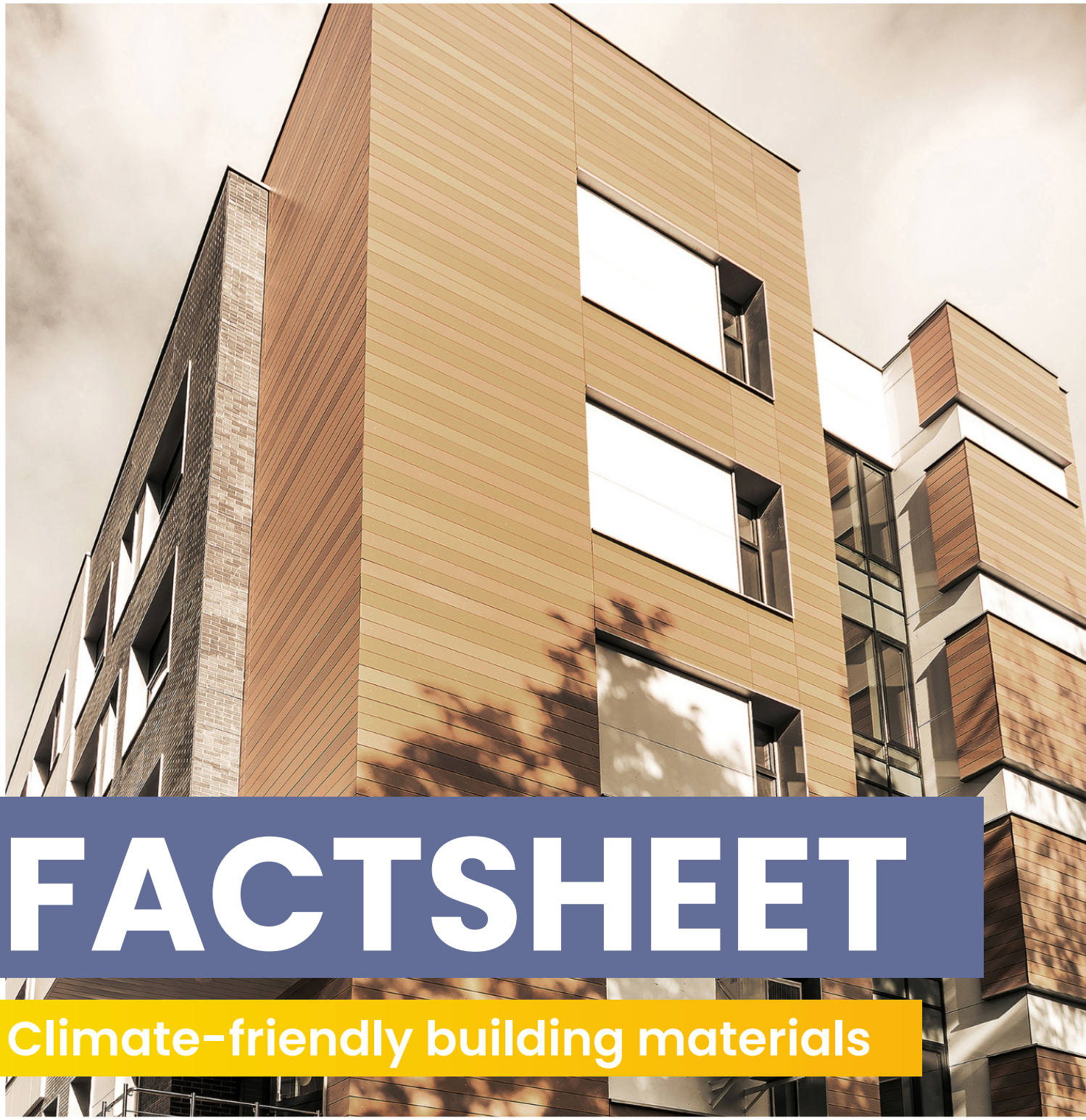

FACTSHEET

Climate-friendly building materials

This document was developed as part of **'SURF – SUstainable Building Renovation – Forming the Future' project.** SURF project is part of the European Climate Initiative (EUKI), a project financing instrument by the German Federal Ministry for Economic Affairs and Climate Action (BMWK). The EUKI competition for project ideas is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. It is the overarching goal of the EUKI to foster climate cooperation within the European Union (EU) in order to mitigate greenhouse gas emissions.

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INTRODUCTION

The building sector is a key leverage point to reduce greenhouse gas (GHG) emissions in the European Union (EU), as around 36% of the EU's energy-related GHG emissions originate from the building stock.[1] In 2019, the European Commission presented the European Green Deal, its roadmap for Europe to become a climate-neutral continent by 2050. It sets a goal of reducing GHG emissions by 55% by 2030. The European Green Deal aims, among other things, to improve the efficient use of resources through the transition to a clean, circular economy and to stop climate change. It covers all economic sectors, especially transport, energy, agriculture, industries and buildings.[2] Nevertheless, the EU goal of climate neutrality for buildings by 2050 can only be achieved through increased and sustainable building renovation.

To help achieve climate neutrality of the building sector by 2050, the **SURF project** was launched under the **European Climate Initiative** (EUKI). The main objective of this project is to address the knowledge and capacity gaps of municipal stakeholders in EU Member States regarding sustainable building renovation and, by empowering them, to promote the implementation of deep and sustainable building renovation projects across the EU.

As part of the SURF project, three factsheets on different sustainable renovation topics were developed to expand the know-how of municipal stakeholders and support them with this knowledge transfer in the planning and implementation of sustainable building renovation projects. Each factsheet contains background information on a dedicated topic, related best practice examples from European municipalities, as well as important lessons learnt.

This factsheet focuses on the topic of climate-friendly building materials. Two further factsheets are dedicated to the topics of financing sustainable renovation projects and Green Public Procurement (GPP) in the building sector, including the integration of environmental aspects in procurement procedure.

[1] European Commission. Energy Performance of Buildings Directive. • Available here

[2] European Commission. 2050 long-term strategy. • Available here

1 CLIMATE-FRIENDLY BUILDING MATERIALS

CO_2 emissions are released not only during the operational life, but also during the manufacturing, transportation, construction and end-life stages of buildings. These emissions, usually referred to as embodied carbon, have been largely overlooked in the past. **However, they are responsible for approx. 11% of all global carbon emissions. CO_2 emitted before the building is in use (also known as 'upfront carbon') will account for half of the total carbon footprint of new buildings by 2050 and threaten to consume a large share of our remaining carbon budget.**[3]

As operational carbon is reduced, the share of embodied carbon in total emissions will grow in importance. Thus, for example, while the average share of embodied GHG emissions in buildings constructed under the current energy performance regulations accounts for 20-25% of life cycle GHG emissions, this figure increases with the implemented energy efficiency measures (e.g. higher degree of insulation, triple-glazed windows, solar panels etc.): to 45-50% in case of highly energy efficient buildings and in extreme cases it may even reach 90%.[4]

In addition, building industry is the key end user of materials with high environmental impact, such as cement, iron and steel. For example, **51% of the CO_2 emissions from the cement industry** and 32% of the CO_2 emissions from iron and steel production are linked to the building sector.[5]

CO_2 emitted before the building is in use (also known as 'upfront carbon') will account for half of the total carbon footprint of new buildings by 2050.

Embodied carbon can be reduced by the following measures: [6]
Prevention. Avoiding the construction of buildings is the most impactful measure to avoid embodied carbon.
Reduced and optimized use of building materials. Using fewer and/or climate friendly (low carbon) building materials reduces embodied carbon. Climate friendly building materials include, for example, renewable raw materials, i.e. agricultural and forestry products or side-products, such as timber, hemp, straw, etc.
Circularity. Embodied carbon can also be reduced by reusing and using recycled building materials.

[3] The World Green Building Council et al. (2019): Bringing embodied carbon upfront. Coordinated action for the building and construction sector to tackle embodied carbon. • Available here

[4] Röck et al. (2020): Embodied GHG emissions of buildings – The hidden challenge for effective climate change mitigation, Applied Energy. Volume 258, 15 January 2020, 114107. • Available here

[5] Architecture 2030. Why the built environment. • Available here

[6] Prof. Zsuzsa Szalay: Basics of Life-Cycle Assessment (LCA) of buildings not publicly available online course material Lecture 3 by HuGBC, 2024

Thus, one of the above given options to reduce embodied carbon is to use climate friendly building materials. But what are climate friendly building materials? **Climate-friendly materials are alternatives to conventional building materials that have less negative impact on the environment because they are regional and durable and can be reused at the end of the building's life cycle.** Moreover, their production is less energy intense. As a result, the use of climate-friendly building materials reduces the carbon footprint of a building. They normally include renewable raw materials (e.g. timber, clay, straw or hemp), reusable or recycled materials.

By reusing and recycling building materials, you can not only reduce CO_2 emissions from buildings, but also minimize the consumption of natural resources and waste. Examples of recycled materials that can be used in construction and renovation projects include recycled steel, metal, glass, plastic, wood, bricks, metal, concrete. For example, the CO_2 footprint of virgin steel is five times higher than the CO_2 footprint of steel with a high recycled content.[7] Furthermore, by using recycled wood, we save the energy that would have been needed to fell the wood, transport it to the sawmill and process it. In addition, the saved trees continue to sequester carbon.

Thus, while there is a need for continued focus on operational carbon, we must now also rapidly scale up our efforts to tackle embodied carbon emissions.[8]

Achieving a climate-neutral building stock by 2045 thus requires a holistic view on buildings over their entire life cycle: from construction (e.g. due to use of construction materials and construction products) through use (e.g. due to building operation and maintenance) to end-of-life (e.g. due to demolition).[9] Sustainable and life-cycle-based renovations are therefore pivotal for successful climate action.

2 GOOD PRACTICE EXAMPLE:
By-products of rice cultivation as sustainable insulation material

Currently, agricultural by-products rice straw and husk are usually burned in Italy. However, burning them releases CO_2 emissions and other harmful air pollutants into the atmosphere. If rice straw and husk are not burned but used as building materials, they can sequester significant amounts of CO_2 in buildings. By involving various links in the supply chain for rice straw and husk, it is possible to create new opportunities for the production of innovative climate-friendly insulation materials for healthy buildings and contribute to mitigating climate. This can be illustrated using the example of **CLEVER Cities project** implemented in Milan by Ricehouse. **Ricehouse** is a consultant and implementer working with municipalities and other stakeholders willing to retrofit their buildings with rice by-products.

In Italy, 230,000 hectares are used for rice cultivation. 93% of these areas are loccated in the north of the country, where Ricehouse is based. The annual rice yeald is 1.6 million tons.

[7] AIA California. Embodied carbon. • Available **here**

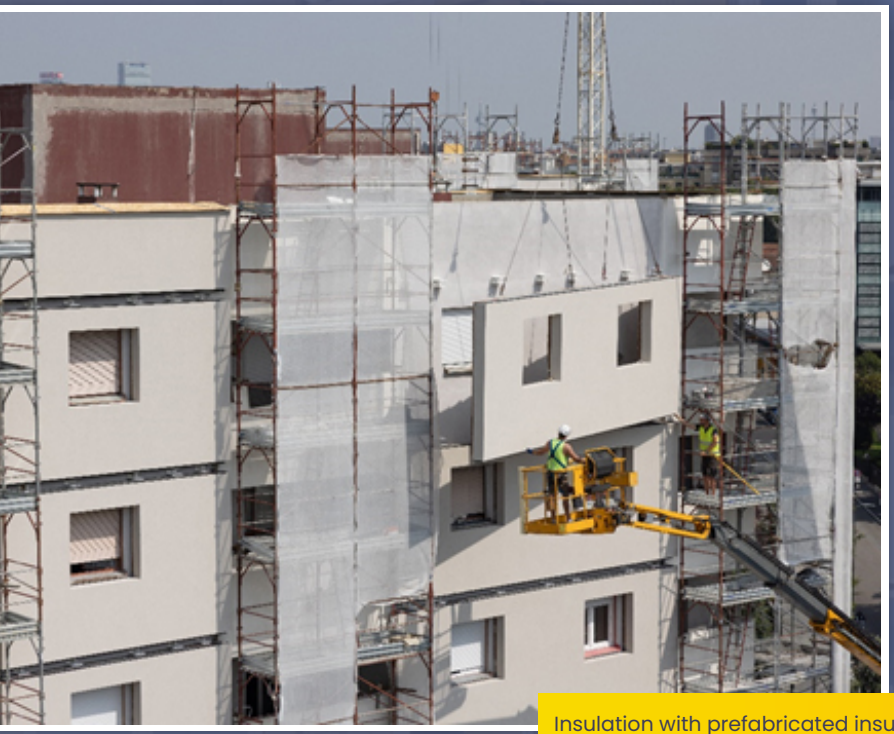
[8] Ibid.

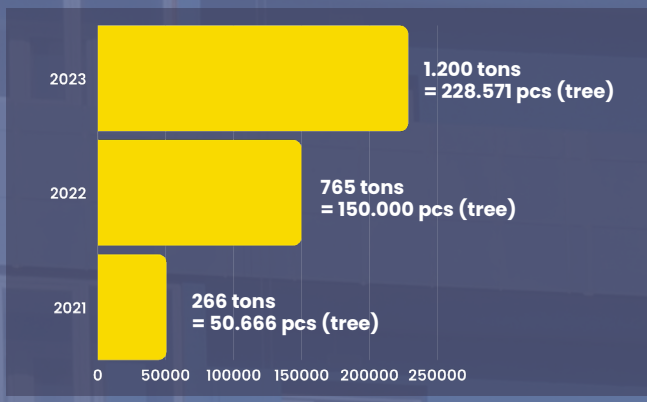
[9] DGNB (2020): Building life cycle assessment. New buildings criteria set. Version 2020. International.

Using by-products of rice cultivation as sustainable insulation material for buildings[10]	
What	As part of the CLEVER Cities project, four social housing units (Torri Via Russoli) were renovated with prefabricated climate-friendly insulation made from rice by-products - rice husks and straw - between 2022 and 2023. The renovation led to a huge improvement in energy efficiency, from energy efficiency class G to A4.
Who	Ricehouse
Where	Milan, Italy
When	2022-2023

Within the frame of the CLEVER Cities project, four social housing buildings built in the 1980s and owned by the Lombardian housing association ALER (Azienda Lombarda Edilizia Re-senziale Milano) were refurbished with prefabricated **climate-friendly insulation made from rice husk and straw.** A decade ago, it was discovered that the insulation panels on the façades of the four buildings contained asbestos and therefore had to be removed. Once removed, the panels were not replaced with new ones for a long time, leading to heat losses and discomfort for the residents (negative economic, environmental consequences), until the CLEVER Cities project was implemented.

The Ricehouse architecture projects, in which by-products from rice cultivation were used as sustainable insulation material for buildings, resulted in the following sequestered CO_2 emissions in 2021-2023:[11]





The estimated annually sequestered CO_2 in Italy amounts to 2.440.000 tons (= 464.761.905 trees) if all available by-products of rice cultivation were used.[12]

Insulation with prefabricated insulation panels made from rice by-products (© Ricehouse)

[10] Description in the table and Background section is based on the presentation given by Alessio Colombo in the online 'Renovation Lunch' on February 20, 2024, as part of SURF project.

[11] Eni Integrated Technical Study „Sustainable land use management and forest offsets" San Donato Milanese, October 2018; presentation of Alessio Colombo at SURF 'Renovation Lunch' on 20.02.2024. • Available here

[12] Ibid.

Implementation

The refurbishment of four eight-storey social housing buildings was carried out in 2022-2023 as part of an architectural project for energy-efficient refurbishment with prefabricated systems.

Prior to the renovation, the façades of the buildings were 12 cm thick and offered neither protection from the cold in winter nor from the heat in summer. As part of the **CLEVER Cities project,** the façades were insulated with fireproof panels of compressed rice straw and covered with rice husk-based plaster.

After the renovation, the energy efficiency of the four buildings was improved dramatically: from energy efficiency class G to class A4 (A++++), i.e. they were upgraded to nearly zero-energy building (nZEB) standard. The annual energy demand of originally nearly 60,000 kWh/year was reduced to less than a tenth (around 5,000 kWh/year).

In addition to the façades, the roofs were also insulated. Moreover, solar PV systems were installed on parts of the roof and roof gardens were created. Converting flat roofs into roof gardens not only promotes biodiversity, but also counteracts the heat island effect and creates new green spaces. The project therefore resulted in positive environmental and social impacts on the neighbourhood.

The project has diverse additional positive benefits, such as:
The roof-gardens enable low-income tenants to produce food at low cost and also creates a 0 km production chain.
It leads to integration between citizens and the recovery of good-neighbourliness.
It promotes citizens' respect for public space.

The implementation of the project was made possible by the following factors:
The design and partly also the implementation phase were funded by the 'Superbonus 110%' financial scheme based on the Decree-Law 19 May 2020.
The rest of the funding needed was provided by CLEVER Cities project (LIFE).
The stakeholders ensured the management and communication of the project development.

Regarding stakeholder engagement, a complex co-creation and co-design process was developed between designers and all types of stakeholders (universities, public and municipal institutions as well as private companies) throughout the phases of inspiration, conception, and implementation.

The CLEVER Cities co-design process represented a starting point for initiating a collaboration between the residents in the four social housing towers.

Lessons learnt

The following insights can be gained from the good practice example – insulation of social housing buildings with by-products of rice cultivation in Milan:

Energy requirements and climate change mitigation goals can also be met by using natural insulation materials.

Although match funding is somewhat challenging, in most cases it ultimately results in successful project implementation.

Collaboration with innovative small and medium enterprises (SMEs) can be fruitful for municipalities.

Where rice-by-products are not available due to climate restrictions, one should search for alternative renewable raw materials (e.g. other kinds of straw, wood fiber, etc.).

Further information

- Presentation about the CLEVER cities project
- Ricehouse website: https://www.ricehouse.it/en/
- CLEVER Cities project website: https://clevercities.eu/news/?c=search&uid=DY5k7QQD

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