TOWARDS CLIMATE RESPONSIVE RECONSTRUCTION IN UKRAINE

Volume I

PERSPECTIVES OF URBAN MINING AND CIRCULAR (RE-) CONSTRUCTION IN UKRAINE

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Written by Skat Consulting Ltd, January, 2024 Final Version, Geneva 29.02.2024 dwy

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Baubüro In-Situ and its spin-off **ReWin** are pioneers of Circular Construction, the architectural design with reused building material and the promotion of component reuse in Switzerland and abroad.

insitu.ch ; re-win.ch

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Preface

In the context of the reconstruction of the Ukrainian villages and towns destroyed by the war, urban mining for reuse is the most efficient method to reduce CO2 emissions in the construction sector. Reuse requires less new resources, reduces the amount of scrap, favors local manpower and know-how. Self-help and local trades are enabled and strengthened by the use of readily available versus imported materials.

Concrete elements, bricks, timber and insulation material are ideal for reuse. The available materials must be collected in Circular Construction Yards and made visible in an online marketplace, so that the builders can choose them as easily but cheaper than new construction materials.

Pilot projects are needed to test the processes, the financial impacts, compare the CO2 emissions, and to eventually enhance the acceptance of reuse.

I therefore strongly support the reuse of construction elements and materials as a strategy for the reconstruction of Ukraine!

Barbara Buser

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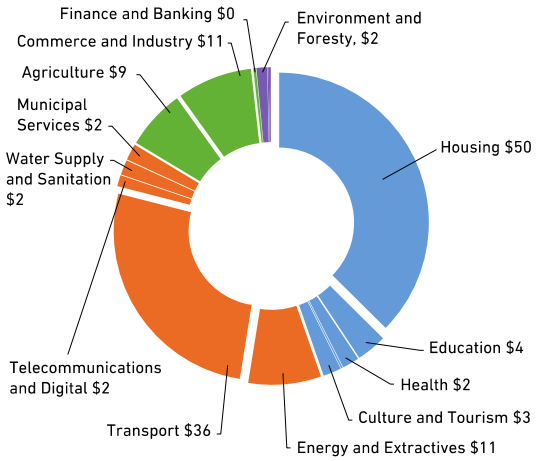
About the Building Destruction in Ukraine

THE VOLUME OF RECONSTRUCTION

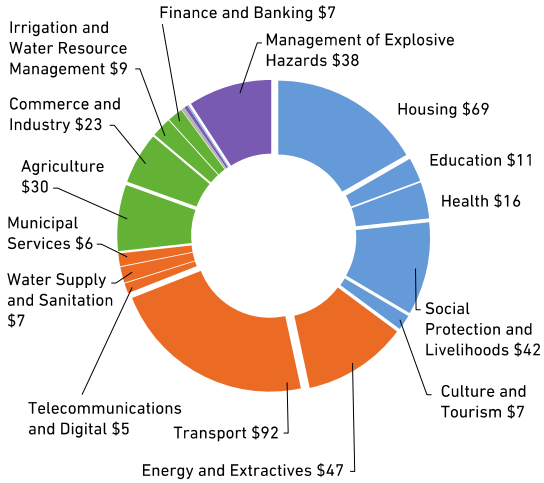
The war in Ukraine has led to widespread destruction of buildings and infrastructure. Housing has been the most affected sector. Current estimates value damage to housing at around US$ 51.3 billion (World Bank, et at., 2023).

Around 167,200 residential buildings have been damaged or destroyed, including 147,800 private houses and 19,100 apartment buildings, representing around 8% of total national housing stock.

Considering anticipated increases in construction costs and build back better principles, costs for housing recovery and reconstruction are estimated at US$ 69 billion (World Bank, et at., 2023). Given that total annual construction activity prior to the war was valued at around US$ 5.5 billion (UNCTAD, 2024), housing recovery and reconstruction needs will require a massive expansion in construction capacity.



Total damage (US$ billion) :
US$ 135 billion (RDNA, February 2023)

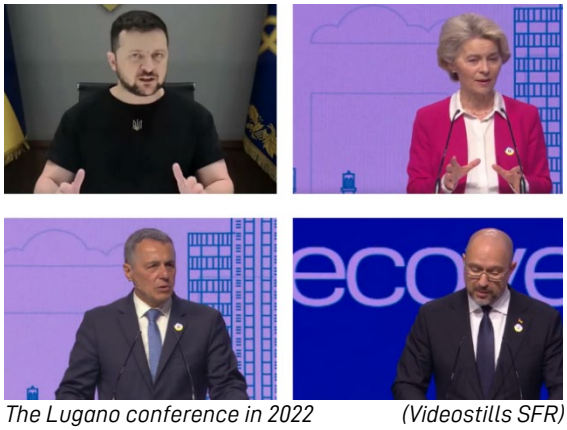


Total recovery and reconstruction needs (US$ billion) :
US$411 billion (RDNA, February 2023)

IMPACT ON THE LOCAL SUPPLY CHAINS

Increased construction demand will drive rapid changes in supply chains for construction resources such as labour, raw materials and manufactured components.

Ukraine's second Rapid Damage and Needs Assessment RDNA (UNDP website)



The Lugano conference in 2022 (Videostills SFR)

Despite a significant reduction in construction activity during the war, shortages in construction labour have already been observed. Notwithstanding the return of soldiers to productive activities upon the end of the war, these labour shortages are expected to be exacerbated by the increase in construction activity accompanying reconstruction.

In light of experiences of post-conflict reconstruction in other countries, shortages of construction labour – particularly skilled labour – are expected to persist and contribute significantly to increased construction costs.

Supply chains for raw materials and manufactured components for construction have also been interrupted by the ongoing war. Prior to the war, demand for important construction inputs such as cement and steel were largely met by domestic production (UkraineInvest, 2023).

Following war-time interruptions, resumed production may be expected to restore domestic output. In addition to any increases in domestic production, international supply chains are expected to expand to meet increased demand for construction in post-conflict reconstruction.

Considering the pace of Ukraine integration with European logistics and supply networks prior to the war, international supply chains are expected to expand rapidly as the conflict ends, ensuring supply of important material resources for construction. However, prices for construction materials and components during post-conflict reconstruction will depend upon transport and other costs of importation.

Statements from the Lugano conference in 2022

Statements from the Lugano conference in 2022

Collapsed Khrushchevka Building in Borodyanka *(Web image 1)*

ENVIRONMENTAL ASPECTS

The large extent of construction for Ukrainian recovery and reconstruction will entail substantial environmental impacts.

Building construction and use account for around 37% of annual greenhouse gas emissions, including around 9% of global emissions attributed to the production of materials for building construction (UNEP, 2022). Considering these environmental impacts, the large extent of construction for post-conflict reconstruction could undermine one of guiding Lugano principles of rebuilding Ukraine in a sustainable manner in line with the 2030 Agenda for Sustainable Development and the Paris Agreement.

Beyond climate impacts, the extent of damage and destruction of buildings and infrastructure will require demolition and disposal of building debris and waste at a scale that presents further environmental risks.

The Ukrainian Ministry of Environmental Protection and Natural Resources estimates that war-related destruction of buildings resulted in around 10-12 million tonnes of demolition waste in 2023. The EU Waste Management Directive calls for member states to ensure recycling of 70% of construction and demolition waste (EU, 2016). In the absence of infrastructure for recycling in Ukraine, demolition waste during recovery and reconstruction is expected to be disposed in landfill sites, with significant long-term environmental implications. The building material industry's share of Ukraine's energy consumption

Damaged Building in Ukraine (Image UNDP)

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Linear vs Circular Construction

Linear Economy *(Web image 2)*

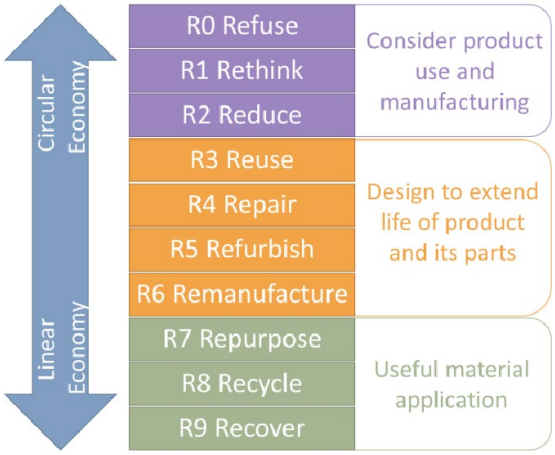
Circular Economy *(Web image 3)*

About Urban Mining and Circular Construction

The concept of urban mining addresses the urban environments as repositories of material resources. From this perspective - alongside the wide array of materials contained within urban environments - materials from obsolete buildings are viewed not as waste, but rather, as resources for new construction.

This urban mining perspective on the built environment derives from the broader model of a circular economy. Distinct from the conventional model of a linear economy - characterized by a linear path from resource extraction, through production and distribution, to disposal and waste management – the model of a circular economy involves sharing, repairing, refurbishing, reusing and recycling existing materials and products in order to minimize environmental impacts.

More broadly, transition to a circular economy entails the promotion of 9 Rs:



The 9 R s of Circular Construction *(Web image 4)*

Each of these circular economy strategies entail different resource requirements and environmental impacts.

In general, refuse and reduce seek to eliminate unnecessary resource extraction and production. Reuse, repair, refurbish and repurpose are related strategies to minimize new production by prolonging the lifespan of existing products through interventions that utilize less resources with less environmental impacts than new

production. In contrast, remanufacture, recycle, recover and re-mine entail the use of existing materials in new production processes, thereby minimizing resource extraction while still involving environmental impacts of new production.

Circular construction refers to the application of circular economy principles to production of the built environment. In this context, various circular economy strategies – primarily reuse, repair, refurbishment and recycle – may apply to buildings and infrastructure. Among these, reuse and recycle provide strategies for the provision of materials and components for new building construction. Distinct from recycling, which involves the processing of materials to provide input for new production, reuse in construction refers to salvaging of valuable materials and components and reuse in their original form.

RECLAIMING BUILDING MATERIAL FOR REUSE, REPAIR AND REMANUFACTURE

Reuse in construction can encompass a wide range of materials and components, including basic materials such as bricks and concrete slabs and more complex components such as windows and building services equipment.

Considering additional financial and technical requirements of selective demolition and reclamation, circular construction is not expected to meet a large proportion of construction requirements for recovery and reconstruction. Nevertheless, integration of circular construction within reconstruction efforts can establish practices and infrastructure to support broader Ukrainian ambitions for green reconstruction and alignment with European standards.

In addition to addressing environmental impacts and national policy objectives, establishment of circular construction practices can ameliorate supply chain restrictions on important materials and components. Reclamation and reuse of bricks, structural steel, precast concrete slabs and insulation panels, for example, could reduce demand - and hence prices – for imported materials with relatively high transportation costs.

The 5 Key "R's" of Circular Reconstruction (by In-Situ/ReWin)

1. Refuse
2. Reduce
3. Reuse
4. Repair
5. Recycle

1. Refuse
Refuse is one of the mightiest principles: Refuse to buy a new car, new trousers, to build a new façade, etc - just because it seems that a new car makes you happier – for how long? If there is less demand, the offer will be less as well.

2. Reduce
Reduce the surface you live on, reduce the travels you make, reduce the meat you eat – it's the cheapest way of living more sustainable.

3. Reuse
Reuse the windows that are replaced, reuse the sofa somebody else is dumping, reuse the old sink of your grandmother's which is still good. To make a kitchen sink, it takes a full factory, to dismantle and install it again, you only need a screwdriver.

4. Repair
Repair stitch in time, saves nine. Examine and repair your building regularly: Regular maintenance extends its lifetime considerably.

5. Recycle
Recycle materials only when they cannot be reused in their existing form. Recycling saves only little of the embodied energy or CO_2.

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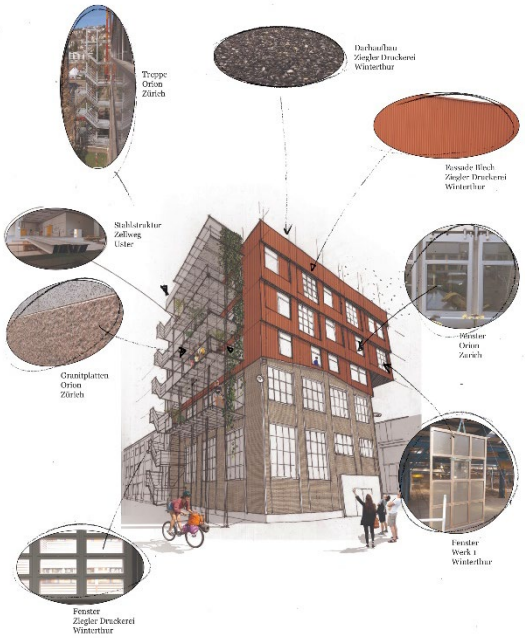


Building K118 in Winterthur made entirely of reclaimed material, Winner of the Holcim Price and Prix Acier 2021

International Best Practices

Numerous examples are available illustrating the potential of circular construction approaches and reuse of structural and non-structural building materials and components.

Baubüro In-Situ's K118 Building in Winterthur

Reuse of structural steel and building envelope elements including metal walls and roof cladding, windows and insulation are well illustrated in the K118 Building at Winterthur, Switzerland, completed in 2022. The building reused structural and non-structural materials and components sources from a range of demolished buildings located within 100km of the construction site, enabling the renovation, extension and change in function of an existing industrial building.

Reuse of precast concrete in Gothenburg

Reuse of precast concrete panels has a long history throughout Europe, with the potential large-scale application of the approach well illustrated in a project from Gothenburg, Sweden, completed in 1984.

Floor and façade panels salvaged from housing demolition at Gothenburg, Sweden (Image: Mühlestein, 1987)

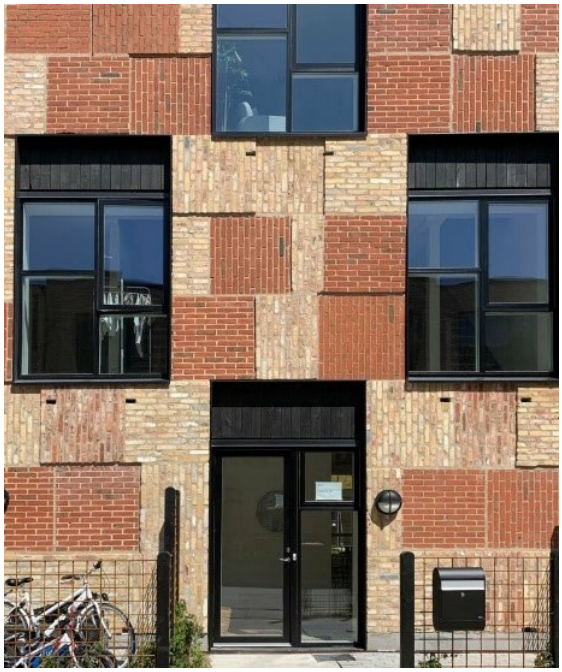
New detached housing built from salvaged precast panels at Gothenburg, Sweden (Image : Geiselmann, 1991)

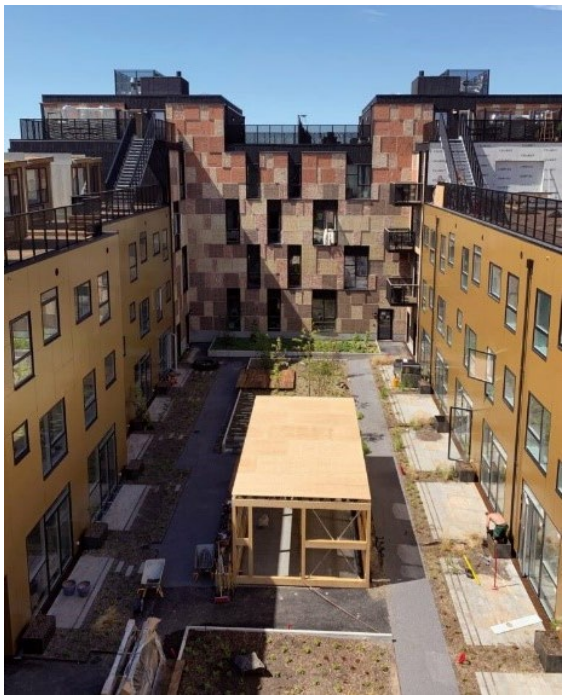
Precast concrete floor and façade panels from demolition of an obsolete mass housing project were reused in the construction of 320 new residential units in a new 7-storey apartment three sets of low-rise houses, highlighting the potential to efficiently reuse precast concrete panels for large-scale housing development.

Reuse of clay bricks in Copenhagen

Reuse of fired clay bricks for new building façades is well illustrated in a residential project in Copenhagen, Denmark, completed in 2019. Construction of a new housing development comprising 3-storey terrace houses and 5-storey apartment buildings highlights the potential large-scale reuse of materials in the development of high-quality housing.

These three examples are a small sample of the wide range of projects adopting circular construction principles to address environmental impacts and economic constraints.





Residential development using reclaimed bricks at Copenhagen, 2019

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Urban Mining: Demolition-Sorting-Cleaning

REPAIR, REUSE, UPCYCLE OR RECYCLE

The concept of urban mining addresses the built environment as a repository of material resources. From this perspective, materials from obsolete buildings are not viewed as waste, but rather, as resources for new construction.

From this fundamental revaluation of building materials that would otherwise be considered waste follow processes to repair, reuse or recycle. The basic distinction between these different approaches lies in the extent of intervention or modification.

Repair and reuse entail the restoration of materials or components in their existing form in the same function or a different function. For example, the repurposing of structural steel members or precast concrete slabs in their existing form for new structural or non-structural purposes. Minimising the extent modification of existing materials and components can be a cost-efficient approach that avoids environmental impacts of new production processes.

In contrast, recycling utilises existing materials as inputs for new material production. For example, the melting of steel for new steel products or crushing concrete for use as recycled aggregates. While minimising waste and avoiding extraction of natural resources, recycling involves new production processes and any environmental impacts that they entail.

Common reuse practices encompass a wide variety of structural and non-structural building materials and components, including (but not limited to):

- clay bricks
- steel structural elements
- timber structural elements
- timber shuttering
- insulation panels
- wall and roof cladding
- windows and doors
- natural stone and ceramic elements
- timber flooring
- fabricated structural steel elements, e.g. trusses
- technical equipment for building systems
- sanitary and electrical fixtures

The processes required for selective dismantling, processing and distribution varies across the different types of building materials and components and the circumstances of their installation.

THE ECONOMICS OF CIRCULAR CONSTRUCTION

Beyond environmental considerations underpinning circular economy approaches to the built environment, the economics of circular construction rests on comparisons of costs of selective dismantling, processing, and redistribution.

Demolition of a Building in Ukraine (Image Euronews)

Selective dismantling for reuse typically involves additional labour and equipment beyond that required for indiscriminate building demolition. These requirements can vary; e.g., labour required for selective dismantling of masonry walls for reuse of bricks, or cranes and other heavy-lifting equipment for selective dismantling of structural streel and precast concrete elements.

Similarly, reprocessing requirements varies with the type of material and the circumstances of its original installation and use. For example, removal of mortar from reclaimed bricks may be done manually or automatically with machinery, depending upon original mortar characteristics. Many reclaimed materials require only minor reprocessing such as cleaning prior to reuse.

Redistribution of reclaimed materials can range from the minimal situation in which materials are reused at the same site of reclamation, to situations in which materials and components are transported to a site for processing and storage (e.g., a storage yard) before being transported again to a new construction site for reuse.

Beyond the variations in dismantling, processing and distribution costs for specific materials and their application, underlying cost of reuse are subject to economies of scope and scale.

Sourcing different types of materials and components from the same building and consolidating dismantling, processing and distribution can support significant cost efficiencies. Similarly, processing and distributing reclaimed materials at scale support cost efficiencies and commercial viability.

Ultimately, the economics of reuse rests of comparisons of costs of selective dismantling, reprocessing and redistribution, with purchase and logistics costs of new material/components.

Some circumstances of reconstruction in Ukraine could support the application of circular construction approaches in general and reuse in particular.

Concrete recycling Plant in Switzerland (Eberhard)

The large scale of building damage provides wide scope for selective demolition and reclamation. Conversely, the large demand for building materials and potential restrictions on supply chains accompanying reconstruction could support demand for reclaimed materials. In particular, materials and components that involve high production costs – e.g., windows and insulation panels – may be particularly suitable for reclamation and reuse.

Similarly, demand for reclaimed materials that involve high transportation costs – e.g., masonry elements and precast concrete panels – may increase due to effects of high reconstruction demand on construction markets.

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Urban Mining's Low-Hanging Fruits in Ukraine

URBAN MINING VS DEMOLITION AND RUBBLE REMOVAL

The Ukrainian Ministry of Environmental Protection and Natural Resources estimates that war-related destruction of buildings resulted in around 10-12 million tons of demolition waste in 2023 alone, suggesting more than 20 million tons of rubble have resulted from nearly two years of war. Costs for demolition and debris removal are estimated at more than USD 5 billion (World Bank et al., 2023).

Addressing the challenges related to severely damaged and collapsed buildings represents a major hazard to the population and can be addressed in two different ways:

Removal of rubble after a natural or man-made disaster is a usual reconstruction task of the Government and often supported by experienced international partners such as the UN, Red Cross, or bilateral development partners. With the objective to clear roads and public space and remove safety hazards such as semi-collapsed buildings, rubble removal in conflict areas consists of:

- clearing roads and public space
- the demolition of damaged buildings and infrastructure
- breaking, crushing, transporting and disposing the material at specific landfills for construction material.

Urban Mining, however, considers debris as a resource or commodity and therefore focusses on selected materials that can be reinjected into the supply chain in a cost effective and commercially viable manner.

In Ukraine, the following factors determine a building element's commercial suitability for urban mining:

1. Is there currently a market demand for the item?
2. Will there be a market growing during the coming 15 years of intensive reconstruction?
3. How easily can the item be integrated into design and construction processes?
4. Can a realistic sales price compete with new material of similar quality?
5. How accessible is the targeted item on the demolition site?
6. Is the item available in sufficient quantities to satisfy demand?
7. Can the quality of the item be verified or even certified?
8. Can quality-sorting be done on site before transport to a storage or processing facility?
9. Will the item be damaged during dismantling or demolition processes?
10. What are the extra costs of selective dismantling compared to simple demolition and disposal?
11. What are the extra costs of transportation and handling compared to the transportation costs of new material?

12. What are the costs for cleaning and processing compared to the production cost of a new material?
13. What are the costs for storing and marketing compared to the supply and sales costs of comparable new materials?

EXAMPLES OF LOW HANGING FRUITS IN UKRAINE

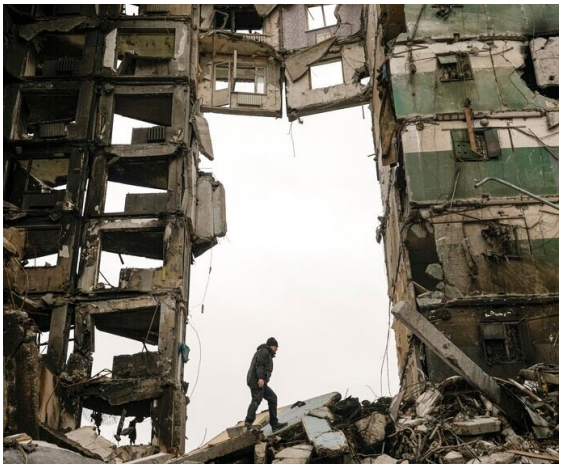
Movable building parts

Doors, sinks, showers, etc. are movable building parts that are relatively easy to dismount, handle and transport. Therefore, these are normally the first items that are "mined" or reclaimed from demolished buildings. After dismounting they are usually either:

- sold online,
- stored and locally advertised then sold on-site,
- collected by specialized resellers that actively identify demolition sites containing valuable material.

Sinks and windows, removed from a destroyed building on the Kharkiv Oblast in Ukraine (Image Daniel Wyss)

Used sinks and bathtubs exhibited at the Bauteilbörsen (Secondhand Building Part Outlets) in Switzerland are the longterm customer-favourites (Image Daniel Wyss)



Collapsed Khrushchevka Building made of precast concrete panels in Ukraine (Web image 5)

Precast concrete panels

Soviet-era residential buildings typically made comprising precast concrete structural elements represent a large proportion of Ukraine's residential stock of multi-apartment buildings. Thousands residential buildings containing precast concrete panels have been damaged beyond repair, thus hundreds of thousands of panels will have to be dismantled crushed and disposed during the next 10-15 years.

Direct reuse of these panels to repair neighbouring buildings of similar design is the most cost-effective reuse approach. But dismantling precast concrete buildings requires heavy machinery and complex procedures to verify structural integrity prior to reuse.

Notably, structural damage from shocks and fire may not be visible on wall panels, and contamination from the explosives requires assessment. Therefore, damage diagnosis of panels should be conducted with the help of appropriate testing protocols and laboratory equipment.

Due to testing and equipment requirements, most precast concrete panels would not qualify as low hanging fruit or starter material for urban mining. Nevertheless, precast concrete panels represent a significant resource for reconstruction.

Fired clay bricks

The Oblasts of Kyiv and Kharkiv contain large clay deposits that have supplied raw materials for construction of a significant part of the region's housing stock, built with fired clay bricksprior to the Soviet Union's launch of large-scale supply of precast-concrete apartment blocks in the 1970s and 1980s.

An old brick factory in from the beginning of the 20st century in Dehachi, Ukraine (Image Daniel Wyss)

Fired bricks are more shock- and fire-resistant than concrete panels and for reuse during reconstruction, their quality and durability is relatively easy to assess with simple tools and procedures in comparison with precast concrete panels. The small size and weight of clay bricks makes them easy to handle by demolition teams and easy to sort on construction sites.

In the Kharkiv and Kyiv Oblast a market currently exists for reclaimed bricks at village level and in segments of urban construction markets. A few prominent architects have built well publicized buildings using reclaimed bricks.

Bricks therefore have potential as a pioneer material for circular construction. However, cost-effective dismantling, quality-sorting and mortar removal are crucial to make reuse of bricks competitive and economically viable.

Timber

Timber is a robust building material and resilient to shocks and heat exposure. Being light weight and easy to cut and transport, timber is clearly a low hanging fruit for reuse. Reuse of timber is already common practice, particularly in rural settings. Alongside, ready availability of new timber, used timber can be recycled with significant economic and environmental benefits.

Insulation material

A Khrushchevka-apartment in Makariv with an external thermal insulation added by the homeowner (Image Daniel Wyss)

A significant proportion of buildings in Ukraine lack adequate insulation. Many families have added polystyrene boards to Soviet-era residential buildings to provide insulation during cold winters and to reduce heating costs. However, polystyrene insulation boards have been frequently blown off through explosions, contributing visibly to building waste. Polystyrene is unsolvable waste and source of micro-plastic contamination of food chains and ocean water, that will last for millennia.

Reuse of polystyrene waste instead of disposal in landfill sites has significant environmental benefits.

Because it is easy to carry and to process, polystyrene waste can be used for insulation in ceilings, roofs, and cavity walls (see chapter F).

Prominent urban mining cases in Ukraine

Urban Mining and reuse of building material is not only an old and widely lost tradition in rural settings but can also be a fashionable element for ambitious architecture.

While at international level, prestigious awards and professorships are granted to pioneers or circular building design, Ukraine has also produced prominent examples of circular architecture.

The Markhouse Villa made of reclaimed bricks in Kharkiv Drozdov & Partners, (Image Andrey Avdeenko)

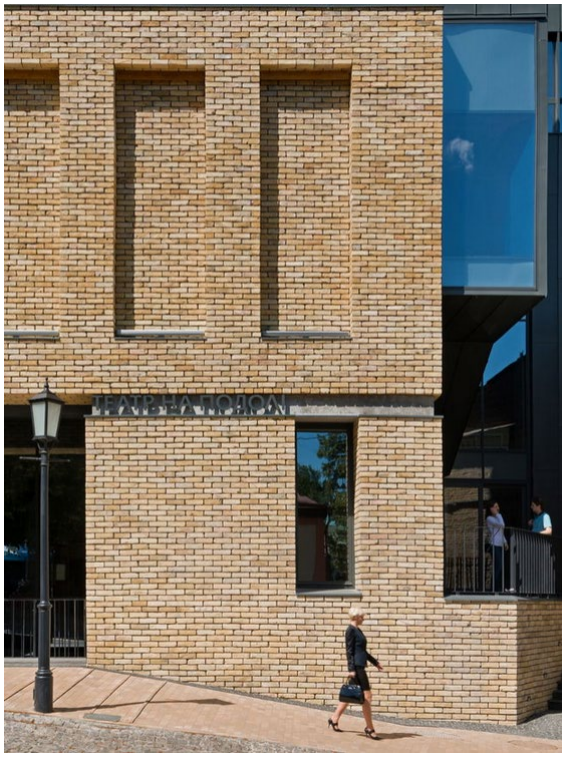
The Markhouse by Drozdov and Partners in Kharkiv is a generous contemporary villa that celebrates the visual quality of reused building material. Its outer walls are built of reclaimed bricks and offer the straight and functionalist walls its unique character.

In several interviews, (see Vol II of this document) the architect highlighted that construction with reclaimed bricks was simple and that local masons were able to produce high quality walls without special training nor additional costs.

The Markhouse Villa (Image Daniel Wyss)

The Markhouse Villa made of reclaimed bricks in Kharkiv by Drozdov & Partners,Architects (Image Daniel Wyss)

The theatre "Teatr Na Podoli" in Kyiv



The theatre "Teatr Na Podoli" in Kyiv built of reclaimed bricks Drozdov & Partners (Image Andrey Avdeenko)

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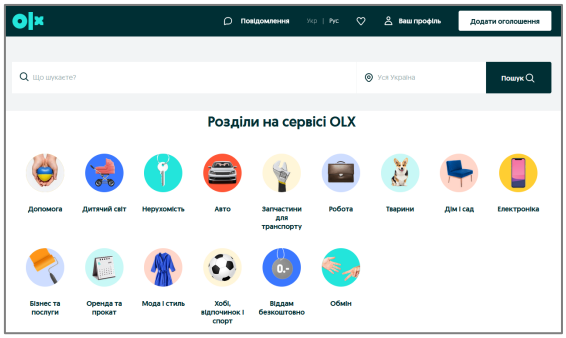
The Role of Online and Physical Marketplaces

Building materials and components that can be readily transported with small and medium-sized vehicles are often sold:

- directly from owner to customer, through online marketplaces,
- via small advertisements posted at public locations, or
- making them visible to potential buyers at the demolition site.

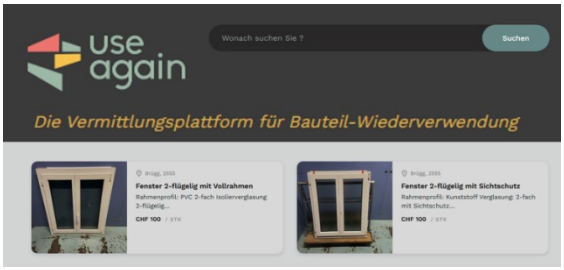
Mainstream Online Marketplaces - advantages and limitations

In Ukraine, as in other countries, there are several online marketplaces available, ranging from popular mainstream apps to more specialized websites for specific types of product and specific markets.



Mainstream online marketplace in Ukraine

Popular mainstream online marketplaces such as www.olx.ua or www.izi.ua are attractive due to their broad customer base, variety of products, accessible user interfaces and customer feedback/rating systems. They are useful for individual clients who want to repair minor building damage or self-build basic structures such as sheds or garages.



Online market place for building professionals
www.useagain.ch

For larger projects and professional clients such architects or building firms, quantities of the building materials and components advertised in generic online marketplaces are often inadequate for project requirements. Furthermore, product descriptions are often vague and search engines do not allow effective filtering of advertisements.

Online marketplaces focusing on used building materials and components are more suitable for larger projects and professional clients. Websites such as useagain.ch or materiuum.ch offer detailed product descriptions that allow of architects to search products according to size or other technical criteria and to

integrate them early in the design process. Other online marketplaces specializing in circular construction such as salza.ch connect owners and clients, rather than selling the products. Their disadvantage, however, is their relatively small userbase.

>> More details about the common Ukrainian online marketplaces can be found in Volume II

COMMON PHYSICAL MARKETPLACES FOR REUSABLE BUILDING MATERIAL

Demolition sites

Demolition sites are common physical "marketplaces" for used building materials and components. In Ukraine, building materials and components are displayed for sale (or offered without cost) around damaged properties. This direct sale or donation of materials reduces disposal costs for the owners of damaged buildings. Availability of material is often advertised at local bulletin boards or spread through word-of-mouth.

Homeowner exhibiting timber and blocks in Makariv (Image Daniel Wyss)

Meeting on the reuse of building material in front of the public village info-pin-wall on Ruska Losova (Image Daniel Wyss)

Second-hand shops or open-air markets

Open-air (flea-) markets are also used to resell small building items, which dealers can transport, exhibit or store within reasonable cost-limits. Beyond the sale of materials, specialized resellers can also be important sources of information and brokerage between used material suppliers and professional clients such as architects and construction firms.

Secondhand building material market in a Roma Settlement in Area 029 in Fushe Kosova (Image Daniel Wyss)

Demolition companies

Demolition companies are usually key players in used building material markets. Some demolition companies sort and resell valuable material themselves, while others hire specialized teams to remove valuable items from buildings before demolition.

>> More details and interviews with Ukrainian demolition firms can be found in Volume II

Construction firm in Makariv, selling remnants and material from demolition sites (Image Daniel Wyss)

Construction companies

Construction companies are often able to identify building materials and components

that can be reused in-situ (i.e., at the site of demolition and new construction) or for planned or ongoing projects at other locations. Construction companies typically have necessary resources supporting reuse, such as vehicles, cleaning tools and storage space. Thus, construction companies can access and reuse material cost effectively.

>> More details and interviews with Ukrainian building contractors can be found in Volume II

Material manufacturers

Manufacturers have an inherent interest is in production and sale of new materials and components. Nevertheless, manufacturers may integrate reuse and circular practices alongside core production. In Scandinavia, brick factories also supply reclaimed bricks to serve demand for vintage bricks.

Brick factory Egernsund (Wienerberger), Denmark increasingly sells used rustique bricks in Scandinavia

Professional resellers

Resellers of used building materials have historically been a common feature of construction industries throughout Europe, including Ukraine. Many specialized resellers have disappeared with the country's increasing industrialization. Nevertheless, high-value building parts such as steel trusses to building antiques have always been traded by specialized resellers. The growing demand for vintage products has also created new markets and revived old skills in building supply chains.

Steel trusses for reuse – A scrab iron trader in Germany

>> More details about the common Ukrainian resellers of used building material can be found in Volume II

Bauteilbörse:

Bauteilbörsen are specialized shops for used building parts. First established in Switzerland and Germany during the 1980s, many now operate with a variety of business models and under various names.

Some Bauteilbörsen are specialized in a small number of items (e.g., antique doors and windows) while others, such as the Bauteilbörse in Basel, cover a wide range of building materials and components, from small components to entire structural systems.

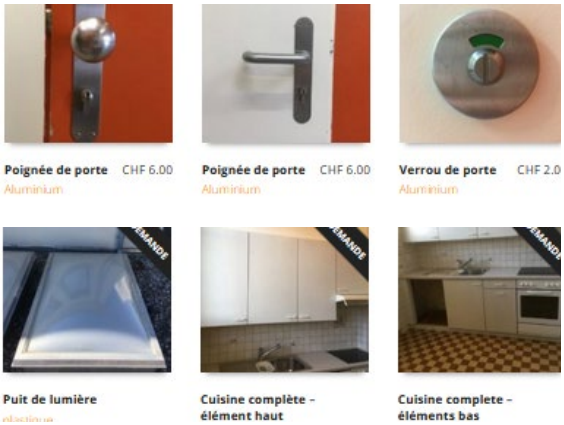
Bauteilbörse in Basel, Switzerland (Web image 6)

While the specialized shops are usually fully commercial businesses, the larger Bauteilbörsen are often organized as non-profit initiatives or associations with an environmental and social mission. Some offer work to unemployed people, who process used materials and components, including making repairs where required. Many Bauteilbörsen receive subsidies, donations or in-kind support such as free storage space.

Many Bauteilbörsen are well-established, within the construction sector. They made reclaimed material accessible for green and affordable construction and contribute to turning reused building parts into fashionable products that inspire ambitious architects and interior designers.

Storage of assorted building materials (HildaWeges /iStockphoto)

A shop for antique doors and building parts in Germany - Market for remnants and used building material web



Swiss French online portal: https://materiuum.ch/

Bauteilbörse Basel

7

Examples of New Specialized Circular Construction Trades

Demolition teams in the Balkans

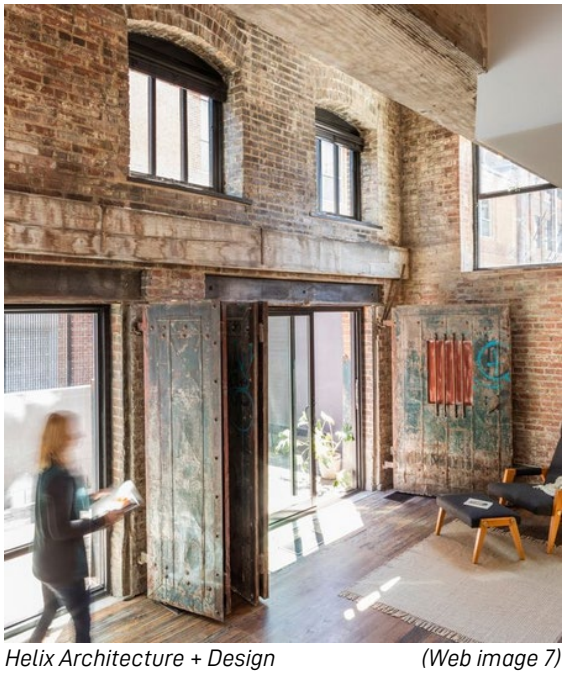
Specialized companies for smart demolition, repair/refurbishment and selling of used building material can often be found within Roma communities of the Balkan region. Organized formally or informally, they are frequently hired or offered access to demolition sites to remove valuable materials that can be sold through various marketplaces. Stores for used building materials can be found in many Roma settlements throughout the Balkans.

Image Peter Milto

Brick cleaners in Serbia *(Image Daniel Wyss)*

Architecture

In the field of interior architecture, a new type of construction firms has evolved that specializes in construction of vintage spaces for restaurants, hotels and high-end villas. Such companies specialize in reclamation of material from demolition sites - and subsequent refurbishment – for use in new spaces with ambitious interior designs. While these skills and practices were once primarily restricted to a small group of specialists for the restauration of built heritage, the market shifts from the monuments towards residential areas architecture and hospitality buildings.



Helix Architecture + Design *(Web image 7)*

Re-Brick Companies

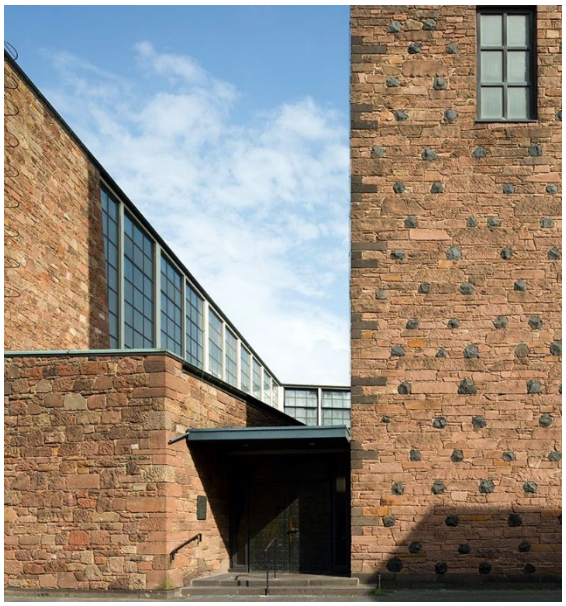
A growing building material industry across the globe specializes in supplying used building material at large scale.

A brick reclaiming firm" Colonial Bricks" in Chicago USA (Image Daniel Wyss)

In prominent examples from the United States, Europe and Australia, medium to large companies specialize in reclaiming fired clay bricks, including cleaning, processing, and certifying them for large scale application for major construction projects. Most large suppliers of used building material started as small artisanal firms that have now reached industrial scale and successfully established product brands. Beyond aesthetics, reclaimed brick firms often also "sell" the stories of the reclaimed bricks (which are often more than 100 years old) and can provide a new building with a sense of history and pride.

A Company reclaiming, upcycling and supplying bricks in Chicago USA (Image Daniel Wyss)

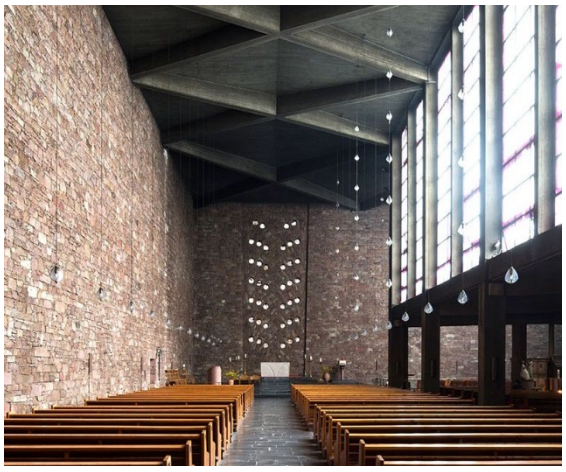
Notkirche (emergency church and shelter) after WW2



Church built of debris from WW2 by Rudolf Schwarz

Dealing with memories and scars of war

With the same intention of remembering the history of war, prominent architects have built iconic buildings out of the debris of bombarded churches or smoke-blacked damaged houses of the post-WW2 and post Balkan wars period.



Church built of debris from WW2 by Rudolf Schwarz web

8

Maximising the Reusability of Material from War-Damaged Buildings

With increasing demand for vintage building material, pioneering companies have gradually improved working methods, tools and machinery to increase the range of products, lower processing costs, and reduce environmental footprints of recycled products.

EXAMPLES OF TYPICAL URBAN MINING AND UPCYCLING TECHNOLOGIES

Low carbon concrete recycling

Recycling of concrete is an energy intensive process, requiring energy-consuming heavy-duty equipment. Thus, CO_2 emissions associated with recycled concrete are comparable with those of new concrete production, and recycled concrete typically doesn't have a positive CO2 balance compared to new concrete. However, companies such as Zirkulit and Eberhart AG in Switzerland have developed innovative technologies that lower the CO_2 emissions of recycled concrete by injecting CO_2 gas into the recycling concrete.

CO_2 absorbing Concrete recycling (web image)

Recycling and reclaiming bricks

Crushing is still the most common method to recycle brick debris for use as a substitute for gravel (e.g., for landscaping, road construction, sports surfaces). Brick powder (brick grog or chamotte) is also used in the production of fire-resistant refractory bricks used for the construction of ovens or kilns.

Crushed bricks for landscaping in Switzerland web

For pre-Khrushchev-era urban buildings in Ukraine, reclaimed or crushed bricks were often used for the construction of light weight concrete slabs.

An old slab in Kharkiv, made of concrete and old bricks

(Semi-) industrial brick cleaning machines are utilised by pioneering brick reclamation businesses in Scandinavia, Canada and Australia. Semi-mechanised sorting and

upcycling lowers processing and handling costs enabling competitive prices for used bricks.

Brick Upcycling Factory in Australia (Web Image)

In Norway, Wienerberger - a major international brick producer - is investing in urban mining by trialing automatic brick upcycling lines in a pilot brick factory, to meet growing demand for reclaimed bricks and to meet environmental targets of 2050.

Production line for used bricks at Wienerberger factory

The most used technologies for brick upcycling include:

- mobile tools and machines for brick cleaning at demolition sites,
- small factory-based brick cleaning lines with larger and more sophisticated machines that allow cost-optimised cleaning of large quantities of bricks,
- robotised processing of used bricks is being piloted,
- sensor based brick sorting with the use of machine-learning (AI) is not yet applied at industrial scale.

These innovations made brick reclamation a profitable business in nordic high-salary countries. Standardized processes allow these companies to CE-certify products and to provide quality guarantees, like regular producers and suppliers.

Simple tools for rapid in-situ brick cleaning are utilized in the Netherlands and Scandinavia to efficiently remove small pieces of mortar. Larger mortar joints are knocked with hammer or through vibration, on-site or at the factory.

In-Situ Brick cleaners in Scandinavia Image: Youtube

In-situ tools and brick processing machines are utilized and sold in Canada and the USA. Mobile brick trimming machines can be installed directly at the scaffolding of demolition or renovation sites. They remove even very sticky mortar on the spot, thus lowering costs of handling and transportation.

In-Situ brick trimming in Canada Image: Youtube

Various other technologies, cleaning products and working methods have been developed and are shared among the professionals, though are not commercially available to customers.

Walling technologies

During its more than 40 years of research, technology-transfer, -adaptation and promotion, in projects funded by SDC, EU and HEKS, Skat has developed a walling system that allows optimised use of reclaimed bricks and insulation material. It is based on a century old walling system - Rowlock Bond - which Skat adapted for use in cold climates and urban environments, and promoted in Eastern Europe, Asia and the Great Lakes Region.

Rowlock Bond with reclaimed bricks and waste-based insulation (Balkans, SDC, HEKS, VoRAE, Skat) I: D. Wyss

THE PERFORMANCE OF CIRCULAR CONSTRUCTION COMPARED TO LINEAR MINING AND CONSTRUCTION

The examples demonstrate economically viable business models and technologies that can be applied for urban mining and construction with reclaimed material. Most successful companies have evolved slowly and developed skills relevant to identify context-specific conditions, which are favourable for circular construction and learned how to detect risk factors, that would make reuse unprofitable.

To establish circular construction in Ukraine, the following factors will determine the economic viability of projects:

Transportation distance: Especially for heavy or very bulky building material, reuse is only economically and environmentally viable within a limited radius from the source location (nominally 50km).

The semi-collapsed School 134 in Kharkiv: Source of approximately 1.000.000 Pre-Revolution or Stalin-Era Bricks, at the hearth of Kharkiv, Ukraine

However, more easily transportable or high-value components may be transported profitably over greater distances. Re-Win has calculated that cross border transportation from Switzerland to Ukraine reduces CO_2 emissions compared to new windows from neighboring countries.

Swiss highly insulating second-hand windows shipped by Re-Win to Kyiv and Kharkiv (Image Daniel Wyss)

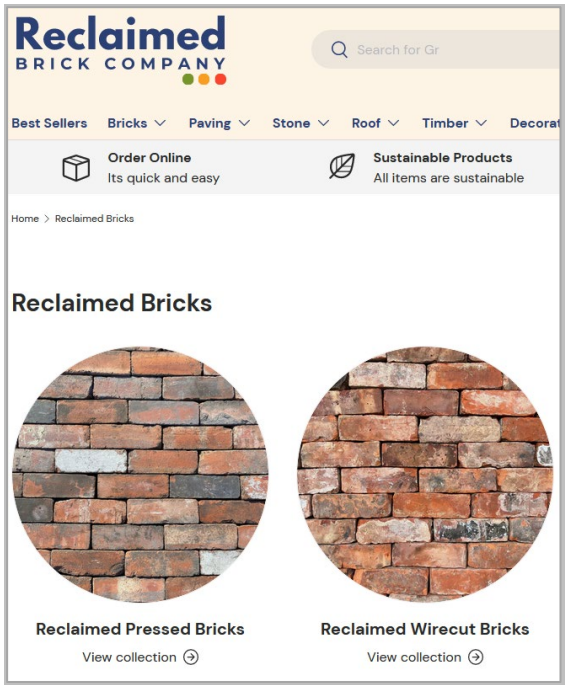
Verifiable quality: Reclaimed building materials must meet the same quality standards as other building material. However, original product quality and external influences during original use that might reduce quality or durability is usually undocumented.

On the other hand, most reclaimed bricks have been naturally tested in real life conditions and have proven their durability over decades or centuries. This allows specialists to identify their quality and durability with relatively simple protocols and testing equipment.

CE-Certification of reclaimed Bricks in Denmark

The available quantity of a material has a significant impact on reusability for large building projects. Large quantities allow cost-efficient sourcing and processing. Large (predictable) quantities also support architectural and engineering design and the construction process.

Many companies involved in circular construction define minimum quantities of a product to warrant inspection at a demolition site.



British online portal for reclaimed bricks

A damaged house with 10-20.000 reclaimable bricks

Ease of access and ease of sorting are key conditions for economically viable reuse. Material that can only be accessed after heavy and costly demolition of other material (e.g., concrete. slabs), can render reclamations economically unviable. Also, salvage of small quantities of reusable products from large heaps of construction waste reduces economic viability for reclamation and resale.

Brick sourcing in Canada *(Web image 8)*

Safety considerations are especially important in war-damaged demolition sites, where unexploded ordnance might affect the reclaiming process. This includes hazardous trace elements from the exploded warheads that may contaminate building materials and components.

Material and workflow management affects the profitability of urban mining and the upcycling of reclaimed material. The key for competitive upcycling of used material is optimized procedures for sourcing, transportation, and processing.

Manual, small-scale upcycling can compete with new material if decentralized at demolition sites - with simple equipment and small quantities - or centralised in the

workshop or factories for larger quantities requiring processing and the involvement of semi-mechanised machinery. Both require careful design of each step of the upcycling process.

The labour costs are another important factor for profitable material reuse. Even with optimised workflows, material upcycling requires significant amounts of manual work compared to industrial production of in new material. Circular construction is thus often most economically viable in low- and middle-income countries with lower labor costs. In Ukraine an average demolition worker currently earns USD 20-25/day (see Volume 2), which could support commercial viability of labor-intensive material upcycling.

Notwithstanding labor costs, circular construction is expanding in high income economies, supported by technical innovations in optimised processing and certification.

In middle- and high-income economies, reclamation and reuse processes are also appreciated for social benefits the creation of more employment compared to linear industries, allowing integration of a low-skilled segment of the workforce into the construction industry.

The completeness of the supply chain will finally determine whether new circular construction ventures can develop reliable products, satisfy market demands, become economically viable, and grow to a self-sustainable scale within building supply chains.

Damaged brick Building in Kharkiv (Image Daniel Wyss)

Reclaimed upcycled bricks, ready to be transported to a large construction site (Web image 9)

Reclaimed timber prepared for transportation (image 10)

Robotized brick handling in Scandinavia (Web image 11)

9

Lessons Learned from the CC-Yard Pilot Project

THE CIRCULAR CONSTRUCTION-YARD

About the Pilot CC-Yard in Rus'ka Losova

In 2023, the *Repair Facilitation Project for Ukraine* (REFAUK) established a small pilot circular construction yard in the village of Rusko Losova. The village is located between Kharkiv City and the border with Russia, and suffered heavy losses prior to its liberation. Many houses and public buildings were destroyed. The local authorities of Rus'ka Losova were interested in the idea of piloting a rural Circular Construction Material Yard (CC-Yard).

The CC-Yard offers space to assemble and store reusable building material collected in the village. The yard also provided facilities to test upcycling methods in order to learn how to reinject materials and components into supply chains supporting local reconstruction efforts.

The Circular Construction Yard was managed by Helvetas and locally operated by Zero-Waste Kharkiv, with Skat Consulting providing technical advice and support.

EXPERIENCES FROM THE CC-YARD IN RUS'KA LOSOWA

Pre-Soviet brick building in Rus'ka Losova (D.Wyss)

The building stock of Rus'ka Losova

Rusko Losova is located in the outskirts of Kharkiv City and primarily comprises detached residential buildings. Many of the houses were built in the pre-Soviet era and during the early period of industrialization. They follow traditional single storey typologies for rural villas.

The Kharkiv Oblast contains large clay deposits and many brick factories that produced the majority of walling material for buildings throughout the region, including Rus'ka Losowa. Roofs typically include a timber structure covered with corrugated fibre-cement roof sheets. A small number of concrete buildings have been built in town. Thus, timber and fired bricks, including the so called "Pre-Revolution Bricks" (or Zarska Zigla) are the predominant building materials.

The Pilot CC-Yard visited by a delegation from SDC *(Image Zero Waste Kharkiv)*

The CC Yard's initial focus material

The Rus'ka Losova CC-Yard was set up in the walled courtyard of an old public building. It was equipped with a large tent to store mobile items such as windows, doors and sanitary equipment, providing protection from rain and snow.

An outdoor display area allowed large quantities of heavy materials such as concrete blocks and bricks to be off-loaded, cleaned and displayed. An area for material sorting was established separate from storage and display of materials and components for sale.

The CC_Yard's storage tent with windows, doors and sanitary equipment *(Image Daniel Wyss)*

The initial items arriving at the CC-Yard were windows, doors, sinks and toilet seats, followed by large quantities of walling material such as silica blocks and clay bricks from the early Soviet period.

Given the relatively high quality of bricks collected early in the operation of the CC-Yard, it was decided to focus on developing a better understanding of this material and to test innovations from the Balkans could also be applied in the Kharkiv area.

Testing the construction of insulated Cavity walls built of reclaimed bricks *(Image Daniel Wyss)*

People's and authority's reception

Initial local reactions on the idea of fostering reuse of building material from war-damaged houses were mixed. In 2023 building materials remained readily available at relatively low prices. Furthermore, building material for housing

repairs was often distributed free of cost by the Government and humanitarian organizations. In this context, provision of used materials of un-certified quality material - instead of new building material – received mixed reactions among the local population and local humanitarian actors.

However, awareness was high among authorities of Rus'ka Losova about the value of material and components from damaged buildings. For officials, reuse was a practice with a long tradition, that hasn't been fully lost with industrialization.

>> More details about the local community's and authority's opinion can be found in Volume II

The CC-Yard's construction tool, that can be borrowed by the village community (Image Daniel Wyss)

The Perspectives of a rural CC-Yard

Villages such as Rus'ka Losova are suitable locations to gain initial experiences in the development of facilities to support circular construction. The buildings are of relatively low structural complexity, and most are built of durable and easily reusable material. Furthermore, local building contractors, are familiar with the reuse of old building material and can determine the quality of used elements.

Despite the relatively low cultural barriers, local markets in rural areas may be too small for a commercially viable CC-Yards. Moreover, distances are greater to urban markets featuring higher prices and more rapid turnover of material that would support sufficient income to cover costs of a permanent CC-Yard manager and technician.

A Model for Village based CC-Yard

In the present humanitarian and economic environment, community, NGO or municipality-driven CC-Yards are more viable than commercially motivated initiatives. For heavily damaged villages, like Rus'ka Losova, such not-for-profit CC-Yards would allow storage of building material until they reach sufficient quantities for sale at a symbolic or cost covering price.

Comparable with a Municipal Recycling-yard or Werkhof Facility, in Switzerland, Germany or France, a CC-Yards could offer the following services:

- a collection point for household recycling material,
- a temporary storage or pre-sale depot of reusable building material,
- a small public workshop for small repair work.

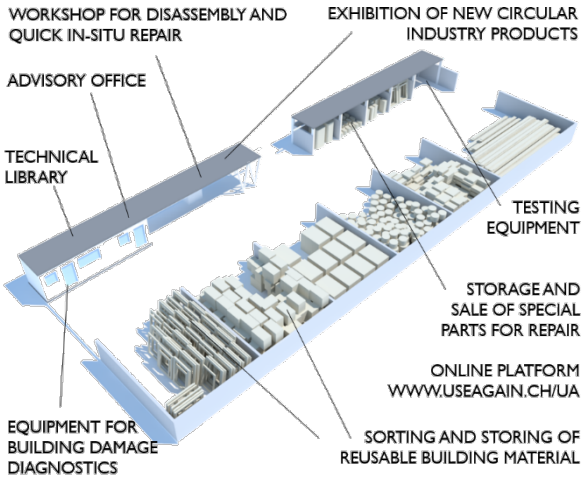
Such village recycling yards could be operated at part-time basis (say, 1-2 afternoons per week) by a municipal officer, a local association, an NGO, or even a local entrepreneur, in exchange to storage and display space.

Werkhof of the Municipity of Steinfurt (Web image 12)

Werkhof of the Municipity of Steinfurt (Web 13)

Municipal Public Workshop in Chatel (Web image 15)

Werkhof of the Municipity of Steinfurt (Web 14)



Schema of a Circular Construction Yard by Skat 2022

10

Potential for Continuation and Upscaling

OPPORTUNITIES FOR EXPANSION

Three approaches have been identified for expansion of the Rus'ka Losova Model of a Village CC-Yard:

1. **Replicating** similar CC-Yard models in other heavily damaged villages of rural Kharkiv area, Kyiv and Cherson, and interlinking them with other Village CC-Yards and online marketplaces, in order to facilitate the exchange of knowledge and best practices,

2. **Supporting local artisans** to make best use of the available material through:
    a. Skills training,
    b. awarding micro-grants to private initiatives
    c. establishing a demonstration building (co-sponsored with humanitarian funds).

3. **By connecting the CC-Yard to urban markets,** e.g. through the establishing links to a CC Material Outlet (Bauteilbörse) in Kharkiv City, to existing building material markets and specific projects or construction firms. (n.b., any CC Material Outlet currently operates in Kharkiv).

WHAT BUILDING PARTS COULD BE RECLAIMED IN KHARKIV AND KYIV OBLAST

Considering the damaged housing stock of Kharkiv and Kyiv Oblasts, the following materials seem to be available in sufficient quantities to support semi-commercial CC-Yards and related specialised services:

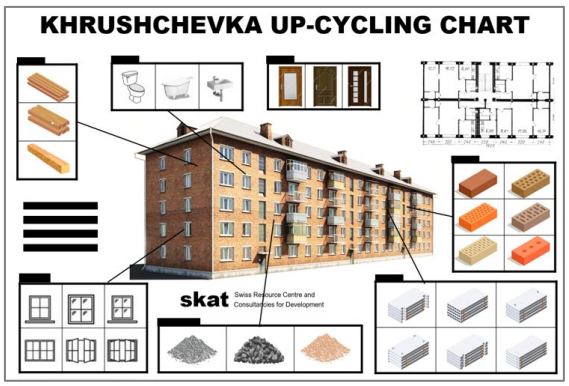


Illustration by Skat of an Upcycling chart for different types of standardised buildings (Khrushchevkas and other), to ease the reuse and redesign process for architects and building project managers (Daniel Wyss)

Precast concrete wall panels

Precast concrete panels are available from numerous large Krushchevka apartment buildings that have been severely damaged. Considering the extent of damage to multi-residential buildings - large numbers of precast panels would potentially be waiting to be disposed, recycled or reused.

Damaged Khrushchevka building in Kharkib (D.Wyss)

While many panels are severely damaged, through explosions, fire or frost, most of them haven't been directly exposed to heat, shocks or contamination, and might basically be intact or repairable for reuse. Fire-damaged panels will be subject to recycling or disposal. Unexposed panels may be reused to repair other similar buildings. Currently, there is very little experience in dismantling Khrushchevka buildings without damaging the panel structural connections (such as welded plates and mechanical fixings).

Destroyed Khrushchevka building in Borodyanka (Wyss)

Selective dismantling of these precast wall panels will require heavy equipment and technical innovation. In addition, reliable quality testing and certification protocols must be developed to identify the structural integrity of each panel prior to reuse. Notwithstanding these efforts, the large number of damaged Khrushchevka buildings and the significant costs of demolition and disposal, could offset the effort of selective dismantling and reuse.

Repairable Khrushchevka building in Borodyanka?

Precast concrete floor slabs

While the precast walling panels are relatively complex, including multiple layers and fixing systems, precast concrete floor slabs are robust and relatively simple elements that are used in a variety of buildings.

As with precast wall panels, floor slabs are relatively heavy and require heavy machinery for dismantling. Nevertheless, they are well suited for direct reuse. Many floor slabs can be observed stacked at the demolition sites awaiting reuse in new construction projects.

Precast slab panels in Makariv (Image Daniel Wyss)

Reclaimable Bricks

Given the brick industry dominant role during the Kharkiv Oblast's peak of urban development, clay bricks are widely available in the Kharkiv and the Kyiv area. While bricks from village houses are available in large numbers and accessible without heavy machinery, they are distributed in small quantities at properties throughout the Oblasts, entailing relatively high collection costs.

Village scale brick source in Rus'ka Losova (D.Wyss)

Bricks from larger buildings such as schools or 5-storey brick Khrushchevkas provide larger quantities per location but require light to medium scale machinery for selective demolition and reclamation.

Damaged urban brick building in Kharkiv (Daniel Wyss)

Damaged urban brick building in Kharkiv (Daniel Wyss)

Older bricks typically feature few perforations, facilitating relatively easy cleaning and processing, compared to bricks from late soviet and post-soviet era, in part because mortar from before the late 1960s contains lime-based binder instead of Portland cement.

>>Extract from Volume II: While a new brick costs USD 10-25cts, reclaimed bricks are sold online for USD 5-40cts per piece, depending on their age or quality. Old vintage bricks even for up to 50cts.

Damaged urban brick building in Kharkiv (Daniel Wyss)

Light weight building parts

Doors, windows, sinks and toilet seats are also available in large quantities and are particularly interesting for reuse in buildings of similar design, such as Khrushchevkas or schools or other public buildings with standardised building parts.

Semi-collapsed of typical urban building from the early XX Century in Kharkiv (Image Daniel Wyss)

11

Markets to be tapped

Repair and reconstruction of village houses

Rural houses and auxiliary buildings (such as garages) provide the most accessible market for reused material. Rural construction is generally simpler and can meet construction code requirements more easily than more complex multi-storey buildings in urban environments. Also, the common rural practice to reusing building materials ensures the availability of requisite skills in most villages.

Village house repaired with used bricks (Image D. Wyss)

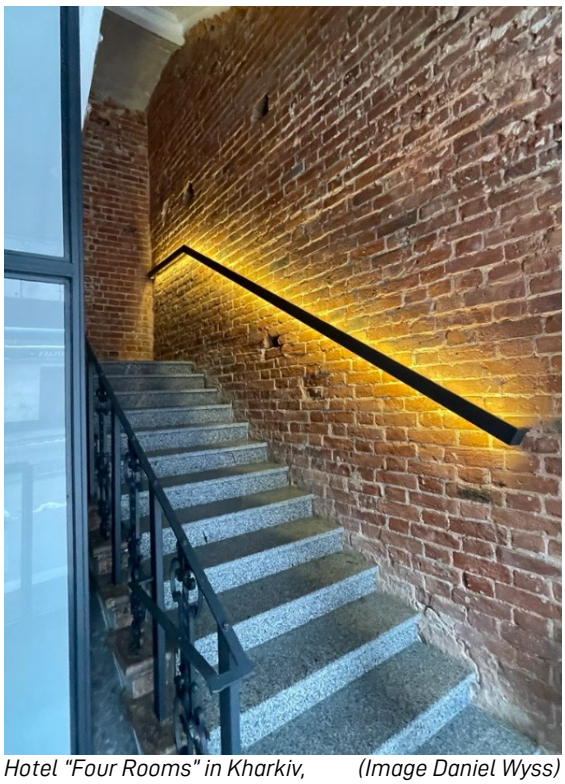
Typical village house in Kyiv Oblast (Image Daniel Wyss)

Industrial Building in Makariv, made of reused bricks (Image Daniel Wyss)

Agrarian or industrial buildings

Hangars, stables, workshops, or similar buildings in villages and peri-urban areas can be rebuilt with reclaimed material. Like auxiliary village buildings, such agrarian and small industrial buildings have been built from remnants from material stocks or demolition sites also in the recent past and are therefore natural markets for reclaimed building elements.

Industrial Building in Makariv, made of reused bricks



Hotel "Four Rooms" in Kharkiv, (Image Daniel Wyss)

Hotel "Four Rooms" in Kharkiv (Image Daniel Wyss)

The appearance of old rustic bricks appears to be in high demand in hospitality and high-end residential segments of Ukrainian building markets. This support demand for reclaimed bricks in small though highly visible areas of building markets. Thus, they have the potential to make reclaimed material fashionable and to open the door to mainstream markets.

Hotels, restaurants and high-end housing

Rustic-appearing brick walls are popular elements for interior hospitality design. Many such hospitality spaces highlight old masonry by removing the mortar from old brick walls (see the images on this page). There is also an industry for new bricks that are treated to give the appearance of old, used bricks (available in Kharkiv and Kyiv at the high price of 2 Euros/piece) where genuine reclaimed bricks are not available. These fake vintage bricks could be challenged by local truly old bricks from war-damaged houses.

Restaurant in Kharkiv (Image Daniel Wyss)

Hotel Kulikovskiy in Kharkiv (Web image 16)

Brick-Khrushchevka apartment buildings in Makariv, before and during reconstruction (Image Daniel Wyss)

Repairing urban damaged buildings

Repairing damaged buildings with the materials that are of identical shape and quality to the original materials is typically the technically recommended and most accepted approach in repair and reconstruction. This replication of appearance of older materials presents another market for reclaimed material.

Brick-Khrushchevka apartment buildings in Makariv, before and during reconstruction (Image Daniel Wyss)

Construction of new urban buildings

Construction of new urban buildings with old material will require material certification processes for reclaimed material. Such new certification of used materials is novel in Ukraine. Protocols for testing and certification will therefore be required before this urban building markets can be accessed at large scale.

Urban Building in Kharkiv by Drozdov and Partners made of used bricks

Public Buildings

In wartime and post-war environments, the use of reclaimed material from damaged building can have highly symbolic value, providing visible expressions of endurance, resistance, and reconstruction. Thus, integration of reclaimed materials in reconstruction of public buildings can provide symbolic and environmental benefits alongside potential cost-benefits. Reuse can provide a durable representation of history to future generations.

School 134 in Kharkiv (Image Daniel Wyss)

School Frederiksbjerg made of reclaimed bricks, Image: Henning Larsen Architects, Denmark

12

Possible Measures

DEMAND-SIDE MEASURES TO ACCESS NEW MARKETS

A replicable model for a Village CC-Yard

For the promotion of circular construction in rural areas, simple non-commercial Village CC-Yards would be sufficient to stimulate use of reclaimed building materials and components. Establishing yards in municipal facilities could enable operation with the limited involvement of a municipal officer, thereby minimizing costs according to the local needs.

To stimulate local innovation and efficiencies, it would be useful to connect Village CC-Yards in different municipalities among each other and to connect these rural CC-Yards with urban CC-Outlets in Kharkiv and Kyiv. These physical yards could also be connected to online marketplaces.

A CC-City Outlet in Kharkiv and Kyiv

Urban areas will provide the main markets for reclaimed building materials. Therefore, a well-located city outlet for high- and middle-value items would build awareness among the urban target groups and allow urban pioneer clients to access products locally. The CC-City Outlet could start as a CC-Boutique, with a small number of selected high-value products. In the medium term, such an outlet could grow with demand into a Bauteilbörse or fully-fledged CC-City Outlet.

Demonstration buildings in Kharkiv & Kyiv

Reclaimed materials are already well-known features in hotels, designer villas and restaurants. Nevertheless, many potential customers and planners have difficulties to imagine the architectural quality of reused material at building scale.

Establishing a well-located and well-designed iconic model house, will be of major importance for accessing not only private markets, but also to stimulate the debate and to create interest among decision makers.

SDC's Swiss Cube Demo House at UN Habitat's HQ design and implementation: Skat (Image Daniel Wyss)

SUPPLY SIDE MEASURES

Introducing building technologies that maximise use of reclaimed material

Applying reclaimed building materials and components in conventional ways is usually the safest and most cost-efficient solution. However, older building components may not meet current requirements for properties such as thermal insulation. New, construction systems that make better use of reclaimed material may need to be identified and adjusted to the local context.

Establishing protocols for the certification of selected building materials and building systems

CE certification laboratory for reused bricks in Denmark

Construction codes define target values for properties such as durability, strength, thermal insulation, etc. Building and components must meet these values regardless of the age of a building material. Most quality certification protocols are designed for new material. Thus, new protocols and testing methods may be required to certify reclaimed material. Such protocols could be developed during the development of a pilot building project.

Collaboration with the official certified material laboratories will be required for the development of testing and certification protocols. This could be supported by collaboration with international research centers such as the Swiss Material Science and Technology Center (EMPA), which has expressed support for such a process.

Supporting the creation of competitive urban mining and upcycing firms

Demolition companies will require training for selective dismantling of buildings that minimizes material damage during demolition. New tools and incentive systems will encourage entrepreneurs, demolition workers, and demolition project supervisors to adapt work practices to support a shift towards circularity.

Material producers or upcycling firms will need to develop cost-effective sorting and cleaning methods, including investment in equipment that enables cost-effective material- and workflow, at the scale required to compete with the material suppliers. Fostering collaboration between motivated Ukrainian actors and successful foreign companies could support transfer of technologies and the adaptation of international best practices to local conditions and requirements.

Community based "Co-production", has been a successful approach to upcycling material in other conflict-affected settings, involving local communities and unemployed or under-employed people in the process of circular construction. Such community coproduction can be a practical, and cost-effective approach to dismantling and upcycling damaged buildings.

Co-production can be facilitated through coordination by local authorities or NGOs (e.g., in a public demolition site or in a Village-CC-Yard).

Alternatively, co-production could be led by a local company that offers equipment and contracts a local community to participate in urban mining and upcycling tasks.

Reclaiming Bricks as a community activity in Denmark

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Key-questions to design a CC-Pilot

DEMAND-SIDE MEASURES TO ACCESS NEW MARKETS

Designing a CC Pilot

Common Circular Construction Pilots are:

- Pilot Services
- Pilot Facilities
- Pilot Buildings

To design the framework of a pilot service facility or building for circular construction, the following questions should be addressed:

1. Unused potentials: What valuable material is currently treated as waste?
2. Problem statement: What are the problems generated by the current practice?
3. What causes the problem and why hasn't it been addressed yet?
4. Is the problem only local and addressed successfully nearby?
5. What are the market failures: E.g., why isn't anybody buying the material and reselling it to customers?
6. Who could/should change his/her practice to improve the situation?

What is missing?

1. **Is there a Services gap?** What service could be offered to encourage or enable the key actors to shift from linear to circular practice?
2. **Is there a missing facility?** Is it a lack of specific working equipment or a facility that hinders key stakeholders from changing practices?
3. **A demonstrator**? Would a demonstration building help trigger a change of the market dynamics and of the local reconstruction policies?

For Pilot Services

1. Who could offer such a service? Who has the requisite skill, motivation, and credibility?
2. Where should the service be offered to address problem effectively?
3. What does the service provider need to offer the service successfully?
4. How can the service become a sustainable element of the supply chain of circular construction?

For Pilot Facilities

1. Who are the users of the facility?
2. What change of practice will the facility trigger among its users?
3. What equipment is required to trigger the change?
4. Where shall the facility be located?
5. Who will own the facility and its equipment and who will pay for it?
6. Who will manage and maintain it?
7. How will the facility become a sustainable element of the supply chain of circular construction?

For Demonstrators / Pilot Buildings

1. Who needs to be inspired or convince by the demonstrator?
2. What change of practice will the demonstration trigger?
3. What are the characteristics of the demonstration that can trigger the change of practice?
4. Where shall the facility be located?
5. Who will design and build the facility?
6. Who will own the facility and its equipment and who will pay for it?
7. Who will manage and maintain it?

Arkadia, An Urban Building in Sidney, Australia made of reclaimed bricks (Web image 17)

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Web images

Web image 1 Collapsed Khrushchevka Building in Borodyanka (URL: https://ludmila-shevchenko.medium.com/be-a-ukrainian-who-illustrates-the-war-now-a0f4236418)

Web image 2 Linear Economy (URL: https://ccecosystems.news/en/sustainable-finance-a-step-toward-the-circular-economy/)

Web image 3 Circular Economy (URL: https://ccecosystems.news/en/sustainable-finance-a-step-toward-the-circular-economy/)

Web image 4 The 9 R s of Circular Construction (URL: https://www.researchgate.net/figure/Circular-economy-and-the-9-Rs-adapted-from-24_fig1_365310478)

Web image 5 Collapsed Khrushchevka Building made of precast concrete panels in Ukraine (URL: srf.ch/news/international/ein-jahr-krieg-in-der-ukraine-als-ob-die-zeit-vor-dem-krieg-bloss-ein-traum-gewesen-waere)

Web image 6 Bauteilbörse in Basel, Switzerland (URL: https://www.derstandard.at/story/2000138235081/wiederverwertung-in-der-architektur-die-bauteiljaeger-von-basel)

Web image 7 Helix Architecture + Design (URL: https://helixus.com/project/atlas)

Web image 8 Brick sourcing in Canada (URL: Restoring Queensland's oldest surviving school building - Conrad Gargett)

Web image 9 Reclaimed upcycled bricks, ready to be transported to a large construction site (URL: Products | Recycled Bricks Sydney | Second Hand Bricks (thebrickpit.com.au))

Web image 10 Reclaimed timber prepared for transportation (URL: Facebook)

Web image 11 Robotized brick handling in Scandinavia (URL: Rebrick :: Rebrick (gamlemursten.eu)

Web image 12 Werkhof of the Municipality of Steinfurt (URL: Denkmalpflege-Werkhof Steinfurte.V.)

Web image 13 Werkhof of the Municipality of Steinfurt (URL: Steinfurt (URL: Besichtigung des Denkmalpflege-Werkhof Steinfurt e.V. | Bezirk Münsterland (verdi.de)

Web image 14 Werkhof of the Municipality of Steinfurt (URL: Besichtigung des Denkmalpflege-Werkhof Steinfurt e.V. | Bezirk Münsterland (verdi.de)

Web image 15 Municipal Public Workshop in Chatel (URL: Châtel. L'atelier municipal de menuiserie dispose d'une aspiratrice (ledauphine.com)

Web image 16 Hotel Kulikovskiy in Kharkiv (URL: Hotel "Kulikovskiy", Kharkiv - official site (kulikovskiyhotel.com)

Web image 17 Arkadia, An Urban Building in Sidney, Australia made of reclaimed bricks (URL: Gallery of Arkadia / DKO Architecture + Breathe Architecture - 5 (archdaily.com)