

Designs  
**2026**  
Conference

The 1st International Online Conference on Designs  
**Energy Systems and Artificial Intelligence**

9–10 February 2026 | Online

Chaired by Prof. Dr. Wenbin Yu



**Circular design as a key strategy to cut embodied energy.  
A digital AI tool to support materials and data exchange for a  
sustainable built environment**

9th February 2026

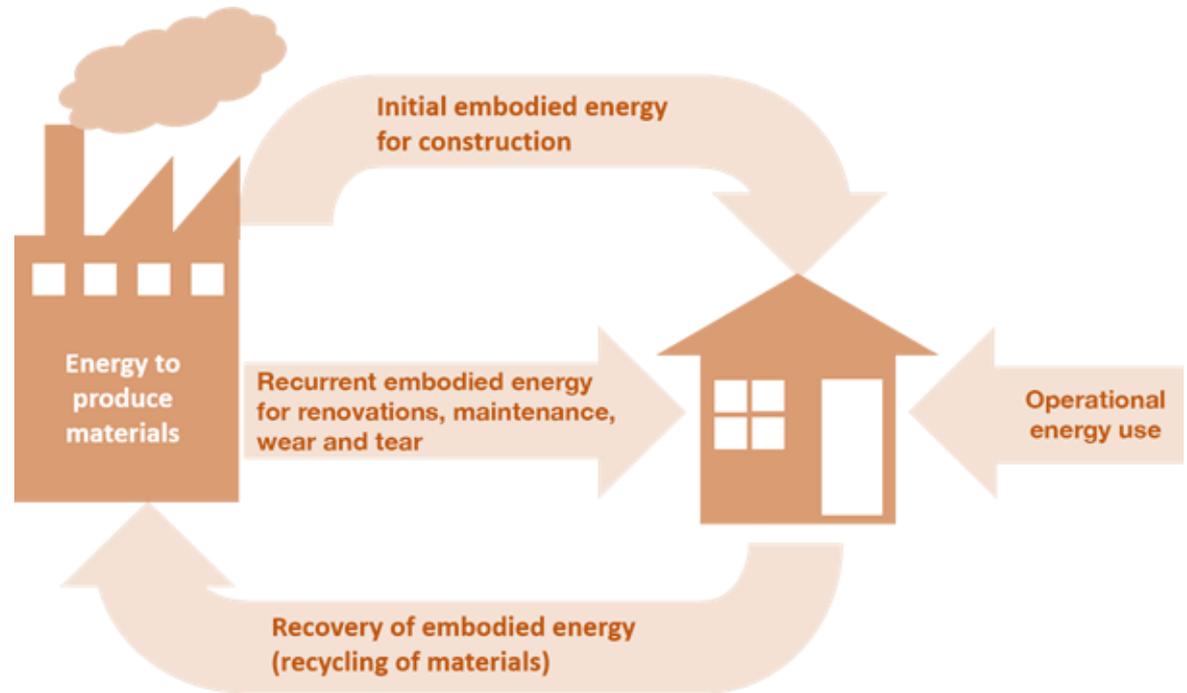
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## Circular materials as solution to lower the embodied energy in buildings and products

Embodied energy (EE) is a calculation of all the energy that is used to produce a material or product, including mining, manufacture and transport.

Improvements in energy efficiency within manufacturing industries and the production of materials with recycled content can contribute significantly to reducing the energy embodied in materials.



Source: Murray Hall (<https://www.yourhome.gov.au/materials/embodied-energy>)

Material	GJ/t
Wood	1,43
Aluminum	192,15
Recycled aluminum	12,70
Polystyrene insulation	117,00
Cellulose fiber insulation	3,30

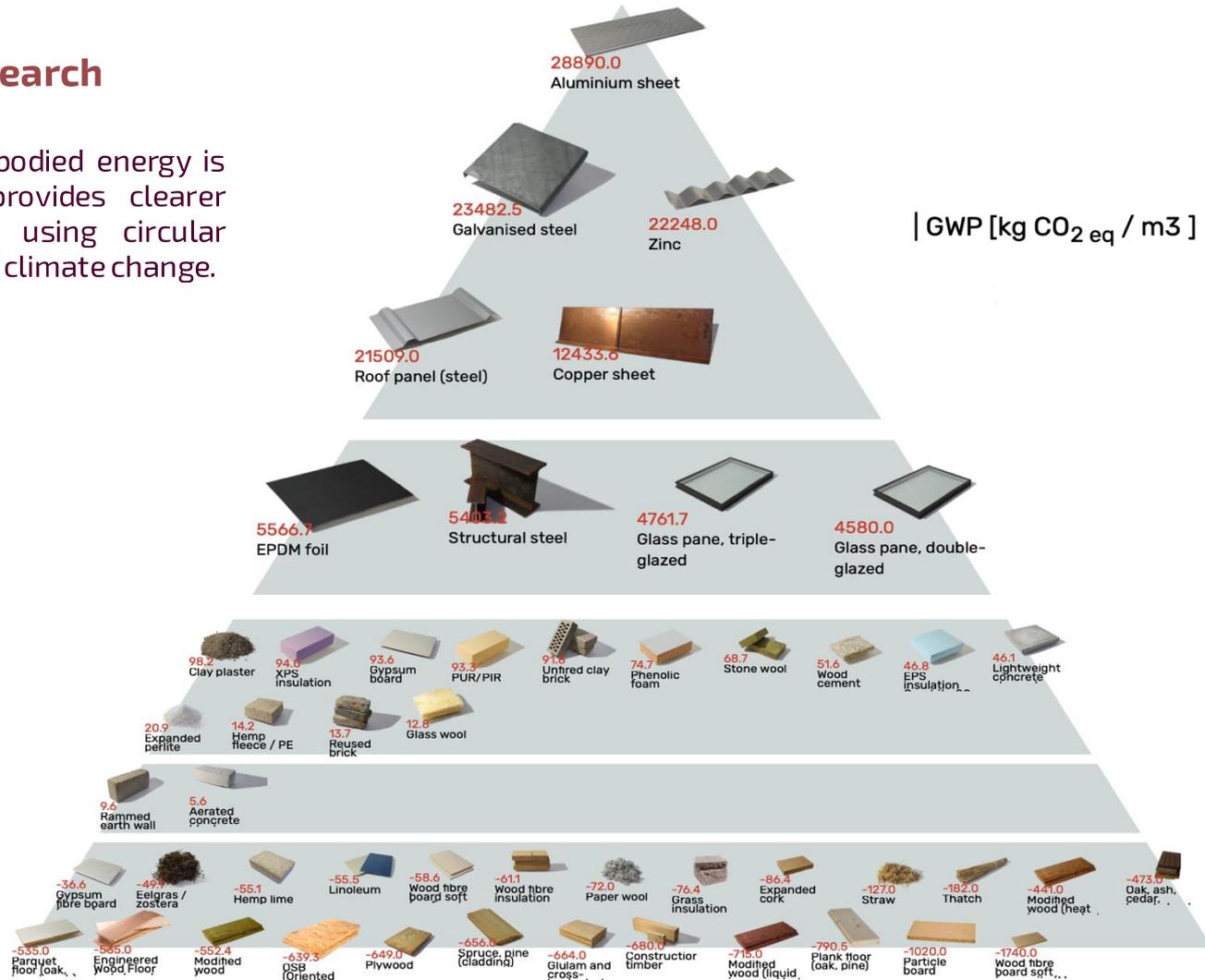
(Source: CRAS, Ecological Footprint, 2004)

## AI, EE, EC: state of the research

The main indicator related to embodied energy is embodied carbon (EC), which provides clearer evidence of the advantage of using circular materials with a view to mitigating climate change.

**Research project A SECOND CHANCE: from scrap to new through AI.** Photogrammetric surveying, BIM scanning, and parametric modeling using Rhinoceros and Grasshopper, coordinated by Dept. ABC Politecnico di Milano with BAGATTINI srl (Italy)

**Horizon project SNUG.** «Innovative methodology based in circular economy and artificial intelligence to foster the transition to Sustainable and very high energy performance buildings at a cost optimal level», coordinated by INST. TECNOL. METALMECANICO (Spain)



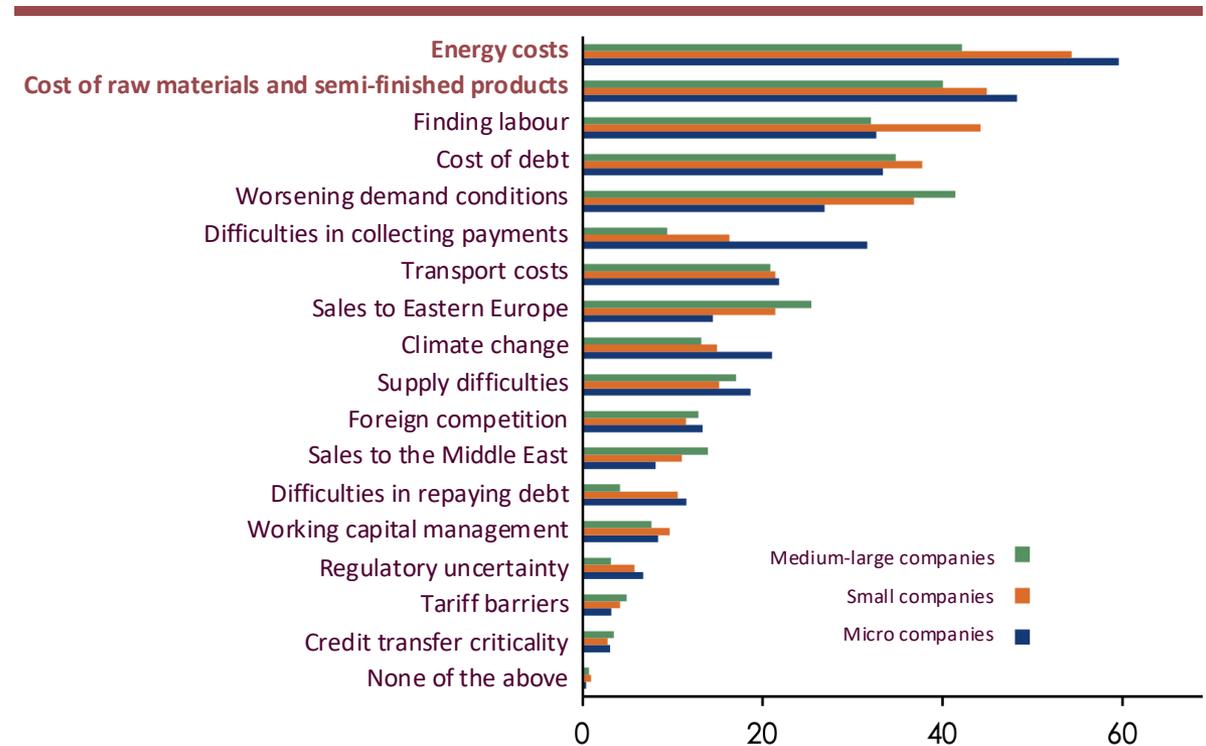
Source: Materiale Pyramiden ([www.materialepyramiden.dk](http://www.materialepyramiden.dk))

## Critical issues for companies in the Italian industrial landscape

Energy costs represent the primary challenge for Italian companies of all sizes, both within industrial districts and elsewhere, but they particularly affect micro and small businesses, which constitute the very core of the Italian industrial landscape.

Furthermore, among the green strategies on which companies are focusing, the transition to renewable energy has been adopted by more than 40% of Italian industries, energy efficiency improvements by around 30% of companies, and the use of secondary materials by 20%.

Industrial districts: main difficulties encountered by client companies by company size  
(% of managers, multiple answers possible)



Source: Intesa San Paolo survey (November-December 2023)



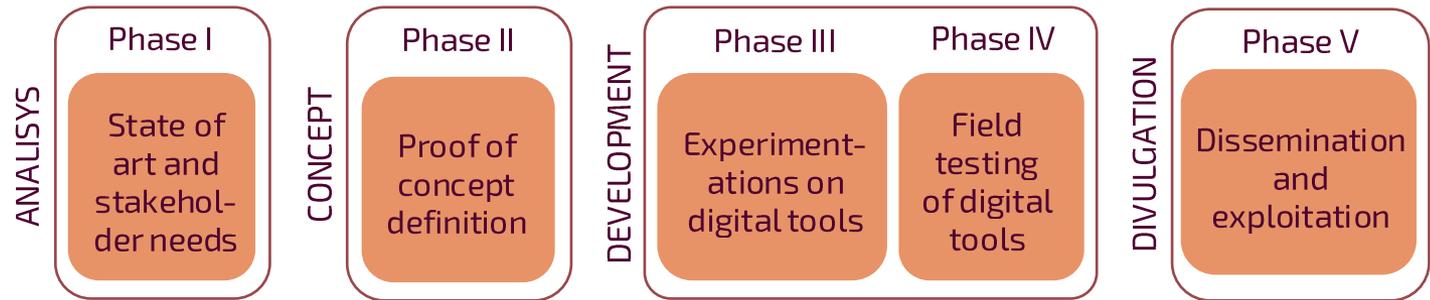
**Project 1.7**  
**From waste to manufacturing.**  
**Digital tools to establish virtuous cycles**

*Project Leader:* Lorenzo Imbesi, Sapienza University of Rome  
*Partners involved:* Università degli studi di Napoli Federico II, Università degli Studi di Firenze, Alma Mater Studiorum – Università di Bologna  
*Project Team members:* Lorenzo Imbesi, Sabrina Lucibello, Serena Baiani, Emanuele Panizzi, Viktor Malakuczi, Paola Altamura, Luca D'Elia, Carmen Rotondi, Mariia Ershova, Gabriele Rossini



**Research aims** | The Project aims to promote the use of circular materials in the Italian furniture industry, by enabling the connection among different stakeholders in the value chain. The research's final goal is to create a digital tool fostering data exchange related to materials, enabling waste valorization into circular materials and products.

**Research methodology** | The research framework is divided into 5 Phases.



## Digital platform benchmarking

### ReMade

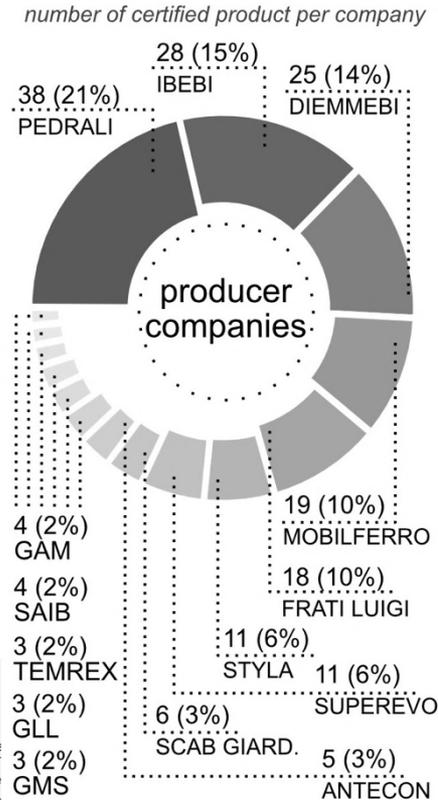
The research reviewed databases of certified furniture materials, components and products, including EU Ecolabel, C2C, ReMade in Italy, Plastica Seconda Vita and EPDIItaly, to map certified items. The research focused on the analysis of the ReMade in Italy catalogue because the Remade database contains the largest number of national certified furniture products.

Chi siamo ▾ Catalogo ReMade ▾ Certificazione ▾ Servizi e Consulenza ▾

Categoria: Materiali e semilavorati ▾ Tipologia: Plastiche riciclate ▾ Materiale: Tutti i materiali ▾ Azienda: Tutte le aziende ▾ Classe: Tutte ▾

60 results Materiali e semilavorati × Plastiche riciclate ×

Materiali e semilavorati	Materiali e semilavorati	Materiali e semilavorati	Materiali e semilavorati
SERMAG SRL PP INIEZIONE 0206	SERMAG SRL PP INIEZIONE 3050	SERMAG SRL R-POMIX PP INIEZIONE 0206	SERMAG SRL R-POMIX PP TNT 2040
<a href="#">Vai al dettaglio</a>	<a href="#">Vai al dettaglio</a>	<a href="#">Vai al dettaglio</a>	<a href="#">Vai al dettaglio</a>



Recycled, recovered or by-product content certification

PRODUCT NAME  
**LOREM IPSUM  
DOLOR SIT  
AMET ADIPISCI  
NUMQUAM**

**A<sup>+</sup>**

COMPANY NAME  
Lorem ipsum dolor  
sit amet adipisci  
XX - XXXXXXXX - XX

**XX, X%  
RECYCLED**

Type of recycled, recovered or by-product materials	
Material 1	00,00%
Material 2	00,00%
Material 3	00,00%
Material 4	00,00%

Elaborations by the ReMade® Foundation NOT SUBJECT TO CERTIFICATION	
Reduction of energy consumption resulting from recycling	00,00 kmh/kg
Reduction of climate-altering emissions resulting from recycling	00,00 kg CO <sub>2</sub> eq/kg



CONFORMITY  
ASSESSMENT BODY

[www.remade.it](http://www.remade.it)

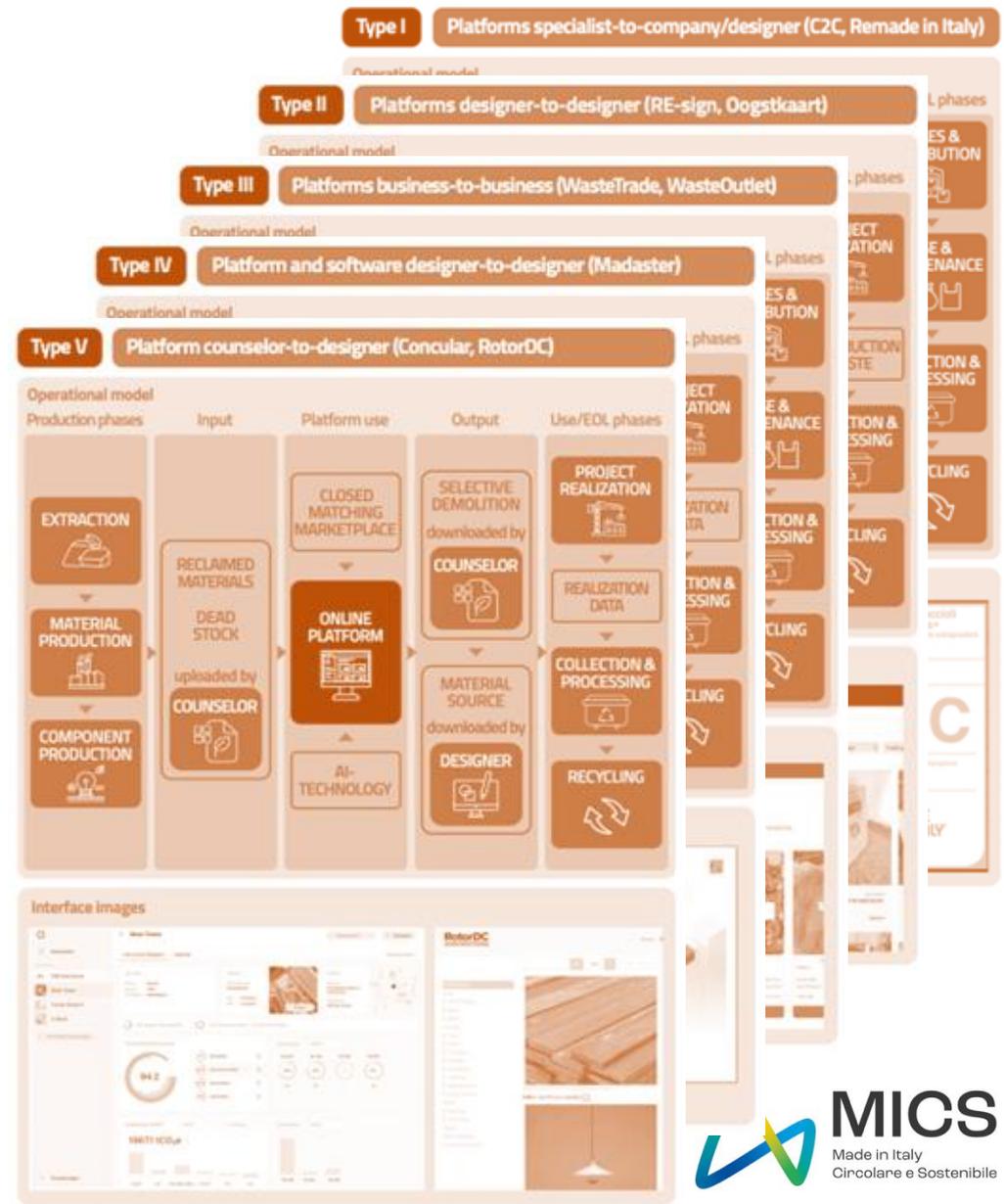
## Digital platform benchmarking

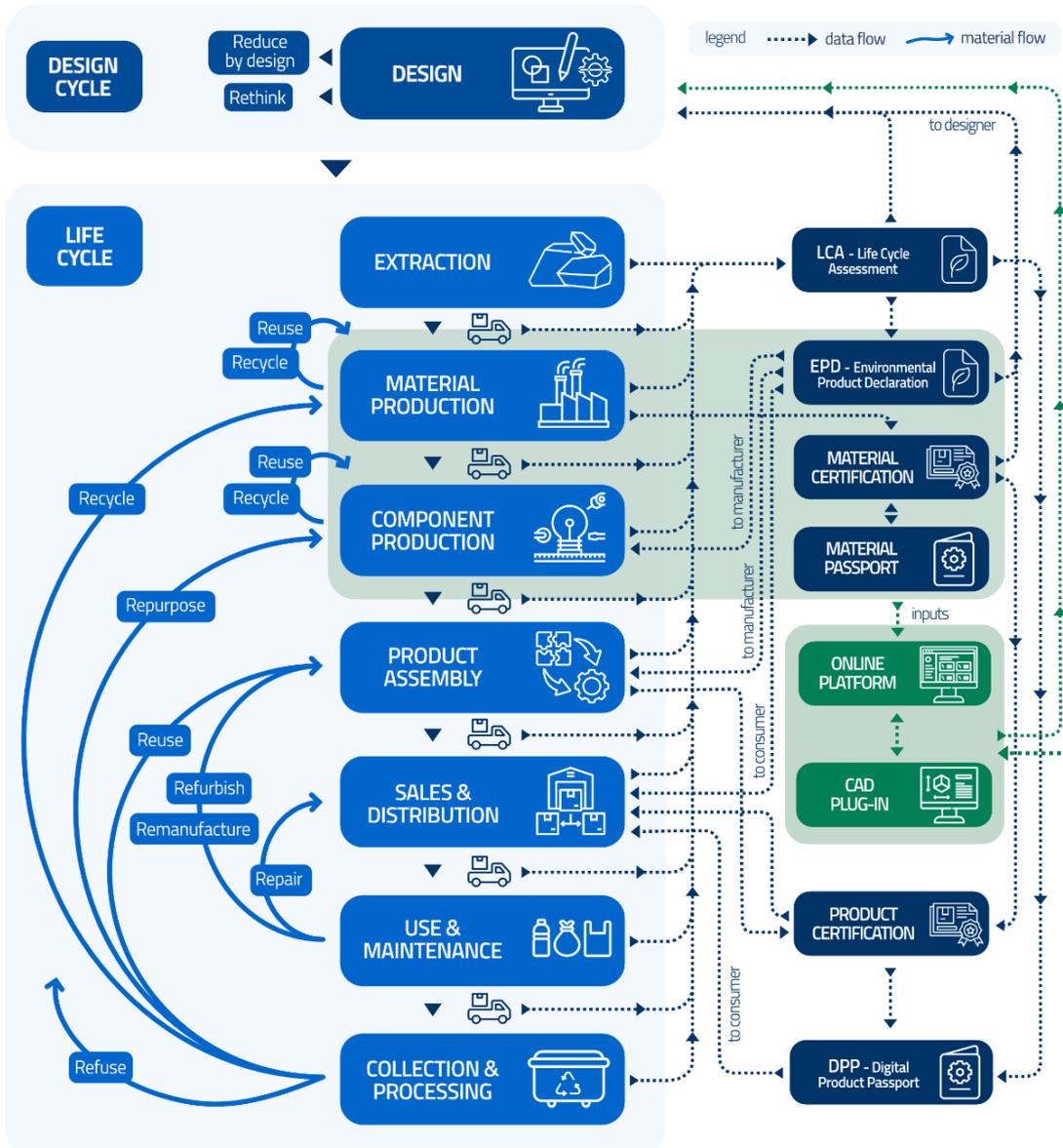
Mapping of existing digital tools supporting Circular Design.

- Selection of specific categories of tools for benchmarking purposes
- Comparative analysis
- Conceptual modelling of the different types of platforms
- Identification of the requirements for the new tool and definition of the model

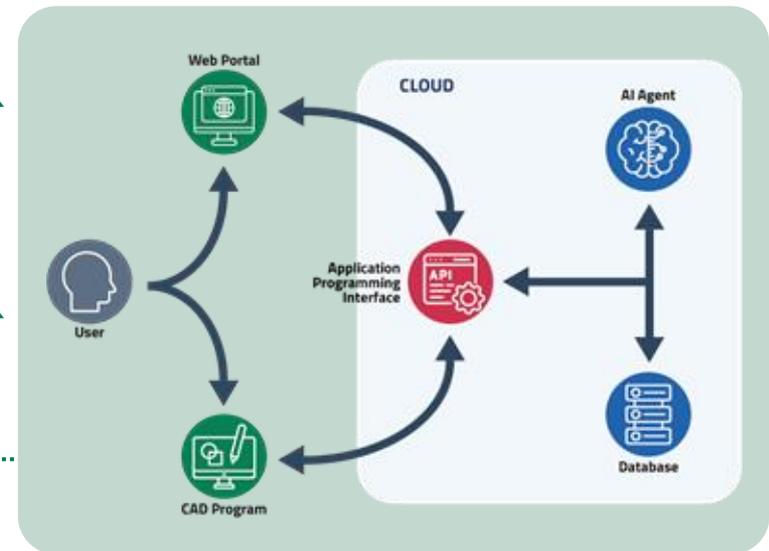
### Concular

Concular disrupts the construction industry by developing a circular process for material flow. The system is based on an AI-driven platform that matches buyers' demand for construction material with suppliers' circular materials. Material demands from construction projects can be uploaded onto the platform, while circular materials from demolition projects can be recorded using a digital material passport.





**Platform and plug-in software  
manufacturer-to-designer**



## The role of AI - First function: data upload

Support in entering data relating to materials present on the platform, through the reading and interpretation of technical data sheets and environmental certifications (e.g. EPD) and subsequent critical extrapolation of the information required by the system

The screenshot shows a web application interface for material data entry. The top navigation bar includes 'Digital Portfolio' and 'MICS' on the left, and 'ENG', 'About', 'Help', and 'Profile' on the right. Below this, a secondary bar has 'Home', 'Explore materials', and 'My materials'. The main content area is titled 'Material' and features an 'AI assistant' icon. A chat window on the left shows a user asking 'was there any parameter that you could not get from the uploaded documents?' and the AI responding with a list of missing parameters: Availability End Date, Package Size, Price Ranges, Available Quantity, Transformation Processes, Embodied Energy, and Embodied Carbon. The main form on the right includes an 'Upload Photo' button, a 'Material Name\*' field with the value 'Pannello Truciolare', a 'Describe Material\*' field with a detailed description, and a 'Basic Information' section with fields for 'Location\*' (LazioWerhouse), 'Availability\*' (Continuously Available, Yearly), and 'Price' (Package size\* 1, Unit panel).

File caricati:  
01\_SAIB\_P2\_E1\_IT.pdf  
P4438\_080920.pdf

File analizzati

was there any parameter that you could not get from the uploaded documents?

Yes, there were several parameters that could not be extracted from the uploaded documents. Specifically, the following parameters were not available: - Availability End Date - Package Size (value is 1 but not specified as a non-negative integer) - Price Ranges - Available Quantity - Transformation Processes - Embodied Energy - Embodied Carbon If you need further details or specific information, please let me know!

Chat with AI. Write a message...

137/500

Upload Photo

Material Name\*

Pannello Truciolare

Describe Material\*

Pannello truciolare grezzo e nobilitato, realizzato con legno riciclato, utilizzato per allestimenti interni e mobili in ambienti secchi.

Basic Information

+ Add location

Location\*

LazioWerhouse

Availability\*

Continuously Available Yearly

One-off Available: until

Temporarily unavailable

Price

Please define the minimum amount of material per package, e.g. if you sell panels by pallet, how many square meters fit in a pallet. You can define volume pricing, offering discounts for large quantities, by adding multiple price ranges. Otherwise, you can also have a single price range.

Package size\* Unit

1 panel

## The role of AI - Second function: material search

Support in searching for materials available on the platform, by understanding the designer's needs through conversation with the chatbot assistant, and then quickly comparing the available alternatives

The screenshot displays a software interface with an AI assistant chat window on the left and a materials search results grid on the right. The chat window shows a prompt: "Find me materials for a chair in Art Deco style". Below the prompt, it states: "Based on your prompt, AI applied the filters: Translucence: Opaque, Texture: Smooth, and sorted the results by distance. Since many options remain, further specifying your requirements could help narrow them down." The chat window also includes a "Sort by" dropdown set to "Sustainability" and a "Filters" section with the following options: "Basic search" (plastic...), "Standard virgin material" (checked), "Circular material from W2M" (checked), "Region" (Lazio), "Address" (street...), "within: 150 km" (slider), "Price per unit" (€ 10-100, slider), and "Availability" (Continuously Available, One-Off Available, and Temporarily unavailable, with the first two checked).

The materials search results grid displays four material options, each with a thumbnail image, a title, a price range, quantity available, and region:

- Luminous Plastic** (Sapienza, One-Off Available): 5.00–8.00 € per kg, Quantity Available 500 kg, Region Lazio.
- EcoMosaic – Recycled PP** (EcoMateria Solutions, One-Off Available): 20.00–30.00 € per m<sup>2</sup>, Quantity Available 300 m<sup>2</sup>, Region Tuscany.
- GradaForm Birch Panels** (NordicGrain Woods, One-Off Available): 30.00–50.00 € per panel, Quantity Available 150 panels, Region Lombardy.
- Aurora Wood** (LumiTimber Creations, One-Off Available): 40.00–60.00 € per m<sup>2</sup>, Quantity Available 1,000 m<sup>2</sup>, Region Emilia-Romagna.

Each material card includes a "Select material" button and a green circular icon. The interface also features a "Show standard virgin materials" button at the top right of the grid and a "Download report" button on the right side of the screen.

## The role of AI - Third function: comparison of scenarios

Integration with the software plug-in in the restitution of crucial positive and negative aspects for each design scenario, based on the characteristics and peculiarities of the chosen material

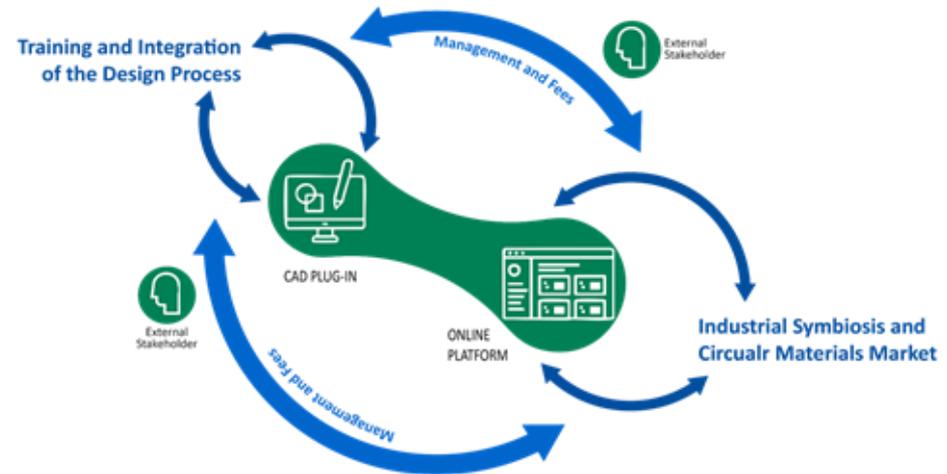
The screenshot displays the Rhinoceros 7 software interface. The main viewport shows a 3D model of a chair with a brown seat and backrest, and a light grey frame. The software's menu bar includes File, Edit, View, Curve, Surface, SubD, Solid, Mesh, Dimension, Transform, Tools, Analyze, Render, Panels, and Help. The command line shows 'Command:' and 'Select objects. Press Enter when done: \_Pause'. The toolbar includes various tools for modeling and rendering. The material configuration panel on the right shows two variants for comparison. Variant 1 uses Virgin Aluminum for the frame and Virgin PET for the seat and backrest. Variant 2 uses GradaForm Birch Panels for the frame and Virgin PET for the seat and backrest. The AI assistant suggests a sleek virgin aluminum frame and glossy virgin PET seat embodying Art Deco elegance and sophistication.

Material configuration	Variant 1	Variant 2
Material group 1: Frame	Virgin Aluminum	GradaForm Birch Panels
Material group 2: Seat&Back	Virgin PET	Virgin PET
Percentage of recycled material (weight) [%]	0 %	-
Embodied energy [kWh/kg]	152 kWh/kg	-
Embodied carbon [kg CO <sub>2</sub> eq/kg]	7.8 kg CO <sub>2</sub> eq/kg	-

AI assistant: Sleek Virgin Aluminum frame and glossy Virgin PET seat embody Art Deco elegance and sophistication.

## Testing phase

Designers and material producers gave positive feedback overall. While acknowledging its limitations due to ongoing development, users appreciated the platform navigation experience and AI support, emphasising how the data entry support function significantly speeds up the process of interfacing with the tool.



## Conclusions and research perspectives

Although the software plug-in remained in the embryonic prototype stage, the tool was met with enthusiasm by the stakeholders involved. Continuing the research, through collaboration with external certification bodies, will enable the development of a comprehensive and effective AI-based tool to reduce the impact of the furniture sector in terms of embodied carbon and embodied energy.

Thank you!

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