A Material Compass for EU-Oriented Reconstruction of War-Damaged Residential Buildings in Ukraine

Embodied Carbon

Втілений вуглець

FELICITY
Accelerating investments for low carbon cities

Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety
IKI INTERNATIONAL CLIMATE INITIATIVE
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Why circular reconstruction in Ukraine?

The photo shows volunteers in Kharkiv clearing debris from a residential building.
© Yevgeniya Kutnova

Ukraine faces a dual reconstruction challenge:

14%

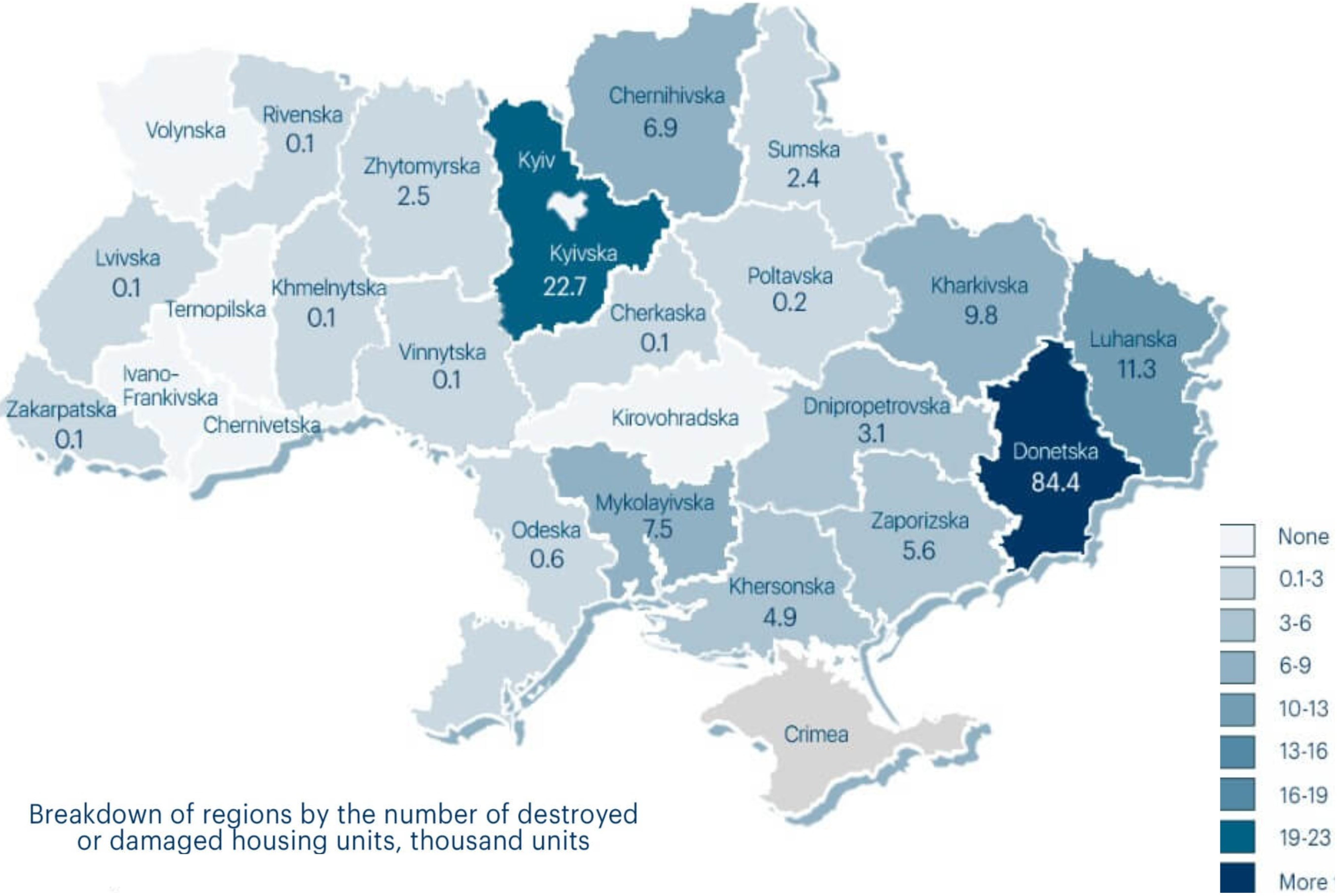
of the national housing stock damaged or destroyed

85–90%

remaining buildings are highly energy-inefficient

Post-war recovery must therefore address both reconstruction and deep renovation.

Circular approaches offer a pathway to rebuild faster, more affordably, and with lower environmental impact



Breakdown of regions by the number of destroyed or damaged housing units, thousand units

From Emergency Response to Long-Term Resilience

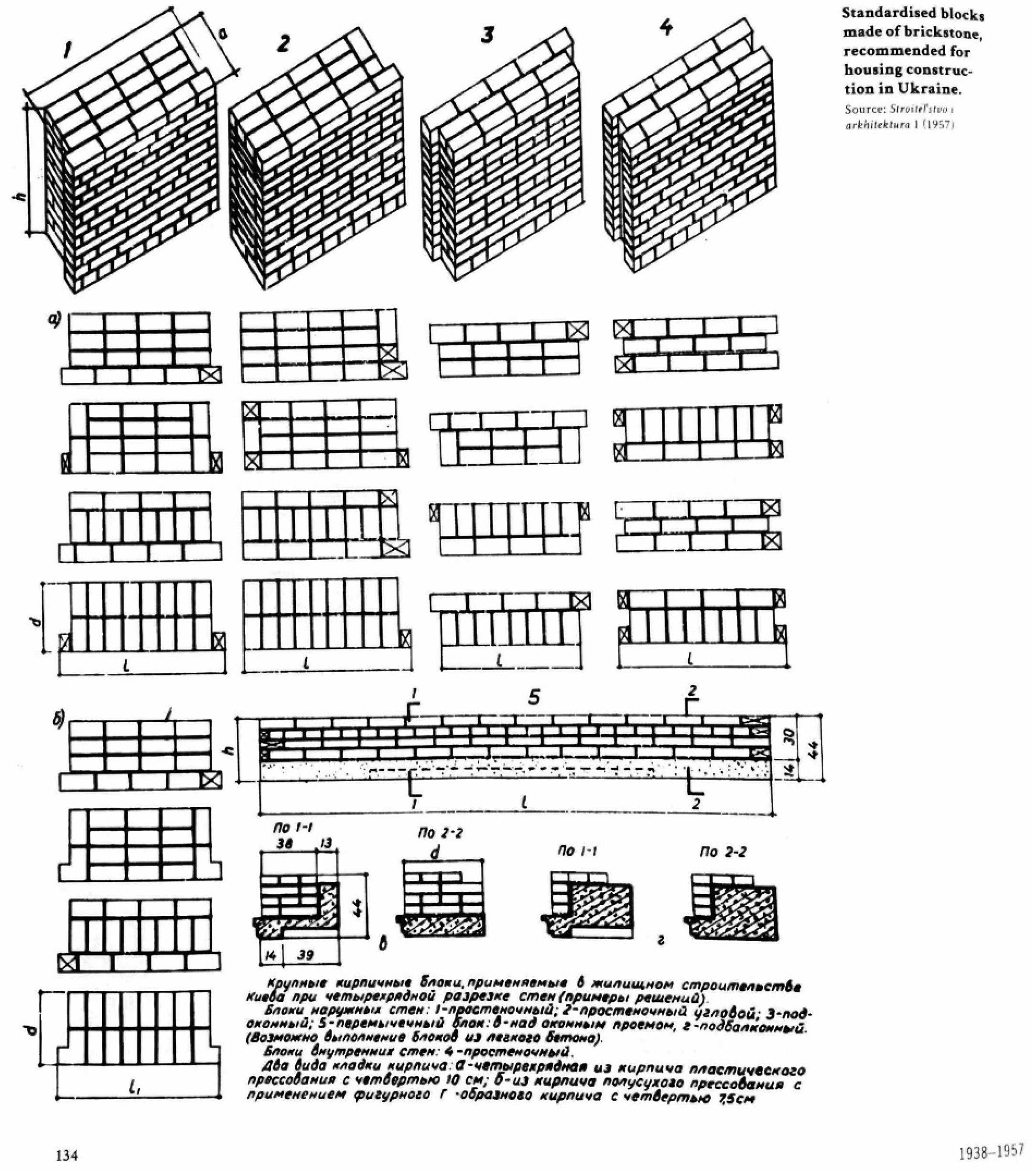
Post-war reconstruction is not only about replacing lost housing. It must also:

Reduce long-term energy demand

Lower operational costs for households

Increase resilience to energy shortages and future crises

Circular construction integrates material efficiency, life-cycle thinking, and adaptability

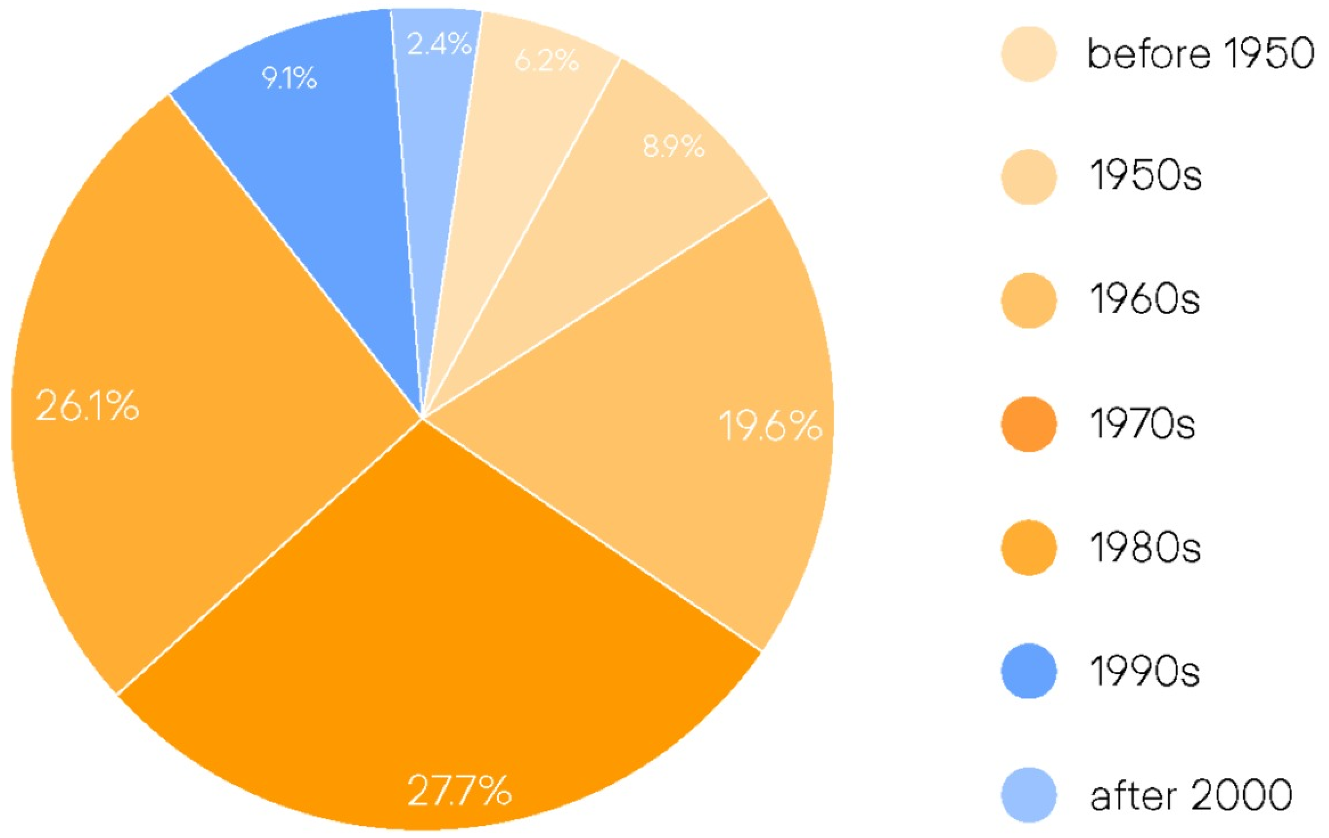


Standardised blocks made of brickstone, recommended for housing construction in Ukraine.
Source: *Stroitel'stvo i arkhitektura* 1 (1957)

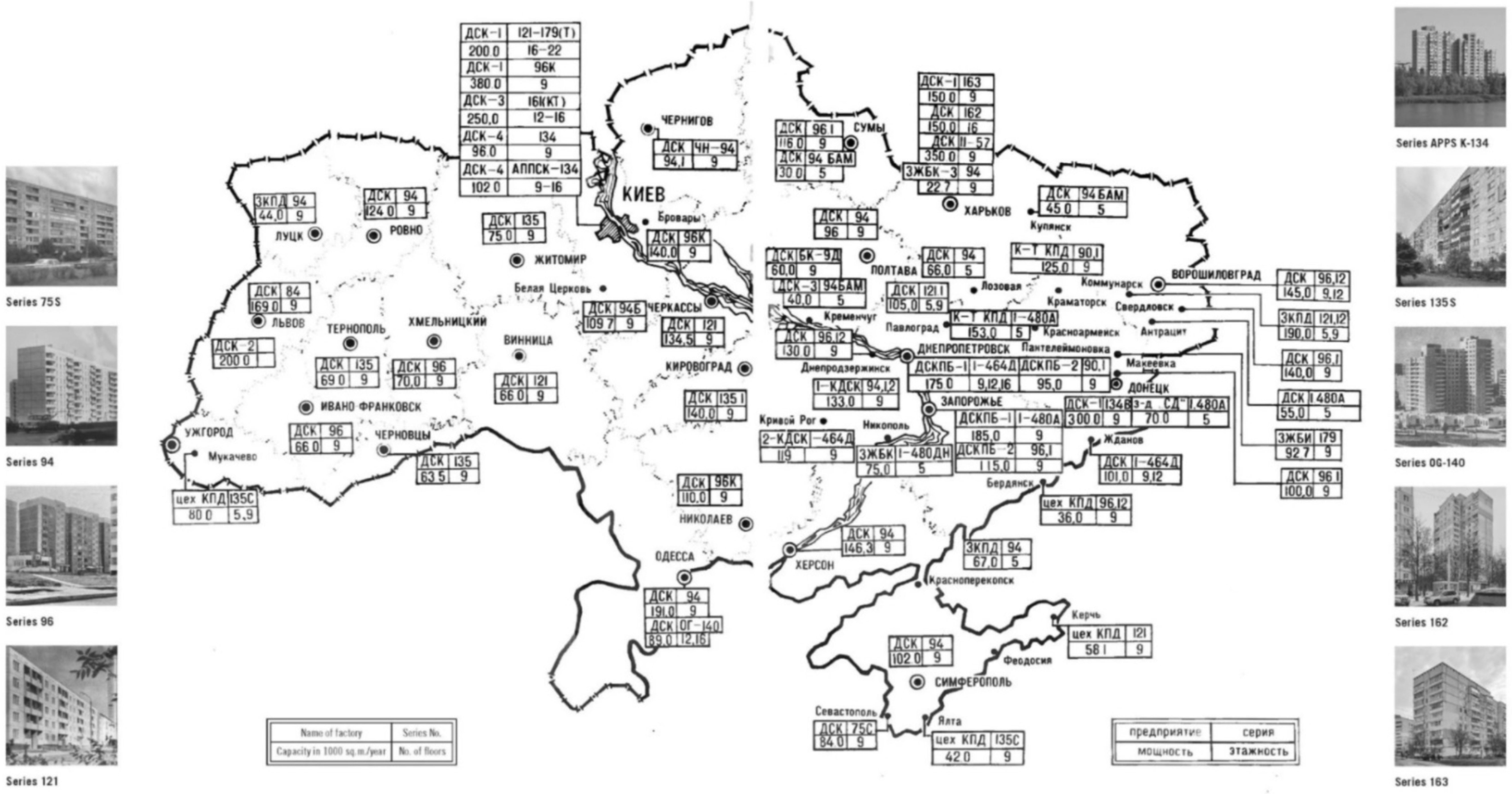
Renovation of Mass Housing

Using Circular Construction

Understanding typological differences within the existing building stock enables the development of **scalable, easily replicable renovation strategies**.



distribution of housing stock in Ukraine by period.



Semen Shyrochyn, “The housing heritage of Ukraine”, lecture at RWTH Aachen on March 2024

Embodied carbon

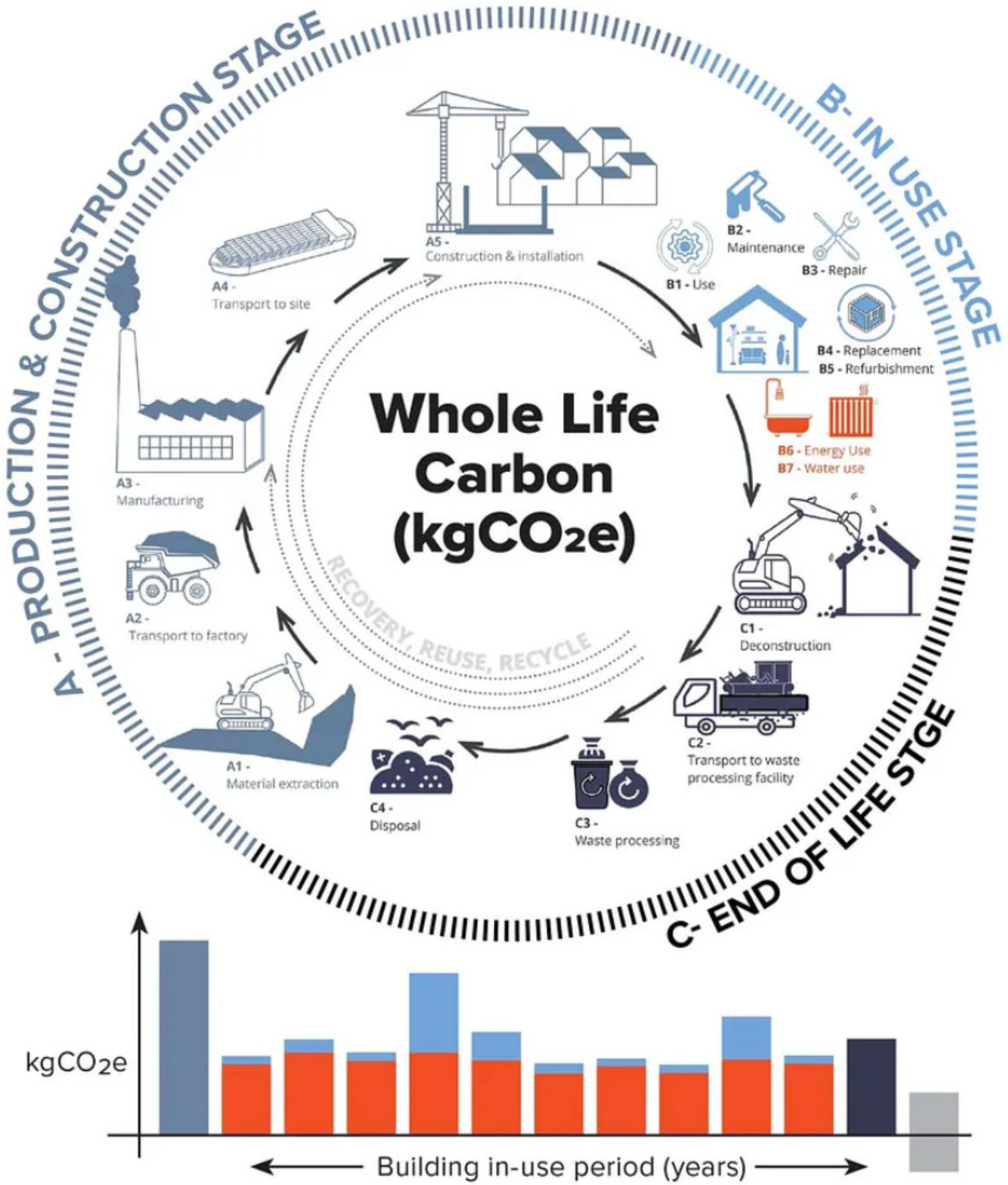
What is it and why does it matters

Embodied carbon is the total greenhouse gas emissions associated with a material's entire lifecycle, from raw material extraction and manufacturing to transportation, construction, maintenance, and disposal.

Unlike operational carbon (emissions from a building's energy use), embodied carbon is "locked in" before the building is even occupied, making it crucial to address during the design and construction phases to meet climate goals.

Building construction and operations are pivotal in climate mitigation efforts.

While emissions from building operations can be easily reduced through renewable energy adoption and improved energy efficiency, the so-called "embodied" greenhouse gas (GHG) emissions, also called "embodied carbon," associated with building material production and processing are expected to rise due the global construction demand.

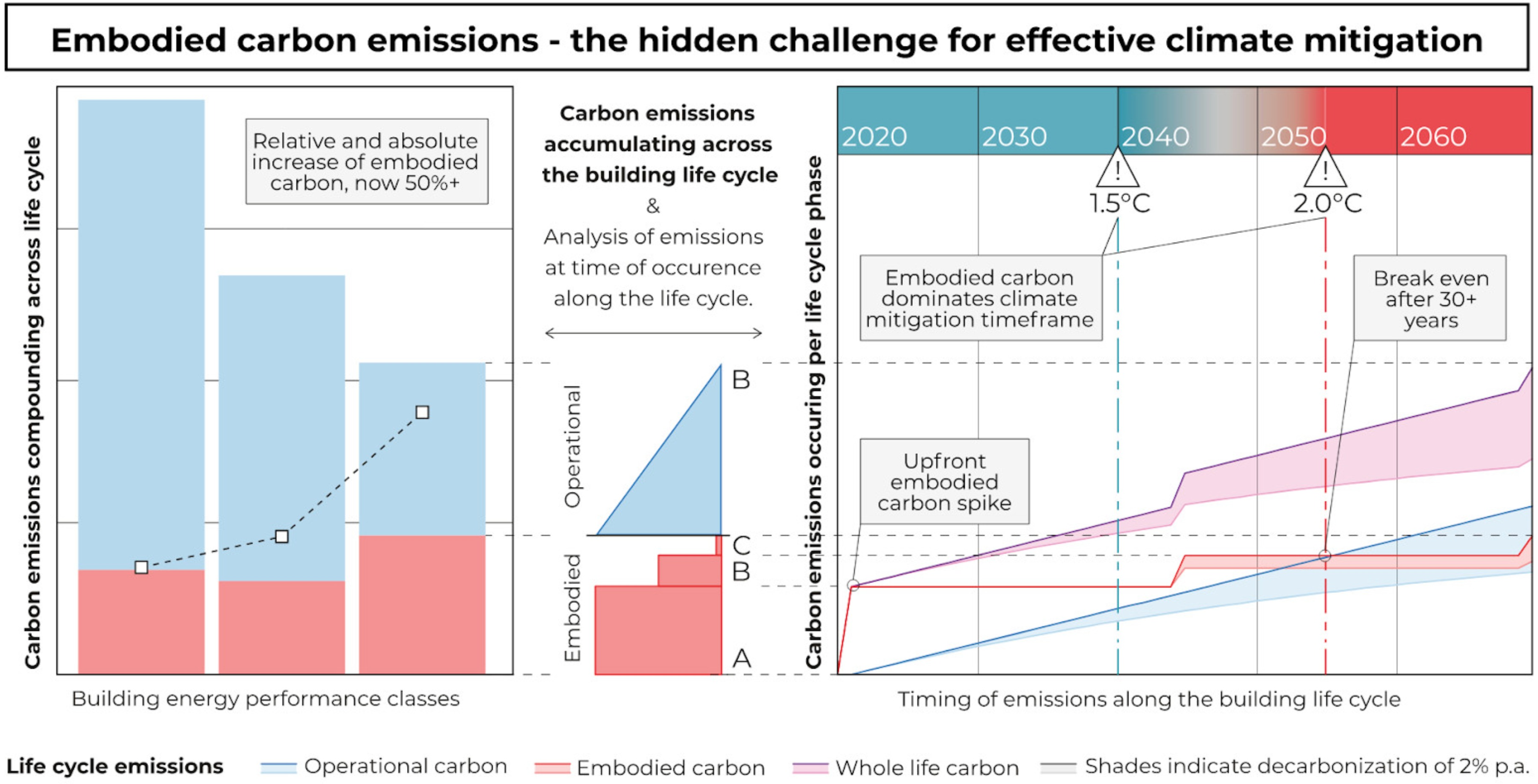


Source: https://www.canadianarchitect.com/hiding-in-plain-sight-embodied-carbon-mep-systems/

Unlike operational carbon, which is emitted continuously throughout a building's use phase, embodied carbon is released in concentrated "spikes" at specific moments in a building's life cycle.

The most significant of these occurs at the very beginning, during the production and processing of construction materials, as well as during transportation and on-site construction

This initial phase therefore represents the greatest opportunity for emission reductions.



Martin Röck et al., "Embodied Carbon Emissions of Buildings and How to Tame Them," One Earth 6, no. 11 (2023): 1458–64, https://doi.org/10.1016/j.oneear.2023.10.018.

Scope of the project

In the Ukrainian context, reconstruction efforts cannot be separated from the substantial emissions associated with the construction sector.

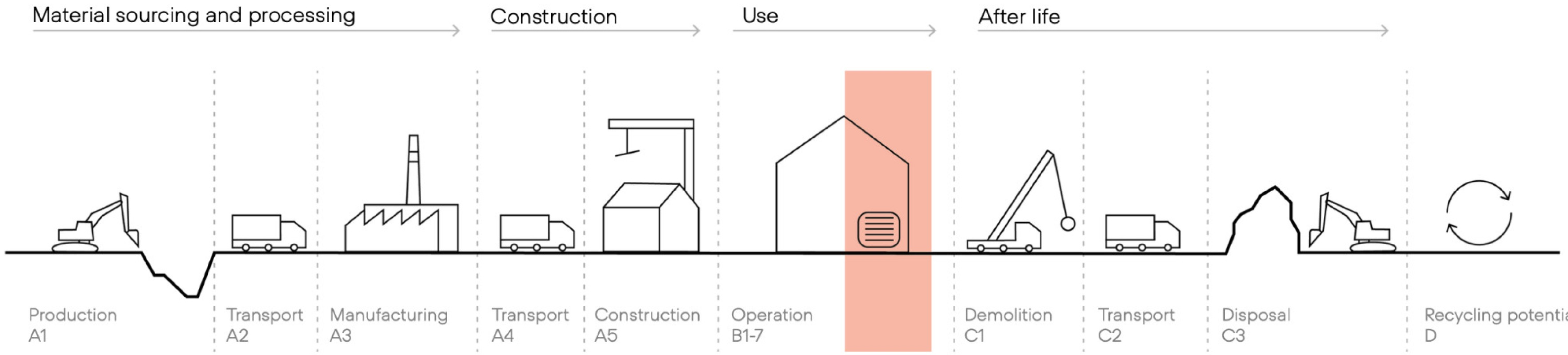
Accordingly, the objective of this research is to raise awareness of the social, economic, and environmental dimensions of embodied carbon and to introduce a whole-life carbon perspective into post-war reconstruction.

This approach supports alignment with EU decarbonisation targets and with holistic reconstruction principles, such as those articulated by the New European Bauhaus.

Following an overview of Ukrainian material sheds, the study proposes a general reconstruction assessment guide based on the analysis of a war-damaged multi-family building in the municipality of Mykolaiv.

The research concludes by identifying barriers to the implementation of the proposed measures, as well as opportunities to address this dual challenge.

These opportunities include positive spillover effects such as the creation of local value chains, which can contribute to broader reconstruction goals in line with the Build Back Better principles.



Life-cycle perspective. Graphic © Bauhaus Earth

Regenerative Construction in Ukraine, why right now?

1. Scarcity of materials and resources
2. Long term global challenges, climate and resources
> material security and local value creation
3. Regulatory readiness > EU alignment and long-term resilience

Presentation

1	EU+UA	EU Frameworks – Renovation Wave + NEB UA alignment with EU Frameworks
2	Local Specificity	Material Sheds for Low-Carbon Reconstruction. Nature-Based Materials – Availability + Regulations Secondary Materials – Availability + Regulations Industrial Waste – Availability + Regulations
3	Two pilot buildings in Ukraine	in Mykolaiv and Kryvyi Rih + Local Material Manufactures
4	Conclusions + recommendations	

EU principles
EU-aligned criteria
NEB values

Graphic © Ormazabal Velatia

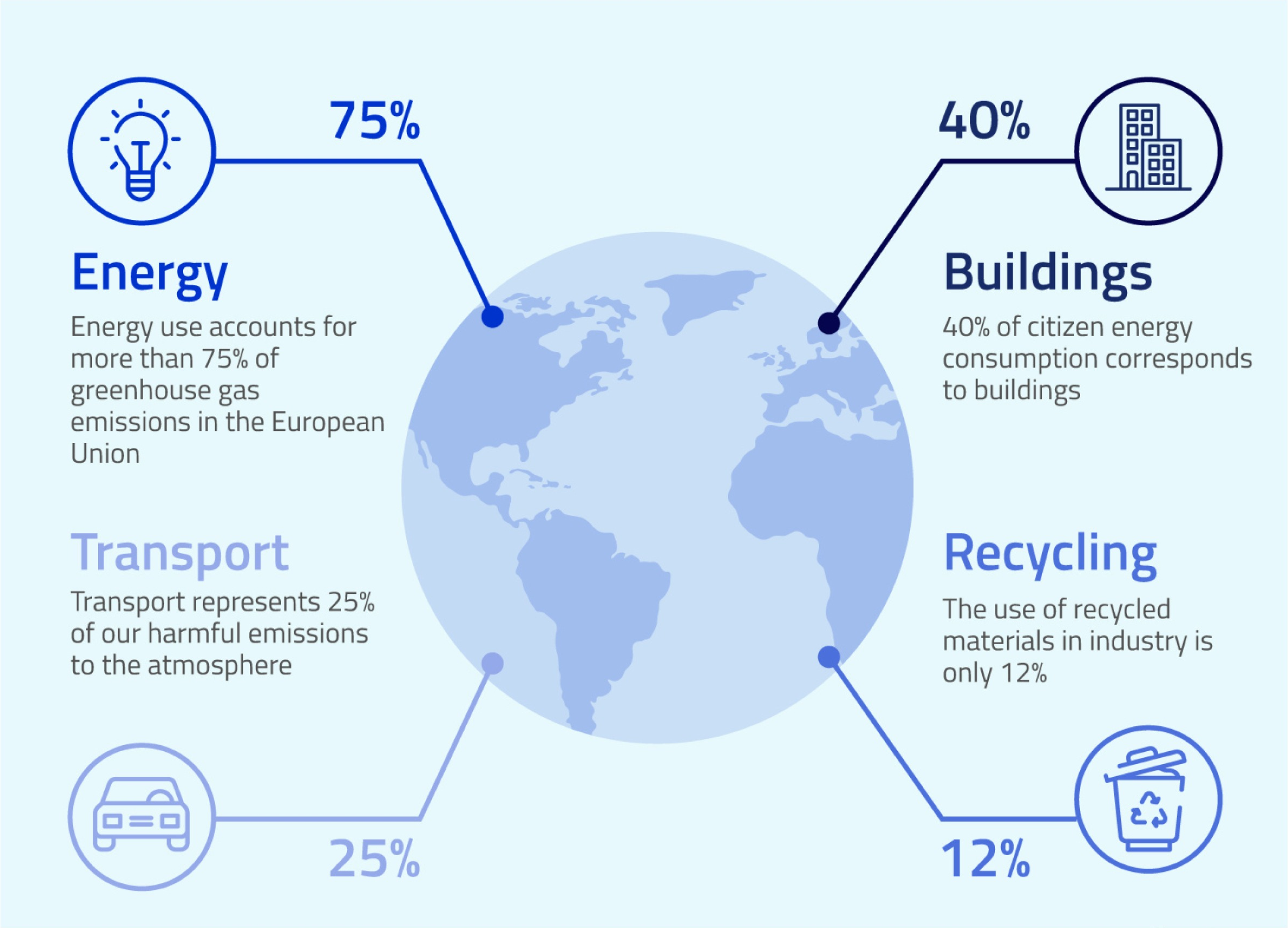
EU Targets

The EU aims to become the world's first climate-neutral continent by 2050.

With buildings accounting for 40% of the EU's final energy consumption and 36% of its energy-related greenhouse gas emissions, they sit at the center of the climate debate.

In 2019, the Member States of the European Union committed to the ambitious goal of making Europe the first climate-neutral continent by 2050. This commitment was formalised through the European Green Deal (EGD), a comprehensive policy framework that seeks to reduce net greenhouse gas emissions by at least 55 per cent by 2030 compared with 1990 levels.

This framework adopts a systemic and cross-sectoral approach, encompassing energy, industry, mobility, construction, and finance, while recognising that climate change and biodiversity loss are global challenges requiring coordinated action beyond national borders.



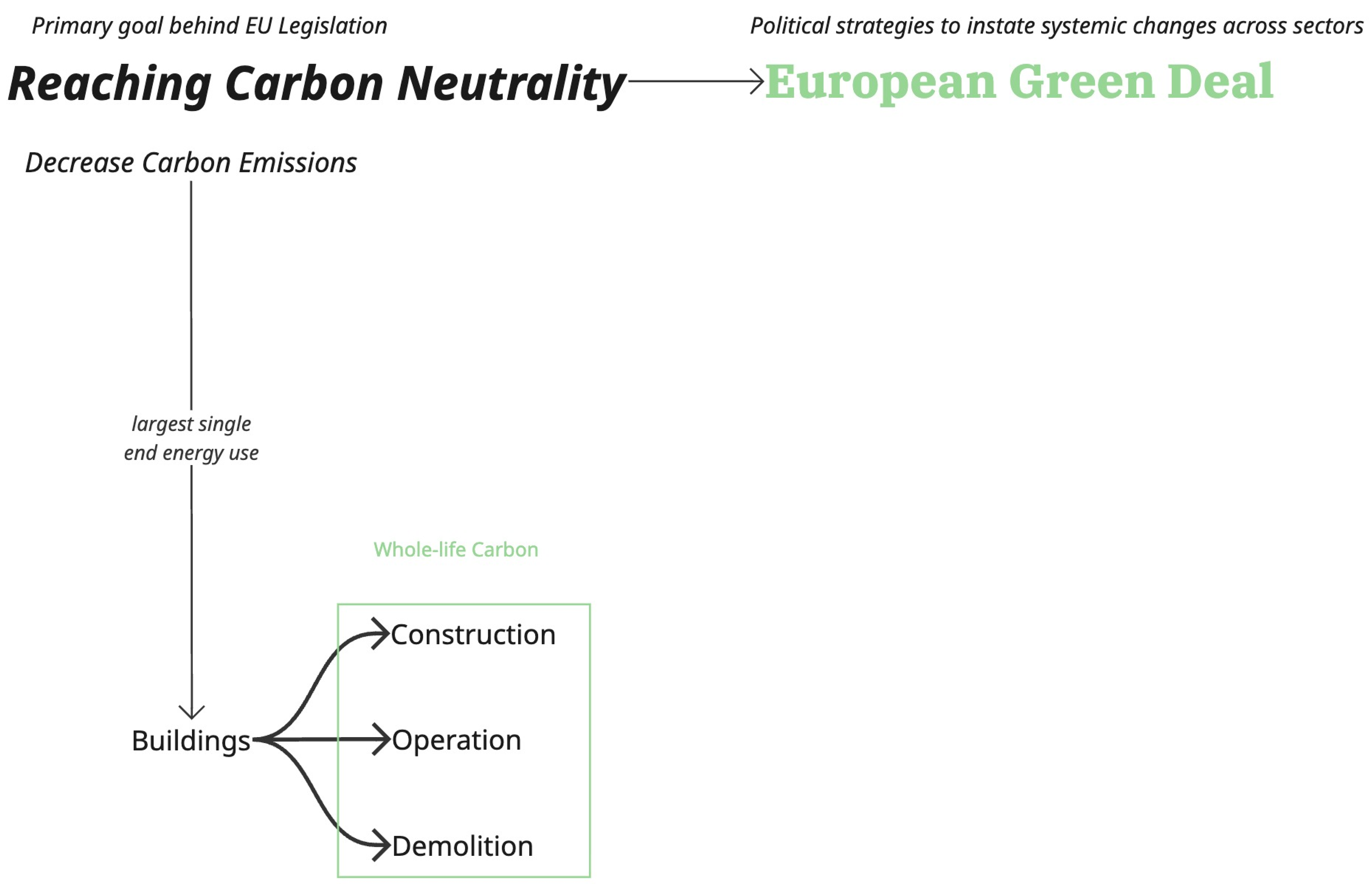
Graphic © Ormazabal Velatia

EU Targets

+ The construction sector accounting for approximately 40% of total energy use in Europe [8]

+ Europe's building stock: cultural, and social value and a major sustainability challenge– 75% of EU buildings classified as energy inefficient. [9]

+ Demolishing and replacing old buildings is not a viable solution. This would worsen the problem by substantially increasing the embodied carbon emissions associated with producing, transporting and disposing of construction materials.



8] "2050 Long-Term Strategy - Climate Action - European Commission," accessed February 3, 2026, https://climate.ec.europa.eu/eu-action/climate-strategies-targets/2050-long-term-strategy_en.

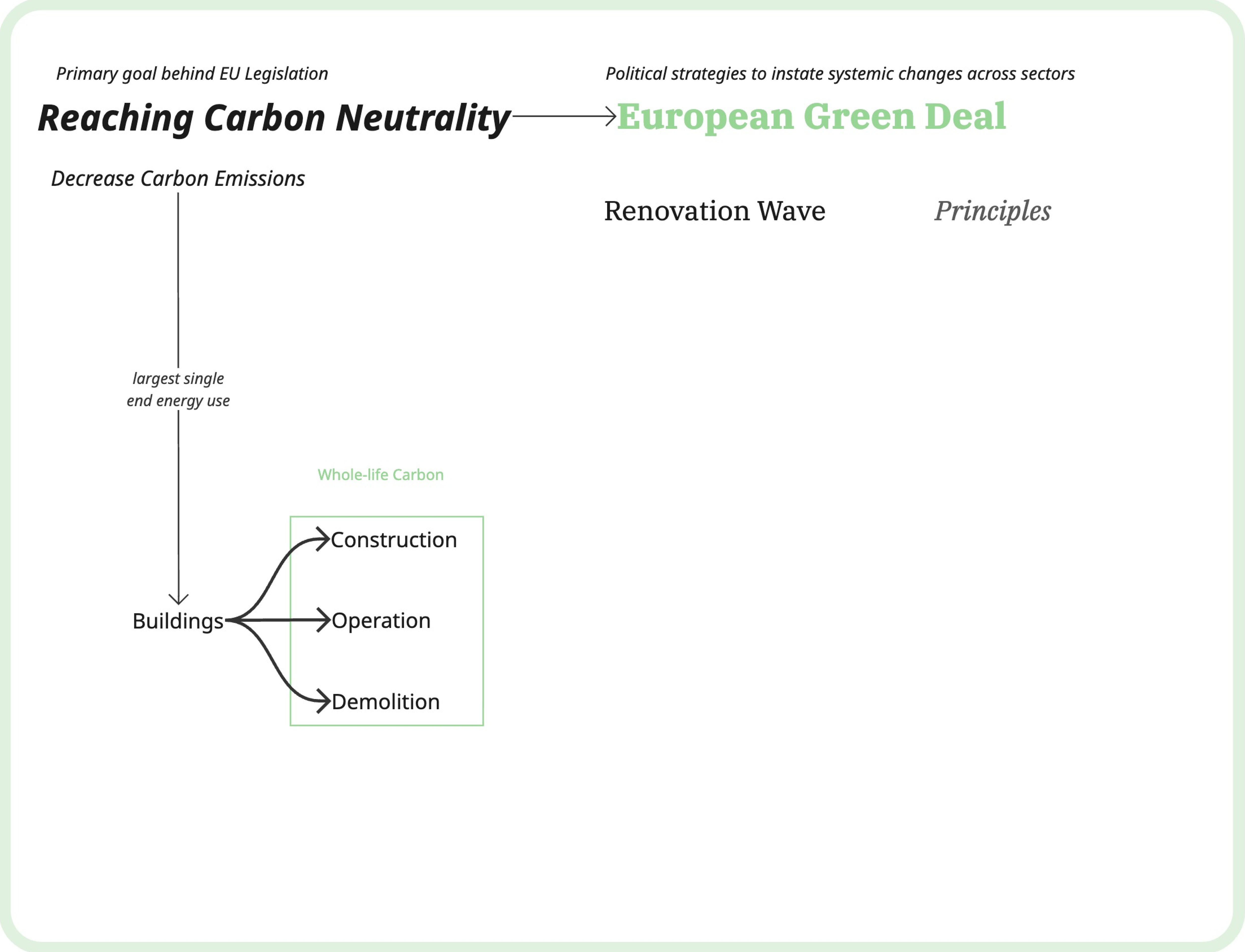
[9] Faidra Filippidou and Juan Pablo Jimenez Navarro, Achieving the Cost-Effective Energy Transformation of Europe's Buildings: Combinations of Insulation and Heating & Cooling Technologies Renovations: Methods and Data, with Europäische Kommission, JRC Technical Report (Publications Office of the European Union, 2019), https://doi.org/10.2760/278207.

EU Targets

A critical point raised by the European Commission is that **climate and environmental objectives cannot be pursued in isolation from social considerations**. Social justice and a fair transition are integral to effective renovation strategies.

Renovations planned in a holistic manner can simultaneously improve energy performance, enhance health and comfort, increase resilience to climate risks, support social inclusion, and better integrate buildings into local energy and mobility systems.

The EU has established dedicated instruments, incentives and investment mechanisms to enable this transformation.



environmental

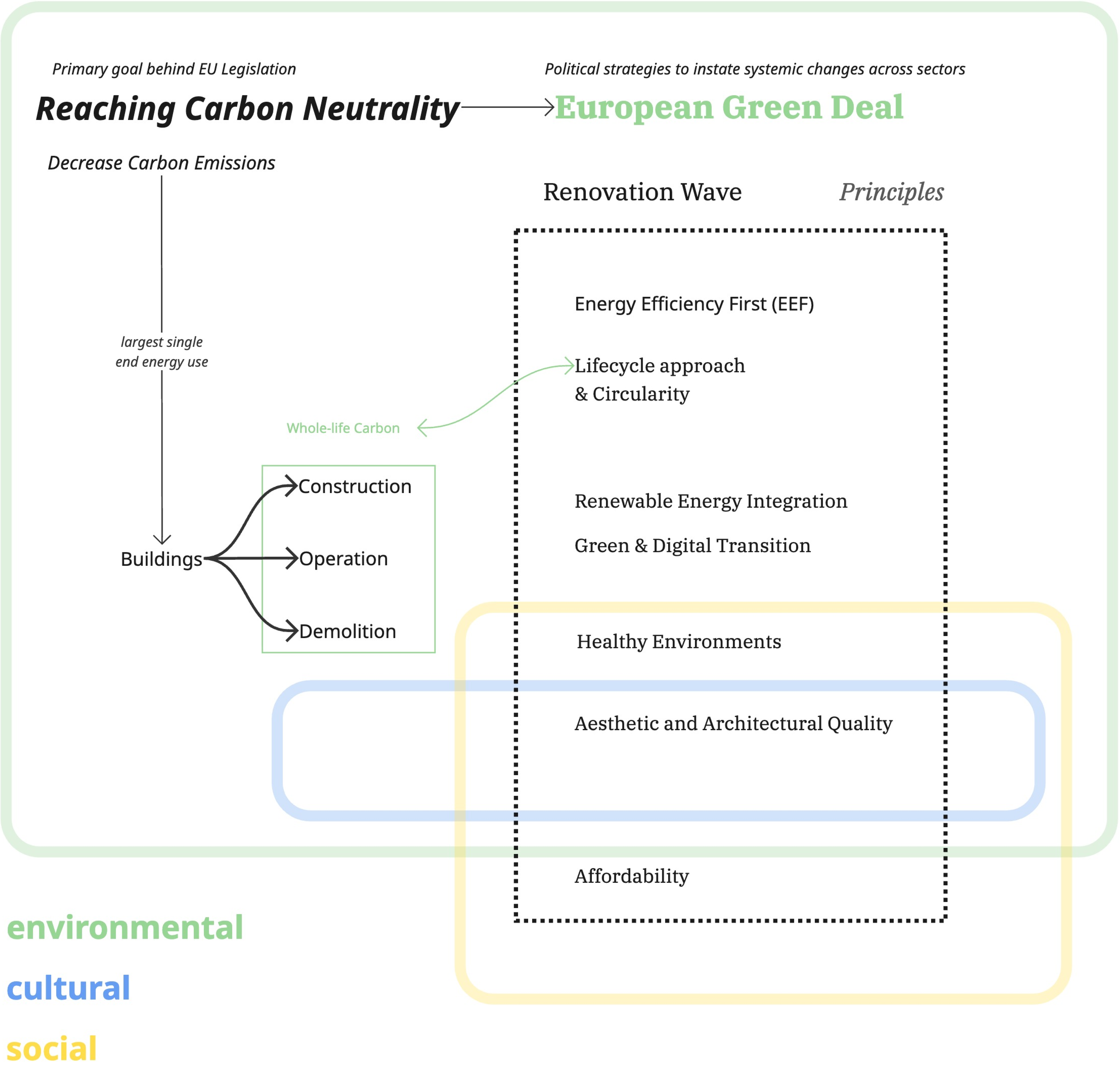
EU Targets

Renovation Wave

The EU Renovation Wave is a flagship political strategy under the European Green Deal, aiming to double the renovation rate by 2030.

This initiative aims to renovate and improve the energy efficiency of approximately 35 million buildings, reduce greenhouse gas emissions, alleviate energy poverty, and create around 160,000 green jobs in the construction sector.

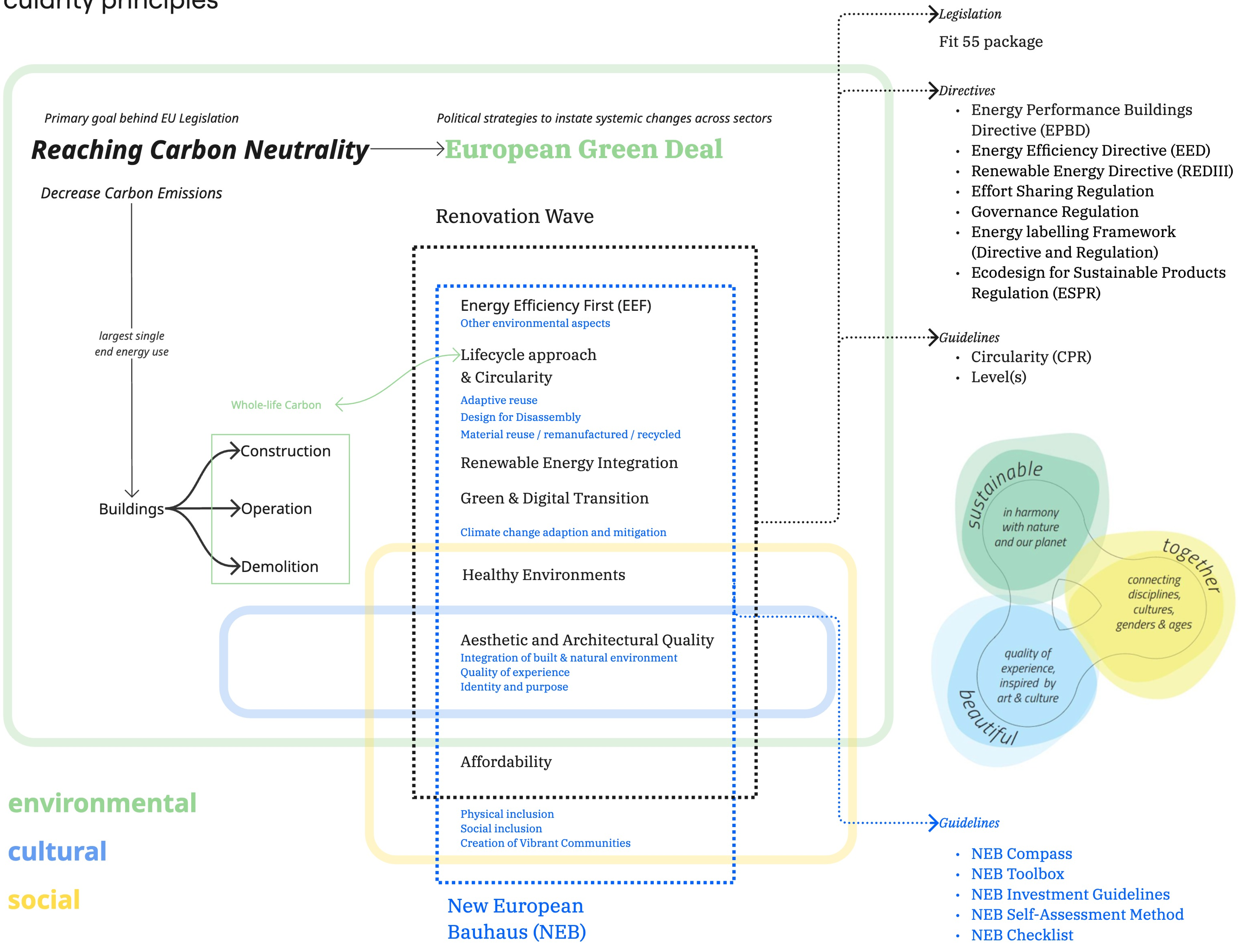
The 2024 recast of the Energy Performance of Buildings Directive (EPBD) introduces **seven principles** to guide the implementation of actions identified by the European Commission identified priority areas of intervention in a holistic manner.



EU Targets

The New European Bauhaus

Launched in 2020 alongside the Renovation Wave, the New European Bauhaus seeks to ensure that the large-scale greening of Europe's building stock is not only technically effective, but also architecturally ambitious, inclusive, and people-centred. While the former provides the operational framework and financial scale, the latter offers the guiding principles and methods to ensure that this transformation delivers high-quality, inspiring, and socially meaningful outcomes.



EU Principles, Directives and Guidelines

Principle	Energy Efficiency First (EEF)	Decarbonisation of Heating and Cooling	Life-Cycle Thinking and Circularity
Goal	Reduce energy demand before considering renewable energy supply or offsets.	Phase out fossil fuels, promote renewables and district heating/cooling systems.	Address embodied carbon, material reuse, and whole-life carbon emissions
Regulations	+ Energy Efficiency Directive (EED) • Article 3: Makes the "Energy Efficiency First" principle a legal obligation for planning and investment. Linked to Level(s) Indicator 1.1 + Recast Energy Performance of Buildings Directive (EPBD) (EU) 2024/1275 • Annex 1. Minimum Energy Performance Standards (MEPS): For existing buildings, MEPS define required improvements over time. • Annex 3. Energy Performance Certificates (EPCs): Rating systems that classify and compare building performance.	+ Energy Efficiency Directive (EED) — Directive (EU) 2023/1791 + RED III (EU) 2023/2413 • Article 15a + Recast Energy Performance of Buildings Directive (EPBD) (EU) 2024/1275 • Article 7, 12: Mandates Whole Life Carbon (WLC) reporting and a 49% renewable share by 2030. • Article 9 (MEPS): Introduces Minimum Energy Performance Standards. It requires non-residential buildings to hit specific energy targets by 2030, with 2026 serving as the baseline for national staging. + Ecodesign for Sustainable Products Regulation (ESPR) Energy Labelling and Ecodesign Regulations	+ Recast Energy Performance of Buildings Directive (EPBD) (EU) 2024/1275 • Article 1: Includes "Whole Life Carbon". + Circular Economy Action Plan (CEAP) • Section 3.6
Guidelines	+ Level(s) • Indicator 1.1 measures Use-stage energy performance, ensuring that renovations focus on reducing demand before adding renewables. + New European Bauhaus (NEB) Compass / Investment Guide • Sustainable: Prioritizing "Regenerative" designs that go beyond efficiency to restore ecosystems.	+ Level(s) • Indicator 1.2 (Life-cycle Global Warming Potential): Measures the CO2 equivalent emissions (kg CO2e/m2) from "cradle to grave." This includes the carbon emitted to manufacture new insulation or windows, ensuring the "embodied carbon" doesn't outweigh the operational savings. + New European Bauhaus (NEB) Compass / Investment Guide • Sustainable: Integrating "Nature-based solutions" (e.g., green roofs) and renewable tech into the aesthetic design.	+ Level(s) • Indicator 2.1 (Bill of quantities, materials, and lifespans): Requires a detailed list of materials to encourage the use of sustainable or bio-based products. • Indicator 2.2 (Construction and demolition waste and materials): Tracks how much waste is diverted from landfills (kg of waste per m2). • Indicator 2.3 (Design for adaptability and renovation): Provides a score on how easily a building can be changed in the future, preventing "obsolescence" and further waste. • Indicator 2.4 (Design for deconstruction, reuse, and recycling): Focuses on how easily materials can be recovered at the end of their life. + New European Bauhaus (NEB) Compass / Investment Guide • Sustainable (Circularity): Closing loops through the reuse of materials; "Closing the loop" on neighbourhood waste

EU Principles, Directives and Guidelines

Principle	Affordability and Social Inclusion	Digitalisation and Data Availability	High Health, Architectural Quality, Environmental Standards and Aesthetics
Goal	Ensure that vulnerable groups benefit from renovation and are not excluded	Use digital tools (BIM, LCA, SRI) for performance monitoring and transparency.	Ensure renovations improve well-being, design quality, and cultural identity.
Regulations	+ Recast Energy Performance of Buildings Directive (EPBD) (EU) 2024/1275 • Article 15: Mandates "One-Stop Shops" and financial aid to prevent energy poverty.	• Recast Energy Performance of Buildings Directive (EPBD) (EU) 2024/1275 • Article 12, Annex VIII: Renovation Passports	+ New European Bauhaus (NEB) • Compass & Investment Guide
Guidelines	+ Level(s) • Indicator 6.1 tracks Life-cycle costs, proving that green renovations save money over 30+ years, even if upfront costs are higher. + New European Bauhaus (NEB) Compass / Investment Guide • Together (Inclusion): Focus on "Accessibility and Affordability" to ensure green housing is not a luxury.	+ Level(s) • Indicator 1.2 (Life-cycle Global Warming Potential): Measures the CO2 equivalent emissions (kg CO2e/m2) from "cradle to grave." This includes the carbon emitted to manufacture new insulation or windows, ensuring the "embodied carbon" doesn't outweigh the operational savings. + New European Bauhaus (NEB) Compass / Investment Guide • Sustainable: Integrating "Nature-based solutions" (e.g., green roofs) and renewable tech into the aesthetic design.+ Level(s) • Indicator 5.1 (Protection of occupier health and thermal comfort): Uses digital modeling to project climate resilience into the years 2030 and 2050, helping planners use "digital twins" to future-proof buildings against a warming climate. • + New European Bauhaus (NEB) Compass / Investment Guide • Participatory Process: Using digital tools (BIM/Logbooks) to enable "Co-design" with citizens and local communities.	+ Energy Performance of Buildings Directive (EPBD) • EPBD Annex 4. Renovation Passport • EPBD Annex 10. Technical building systems, indoor environmental quality and inspections

Construction sector in Ukraine today

illia-horokhovsky-NzhyFkW_MJI-unsplash

Construction Sector Structure in Ukraine

Circular Transition Potential

Market Structure

The Ukrainian construction market is **dominated by SMEs** (Derzhstat).
Large enterprises account for only ~4% of sales in residential and non-residential construction.
Pre-war growth was strong (more than tripled since 2010), while **market structure remained unchanged**.

Opportunity for Circular Transition

SMEs are more flexible in adapting business models and adopting new technologies.
This flexibility positions SMEs as **key drivers of circular construction practices**.
The sector structure creates a **unique opportunity for system-wide change**, not limited to niche pilots.

Enabling Conditions

Transition requires a **supportive legislative and regulatory framework**.
Targeted incentives and guidance can **activate SME capacity at scale**.
Aligning policy with sector structure can unlock a **large-scale shift towards circularity**.

Building culture and economy

Circular Transition challenges

Building culture

The building culture in Ukraine is dominated by the legacies of Soviet architecture, prioritising the use of concrete, steel, and glass. The methods and materials being used have been optimised during the last few decades. The Ukrainian law does not allow using other materials than the ones being certified and approved by the ministry. Since the priority for certifying new materials is low at the moment, the building sector does not push this, and keeps using previous approaches.

Costs

Regarding rebuilding and renovation, the cost aspect is crucially important. Next to war and safety, the economy, inflation and taxes, are major challenges the Ukrainians are facing now, even with the international support they get.

The values of housing in municipalities largely affected by the military-related activity, such as Mykolaiv and Kryvyi Rih, have dropped largely.

Enabling Conditions

Therefore, extra activities are needed: change of legislation, pilot projects, price incentives. Investments for change can be valuable when there will be

- small differences between 'traditional' and 'circular' costs, step by step.
- opportunities of upscaling for local economic business potential
- focus on nearby production
- direct other benefits for stakeholders involved (like space, health, monthly costs)

***Legal framework*:**

Ukrainian regulations

Following the country's EU candidate status in 2022, Ukraine has been actively engaged in the negotiation process to become a member, progressively aligning its policies and standards with those of the European Union.

Ukraine is preparing for adaptation towards EU guidelines. The National Recovery and Energy Strategy describes the long term ambition to align the Ukrainian regulatory framework with EU directives under the Energy Community Treaty.

Photo: Flags of Ukraine and the EU (neweasterneurope.eu)

EU vs Ukraine :

Energy Efficiency

EU Framework

- **Key directives:** EPBD Recast 2024, EED 2023, RED III

Goal

- zero-emission building stock by 2050
- MEPS + renovation passports
- Phase-out fossil heating, scale renewables
- Implementation focus: 2025–2030

Ukraine Alignment

- Energy efficiency laws (2017, 2021) + updated codes
- NZEB requirements (2025)
- By 2050: 35% residential & 10% public retrofitted
- Min. energy class C, –50% heating demand
- NECP 2025–2030 aligned with EU pathway

Key Barriers

- Limited financing & municipal capacity
- War pressure & urgent reconstruction
- Weak EPC system, no renovation passports
- Energy poverty & fragmented ownership

EU Regulations and Guidelines

Regulations and Guidelines:

- Directive (EU) 2024/1275 on the energy performance of buildings (EPBD Recast)
- Directive (EU) 2023/1791 on energy efficiency (EED)
- Directive (EU) 2023/2413 on the promotion of the use of energy from renewable sources (RED III)
- Level(s) Framework

Long Term Goal (2050):

- Decarbonization of the building stock (deep renovations, prioritizing worst-performing buildings)
- Zero-emission building stock (all existing MFH (Multi Family Housing) to achieve at least minimum energy performance levels and use low- or zero-carbon energy sources)
- National Building Renovation Plans with MEPS (Minimum Energy Performance Standards)
- Elimination of fossil heating systems

Expected Legal Implementation:

- Member States must implement EPBD (May 2026)
- Establish MEPS for worst-performing buildings (starting with non-residential, then residential) (2027-2030)
- Strengthen Energy Performance Certificates (EPC) and introduce Renovation Passports (2026)
- Align building retrofits with EED national energy-saving targets (2025-2030)
- Promote on-site RES integration in line with RED III (2025-2030)

UA Regulations and Guidelines

Regulations and Guidelines:

- Law of Ukraine 'On Energy Efficiency of Buildings' No. 2118-VIII (2017, as amended)
- Law of Ukraine 'On Energy Efficiency' No. 1818-IX (2021)
- DBN B(V).2.6-31:2021 Thermal Insulation and Energy Efficiency of Buildings
- National Recovery and Energy Strategy

Long-term goal (2050):

- Retrofit of 35 % of residential and 10 % of public building stock.
- Achieve minimum energy efficiency class C for most buildings and reduce heating energy consumption by 50 %
- Gradual integration of renewable energy systems and smart technologies
- Align regulatory framework with EU directives under the Energy Community Treaty

Current ambitions:

- Law of Ukraine "On Energy Efficiency of Buildings" No. 2118-VIII (2017) establishes minimum energy efficiency requirements for buildings, certification system, and framework for building-energy policy
- On 4 April 2025, new governmental Order No. 168 dated 6 February 2025 came into force: new energy-efficiency requirements for buildings with nearly zero energy consumption (nZEB standard) for new and renovated buildings
- Ukraine's National Energy and Climate Plan of Ukraine (NECP) 2025-2030 sets ambitions for energy efficiency as part of sustainable development and alignment with the EU
- Buildings Performance Institute Europe (BPIE): Ukraine aims to embed energy efficiency in its "green recovery" and renovation strategy for building stock

Identification of existing barriers

The most important barriers for full Implementation of Energy Efficiency standards on EU level are:

- Lack of Minimum Energy Performance Standards (MEPS) and renovation passport system
- The low quality of Energy Performance Certificates (EPC) and no digital logbooks
- Limited municipal and state capacity
- Limited access to Commercial Financing
- Inflation and war-related economic pressure
- Reconstruction urgency vs Energy Performance of Buildings Directive (EPBD) depth
- Complex multi-owner decision rules in Multi Family Housing (MFH)
- Energy poverty / low ability to co-finance
- Grid & DH constraints for heat pumps / PV (damage to existing infrastructure, low operational efficiency, insufficient grid capacity for integration, and significant financial difficulties)

EU vs Ukraine :

Circularity

EU Direction

- Circular Economy Action Plan + **Level(s)** framework
- **70% C&D waste recovery target**
- Digital Product Passports & material traceability
- Design for reuse, modularity, low waste
- Circularity embedded in building logbooks & renovation plans

Ukraine Progress

- **Waste Management Law (2022)** aligned with EU hierarchy
- National Waste Plan to 2032
- Rules for demolition debris & recycling infrastructure
- Long-term: reuse/recycling chains, material passports, regional plans
- Circular principles entering reconstruction strategy

Key Barriers

- Limited funding & circular supply chains
- No large-scale reuse market for materials
- Fast rebuild urgency → risk of linear construction
- Limited standards for bio-based materials & embodied carbon
- Public procurement rarely supports circular/bio-based solutions

EU Regulations and Guidelines

Regulations and Guidelines:
- EU Circular Economy Action Plan (CEAP 2020)
- Waste Framework Directive (70% C&D recovery target)
- Ecodesign for Sustainable Products Regulation
- Level(s) Framework (Circularity Indicators 2.1–2.4)
- “Circular Buildings and Infrastructure” report by the European Circular Economy Stakeholder Platform (ECESP)

Long Term Goal:
- Transition to retain, reuse, repair, regenerate
- Maximize material reuse and recycling
- Design building components for adaptation, modularity, deconstruction
- Minimize construction waste - shift to circular value chains
- Embed circularity tracking into renovation passports and building logbooks

Expected Legal Implementation:
- Waste Framework Directive - 70% C&D waste recovery target (2025) and selective demolition; designed to enable the removal and safe handling of hazardous substances such as asbestos, lead, or PCB-contaminated materials, allowing the rest to be deconstructed and reused.
- EU waste audit guidance applied to major renovation/demolition
- Digital Product Passports for key materials (CPR and ESPR, phasing from 2026 - 2030)
- Level(s) indicators expected to be referenced in EU-funded projects

UA Regulations Regulations and Guidelines

Regulations and Guidelines:
- Law “On Waste Management” No. 2320-IX (2022, effective 2023)
- National Waste Management Plan until 2032
- Law “On providing construction products to the market”
- Cabinet Resolution No. 1073 (2022) – procedure for handling demolition debris
- National Standard on Life Cycle Costs for Buildings (2022)
- Draft Law “On Packaging and Packaging Waste” – aims to implement EPR and packaging waste targets. (Pending Sectoral Laws -not yet enacted)
- EU Association Agreement & Energy Community commitments

Long-term goal:
- Integrate circular principles into reconstruction and retrofits
- Establish construction material reuse and recycling chains
- Align with EU waste separation and recovery standards
- Introduce building material passports, demolition audits

Current ambitions:
- Waste law introduces EU waste hierarchy, C&D waste category
- Cabinet Resolution No. 1073 (2022) – procedure for handling debris from damaged buildings
- Supporting acts for waste system implementation (local waste-management plans, waste classification/UA Waste Catalogue)
- Asbestos banned in new construction materials; guidance for handling debris
- increasing preparation for reuse, recycling and other recovery of non-hazardous materials to at least 70% by weight by 2033, etc.
- Regional waste management plans

Identification of existing barriers

The most important barriers for full Implementation of Circularity standards on EU level are:

- Lack of funding support for Ukrainian building innovation sector
- Lack of selective demolition standards
- No reuse-ready supply chain (sorting, testing, logistics)
- High urgency for fast rebuilds - risk of linear rebuilding
- No market yet for reclaimed components (windows, bricks, steel, timber) in large scale developments
- No national definition of "bio-based construction materials" and no embodied carbon thresholds yet
- Limited standardised testing & certification routes
- Fire and durability norms are often designed around mineral/fossil materials
- Public procurement rarely includes low-carbon materials

EU vs Ukraine :

Embodied Carbon

EU Direction

- From energy efficiency → **whole-life carbon**
- Mandatory life-cycle assessment (LCA) & embodied carbon disclosure (~2030)
- Digital Product Passports + harmonised EPDs
- Net-zero embodied carbon target
- Integration with BIM, prefabrication, circular design

Ukraine direction

- Reconstruction as alignment opportunity
- Gradual LCA adoption (EN/ISO-based)
- Emerging carbon footprint & sustainability standards
- Focus on low-carbon materials & circular practices

Overall conclusions

- Strong legal basis (energy, waste, LCA)
- Implementation limited by war, funding, capacity
- Reconstruction = chance to **build back greener**
- Priorities: financing, supply chains, standards, institutions

Life-Cycle Assessment (LCA) & Overall Insights

EU Regulations and Guidelines

Regulations and Guidelines:

- Level(s) Framework – EU building sustainability indicators
- EU Circular Economy Action Plan (CEAP 2020)
- Regulation (EU) 2023/1542 (Eco-design framework for sustainable products)
- Ecodesign for Sustainable Products Regulation (ESPR) – introduces Digital Product Passports (DPP)
- Revised Construction Products Regulation (new CPR)
- CEN/EN standards for life-cycle assessment (EN 15978)

Long Term Goal:

- Reduce embodied carbon in buildings through reuse, recycling, and low-carbon production (Net-zero embodied carbon for most new buildings)
- Phase-in whole-life carbon (WLC) assessment across building sector
- Digital product traceability for environmental performance
- Widespread adoption of low carbon materials and techniques
- Widespread use of tools such as BIM, standardization, pre-fabrication etc
- Widespread adoption of low-carbon alternatives and material-efficient designs

Expected Legal Implementation:

- LCA mandatory for new buildings (2030), possible extension to renovations
- Mandatory disclosure of embodied carbon and benchmarking
- Mandatory Digital Product Passports for construction products (from 2026)
- EPD expansion and harmonization under CPR revisions
- EU Green Public Procurement criteria to favor low-carbon and recycled content
- Selective demolition & material recovery guidelines in Level(s) - gradually binding through CPR/ESPR
- Mandatory minimum environmental standards for all materials (until 2050)

UA Regulations and Guidelines

Regulations and Guidelines:

- DBN building codes (incl. DBN B.2.6-31:2021 - focus on thermal performance)
- Draft of Ukraine Recovery Plan: Construction, Urban Planning, Modernisation of Cities and Regions
- "Moving Towards Circularity: Ukraine Factsheet"

Long-term goal:

- Use reconstruction to retrofit, modernize built environment toward low-carbon materials and in alignment with EU
- Increase local production of energy-efficient and sustainable building materials
- Gradual adoption of circular economy and reuse practices

Current ambitions:

- Implementation of EN 15804-based life-cycle assessment (LCA) for construction products
- National Guiding Framework of Standards and Technical Regulations for the green reconstruction of Ukraine proposes implementation of:
  - ISO 21928-2 Sustainability in buildings and civil engineering works
  - ISO 14064-1 Greenhouse gases
  - ISO 14067 Requirements and guidelines for quantification of carbon footprint

Key Takeaway

Transition to a Circular Construction Economy Conclusions

Ukraine's transition to a circular construction economy depends on building an evidence base through pilots, mobilising SME capacity, and aligning policymakers, municipalities, investors, and NGOs around scalable circular solutions.

Drivers of Transition

EU experience and ongoing R&D offer transferable knowledge;
structured exchange and partnerships can accelerate circular transition in Ukraine.
Key actors: policymakers, investors, and developers.
Policymakers require a **clear evidence base** (implemented projects).
Investors and developers can **create this evidence base** by demonstrating commercial viability.
Ukraine's construction sector is **SME-dominated** (only ~4% large enterprises);
SMEs are more likely to adopt circular business models.

Context & Momentum

Large volumes of demolition waste create a **strong momentum for large-scale urban mining and recycling** in Ukraine.

The war has generated a **unique convergence of internal reconstruction needs and external investor interest** (public and private).

This context enables **pilot circular projects with international relevance**, provided enabling conditions are in place.

Enabling Conditions & Governance

Early involvement of municipalities is critical:
they act simultaneously as policymakers and potential long-term investors in housing and infrastructure.

Ukrainian NGOs are essential intermediaries, bridging local authorities and international partners and providing contextual knowledge.

Scaling circular construction requires **investment in infrastructure, recycling know-how, remediation, and new technologies**, supported by coordinated governance.

Local Material Sheds for Low-Carbon Reconstruction


Ukrainian black soil. Photo: UNIAN

Defining Renewable Resource Regions and Material Sheds

Local Material Sheds for Low-Carbon Reconstruction

- *Building with **Nature based** materials*
- *Urban mining- Building with **Re-used building components & industrial waste***

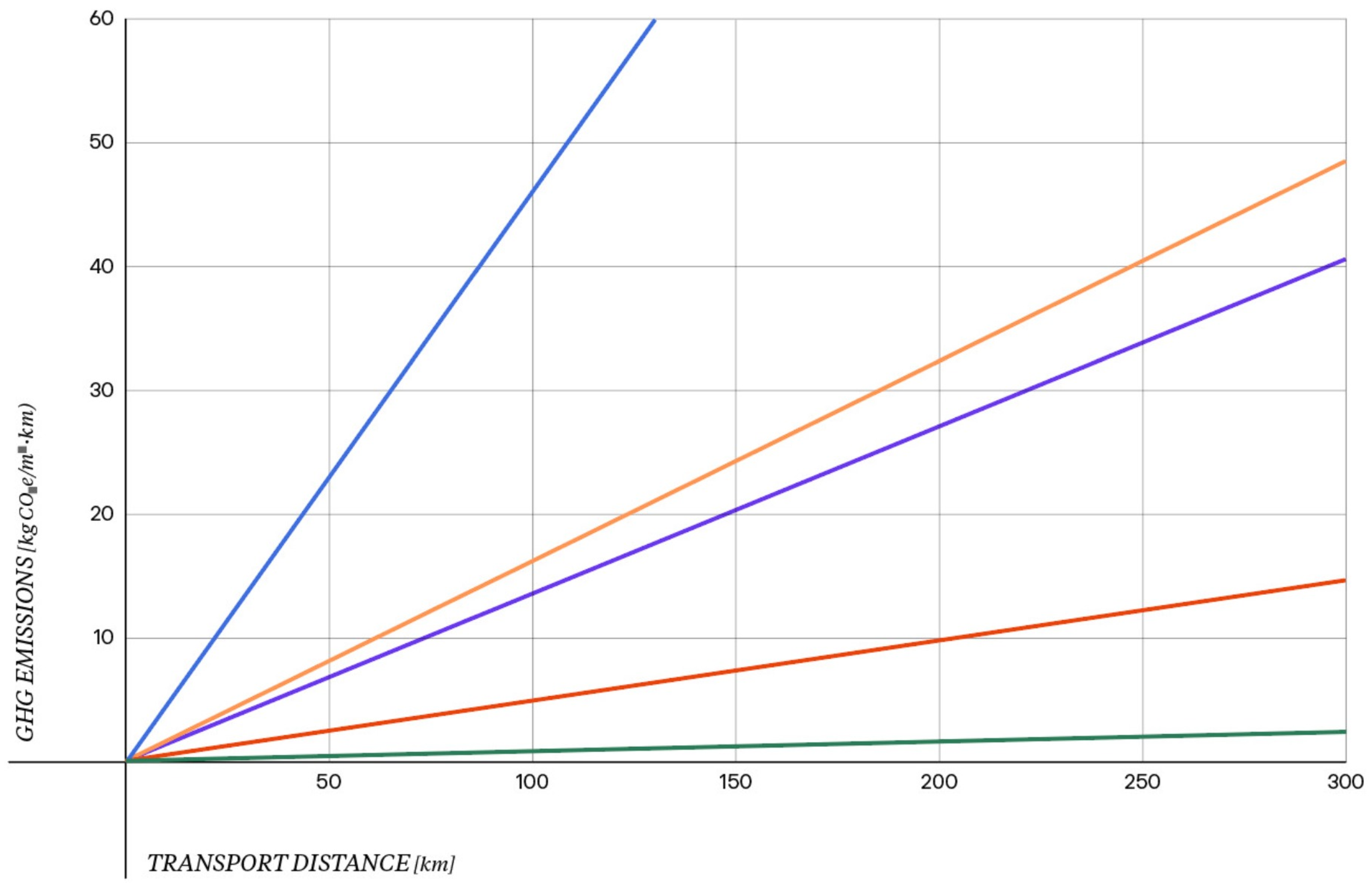
Credits to agroone.info & pinterest.com

Impact of distance

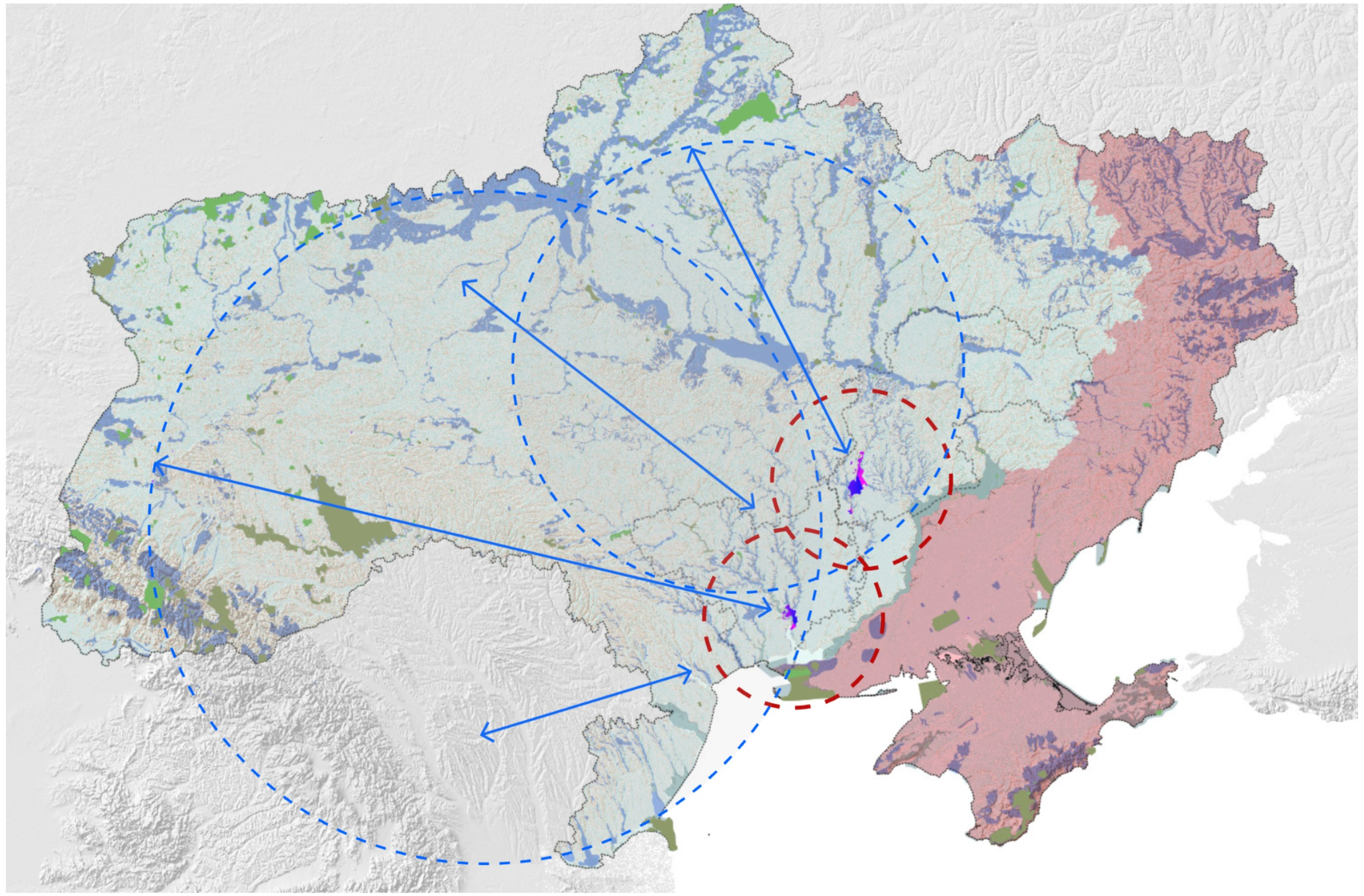
transport, and conflict-related disruptions on embodied carbon

A renewable resource region is much more than bio-availability of materials or the existing infrastructure for sourcing them. Factors such as geopolitical changes, security and regional resilience are just as important as physical proximity.

At the same time, transport emissions have a different impact on each material. Following this considerations, it is possible to consider Ukraine as a whole, prioritising proximity to the construction site when possible.



Concrete	138.65 g $CO_2e/m^3 \cdot km$
Steel	463.15 g $CO_2e/m^3 \cdot km$
Mass Timber	51.72 g $CO_2e/m^3 \cdot km$
Earth Bricks	164.90 g $CO_2e/m^3 \cdot km$
Biobased Insulation	9.25 g $CO_2e/m^3 \cdot km$



Map of Ukraine depicting the municipalities of Mykolaiv and Kryvyi Rih in relation to the temporary occupied territory and the rest of the country © Bauhaus Earth

BAUHAUS EARTH ro3kvit

Value Chain Approach

Circular supply chain collaboration involves companies with different roles in the supply chain working together. A supply chain encompasses all the steps involved in creating, using and processing a product after disposal. The aim of circular supply chain collaboration is to perform activities jointly that directly or indirectly lead to reduced consumption of (new) raw materials and waste prevention.

Integrating bio-fibres into the local built environment oftentimes requires establishing new value chains. In the context of Ukraine's reconstruction process, large-scale rebuilding efforts risk reinforcing carbon-intensive supply chains if the process is dominated by conventional materials such as cement, steel, and imported insulation. At the same time, disrupted logistics and geopolitical instability expose the vulnerability of externally dependent material structures.

The hemp-based value chain exemplified in the diagram directly addresses embodied carbon. The cultivation of natural fibres captures atmospheric CO_2 during growth, and processing these fibres into domestically and industrially manufactured building components minimises transport-related emissions while making use of the carbon storage potential of fast-growing annual crops.

Ukraine already possesses the agricultural capacity and primary infrastructure required for biomass production. Organising farmers into cooperative structures ensures a reliable supply of raw materials while creating economic incentives for regenerative cultivation practices. Rather than exporting raw biomass, value is retained within the country through local processing and manufacturing.

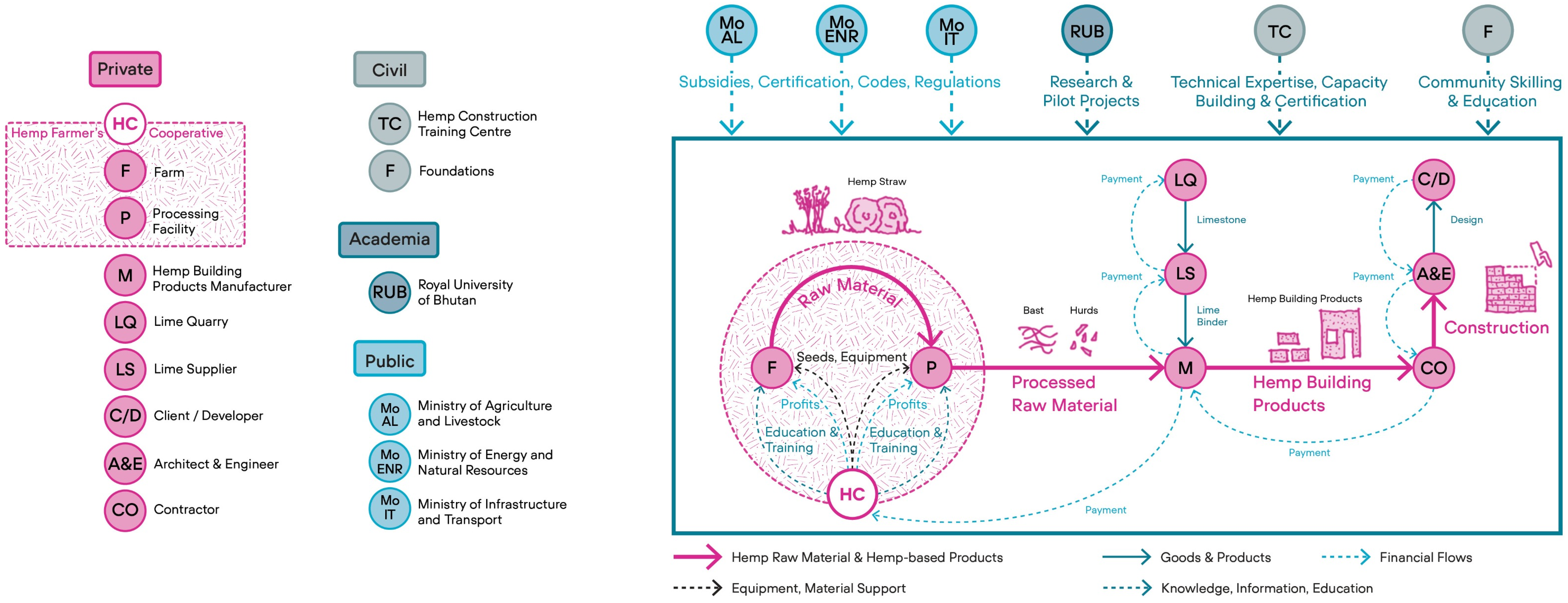


Fig. 45: Overview of relations and interactions between the involved actors

Koschany, Kéan. Serpentine Value Chains: On the Potential of Hemp-Based Products for a Socio-Ecologically Just Building Sector in Bhutan. Masterarbeit, Technische Universität Berlin, 2025.

Building with Nature based materials

Nature-Based Material Resources

Ukraine's varied landscapes, such as forests, wetlands, and steppe, provide a rich palette of natural materials.

Forested regions (e.g., Polissia, Carpathians): are able to supply wood, straw and grasses; suitable for natural insulation and finishes.

Reeds from wetlands in Polissia can be used in eco-insulation. Reeds is found as a traditional roof material in Ukraine.

Local soils are viable for sustainable earthen construction, adobe, and rammed earth techniques.

Industrial waste, such as iron **slag** found in Kryviy Rih can be used for creating slag blocks for construction.

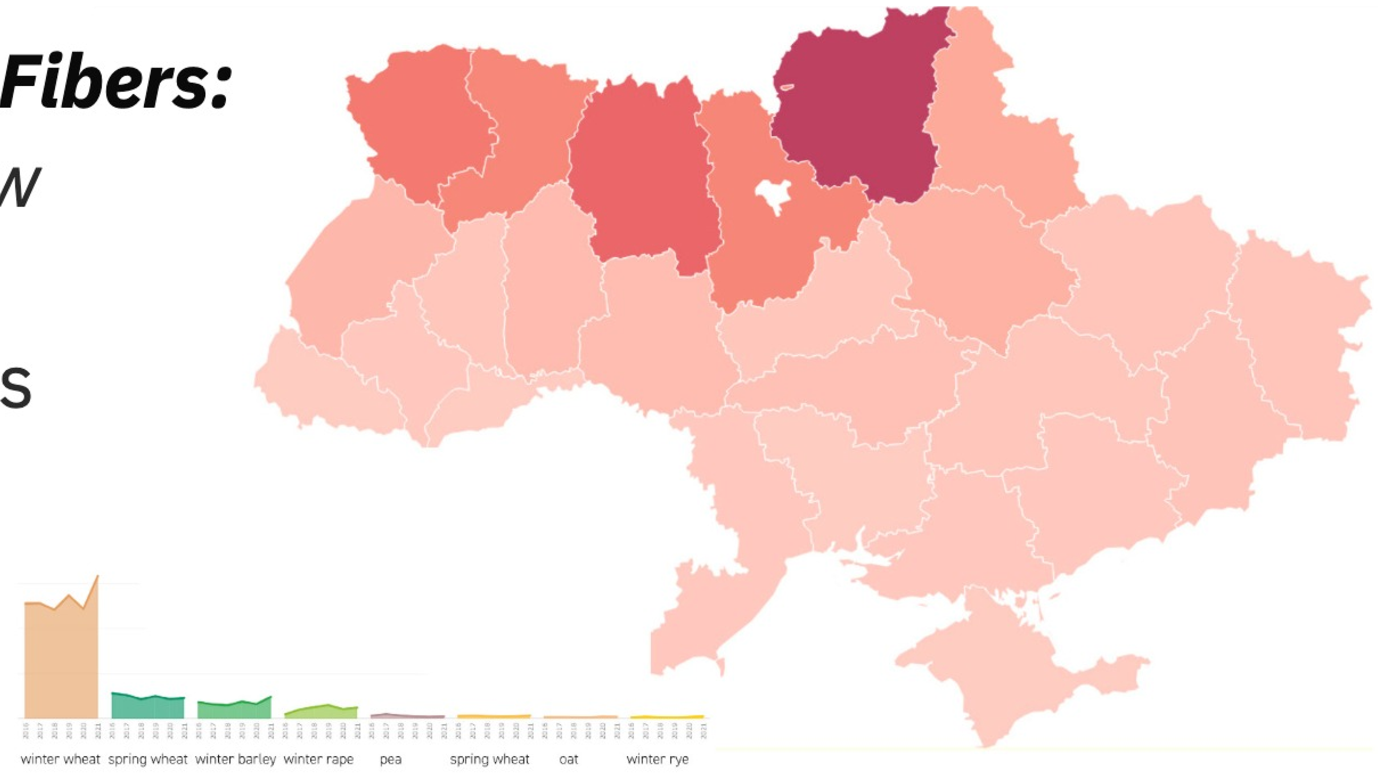
Mapping these resources allows pilot cities to source ecological, locally-regenerative materials that align with EU sustainable and circular-economy frameworks connected on the national or local level

Natural Fibers:

Rye straw

Hemp

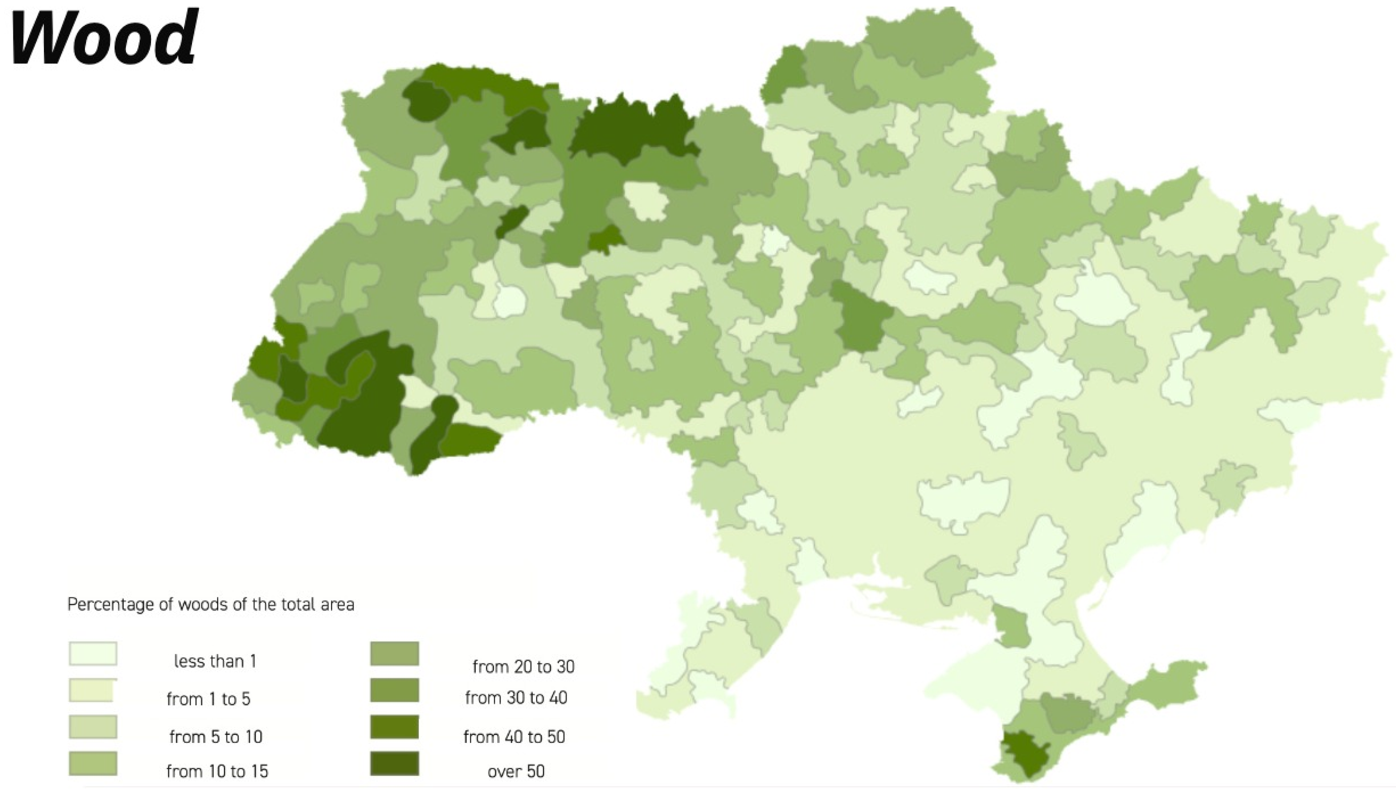
Wetlands



Map: Rye crops distribution in Ukraine
Chart: Rye production compared to other crops
Source: https://public.tableau.com/ map created by MUKOVOZ.DESIGN

© west-reed.com

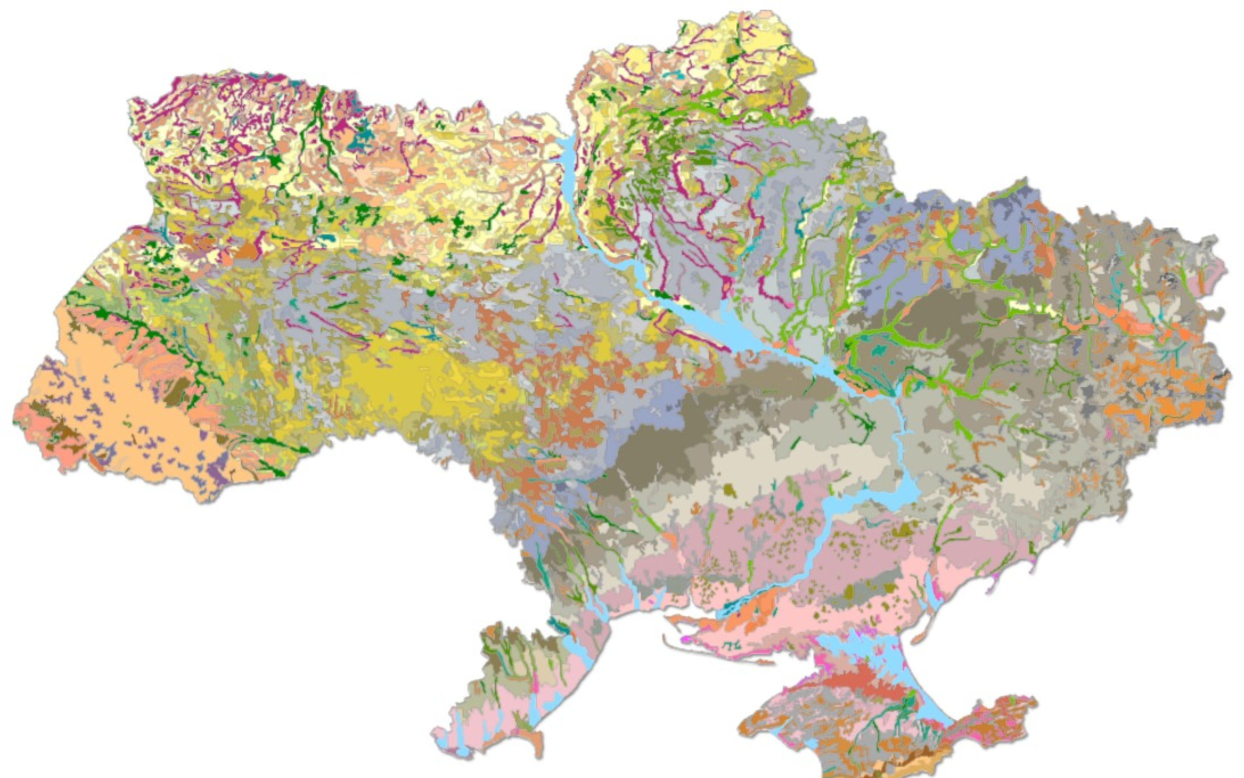
Wood



© geomap.land.kiev.ua

© agrikol.com.ua

Soils



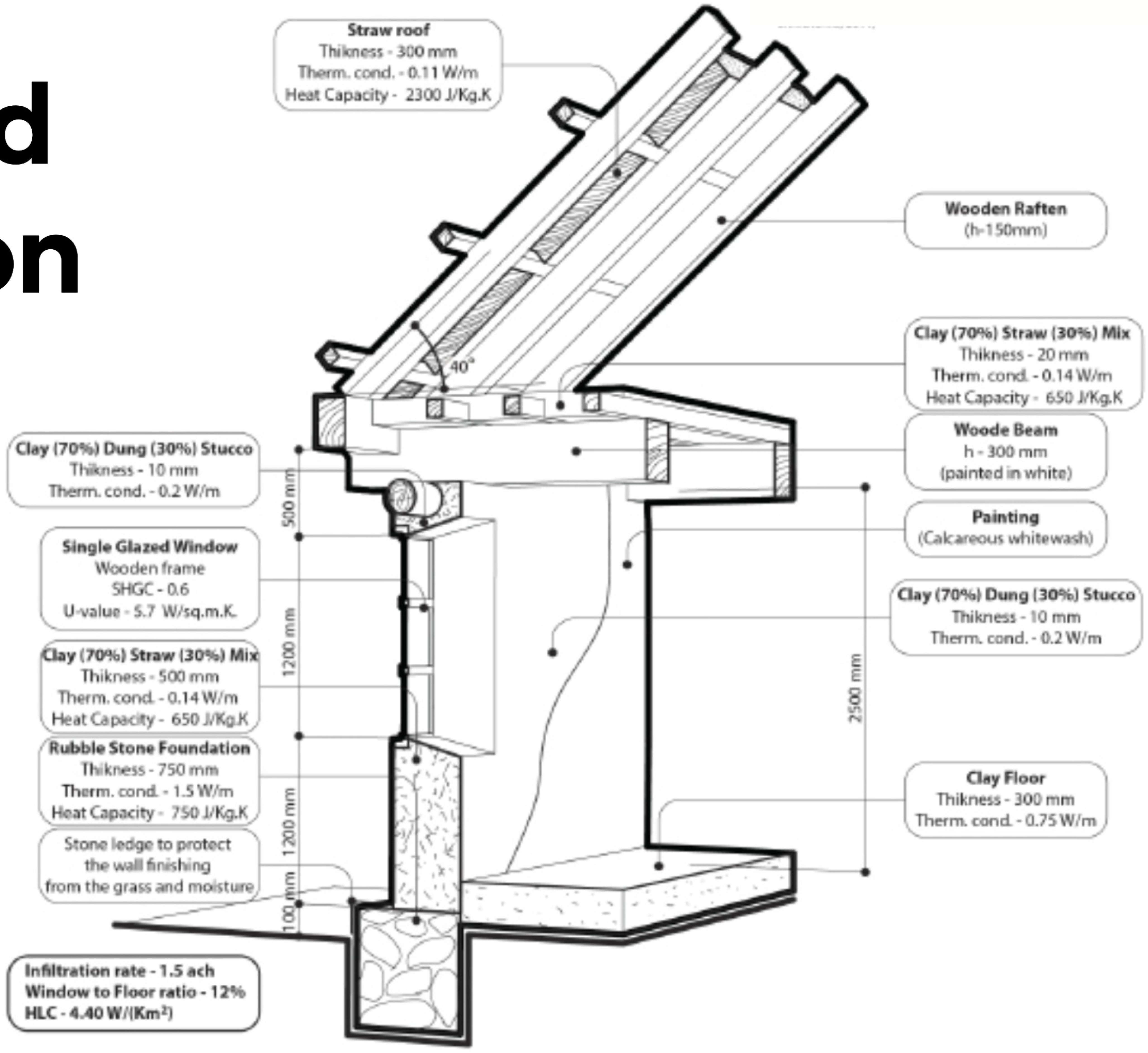
© geomap.land.kiev.ua

Raw clay bricks (CEB – Compressed Earth Blocks), © ucu.eu

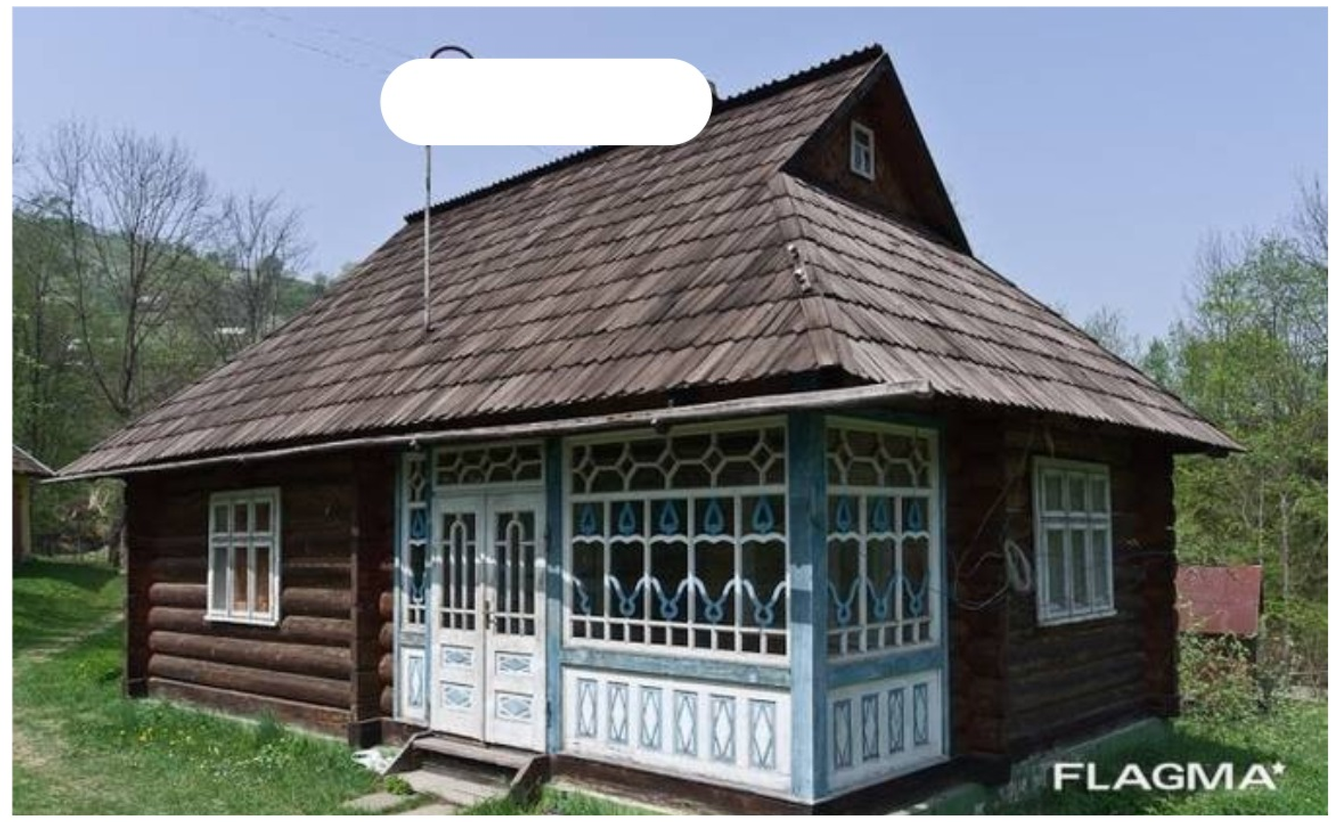
Nature based local tradition

Historically, rural housing in Ukraine relied on locally available nature-based materials such as **local soils, straw, and wood,** exemplified by the *Mazanka* typology.

These construction methods resulted in very low embodied carbon, minimal industrial processing, and strong climatic responsiveness, with their long-term viability evidenced by the continued presence of such housing in rural areas today.



Artem Oslamovskyi:
Typical construction scheme of a Mazanka house



Traditional Ukrainian Building Techniques: wooden log cabin with wooden shingle roof

Traditional Ukrainian Building Techniques: Mazanka © galushkivka.com

Traditional Ukrainian Building Techniques: Mazanka
© Earth Architecture eartharchitecture.org

Solid and Engineered Timber

Potential
Engineered wood offers a low- to carbon-negative alternative to concrete for load-bearing structures, with CLT and glulam systems providing comparable structural performance. Design for adaptability and disassembly enables long-term material circulation and repeated reuse. CLT panels are already produced in Ukraine, indicating initial industrial capacity.

Engineered wood offers a low- to carbon-negative alternative to concrete for load-bearing structures, with CLT and glulam systems providing comparable structural performance.

Design for adaptability and disassembly enables long-term material circulation and repeated reuse.

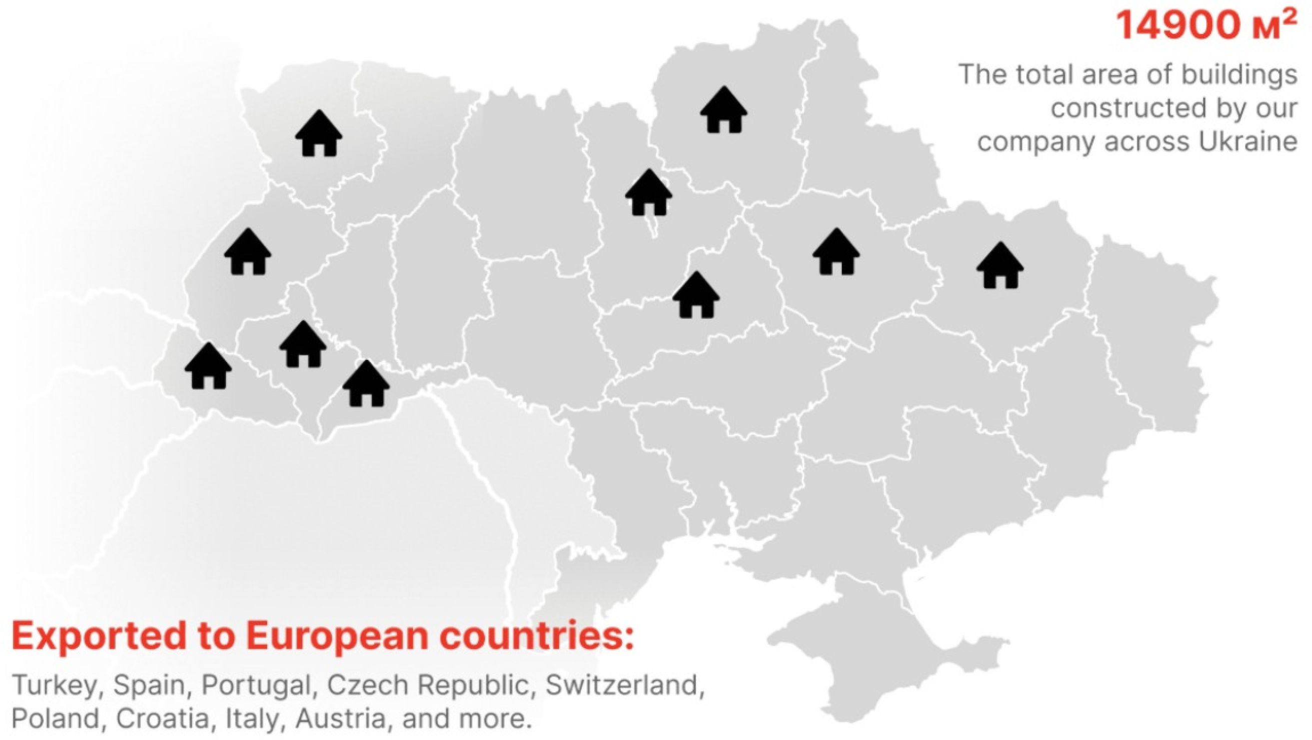
CLT panels are already produced in Ukraine, indicating initial industrial capacity.

CLT Modules produced in Korosten, Zhytomyr Obl., © CLT Rezult. https://clt-rezult.com/en/

Producers in UA:

CLT Rezult is the first and only manufacturer and supplier of multi-layer cross-laminated timber (CLT) panels in Ukraine.

We are **introducing innovative CLT panel construction** in our country. We provide consultations, educate and accompany you, from the creation of an architectural solution to the construction of a house.



© CLT Rezult. https://clt-rezult.com/en/

Future Potential

Recommendations

Use of engineered wood for building structures which (=most long-lasting building layer)

Design structures for maximum adaptability and future disassembly to ensure maximization of life-cycle

Prefer use of spatial modules from CLT for better structural stability and high resource efficiency.

Key Constraints

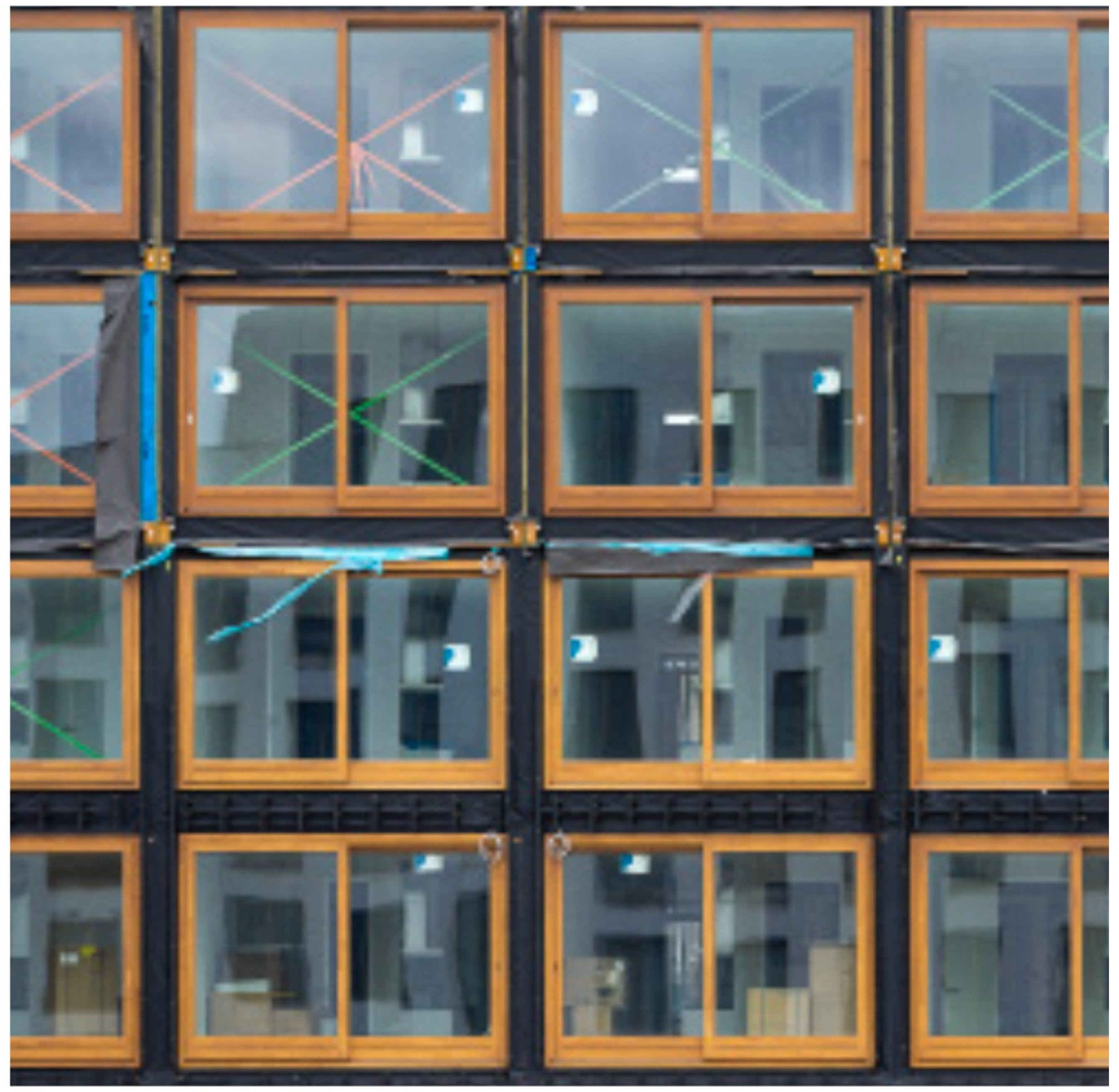
Limited availability due to high material costs and insufficient technical expertise.

Regulatory restrictions: structural timber construction is currently permitted only for low-rise buildings up to three storeys.

Lack of national standards for advanced timber systems (e.g., CLT, mass timber).

Restricted access to wood resources, further constrained by:

- war-related forest damage,
- increased demand for firewood during power outages.



Façade © SeARCH architects

© SeARCH architects

Tallwood House is an 18-storey mass timber hybrid student residence at the UBC Vancouver campus.
© Living Labs UBC, https://livinglabs.ubc.ca/projects/brock-commons-tallwood-house

Natural Fibers

Biobifers can be harvested as agricultural byproducts and from wetlands through paludiculture.

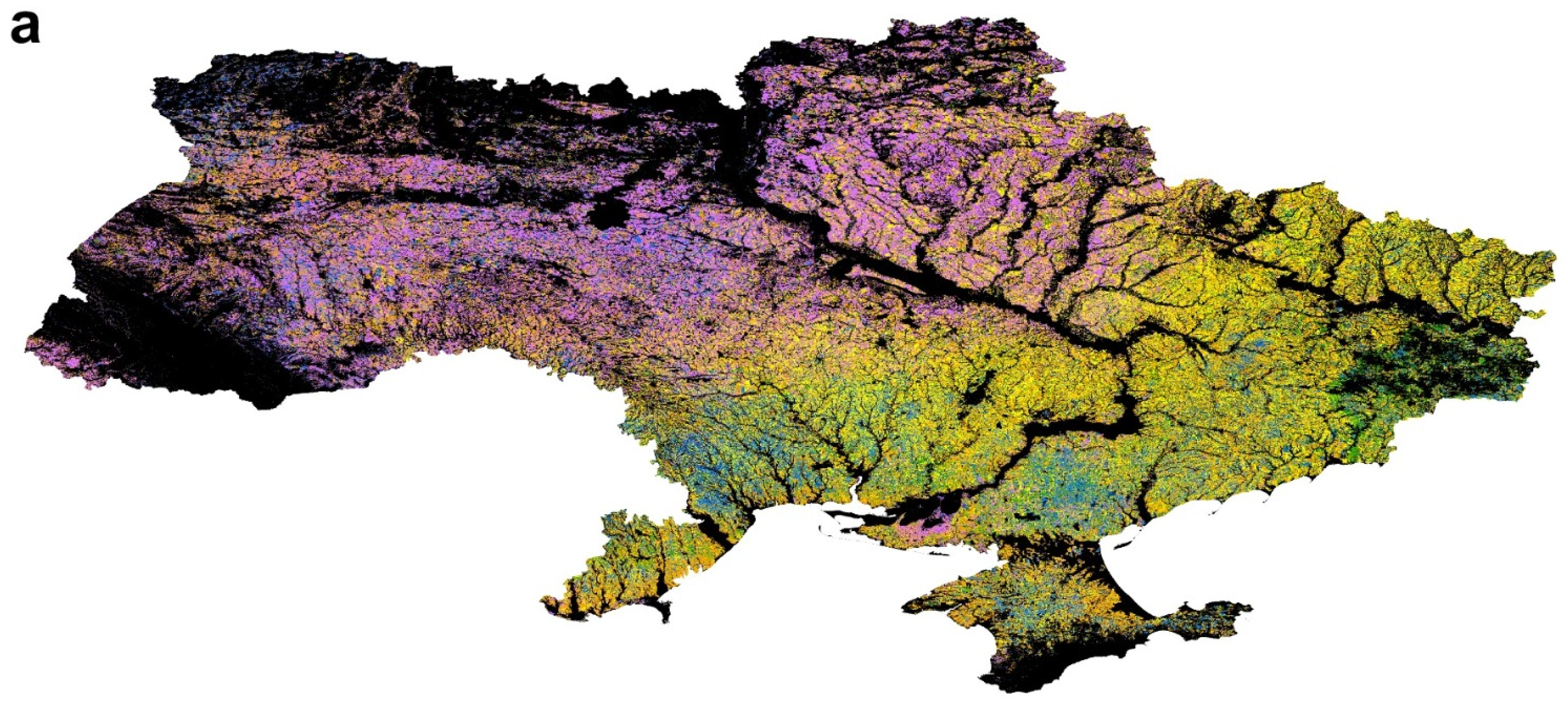
Given that Ukraine's agricultural sector is one of the largest in Europe, using agricultural by-products to make lightweight insulation panels, renders and bio-binders is a sensible approach. Many of these materials are already used in the EU and can easily be transferred to Ukraine in terms of both technical know-how and regulations.

Wetlands in Polissia and near the pilot areas in the Dnipro Delta and Yagorlytska Bay offer significant potential for bio-based insulation materials.

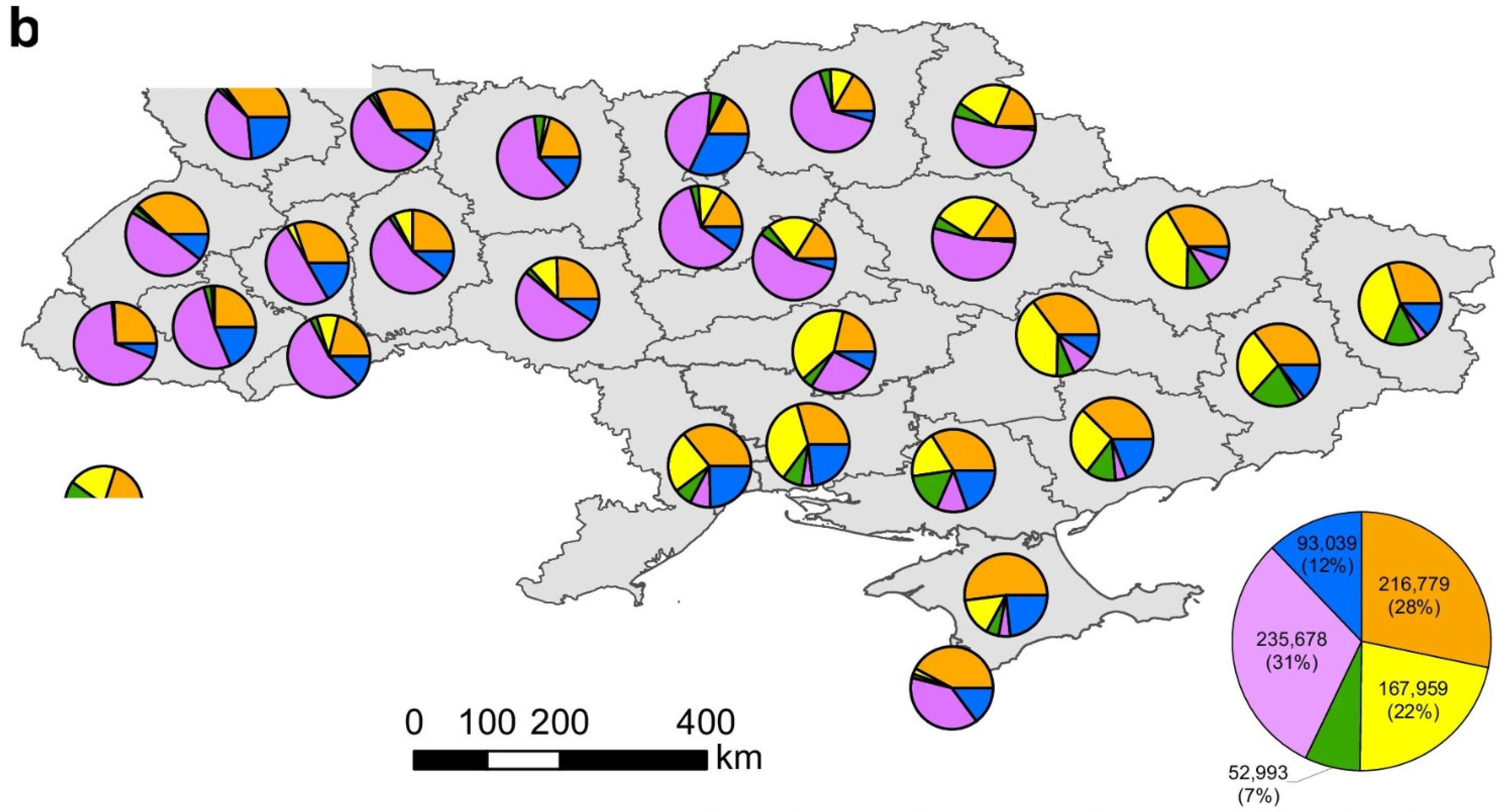
Reeds and typha provide high-yield, renewable biomass—up to four to five times the material output of coniferous forests—while alder and willow, particularly willow with phytoremediation properties, support regenerative wetland management that combines ecosystem protection with local material supply.

Image © Broads Authority - Fen landscape

The 10-m crop classification map derived from Sentinel imagery



pie charts showing the provincial crop area distribution. The pie chart in the lower right illustrates the national share of each crop area.



Potential Straw Production from Agriculture: Geograp our major crops: wheat, maize, sunflower, and rapeseed in Ukraine.
Bin Chen et al., "Quantification of Losses in Agriculture Production in Eastern Ukraine Due to the Russia-Ukraine War," Communications Earth & Environment 5, no. 1 (2024): 336, https://doi.org/10.1038/s43247-024-01488-3.

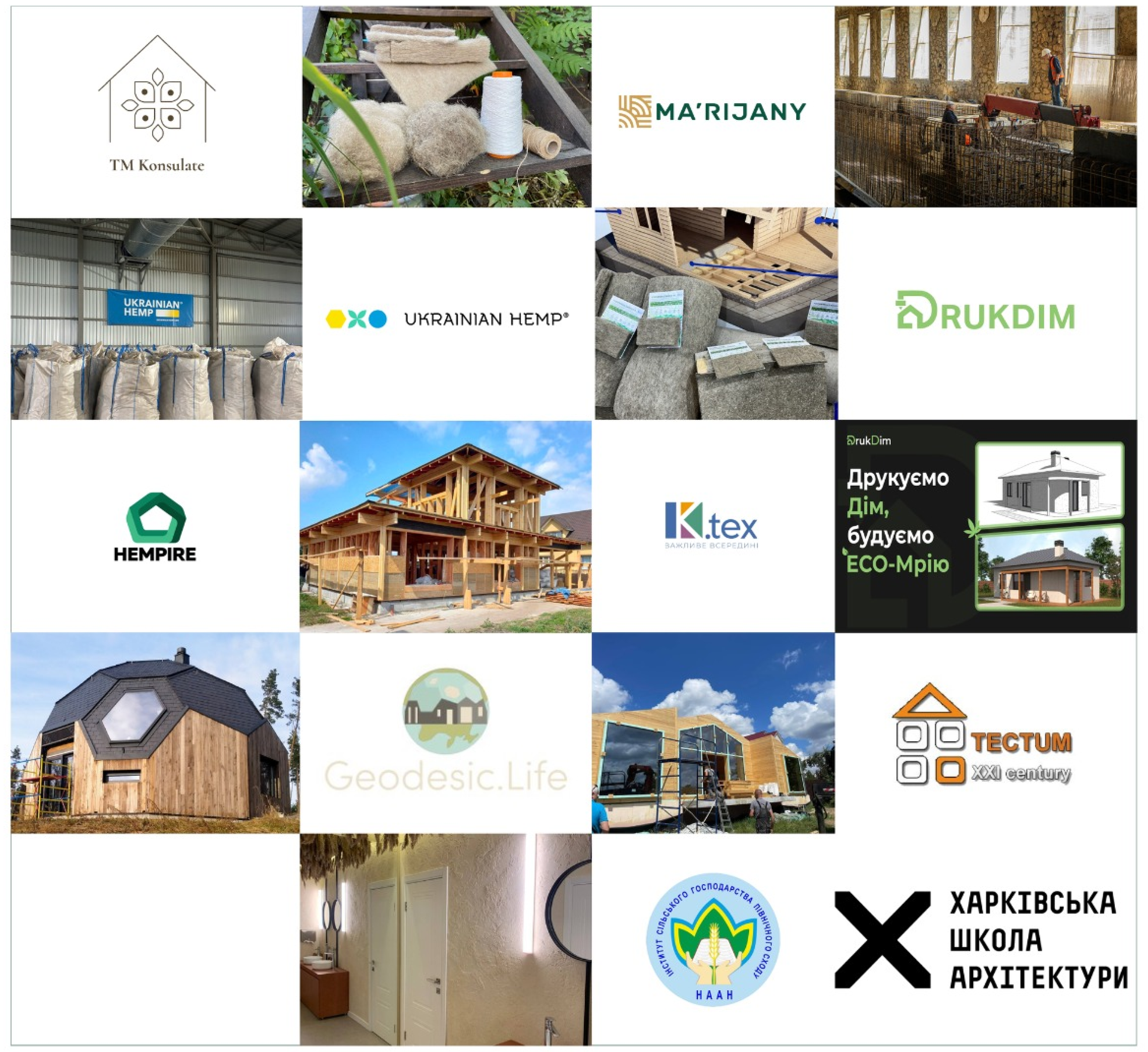
Fibres from Paludiculture © https://static.dezeen.com

© Straw Panel Company, Kyiv, UA

Hemp in Ukraine Recovery

Additional to agricultural byproducts and paludiculture, hemp can be a promising crop when thinking of the reconstruction of Ukraine thanks to its potential for manufacturing insulation products amd for soil remediation.

Historically, Ukraine has been one of Europe's leading hemp producers. Currently, most production is concentrated in the Sumy, Zhytomyr, and Khmelnytskyi regions, but this could be expanded. The hemp plant also has high phytoremediation potential.



Ukrainian Hemp Building Association

Hemp Hurds

- Processed Ukrainian hemp hurds
- We guarantee quality and convenient packaging, which will save time and money during transportation and construction
- The size of this product is best suited for hemplime insulation

Milestones: Ukrainian hemp history

Pre-1700s	1700-1750	1750-1800	1800-1	0-1900	1900-1950	1950-2000	2000-2025
Hemp introduced via trade routes, becoming integral to rural agriculture and traditional crafts.	Ukrainian hemp gains recognition as a key export for European maritime rope production.	Expansion of hemp cultivation in Left-bank Ukraine for textile and oil production.	Russian Empire promotes hemp cultivation; Ukraine becomes a leading producer of bast fibers.	Processing advances with steam-powered decorticators improving efficiency.	Soviet era: Ukraine designated strategic hemp research center. Institute of Bast Crops opens (1931)	Institute of Bast Crops develops low-THC, high-yield hemp varieties to meet 0.08 THC limit.	Post-Soviet revival: Hemp industry revitalized for fiber, grain, and eco-construction applications.

Hemp Variety	Type	Registration
USO 14	Fiber/Grain	Ukraine, EU, Canada
USO 31	Fiber/Grain	Ukraine, EU, Canada
Zolotoniski 11	Fiber/Grain	Ukraine, Canada
Zolotoniski 15	Fiber/Grain	Ukraine, Canada
Hlukhivskyi 46	Fiber	Ukraine
Hlukhivski 33	Fiber/Grain	Ukraine

While hemp processing infrastructure in Ukraine needs to be upgraded and modernized, production has been ongoing for centuries. Most hemp farming and processing stretches across the northern half of the country.

Hemp in Ukraine Recovery

The use of hemp construction in reconstruction is rapidly spreading throughout Ukraine, as primary processing of industrial hemp is available in almost every region. This has a positive impact on local economies and is convenient in terms of transportation.

The ease of use of Hempire TM technology allows not only to quickly build new houses, but also to restore damaged ones, which is especially important during the war. All these aspects allow the project to be scaled up to other communities in need, especially in the de-occupied and most damaged areas.

Hempcrete blocks made from hemp shives and lime. They offer high acoustic and thermal comfort, as well as high fire resistance.

Clay-hemp plaster

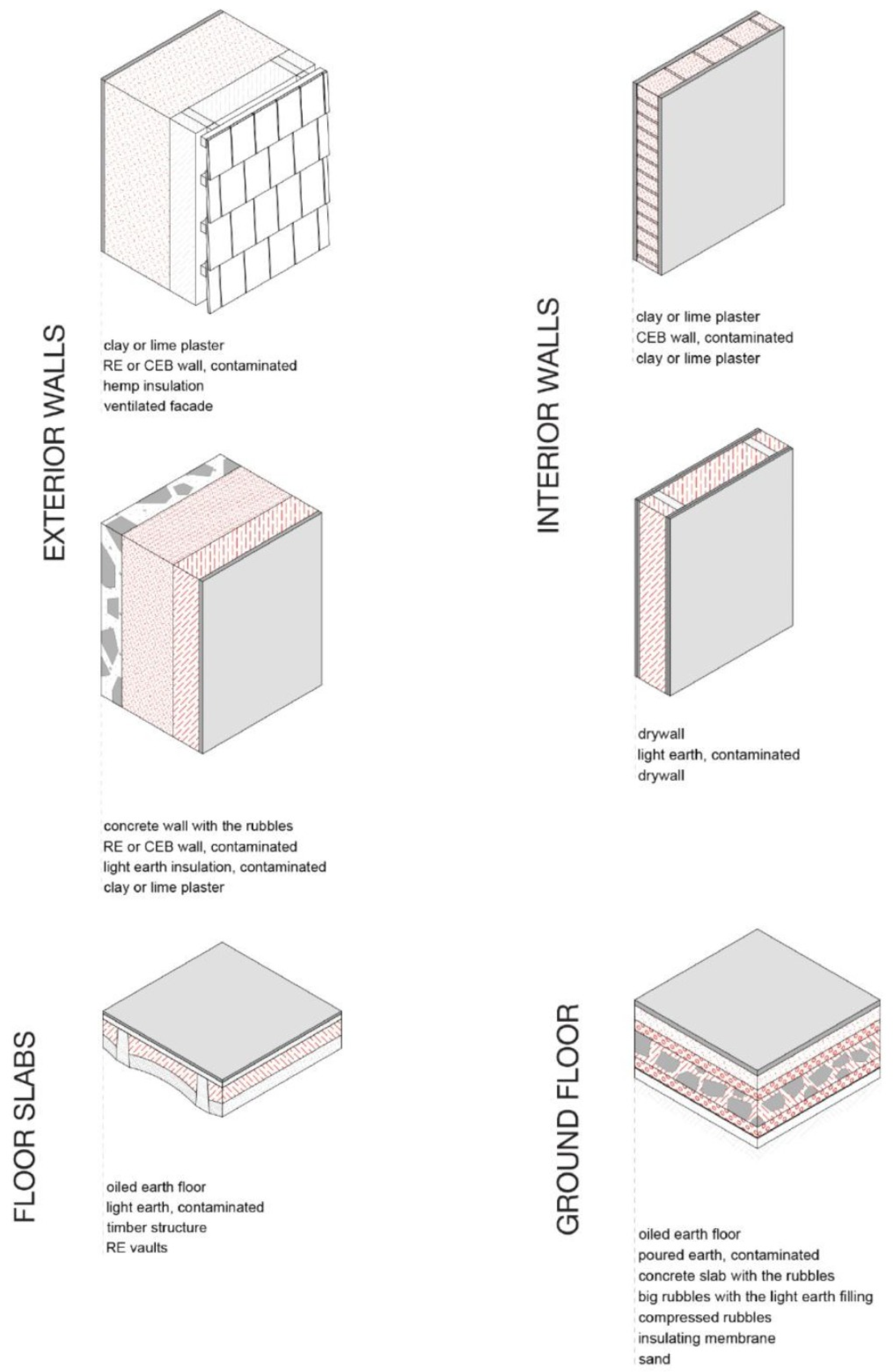
Lime-hemp plaster

Construction of eco-friendly housing for refugees using Hempire TM (hempcrete) technology while training internally displaced persons in this technology.

Earthen Materials

Local earth can be used in light-earth construction, where earth acts as both a binder and a natural regulator of heat and humidity. Across Europe, non-fired earth materials are already applied at multiple scales for structural and insulation purposes and can be endlessly reused and recycled when their mineral composition remains unchanged.

Although earth construction is deeply rooted in Ukrainian building traditions, much of this knowledge has been lost and requires adaptation to contemporary standards. Reviving these practices enables the use of local materials in a distributed, low-carbon, and resilient construction approach.



Details of Contained Earth © Anna Pommazana & Mykhailo Shevchenko. Grunt Experimental Fellowship with Bauhaus Earth.

The photo shows bricks made of local earth by the Ukrainian brand Glinko. Photo © Natalia Azarkina

Production of CEBs from local soil in Lviv by Anna Pommazana & Mykhailo Shevchenko. Grunt Experimental Fellowship with Bauhaus Earth. Photo © Zlatoslava Kryshtafovych

Earthen Materials

Earthen materials demonstrate significantly lower embodied carbon (A1–A3 stages) compared to cement-based products due to minimal processing and absence of clinker production.

Non-fired earth systems enable closed material loops, with high potential for reuse and recyclability (C & D stages), supporting whole-life carbon reduction.

When integrated with prefabrication and hybrid structural systems, earth-based solutions can contribute to measurable reductions in life-cycle GHG emissions while maintaining thermal mass and indoor hygrothermal performance.

The project at 17 Rue des Quatre-Cheminées seen from the front ©Salem Mostefaoui

Earth Pavilion and Reclaimed Materials in Lviv. Project by Anna Pommazana & Mykhailo Shevchenko. Grunt Experimental Fellowship with Bauhaus Earth. Photo © Zlatoslava Kryshtafovych

Combined Material Strategy

Hybrid systems including two or more nature based materials have proven to be the most efficient when combining their material properties.

Projects like the *Soubeyran Housing Cooperative* in Geneva, CH, demonstrate how hybrid mineral–biobased construction can integrate energy efficiency, circularity, and social sustainability. In this example, light concrete structure, straw bale façade insulation, and earth interior finishes, achieving energy class A+. Circular systems include compost-based sanitation and grey water reuse. Led by ATBA architects, this building project was developed through active resident participation setting a standard for co-design.

© Bauburo In Situ

© atba.ch

Producers in UA:

- lhb.com.ua/
- ecopanel.com.ua/
- eco-bud.com/
- avers-agro.com.ua/
- www.novator-group.com
- www.soloma.house/

© atba.ch

Panels and houses produced by Life House Building Company
©Life House Building Company, https://www.instagram.com/life.house.building

Natural Materials in Ukraine — Summary Status

Key Takeaway

Most natural materials are legally possible but institutionally unsupported.

Scaling requires standards, testing protocols, and regulatory clarification, not legal permission alone.

Material group	Enabling Conditions	Challenges / Barriers	Current use	Future Potential
Wood / Engineered Timber (CLT, glulam)	• Carbon-negative structural alternative to concrete. • Existing CLT production in Ukraine. • Export experience. • Industrial prefabrication capacity emerging. • Suitable for load-bearing systems.	• Height limits (mainly ≤3 storeys for solid timber) • No dedicated national standards for CLT/glulam • Fire & structural codes adapted to concrete systems • Lack of UN-aligned standards • High costs	• Private / low-rise buildings. • Limited CLT modules produced.	• Mid-rise housing expansion • Modular CLT systems • Structural substitution for concrete • Circular, adaptable structural layer
Natural fibres (rye straw, hemp, reed, typha	• Strong agricultural base. • Large Wetland biomass available (Polissia, Dnipro Delta). • Hemp industry revival. • EU know-how transferable. • High bio-based potential with low embodied carbon.	• Limited standards & certification. • Fire/moisture concerns. • Weak market demand. • Supply chains are not scaled.	• Insulation in low-rise family housing, Small-scale experimental projects • in finishing plaster • reinvented roof cover technic	• Scalable insulation market. • Bio-based panels & prefabricated wall systems. • Rural economic development + circular regional supply chains.
Earth (adobe, rammed earth, light-earth)	• Low price • Very low embodied carbon when locally sourced • Local soils tests. • Cultural tradition (mazanka technology). • Compatible with prefabrication & hybrid systems. • High thermal mass and hygrothermal regulation, improving indoor climate performance • Fully recyclable if mineral composition remains	• No certification/structural codes or calculation methods. • Limited / Lost technical knowledge, professional expertise. • Soil pollution (industrial, war related)	• Vernacular, small-scale, experimental.	• Standardised light-earth systems for housing. • Hybrid low-carbon envelopes. • Distributed local production technic for resilient reconstruction.

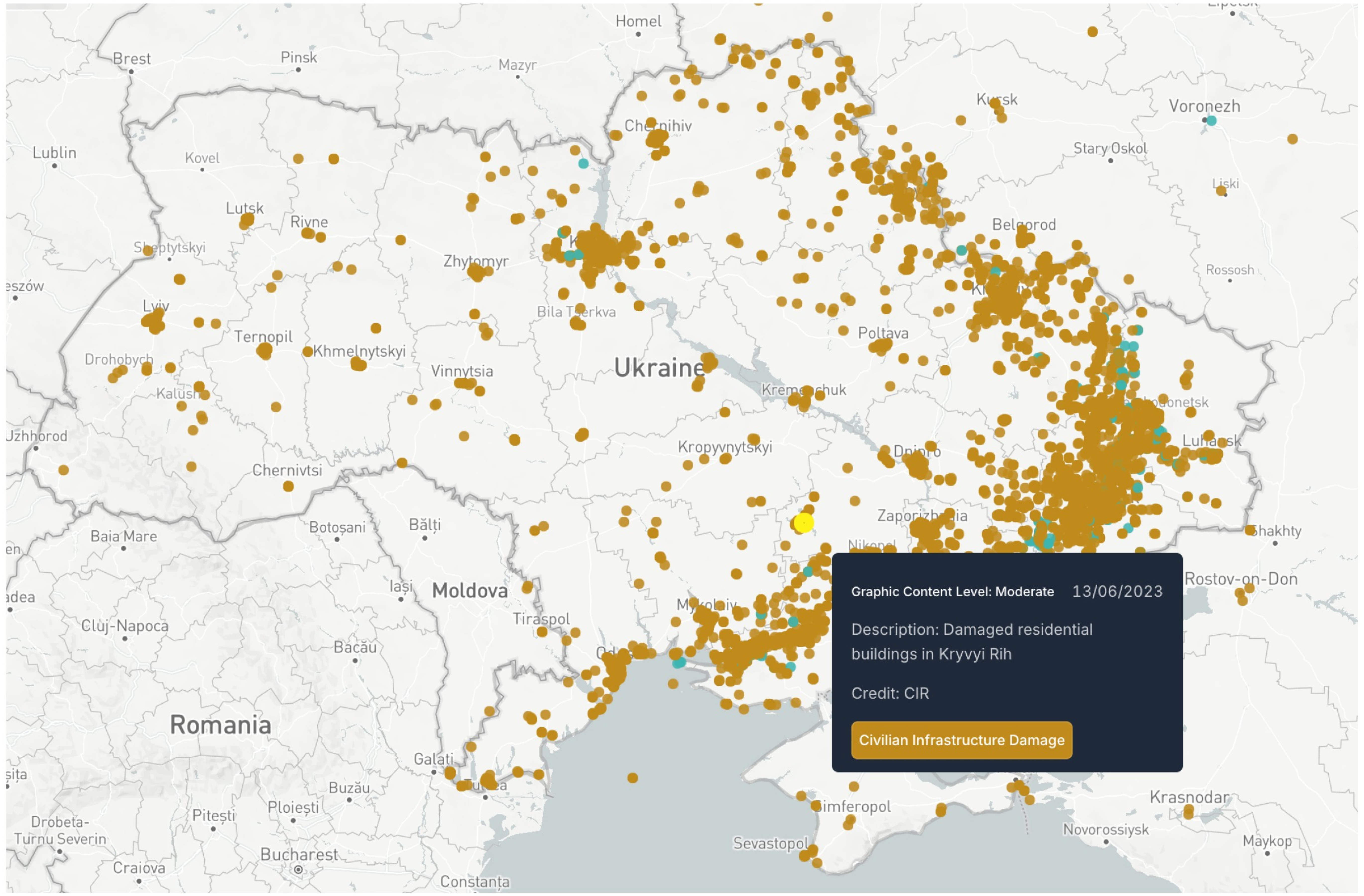
Building with Re-used building components

The photo shows volunteers in Kharkiv clearing debris from a residential building. © Yevgeniya Kutnova

Urban mining

Buildings are also material banks. When they reach the end of their lifecycle, we can access them and retrieve the materials needed for new construction

Neo-Eco Ukraine is dismantling a damaged high-rise building in Gostomel. Photo provided by the company.

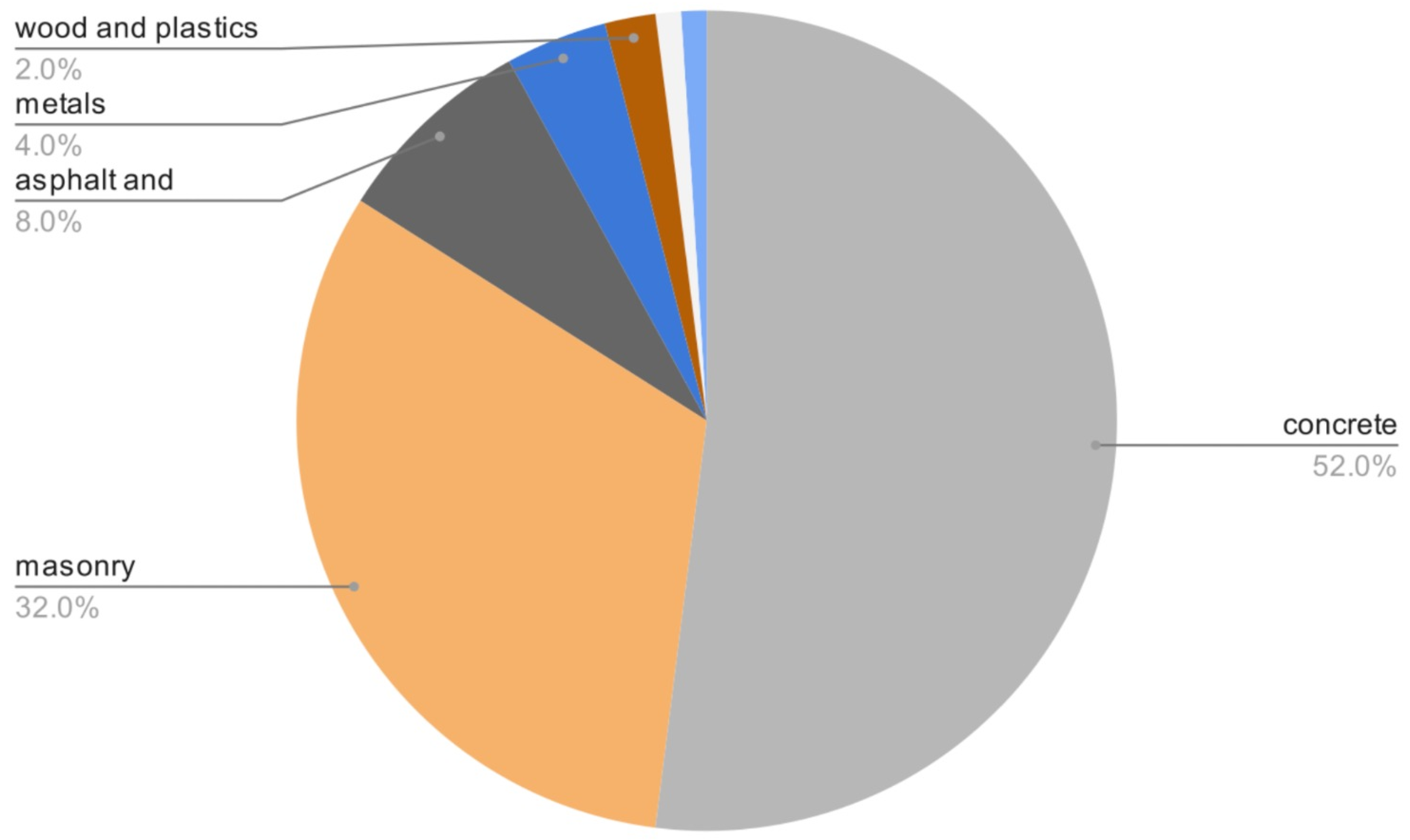


Civilian Infrastructure Damage by period / 17/02/2022 - 15/01/2026 © Eyes on Russia Map

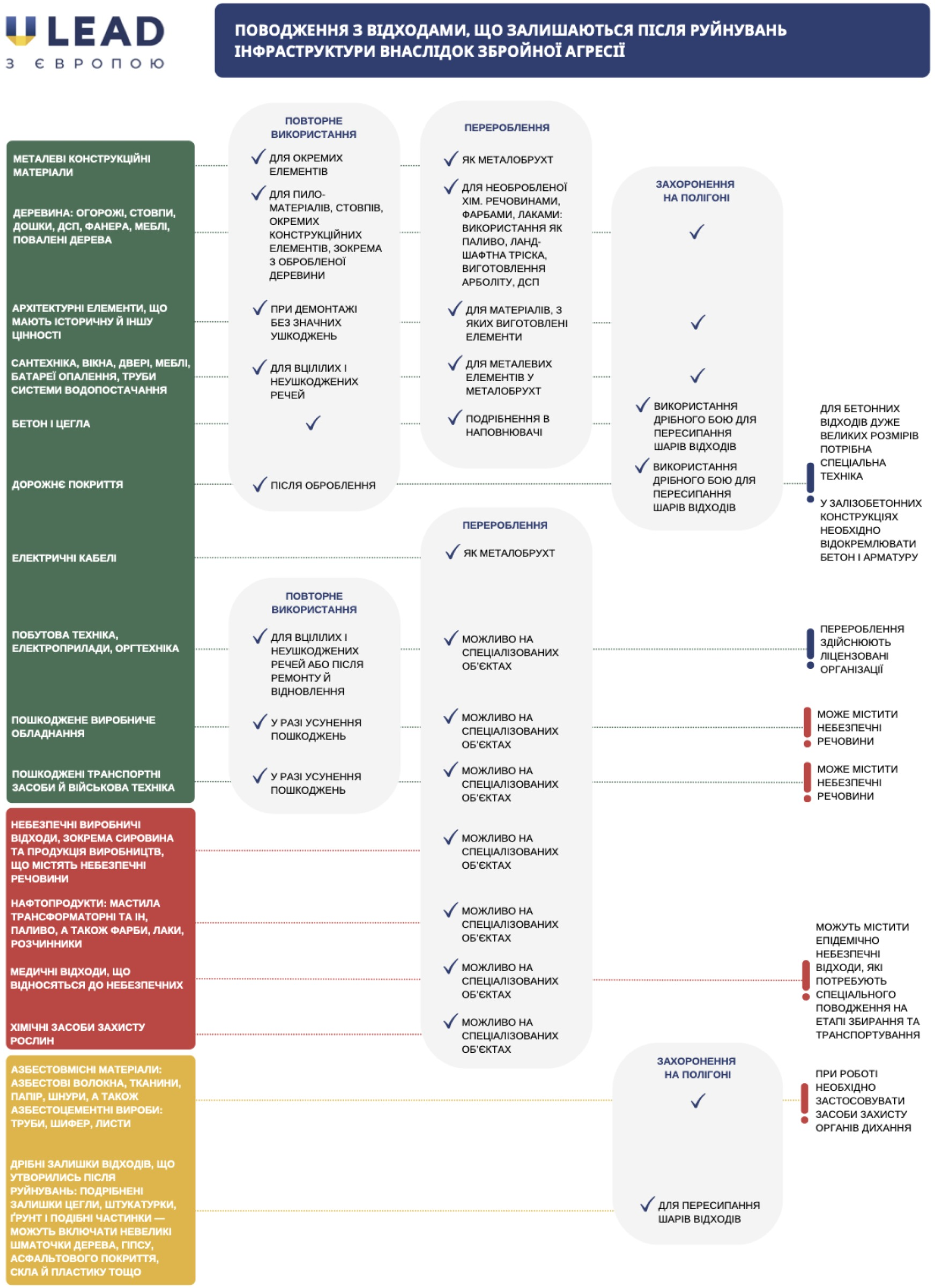
Composition of demolition waste

From a circular economy perspective, the recycling potential is proportional to the quantity of materials recovered.

Concrete and masonry account for more than 80% and have significant economic potential, while metal recycling is already well-established and economically viable.



Source: National Strategy for Waste Management until 2030 in UA, issued 2017

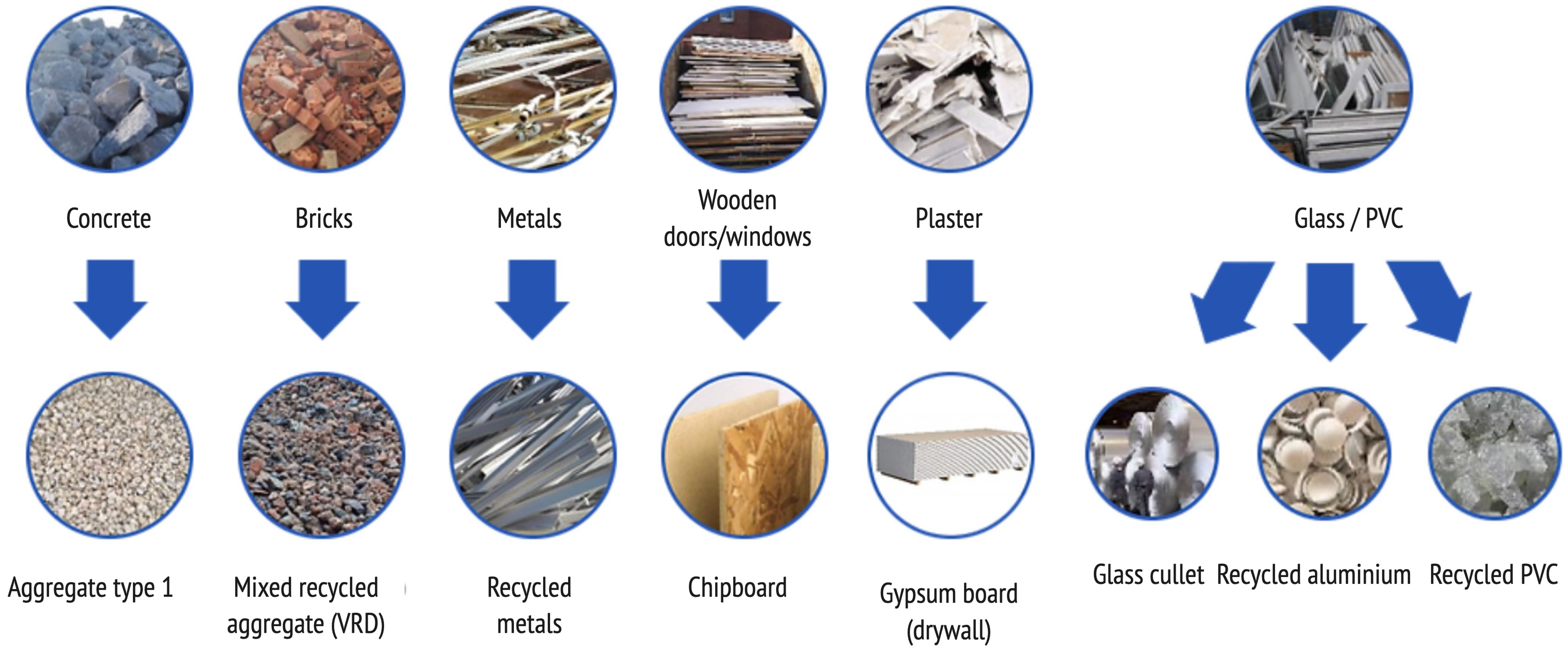


The scheme demonstrates how certain demolition waste can be used. © NGO DESPRO

Re-used building components

How different types of construction waste can be used:

Identifiable material reuse pathways include clean concrete aggregates for road foundations and mixed mineral aggregates for backfilling and non-structural elements, as well as combustible fractions, such as treated wood and plastics, for energy recovery (e.g. in cement plants).



Graphic © Neo Eco, www.neo-eco.com.ua

Concrete recycling

Post-war reconstruction gives Ukraine a one-time opportunity to move concrete recycling from emergency waste handling to a scalable, low-carbon construction system.

Ukrainian cases illustrate circular cement and concrete pathways:
Research-led: Lviv Polytechnic and the National University of Water and Environmental Engineering develop new cementitious mixes, addressing the ~52% share of concrete waste through mobile recycling.

Industry-led: Neo-Eco Ukraine and Mission East are establishing a DGBP-approved demo plant in Mykolaiv for low-carbon cement and green concrete from war debris.

Pilot circularity project in Hostomel. © Neo-eco

The process of crushing construction waste and turning it into new building material © Neo-eco

Pilot Circularity Project in Hostomel

In early 2023, Neo-Eco Ukraine demonstrated that **90% of 50,000 tonnes of demolition material** could be recycled; recovered sand, aggregates, and slag were proven suitable for reuse in reconstruction.

Impact: The project avoided **thousands of tonnes of CO_2 emissions**, created **20 temporary local jobs**, and prevented **7,150 m^3 of waste** from being landfilled, showcasing the feasibility of circular economy approaches in Ukraine's post-war recovery.

Metal Reuse and Recycling

Ukraine has historically been a major steel-producing country, with industrial hubs such as Mariupol playing a central role in the metallurgy sector.

War-related destruction has generated vast volumes of scrap metal from damaged buildings, infrastructure, and industrial plants. Metal recycling in Ukraine has become both an economic necessity and a strategic resource issue.

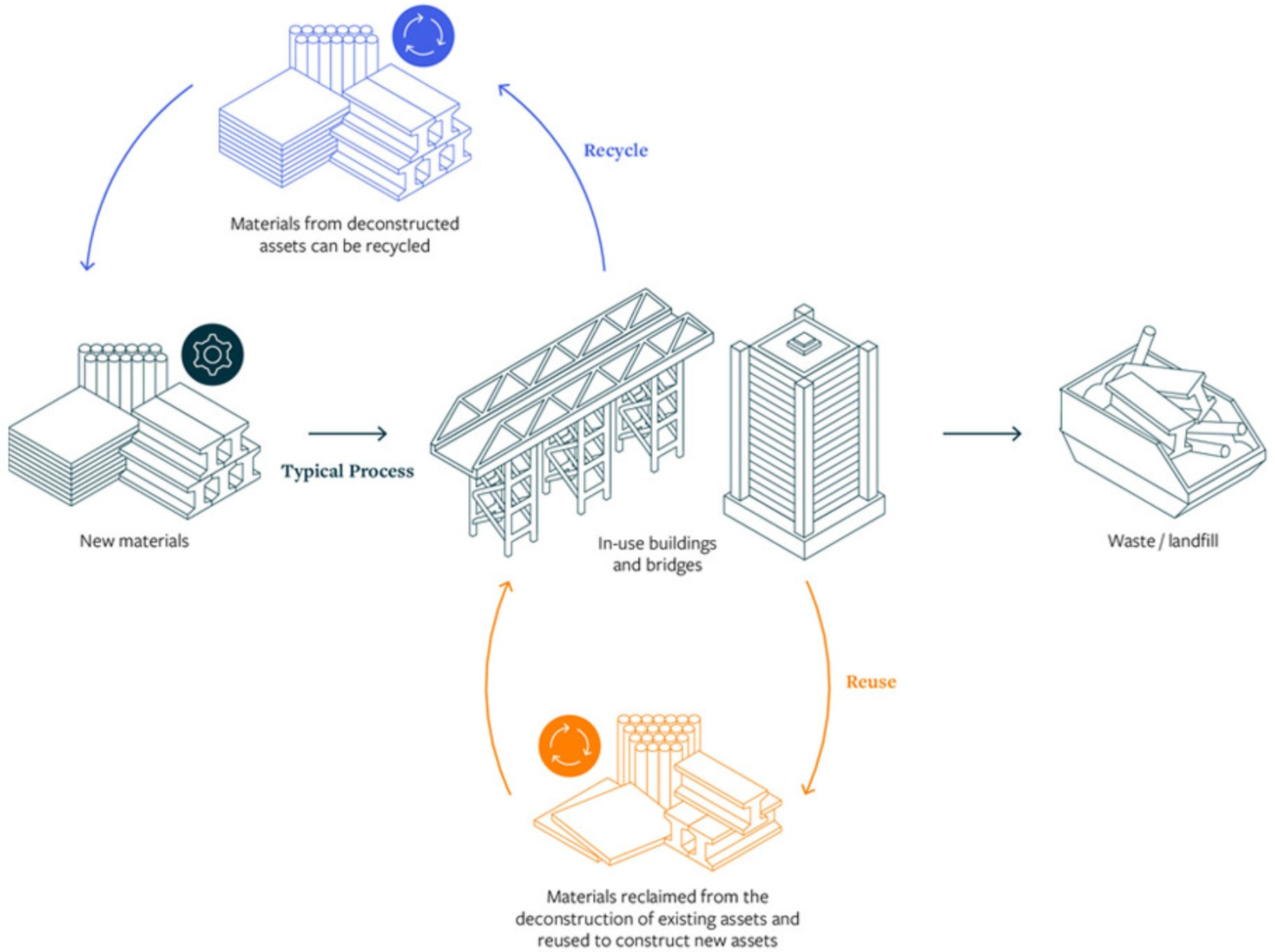
Scrap metal represents not only waste, but a secondary raw material critical for reconstruction.

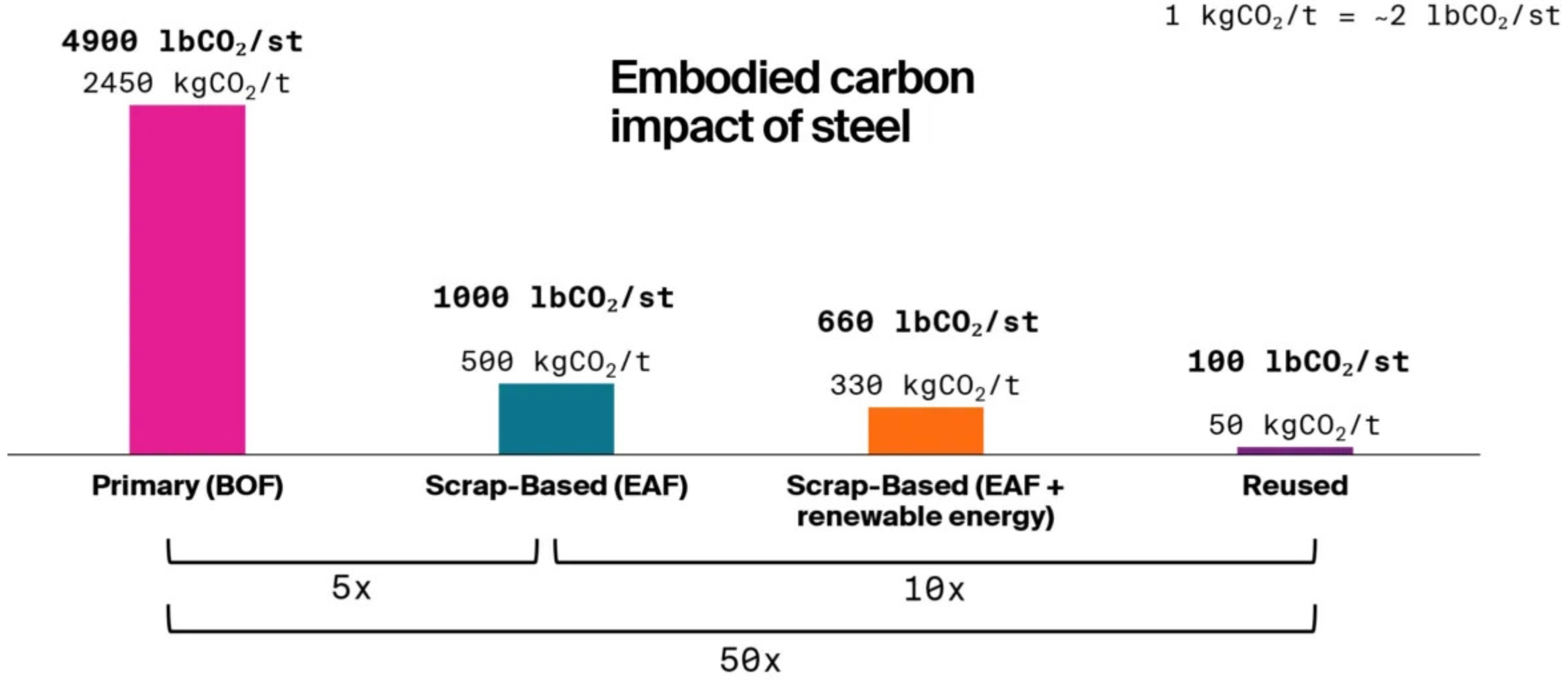
Metal reuse and recycling practices offer one of the fastest carbon-reduction pathways in reconstruction.

Reused Steel Stockmatcher © UKGBC, https://ukgbc.org/resources/reused-steel-stockmatcher/

Steel lifecycle diagram

courtesy of Thomas. Matthews





© elliottwood.co.uk , londons-steel-reuse-lessons

Brick Reuse & Recycling

Why it matters for Felicity II

Brick reuse is one of the fastest and most effective embodied carbon reduction measures available today.

Brick reuse = immediate, proven low-carbon strategy

Applicable to post-war reconstruction & renovation

Aligns with whole-life carbon logic and circular construction

Existing Building Stock
- Pre-1970 brick buildings
- High material quality
- Embodied carbon already invested

Selective Deconstruction & Sorting
- Manual or selective dismantling
- Separation of bricks by mortar type
- Lime mortar = high reuse potential

Cleaning & Preparation
- Removal of mortar residues
- Minimal processing (especially with lime mortar)
- Quality control & sizing

Reclaimed bricks. Kyiv, Ukraine, drama theatre © Drozdov Partners
drozdov-partners.com/

Reclaimed bricks. Paris © Plan Común

The brick modules at the Resource Rows in Copenhagen were cut out of old buildings at the Carlsberg Brewery.
Lendager Group, 2019, Photo © Lendager

Recycling of tiles and ceramics

Bricks, tiles, and ceramics can be processed into mixed recycled aggregates suitable for backfilling and non-structural construction materials such as paving blocks, non-load-bearing wall units, and terrazzo flooring.

However, recycling this type of demolition waste faces similar challenges to concrete recycling, including limited availability of crushing equipment and contamination with hazardous materials.

Mixed recycled aggregates © cyrkl.com


https://www.dwell.com Photo © Céline Clanet


Polished Concrete Overlay, Terrazzo Benchtop Slabs & Tile © concrete-collaborative.com.au

Dave Hakkens Rubble Floor with Recycled Materials © inhabitat.com

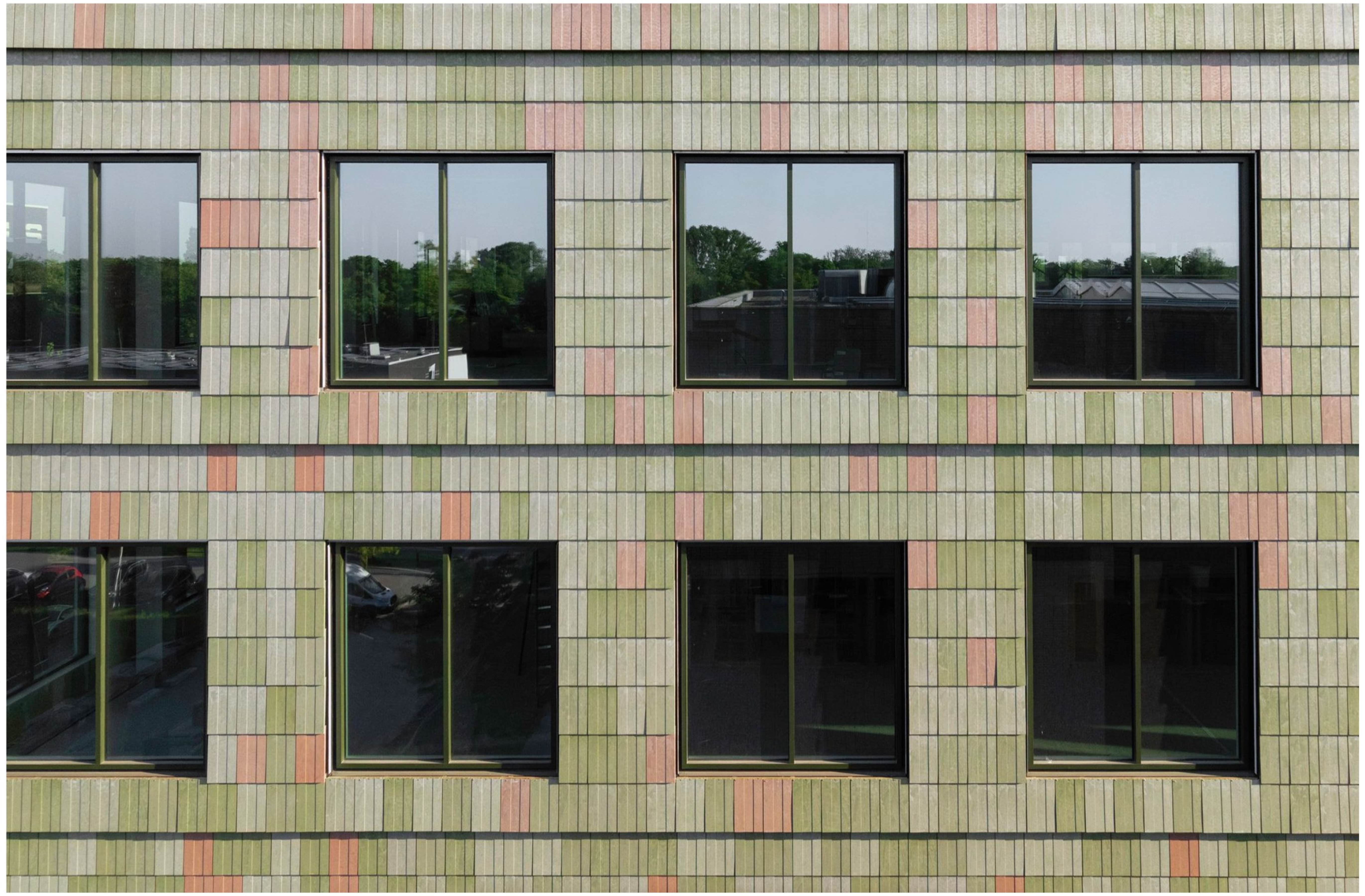
Plastics Recycling

Large volumes of plastic waste are generated from damaged buildings (insulation, pipes, window frames, membranes, packaging).
Most construction plastics (PVC, EPS, XPS, PE, PP) are technically recyclable but often under-collected and contaminated.

Key challenges: material mixing, additives, fire retardants, and lack of sorting infrastructure.
Mechanical recycling is most common; chemical recycling is emerging but energy-intensive.

High potential for circular reconstruction through closed-loop systems (e.g., recycled PVC windows, insulation boards, piping).

Reduces embodied carbon compared to virgin polymer production and decreases landfill pressure.



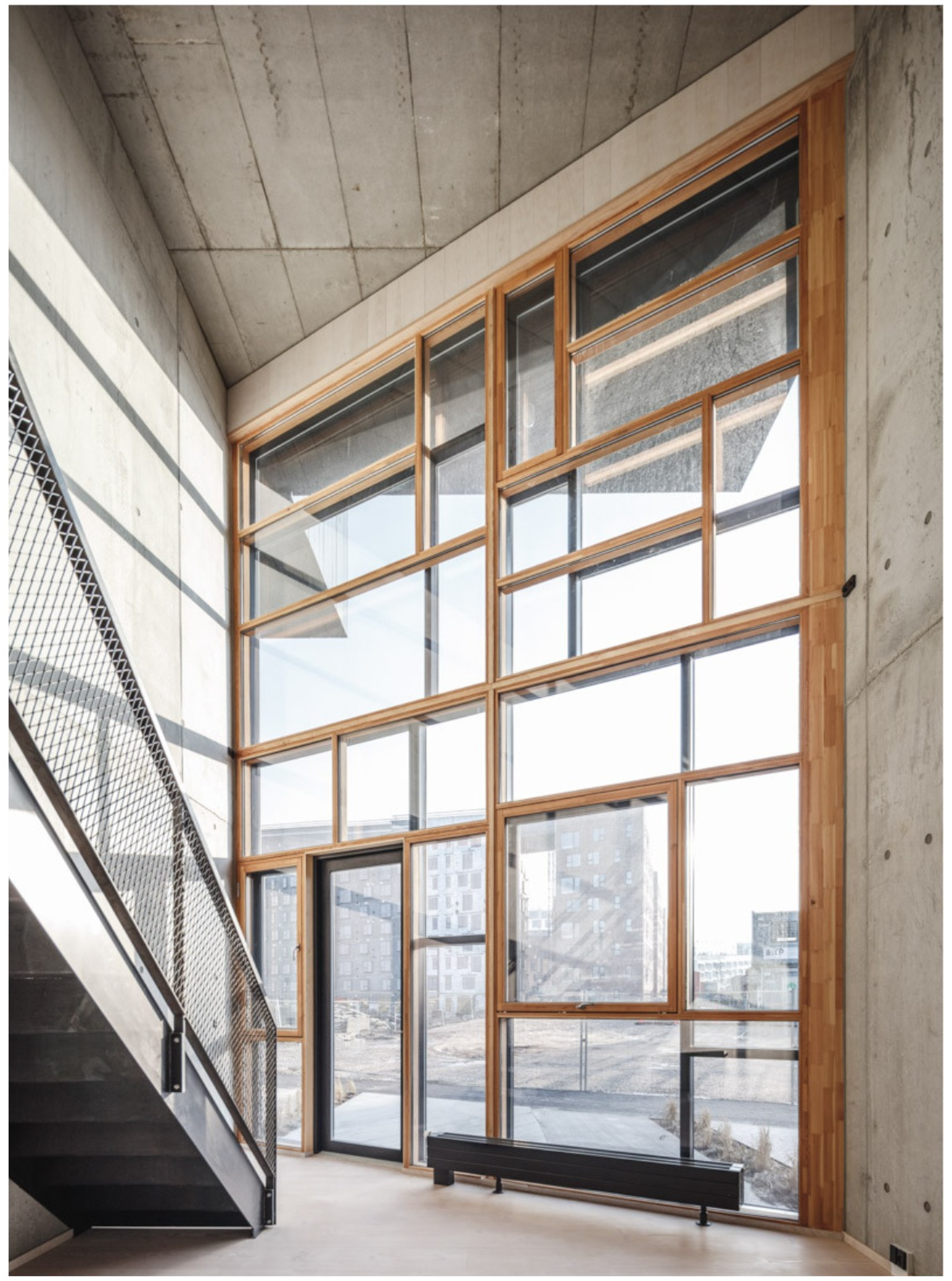
Facade Tiles © Pretty Plastic, NL

Reuse of windows & glass

The project *Vikna dlia Ukrainy* demonstrates a circular, low-carbon approach to rebuilding Ukraine by collecting, refurbishing, and reusing windows from donor countries for installation in war-damaged buildings.

The initiative addresses urgent housing needs while avoiding the embodied carbon associated with manufacturing new windows, which is typically high due to energy-intensive glass and frame production.

As a practical example of material reuse at scale, the project shows how existing building components can be reintegrated into reconstruction workflows through logistics, quality control, and standardisation.



Upcycle Studios © Lendager Group, DK, 2020

Warsaw volunteers collect and send reuse-windows to reconstruct Ukrainian cities and villages
© rubryka.com/article/vikna-dlya-ukrayiny

Secondary Materials in Ukraine – Summary Status

Recycled or reused material group	Enabling Conditions	Cross-Cutting System Barriers	Current use	Future Potential
Concrete (recycled aggregates & elements)	• Massive feedstock (≈52% of construction waste is concrete) • Existing crushing operations • EU precedents (SmartCrusher, carbonation tech) • Recycling pilots	• Lack of equipment & sorting infrastructure • Regulatory & market gaps • Absence of national standards for reuse grading • Significant hazardous materials (asbestos, PCBs) • No demolition audits or material passports • No whole-life-carbon criteria in procurement	• Mostly downcycled (road base, backfill)	• Systematic deconstruction • High-grade recycled aggregates • Carbonated recycled concrete • Wide range of Prefabricated products ready to use in construction and Landscaping
Steel / Scrap metal	• Established recycling industry • Large demolition volumes from war damage • High material demand for reconstruction • Existing industrial dismantling capacity • Performance-based approval legally possible		• Scrap recycling (secondary steel production)	• Direct structural steel reuse • Material banks • High embodied carbon savings vs primary steel
Fired bricks	• Old stock brick buildings with high-quality material • High embodied carbon already invested • Selective dismantling possible		• Small-scale selective reuse • Heritage renovation	• Systematic deconstruction • Certified reclaimed brick market • Immediate carbon reduction strategy
Tiles and ceramics	• Processable into recycled aggregates • Suitable for non-structural applications • Strong implementation experience from Soviet-era mass construction, particularly in prefabrication, panel systems, flooring		• Mixed aggregates • Non-structural blocks • Finish materials	• Terrazzo, paving blocks • Non-load-bearing wall units
Plastics (PVC, EPS, XPS, PE, PP)	• High circular potential • Emerging mechanical recycling • Closed-loop systems possible		• mechanical recycling mainly(PVC, PE, PP). • Recycled PVC in pipes, cable ducts, and some window profiles. • EPS/XPS regranulate used in lightweight concrete and fillers. • Small-scale WPC decking, façade elements, and urban furniture.	• Recycled PVC windows • Insulation boards • Pipes (closed-loop systems) • Recycled Roof/Facade tiles • Street Furniture
Windows and glass	• Practical pilot examples (e.g., reuse from donor buildings) • High embodied carbon avoidance • Logistics & quality control models emerging		• Pilot projects (e.g., window reuse initiatives) • Small-scale private reuse market	• Standardised reuse workflows • Refurbishment hubs • Integration into social housing reconstruction

Key Takeaway

With the right policy framework and pilots, demolition waste can shift from a liability to a core pillar of circular construction in Ukraine.

Building with Industrial Waste

Metallurgical waste of Kryvyi Rih

More than 95% of waste generated and accumulated in Ukraine consists of industrial waste, with the largest share coming from the metallurgical sector.

Metallurgical waste—primarily slags—represents a valuable resource for the construction industry, particularly for low-carbon building materials and circular applications.

Analysis shows that in 2020, the volume of waste generated from the iron-ore industry in the city of Kryvyi Rih is 0.256 billion tons, which is 92.08% of the total waste accumulation in the Dnipropetrovsk Oblast and 65.5% of the whole Ukraine.

This demonstrates the powerful importance of the city of Kryvyi Rih and the Kryvyi Rih Iron-ore Basin as a whole in the generation of large-tonnage industrial waste both in the Dnipropetrovsk Oblast and in Ukraine.

Comprehensive assessment of the earth’s surface state disturbed by mining and ways to improve the situation: case study of Kryvyi Rih Iron-ore Basin, Ukraine
© 2024 Bazaluk, Petlovanyi, Sai, Chebanov and Lozynskyi.

Slag-Based Building Materials today

Due to its strength, porosity, wear resistance, and water absorption properties, steel slag is widely used as aggregate in asphalt, as clinker raw material, railway ballast, and fill material.

ArcelorMittal, Kryvyi Rih's large-scale use of blast furnace slag in road construction, demonstrates the technical, regulatory, and logistical feasibility of circular material flows in Ukraine.

The first experimental road made of ash in Ukraine by DTEK Energo's near the Burshtyn Thermal Power Plant demonstrates that ash-and-slag materials can replace conventional mineral components while maintaining technical performance and reducing costs.

Laboratory testing confirmed equivalence with standard asphalt concretes.

The *Mykolaiv Alumina Plant* has validated red mud use in cement production, with up to 180,000 t/year planned for reuse.

Proven potential: Demonstrates that high-volume industrial by-products can be safely integrated into construction.

Broader uses: Red mud can be developed into low-carbon binders, SCMs, bricks/blocks, prefabricated elements, and façade or paving products, supporting circular material production.

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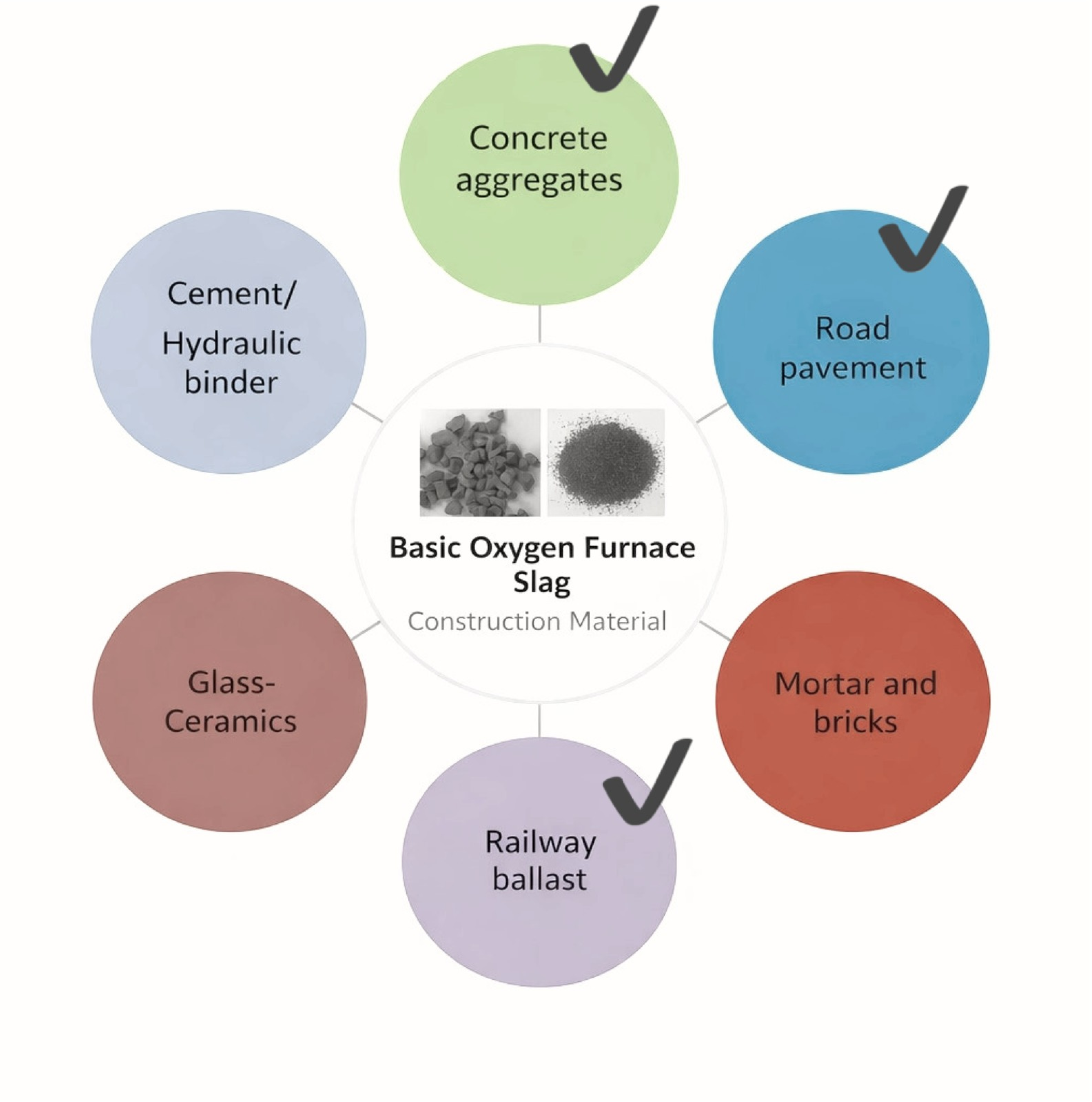
© rcauroville.com/post/red-mud-plaster-experiment

Future Potential

Proven large-scale use of slag in infrastructure demonstrates its technical reliability, regulatory feasibility, and logistical scalability. Building on this precedent, slag can be redirected from low-value applications toward higher-value building components, such as façade panels, prefabricated elements, and low-carbon concrete systems, while simultaneously supporting landscape applications including pavements, embankments, and public spaces. This dual pathway enables integrated circular material flows that reduce embodied carbon, replace virgin aggregates, and support scalable post-war reconstruction across buildings and open spaces.




No-Fines Concrete with Steel Slag Samples. Photo © L.Korat et al. , 2015. Image via ResearchGate.


Red mud foamed concrete block. Photo ©


Iron-ore slag foamed concrete block. Photo ©


Slabbing Products © Saltech Pavement

Secondary Indusrtrial Vaste Materials in Ukraine —

Summary Status

Slag is technically validated at scale but remains economically under-valorised, primarily confined to low-value infrastructure uses.
A strategic transition — from infrastructure downcycling to architectural components and low-carbon building systems — would unlock significantly higher value and climate impact.

Recycled or reused material group	Enabling Conditions	Cross-Cutting System Barriers	Current use	Future Potential
Slag-Based Materials	• Extremely large industrial stockpiles (Kryvyi Rih, Dnipro region) • >95% of accumulated waste in UA is industrial; metallurgy dominant sector FII – Embodied Carbon _ BE x R3... • Proven large-scale use in infrastructure (roads, ballast, asphalt) • Demonstrated technical feasibility (DTEK ash-road, ArcelorMittal slag roads) • Validated cement integration (red mud reuse up to 180,000 t/year) • Strong industrial base & logistics capacity	• Mostly downcycled into low-value infrastructure uses • No architectural / façade product standards • Limited embodied-carbon incentives • Conservative building codes (cement/concrete benchmarked systems) • Market perception as “waste” rather than construction-grade material • Limited prefabricated product development	• Aggregate in asphalt • Clinker raw material in cement • Railway ballast • Road subbase & embankments • Fill material • Cement additives (Primarily infrastructure-scale, low-value applications)	• Slag-based façade panels • Prefabricated building elements • Low-carbon binders & SCMs • Foamed slag concrete blocks • Paving systems & landscape products • Substitution of virgin aggregates in housing reconstruction • Integration into circular urban material flows

Pilot Buildings in Mykolaiv and Kryvyi Rih

Renovation of Mass Housing Using Circular Construction and Carbon neutrality principles context

Pilot Buildings:

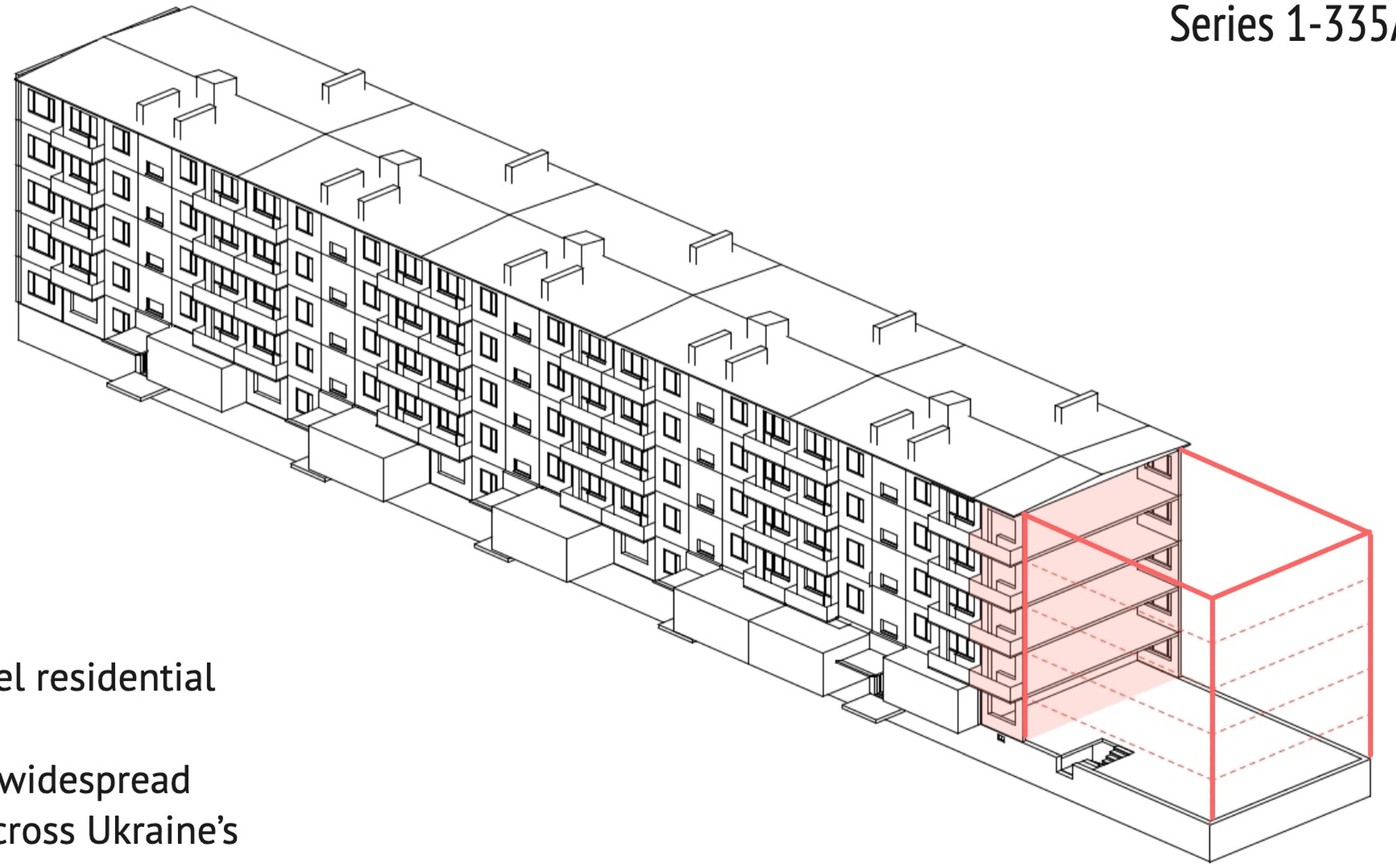
Mykolaiv and Kryvyi Rih were selected as partner municipalities to implement refurbishment measures in representative pilot residential buildings affected by missile damage.

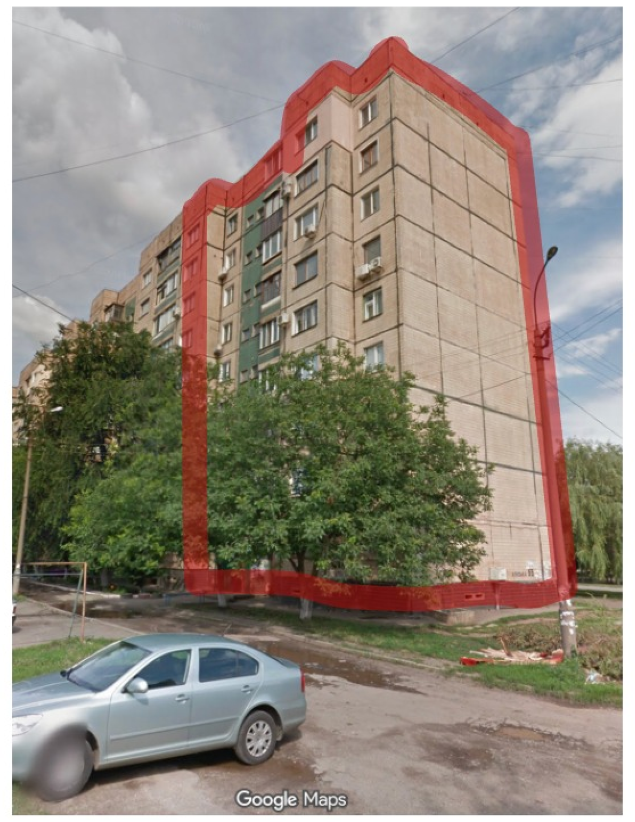
We focused on the Mykolaiv pilot — a typical and widespread panel housing typology — to demonstrate a practical low-carbon renovation model.

While the following slides present solutions for this specific building, the approach serves as a scalable algorithm for renewing similar housing across Ukraine.

Mykolaiv Pilot Building
49/1 General Karpenko Street
A representative 5-storey panel residential building
It belongs to one of the most widespread 1960s housing series found across Ukraine's cities and district centres.

Series 1-335A

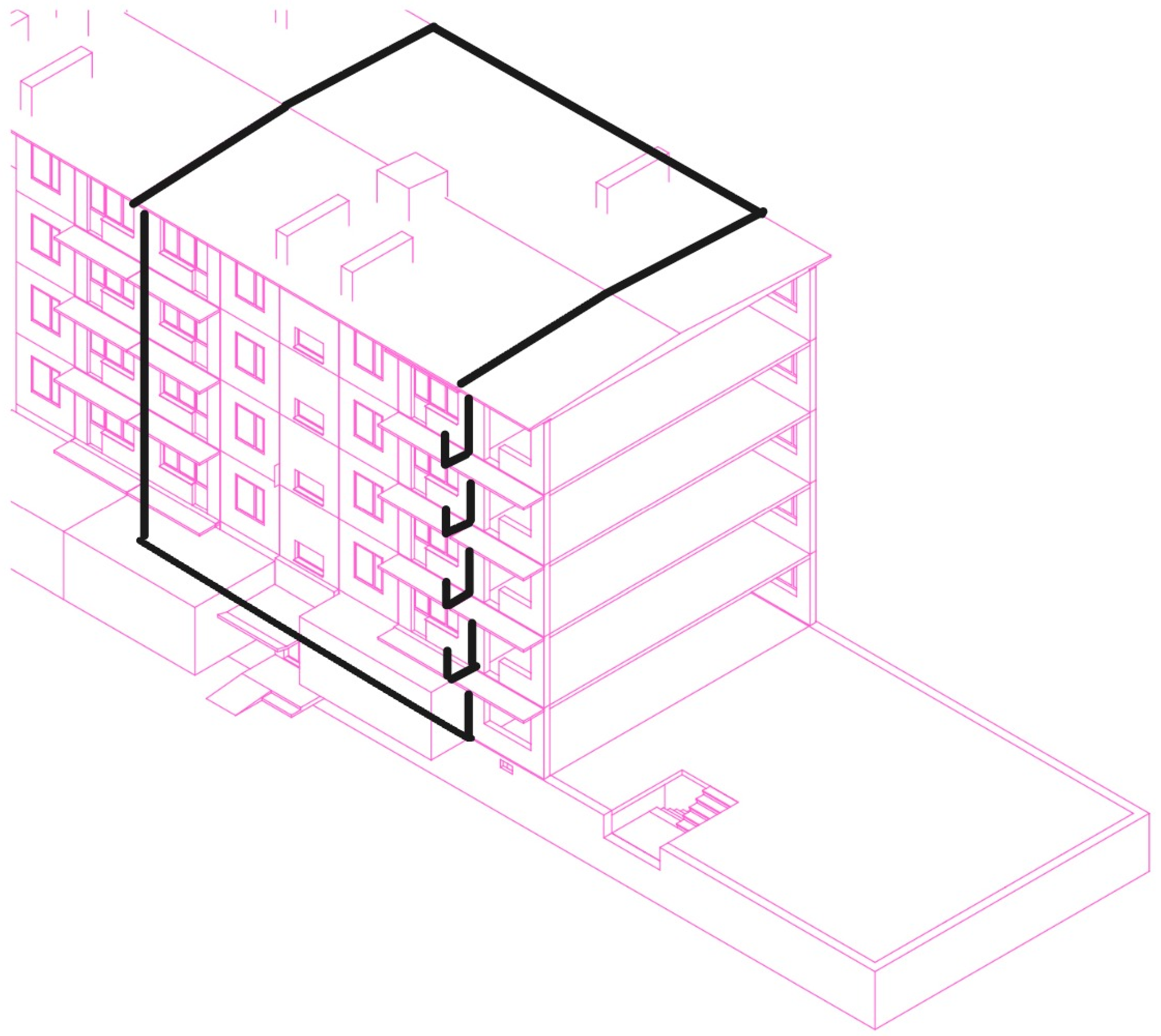




Kryvyi Rih Pilot Building
No.1, Українська,55
A typical multi-family 9-storey
Initial assessment indicated the need for façade repair, energy retrofitting, and partial structural intervention.

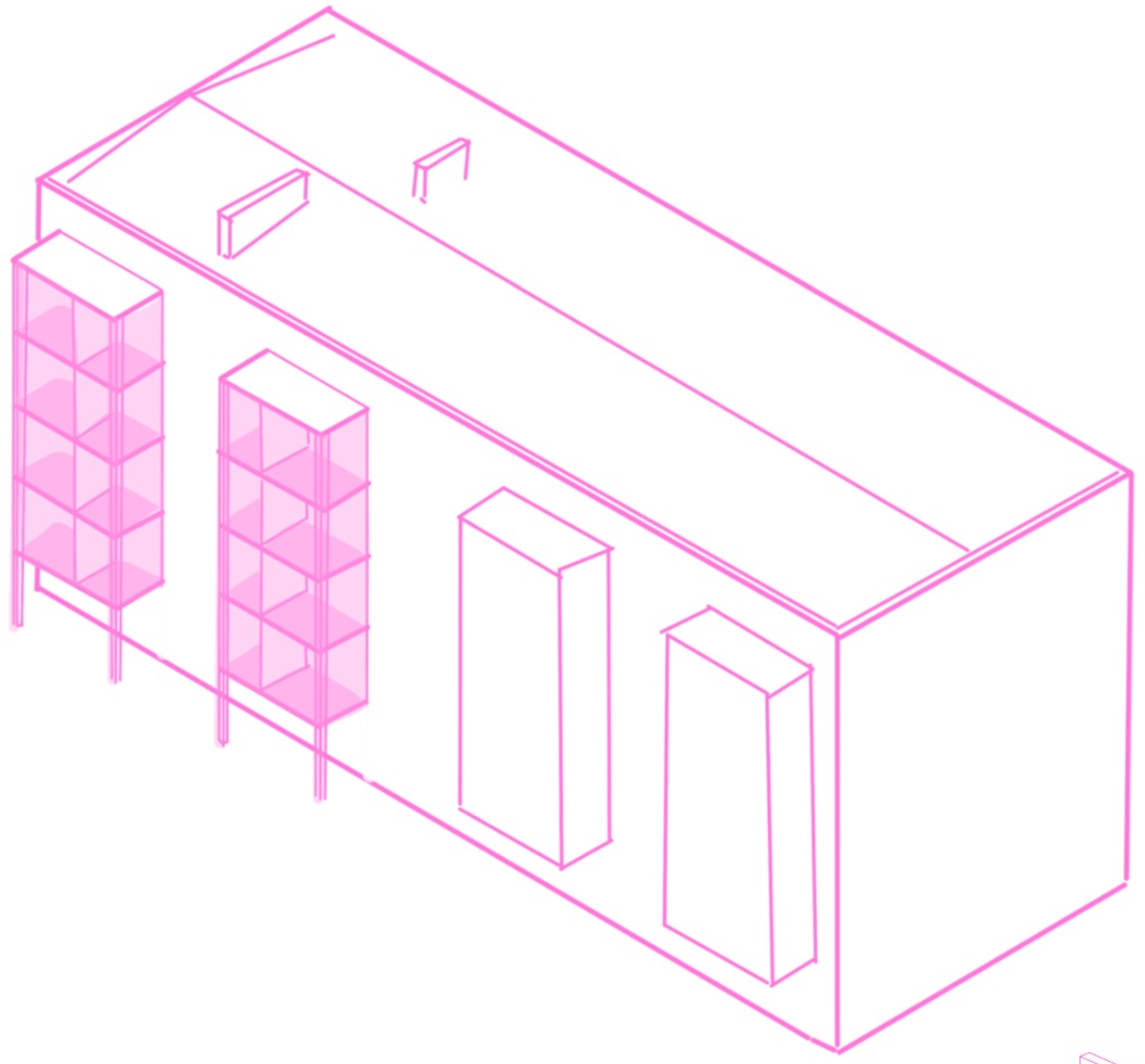
Series 111-90
/or its lokal modification/

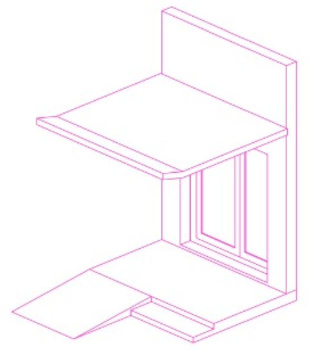
External Envelope



Overall, the building renovation boils down to standard solutions for:

- 5 types of panels
- 4 types of windows
- 1 Balcony type
- 1type Entry
- Roof insulation and water capturing





Roof
require insulation and water capturing

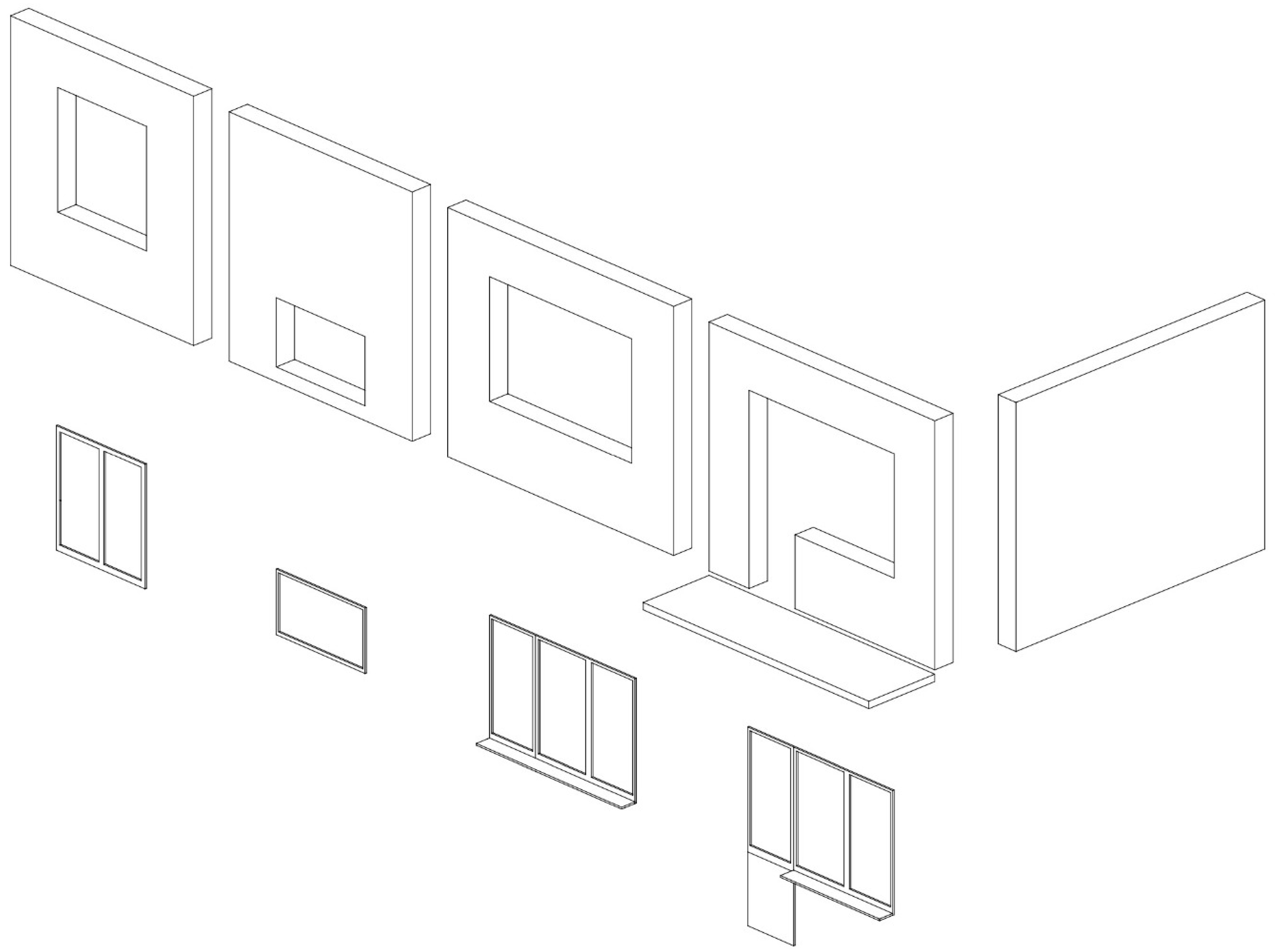
Walls require energy-efficient insulation + finishes

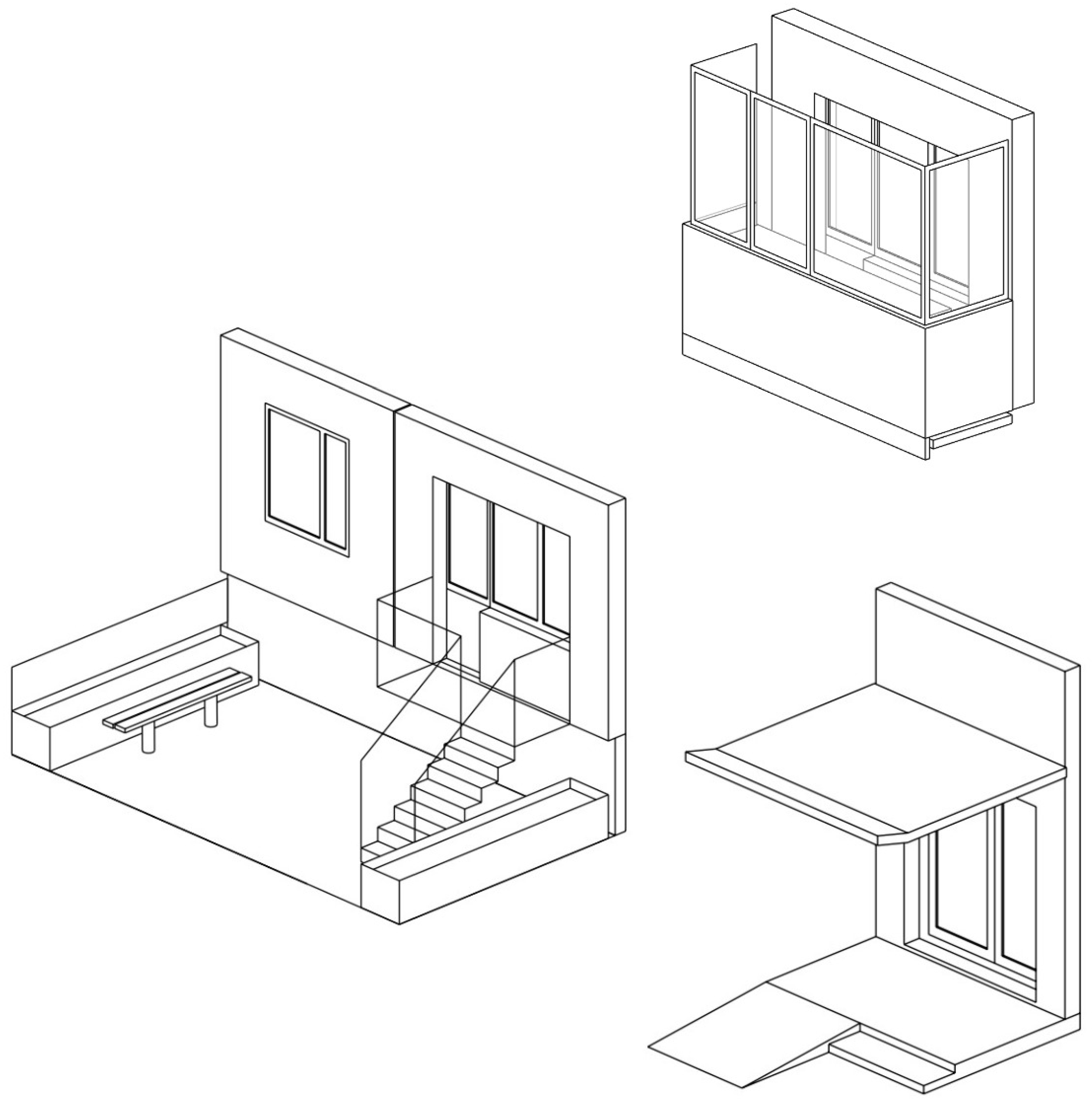
Windows
require energy-efficient replacement.

Safe and Accessible Entrances
Transparent entrances increase visibility and safety when entering a building. A sidewalk- or courtyard-level entrance provides accessibility for all users. Space for bicycles and strollers can be added at the entrance too.

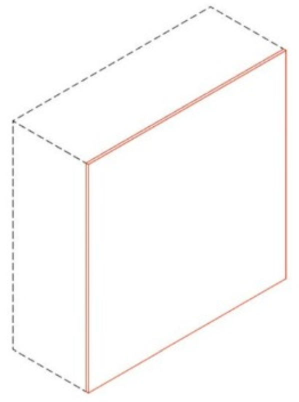
Unified Balcony Design
Building new balconies or updating old balconies provides a unified and harmonised compositional solution for building facades, providing residents with new places for open-air leisure.

Facade Envelope - typical elements:

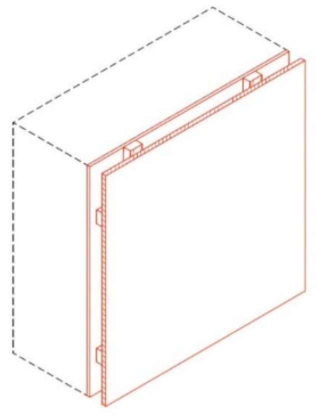




Façade Solution opt1
Plastered + Recycled Tiles



Façade Solution opt2
Ventilated with fibro-based panels

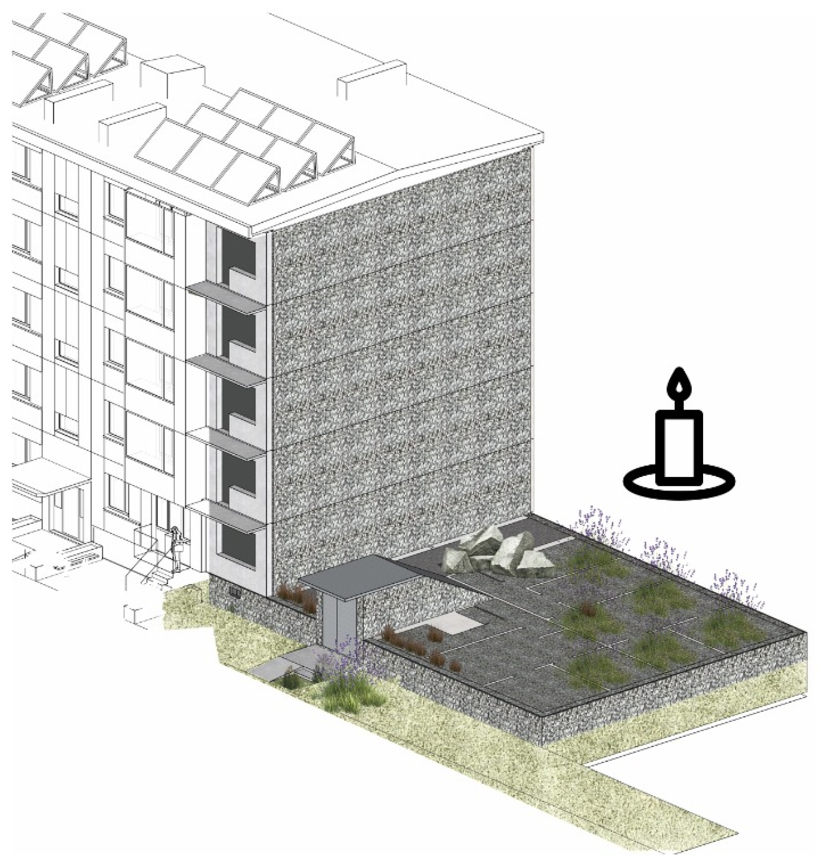


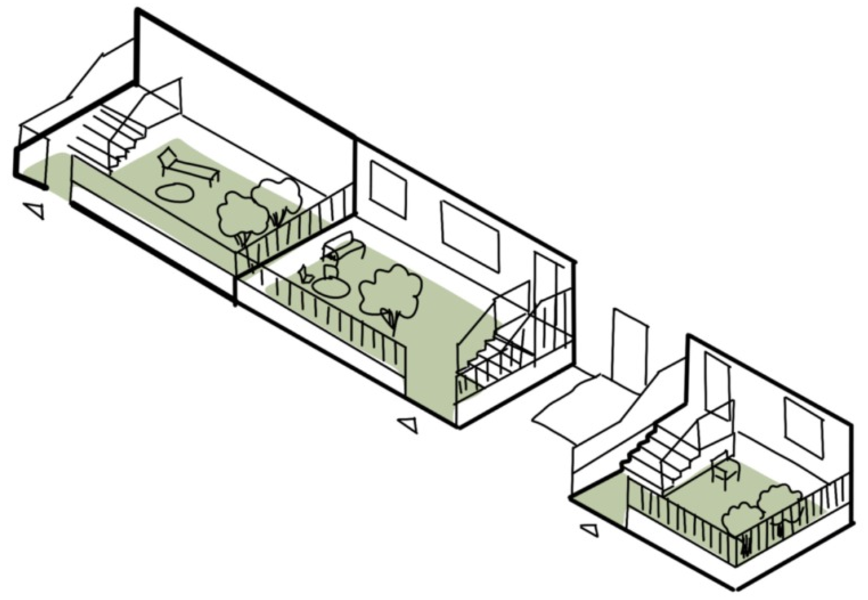
Landscape Solutions

Nature-based solutions are used to transform the destroyed part of the building into a memorial landscape. Green elements, water retention features, and permeable surfaces replace hard reconstruction, supporting climate adaptation while preserving the memory of loss. The space functions as both a place of remembrance and a resilient, low-carbon environment.

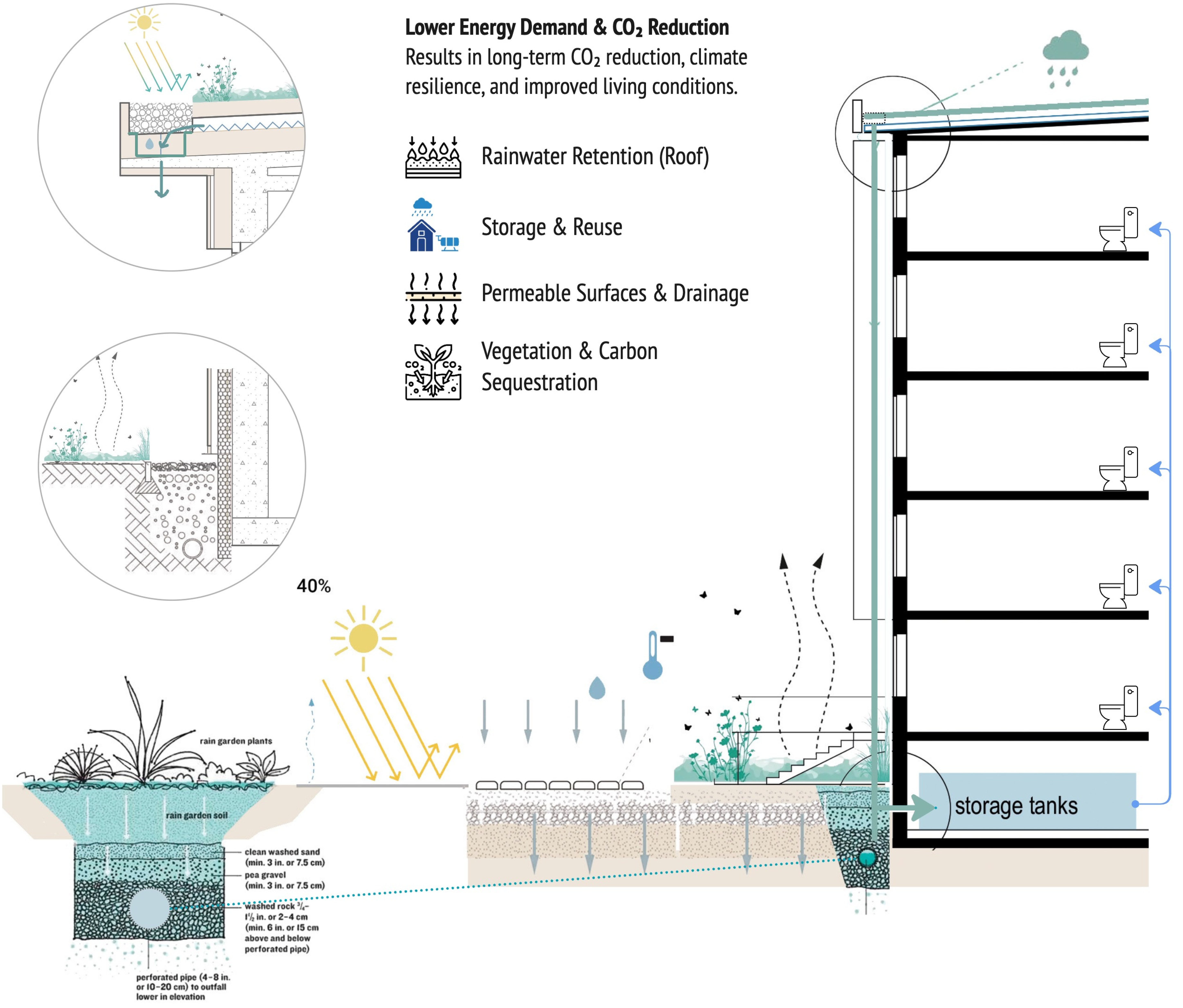
A nature-based system reduces CO_2 by collecting and reusing rainwater, improving drainage to avoid flooding, and cooling the microclimate through vegetation and permeable surfaces.

A Solution for Comfortable **Ground Floor Apartments:**
Creating front yards and gardens in front of ground-floor apartments provides privacy for living spaces, allows for new open-air leisure places, and creates an entrance to the individual apartment from the street.





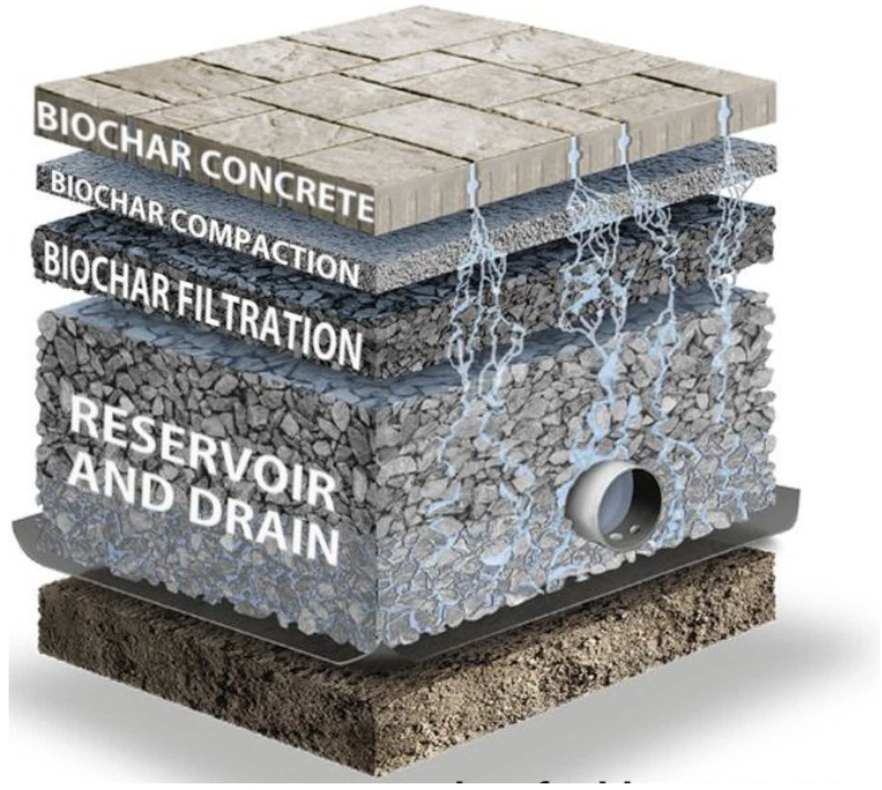
Nature-Based CO_2 Reduction Sequence



pinterest.com

Use of debris and local waste soils/slags for small architectural forms and urban furniture

Using biochar to clean up water



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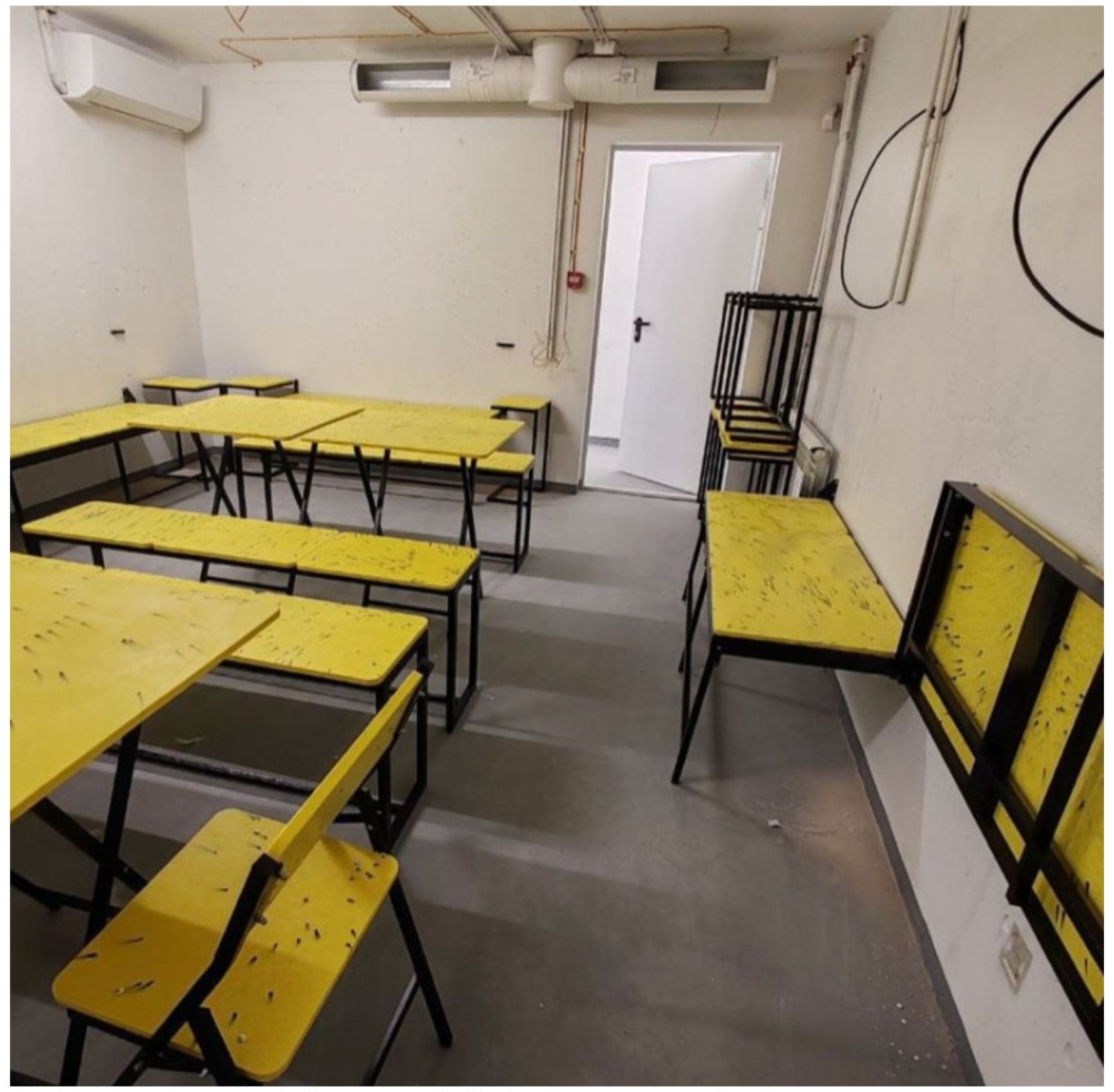
pinterest.com

pinterest.com

Indoor shared spaces

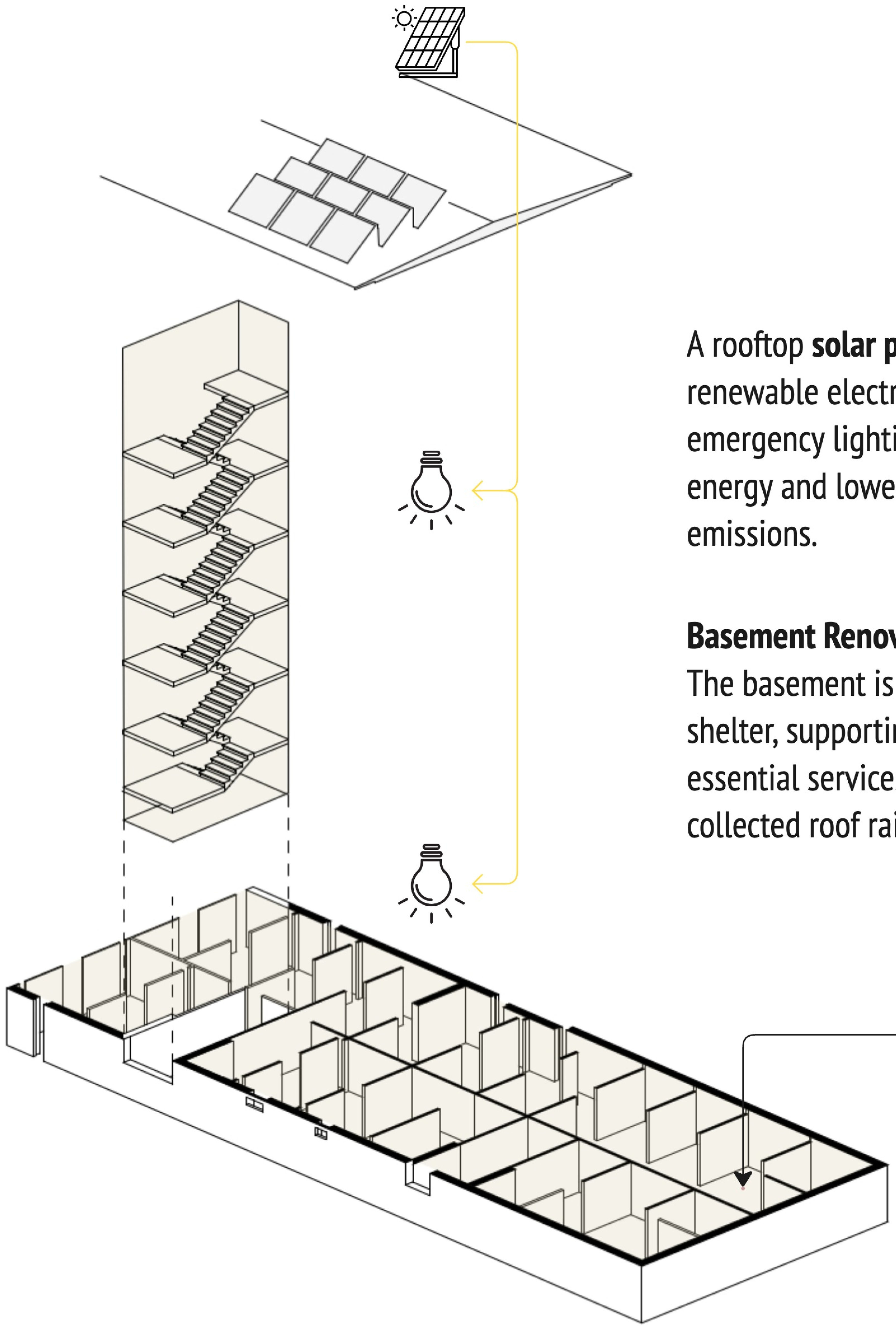
pinterest.com/jaikumaris/stair-railing-design/



shelter furniture made from recycled plastic © recast_plastic

Renovation Plan for Common Staircases

Recycle and reuse materials
Existing railings and metal elements are retained and refurbished instead of replaced.
Remove outdated finishes
Old wall and ceiling coverings are carefully removed to avoid unnecessary waste.
Restore existing concrete structures
Exposed concrete walls, stairs, and slabs are sanded, repaired, and left visible or minimally finished with nature based materials
Minimise new materials and finishes
The renovation prioritises repair over replacement, reducing embodied carbon and construction waste.



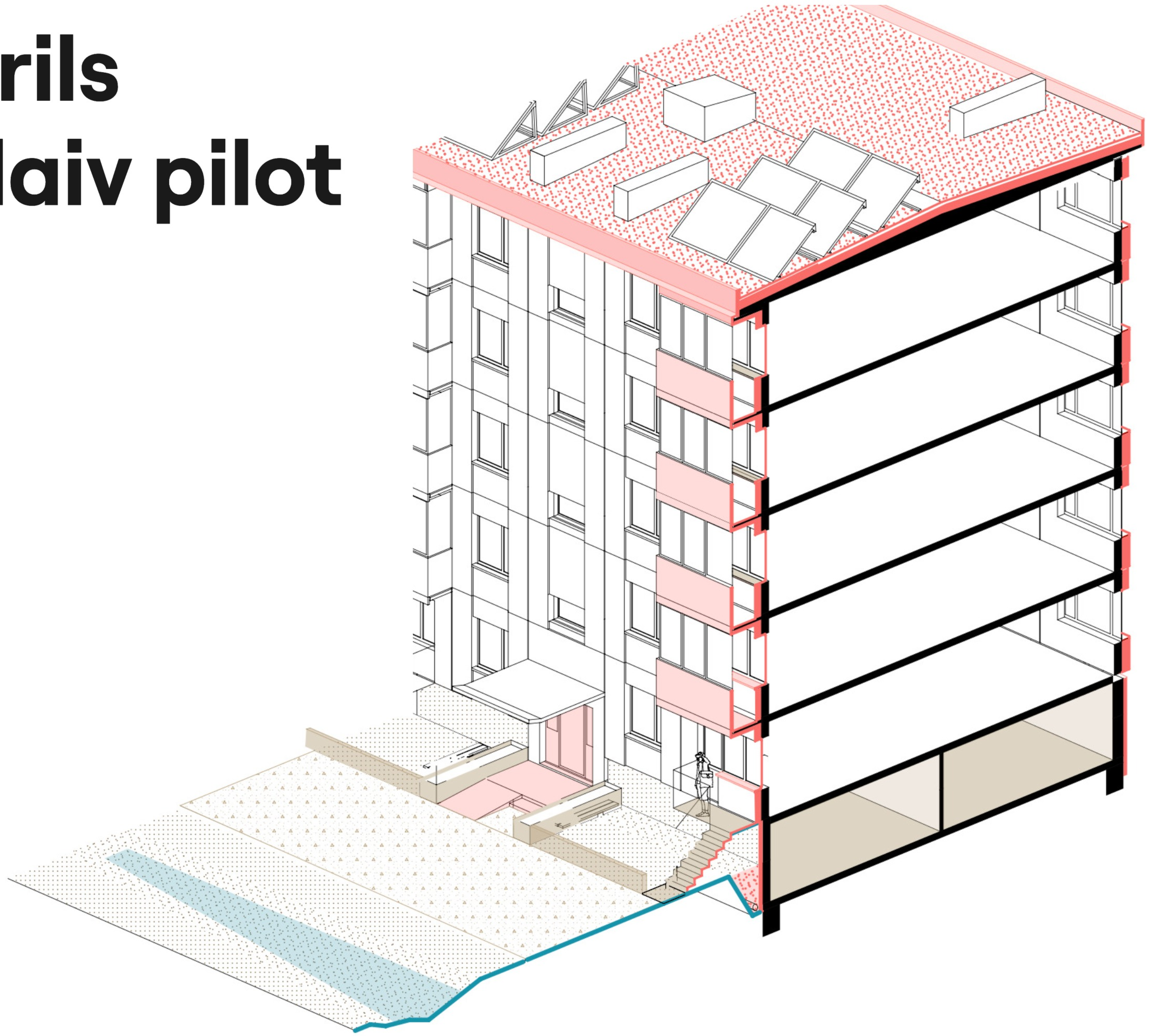
A rooftop **solar power system** supplies renewable electricity for shared spaces and emergency lighting, reducing reliance on grid energy and lowering operational CO_2 emissions.

Basement Renovation
The basement is reorganised as a shared hub and shelter, supporting safety, continuity of use, and essential services, including storage and reuse of collected roof rainwater.

oiled earth floor

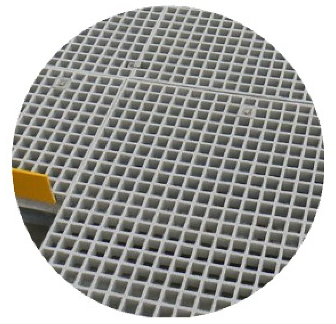
Urban terrazzo

Proposed materils based on Mykolaiv pilot Building



Landscape


Recycled brick


Fiberglass stairs& Floor Grating


prefabricated compressed soil block


ramed earth street furniture / low fences


Crushed Concrete/Bricks for driveways, walkways, and landscaping


Metal Cage filled with construction debris

Roof

Biobased Roofsystem (HEMPLITH)

Facade finishes

HEMP / THERMAFIBER®
MINERAL WOOL
Insulation
GWP A1-A3
1.33 kg CO2e / m2


HICEM / Fibre Cement Board
7-9 kg CO2e / m2


fibre corrugated panels


Biobased Willow Composite Façade Panel


Hemp lime plasters

Indoor


Urban terrazzo

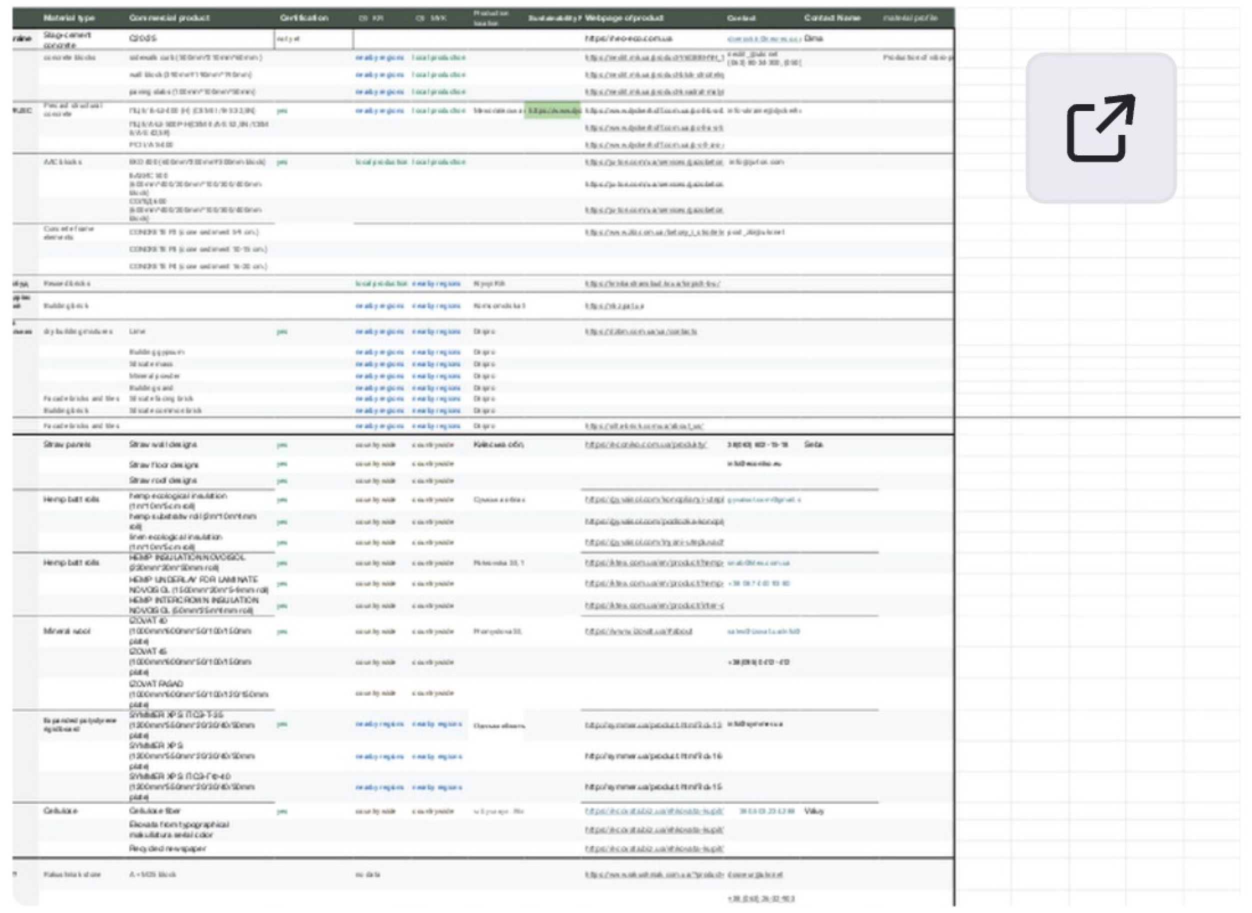

oiled earth floor in shared areas of basement


Hemp clay plaster

Felicity II – Embodied Carbon - Local Specificity: Case Studies

Local Manufactures & Initiatives

Annex 1



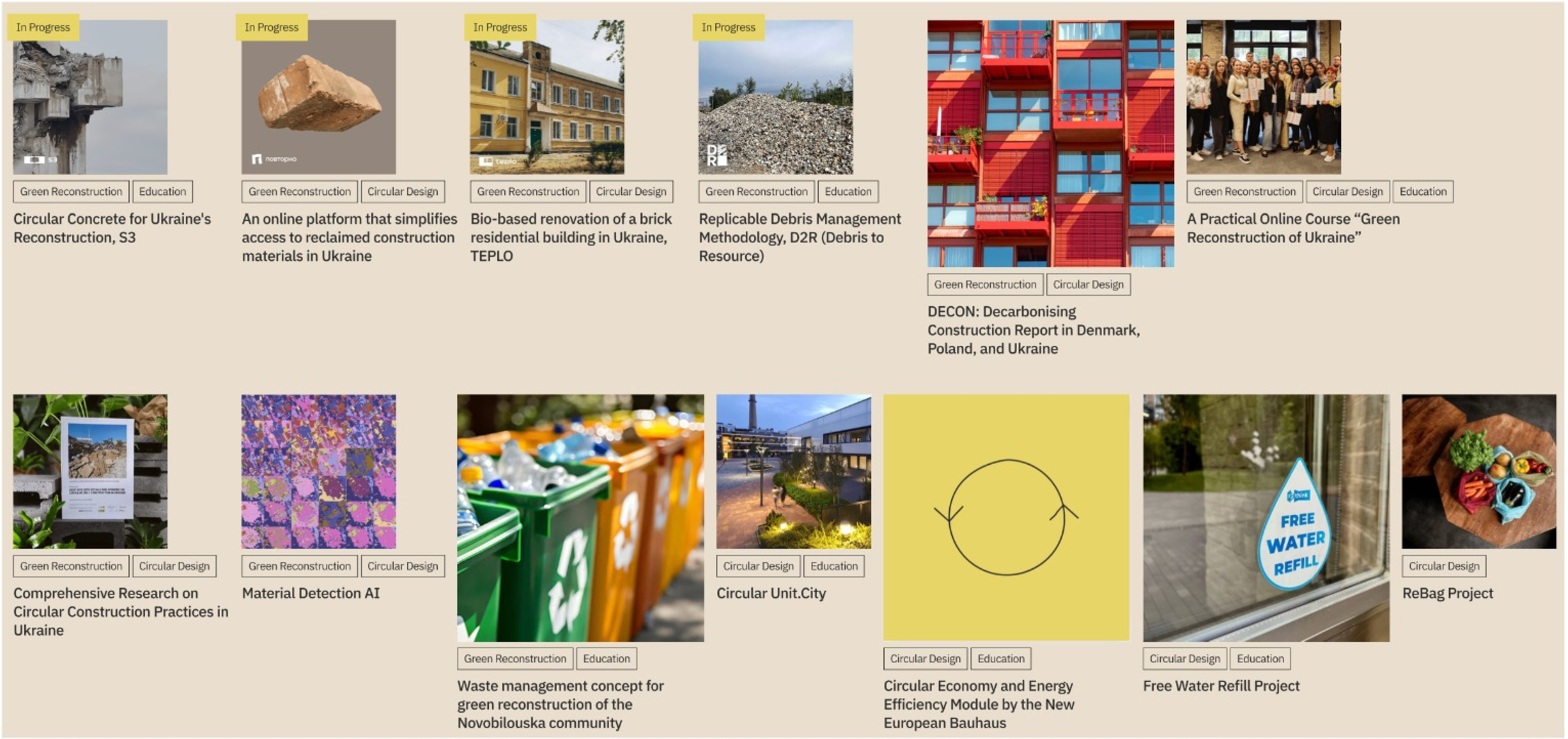
Google Docs

O Felicity II _ Bauhaus Erde UA circular build...

Rethink

What We Do

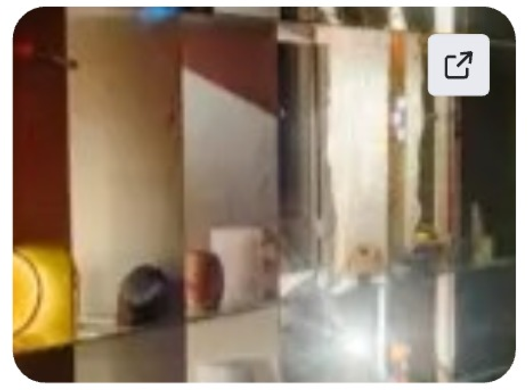
An online platform that simplifies access to reclaimed construction materials in Ukraine



COHATY

CO-HATY | Housing for those who lost it dur...

CO-HATY is a housing project for IDPs who lost their homes due to the Russian-Ukrainian war.



Metalab

SUSTAINABLE MATERIALS LABORATORY

The Sustainable Materials Laboratory is a harmonious part of the makerspace. The METALAB team collaborates with specialists from various industries...

Exemplary Assessment Guide

Pilot Building Mykolaiv

Objective:

1. Restore building integrity

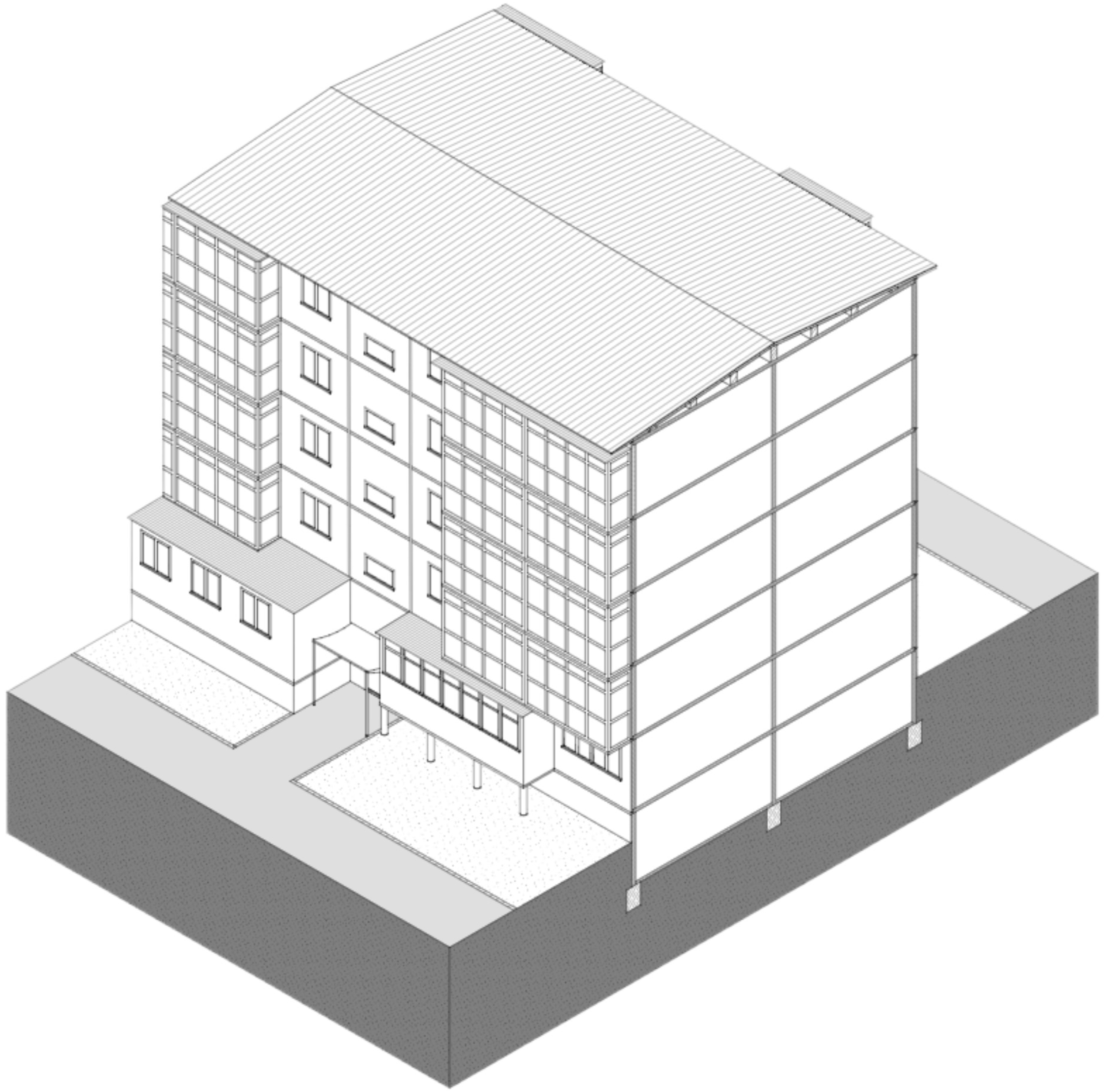
2. Improve energy performance

3. Ensure fire safety

4. Prioritize low embodied carbon materials

5. Replace or repair balconies

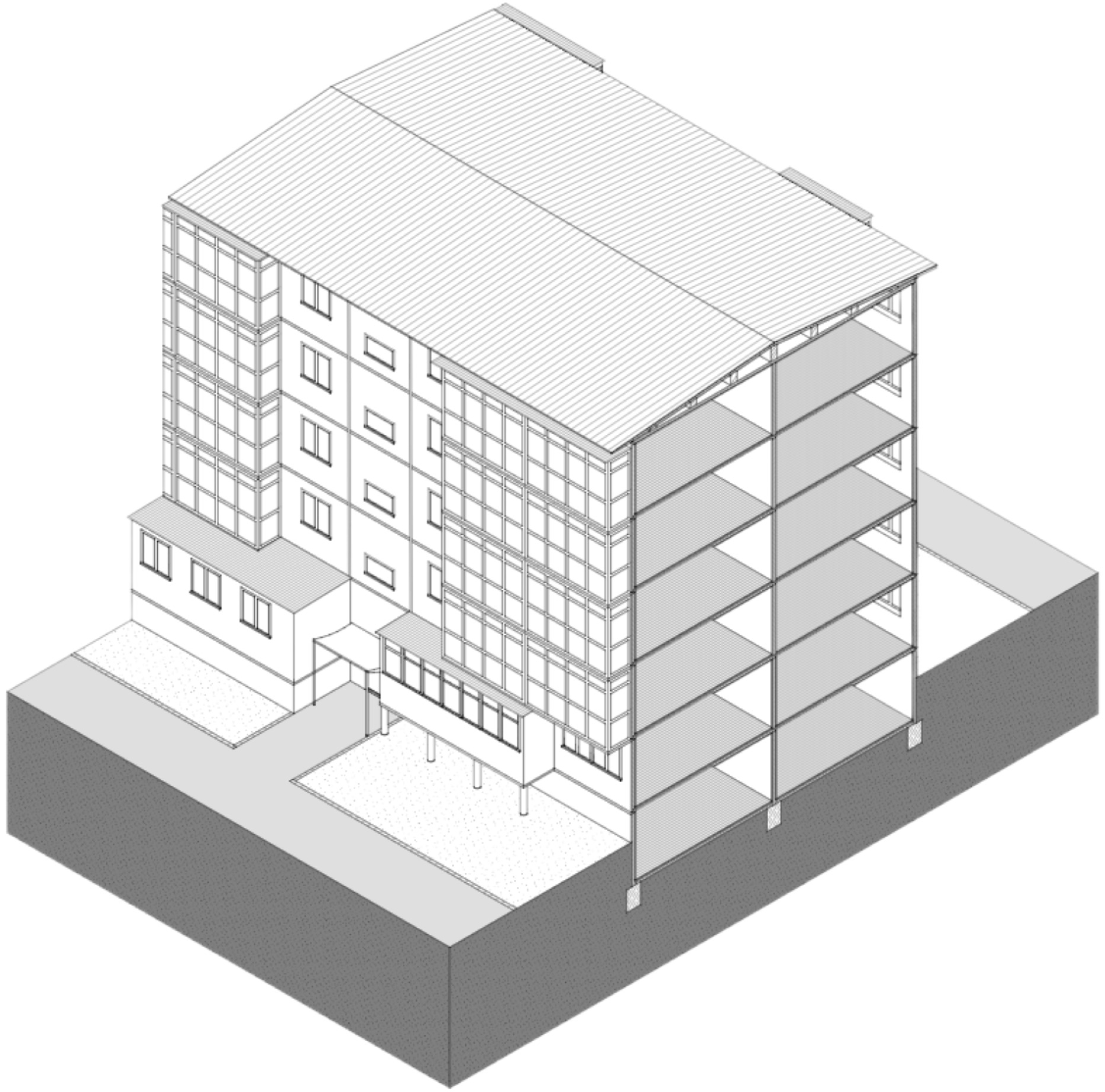
6. Design of new façade



Proposed Measures

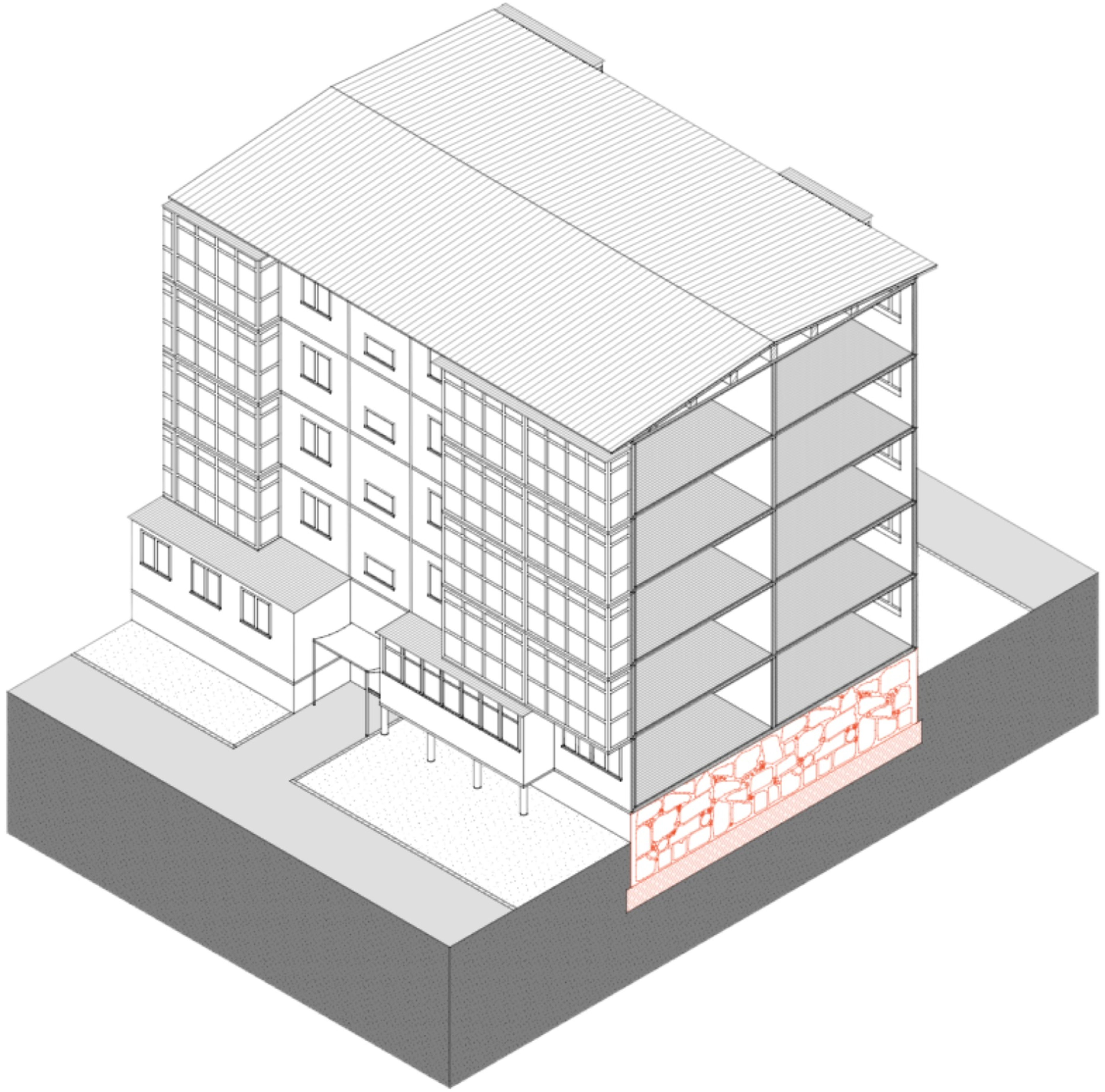
1. Partial Deconstruction

The existing interior wall is damaged and must be deconstructed to allow for the construction of a new load-bearing exterior wall. Alternatively, the existing concrete wall can be repaired and insulated. A structural assessment is required to verify the wall's structural integrity.



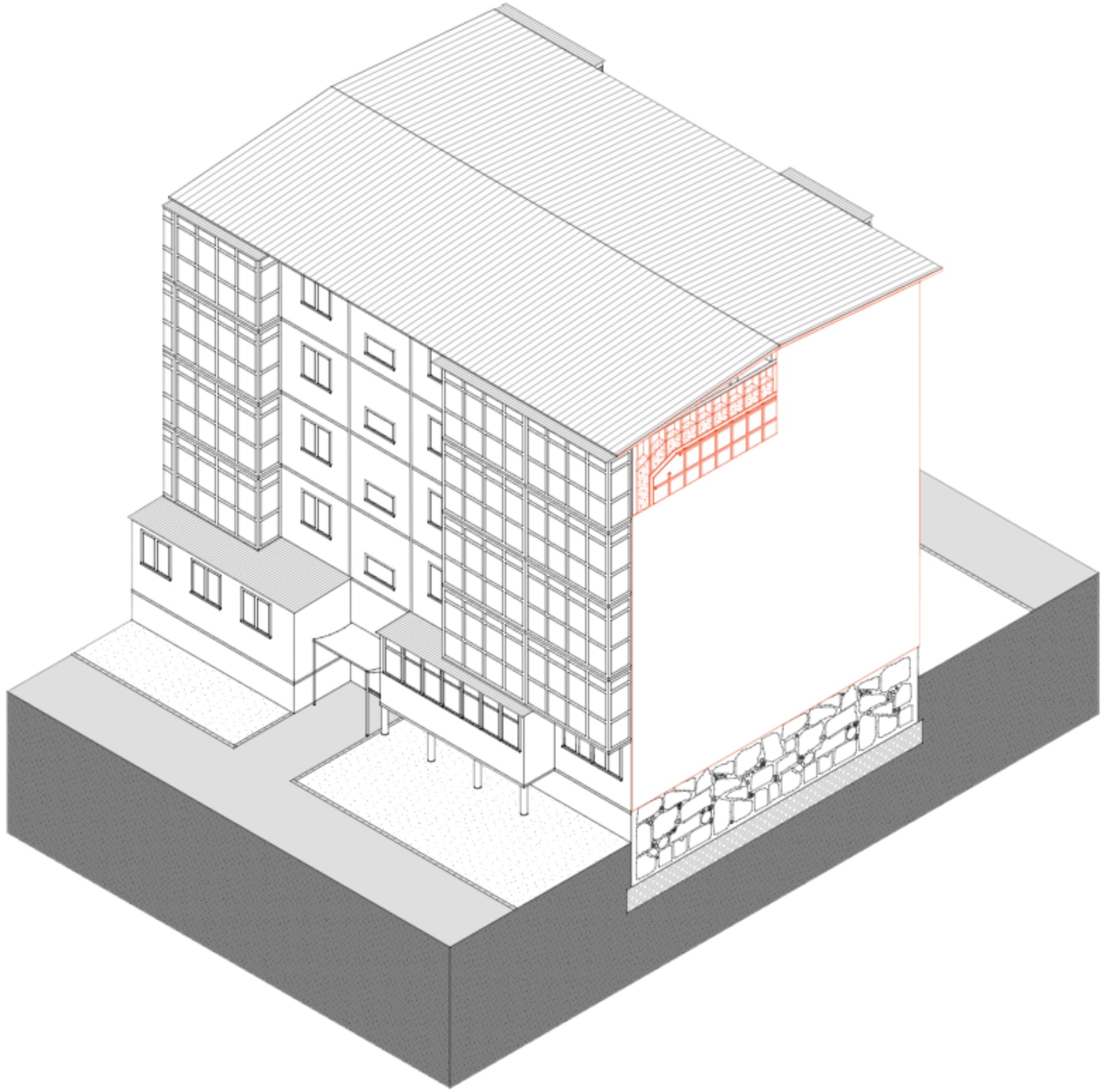
2. Footing and Plinth Zone

In the plinth area, a durable, moisture-resistant structure is required. Demolition material can be reused to build a new plinth zone. This wall sits on a new or reinforced strip foundation, whose size depends on the wall system and loads.



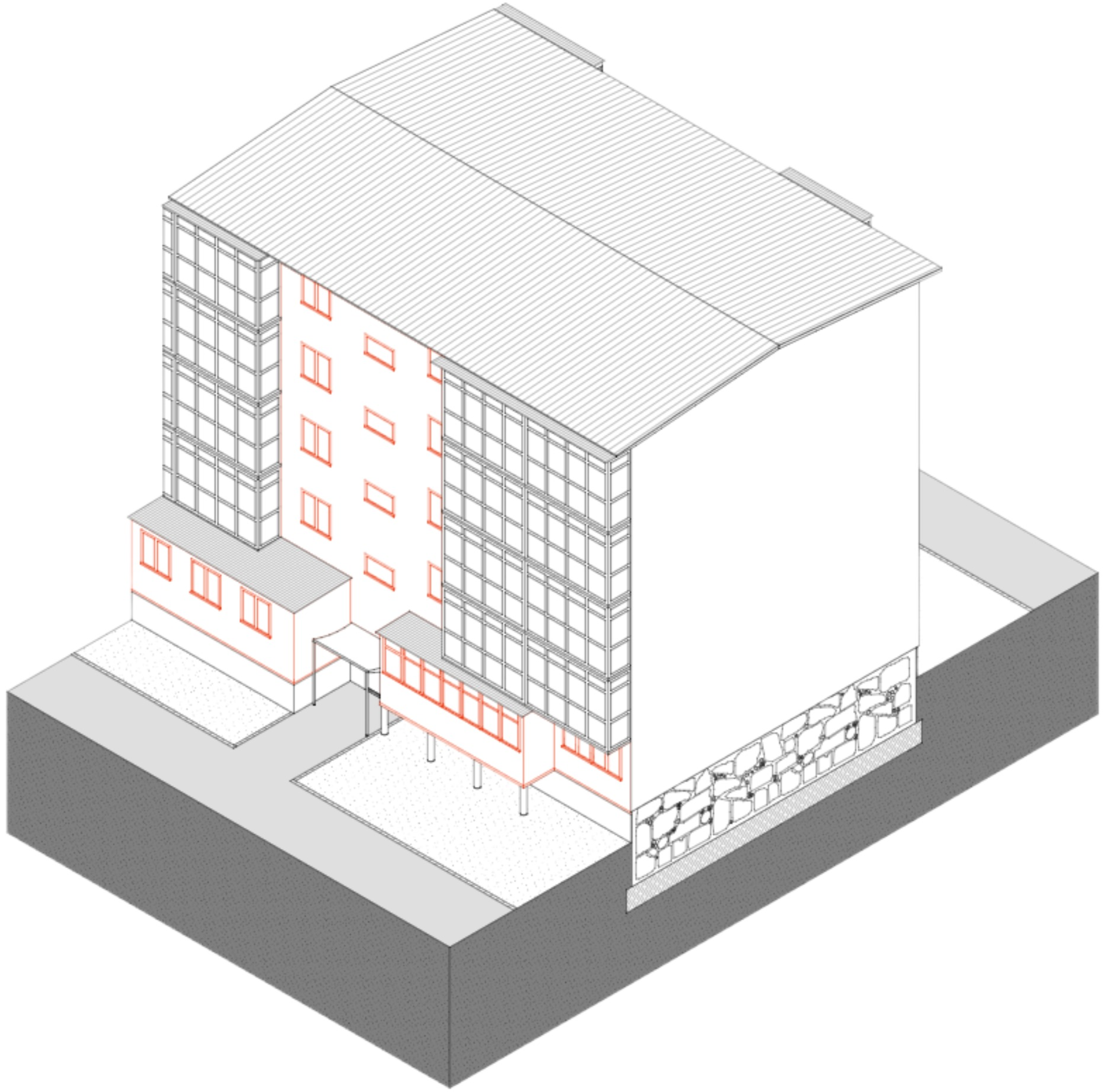
3. New Exterior Wall

The new exterior wall requires a non-combustible load-bearing structure for fire safety, and the use of exterior insulation is recommended. It should be noted that massive wall systems significantly increase structural loads and therefore require a new strip foundation.

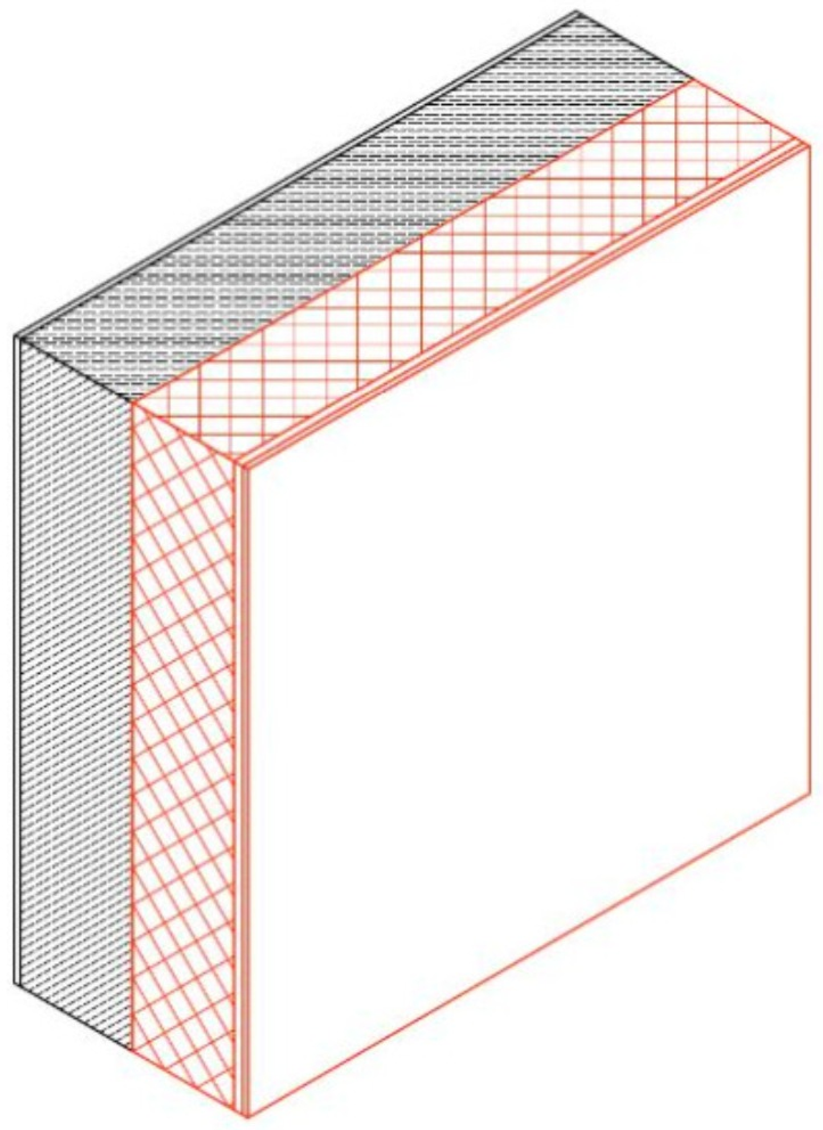


4. Energy Efficiency Retrofit

It is recommended to thermally upgrade envelope of the existing building with an external insulation system.
The retrofit measures should include the exterior walls, roof and ground floor plate. Windows and doors must be replaced.



Energy Efficiency Retrofit: **Exterior Walls**

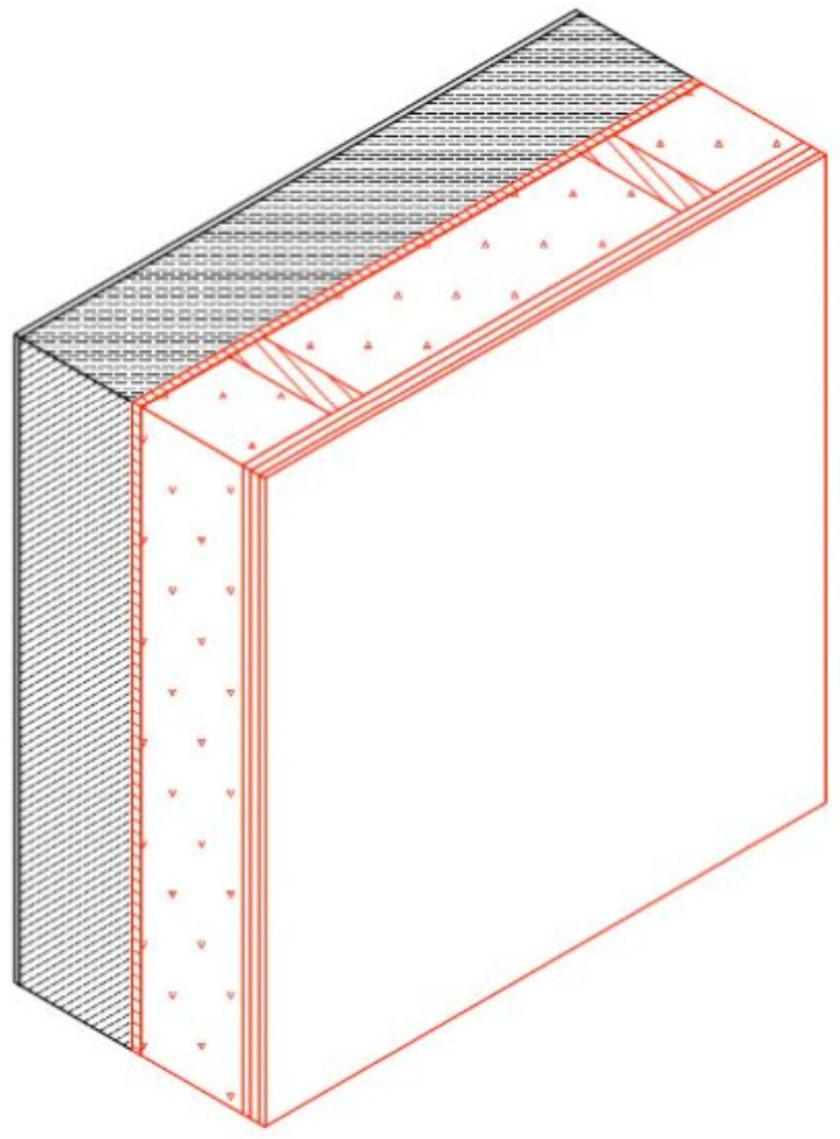


Conventional

Wall paper	5 mm
Concrete Panel	200 mm
Rock wool	180 mm
Reinforcing layer	7 mm
Cement render	5 mm

U Value: 0.18 W/(m^2K)

LCA (A1-A3): **21.4 kg CO_2e/m^2**

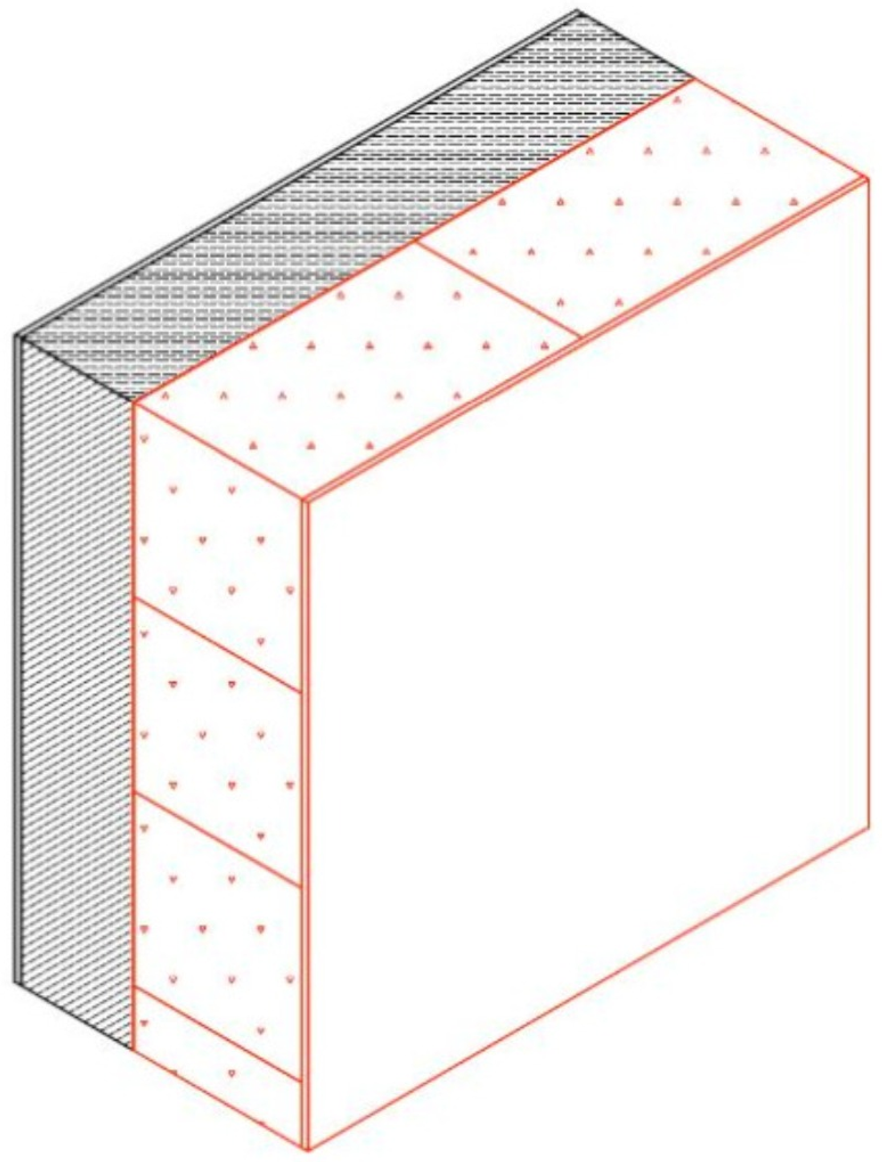


Feasible and Sustainable

Wall paper	15 mm
Concrete panel	200 mm
Wood fiber board	13 mm
Vapor retarder (sd=10)	-
Bio-based fiber insulation/	180 mm
Timber frame	100 x 180 mm
Gypsum fiber board	2 x 15 mm
Lime plaster	10 mm

U Value: 0.18 W/(m^2K)

LCA (A1-A3): **-18.3 kg CO_2e/m^2**



Vision

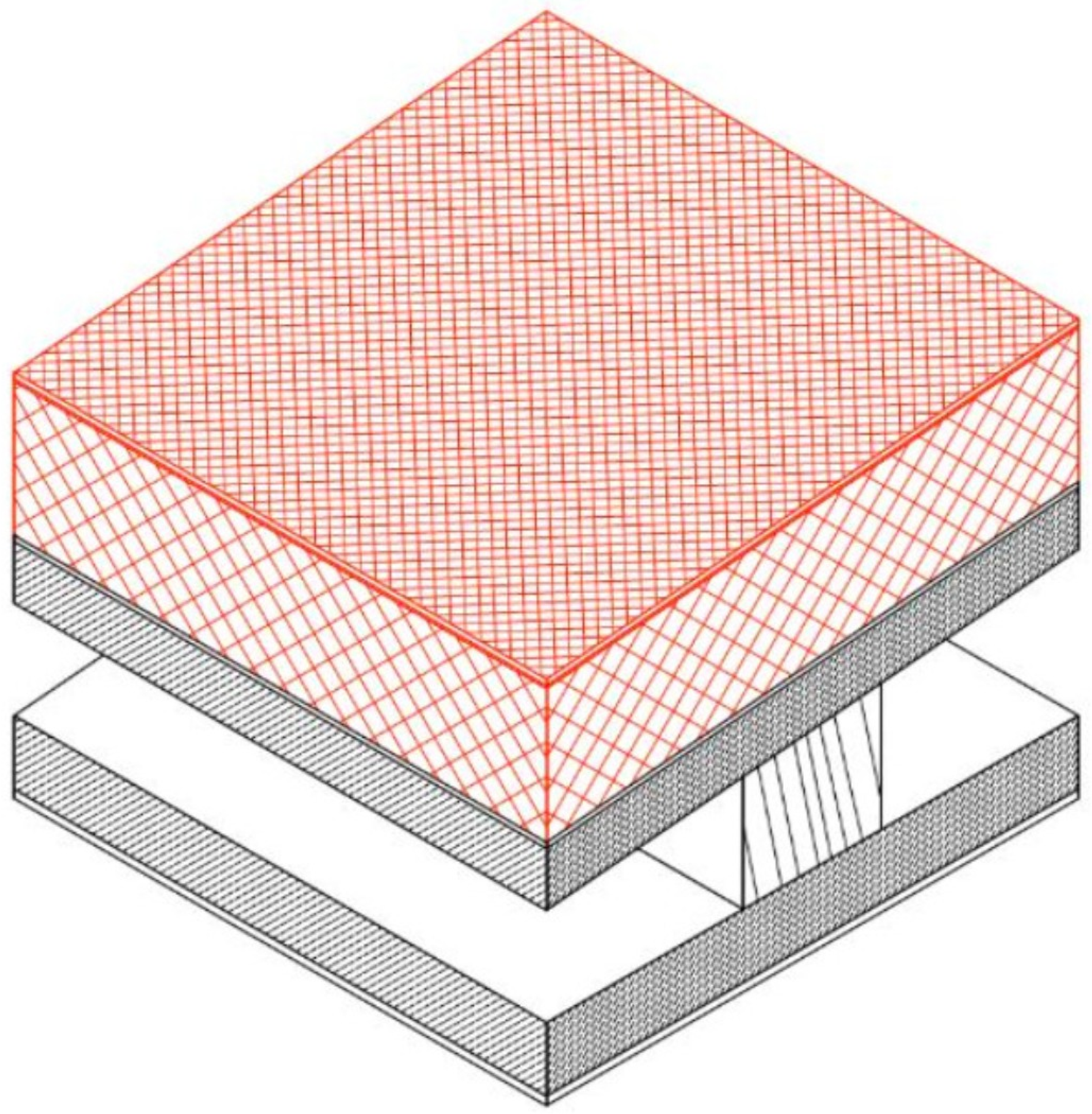
Wall paper	15 mm
Concrete panel	200 mm
Vapor retarder (sd=10)	-
Bio-based composite blocks	300 mm
Lime plaster	20 mm

Barrier: Lime-based binder (e.g., hempcrete) to comply with UA fire safety rules

U Value: 0.21 W/(m^2K)

LCA (A1-A3): **-174.4 kg CO_2e/m^2**

Energy Efficiency Retrofit: **Roof**

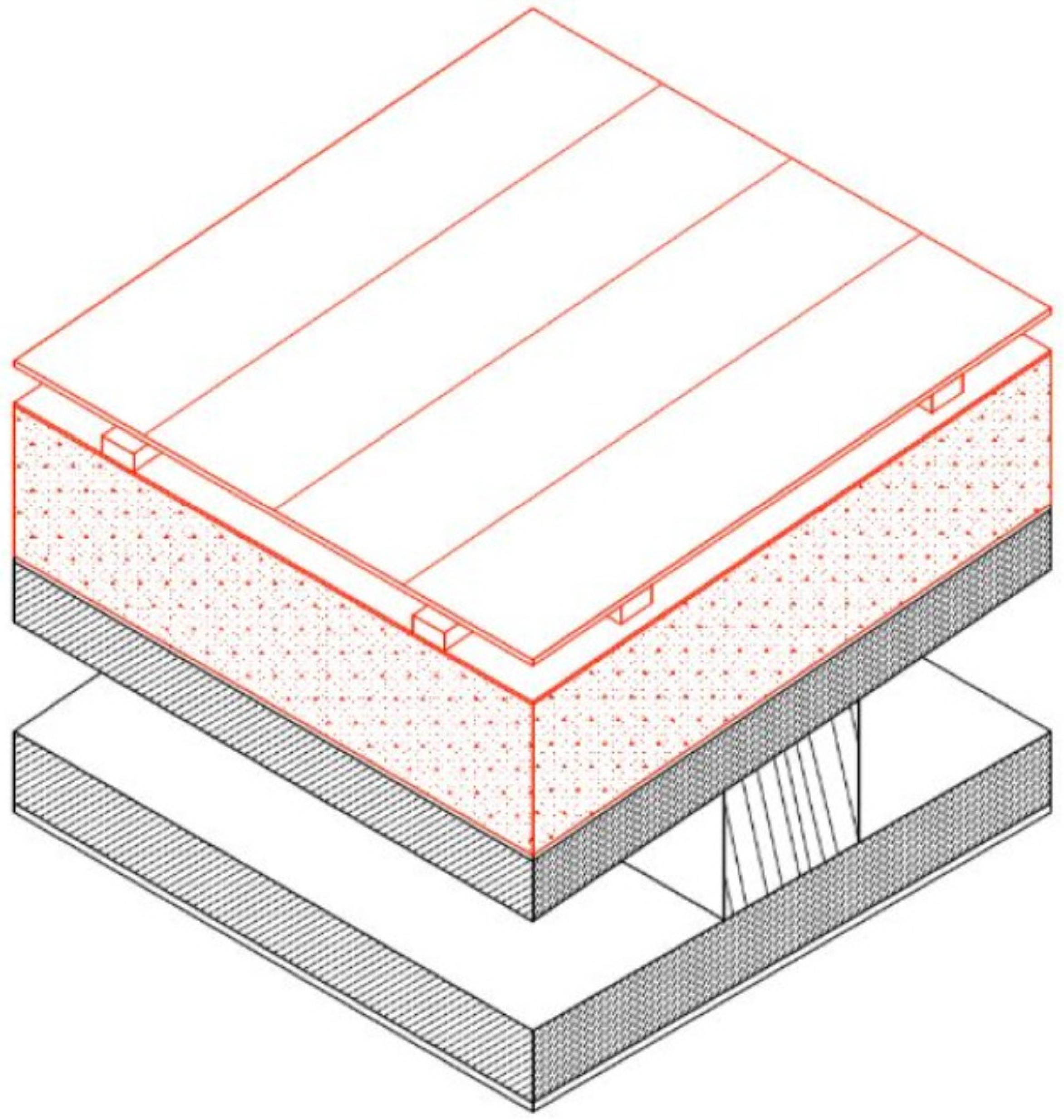


Conventional

Bitumen	5 mm	
Roofing membrane	200 mm	
Rock wool	250 mm	
Vapor retarder	-	
Existing roof structure	250 mm	

U Value: 0.13 W/(m^{2}K)

LCA (A1-A3): **51.2 kg CO_2e/m^2**



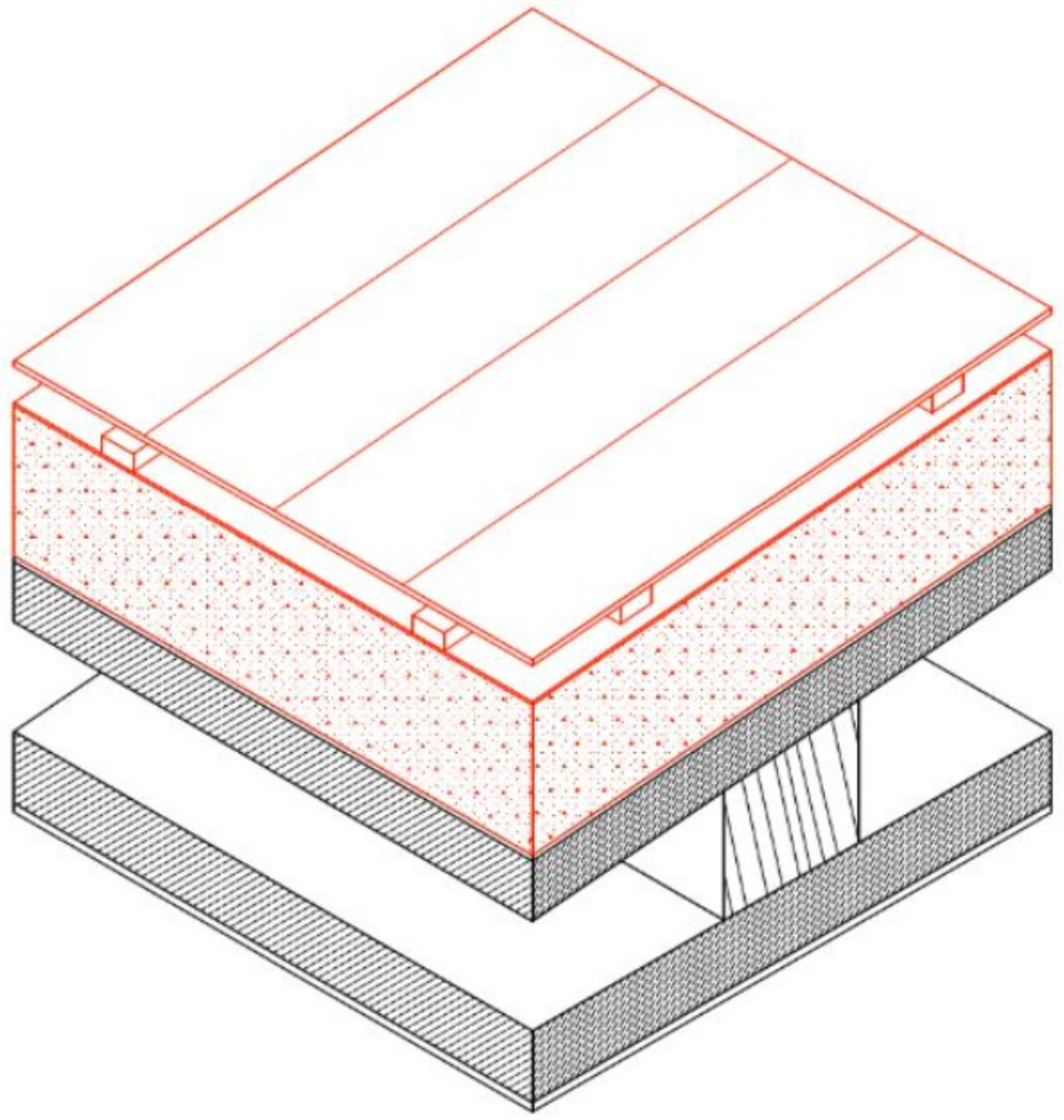
Feasible and Sustainable

Metal roof sheets	10 mm	
Battens	30 x 60 mm	
Counter battens	30 x 60 mm	
Roofing membrane	-	
Bio-based semi rigid boards	250 mm	
Vapor retarder	-	
Existing roof structure	250 mm	

Note: Metal has a higher CO2 impact as a single use material but this decreases when its lifecycle is extended.

U Value: 0.16 W/(m^{2}K)

LCA (A1-A3): **-30 kg CO_2e/m^2**



Vision

Reused metal roof sheets	10 mm	
Battens	30 x 60 mm	
Counter battens	30 x 60 mm	
Roofing membrane	-	
Bio-based semi rigid boards	250 mm	
Vapor retarder	-	
Existing roof structure	250 mm	

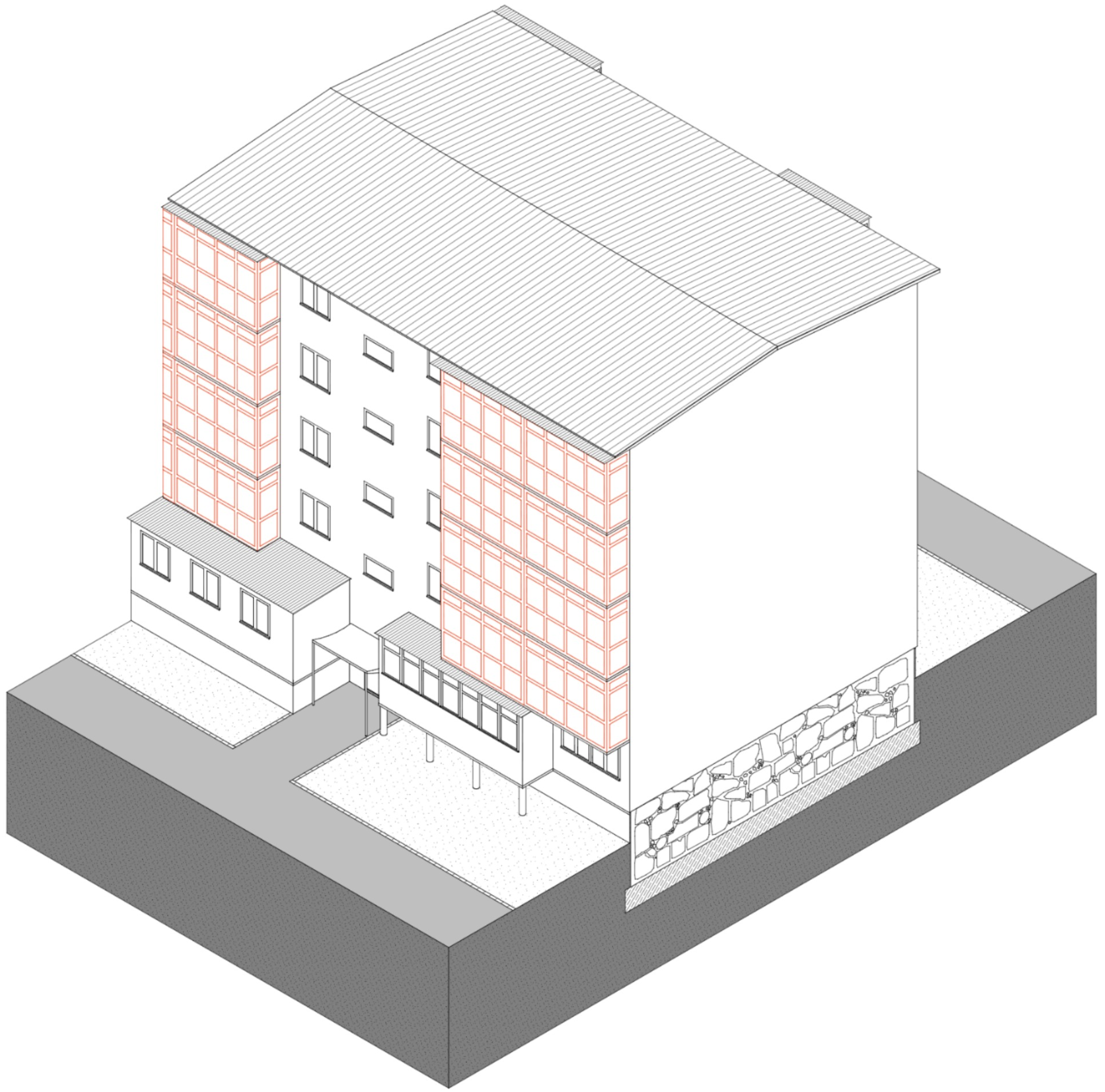
Barrier: Use of reclaimed material is not covered by regulations and needs incentives

U Value: 0.16 W/(m^{2}K)

LCA (A1-A3): **-45.6 kg CO_2e/m^2**

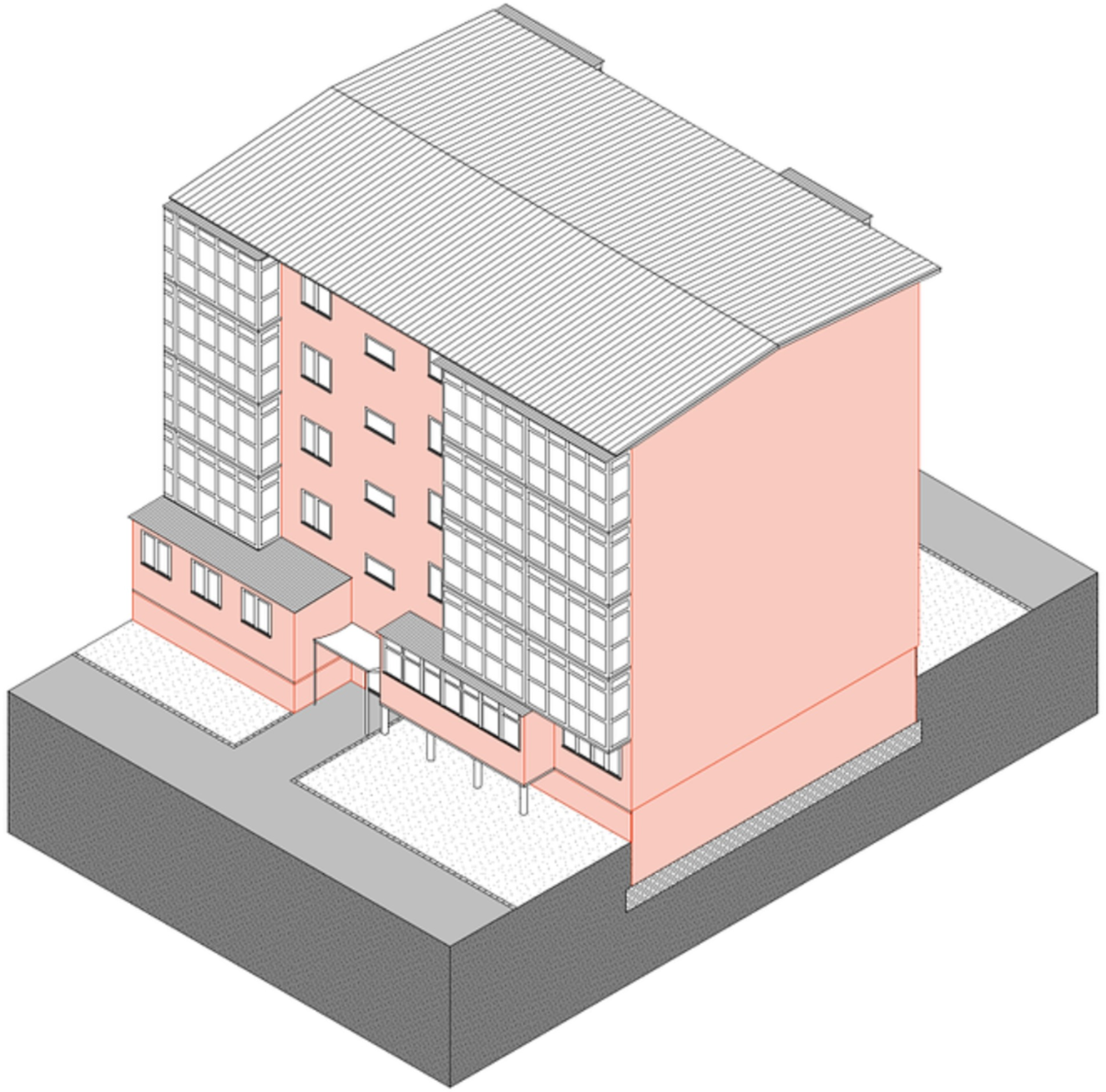
5. Repair/ Replacement of Balconies

Balconies in Soviet-era panel buildings often suffer from concrete damage and corroded reinforcement, which can make them unsafe. Additionally, these defects can significantly compromise the thermal performance, due to cold bridges. All balconies should be inspected during renovation. Smaller defects can be repaired, but severely damaged or unstable balconies should be replaced.

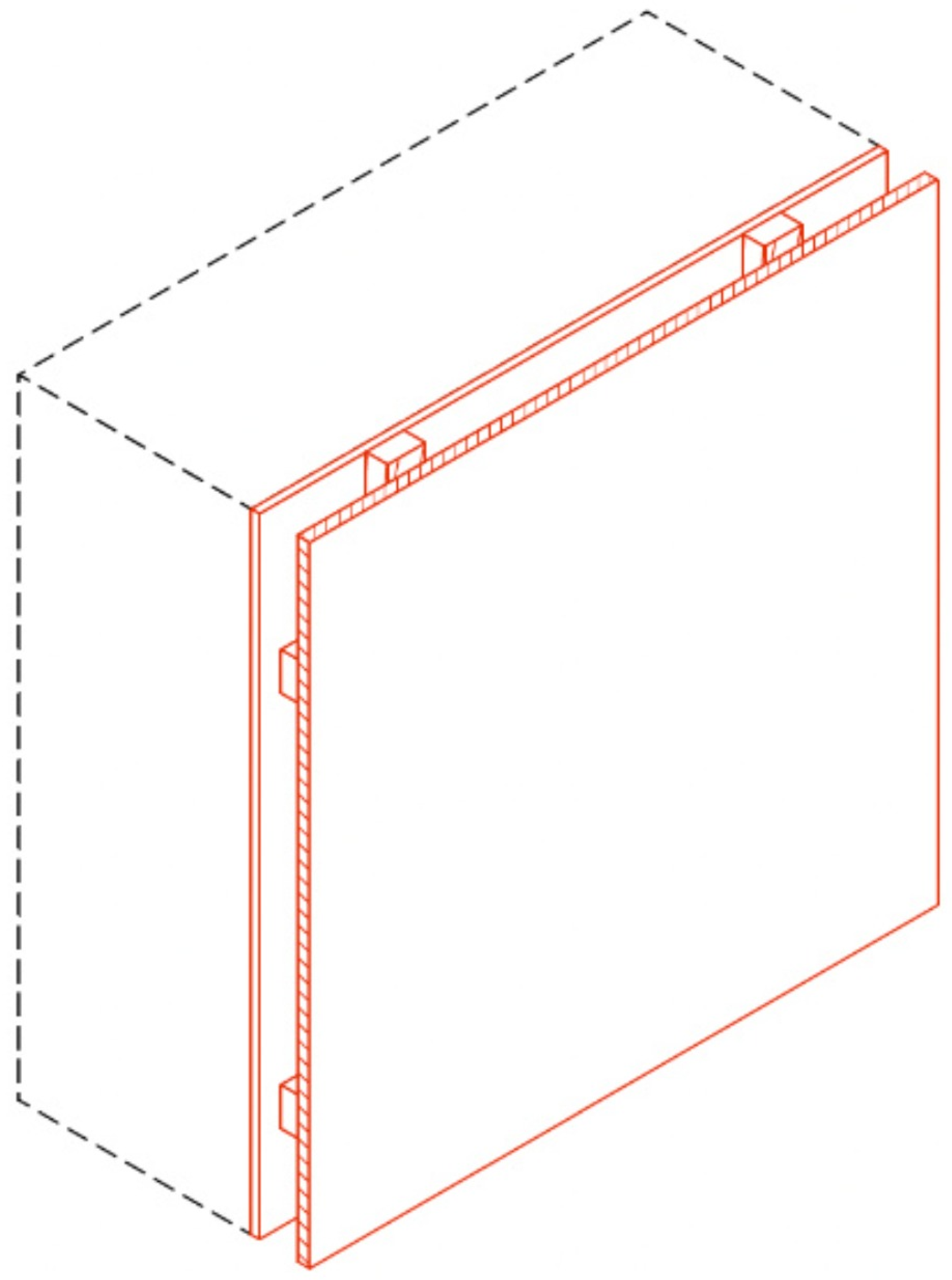


6. Design of new Façade

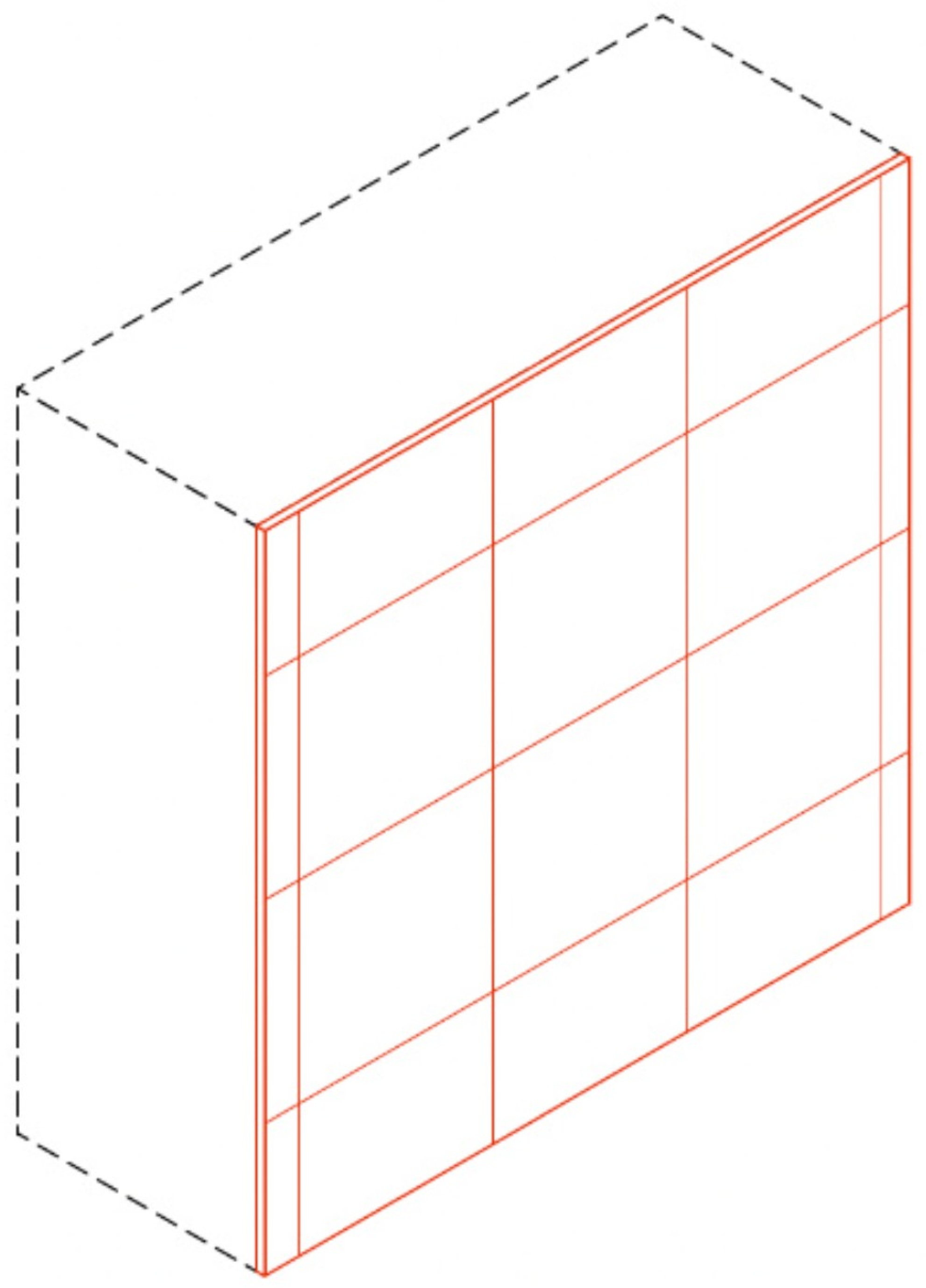
The design of the new façade plays a crucial role in strengthening cultural identity and ensuring social acceptance. A participatory design process involving residents and local stakeholders is recommended to design the façade. Such an inclusive approach fosters a sense of belonging, supports social cohesion, and reflects the community's cultural values.



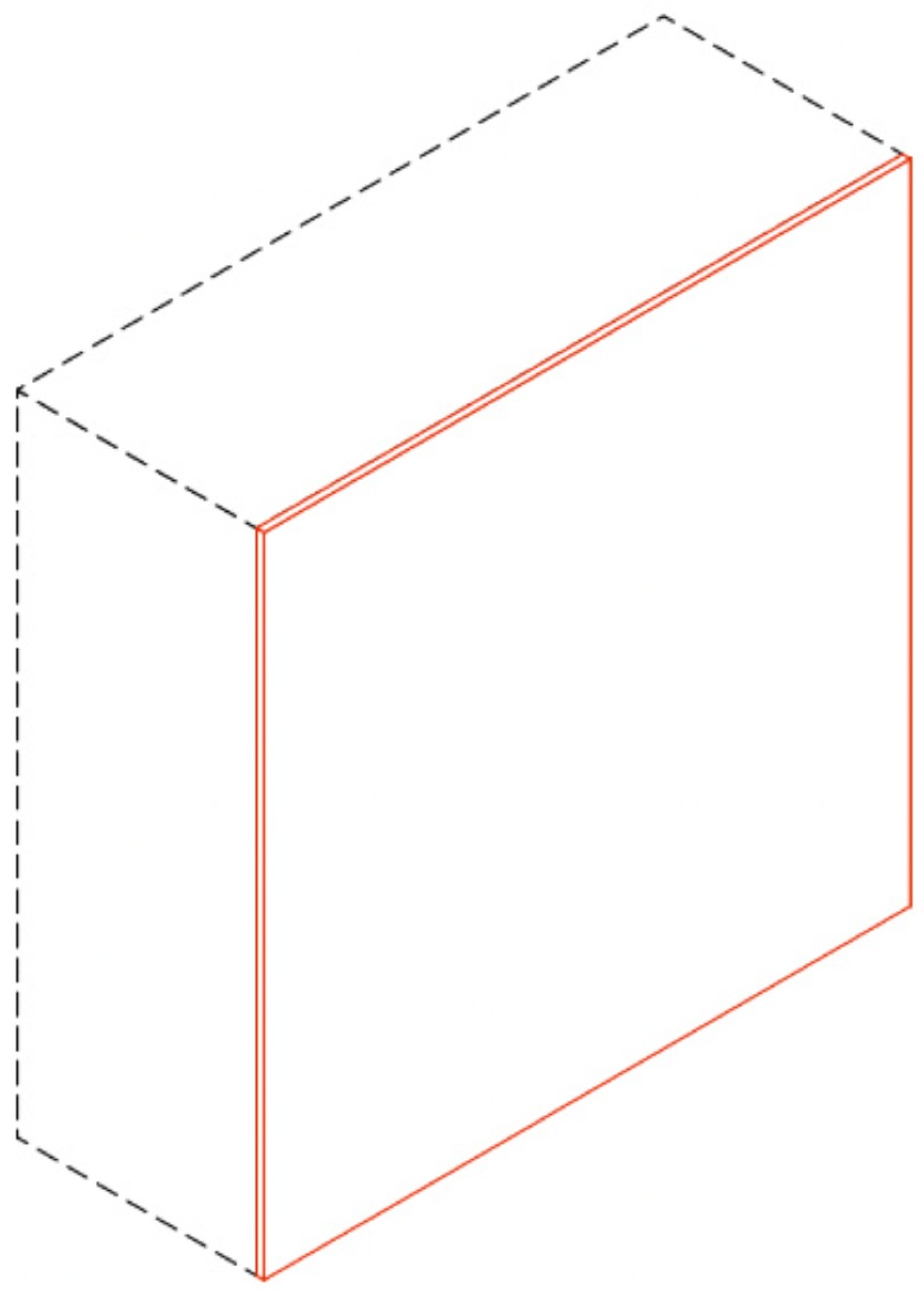
Design of new Façade



Façade Panels



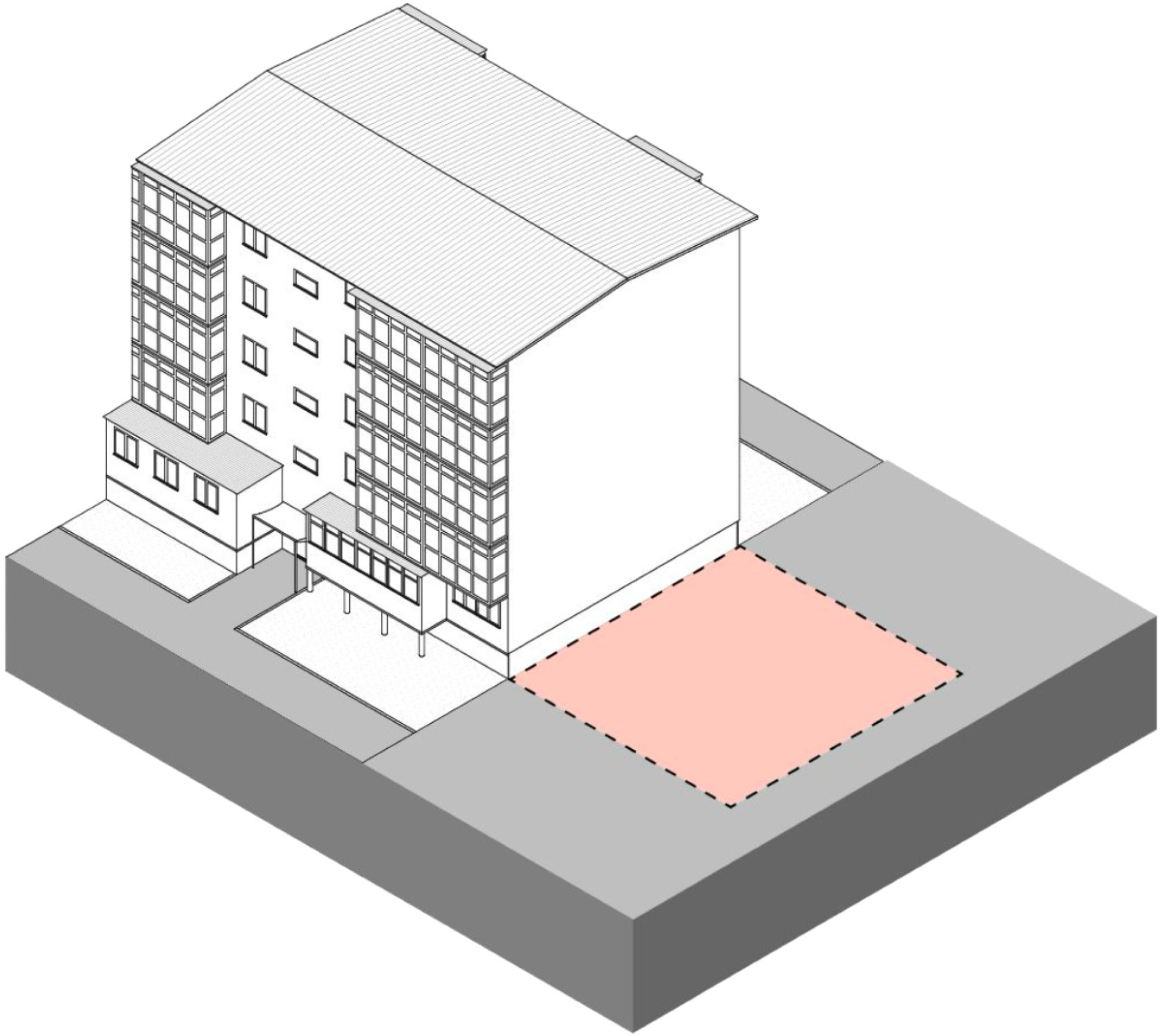
Recycled Tiles



Plastered Façade

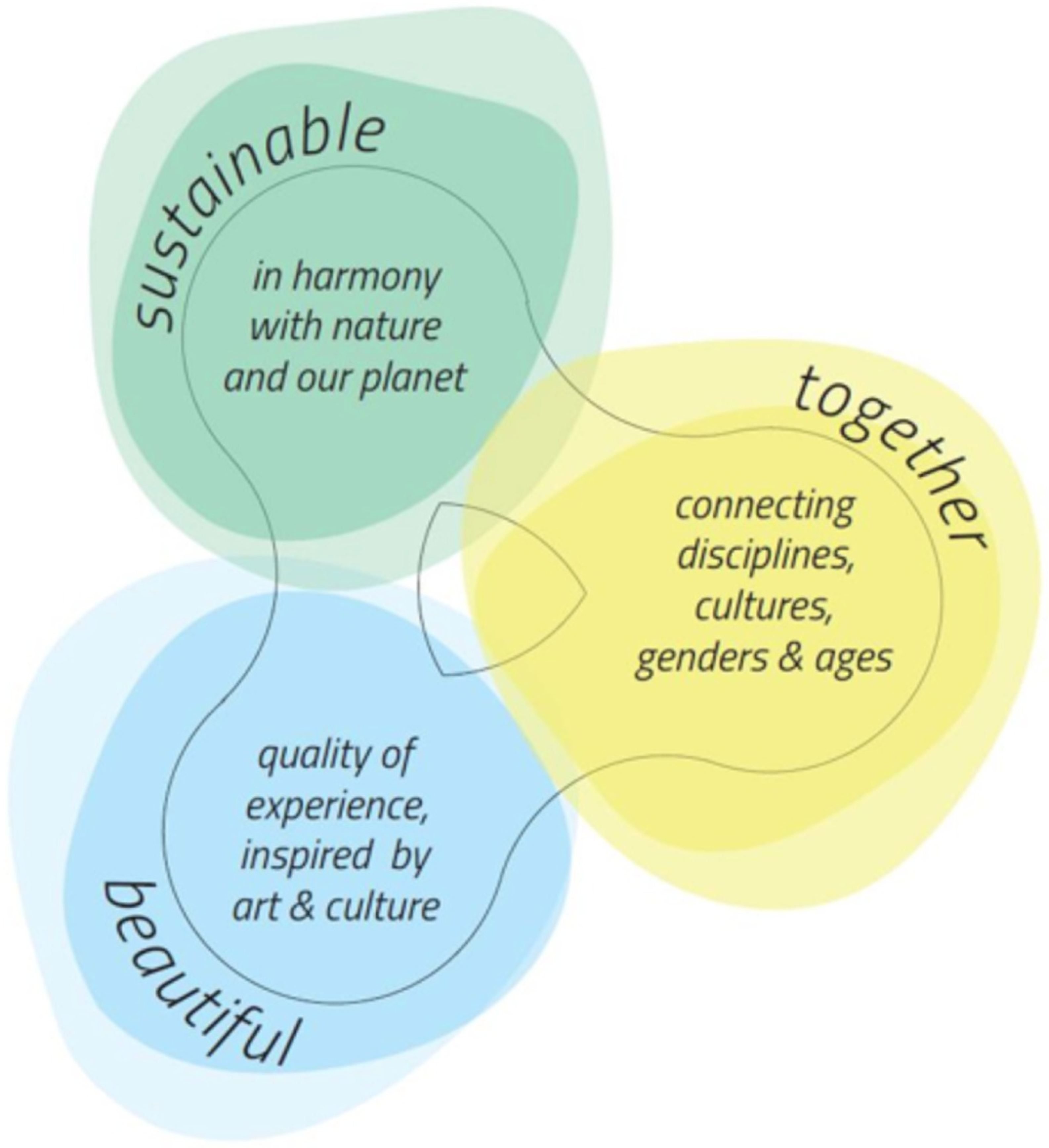
7. Open areas

The open space created by the destruction could be used to establish a communal area for the neighbourhood that honors the memory of the place and strengthens the links within the community. The design and use of this space should be developed in close collaboration with the residents. Possible ideas for the activation of the space would be its integration within safety considerations such as evacuation planning routes.



NEB Alignment

How these pilots and guides connect to the New European Bauhaus principles and values.



Beautiful - activate / connect / integrate

Integration into the built and natural environment

+ Renovation retains the existing structure and upgrades it instead of replacing it
+ Envelope strategy strengthens the relationship between building, site, and open space
+ Nature-based material palette (earth / lime / wood fibre) supports natural environment

Quality of experience

+ Improved thermal comfort through continuous insulation, reduced thermal bridges and vapor control
+ Better indoor climate due to earth based interior plaster

Identity and purpose

+ Façade design becomes a tool for social acceptance and cultural reflexion
+ Architecture communicates long-term value (repair, durability, care) rather than temporary patching
+ Open areas can hold memory and meaning while supporting everyday communal use

Together - include | consolidate | transform

Physical inclusion

+ Envelope retrofit improves comfort for vulnerable households (cold stress, dampness)
+ Open areas can be designed to be accessible, legible, and usable for inclusive use

Social inclusion

+ Participatory façade design and open-space design gives residents agency and ownership
+ Transparent comparison of conventional | feasible | vision supports informed collective decisions
+ Renovation reduces long-term costs and improves living standards without displacement logic

Creation of vibrant communities

+ Communal open spaces support social interaction, shared care and neighbourhood cohesion

Sustainable - repurpose / close the loop / regenerate

Circularity

+ Renovation preserves the existing building structure as much as possible
+ Plinth/footing strategy enables reuse of demolition material and reduces raw material inputs
+ Reduction in assembly complexity supports future disassembly and material recovery

Climate change adaptation and mitigation

+ Substantial reduction of embodied carbon and climate impact through the us of nature based materials
+ Improved envelope performance reduces heating demand and operational emissions
+ Material choices reduce reliance on carbon-intensive products and imported supply chains

Other environmental aspects

+ Reduction of toxicity and improvement of indoor health
+ Regionally available renewable materials strengthen ecological resilience and resource security

Safety - complementary pillar

"Safety" is introduced as an additional pillar within the New European Bauhaus principles in response to the context of war in Ukraine, which has highlighted the critical importance of resilient and secure built environments. This pillar emphasises structural integrity, fire safety, and spatial resilience, aiming to reduce risks, enable safe evacuation and emergency access.

+ Systematic assessment of existing load-bearing elements before reuse or replacement
+ Targeted repair and reinforcement to stabilise damaged structural components
+ Adaptation of foundations and load paths to support new wall systems

Fire safety

+ Use of non-combustible load-bearing structures in accordance with fire regulations
+ Fire-safe material layering and detailing within wall and roof assemblies

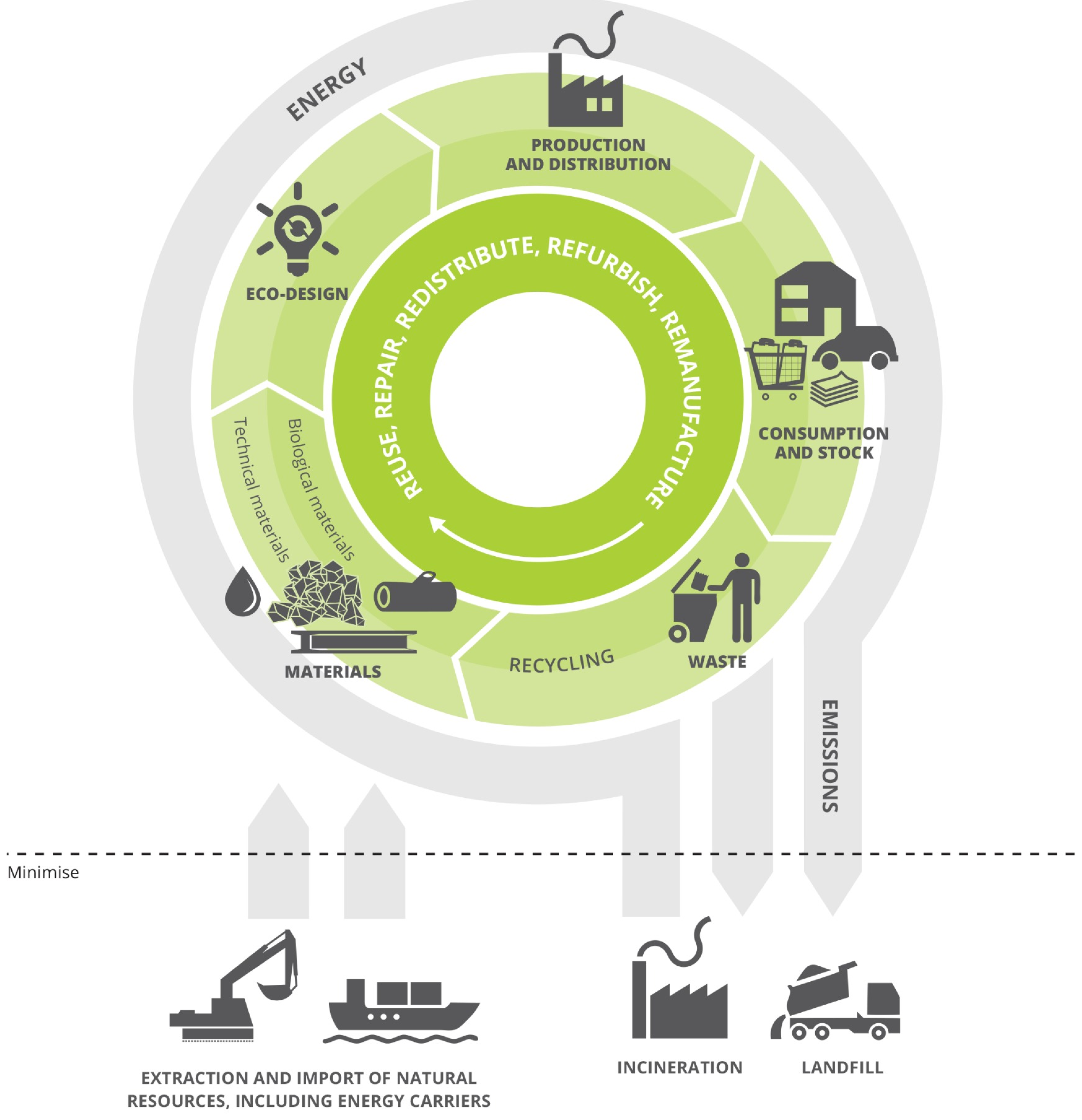
Spatial resilience

+ Integration of open areas into evacuation routes and emergency circulation
+ Provision of accessible emergency access for rescue and maintenance services
+ Dual-use of open spaces for everyday communal use and crisis situations

Conclusions and recommendations :

Opportunities to Strengthen Regenerative Construction in Ukraine

1. EU alignment and regulatory readiness
2. Economic efficiency and low carbon over the life cycle
3. Material security and local value chains
4. Scalability through typology holistic renovation



Why Efficient Reconstruction in Ukraine

EU alignment and regulatory readiness

Cost-Benefit: The increase of energy prices legitimises renovation / isolation costs. A high demand for renovation solution may be expected.

Scalability: Archetypes of buildings from soviet union era presents huge opportunity to roll-out sustainable reconstruction at scale

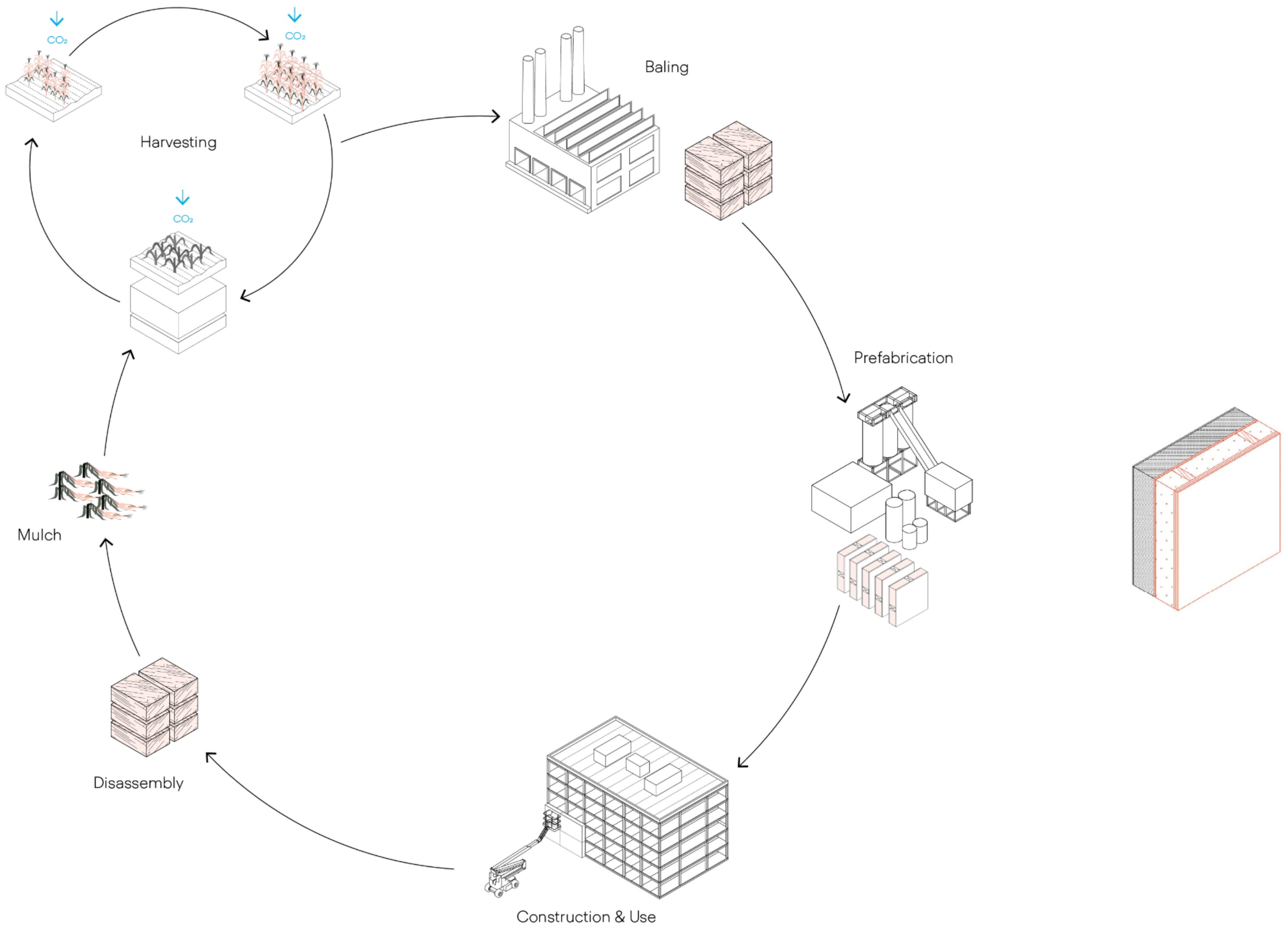
Economic potential: Large amounts of SME's in building construction and material production give flexibility and innovation that is helpful and needed to develop a new economic strong sector

Value Chain Approach

1 For economic, environmental and social development, a systemic approach for material selection is required

2 All sectors are activated through the development of a specific product / material.

3 It will create jobs, and will boost social and sustainable values



Regenerating construction in Ukraine. More than an opportunity!

Will you join?

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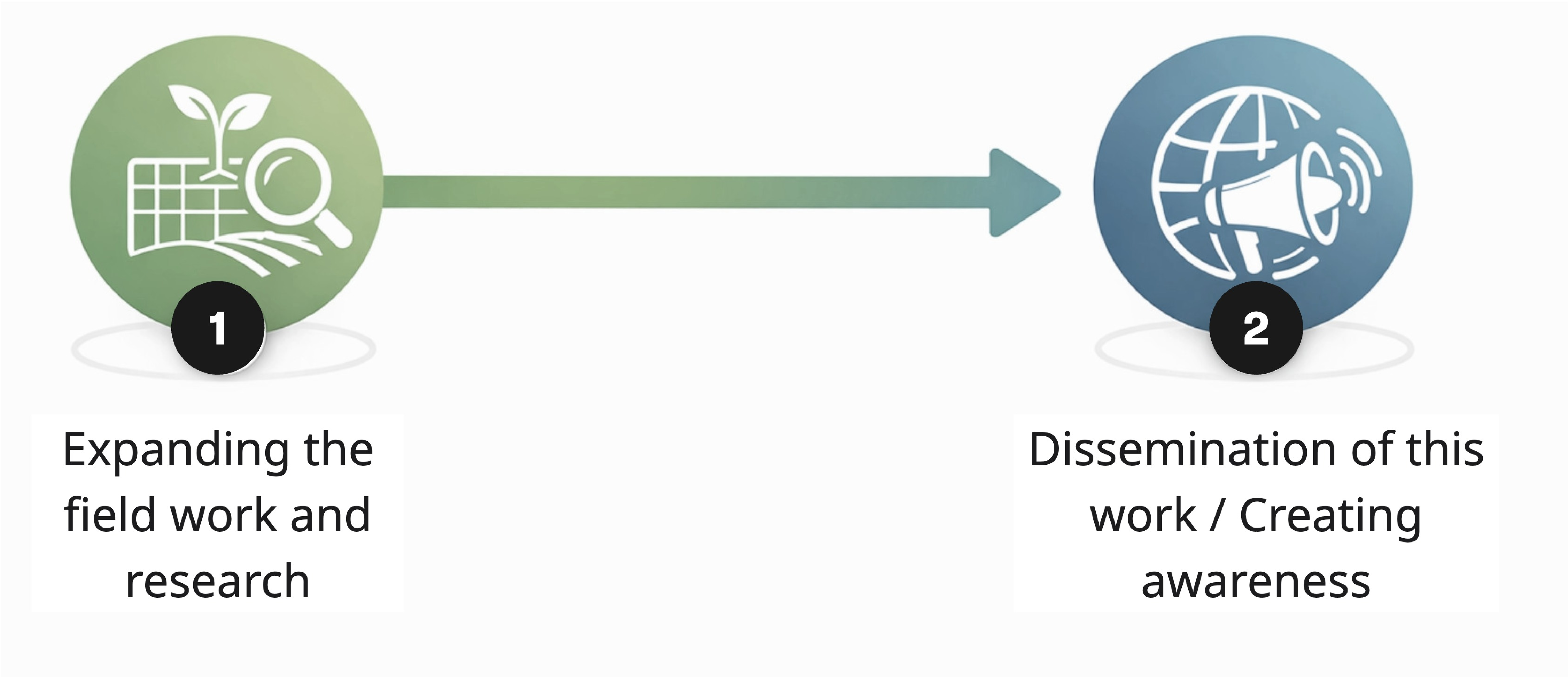
Next steps

Opportunities for further development in regenerative construction

Next steps


1
Expanding the field work and research
2
Dissemination of this work / Creating awareness

Expanding the field work and research

1.1

Expand to other regions to create a longer list and stronger network of stakeholder businesses

1.2

Develop financial calculations comparisons for the pilot buildings, including scenarios. Cost Uplit, Triangulation for one housing archetype, Measure CO2 total captured > Ratio

1.3

Involve more businesses, surveys & needs assessment

1.4

Research on how traditional practices could inform contemporary needs, linked to NEB measures, emphasising cultural identity.

Dissemination / Creating awareness

2.1

Presentations on forums, construction fairs and network meetings

2.2

Include the work in capacity building programs

2.3

Develop media campaigns and conduct interviews

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Disclaimer

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