

## TOWARDS CLIMATE RESPONSIVE RECONSTRUCTION IN UKRAINE

### Volume II

# DEEP-DIVE INTO DETAILS AND OPINIONS ON CIRCULAR (RE-) CONSTRUCTION IN UKRAINE

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Author

Lead and structure



In Situ



## Preface

"In pursuit of Net Zero CO<sub>2</sub> emission communities, the synergy between circular construction and urban energy systems is crucial.

Embracing this holistic approach, particularly in rebuilding Ukraine, can significantly curtail scope 3 emissions through circular construction methods.

Concurrently, rebuilding an energy infrastructure that harnesses local energy resources can diminish scope 1 and 2 emissions.

Combining building construction with urban energy systems will create an affordable, sustainable, and resilient built environment.

The strategies detailed in this booklet for Ukraine's reconstruction offer a blueprint not only for Ukraine's sustainable future but also for other communities aiming for a circular and environmentally conscious transition."

Prof. Matthias Sulzer,

Empa - Swiss Federal Laboratories for Materials Science and Technology

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## Swiss-Ukrainian Partnership

**Rethink** - is the only entity in Ukraine that facilitates circular economy development in a holistic way, focusing on education & awareness, circular innovations, and policy

Since 2017 we have been circular executing projects running advocacy campaigns, organizing fo-rums, seminars, hackathons for young innova-tors and lectures on green innovations, circular economy and circular design, fueling the cre-ation of an enthusiastic circular ecosystem of change-makers.

Since 2019, our special focus is being dedicat-ed to the topic of circular cities and circularity in the built environment, since we do realize that if cities don't become circular - everything else won't matter much.

As Ukraine has to be rebuilt after the war in a better & greener way, we have to work even harder to ensure Ukrainian cities & municipal-ities together with the private sector adopt the most advanced circular strategies on different levels.

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**EMPA** - Empa is a Swiss research institution for application-oriented materials science and technology.

Contact: [www.empa.ch](http://www.empa.ch)

## Abstract

The study focuses on circular construction, materials reuse and recycling practices in the built en-vironment of Ukraine, addressing various aspects like current demolition methods, legislative and economic challenges for circularity, past and present circular construction practices, and potential for deeper pilot projects. The research emphasizes the need for regulatory, economic, and technical improvements to foster sustainable demolition and material reuse, highlighting the importance of transitioning towards circular economy principles in the reconstruction of Ukraine.

## Keywords

UTC<sup>1</sup>, utility company<sup>2</sup>, procedure<sup>3</sup>, the framework law<sup>4</sup>, national strategy<sup>5</sup>, state standard<sup>6</sup>, state emergency service of Ukraine (SESU)<sup>7</sup>

## Foreword by Prof. Matthias Sulzer, Empa (Swiss Federal Laboratories for Materials Science and Technology)

In pursuit of Net Zero CO2 emission communities, the synergy between circular construction and urban energy systems is crucial. Embracing this holistic approach, particularly in rebuilding Ukraine, can significantly curtail scope 3 emissions through circular construction methods. Concurrently, rebuilding an energy infrastructure that harnesses local energy resources can diminish scope 1 and 2 emissions. Combining building construction with urban energy systems will create an affordable, sustainable, and resilient built environment. The strategies detailed in this booklet for Ukraine's reconstruction offer a blueprint not only for Ukraine's sustainable future but also for other communities aiming for a circular and environmentally conscious transition.

1 (ukr.: 'Об'єднана Територіальна Громада (ОТГ)') United Territorial Hromada

2 (ukr.: 'Комунальне підприємство') communal enterprise

3 (ukr.: 'Порядок') is a guide line for local authorities, citizens and enterprises.

4 (ukr.: 'Рамковий закон') is a legal norm with a general content that establishes the principles and directions of the reform, i.e., its "framework."

5 (ukr.: 'Національна стратегія') strategic document defining the main development direction for legislation in different fields.

6 (ukr.: 'Державний Стандарт України (ДСТУ)') standards developed following the current legislation of Ukraine 7 (ukr.: 'Державна служба України з надзвичайних ситуацій (ДСНСУ)') is the main executive body tasked with carrying out state policy in the spheres of civil defense, rescue, creating and managing the system of insurance fund documentation, utilization of radioactive wastes, protection of population and territory in emergencies, emer-gency prevention and response, liquidation in the aftermath, and the Chernobyl catastrophe.

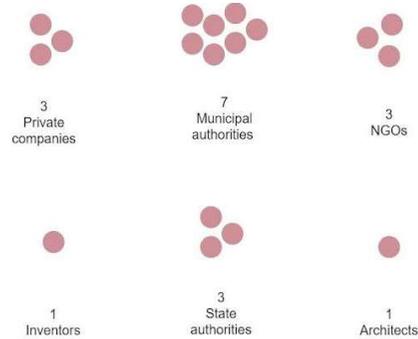
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## Research Methodology

Current research includes qualitative and quantitative analyses. The information and analyzed data for our study comes from multiple sources and could be categorized into the following groups:

- **Interviews and site visits** (*figure 1*). The information from interviews with politicians, civil servants, mayors & municipalities employees, relevant companies, and NGOs is categorized in [the Notion Database](#). The interview recordings and visual materials from the site visits are available by link.
- **Surveys.** The surveys have been run by ReThink with architects, developers, and construction companies and have achieved a representative number of answers. The results of surveys done with Municipalities earlier this year during the capacity building module on circular economy organized by NEB and ReThink are also used in this study (for which we've received permission from the EC).
- **Open source data, publications, and legislative documents.** The selective information from various sources is represented in databases and accessible by links. Data-base on [\(1\) Circular Construction Practices in Ukraine](#), [\(2\) Stakeholders of Circular Construction in Ukraine](#), and [\(3\) Typical Marketplaces of Circular Construction in Ukraine](#). Databases (1) and (2) are linked and related within key actors.

The databases will be updated and complemented until the end of the research. It is developed for internal use, enhancing data analysis and visualization.



*figure 1. Amount of interviews with diverse stakeholders.*

# A

## Common demolition process

The decision on the dismantling of damaged objects is taken by the executive committee of the relevant village, settlement, city council, or, in cases provided for by law, by local state, military-civilian, or military administrations based on a report drawn up based on the results of the survey. The damage assessment also defines the level of destruction based on which the decision on demolition may be considered. These procedures require funds, which some municipalities still need to be included (Zelenyi Hai).

In municipalities, the decision on demolition is taken based on the application to the 'Administrative Services Center' (Ukr.: ЦНАП) (Negresha). After deciding, the local communal enterprises are responsible for the demolition work. 'Inspectorate for Urban Amenities' (Ukr.: Інспекція з благоустрою) is a municipal enterprise that is subordinated to the municipality and also responsible for demotion (Cheychuk). The priority of demolition during wartime is usually given to private housing and outbuildings (Ukr.: Господарчі споруди). (see figure 2)

## Past & current practices for circular demolition in Ukraine

### Short overview of typical demolition practice in Ukraine

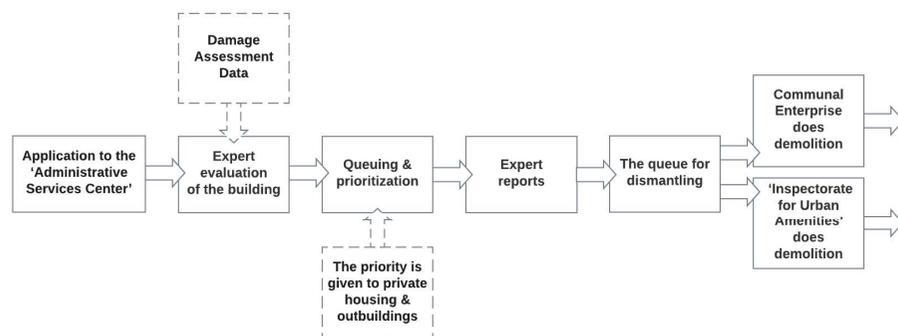


figure 2. Decision on demolition

## The scope of demolition in defined examples

The scope of demolition can vary depending on the company's activity area and the type of structures and objects they work with. Based on the technical aspects, this can be divided into several groups:

- Dismantling of building structures: demolition of walls, floors, ceilings, roofs, etc.
- Removal of equipment: electrical equipment, heating, ventilation, air conditioning systems, pipelines, process equipment, etc.
- Demolition and dismantling of foundation structures: concrete, stone, or other supporting structures, as well as deep foundation demolition.
- Cleaning of the territory - removal of construction waste, garbage, and other materials left after dismantling.

In the context of Ukraine's reconstruction efforts, various entities are actively involved in the demolition and rebuilding process. These include private construction firms, which handle commercial and residential projects, development companies that focus on monolithic structures, and municipal enterprises responsible for private housing.

Additionally, utility companies manage the amenities of such projects. Specialized demolition companies undertake the dismantling of damaged buildings and disinfection tasks. Volunteer and international organizations contribute to the repair and recovery of public buildings, alongside managing waste and material sorting post-demolition. (table 1)

## Case #1 - Current demolition process in Kyiv - ABK Kyiv

ABK Kyiv is a private construction company involved in the sustainable management of construction and demolition waste, with a focus on recycling and reusing materials within a circular economy framework. The process begins with the demolition of various types of buildings, such as private houses, panel and monolith high-rises, each with their own waste potential measured in cubic meters per square meter.

The demolished material is then sorted, with recyclable components directed towards specific recovery processes:

- Bricks are collected and reprocessed into clay for creating new brick mortar, following a 1-2 recycling cycle.
- Metal components are extracted from building structures and concrete slabs. These metals are then cleaned, resold, or reused in other construction projects. (figure 3)



figure 3. Sorting the metal out from the debris after demolition. Photographs made at the ABK Kyiv sorting, storing, and recycling site

- Concrete is processed through several

table 1. Types of companies and organizations that are responsible for the demolition of multi-story and private residential buildings.

Type of company	Name	Location	Activity area
<b>Private construction companies</b>	<ul style="list-style-type: none"> <li>• LLC 'ABK Kyiv' (ukr.: 'АБК Київ')</li> </ul>	<ul style="list-style-type: none"> <li>• Kyiv</li> </ul>	<ul style="list-style-type: none"> <li>• Commercial objects</li> <li>• Multi-story housing</li> <li>• Private housing</li> <li>• Monolith structure</li> </ul>
			<ul style="list-style-type: none"> <li>• Industrial demolition</li> <li>• Excavation of pit foundations</li> </ul>
<b>Development companies</b>	<ul style="list-style-type: none"> <li>• "Tereshchenko" Group of Companies (ukr.: 'Терещенко') - demontazh-group.com</li> <li>• 'OSCAR' Company -https://oscar-dev.net/</li> </ul>	<ul style="list-style-type: none"> <li>• Kharkiv</li> <li>• Khmelnytskyi</li> <li>• Chernivtsi</li> <li>• Sumy</li> <li>• Odesa</li> <li>• Mykolaiv</li> <li>• Poltava</li> </ul>	<ul style="list-style-type: none"> <li>• Recycling and processing of construction waste</li> <li>• Crushing of concrete, limestone, granite</li> <li>• Removal of construction waste</li> <li>• Roadbed filling with secondary crushed stone</li> </ul>
			<ul style="list-style-type: none"> <li>• Private housing</li> <li>• They keep the chosen building materials and structures on the owner's demand</li> </ul>
<b>Municipal enterprises</b>	<ul style="list-style-type: none"> <li>• Local companies that are subordinated to the municipality,</li> </ul>	<ul style="list-style-type: none"> <li>• Ukraine</li> </ul>	<ul style="list-style-type: none"> <li>• Private housing</li> <li>• They keep the chosen building materials and structures on the owner's demand</li> </ul>
<b>Utility companies</b>	<ul style="list-style-type: none"> <li>• Local enterprises</li> </ul>	<ul style="list-style-type: none"> <li>• Ukraine</li> </ul>	<ul style="list-style-type: none"> <li>• Private housing</li> <li>• Utility company's amenities</li> </ul>
<b>Demolition companies</b>	<ol style="list-style-type: none"> <li>1. TekhBudMekhanika (ukr.: 'ТехБудМеханіка', ТБМ) - tbm.com.ua</li> </ol>	<ol style="list-style-type: none"> <li>1. Ukraine</li> <li>2. Kyiv, Kyiv Oblast</li> <li>3. Kyiv, Kharkiv, Poltava</li> </ol>	<ul style="list-style-type: none"> <li>• Dismantling of buildings and structures</li> </ul>
	<ol style="list-style-type: none"> <li>2. 'KyivBudStroi' (KBS) (ukr.: 'Київбудстрой' (КБС)) - https://k-b-s.com.ua/</li> </ol>		<ul style="list-style-type: none"> <li>• Destruction of concrete, foundations, structures</li> <li>• Earthworks and excavation works</li> </ul>
	<ol style="list-style-type: none"> <li>3. UkrTakelazh (ukr.: 'Укртакелаж') - ukrtakelage.com</li> </ol>		<ul style="list-style-type: none"> <li>• Removal of garbage, construction waste, construction waste</li> <li>• Processing of construction waste</li> </ul>

Type of company	Name	Location	Activity area
<b>Volunteer organizations</b>	<ol style="list-style-type: none"> <li>1. Brave to rebuild</li> <li>2. Repair Together</li> </ol>	<ol style="list-style-type: none"> <li>1. Irpin, Bu-cha, Gostomel, Kharkiv region, Kherson region</li> <li>2. Chernihiv region</li> </ol>	<ul style="list-style-type: none"> <li>• Dismantling of damaged buildings</li> <li>• Drying and disinfecting houses in the Kherson region with local activists, NGOs, and the State Emergency Service</li> <li>• Repairing kindergartens, schools, and outpatient clinics</li> <li>• Doing emergency recovery</li> <li>• Then, full recovery for those that can be restored</li> </ul>
			<ul style="list-style-type: none"> <li>• UNDP is doing the whole demolition of the damaged sites and sorting the materials afterward</li> </ul>
<b>International organizations</b>	<ul style="list-style-type: none"> <li>• 'Association of Waste' (WRAUA)</li> <li>• UNDP</li> </ul>	<ul style="list-style-type: none"> <li>• Ukraine</li> </ul>	<ul style="list-style-type: none"> <li>• UNDP is doing the whole demolition of the damaged sites and sorting the materials afterward</li> </ul>
<b>Private individual contractors</b>	<ul style="list-style-type: none"> <li>• Usually found independently through the web platforms:</li> <li>• Kabanchyk platform</li> <li>• Contractors platform</li> <li>• Dexpert platform</li> </ul>	<ul style="list-style-type: none"> <li>• Locally in each hromada</li> </ul>	<ul style="list-style-type: none"> <li>• Financial Aid to support demolition and debris management</li> <li>• Technical Expertise in demolition, waste management, recycling</li> <li>• Equipment and Resources for demolition and waste management</li> <li>• Capacity Building</li> <li>• Policy Support in the development of regulations that promote sustainable demolition and waste management</li> </ul>
			<ul style="list-style-type: none"> <li>• UNDP is doing the whole demolition of the damaged sites and sorting the materials afterward</li> </ul>



table 2. Demolition &amp; smart demolition practices and prices with defined examples.

Type	Private company	Communal enterprise	Volunteer organization
<b>Name</b>	<ul style="list-style-type: none"> <li>ABK Kyiv</li> </ul> NACE code - Recycling of secondary products.	Local communal enterprises	<ul style="list-style-type: none"> <li>Brave to Rebuild</li> </ul>
<b>Practice</b>	Construction company: <ul style="list-style-type: none"> <li>Demolition</li> <li>Smart demolition</li> <li>Recycling</li> <li>Reuse</li> </ul>	<ul style="list-style-type: none"> <li>Assessment and planning - evaluate the damage to buildings, determining which structures need demolition.</li> <li>Demolition and debris removal - conduct the demolition of structures and the removal of resulting debris, clearing sites for rebuilding.</li> <li>Salvaging and recycling - involved in salvaging reusable materials from demolished buildings for recycling.</li> <li>Coordination with other entities - government bodies, NGOs, and international agencies for integrated reconstruction efforts.</li> <li>Safety and compliance - ensure safety standards are met during demolition.</li> <li>Community engagement and support - about demolition and reconstruction plans, addressing concerns and providing necessary support.</li> </ul>	<ul style="list-style-type: none"> <li>Dismantling of damaged buildings</li> <li>Drying and disinfecting houses in the Kherson region with local activists, NGOs, and the State Emergency Service</li> <li>Repairing kindergartens, schools, and outpatient clinics</li> <li>Doing emergency recovery</li> <li>Then, full recovery for those that can be restored</li> </ul>
<b>Location</b>	<ul style="list-style-type: none"> <li>Kyiv + 200 km.</li> <li>Lviv</li> <li>Odesa</li> <li>Dnipro</li> </ul>	<ul style="list-style-type: none"> <li>In every hromada</li> </ul>	<ul style="list-style-type: none"> <li>Irpin</li> <li>Bucha</li> <li>Gostomel</li> <li>Kharkiv region</li> <li>Kherson region</li> </ul>
<b>Scope</b>	40000 sq m per month - demolition, recycling, and transportation	<ul style="list-style-type: none"> <li>Small-scale demolition - a small residential buildings or a single structure</li> <li>Medium-scale demolition - a medium-sized commercial buildings</li> <li>Large-scale demolition - a large industrial complex</li> </ul>	<ul style="list-style-type: none"> <li>Both small and large-scale demolition of the sites damaged due to the Russian war</li> <li>The scope of demolition depends on the demand</li> </ul>

Type	Private company	Communal enterprise	Volunteer organization
<b>Price</b>	Based on the type of structure of the facility: <ul style="list-style-type: none"> <li>private houses - 750-3000 UAH/sq m,</li> <li>brick high-rise buildings - 650-1700 UAH/sq m,</li> <li>panel high-rise buildings - UAH 650-110/sq m,</li> <li>monolithic - 900-3000 UAH/sq.m.</li> </ul>	<ul style="list-style-type: none"> <li>The average salary for a demolition worker in Ukraine is 178,328 Ukrainian Hryvnia (UAH) per year. This figure translates to an hourly rate of approximately 86 UAH. Additionally, these workers receive an average annual bonus of 3,103 UAH. This data covers a broad range of experience levels, from entry-level to senior positions.</li> </ul>	<ul style="list-style-type: none"> <li>The initiative participates in small grants.</li> <li>They work for received support from various organizations - for volunteer vests, materials, and food</li> </ul>

processing. The shredded waste is used again during road restoration, construction of temporary crossings, road crossings, etc. (Drozd).

The prices for landfill disposal:

- The cost of landfill disposal varies between 140 and 210-220 UAH/m<sup>3</sup>, depending on the type of waste.
- The cleaner the waste, the lower the cost
- The average cost is 180 UAH/m<sup>3</sup>

### Illegal disposal

The recent development in waste management laws and frameworks indicates a movement towards tighter regulation and better waste management, including construction waste. The Ukrainian Parliament adopted a draft of the new Law of Ukraine, "On Waste Management," on 20 June 2022, expected to come into effect a year after its official publication ('Law on Waste Management'). This new law aims to enhance the waste management system in Ukraine, which was previously poorly regulated and fragmented across municipalities. The law introduces a European waste management hierarchy, establishes the principle of "polluter

pays," and tightens the licensing requirements for collecting and processing hazardous waste, among other measures.

These recent legislative updates point to a more regulated framework for managing construction waste, but the penalties for the illegal disposal of construction waste must be explicitly detailed. The issue with landfills is that most are dedicated to a mix of domestic and building material waste, which both must be sorted.

Landfills are legal, but landfill disposal is not. Instead, conservation occurs because it is not liquidation - it does not require a separate license, and there is no responsibility. There are other requirements for converters. (reference - ABK Kyiv interview)

## Overview of smart demolition practices in Ukraine with the main examples, actors, locations, scope, and common costs for different materials

Smart demolition generally refers to the use of advanced technologies and precise tech-

niques to bring down structures in a controlled and environmentally friendly manner.

Based on interviews with various municipalities, the majority have a grasp of smart demolition principles, though some respondents sought clarity on the sustainability of their practices. Out of seven personal discussions, almost a half of the respondents already apply circular demolition principles in recovery projects. International donors have supported some of them in material recycling and reuse. For instance, JICA supplied equipment to the Municipality of Irpin for processing, shredding construction waste, and dismantling houses - now utilized by the local communal enterprise (Negresha). Some representatives from municipalities mentioned that their specialists are acquainted with circular demolition terms. However, construction and domestic waste are mostly dispatched to landfills without prior sorting (Kholchenkova). The primary barrier to adopting a circular approach here was the need for more technical or human resources for its implementation.

Smart demolition is a common practice for NGOs participating in rebuilding efforts. However, these organizations mainly work with small-scale objects, suggesting handbook solutions for materials reuse that help vulnerable communities implement those techniques onsite without waiting for donor's investment. (Sakh)

#### Circular construction demolition actors' challenges and lessons learned

The main challenges interviewees face when discussing implementing circular strategies in the demolition process are mostly connected

with such aspects:

Legislative:

- No regulation defines technical specifications for recycled material, and some companies reject implementing smart demolition in their work due to that.

Economic:

- The market needs to be wider and more functional
- The economic viability of secondary materials is currently questionable

Technical:

- There is a certain risk that the technology will not be maintained during the process.

The potential to provide circular practices and smart demolition can be connected to reconstructing Soviet-era prefabricated housing.

## Typical virtual and physical marketplaces for reusing building materials in Ukraine

### Types of common virtual and physical market/swap places in Ukraine. Business models and level of success of virtual and physical market/swap places

General insights into how these platforms might operate based on common business models observed in online marketplaces and swap places (table 3):

- Commission-Based Model: Platforms charge a commission or fee for every transaction made through the platform. The commission rate can vary depending on the marketplace and the product or service sold.
- Subscription Model: Users pay a subscrip-

table 3. List of virtual marketplaces

Name	Status	Short description	Type	Location	Business Model
waste.ua	virtual	Online classifieds website where people can buy and sell a wide range of used building materials.	<ul style="list-style-type: none"> <li>• doors</li> <li>• finishing materials</li> <li>• structural materials</li> <li>• windows</li> </ul>	Ukraine	a hybrid business model that combines elements of the commission-based model, advertising-based model, and listing-fee model.
olx platform	virtual	A well-known online classified market place where people can buy and sell various items, including used building materials.	<ul style="list-style-type: none"> <li>• HVAC and plumbing equipment</li> <li>• doors</li> <li>• finishing materials</li> <li>• structural materials</li> <li>• windows</li> </ul>	Ukraine	typically follows a commission-based or listing fee model, where sellers are charged for listing their items or a commission on transactions.
izi.ua	virtual	Is the No. 2 C2C platform in Ukraine. With this service, users can buy and sell goods from each other, including used building materials	<ul style="list-style-type: none"> <li>• doors</li> <li>• finishing materials</li> <li>• construction materials,</li> <li>• windows</li> </ul>	Ukraine	E-commerce marketplace uses a hybrid business model that combines elements of the commission-based model, advertising-based model, and listing-fee model.
flagma.ua	virtual	online catalog of goods and services in Ukraine with the ability to buy wholesale and retail, including used building materials	<ul style="list-style-type: none"> <li>• HVAC and plumbing equipment</li> <li>• doors</li> <li>• finishing materials</li> <li>• construction materials</li> <li>• windows</li> </ul>	Ukraine	a commission-based business model for generating revenue, and a listing-fee model.
bon.ua	virtual	online classifieds website where people can buy and sell a wide range of used building materials.	<ul style="list-style-type: none"> <li>• construction materials</li> </ul>	Ukraine	a hybrid business model that combines elements of the commission-based model, advertising-based model, and listing-fee model.

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tion fee to access the platform and its features.

- Listing Fee Model: Sellers pay a fee to list their products or services on the platform.
- Freemium Model: Basic services are provided for free, with additional features or services available for a fee.
- Advertising Model: Platforms generate revenue by displaying advertisements to users.

These models can be combined or tailored to suit each platform's needs and market conditions.

### **The marketplaces' newest innovations, challenges, and lessons learned**

We see a gap in Ukraine's market for secondary materials – the lack of established offline marketplaces. On the other hand, most municipalities have legal storage sites for post-destruction secondary materials, giving a unique opportunity to transform these storage sites into offline marketplaces in the future.

This makes sense, as these locations and operators who bring secondary materials to the sites do not need a waste management license (due to the government's resolution).

It is a promising possibility that holds several advantages:

- Local users and stakeholders gain immediate access to readily available resources.
- Material transportation and logistics are minimized.
- Communities gain ownership and involvement in circular economy practices.

However, local authorities must ensure sites are free of hazardous materials like asbestos or harmful fumes and establish clear guidelines and overall management for material access

It is important to understand that currently, sites for secondary building materials are not marketplaces. But theoretically, if local authorities engage companies or simply announce that the sites are now safe to enter, there is no threat, and everything is safe, there is no slate and no harmful fumes or toxic substances, and people can take recyclable materials from there to rebuild, then they could be transformed into marketplaces.

## B

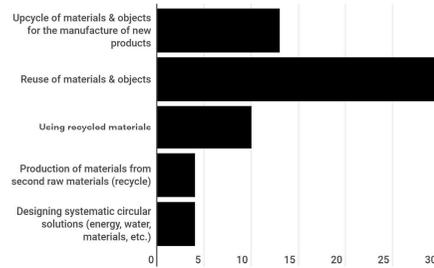


figure 5. Results of the survey for architects on the classification of circular practices in their work

In the *table 4* the common practices and prices are described based on the information from online marketplaces (Izi.ua; **Оголошення** OLX.Ua; 'Flagma.ua'), interviews (Pashynska; Sakh; Selyk; Negresha)(Sakh), video vlogs (Chaplynskyiv Vlog. Lviv Brama Restoration.; Frankivsk. The Doors That Should Be Cherished) and studies (Niemeyer and Kozub; Metalab).

We collected the database of reuse practices and related stakeholders on [the Notion web page](#).

#### Case #2 - Theatre on Podil. Drozdov Architects, Roshen

#### Economics of facade brick reuse

After reusing locally available bricks for two projects in Kharkiv (HoReCa & housing), a prominent Ukrainian architect, Oleg Drozdov, has set a certain trend on such practice in that region. At the same time, Kyiv lacked remarkable examples of high-quality & high-value reuse. Therefore, while working on the Teatr na Podoli (Theatre on Podil) - the first new public theatre built in years(!), Oleg decided to use lo-

table 4. Common second-hand materials and products.

Product name & average price range on the virtual market	Common practices & particular cases
<b>Bearing structure</b>	
<b>Steel structural elements</b> (channel, beam, I-beam) • 15-25 UAH/kg	Drozdov & Partners reused a steel framework from an industrial building nearby for the BMW Salon in Kharkiv in 2015.
<b>Steel structures</b> (f.e. arch trusses) <ul style="list-style-type: none"> <li>• 35 000 - 37 000 UAH</li> </ul>	
<b>Concrete slabs</b> (hollow core floor slabs): The price varies according to the amount of slabs in the selling set and the main dimensions. <ul style="list-style-type: none"> <li>• 300-3000 UAH/set</li> </ul>	People ask communal enterprises during the demolition to avoid dismantling and discarding some structural elements, such as concrete slabs, to reuse them in the future.
<b>Bricks</b> (bearing walls) <ul style="list-style-type: none"> <li>• white bricks (silicate) - 2-5 UAH/piece</li> <li>• red bricks (ceramic) - 2-15 UAH/piece</li> <li>• vintage bricks craft (ceramic) - 2-20 UAH/piece</li> </ul>	Locals reuse bricks and aerated concrete blocks from damaged and destroyed housing for new construction.
<b>Aerated concrete blocks</b> are less present in the second-hand market as it is a relatively new material <ul style="list-style-type: none"> <li>• 20-2000 UAH/set.</li> </ul>	
<b>Non-bearing structures and finishing materials</b>	
<b>Sheet metal profile</b> profiled sheeting - 100-300 UAH/set metal gates and fence - 3000 -20000 UAH/piece	Locals repair the damaged roofs with second-hand materials as it is the cheapest option currently.
<b>Bricks</b> (partitions, walls, finishing) <ul style="list-style-type: none"> <li>• white bricks (silicate) - 2-5 UAH/piece</li> <li>• red bricks (ceramic) - 2-15 UAH/piece</li> <li>• vintage bricks craft (ceramic) - 2-20 UAH/piece</li> </ul>	In 2017, Drozdov & Partners used old bricks for the main facade of the Theatre on Podil to harmonize the new building with its historic surroundings. Vintage craft bricks from pre-Soviet mass production have a high aesthetic value.
<b>Tiles.</b> Ceramic tiles for the interior are almost missed on the virtual market, while pavement tiles are a common product - <ul style="list-style-type: none"> <li>• 50-300 UAH/m<sup>2</sup>.</li> </ul>	The reuse of Soviet ceramic tiles for bathrooms by Metalab became an aesthetically valuable case.
<b>Architectural elements (exterior and interior)</b>	
<b>Windows</b> Not represented sufficiently on the virtual market	Reuse of windows is very common now. The supply from Switzerland and Poland was used in Okhtyrka, Ivano-Frankivsk, and other places. Locally, there was a production reassemble of windows in Chernihiv Polytechnic.
<b>Doors</b> The most represented type is the entrance door <ul style="list-style-type: none"> <li>• 2000-7000 UAH/piece</li> </ul>	Doors restoration for schools by Brave to Rebuild in different locations with financial motivation. Restoration of doors in Lviv and Ivano-Frankivsk by local restorators. Restoration of gates in Lviv and Ivano-Frankivsk by local restorators.

## Past and current practices for building material reuse in Ukraine

### Reuse practices in Ukraine

Reusing materials and construction is one of Ukraine's most common circular practices. According to the surveys with architects - 65.1% of respondents use second-hand objects in their work (*figure 5*). During the full-scale invasion, the reuse in housing reconstruction increased among regular people (Pashynska).

Product name & average price range on the virtual market	Common practices & particular cases
<b>Glass blocks</b> <ul style="list-style-type: none"> <li>• 50-100 UAH/piece</li> </ul>	Reuse of glass blocks for new partitions in Innova-tion Park "Promprylad."
<b>Furniture and plumbing</b>	
<b>Luminaires</b>	Metalab reuses and upcycles luminaires in the Co-Haty project for IDPs.
<b>Metal Elements</b>	Metalab used a metal framework from the old beds for the structure on the terraces. Upcycle of metal elements from the old factory for urban furniture in Ivano-Frankivsk.
<b>Plumbing</b>	Metalab used Swiss second-hand plumbing in the Co-Haty project for IDPs.
<b>Chairs, cabinets, and armchairs</b>	In the past, Metalab restored and upcycled furniture and facilities from the old Promprylad factory in the Parasolka workshop. Now, makers restore and reuse chairs, cabinets, and armchairs for ongoing projects. RePlus-Stare makes custom upcycled furniture and materials.

cal 100+ years old brick for the most exposed part of the building – the facade. (figure 6)



figure 6. Reused brick facade on the Theatre on Podil by Drozdov&Partners. Kyiv, Ukraine, Dec 2023

We asked if the client was happy about the decision (given a certain low-value perception of second-hand materials in Ukraine). "You see, this point has been too critical for me. I insisted.", says Drozdov.

Perhaps one of the factors in accepting this move has also been the fantastic economics of the reuse. The client paid as little as 2 UAH per piece of clean, locally reused brick. Similar new ones would need to be brought from abroad for at least 0,9 EUR (25 UAH at that time) per piece of a smaller size.

"The guy who was cleaning and polishing those bricks got too excited, so now you can't even say those are old reused bricks," - says Oleg Drozdov, architect of the Theatre on Podil.

He and his team also wanted to apply the same approach to the house on Sahaidachno-ho by Saga Development (add link here). However, finding a sufficient amount of such good quality bricks locally turned out to be a big challenge.

**The structure and influence of the market for key second-hand materials.**

The second-hand materials market is rare in Ukraine. The main reason for this is the competitiveness of the new materials market with its wide range of affordable options. The virtual second-hand market is composed of single adverts created by owners. The buyer directly contacts the owner to make a deal (the price is often negotiable). This deal is feasible only if the item is unique or contains a big volume set, providing a financial benefit. At the same time, the physical marketplaces work well with the local proximity for different kinds of sets.

**Case #3 - Eco+Logic**

**Economics of crushed concrete: road bedding vs landfilling**

Eco+Logic is an SME, evolving from a larger waste management company that operates in Kyiv and deals with household waste. In contrast, Eco+Logic focuses mainly on construction & demolition waste and is looking at ways to cut landfilling volumes through higher value upcycling and recycling of built environment materials.

When working on the current study, Rethink experts visited Eco+Logic at their Kyiv facility to look at operations and discuss their challenges and overall economics of demolition waste up-cycling. (figure 7)



figure 7. Rethink on-site interview with Eco+Logic. Kyiv, Ukraine, Dec 2023

While their current (recent) location doesn't look fancy at all, the guys are determined to recover as much value as possible from the materials they're dealing with. And this determination partially comes from the very poor economics of the typical waste management approach, since their tariff covers only landfilling cost (see table 5).

It is rather interesting situation, because we see that circularity on such level is not facilitated by legislative requirements, or green public procurement rules, or fiscal/economic incen-

tives. In contrast, the market saturation and high price sensitivity of demand drives the intention to limit landfilling and reuse as much as possible for such companies as Eco+Logic.

#### Potential of reuse practices.

- According to Brave to Rebuild and Ostriv/Tolokar operators, the physical stockpiling in different settlements is useful for their work and has much potential. However, the main obstacle is the lack of supply chain and space for stock.

table 5. Economics of the typical waste management approach

Indicator	Amount (UAH) - 1500m <sup>3</sup>	Amount (UAH) - 3000m <sup>3</sup>
Rent of the area (300 m2)	10500	10500
Brigade salary (Brigadier)	22000	22000
Brigade salary (Tractor driver)	22000	22000
Brigade salary (Workers) 3 workers + crusher op.	74000	128000
Car rental + 2 containers 20M3	45000	45000
Loader Rental	60000	60000
Crusher Rental	22000	22000
Depreciation (Loader, Crusher, Car) Maintenance	28000	44000
Fuel for the Car and Loader	45000	90000
Car Driver's Salary	24000	24000
Electricity	22000	37000

Indicator	Amount (UAH) - 1500m <sup>3</sup>	Amount (UAH) - 3000m <sup>3</sup>
Waste Disposal Not Subject to Recycling (680 m3)	102000	204000
Total Expenses	374500	504500
Amount of accepted m3 (per month) at 150 UAH/m3	225000	450000
Sales of recycled concrete stone	39600	79200
Total Revenue	264600	529200
Profit	-109900	24700
Profitability %	-29.35	4.90
Ecological component not sent to landfill (m3)	820	1640
Cost of grinding process per 1 m3	631	824

- According to Metalab, metal, and wood have a high reuse and upcycle potential.
- In the field of urban design, such elements as pavement tiles, curbs, and oilers have a higher reuse potential (Pashynska)
- There is also a high potential in raising awareness and knowledge about dealing with second-hand materials as currently people urgently need to self-repair and reuse but don't have the techniques and tools for it (Pashynska; Sakh).

## C

## Legislative framework for circular construction

### Existing laws/policies, regulations & standards in relation to demolition, urban mining & reuse of material

The legislative framework for circular construction in Ukraine is constantly modified and updated.

There are two main reasons for this:

- The need for harmonization with EU standards for construction production as part of EU integration
- The need for construction waste management for the built environment, damaged and destroyed due to war

The *table 6* describes the primary existing laws and policies related to circular construction, ordered by importance/relevance for the report's agenda.

In the *table 7* we demonstrate the comparative analysis of Procedure for waste management and common practices.

table 6. Existing laws and policies related to circular construction

Name & Date	Implementers	Key topics covered
<b>Resolution No. 1073</b> of 27 September 2022, Kyiv on <b>Procedure for Waste Management</b> Generated in Connection with Damage (Destruction) of Buildings and Structures as a Result of Hostilities, Terrorist Acts, Sabotage or Works on Elimination of Their Consequences	<ul style="list-style-type: none"> <li>• The Executive authorities of villages, towns, and settlements are obliged to follow this procedure during the war and after 90 days of the state of war.</li> </ul>	<ul style="list-style-type: none"> <li>• Demolition waste management operations</li> <li>• Peculiarities of handling demolition waste during territory clearance</li> <li>• Features of waste management during the dismantling of damaged (destroyed) facilities</li> <li>• Places of temporary storage</li> <li>• Features of reuse of demolition waste</li> <li>• [Anex x List of components of demolition waste and possible ways of their reuse in construction, construction materials industry (production of construction products)]</li> <li>• [Anex x Form for recording waste from destruction]</li> </ul>
<b>Resolution No. 474</b> of 19 April 2022, Kyiv <b>Procedure for Dismantling facilities damaged or destroyed</b> as a result of emergencies, military operations, or terrorist acts	<ul style="list-style-type: none"> <li>• Executive bodies of village, town, and city councils, and in cases provided for by law - local state, civil-military, or military administrations</li> </ul>	<ul style="list-style-type: none"> <li>• The mechanism for dismantling buildings and structures or their parts damaged or destroyed as a result of emergencies, military operations, or terrorist acts, based on the relevant decisions taken based on the survey results</li> <li>• [Anex x Act of Demolition]</li> </ul>
Redaction from 31 March 2023 <b>The Framework Law on "Waste Management"</b>	<ul style="list-style-type: none"> <li>• State governmental authorities, regional authorities, local authorities, and private and public enterprises</li> </ul>	<ul style="list-style-type: none"> <li>• General requirements in construction waste management (materials separation, recycling, upcycling)</li> <li>• Landfilling procedure</li> <li>• Digital waste accountment system</li> </ul>
Cabinet of Ministers of Ukraine, <b>Order</b> of 8 November 2017 <b>no. 820-r</b> Kyiv <b>National Strategy of waste management in Ukraine</b>	<ul style="list-style-type: none"> <li>• State government</li> </ul>	<ul style="list-style-type: none"> <li>• Description of problems in the building sector and the material proportion of construction waste</li> <li>• [Anex X description]</li> <li>• Ways and means of solving the waste problem in the construction sector</li> </ul>
<b>State Standard</b> of Ukraine <b>9171-2021, Guidelines For Ensuring The Balanced Use Of Natural Resources</b> In The Design Of Buildings	<ul style="list-style-type: none"> <li>• Architects, civil engineers, construction workers</li> </ul>	<ul style="list-style-type: none"> <li>• Dependence of approaches to the preservation and reuse of structures on the typology of architectural and building systems</li> <li>• Application of technical reuse solutions in design</li> <li>• Construction waste management</li> <li>• The list of construction waste to be processed or disposed, and the priority areas of their use for the production of secondary products</li> <li>• [Anex x]</li> </ul>

## Enforcement situation and common practice

table 7. Comparative analysis of Procedure for waste management and common practices with the evaluation of enforcement situation.

Key takeaways from Procedure	Enforcement situation and common practice	Evaluation on enforcement 1- low, 3 - high
Clearing of the site (collection of demolition waste, including sorting of individual components of demolition waste) (par. 15)		
The territories are being cleared of destruction after a set of preparatory measures have been taken as part of the urgent work to eliminate the consequences of the armed aggression of the Russian Federation (par. 18)	The first preparation measure described in various interviews is the demining procedure taken by the State Emergency Service of Ukraine (SESU), which is facilitated by the local authorities. This procedure is obligatory and carried out in almost every settlement except for the Svyatohirsk commune.	● ● ●
If technically feasible, sorting or separate collection of demolition waste (or its components) should be organized during site clearance. (par. 20)	To organize the cleaning process, local authorities hire communal enterprises. The municipality can request sorting. However, there is only one case of such sorting on the demolition site, as it is inconvenient (it is better to do it on the remote site). (Cheychuk)	●
<b>Demolition</b>		
During the dismantling works, if possible, ensure the sorting of demolition waste for its further treatment (recycling) and disposal (par. 24).	The sorting and separation of materials during the demolition is rarely performed in villages and towns. In some cases, certain materials (bricks, slabs) were separated at the owner's request for further reuse. (Negresha)	● ●
Temporary storage facilities (When arranging temporary storage sites, the appropriate organization of the territory should be provided, in particular, areas intended for temporary storage, sorting, processing (recycling), temporary storage of the obtained secondary raw materials (in particular, for the placement of crushing and sorting and other facilities, as well as temporary structures necessary for the management of demolition waste)) (par. 28)		
In temporary storage facilities, only the main components of demolition waste (parts (debris, combat) of building structures, door and window fill, engineering networks, sanitary appliances, etc.) that do not contain and/or are not contaminated with hazardous waste may be processed (recycled). These operations for the treatment (processing) of the main components of radioactive waste include separation, crushing, and fractionation of these components.	The stockpiling was organized almost in all communes according to the procedure. The exception is Svyatohirsk. However, sorting and processing took place only in Irpin and Bucha with the support of UNDP and JIKA. No operations were applied to the waste in other communes, such as Vysokopi-lya and Chernihiv. Municipal authorities relay that it will be taken by someone away and currently don't plan to manage it locally. (Cherniak)	●

Key takeaways from Procedure	Enforcement situation and common practice	Evaluation on enforcement 1- low, 3 - high
<b>Features of the reuse of demolition waste</b>		
Construction products obtained using demolition must meet the Technical Regulations for Construction Products requirements approved by the Resolution of the Cabinet of Ministers of Ukraine of 20 December 2006, No. 1764 (par. 30).	Currently, there is no precedent of certified production using the construction waste generated due to military operations. Several experts mentioned the issue concerning the state standard for raw secondary materials.	●
The authorized body is obliged to take measures to reuse the main components of demolition waste (after their treatment (processing) - if necessary) during the implementation of construction projects for which it is the construction customer and to promote the use of demolition waste by other construction customers.	The Irpin municipality aims to use crushed concrete for the new road construction. The Shevchenkove commune is planning a collaborative project with NeoEco to use secondary materials in the construction of roads. However, in other communes, there is no circular construction noticed.	● ●

## Description of the main challenges

To summarize the main features and challenges in the legislative framework for Circular Construction, there are 2 key topics - Legislative framework for Demolition and materials processing for further reuse, recycling, and upcycling, and State standards in Secondary raw materials share in building production.

### Demolition and materials processing for further reuse, recycling, and upcycling

According to the recent Procedure, local authorities must facilitate the separation, reuse, and recycling of materials. However, as highlighted in *table 7*, only several communes achieved materials separation and have plans for local reuse and recycling. It means that local authorities experience certain challenges:

Even though the Procedure provides the table of Components of demolition waste and possible ways of their reuse in the construction and construction materials industry (production of construction products), the exact mechanisms and technical equipment for recycling are not defined by the procedure. The local authorities highlighted the lack of understanding of the steps after the materials stockpiling on the site (Shuliak).

Lack of financial and human resources is a key obstacle to procedure adherence.

Private property issue mentioned by local authorities (*ref.*).

The aspect of timing in the Procedure states that demolition, materials separation, and processing should occur until the State of War ends and 90 days after its termination.

Document for demolition.

Apart from the practical procedures, there is a challenge for the biggest vision for construction waste management countrywide. The recent

Framework Law on "Waste Management" was very "painful" (Shuliak) to adapt. Some NGOs and experts criticized the law. The document stays open for changes and enhancement ('Are Landfills Here to Stay?'). While the Framework law and National strategy define the general di-rection in the field of waste management, many other by-laws: sectoral laws, regulations, meth-odologies, orders, and instructions, etc., have to be developed in the nearest future, defining the exact mechanisms for the achievement of circular processes countrywide.

#### Secondary raw materials partition in building production

The update of the State Standards and Technical regulations on construction products should be harmonized with the standards of the European Union. The European Commission amended regulation 305-2011 on 1 December 2022. The main question, "How do we encour-age the materials producers and developers in the construction sector to use the second raw materials in their production?" is key (Shuliak).

There are several mechanisms:

- the obligatory law for a certain percentage of secondary raw materials
- the market regulation for the second raw materials
- the fiscal policies for the mining, landfilling, and the second raw materials-based prod-ucts

It is an openquestion how the policies for circular construction will be developed in the nearest future.

From the interview with the Head of the State Agency for Restoration and Infrastructure De-velopment - Mustafa Nayem (*reference*), we

identified three main obstacles to implementing circular practices in the restoration process:

- The biggest obstacle is the need for an ex-pert vision with foreign involvement in the restoration efforts.
- The reformations in the legislative realm - the economy of secondary resources are not defined.
- Logistics of material redistribution is a cru-cial issue connected to the legislative lim-itations.

Due to these obstacles and the active war-time phase, Mustafa believes that Ukrainian businesses are not ready to implement circular practices. He also emphasized the influence levers connected to hiring employees as much as waste management. Support and benefits from the State must stimulate businesses. (*ref-erence*)

***"We had a big cultural center, it was shelled and we glazed the windows. The second time, when the same center was shelled, we just covered the windows with film. The third time it was shelled we covered them with more film, and the fourth time we realized that there was no point in installing double-glazed windows in a 5-kilometer zone at all."***

*Olga Garkavenko, Head of the Novoslobidska hromada*

To perform stakeholders analysis the Notion database was created (figure 8).

The stakeholder`s analysis contains:

1. Categorization by types, 4 main groups: Foreign and International Institutions; Organizations, Foundations, Donors, and Certification Bodies; Ukrainian Institutions, NGOs, Volunteer Initiatives, Citizens, and Activist Groups; Government, Local Authorities & Communal Enterprises- each of these groups has from 5 to 10 subgroups.
2. Power/interests analysis. The score of Power and Interest from 0 to 5 was given to every stakeholder based on the interviews and overviews of the stakeholder`s activities.
3. Geographic distribution. The table/database contains the specification of origin/registration of each stakeholder, which allows for evaluation of the tendency to involvement of foreign actors in the Ukrainian context.

4. Categorization by interest type. It includes 1 governmental interest - policy obligations alignment, 2 social interests - reconstruction urgency and waste removal, and 2 economic interests - cost and profit.
5. Importance of the local project. Considering the specific conditions of the ongoing war, the additional categorization for relevance/importance (low, medium, high) of each stakeholder for the local reconstruction project is provided.

The website links are available in the table. In addition, the database contains relations with the Circular Construction projects.

Figure 9 shows subtypes of stakeholders and their potential role in the local circular reconstruction project.

The operational roles are visualized by centrality:

- Central circle. Key actors operating on the

* Stakeholders in CC in UA										
As Name	Category	Type	# Power	# Interest	Importa...	Interests	Interview	Based	Website	Related projects
NeoEco Ukraine	Companies and entrepren...	Recycling entrepren... Demolition entrepren...	3	5	high	profit		Ukraine	https://www.neo-eco.com.ua/en/home-en/	Hostelnet: from rubble to housing
ABK Kyiv	Companies and entrepren...	Recycling entrepren...	2	5	high	profit	yes	Ukraine		Recycling in Zelenyi Hai
GreenMix	Companies and entrepren...	Recycling entrepren... Recycling plants	2	5	low	profit		Israel	https://www.bnz.co.il/?lang=en	Recycling in Bucha
Hempire	Companies and entrepren...	Recycling entrepren...	3	5	high	profit		Ukraine	https://hempire.tech/ahout	
The good plastic company	Companies and entrepren...	Recycling entrepren...	3	5	low	profit		Ukraine	https://thegoodplasticcompany.com/	
Hamel Ukraine/ТОВ «Хамелон. Україна»	Companies and entrepren...	Recycling facilities p...	2	5	high	profit		Ukraine	http://www.hammel.com.ua/	
Ohnova/СТ-ОЛНОВА	Companies and entrepren...	Recycling facilities p...	2	5	high	profit		Ukraine	https://olnova.eu/	
JICA	Companies and entrepren...	Recycling facilities p...	3	5	high	waste re...		Japan	https://www.jica.go.jp/english/	Recycling in Irpin
Metal recycling plants	Companies and entrepren...	Recycling plants	3	5	high	profit cost		Ukraine	https://www.enfmetal.com/directory/plants/Ukraine	
Drozov and Partners	Companies and entrepren...	Design studio	3	5	low	cost	yes	Ukraine	https://drazov-partners.com/en/	Reuse of bricks in Podil Theater
EcoPlus	Companies and entrepren...	Construction materi...	3	5	high	profit	yes	Ukraine	https://ecologic.kyiv.ua/	
Astor	Companies and entrepren...	Construction materi...	1	1	low	profit		Ukraine	https://www.astor.ua/	
UDP	Companies and entrepren...	Construction develo...	4	1	low	profit		Ukraine	https://udp.ua/en/projects/unit-city/	Unit.City (Factory)
Kovalska	Companies and entrepren...	Construction develo...	4	3	low	profit cost	yes	Ukraine	https://kovalska.com/en	

figure 8. The screenshot of the table of Circular Construction stakeholders in Ukraine from the No-tion database.

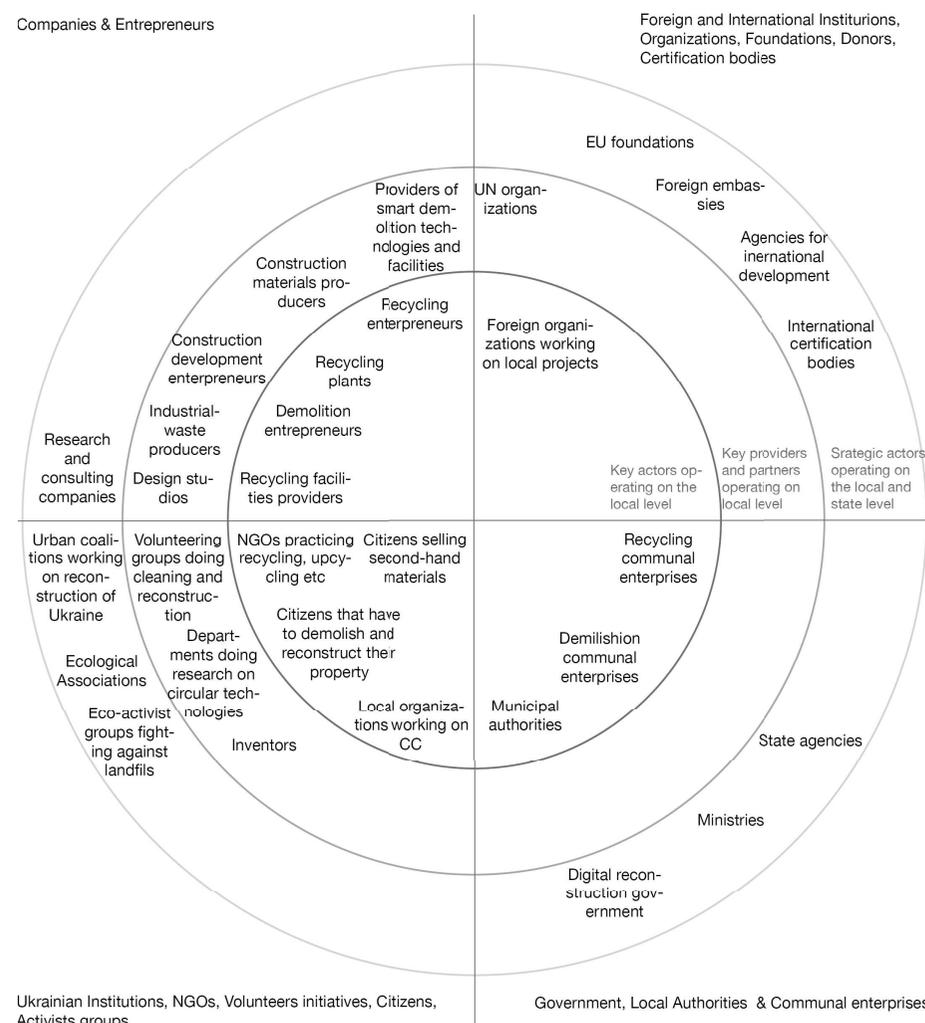


figure 9. Stakeholders map visualization by types of stakeholders.

- local level. These actors are the most important in the circular reconstruction project and directly operate on the site.
- Middle circle. Key providers and partners operating on the local level. These stake-

holders do not necessarily have to be involved in the local reconstruction project, however, they can likely act as providers of facilities, technologies, raw materials and knowledge/expertise.

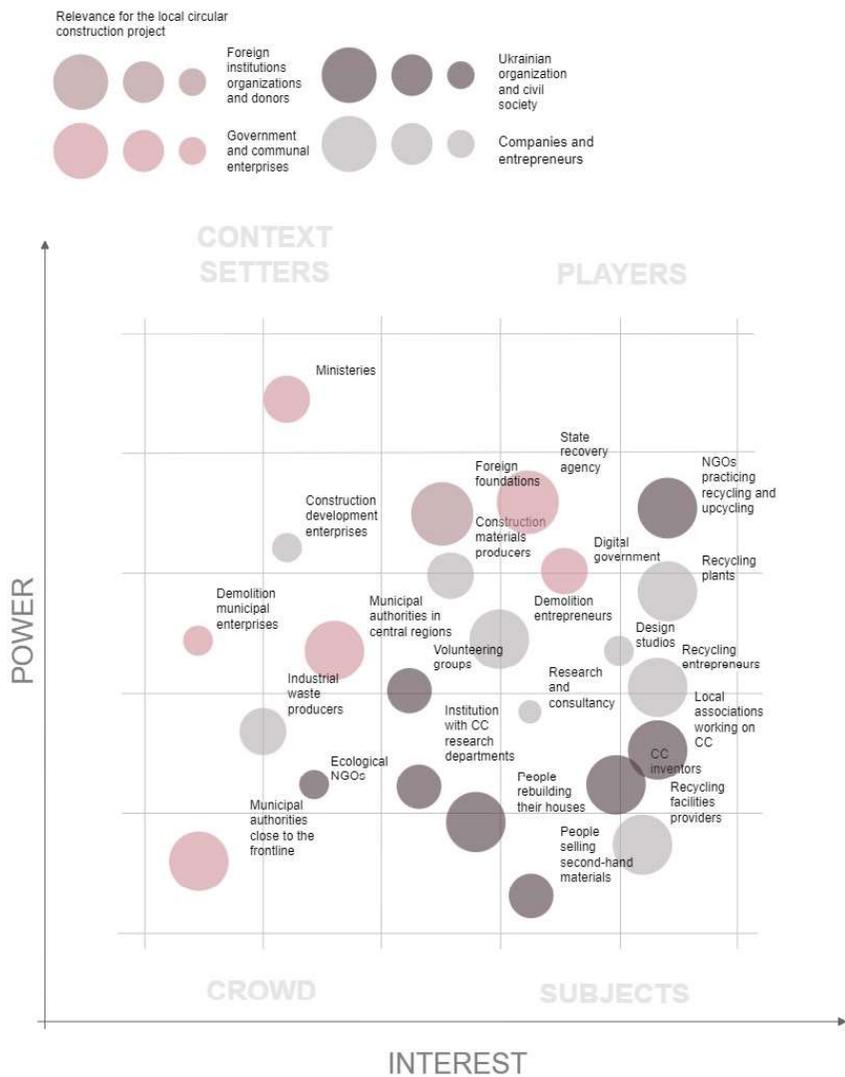
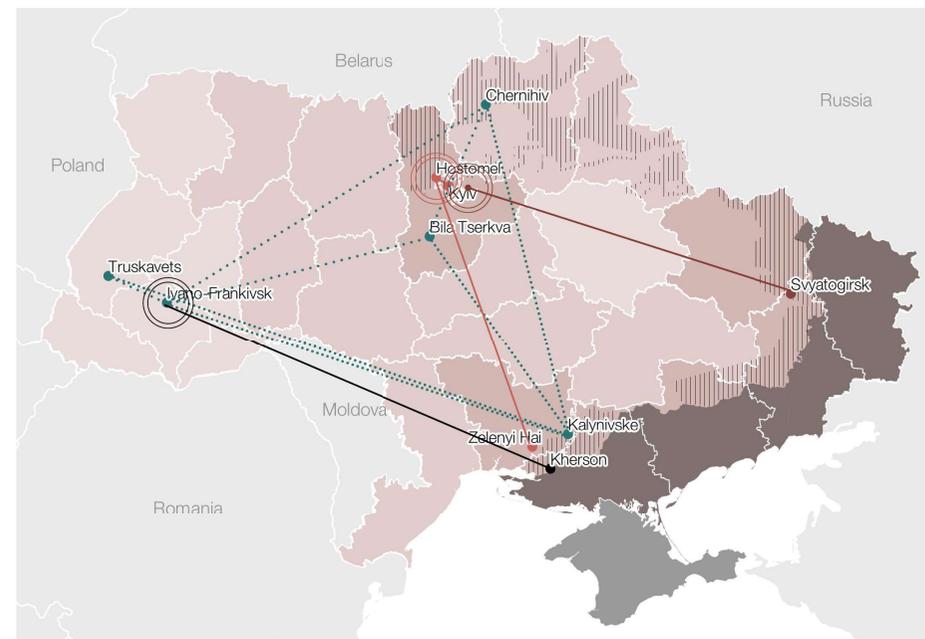


figure 10. Interest & Power matrix.

- Outside circle. Strategic actors operating on the local and state levels. These stakeholders are important in defining the eco-systems, political environment and funding for the local circular reconstruction project but are not directly involved in the project.

- Companies & Entrepreneurs: This category includes private sector entities like construction material producers, industrial waste producers, and recycling facility providers. These stakeholders are likely to be directly involved in the production, disposal, and processing of materials within the industry. They are mainly located in the middle.
- Foreign and International Institutions, Organizations, Foundations, Donors, and Certification Bodies: These are international stakeholders that might provide funding, set standards, or offer certifications for projects. They include entities like EU foundations, UN organizations, and international development agencies. Their role may be more advisory, financial, or regulatory rather than operational on-site, therefore they are mostly localized in the outside circle.
- Ukrainian Institutions, NGOs, Volunteer Initiatives, Citizens, and Activist Groups: This group represents local stakeholders with various levels of engagement, from official institutions to grassroots activists. It includes NGOs involved in recycling and upcycling, citizen groups, local organizations focusing on



Regions classified by damage level  
 1 2 3  
 Liberated area as for 12.12.23  
 Occupied area as for 12.12.23  
 Metalab's relation with Kherson region  
 Urban curators relation with Svyatohirsk hromada  
 Tolocar's network of recovery projects  
 Neo Eco's connections with Zelenyi Hai hromada

figure 11. Geographies of circular practices and NGOs.

circular construction (CC), and eco-activists. These stakeholders may be engaged in advocacy, operational support, or direct action related to construction. Therefore they are distributed in all circles almost equally.

- Government, Local Authorities & Communal Enterprises:

Communal enterprises are located in the centre as they might be involved in the actual demolition and recycling work. The municipal authorities define the procedure of demolition and stay in close communication with communal enterprises, they also own the demolished waste. The state government is responsible for creating and enforcing policies, and regulations, and supporting the infrastructure for construction and demolition. The DREAM working group defines the digital governance of reconstruction projects, which implies the monitoring of sustainable parameters, including the circularity of the construction.

The stakeholder matrix (figure 10) is a strategic tool used to evaluate and categorize various stakeholders relevant to a local circular construction project according to two key dimensions: their level of interest in the potential project and their power to influence its outcomes.

Figure 11 visualizes geographic distribution of the circular construction practices performed by NeoEco (Hostomel, Zelenyi Hai), Urban Curators (Sviatogirsk), Metalab (Ivano-Frankivsk, Kherson region), Tolocar (network of reconstruction initiatives in Kalynivske, Ivano-Frankivsk, Truskavets, Chernihiv, Bila Tserkva).

To summarize, NGOs and companies based in Kyiv and Ivano-Frankivsk support recovery

in the damaged areas, such as Chernihiv, Kherson, Mykolaiv, and Donetsk regions.

Figure 12 discusses the varying types of interests—governmental, economic, and social—about circular construction (CC).

The main insights: Current policies aren't effectively raising interest in CC, but there is openness among policymakers for dialogue to change legislation. The economic incentive for recycling and reusing construction materials among stakeholders is low. This is due to the cost considerations; it is seen as expensive, so it is often disposed of in the cheapest way possible. The statements from various entities highlight skepticism about the economic viability of CC and express the view that the current economic model and building materials standards don't support it.

The social interest is driven by the urgency of reconstruction and the need for efficient supply chain management in crisis conditions. There's a sense that local volunteering groups and individuals are attempting to address the issue of waste removal and reuse on their terms, either through local supply chains or personal initiatives.

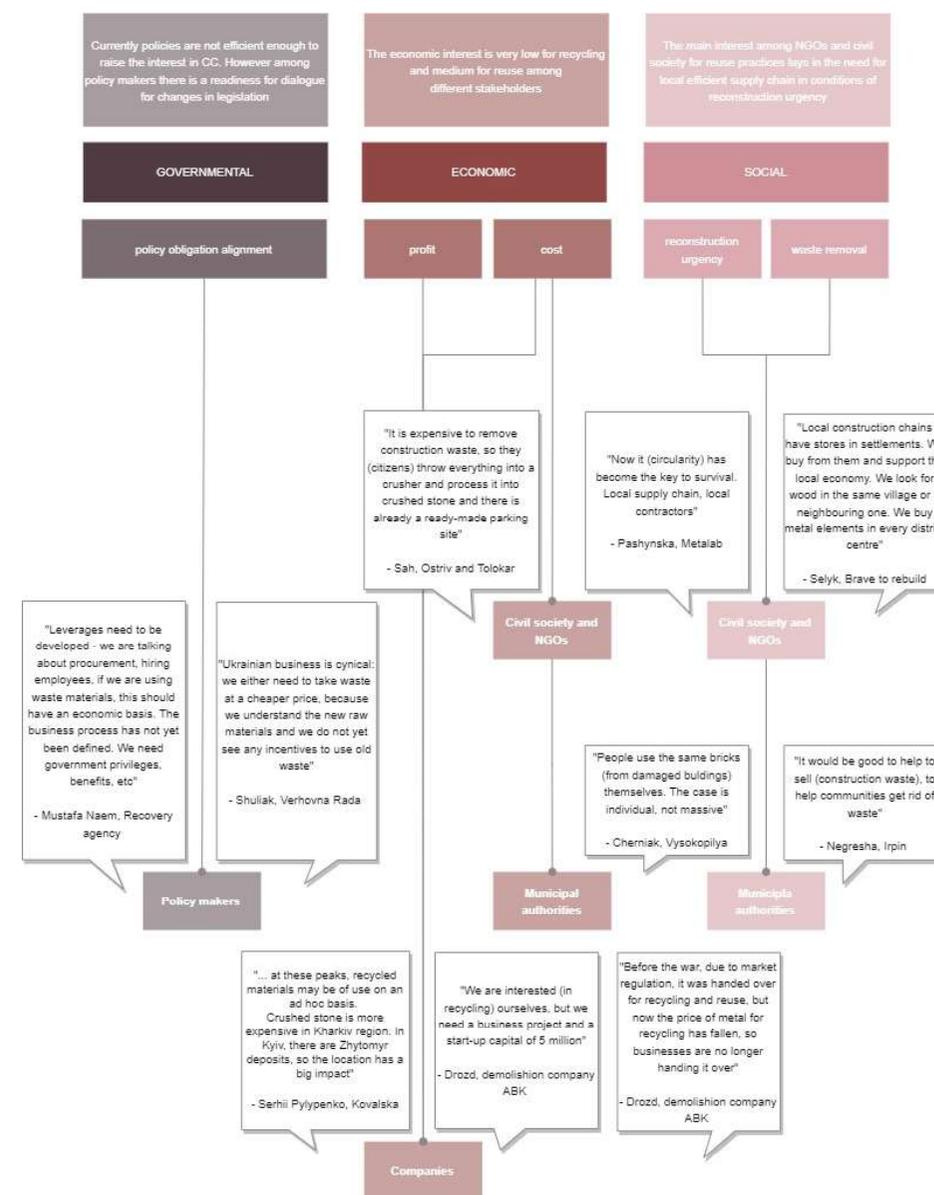


figure 12. Stakeholders interests classification based on the interviews.

# D

In the questionnaire with architects (figure 13), as mentioned above, several sub-sectors that reuse materials daily can be highlighted.

Among them is 'Precious Plastic'. This organization that deals with plastic recycling has the most mentions, indicating it is the most recognized among the architects listed for using secondary resources. Thus, it can probably be considered that plastic recycling is a circular practice that is more commonly understood while others are less. Similar ones also mentioned were 'Anumoplastic' and 'Good Plastic Company.'

All other companies and studios, including 'UBS,' 'Slava Balbek's Studio,' 'Technology Mechanics,' 'Styrofoam,' 'Energoresurs Invest,' 'NeoEco,' 'A Klima,' 'BCMaterials,' 'Rotordc,' 'Hempire,' each have 1 mention. This suggests that they are somewhat known within the sur-

## Private industries, recycling companies, & architects

### Building sub-sectors that reuse material daily

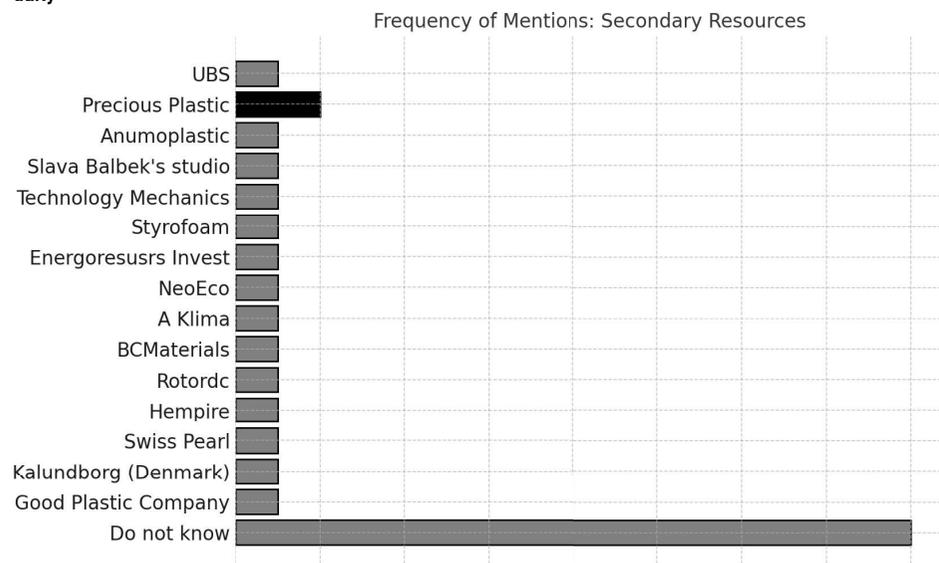


figure 13. Companies that use secondary resources to make construction materials/products

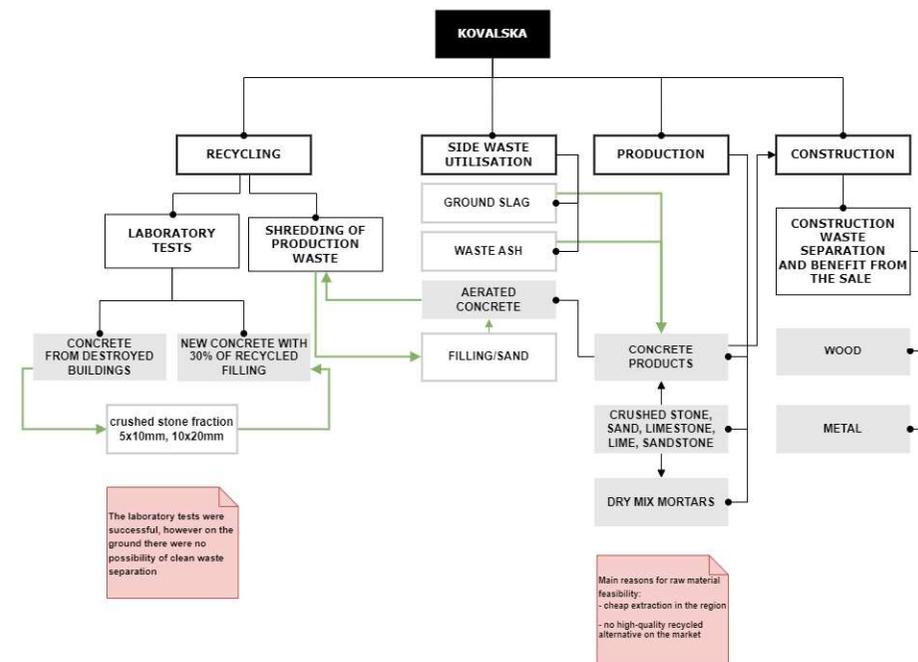


figure 14. Practices of private development company Kovalska

veyed group for using secondary resources but are not as prominent as those dealing with plastic recycling and reuse. Important to mention that some of the named companies do not operate in Ukraine, such as 'Swiss Pearl' and 'Kalundborg (Denmark)', which could indicate low awareness of the practices within the country.

Also, 16 responding architects couldn't name a single company that works with secondary resources. This also indicates that many respondents were either unaware of companies that use secondary resources or did not recall any at the time of the survey.

## Industries producing common building products with recycled raw materials inside or outside the building sector

### Case #4. Kovalska

The processes of construction waste management and recycling by Kovalska is broken down into several key stages (figure 14):

- The recycling Stage begins with the recycling of materials, where laboratory tests are conducted to assess the quality of recycled materials. This is followed by the shredding of production waste, which involves break-ing down the waste into smaller, more man- ageable pieces for further use.

- Utilization of Side Waste stage. This is the step where side waste products such as ground slag and waste ash are repurposed. These materials are incorporated into aerated concrete production and used as fillings or as a sand substitute.
- Production of the Building Materials process involves using various raw materials, including crushed stone, sand, limestone, lime, and sandstone. These are used to create concrete products and dry mix mortars, essential components in construction.
- At the Construction and Waste Separation stage, there is an emphasis on separating waste to recover materials that can be sold or reused. The separation process specifically categorizes wood and metal, which can be beneficially sold post-separation.

Concrete from demolished buildings is recycled and used to create new concrete, with a composition that includes 30% of recycled material. This recycled concrete uses crushed stone fractions of defined sizes for consistency. Two important notes to highlight:

- Despite successful laboratory tests indicating the viability of the recycled materials, there is a practical issue on-site due to the absence of a system for clean waste separation.
  - The reasons for the raw material feasibility include the low-cost extraction of materials in the region and the lack of high-quality recycled alternatives available in the market.
- The figure illustrates Kovalska's integrated approach to managing and recycling construction waste, focusing on sustainability and market adaptability. It showcases the company's efforts in transforming waste into valuable materials for construction while highlighting the

challenges and economic considerations involved in such an endeavor.

## Material research institutions involved in recycling & upcycling research

The research in the field of recycling and upcycling in Ukraine is notable, particularly in the context of post-war construction. A few examples of such research were conducted in Kyiv National University of Construction and Architecture (KNUCA) and Lviv Polytechnic University.

One significant example is the study developed by a Ukrainian, Swiss, and French university team focusing on concrete recycling. This research, led by Viacheslav Troian, a profes-

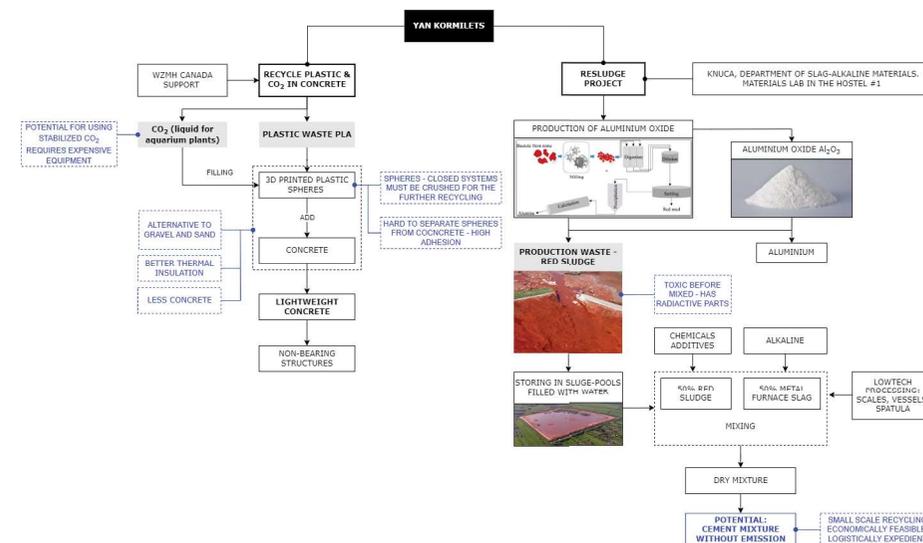


figure 15. Yan Kormilets' material recycling practices

or at the KNUCA, highlights the potential for recycling concrete in Ukraine's reconstruction efforts. (Troian et al.) It explores the challenges of recycling materials, especially for rebuilding damaged infrastructure and residential buildings. The team suggests that pre-wetting crushed concrete could effectively overcome quality deficiencies in recycled coarse aggregate. Given the current constraints and need for reconstruction, this approach is seen as a viable option for rapid deployment in Ukraine. (Troian et al.)

Another example of the research conducted at KNUCA provides insight into modern construction technologies by recycling red sludge from aluminum production. This project is called "RESLUDGE". It is a 9-month endeavor, built upon past experimental work with red sludge recycling by a faculty member of KNUCA from the 1980s. Yan

Kormiltsev, our respondent, bachelor student, and initiator of this study, shared some insights on his experiments. The central issue was recycling red sludge, a toxic byproduct of aluminum production, stored in vast quantities and posing environmental hazards. (figure 15) These experiments involved slag-alkaline materials, which are now being revised and applied. (Kormilets)

Yan is also exploring creating a small laboratory with materials recycling near production factories to convert red sludge waste into dry construction mixtures. This concept is novel in Ukraine, where there is little understanding of utilizing such waste economically; however, small-scale experiments bring significant results and require low-tech processing. Challenges include dealing with former oligarch-controlled aluminum factories and logistical difficulties sourcing materials. (Kormilets) Another project involves a collaboration with

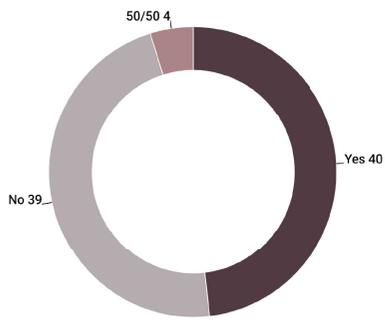


figure 16. The understanding of the circular economy by architects. Survey 79 responses

The most prominent fields of practice of the respondents are "Residential housing design," "Public buildings design," and "Private housing design," where the majority of them are primarily involved in the architectural design of living spaces and public-use facilities. (figure 17) This can indicate that the circular practices mentioned above are predominantly implemented within these specific fields. "Interior design" and "Landscape design" also feature prominently, while other areas such as "Urban planning," "Industrial design," and "3D visualization" denote fewer respondents in these specialties. The word cloud in Figure N serves as a visual representation of the professional focus areas among the architects participating in the survey.



figure 17. The main areas of activity of respondents. Survey, 79 responses

The responses on circular practices reveal a trend toward circularity, where reuse is the most popular practice, embraced by 30 architects who repurpose materials in their projects. (figure 18) Recycling and upcycling received 13 responses, reflecting efforts to convert waste into new materials or enhance the value of repurposed items. Resource conservation is also significant, with 17 architects focusing on efficiently using energy and water. Contrastingly, 3 architects reported not engaging in any circular practices, indicating a potential area for growth in sustainable design. Additionally, a single respondent applied a comprehensive approach by integrating all the mentioned circular practices, and only 3 of the architects stated the absence of circular strategies in their practice.

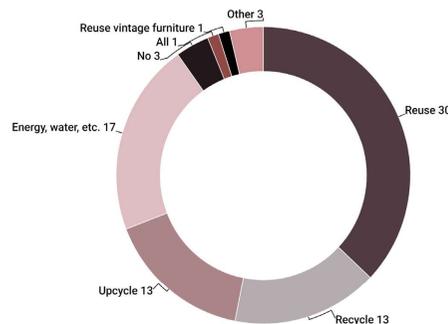


figure 18. Architects most commonly implemented circular practices. 79 responses

The survey results clearly lean towards environmentally conscious practices in architecture, with a need to create suitable conditions for their further promotion and practical realization. (figure 19)

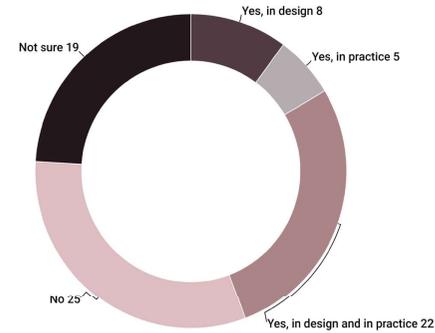


figure 19. Architects that implement circular practices (based on the questionnaire). 79 responses.

Survey also revealed the perception of circularity by architects mostly as an object reuse and restoration practice and less as circular construction. As seen in the bar chart below (figure N), Replus Bureau, which mostly deals

with furniture restoration, stands out as the most frequently mentioned entity, with 5 mentions, indicating it has a significant presence or recognition in the field of circular practices by respondent architects.

Parasolka & Metalab, which are involved in material recycling, circular construction, and object reuse, is the second most referenced, with 3 mentions, suggesting they are also well-regarded for their circular strategies.

All other listed entities—BC Architects, Iyaturabelidze Studio, Metáfora, Plastic Fantastic in Peremoha.space, Pus.Lviv, Anumo.plastic, Lisova.3, Research Institute of Construction Mechanics, Drozdov & Partners, Kudin Architects, BRDA Foundation (PL+UA), Formogra-fia, Balbek bureau, Powerhouse company, and Eco Misto—received 1 mention each. This suggests they have some recognition in this area, but not to the extent of Replus Bureau or Parasolka & Metalab. (figure 20)

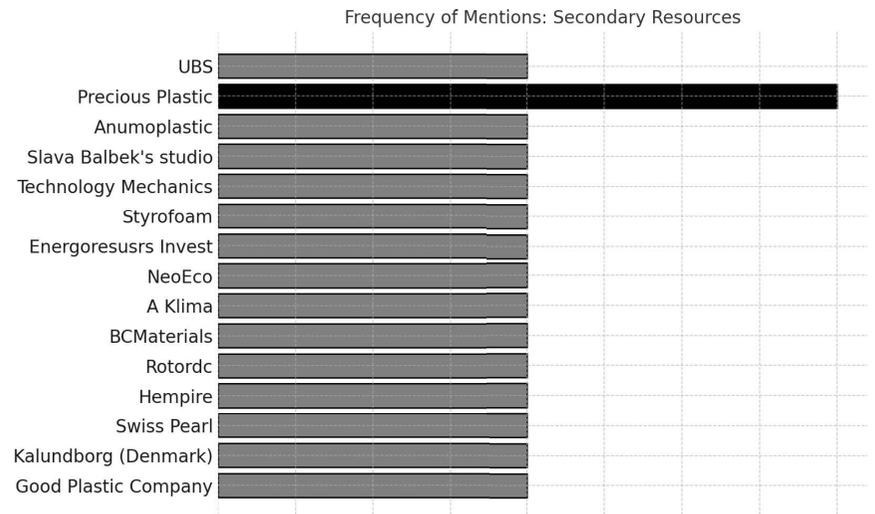


figure 20. Architects, artists, and designers who practice the reuse of materials in their projects. Survey, 79 responses

Based on the questionnaire, the main obstacle architects see in implementing circular practices is related to the limitations in the legislative mechanisms. This might be connected to the absence of mandatory waste management and demolition measures before the newly implemented laws of 2022-23, which also influence the construction and design solutions. As some decrees, for instance, were only implemented recently, most construction companies architects work with didn't fully insert these measures in their practice, and it is out of architects' control to evaluate the execution of these laws. This, in turn, minifies the market for secondary materials. Reconstruction efforts also depend on local regulation.

Also, most respondents indicated the ab-

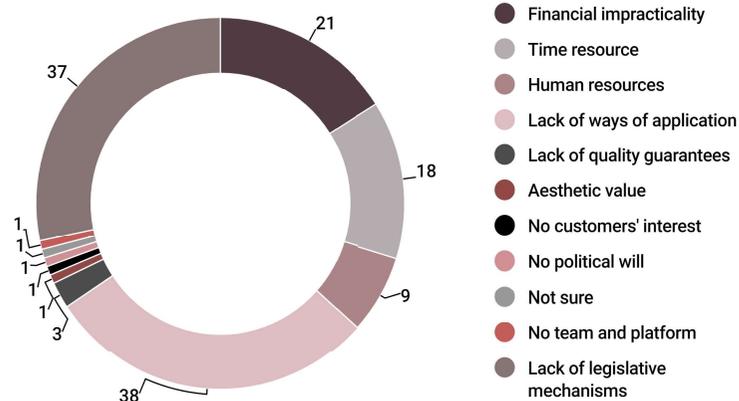


figure 21. Obstacles in applying circular practices. Survey, 79 responses

sence of knowledge of the application of circular practices (38 respondents) (figure 21). This can be tightly related to the legislative framework's absence of obligations, as it defines the capabilities and strategies of handling the secondary resources and circular construction. With the lack of customer knowledge and support, on the other hand, architects often face the impossibility of implementing a circular approach in design solutions (reference to the interview and questionnaire).

Financial impracticality (21 respondents) and time resources (18 respondents) are the next most prominent obstacles in applying the closed-loop economy that designers pointed out.

# E

## Civil society organizations

### Leading and most successful NGOs involved in promoting the circular economy and reuse of products in Ukraine. NGO's present and potential role, strength, and added value; interests, challenges, needs, and options to support circular construction

While circular practices are still gaining popularity in Ukraine, and the consequences of military actions make their implementation even more urgent, ukrainian public organizations have been conducting experiments on implementing such practices for many years. They organize educational programs, seminars, and workshops to popularize them.

Metalab is one of such NGO's. They have developed a circular practices model that integrates various sustainability initiatives across recycling, reusing, and repurposing materials with an aim to add value and strengthen their role in community support. At the core of

their model is the creation of recycle and reuse handbooks, which could serve as guidelines for circular projects for others.

The recycling aspect within their several projects involves collecting samples of damaged structures and materials from different regions to create new materials. They use techniques such as Roman concrete technology and a three-phase processing method, particularly for plastics, to generate products like fiber-glass, acoustic panels, and recycle wallpaper. (figure 22) In the reuse component, Metalab strongly emphasizes storing reusable materials such as bricks in their facility Prompylad in Ivano-Frankivsk. Their production methods are also unique, with the cultivation of kombucha mushrooms to create sustainable materials like lamps. The object reuse dimension involves organizations' repurposing everyday items such as furniture, doors, windows, lighting fixtures, old tiles, and double-glazed windows, extending their life cycle. Small-scale smart demolition is another element of NGO's practices, where careful sorting of materials from deconstructed structures is practiced, emphasizing maximizing material recovery and reuse. This process feeds into two dedicated storage facilities that manage the sorted materials. Material reuse focuses on fabrics, local woods, and metals, which are transformed into useful items such as curtains for Internally Displaced Persons (IDPs) accommodations, supporting local manufacturers and inventors, and creating bed frames and outdoor terrace frames. Lastly, Metalab is committed to community involvement and support. Manufacturing items like curtains and beds for IDPs promotes material reuse and contributes to social welfare.

Metalab's circular practices model is an eco-

system of interconnected activities that promote environmental sustainability through innovative recycling and reuse strategies while

simultaneously addressing community needs and supporting local economies.

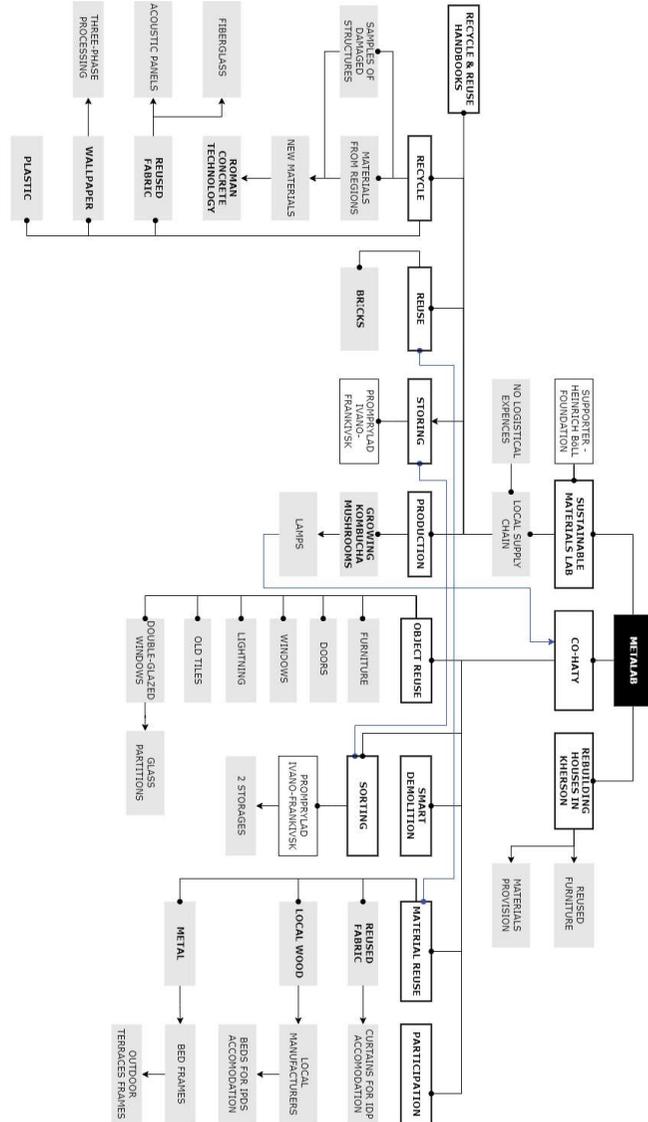


figure 22. NGO Metalab circular practices model (turn the page horizontally)

*“All the tanks that were coming to Kyiv, were coming through us from morning to evening for 39 days. I asked people not to go out, so they wouldn’t be shot.”*

*Olga Garkavenko, Head of the Novoslobidska hromada*

Figure 23.1 shows hromadas and cities that took part in the educational program on circularity and energy efficiency organised by NEB and ReThink in the spring of 2023. The selection was driven by the need to equally cover Ukrainian regions, particularly the most damaged ones. Figure 23.2. shows only municipalities that were interviewed by ReThink in the current research.

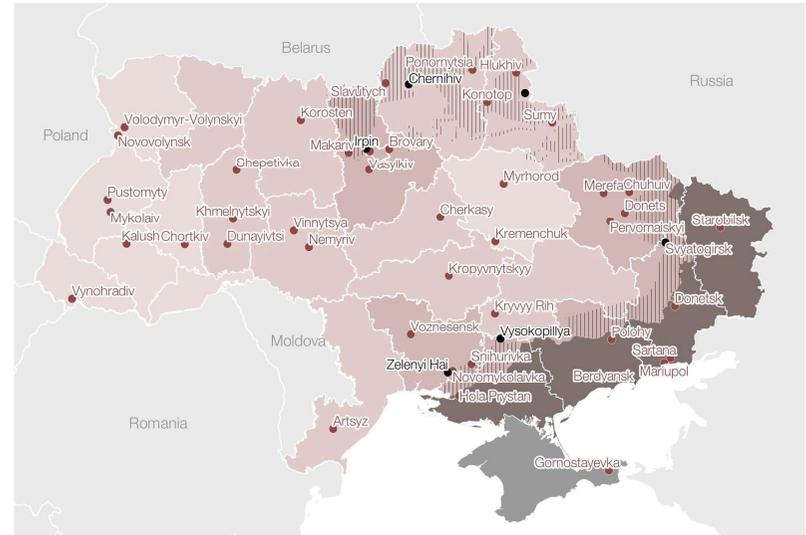
The level of interest\* in potential circular construction projects differs among hromadas:

- Sviatohirsk - 1,
- Nova Sloboda - 1,
- Chernihiv - 2,
- Zelenyi Hai - 4,
- Bucha - 3,
- Irpin - 4,
- Vysokopilya - 2

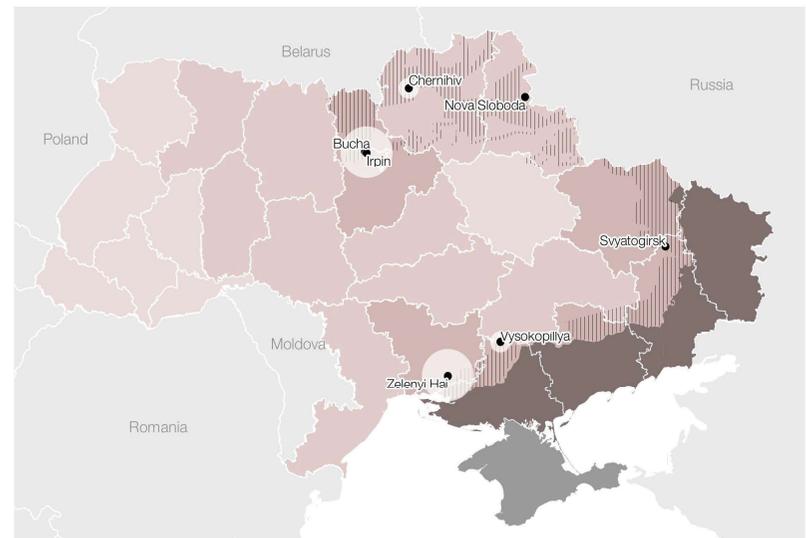
\*the bigger number - the bigger interest

The municipality of Bucha and Irpin expressed a certain interest in piloting the cc

project, however, due to the almost finished reconstruction process in this hromadas it is not the primary in their agenda. Such hromadas as Sviatohirsk and Nova Sloboda made clear that it is not the right time for the cc project in these hromadas due to the urgent problems related to the ongoing war and the inability to plan and implement the reconstruction projects. The authorities of Zelenyi Hai are interested in circular practices in general as they envision an economic benefit from it. In addition, they are involved in the ongoing project with NeoEco. The municipality of Chernihiv was not interested in the management of the circular construction project, however, they expressed the readiness to support it. The local authorities of Vysokopilya performed the stockpiling of the construction waste from the demolished buildings, however, currently they don't see a way of recycling and reusing inside of the hromada, while they are ready to support other actors in doing it by providing the materials.



Regions classified by damage level  
 1 2 3  
 Liberated area as for 12.12.23  
 Occupied area as for 12.12.23



figures 23.1 & 23.2. Scope of municipalities acknowledging circular construction and their level of interest.

## F

## Hromadas' opinions on benefits & obstacles for implementing circularity in rebuilding

### Municipalities interest level\*

- Sviatohirsk - 1
- Nova Sloboda- 1
- Chernihiv - 2
- Zelenyi Hai - 4
- Bucha - 3
- Irpin - 4
- Vysokopillya - 2

\* the bigger number - the greater interest

## Municipalities' level of understanding of circular practices and their capacity

Based on the responses from the municipalities (7 respondents), damage assessment has been done in most cases. Specifically, 85.7% (6 out of 7) of the municipalities reported conducting damage assessments. Only the municipality of Nova Sloboda indicated that they do not have big destructions. The responsibility for damage assessment varies by municipality. It may be designated to specific municipal officials, such as heads of local government bodies or specific departments like housing and communal services, economic development, or investment departments. In some cases, commissions with building specialists are formed to conduct the assessments.

The level of destruction of some of the interviewed municipalities:

- Municipality of Irpin: 3200 private sector houses were damaged, 1500 are destroyed and require dismantling, 38 apartment buildings need dismantling, and 30 need reconstruction. There is damage to 3 cultural centers and 2 sports facilities, and significant damage to the University, including a destroyed central building and damaged dormitories.
- Municipality of Sviatohirsk: The area is described as a "complete desert, destroyed, without communications," with 30% of the private sector remaining.
- Municipality of Zelenyi Hai: In 4 settlements, multi-story buildings need complete dismantling. Due to financial constraints, there are also problems with dismantling

additional facilities like schools and kindergartens.

- Municipality of Bucha: About 4000 objects are registered as damaged, including 2700 housing units, 500 non-residential, and over 100

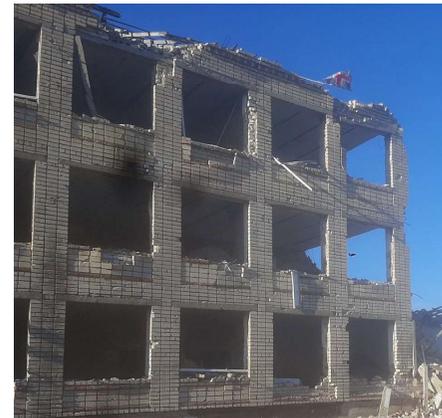


figure 24. Photos of destroyed buildings in Shevchenkivska united territorial hromada.

The interviews revealed various challenges and efforts across the municipalities in implementing circular practices after significant damage. Each encompasses various strategies, from prioritizing demolition and reconstruction to managing and recycling construction waste. Their main emphasis is balancing reconstruction speed with ecological considerations, community involvement, and leveraging support from international organizations. All seven municipalities focus on sustainable rebuilding despite the varied levels of implementation of circular practices across them.

Irpin shows extensive damage and reconstruction needs, highlighting challenges in demolition, permission for rebuilding, and waste management. Sviatohirsk, Nova Sloboda, and Chernihiv indicate a focus on community involvement and local committee oversight, and they agree on the need for awareness of circular practices. All municipalities face challenges in efficiently managing and reusing construction waste, balancing reconstruction speed with ecological considerations, and overcoming financial and administrative hurdles. They show varied levels of implementation and awareness of circular practices, shaped by their specific conditions and resources.

### Regulations, guidelines, and support services municipalities receive from higher government levels

#### Case #5. Municipality of Vysokopillia

Support they receive:

- They draw up an inspection report and allocate up to 2,000 euros per household to

restore housing.

Procedure to receive support from the government:

- The reconstruction project must be registered on the DREAM platform (beta).
- After registration - receives liquidation funding and obtains financing.
- A list of documents and justifications has to be provided.
- The site has to meet safety requirements (shelter) and be no closer than 30 km from the front
- The calculation of the efficiency ratio has to be made.
- All the abovementioned information has to be provided in PDF format with an electronic stamp
- The Department of Territorial Development or the Restoration Service - the Ministry of Development functions as customers.
- Cadastral numbers and urban development conditions must be provided

**Case #6. Municipality of Bucha**

Support they receive:

- The state provides funding
- Receive support through the E-Recovery Procedure to receive support from the government:
- There is a procedure for submitting a recovery program to the Regional Administration to receive funding.

Figure 25 illustrate how crushed old bricks were reused in early April 2022 at Novoslobidska commune to fix huge holes in the road after russian military units left the Sumy region, This might have been the first very small case of a circular reconstruction of Ukraine under the full-scale invasion. (figure 25)

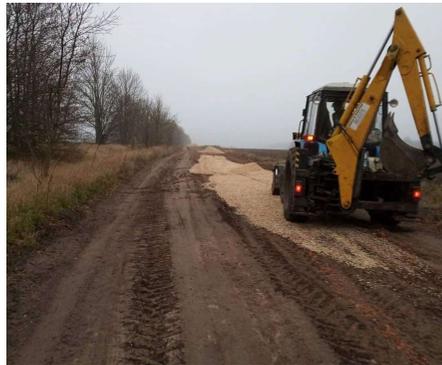


figure 25. Example of circular road reconstruction in Novoslobidska territorial hromada (Sumy region, close to russian border).

**Interest and obstacles of municipalities in circular construction.**

Municipalities face various challenges in implementing circular construction practices, with the primary issues being a need for knowledge and technology, economic constraints, and processing difficulties. These challenges suggest that for circular construction to be more widely adopted, there must be an investment in education and technology, economic incentives, and supportive legislation. Additionally, addressing the enforcement against illegal dumping and minor concerns about aesthetics could further facilitate the transition to circular construction methods. (figure 26)

As seen from the survey results with 32 respondents of different municipalities that our organization conducted before the Russian full-scale invasion (figure 26), there must be more knowledge and technology to implement circular practices. It indicates a significant gap in expertise and resources necessary for this. Economic impracticality is the second-largest concern at 26%, suggesting that many see these practices as not financially feasible. Difficulties with processing and the lack of profit in recycling are next, with 18% of respondents indicating that the complexity and costs involved do not lead to financial gains. A lack of encouraging legislative regulations is cited by 12%, showing a need for laws that promote circular construction. Illegal dumping without repercussions is a problem for 10% of the participants, pointing to enforcement issues. Finally, the aesthetic appeal of recycled materials is the least concern, at 1%, hinting at minor apprehensions

about the look of recycled constructions.

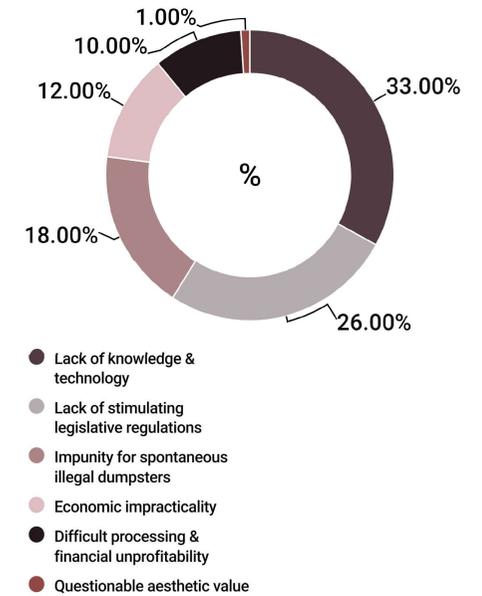


figure 26. The biggest obstacles to implementing circular practices, specifically recycling and reuse, before February 24, 2022. Rethink 20223 survey - 35 respondents

From the data gathered, we have identified another 15 challenges to implementing circular strategies in municipalities. (figure 27) The first notable barrier is the necessity for long-term strategic planning, which highlights a lack of progressive, comprehensive approaches to the multifaceted nature of circular practices. Another significant issue is the need for dedicated funds for the dismantling phase, which is essential for material recycling and reuse, indicating a shortfall in the necessary financial infrastructure.

There is also an evident need for rapid and

legally backed norms to encourage the shift to circularity. The issue of circularity being a low priority suggests that immediate concerns overshadow the importance of sustainable practices, particularly in times of war. The economic aspect also poses a significant barrier; the sometimes lower cost of new materials than recycled counterparts discourages the adoption of circular methods, indicating a potential necessity for economic reforms to enhance their viability.

Furthermore, the comprehensive costs as-

sociated with resources — including energy, labor, and materials — add to the economic strain on municipalities, implying that circular methods are not perceived as cost-effective. The lack of demand for secondary materials suggests a misalignment between consumer preferences and circular practices, potentially hindering the development of a market for recycled goods. These barriers, in their entirety, present a complex web that municipalities must navigate to advance toward a more ecological recovery approach.

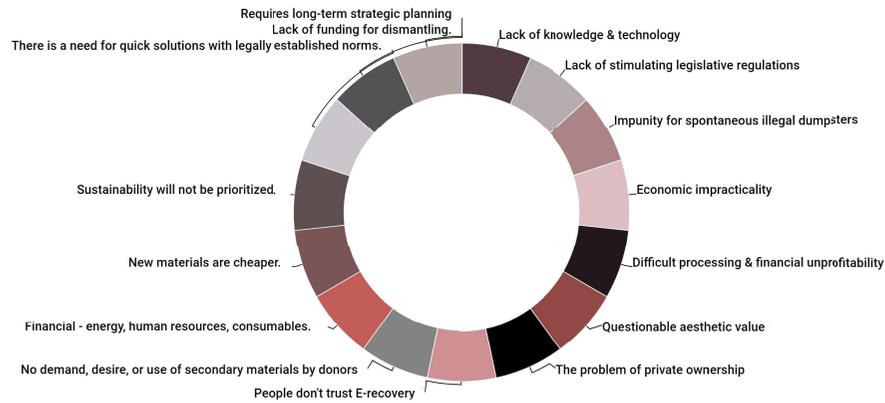


figure 27. The biggest barriers to implementing circular practices. Rethink 2023 interviews with 7 municipalities - 7 respondents.

## G

## Hromadas' key needs & opportunities in implementing circularity

In summarizing the interviews, three main needs in implementing circularity in rebuilding can be highlighted. First, there is a need for localized damage assessment. Community-driven, localized approaches are needed to assess and address the damage caused by the Russian invasion, allowing for more sustainable, resource-efficient rebuilding strategies.

Second, all municipalities emphasized the need for expert involvement. They seek opportunities to involve building and environmental experts in rebuilding, ensuring the adoption of circular practices like recycling and reusing building materials. In some cases, this expertise has already been provided to them (Irpin, Bucha) when other municipalities, like Sviato-hirsk and Nova Sloboda, still lack it.

Another important need was connected with multi-sector collaboration. The rebuilding process needs the involvement of various sectors (private, public, architectural, and communal services), offering opportunities for cross-sector collaboration in implementing circularity principles.

Most of the municipalities' needs are connected with the urgent response to the damage and safety, usually related to the damaged road restoration and product provision, along with the need for governmental attention and financial support.

As seen in *figure 27*, (The biggest obstacles to implementing circular practices) lack of knowledge and technology (33%) and limitations in legislative regulations (26%) play a crucial role in the implementation of circular practices. Thus, the municipalities need to be provided with a guide in implementing circularity by both education programs and more government support.

### Municipalities' needs

The interviewed municipalities that felt the consequences of Russia's full-scale invasion indicate a situation with a blend of infrastructure challenges, a need for an urgent response, and supply chain disruptions regarding the possible implementation of circular practices (*figure 28*). For instance, the municipality of Bucha has highlighted a need for space to store materials, indicative of an ongoing need to manage supplies for construction, humanitarian aid, and other purposes.

Additionally, there's a call for financing to dismantle, clear up, and break down structures for reconstruction. They also mention the need for

road filling materials, needing swift restoration to facilitate mobility and access. (*Figure N*)

In Vysokopillia, the construction of roads is a significant concern, pointing to the criticality of transportation infrastructure in the recovery process. The desire to restore a brick factory is notably specific, signaling an effort to revive an important local industry, which they find important for building materials and employment.

The need expressed by Zelenyi Hai revolves around financing the dismantling. This need, shared with Bucha, underscores the importance of securing funds to deconstruct damaged structures safely.

The municipality of Nova Sloboda indicated the need for the supply of products to villages, which points to a disruption in supply chains and the critical need to ensure that villages have access to necessary goods. This could encompass a range of items from essentials to construction materials, all crucial for sustaining daily life and supporting rebuilding efforts.

The main need of all the interviewed municipalities is connected with the urgent responses to the level of damage they are witnessing.



*figure 28. Municipalities needs based on the interview responses. (only four respondents provided their intake)*

### Municipalities' opportunities

The potential for municipalities to adopt circular construction methods as part of their rebuilding and development strategies, promoting sustainability and resilience in their communities consists of a few steps:

- **Damage Assessment as a Catalyst for Circular Construction**  
Municipality of Irpin: Respondent Dmytro Negresha (Negresha) mentions that they began assessing the damages right after the area was liberated. This highlights an immediate need for reconstruction, which could be an opportune moment to introduce circular construction methods. Using salvaged materials from the damaged structures as a sustainable approach to rebuilding.
- **Influential Leadership for Implementing Circular Practices**  
Municipality of Vysokopillia: Nadia Chornyak (Chornyak), responsible for housing and communal services, economic development, and investments, could play a critical role in integrating circular construction principles in rebuilding efforts.
- **Resource Management Through Circular Methods**  
Municipality of Chernihiv: Natalia Kholchenkova's (Kholchenkova) involvement suggests the presence of a structured approach to handling construction-related activities. This structured approach could be beneficial in implementing circular construction practices, especially in managing and recycling building materials. Community
- **Engagement in Circular Construction Initiatives:**

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Municipality of Nova Sloboda: Olena Garkavenko (Garkavenko) mentions a commission in the village council responsible for assessments post-occupation. Engaging such community-level bodies in circular construction practices can enhance local participation and ensure sustainable rebuilding.

- Policy and Planning for Sustainable Rebuilding: Municipality of Bucha: Dmytro Chaichuk (Chaichuk), the Deputy Mayor, being involved in the distribution of responsibilities in the construction sphere. This indicates a potential for policy-making that could include circular construction methods as part of sustainable urban planning.

These specific references from the conducted interviews underscore the opportunities for these municipalities to integrate circular construction practices in their reconstruction and development efforts. By focusing on sustainable rebuilding, resource management, community engagement, and policy-making, they have opportunities for more resilient and environmentally friendly construction practices.

***“When an ammunition explodes, the harmful substances from the explosions (from radiation to chemical effects) are very large. As a rule, there is fuel, and there are components that affect the material, so reuse of bricks, for example, is possible only for crushing and using them for roads. Every upcycling where there has been a heavy battle is a road to oncology, and this must also be taken into account. This is not a traditional destruction of an object.”***

*Olena Ivanova - Chief architect at Sviatohirsk City Council  
(Donetsk region)*

## H

## Possibilities for community-driven hands-on pilots to showcase circular construction

### Pilot option #1: Deepening circular construction value chain (Eco+Logic)

It is crucial to emphasize the gravity of the plastic waste predicament, a predicament underscored by the relentless degradation of our environment and its cascading ramifications. In light of this, the pursuit of sustainable practices in construction materials becomes an urgent mandate, and the incorporation of plastic bottles into sidewalk tiles emerges as a note-

worthy stride in this direction. This message delves into the intricacies of this transformative technology, exploring not only its environmental merits but also delving into the meticulous processes and compositional elements that underscore its viability. Through a pragmatic lens, we examine the nuanced interplay between polymeric components, ensuring that the resulting sidewalk tiles not only contribute to waste reduction but also embody durability, aesthetic appeal, and functional excellence.

It's worth noting that sidewalk tiles made from plastic bottles exhibit excellent aesthetic properties. They are suitable for implementing bold and diverse design solutions. The material's color doesn't fade under the influence of sunlight, and the tiles remain resistant to deformation and wear. The external appearance of the material is unique, and the processing of such products will look elegant and original.

#### *Components of the Material*

To manufacture sidewalk tiles, not only from plastic bottles but also from other polymers, one will need sand and pigment. The raw material consists of simple bottles that don't even require cleaning from labels and food residues. All unnecessary ingredients combust without a trace. Sorting is not necessary.

In addition to bottles, craftsmen recommend adding polyethylene bags or film, parts of plastic boxes, and containers. Using polyethylene is desirable because it gives the products a glossy finish. Soft polymers also provide plasticity to the finished tiles. The key requirement is to adhere to the following proportions:

- Soft polymers: 40%
- Hard polymers: 60%

This is necessary to ensure the optimal rigidity of the plastic tile. Applying this technology practically eliminates polymer waste. It is not allowed to add polycarbonate or fluoroplastic, as well as rubber. These ingredients cannot enhance the properties of the products, but they disrupt the structure of the material, losing its uniformity.

Sand is purified from impurities (its content, including clay, does not exceed 1/5). In the case of Eco+Logic, sand is replaced with crushed

concrete, brick, or a mix (brick and concrete). The drier the sand (brick or concrete), the less time is spent on making one tile. The quality of the finished product depends on the uniform mixing of sand and plastic. The proportions of the mixture are as follows:

- Sand (brick, concrete): 90%
- Polymers: 9%
- Pigment: 1% (if added)

It is recommended to add inorganic pigments. Without them, the products will have a dirty-gray color.

Equipment for the production of polymer tiles includes the following:

- Shredder for grinding plastic raw materials
- Extrusion machine for melting and mixing ingredients and extruding the finished mixture
- Molding press

The entire technological process is safe but

is carried out in well-ventilated premises using respirators and protective gloves.

The manufacturing process is relatively simple and consists of the following stages:

- The polymer material is shredded into small pieces.
- When the ingredients enter the extrusion machine, the melted viscous plastic envelops the particles, is mixed multiple times, and a dough-like mass is produced. At this stage, the pigment is added.
- The extruder extrudes the mixture, the temperature of which reaches 200 degrees. It is cut into the required quantity and placed in molds.
- Under the molding press, the product is given its final appearance, and simultaneous cooling takes place.

For the initiation of the current pilot project, Eco+Logic possesses a readily available raw material that can be continually replenished over the course of operations. The primary requirement for the success of the initiative is the acquisition of essential equipment, detailed below:

- Hydraulic Hammer: €9,500
- Tile Press: €10,500
- Extruder: €16,000
- Heated Mixer: €18,900

- Plastic Shredder: €5,400

"These critical pieces of equipment are indispensable for the success of our environmentally driven venture. This strategic amalgamation of technology and ecological responsibility envisions a sustainable future through innovative solutions and the promotion of circular economy principles", says Valeriy Kevorkov – CTO of Eco+Logic.

### Pilot option #2: Cultural center restoration

Since Russia's full scale invasion in February 2022, more than 69 cultural heritage objects have been damaged in Kyiv region only (Bilotserkivskiy district – 1; Brovarskiy district – 5; Buchanskyi district – 14; Vyshhorodskiy district – 6, Kyiv city – 43). Those include 16 objects of national importance, 37 - of local importance and 16 newly discovered objects. As for the whole country – there are 872 damaged cultural heritage objects. (KODA)

As the government of Ukraine is struggling to fulfill a top priority reconstruction need (housing & social infrastructure), it is understandable that even some ancient, valuable & important cultural heritage objects are not in the first half of the line for resources and efforts. On the other hand, it is extremely important to rebuild Ukraine's cultural assets as those have enormous value not only for Ukrainians, but also for millions of foreigners, who'll be visiting Ukraine and will try to understand it after the war.

Therefore, as an option for circular construction intervention, we're considering partial renovation of cultural assets like museums or houses of culture. Together with the project House of Culture, which is exposing Ukrainian damaged cultural heritage to the public, we could suggest focusing on the following locations:

- Skovorodnivka, Kharkiv region;
- Parkhomivka, Kharkiv region;
- Mala Rohan, Kharkiv region;
- Bashtanka, Mykolaiv region.

In addition, still within a cultural context, there is another project, which needs renovation and

modernization of an old piece of heritage – the Intermezzo.

«INTERMEZZO» is an artistic residence for young artists and writers from the East and South of Ukraine. It is located in Poltava region in a to-be-restored historic building in the Ukrainian modern style (one of the Slation schools) (figure 29).

The residence will accommodate 2 artists at the same time for a duration from 2 weeks to 2 months. At the end of their stay, the artists open an exhibition of works created during the

residency for local residents and visitors.

At the end of the residency year the following is planned by the organizers:

- publication of an almanac with works by residents;
- at least 20 exhibitions, readings and other artistic events held at the residency;

This way, to implement this project, the pilot should provide support for:

- revitalization of the building into a residence
- buying materials, furniture, appliances.



figure 29. Slation school

### Pilot option #3: Circular reconstruction of housing

As Russian missiles continue to strike Ukrainian cities, causing destruction and fear, the need for fast and effective reconstruction assistance becomes even more apparent with each attack. Individuals who have lost their homes can seek financial support through the government's 'eВідновлення' ('eRecovery') program for necessary renovations. However, due to the high volume of applications, the processing time frequently exceeds the promised 30 days.

Recognizing the urgency of the situation, our proposed pilot option aims to address this urgent need through the implementation of circular economy practices in renovating a residential building in the Kyiv region affected by the Russia's war on Ukraine. By doing so, we aim to set an example for sustainable reconstruction while fostering community engagement and empowerment.

We outline two distinct funding approaches: self-sufficient funding and collaborative co-funding partnerships.

#### Self-Sufficient Funding

The objective would be to renovate a residential building with minor destruction using circular practices, engaging residents in sustainable renovation processes. Here we'd identify a building with minor damages (broken windows, damaged tiles, etc.) that can be restored to pre-attack conditions with self-sufficient funding. By design, contractors shall implement circular design principles, utilizing existing materials and urban mining practices to minimize environmental impact; and work with local suppliers to secure used batches of imperfect tiles and organize community art projects to repurpose broken or discarded tiles creatively.

#### Co-Funding Partnerships

As an option, we could collaborate with the United24 renovation project to rebuild affected

buildings on a larger scale, showcasing circular practices to governmental actors.

Implementation:

Partnership with United24: Collaborate with United24 donors to contribute to a large-scale renovation effort (\$120 000+ budget), showcasing circular practices such as reuse and repurposing materials. Utilize the co-funding opportunity to engage with the government, showcasing circular practices employed in large-scale renovations as a model for future reconstruction projects.

Expected Outcomes:

Timely and Sustainable Renovation: Demonstrate the feasibility of timely and sustainable renovation practices, setting a precedent for future reconstruction efforts.

Community Empowerment: Engage local communities in the renovation process, fostering a sense of ownership and circularity awareness.

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