

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

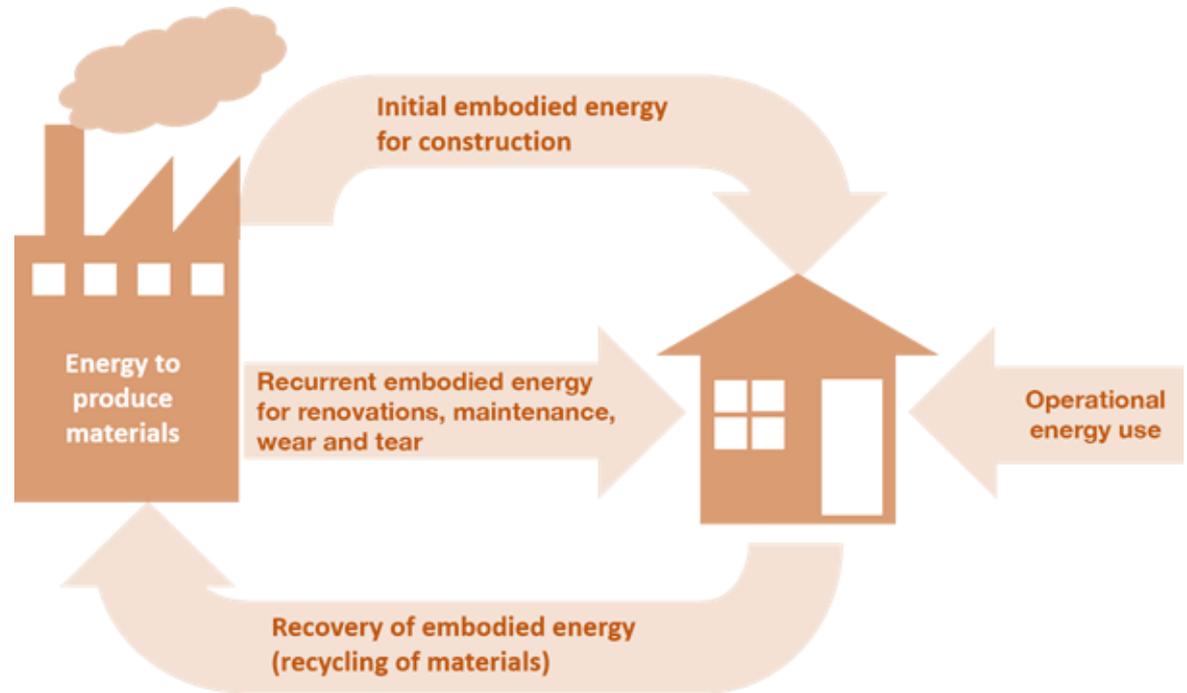
Gabriele Rossini

Planning Design Technology
of Architecture Department
Sapienza University of Rome
gabriele.rossini@uniroma1.it

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

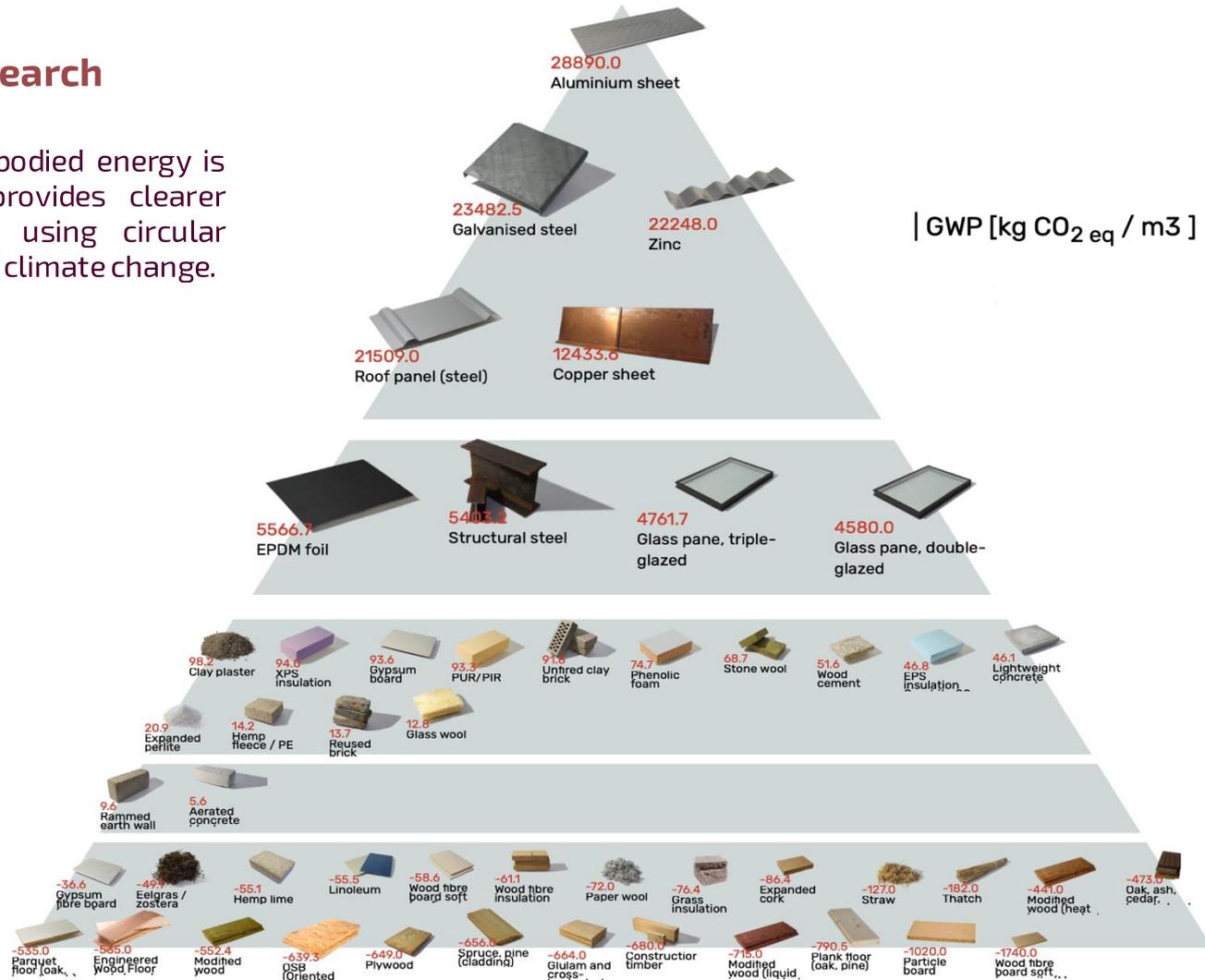
(Source: CRAS, Ecological Footprint, 2004)

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)



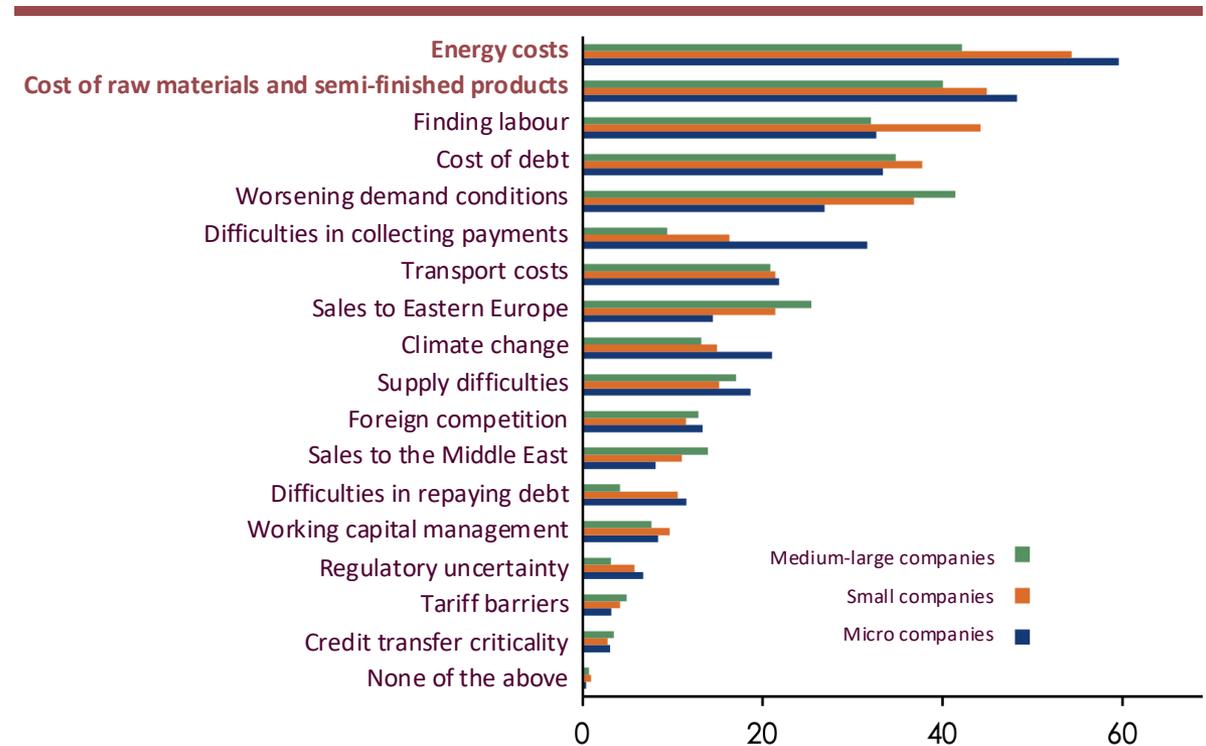
Source: Materiale Pyramiden (www.materialepyramiden.dk)

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)



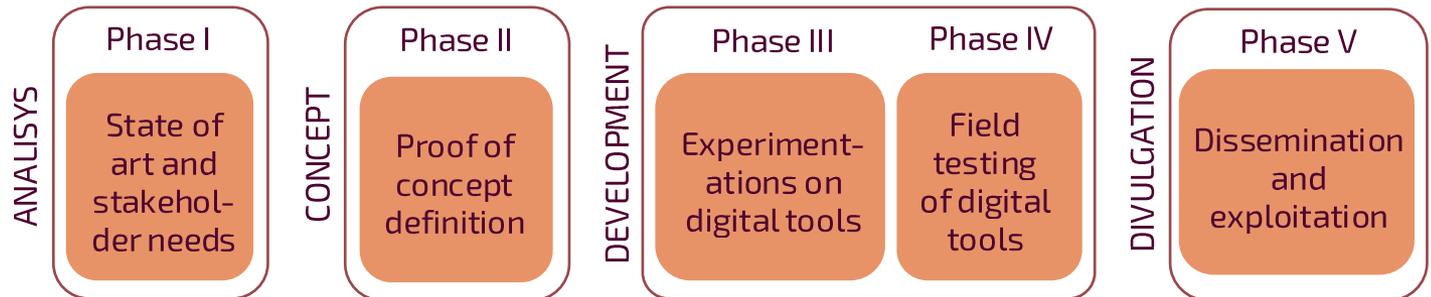
Project 1.7
From waste to manufacturing.
Digital tools to establish virtuous cycles

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

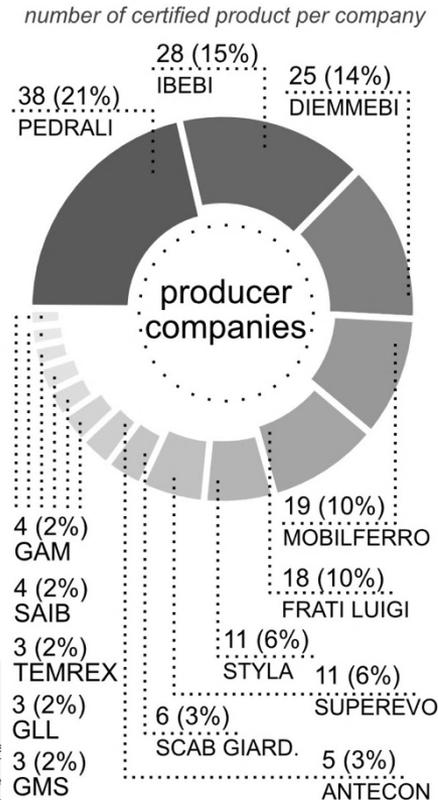
The research reviewed databases of certified furniture materials, components and products, including EU Ecolabel, C2C, ReMade in Italy, Plastica Seconda Vita and EPDIItaly, to map certified items. The research focused on the analysis of the ReMade in Italy catalogue because the Remade database contains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

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
Vai al dettaglio	Vai al dettaglio	Vai al dettaglio	Vai al dettaglio



Recycled, recovered or by-product content certification

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

A⁺

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 ₂ eq/kg



CONFORMITY
ASSESSMENT BODY

www.remade.it

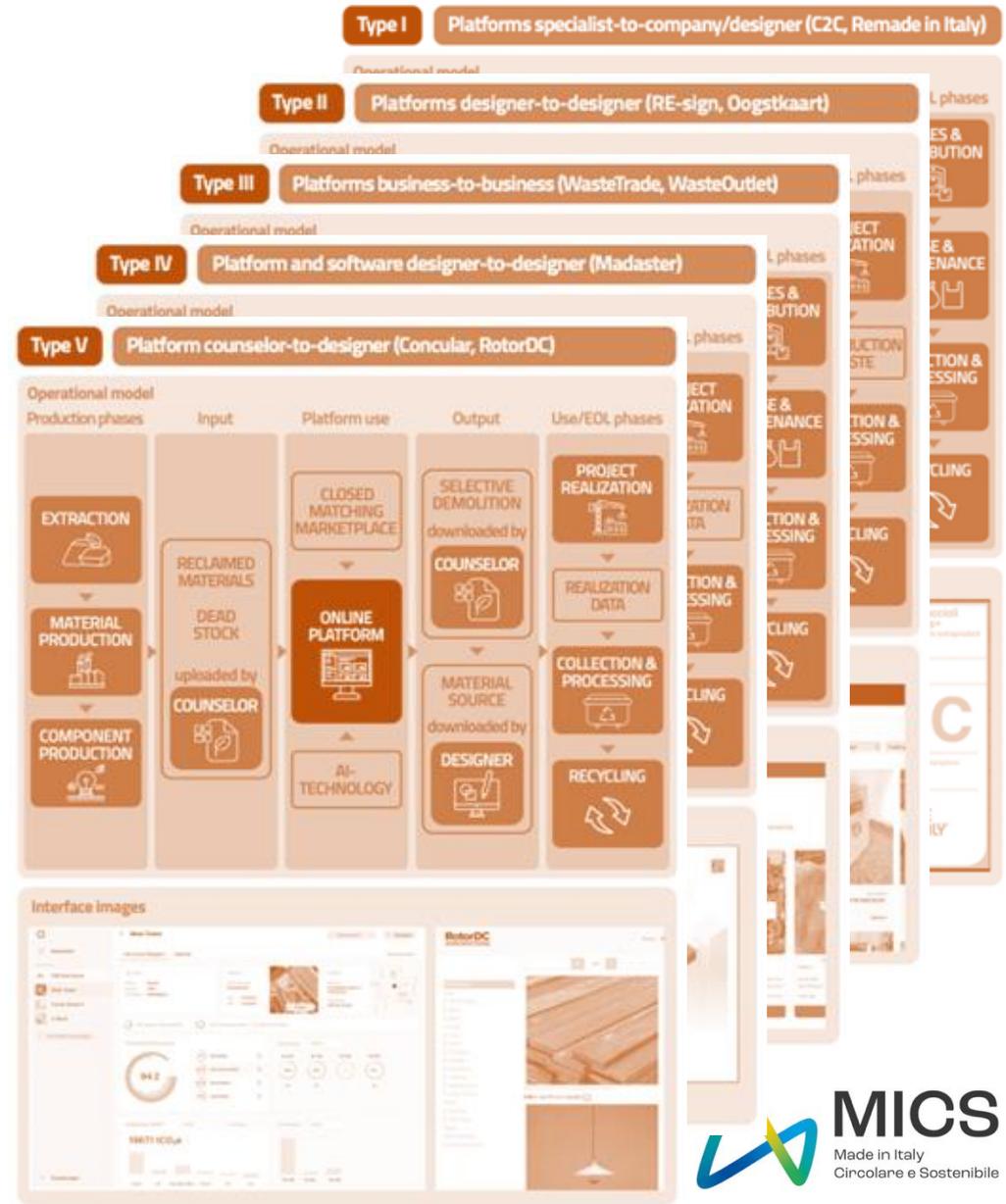
Digital platform benchmarking

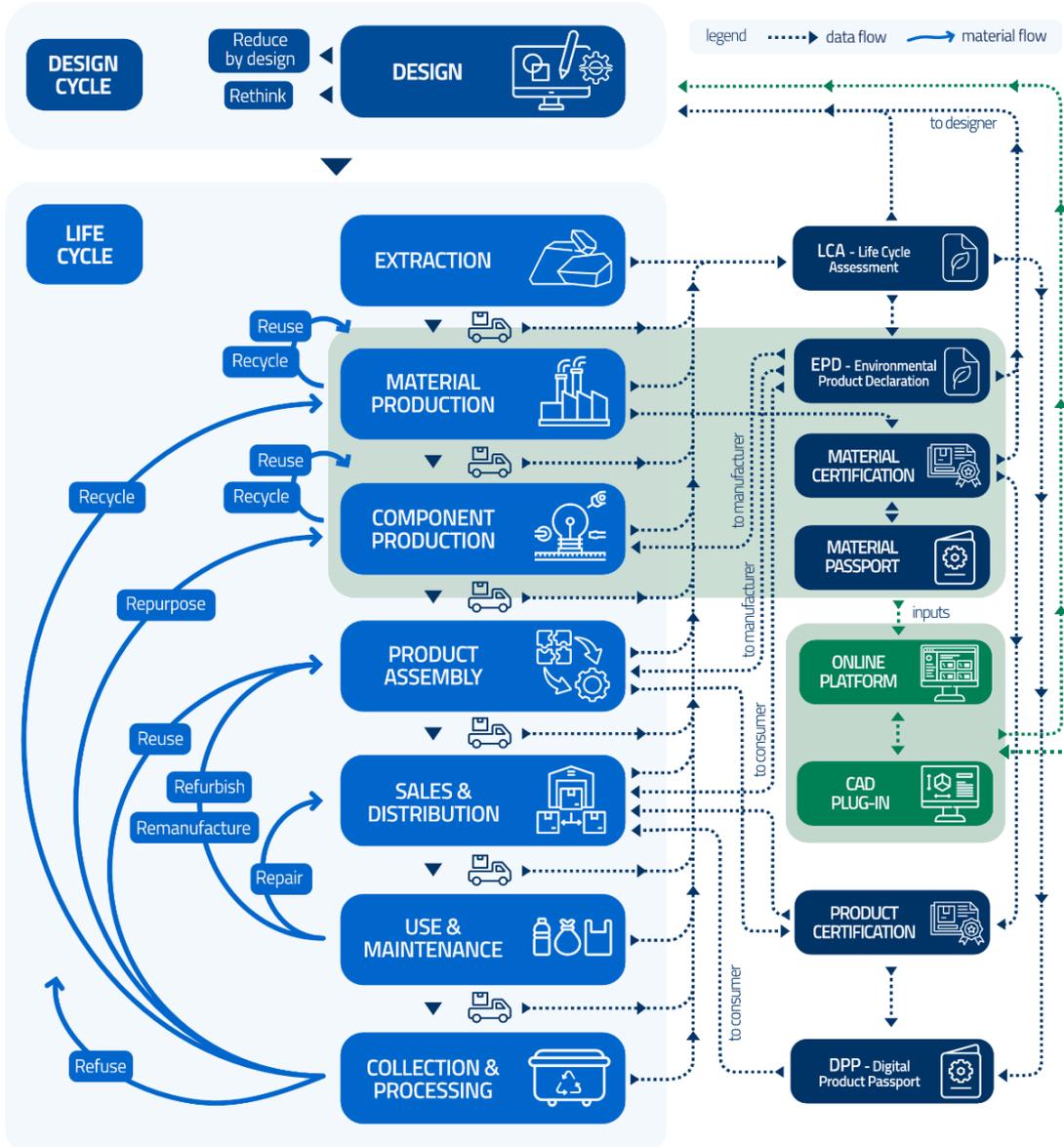
Mapping of existing digital tools supporting Circular Design.

- 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

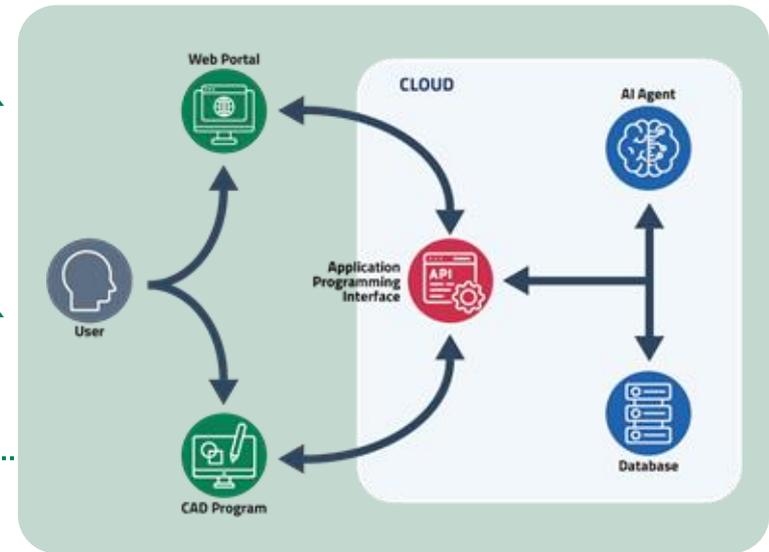
Concular

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*' text area with the description 'Pannello truciolare grezzo e nobilitato, realizzato con legno riciclato, utilizzato per allestimenti interni e mobili in ambienti secchi.', and a 'Basic Information' section with an '+ Add location' button, a 'Location*' dropdown menu set to 'LazioWerhouse', 'Availability*' radio buttons for 'Continuously Available' (selected), 'One-off Available: until', and 'Temporarily unavailable', and a 'Price' section with a 'Package size*' input set to '1' and a 'Unit' dropdown set to '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, Temporarily unavailable). The materials search results grid displays four material cards:

- 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 m², Quantity Available 300 m², 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 m², Quantity Available 1,000 m², Region Emilia-Romagna.

Each card includes a "Select material" button and a small 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.

The role of AI - Third function: comparison of scenarios

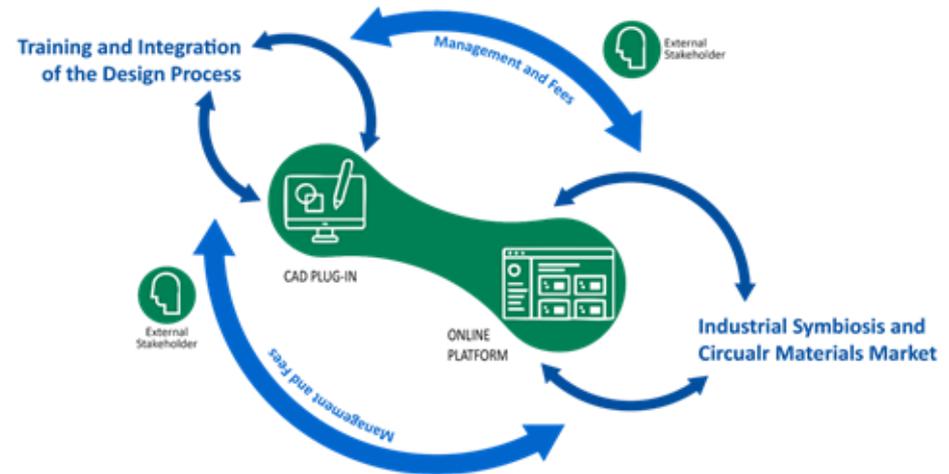
Integration with the software plug-in in the restitution of crucial positive and negative aspects for each design scenario, based on the characteristics and peculiarities of the chosen material

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 the current view is 'Perspective'. The material configuration panel on the right is titled 'Material configuration' and includes a '+ Add variant' button and a 'Download report' button. It shows two variants: Variant 1 and Variant 2. 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 a placeholder for the seat and backrest. The panel also displays metrics for embodied energy and embodied carbon for each variant. An AI assistant section at the bottom of the panel suggests 'Sleek Virgin Aluminum frame and glossy Virgin PET seat embody Art Deco elegance and sophistication.' The status bar at the bottom shows various settings like 'End', 'Near', 'Point', 'Mid', 'Cen', 'Int', 'Perp', 'Tan', 'Quad', 'Knot', 'Vertex', 'Project', 'Disable', 'CPlane', 'x 59.420', 'y 25.853', 'z', 'Centimeters', 'Screws', 'Grid Snap', 'Ortho', 'Planar', 'Osnap', 'SmartTrack', 'Gumball', 'Record History', 'Filter', and 'Absolute tolerance'.

Metric	Variant 1	Variant 2
Percentage of recycled material (weight) [%]	0 %	-
Embodied energy [kWh/kg]	152 kWh/kg	-
Embodied carbon [kg CO ₂ eq/kg]	7.8 kg CO ₂ eq/kg	-

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!

Gabriele Rossini

Sapienza University of Rome

gabriele.rossini@uniroma1.it

Paola Altamura

Sapienza University of Rome

paola.altamura@uniroma1.it

Serena Baiani

Sapienza University of Rome

serena.baiani@uniroma1.it