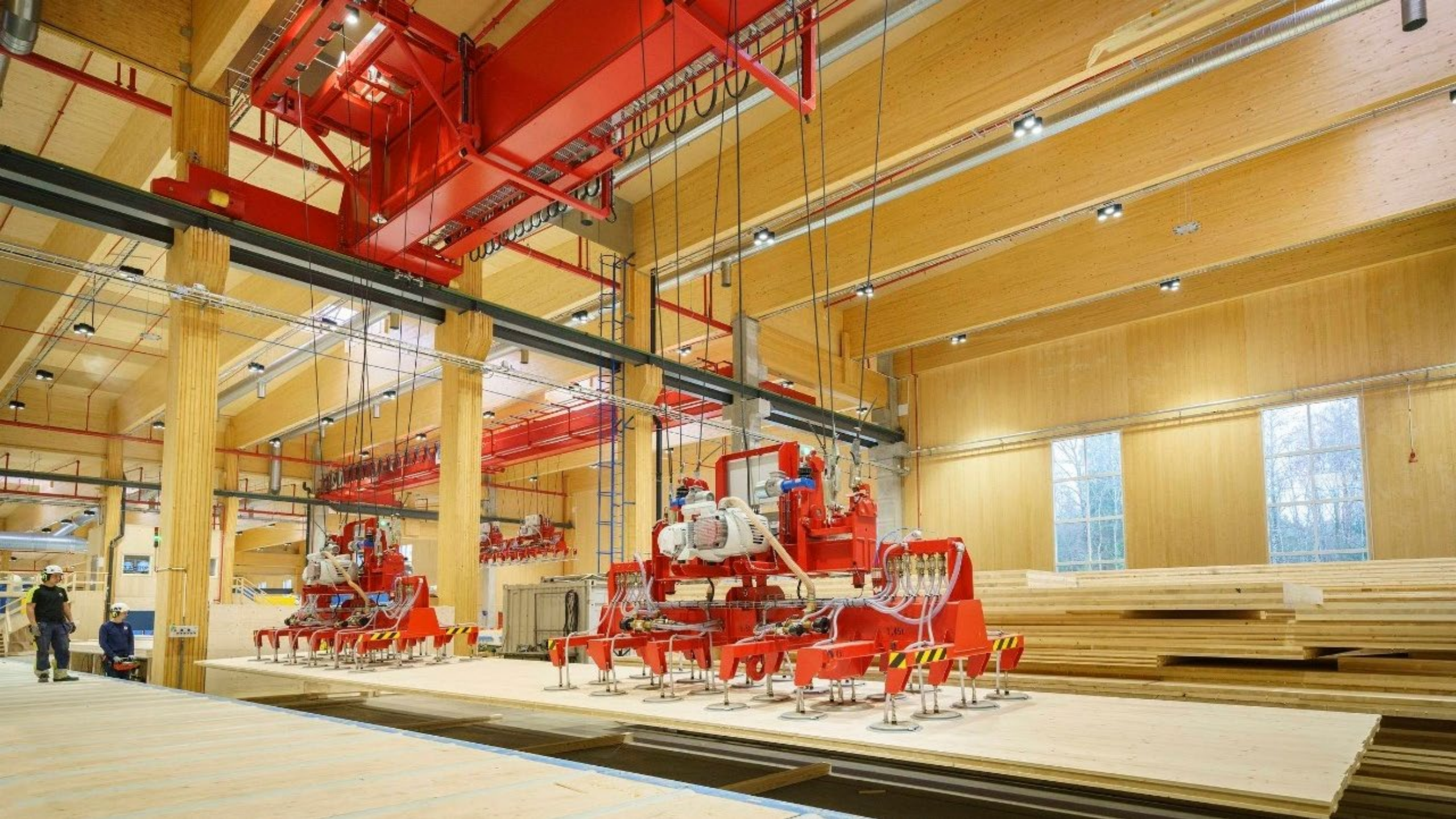


Image: Polyhedral Structures Laboratory at Penn

## Penn Set to Receive \$2.4M in Funding to Research Turning Buildings into Carbon Storage Structures

The University of Pennsylvania has been selected to receive \$2.4M in funding from the US Department of Energy Advanced Research Projects Agency-Energy (ARPA-E). The funding is part of the ARPA-E HESTIA program, which prioritizes overcoming barriers associated with carbon-storing buildings, including scarce, expensive and geographically limited building materials. The goal of the HESTIA program is to increase the total amount of carbon stored in buildings to create carbon sinks, which absorb more carbon from the atmosphere than released during the construction process.

The University of Pennsylvania, in collaboration with Texas A&M University, The City College of New York, KieranTimberlake, and Sika, will design carbon-negative, medium-sized building structures by developing a high-performance structural system for carbon absorption and storage over buildings' lifespan.











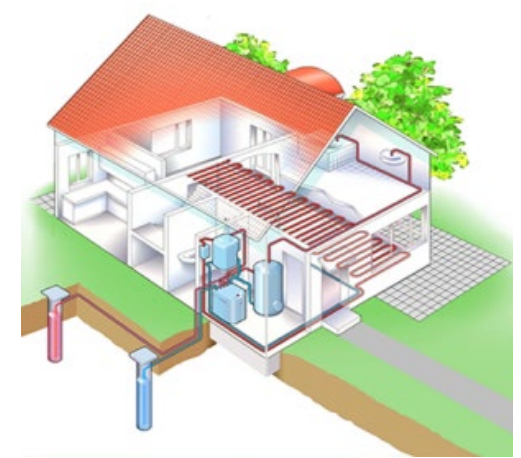




# Green Deal

## Reduction of operational carbon

# Operational carbon: electrification of HVAC (Heating, Ventilation, Air Conditioning) ... of course + insulation







Operational carbon: "SMART buildings" use deep data tools to optimize building performance





# The role of deep-tech in renovation, disassembly, re-use and recycling pathways



Problem to be solved: demolition waste, 35% of EU waste stream



What is the role of deep-tech in disassembly, re-use and recycling pathways?



European Renovation Wave: what is the role of deep-tech in renovation?

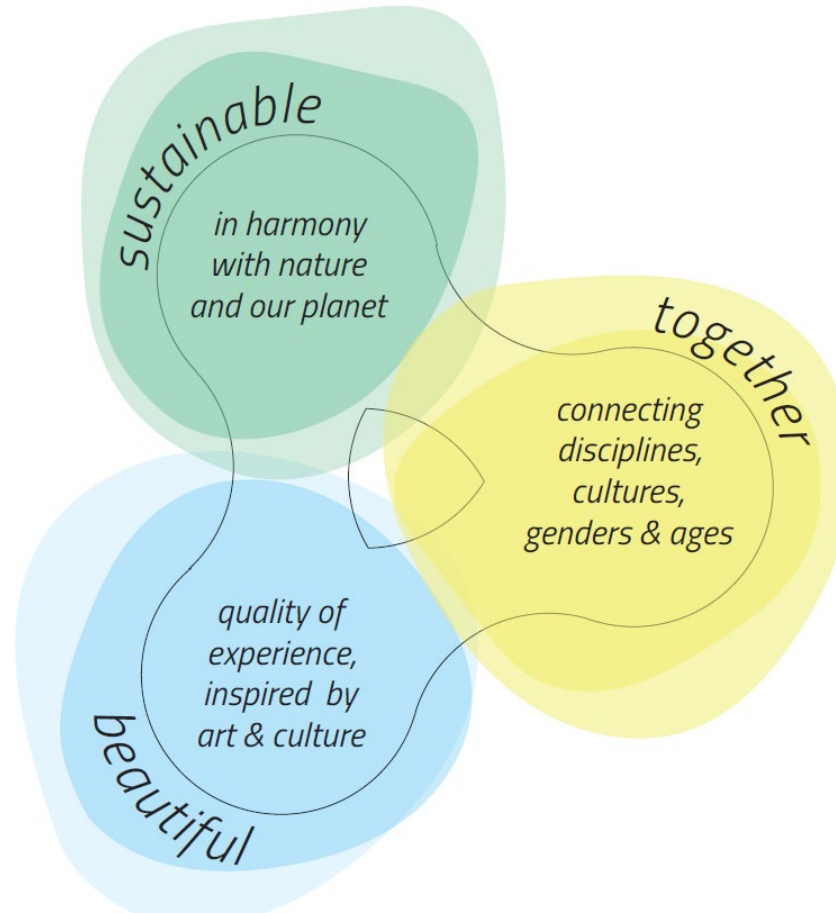


# New European Bauhaus

Problem to be solved: soul destroying ugliness. New European Bauhaus provides heart and soul to EGD.



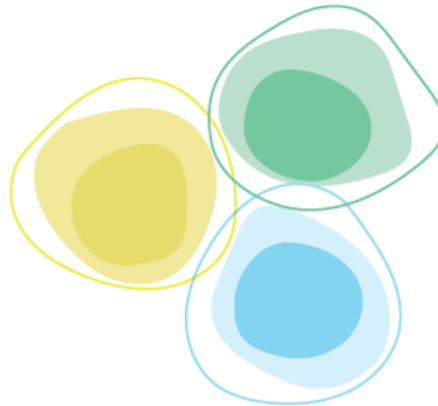
# New European Bauhaus



# New European Bauhaus

## Inclusion

- LEVEL I: Embedded
- LEVEL II: Consolidated
- LEVEL III: Transformational



## Sustainability

- LEVEL I: Linear
- LEVEL II: Circular
- LEVEL III: Regenerative

## Quality of Experience

- LEVEL I: Fragmented
- LEVEL II: Connected
- LEVEL III: Integrated



# NEB Compass

References



# NEB Compass

References



# Quality of Experience

LEVEL 1: Fragmented

LEVEL 2: Connected

LEVEL 3: Integrated

UNDERLYING DIMENSIONS →

Context (Re)activation | Sensuous Experience | Aesthetics

Connection across Contexts | Collective Experience | Sense of Belonging

Empowerment to co-create New Context(s) | Transcending Boundaries | Long-lasting Movement

# NEB Compass

References



LEVEL 1: Embedded

LEVEL 2: Secured

LEVEL 3: Transformational

UNDERLYING DIMENSIONS →

Equality | Accessibility | Prioritizing disadvantaged people

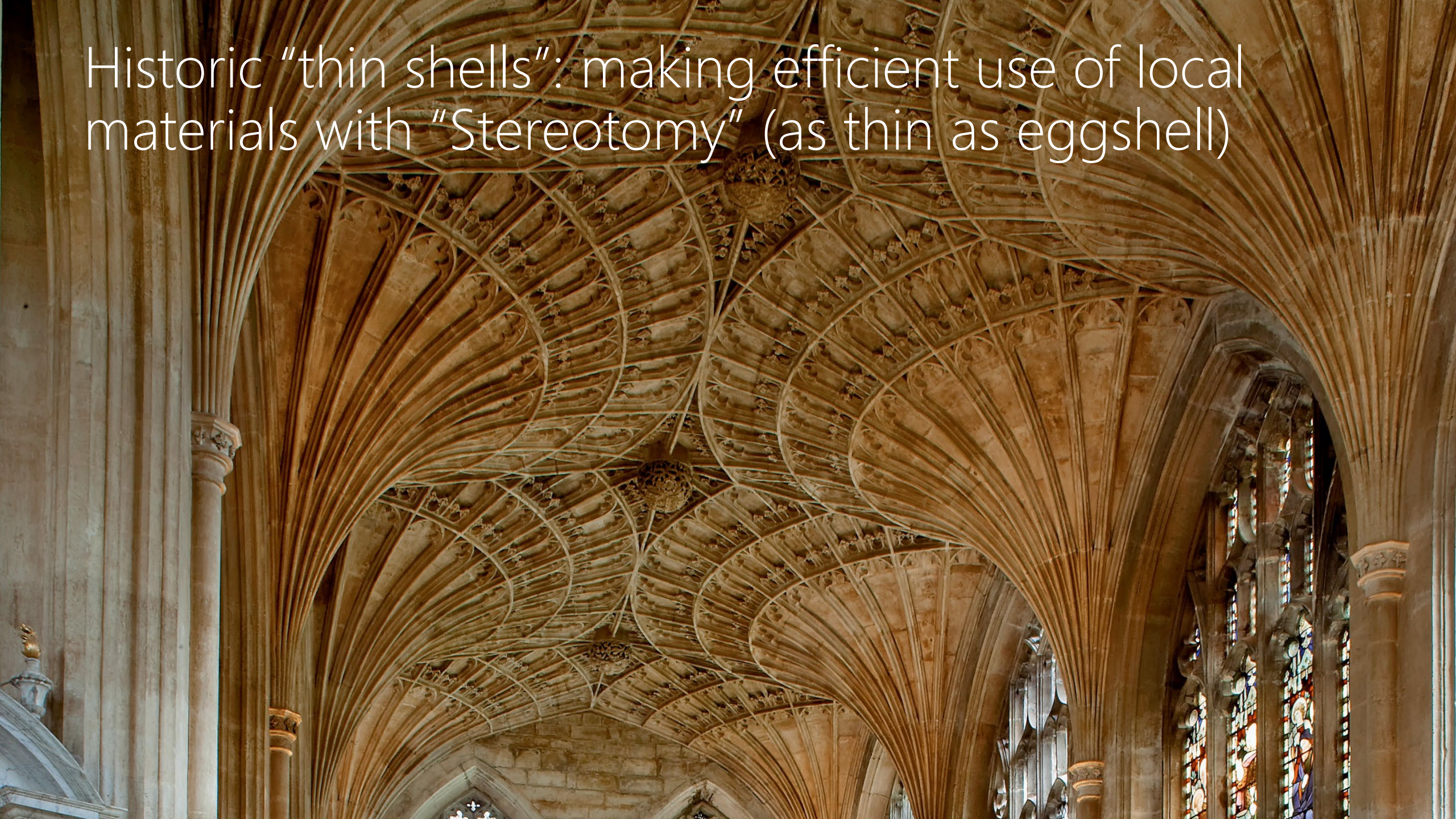
Overcoming segregation | Representation and social stability | Sharing resources and opportunities

Fostering shared social values | Societal development and collective growth | New ways of living (together)





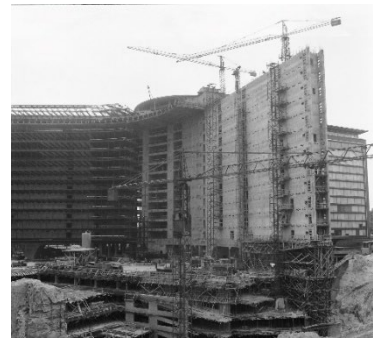
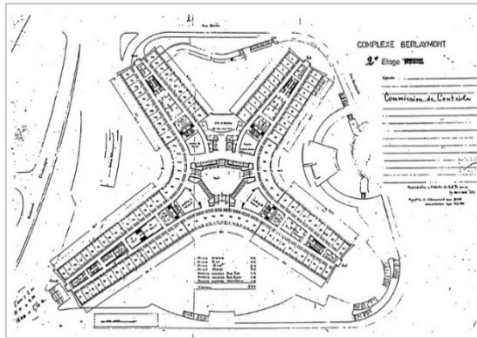
Historic "thin shells": making efficient use of local materials with "Stereotomy" (as thin as eggshell)





# Barriers for AEC innovation

# To the future and back: regulation and design decisions made today affect people generations from now.



----- 1959 ----- 1963 ----- 1969 ----- 2022 -----



Regulations and policies maintain the old or enable the new. The context is critical for innovation success.

