

# Regulation's Role Shaping Prefabrication for Energy Retrofit

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**ISEC**

4<sup>th</sup> INTERNATIONAL  
SUSTAINABLE ENERGY  
CONFERENCE 2026



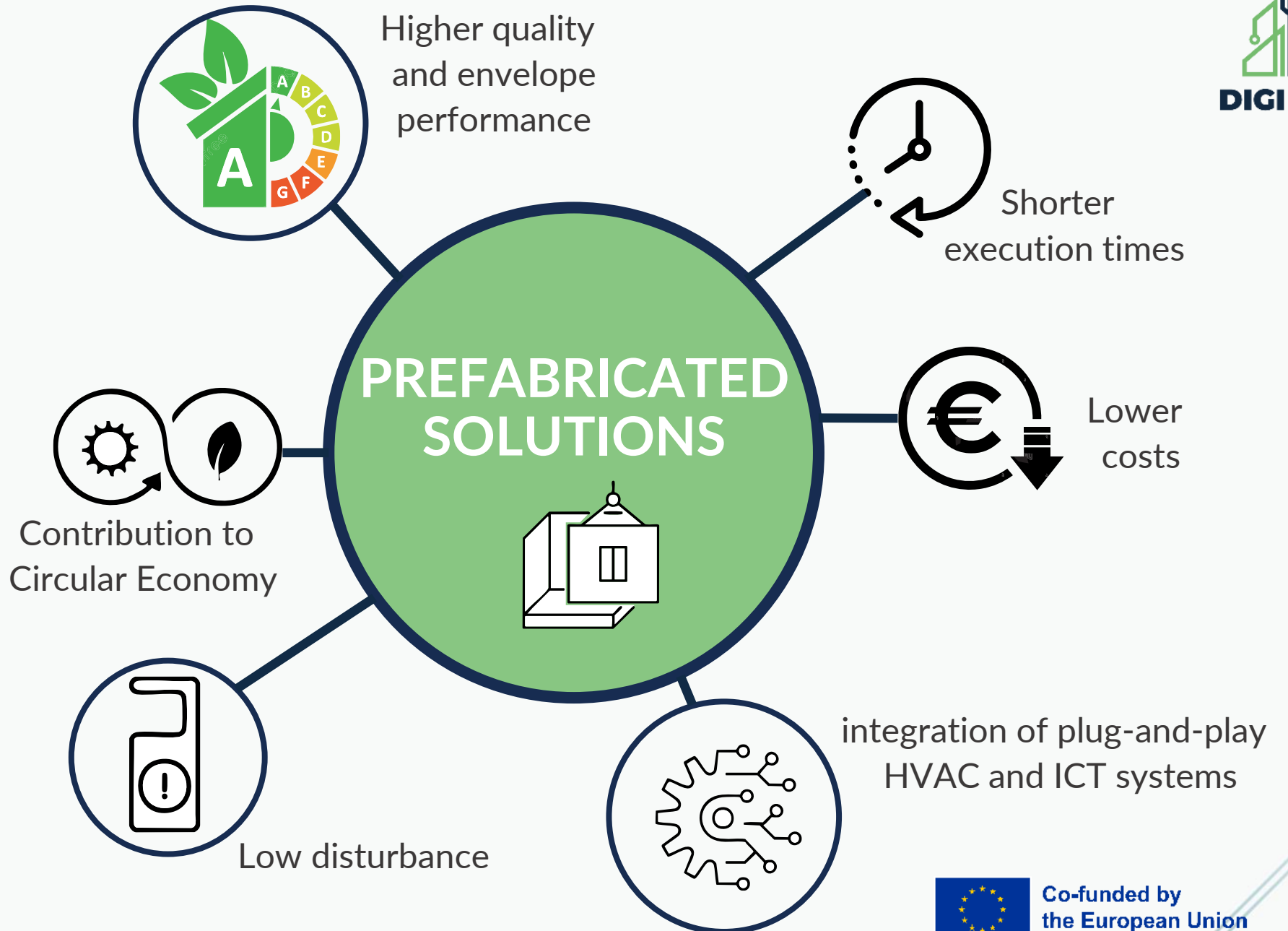
Co-funded by  
the European Union

# Renovation Wave



European  
Green Deal

“Large-scale building upgrades are essential for achieving the successful decarbonisation of the European building sector—yet deep renovations that reduce energy consumption by at least 60% currently take place in only 0.2% of the building stock annually,,



References:

“MORE-CONNECT: Development and advanced prefabrication of innovative, multifunctional building envelope elements for modular retrofitting and smart connections,”

doi:10.1016/j.egypro.2015.11.026

“Technical, financial, and social barriers and challenges in deep building renovation: Integration of lessons learned from the H2020 cluster projects,”  
doi: 10.3390/buildings8120174

“Towards decarbonisation in the built environment: A comparative analysis of conventional vs. industrialised façades in nearly zero-energy building renovations,”  
doi:10.1016/j.enbuild.2025.115885

# Digital Process Chain for Energy Renovations Using Prefabrication



## What



Recycled concrete panel

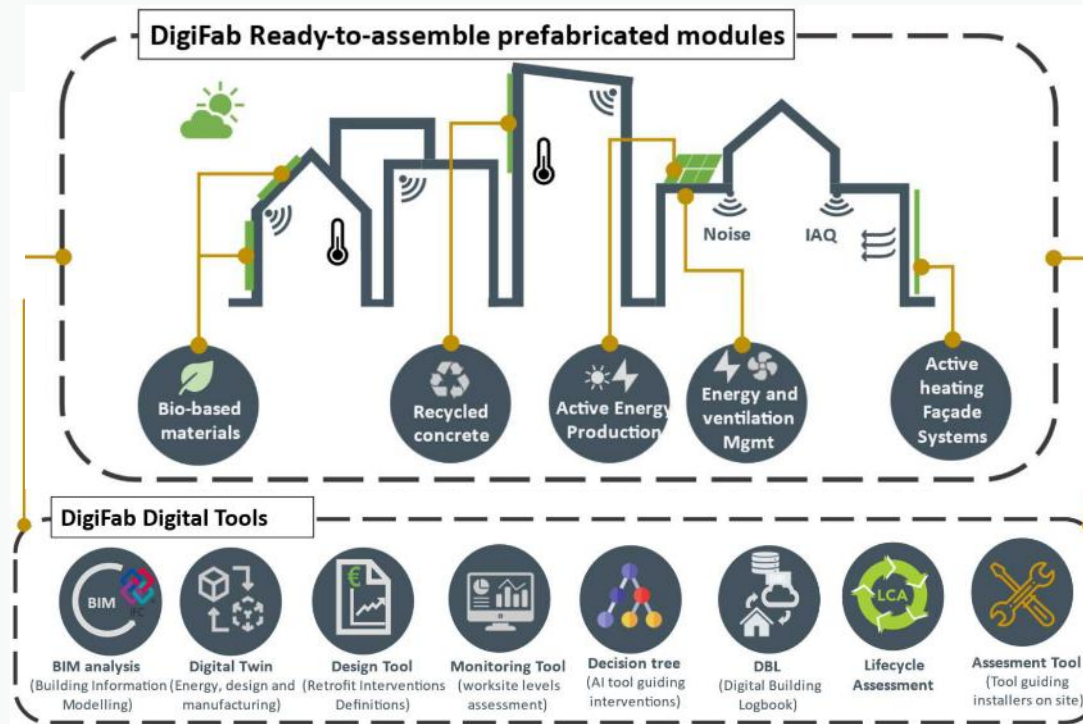


Bio-based materials panel



Active energy production

## How



## Who

Research partners



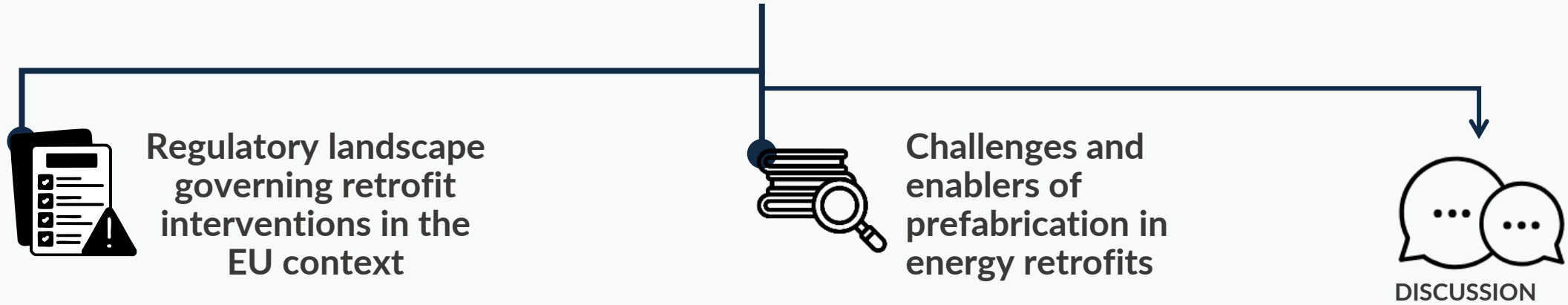
research solutions strategy



Industry partners



# Analysis of context and regulation to apply a digital renovation flow



## 1. Document collection



## 2. Classification & review

Review scheme based on **Level(s)**

Following PRISMA

Challenges and enablers of prefabrication in energy retrofits

Identify potential opportunities for regulation to help prefabrication overcome current challenges



European Commission

# Level(s)



## Macro objectives

## Assessment indicators

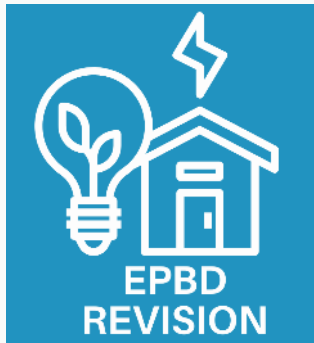
|  |          |  |   |   |   |   |                                    |                                       |  |                      |
|--|----------|--|---|---|---|---|------------------------------------|---------------------------------------|--|----------------------|
|  | <b>1</b> | <b>Green house gas emissions along a building's life cycle</b> | 1.1 Use stage energy performance                    | kilowatt hours per square metre per year [kWh/m <sup>2</sup> /yr]   | 1.2 Life cycle Global Warming Potential               | kgCO <sub>2</sub> equivalents per square metre per year           |                                    |                                       |  |                      |
|  | <b>2</b> | <b>Resource efficient + circular material</b>                  | 2.1 Bill of quantities                              | Unit quantities mass + years  | 2.2 Construction + demolition waste + materials       | kg of waste + materials per m <sup>2</sup>                        | 2.3 Design for adaptability use    | Adaptability score                    | 2.4 Design for deconstruction, reuse + recycling | Deconstruction score |
|  | <b>3</b> | <b>Efficient use of water resources</b>                        | 3.1 Use stage water consumption                     | m <sup>3</sup> /yr water per occupant   |   |   |                                    |                                       |  |                      |
|  | <b>4</b> | <b>Healthy + comfortable spaces</b>                            | 4.1 Indoor air quality                              | Parameters for ventilation, CO <sub>2</sub> + humidity<br><small>Target list of pollutants: TVOC, formaldehyde, CMR, VOC, LCI ratio, mold, benzene, particulates, radon</small> | 4.2 Time outside of thermal comfort range             | % of the time out of range during the heating and cooling seasons | 4.3 Lighting + visual comfort use  | Level 1 check list                    | 4.4 Acoustics + protection against noise         | Level 1 checklist    |
|  | <b>5</b> | <b>Adaptation + Resilience</b>                                 | 5.1 Protection of occupier health + thermal comfort | Projected % time out of range in the years 2030 and 2050 [see also 4.2]   | 5.2 Increased risk of extreme weather events          | Level 1 checklist [under development]                             | 5.3 Increased risk of flood events | Level 1 checklist [under development] |  |                      |
|  | <b>6</b> | <b>Optimised life cycle cost and value</b>                     | 6.1 Life cycle costs                                | Euro per square metre [€/m <sup>2</sup> /yr]  | 6.2 Value creation + risk exposure Indoor air quality | Level 1 checklist   |                                    |                                       |  |                      |

# DigiFab Regulation Review Scheme based on Level(s)

| TIER 1   | TIER 2   | TIER 3                                       |
|--|--|--|
| <b>1</b> Green house gas emissions along a building's life cycle | <b>1.1 Use stage energy performance</b>        |  |
|  | 1.1.1 Limits on energy use                     | 1.1.2 Renewable energy                       |
| <b>2</b> Resource efficient + circular material                  | <b>1.2 Life Cycle Global Warming Potential</b> |  |
|  | 1.2.1 Life Cycle GWP Assessment                | 1.2.2 Long Term Renovation Plans             |
| <b>3</b> Pollution / environmental impact                        | <b>1.2.3 GWP of construction products</b>      |  |
|  | 1.2.4 Carbon storage                           |  |
| <b>4</b> Healthy + comfortable spaces                            | <b>2.1 Construction Products</b>               |  |
|  | 2.1.1 Performance requirements                 | 2.1.2 Chemical substances                    |
| <b>5</b> Safety, Stability & Resilience                          | <b>2.2 C&amp;DW &amp; Material flow</b>        |  |
|  | 2.2.1 C&D waste management                     | 2.2.2 End-of-waste definition & Allowed uses |
| <b>6</b> Well- targeted funding                                  | <b>2.3 Circular Economy</b>                    |  |
|  | 2.3.1 Circular Design (DfD, DfA)               | 2.3.2 Reuse and Secondary materials          |
| <b>3</b> Pollution / environmental impact                        | <b>3.1 Environmental impact</b>                |  |
|  | 3.1.1 Environmental impact Assessment          | 3.1.2 Reduction of noise pollution           |
| <b>4</b> Healthy + comfortable spaces                            | 3.1.3 Local air quality                        | 3.1.4 Impact of refrigerants                 |
|  | 3.1.5 Biodiversity                             | 3.1.6 Cultural heritage and landscape        |
| <b>5</b> Safety, Stability & Resilience                          | <b>4.1 Indoor Air Quality</b>                  |  |
|  | 4.1.1 Pollutants control                       | 4.1.2 Ventilation rates                      |
| <b>6</b> Well- targeted funding                                  | <b>4.2 Protection against noise</b>            |  |
|  | 4.2.1 Sound insulation                         | 4.2.2 Service equipment                      |
| <b>1</b> Green house gas emissions along a building's life cycle | <b>4.3 Visual comfort</b>                      |  |
|  | 4.3.1 Daylight levels                          |  |
| <b>2</b> Resource efficient + circular material                  | <b>4.4 User safety &amp; accessibility</b>     |  |
|  | 4.4.1 Accessibility                            |  |
| <b>3</b> Pollution / environmental impact                        | <b>5.1 Fire safety</b>                         |  |
|  | 5.1.1 Design requirements                      | 5.1.2 Material performance                   |
| <b>4</b> Healthy + comfortable spaces                            | 5.1.3 Testing standards                        | 5.2.1 Basis of structural design             |
|  | <b>5.2 Structural safety</b>                   |  |
| <b>5</b> Safety, Stability & Resilience                          | 5.2.2 Actions on structures                    |  |
|  | 5.2.3-6 Concrete, Steel, Timber, Masonry       |  |
| <b>6</b> Well- targeted funding                                  | 5.2.7 Earthquake resistance                    |  |
|  | <b>6.1 Financing frameworks</b>                |  |
| <b>1</b> Green house gas emissions along a building's life cycle | 6.1.1 Green Public Procurement                 | 6.1.2 Taxation                               |
|  | 6.1.3 Other frameworks                         |  |

# EU Framework

Supportive legislative environment for prefabricated energy-retrofit solutions



Energy Performance  
in Buildings Directive



Energy Efficiency  
Directive

Zero-emission Buildings



Waste Framework Directive



The EU Taxonomy

Transition to a Circular Economy

# EU - to - national alignment



## LEGISLATIVE STRUCTURE

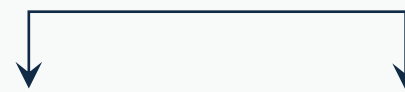


Regional frameworks  
National laws  
Mixed systems

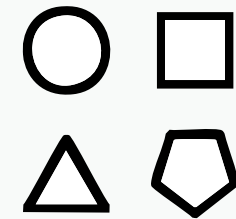
(Federal States)



## COMPLIANCE APPROACH



Prescriptive  
Performance-Based



## VARIABILITY IN SPECIFIC REQUIREMENTS

# EU - to - national alignment



✓ EU regulations    
 ✓ EU standards    
 ✓ National regulations    
 ✓ National standards/non-binding documents

| Consortium country | 1. GHG emissions along a Building's Life Cycle |       |       |   |       |       | 2. Resource efficient & circular material |       |                     |       |                      |       | 3. Pollution & environmental impact |       |       |       |       |       | 4. Healthy and comfortable spaces |       |                              |       |                    |                                 | 5. Safety, Stability & Resilience |       |       |                       |       |         | 6. Well targeted funding |       |       |       |  |
|--------------------|--|-------|-------|---|-------|-------|---|-------|---------------------|-------|----------------------|-------|-------------------------------------|-------|-------|-------|-------|-------|-----------------------------------|-------|------------------------------|-------|--------------------|---------------------------------|-----------------------------------|-------|-------|-----------------------|-------|---------|--------------------------|-------|-------|-------|--|
|                    | 1.1 Use stage energy performance               |       |       | 1.2 Life cycle Global Warming Potential |       |       | 2.1 Construction products                 |       | 2.2 C&DW management |       | 2.3 Circular Economy |       | 3.1 Environmental impact assessment |       |       |       |       |       | 4.1 Indoor Air Quality            |       | 4.2 Protection against noise |       | 4.3 Visual comfort | 4.4 User safety & accessibility | 5.1 Fire Safety                   |       |       | 5.2 Structural Safety |       |         | 6.1 Financing frameworks |       |       |       |  |
|                    | 1.1.1  | 1.1.2 | 1.1.3 | 1.2.1                                   | 1.2.2 | 1.2.3 | 2.1.1                                     | 2.1.2 | 2.2.1               | 2.2.2 | 2.3.1                | 2.3.2 | 3.1.1                               | 3.1.2 | 3.1.3 | 3.1.4 | 3.1.5 | 3.1.6 | 4.1.1                             | 4.1.2 | 4.2.1                        | 4.2.2 | 4.3.1              | 4.4.1                           | 5.1.1                             | 5.1.2 | 5.1.3 | 5.2.1                 | 5.2.2 | 5.2.3-6 | 5.2.7                    | 6.1.1 | 6.1.2 | 6.1.3 |  |
|                    |  |       |       | ✓                                       |       |       | ✓   | ✓     |                     |       |                      |       | ✓                                   | ✓     |       |       | ✓     |       |                                   |       |                              |       | ✓                  | ✓                               |                                   |       |       | ✓                     | ✓     | ✓       | ✓                        | ✓     |       |       |  |
|                    | ✓  | ✓     | ✓     |   | ✓     | ✓     | ✓   | ✓     | ✓                   | ✓     |                      |       | ✓                                   | ✓     | ✓     |       |       | ✓     | ✓                                 | ✓     | ✓                            | ✓     |                    | ✓                               | ✓                                 | ✓     |       | ✓                     |       |         |                          |       |       |       |  |
|                    | ✓  | ✓     |       | ✓                                       |       | ✓     |   |       |                     |       |                      |       |                                     |       |       |       |       | ✓     | ✓                                 | ✓     | ✓                            | ✓     |                    |                                 | ✓                                 | ✓     | ✓     |                       |       |         |                          |       |       |       |  |
|                    | ✓  | ✓     |       | ✓                                       | ✓     |       |   |       | ✓                   | ✓     |                      |       | ✓                                   | ✓     | ✓     |       | ✓     |       | ✓                                 | ✓     |                              | ✓     |                    | ✓                               | ✓                                 | ✓     |       | ✓                     | ✓     | ✓       | ✓                        | ✓     | ✓     |       |  |
|                    | ✓  | ✓     | ✓     |   | ✓     | ✓     | ✓   |       |                     | ✓     | ✓                    | ✓     | ✓                                   |       | ✓     | ✓     |       | ✓     | ✓                                 |       | ✓                            | ✓     |                    | ✓                               | ✓                                 | ✓     | ✓     | ✓                     | ✓     | ✓       | ✓                        | ✓     |       |       |  |
|                    | ✓  |       | ✓     | ✓                                       |       | ✓     | ✓   |       | ✓                   | ✓     | ✓                    | ✓     | ✓                                   | ✓     | ✓     |       |       | ✓     | ✓                                 |       | ✓                            | ✓     |                    | ✓                               | ✓                                 | ✓     | ✓     | ✓                     | ✓     | ✓       | ✓                        |       |       |       |  |
|                    | ✓  | ✓     | ✓     |   | ✓     |       |   | ✓     | ✓                   | ✓     |                      |       | ✓                                   | ✓     | ✓     |       | ✓     | ✓     | ✓                                 | ✓     | ✓                            |       | ✓                  | ✓                               | ✓                                 |       | ✓     |                       |       |         |                          |       |       |       |  |
|                    | ✓  | ✓     | ✓     |   | ✓     |       |   | ✓     | ✓                   |       |                      | ✓     | ✓                                   | ✓     | ✓     |       | ✓     | ✓     | ✓                                 | ✓     | ✓                            |       | ✓                  | ✓                               | ✓                                 | ✓     | ✓     | ✓                     | ✓     | ✓       | ✓                        |       |       |       |  |

# In-depth review of specific requirement in the demo countries



|  |  |
|--|--|
| <b>1</b> Green house gas emissions along a building's life cycle | <u>EPBD transposition</u> : currently developing national long-term renovation strategies, but <b>energy/GWP targets still pending</b> , with <b>regional variation expected</b> (climate zones, building use).  |
| <b>2</b> Resource efficient + circular material                  | <u>Construction Products Regulation (CPR)</u> : EU-wide CPR applies but <b>Austria add extra national requirements</b> , limiting some EU-market products.<br><u>Waste Management and secondary material markets</u> : regional rules on end-of-waste and recycled materials hinder national secondary markets |
| <b>3</b> Pollution / environmental impact                        | <u>Heritage/landscape</u> : Austria & Greece: Binding requirements imposing <b>material/colour/geometry restrictions</b>   |
| <b>4</b> Healthy + comfortable spaces                            | <u>Natural lighting</u> : mandatory in Austria but best practice in Greece & Spain   |
| <b>5</b> Safety, Stability & Resilience                          | <u>Fire safety</u> : all three countries take a prescriptive approach. In the case of Austria with very restrictive requirements.<br><u>Structural safety</u> : Greece is a high seismic zone and adds extra national requirements.  |
| <b>6</b> Well- targeted funding                                  | All three countries have renovation funding mainly regional, <b>producing fragmented schemes</b> . Greece has implemented a national Green Public Procurement Plan.  |

# Challenges of prefabrication for retrofits

The need to adjust an industrial approach to the tailored-solution process of building renovation is the main challenge that is systematically and consistently highlighted in literature.



TECHNICAL

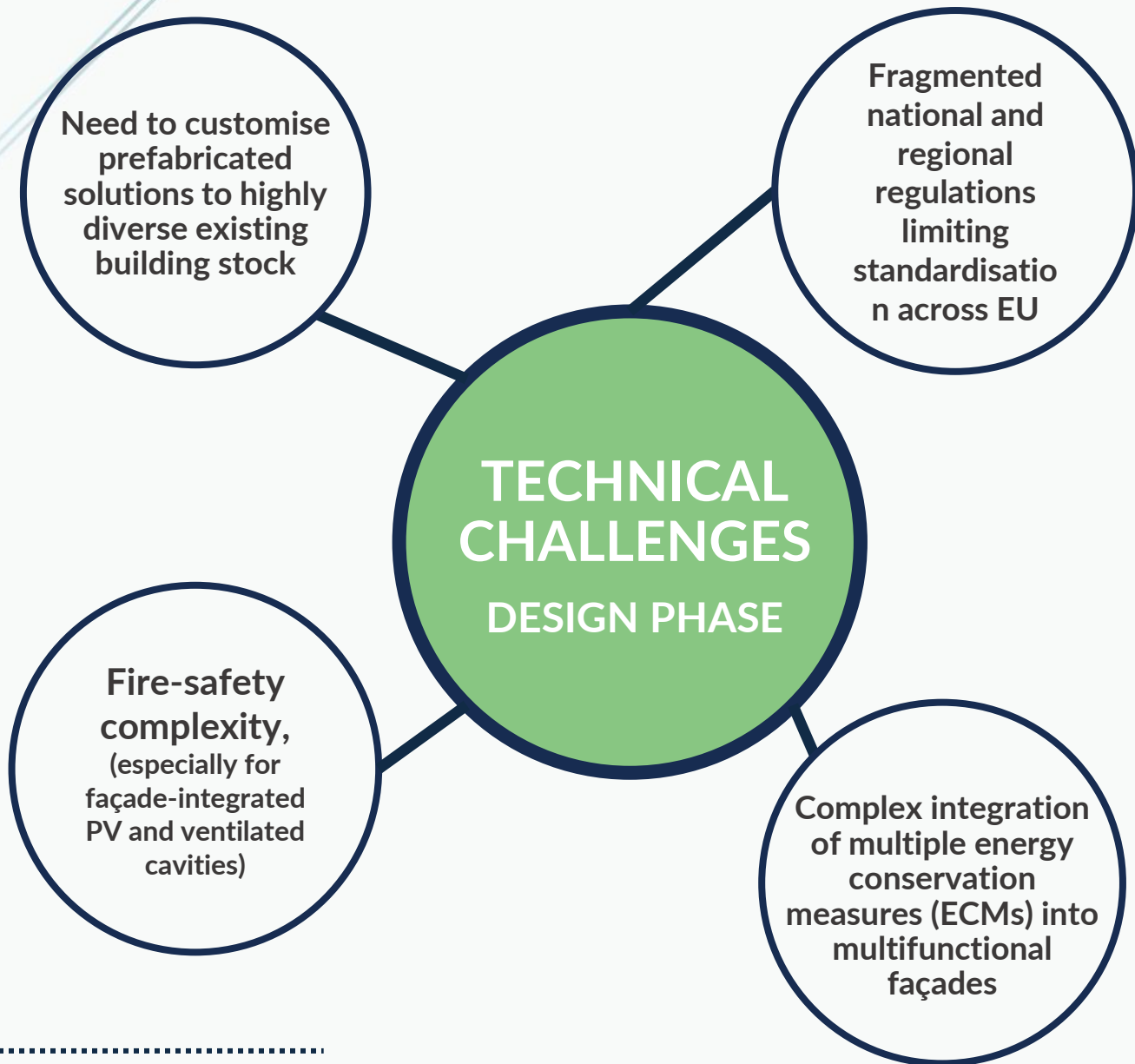

- Design phase
- Construction & maintenance phases





SOCIAL




ECONOMIC

**Harmonisation**





**Performance based approach**




**Data collection for realistic renovation**

Clear compliance pathways for APFs and façade-integrated PV, with specific standards and guidelines for fire behaviour




**Administrative Hurdles**

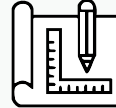
**Streamline testing procedures**



**Automated compliance check**

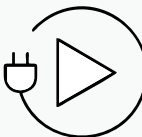


**MODELING**

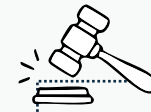
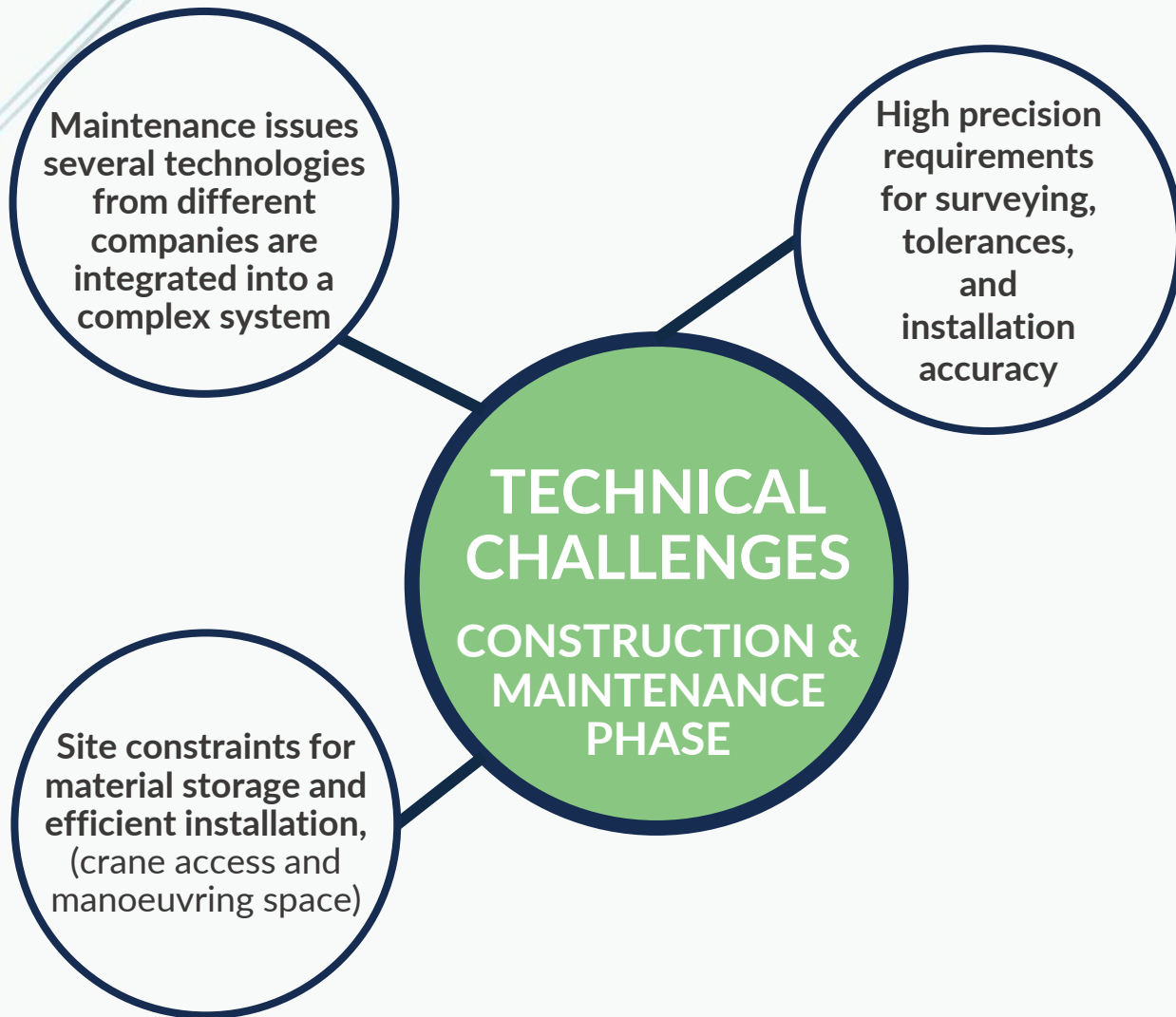


**DESIGN**

Clash detection, interface design, and system compatibility



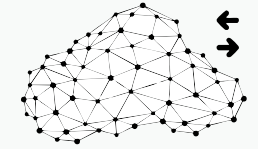
**plug-and-play compatibility with market ready active systems**



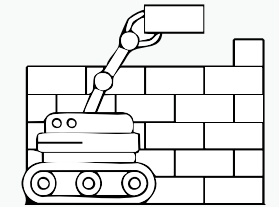
Funding Support



Administrative Hurdles



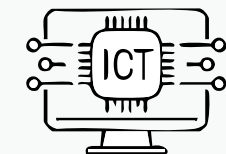
POINT CLOUD




Automation in construction




dynamic layout adjustment during design and installation



BMS & ICT

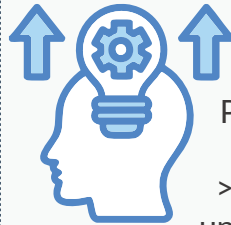



Supportive policy to guide public and private investment




life-cycle-oriented requirements


Include whole-life approach criteria in public-procurement practice




Public funding and PPP >>> workforce upskilling & high-tec



Facilitate participatory processes



Digital end-to-end chain ensuring interoperability, traceability, and coordinated information flow across all renovation stages



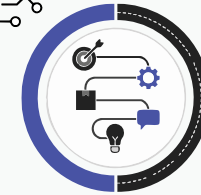
Guided installation protocols, simulation of assembly processes, and automated coordination protocols

## ECONOMIC CHALLENGES

Prefabricated renovation remains relatively expensive compared to conventional renovation



Incentivise prefabricated renovation through funding schemes, taxonomies, and circular-economy aligned procurement.



Digital optimisation reducing extra design planning efforts, waste, installation errors, and rework to lower cost.



Smart monitoring to demonstrate real performance and justify investment (reduction of performance gap).

# Conclusions

Product innovation alone is insufficient to upscale the use of prefabricated solutions in renovation contexts.

- Industrialised approaches struggle with renovation due to the highly variable and case-specific nature of existing buildings.
- Fragmented governance and heterogeneous rules hinder the adoption of uniform prefabricated solutions across Europe.
- Regulation can enable uptake through harmonisation, new guidance, detailed renovation strategies, and supportive funding.
- Certain regulatory constraints, such as fire safety often limit façade prefabrication, requiring performance-based or context-specific regulatory approaches.
- Digitalisation (point clouds, BIM, digital twins) is essential for adapting prefab components to diverse renovation conditions and regulatory requirements.
- Scaling prefabrication requires end-to-end digital workflows spanning surveying, design, manufacturing, installation, and operation.



# THANK YOU!

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digifab-project



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