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Urban Mining Scan IBA’27 Portfolio

INTERNATIONAL BUILDING EXHIBITION 2027

14 November 2024

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Introduction

Remaining within Europe's climate budget requires the construction sector to become climate-neutral as fast as possible. This transformation demands replacing environmentally harmful building materials with recycled or eco-friendly alternatives. Circular construction methods, which focus on minimizing resource consumption and reducing carbon footprints, are key to this shift. The International Building Exhibition 2027 (IBA'27) in Stuttgart plays a role in supporting innovative technologies and planning approaches, enabling buildings to adapt to future developments and set circular ambitions.

The innovative and transformative projects of IBA'27 aim at prioritizing sustainable use of land, space, and resources, while enhancing the natural landscape and quality of life in the Stuttgart region. Urban mining, a circular strategy that concerns the reuse of building materials at a high value, is particularly effective in making a sustainable impact at the project level.

WHAT IS URBAN MINING?

Urban mining of building materials is a circular concept focused on recovering and reusing materials from existing buildings and infrastructure. This report focuses on materials that are released and applied in the construction of buildings.

The principles of urban mining aim to minimize waste and extend the lifespan of building materials, in order to reduce environmental impact. This report is a first high-level assessment of the potential for urban mining in the IBA'27 projects.

URBAN MINING SCAN FOR IBA'27 PROJECTS

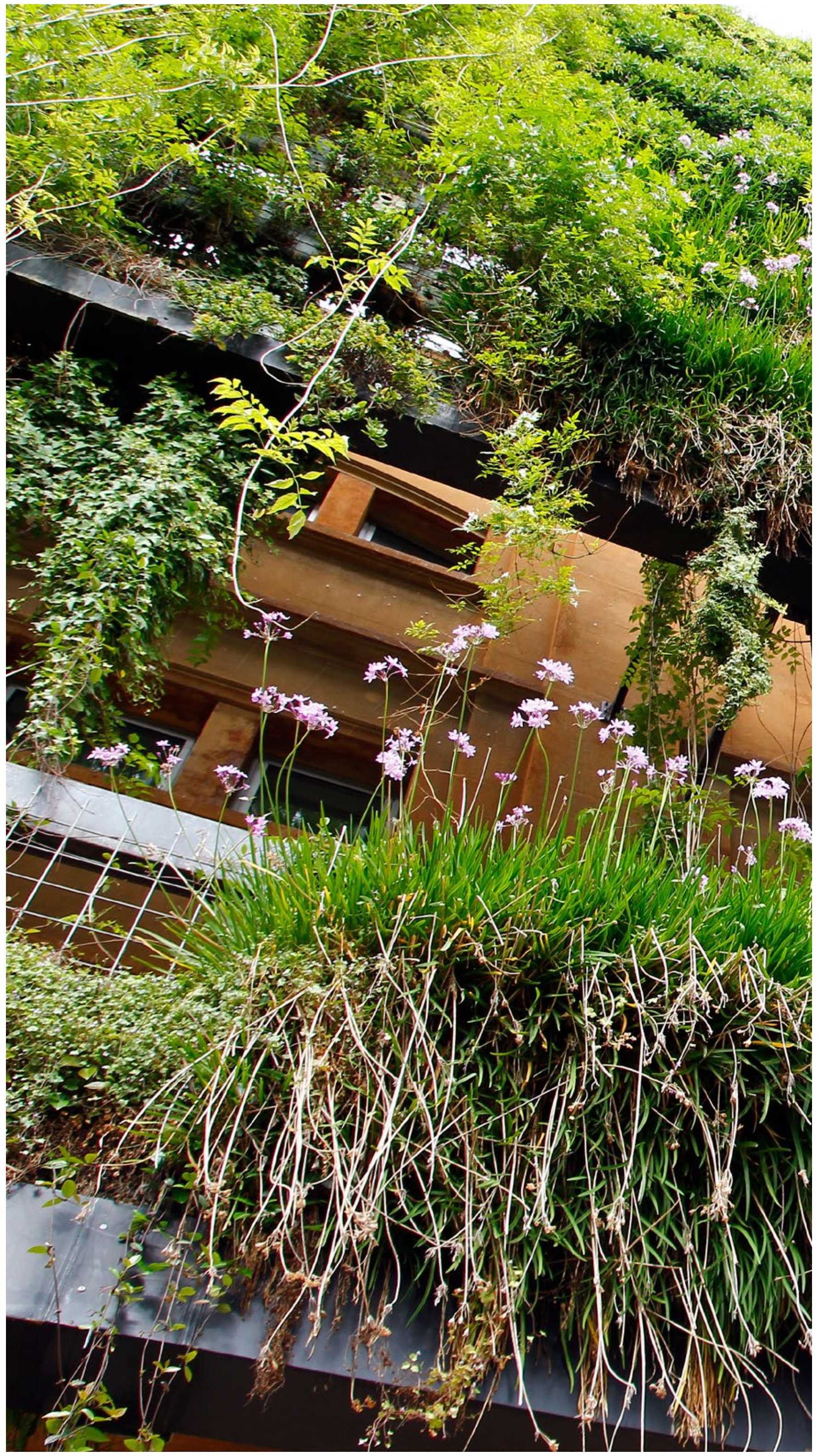
This report provides an analysis of the urban mining potential in a selection of IBA'27 projects. We create a comprehensive overview of materials entering and leaving these projects during construction, renovation and demolition phases.

By highlighting this material flow and its urban mining potential IBA'27 can firstly determine a realistic, but nonetheless ambitious, level of ambition for utilising this potential per project, but also across IBA'27 projects.

Secondly, IBA'27 can use the results to put the potential of urban mining practices in the Stuttgart region on the agenda of partners as well as the municipality.

Thirdly, the urban mining scan can be used to facilitate the development of a urban mining infrastructure for the IBA'27 projects, for example in the form of a (digital) circular construction hub.

Ultimately, this research aims to raise awareness and foster discussions around the opportunities for urban mining and its potential application to these projects.



Method

SELECTION OF IBA'27 PROJECTS

The IBA'27 portfolio contains a wide variety of projects. For this research IBA'27 selected seven projects, based on selection criteria, namely data availability, planning stage and sustainability focus.

The projects that were selected are:

46	Sindelfingen Hospital Area Conversion
48	Backnang West Neighbourhood
67	KaepseLE
136	Living by the River in Untertürkheim
140	Tobias Mayer Quarter
165	Transformation of the Klett area
-	Urban Transformation Flandernhöhe

Thereby 7 of the 29 IBA'27 projects are analyzed.

URBAN MINING SCAN

For the selected projects a data request was made including information regarding the m² floor area that are being developed, demolished or renovated, the original building year, the planned year of completed construction, and the material composition of the buildings.

The supplied data was normalized and data gaps were filled by designing reasonable assumptions based on the information that was available.

This input data was then used to link the projects to Metabolic's own building profiles and adjust these according to the available information regarding the material composition.

For renovation projects custom renovation profiles were created, which either represent "light" interior renovation, or "deep" renovation, often in combination with the transformation of the function of the building.

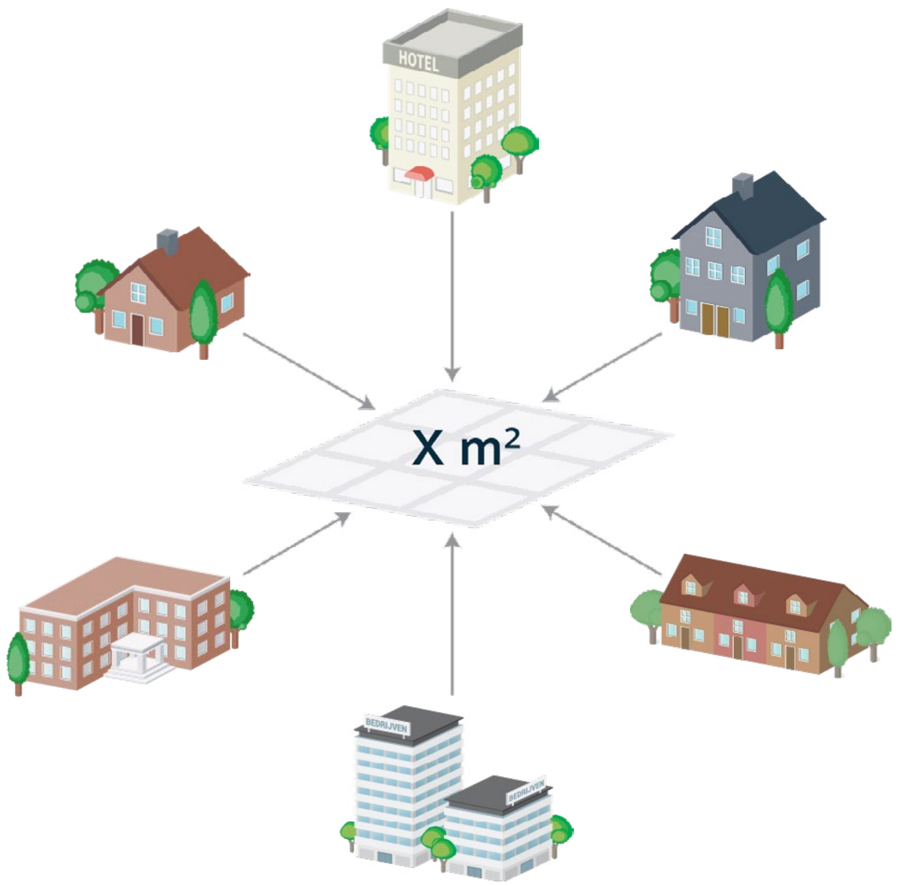
A building profile contains the materials that are most likely to be present in a representative building and details these materials in units per m². In conjunction with the information about the m² floor space we can give an estimation of the materials that are likely to be released or required for the IBA'27 projects (for more information regarding the data analysis see Appendix B).

CO_2-EMISSIONS

The materials that are detailed in the building profiles are linked to information about their environmental impact based on the product's EPD. These environmental impacts are available through the "Nationale Milieu-Database". Based on these impact factors the embedded CO_2-emissions caused by the building materials that are applied in new construction or renovation can be determined. Likewise, the saved CO_2 emissions through reuse can be estimated.

FORECAST

It is important to emphasize that this analysis does not provide a complete picture but offers insight into what is likely to happen based on known data (for assumptions see Appendix A). In practice, the situation may differ, for example, due to rapid innovations in the market for certain materials. However, this forecast provides a solid foundation for planning strategies related to material management and conversations about the circular potential of IBA'27 projects generally.



01
Urban mining scan

Selected projects

This urban mining scan includes seven projects of the IBA'27 portfolio. Most of these projects are brownfield developments, which means that they sometimes include demolition activities and usually include renovation activities (see figure 1). Three projects, namely Backnang, Klett Area and Tobias Mayer Quarter include demolition activities, with Tobias Mayer Quarter having the relatively largest share of demolition of the selected projects. Renovations are a significant aspect of all of the selected projects, except from KaepseLE, which is a greenfield development, which means that exclusively new construction takes place. While most projects have a large share of new construction activities, Klett Area has only a small number of newly built square meters.

Most of the selected projects have a focus on the development of housing, making housing, and a mixed use of housing and retail, the predominant typology across the projects (see figure 2). Klett Area forms an exception again, being the only project that will be exclusively an office function. The most diverse project is seemingly Backnang, however, other projects, such as Sindelfingen Hospital are likely to be equally diverse in functions. This skewed representation is most likely caused by the different planning stages of the projects.

There is a large variety in the size of the selected projects, ranging from 24.323 m² GFA in Klett Area, to 189.600 m² GFA in Sindelfingen Hospital. The average project size is 85.612 m² GFA.

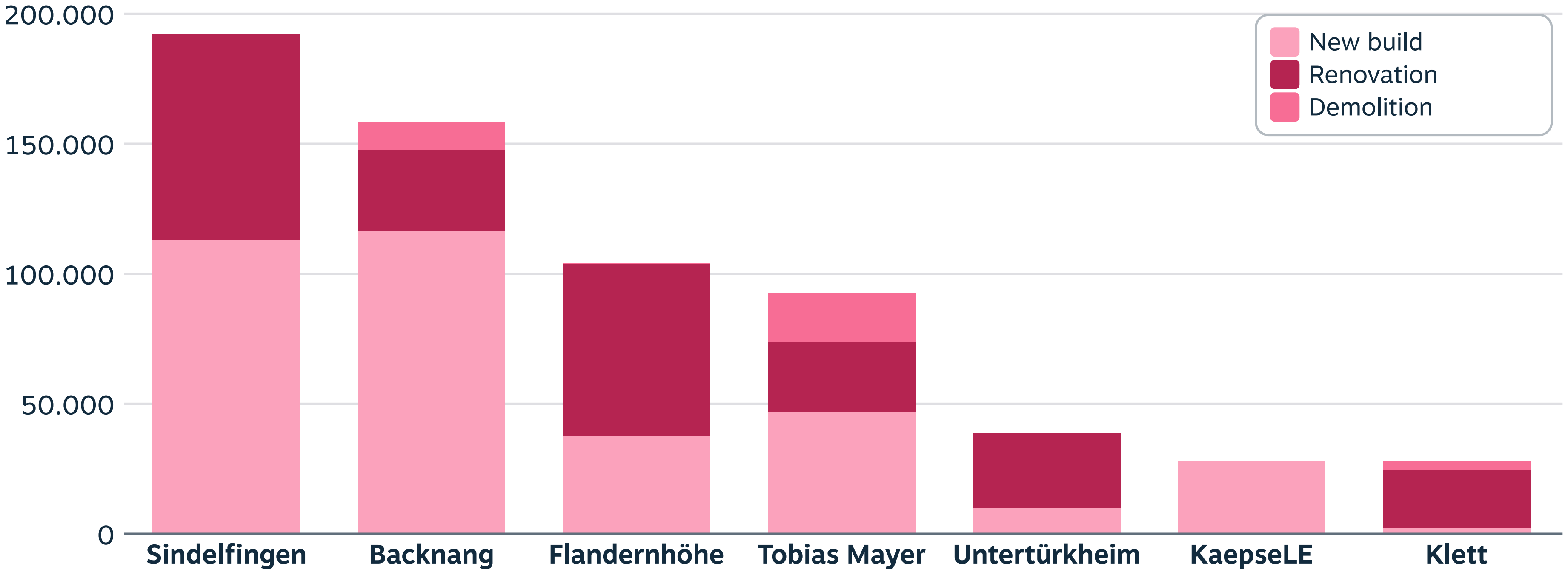


Figure 1 *Activities per project in square meters.*

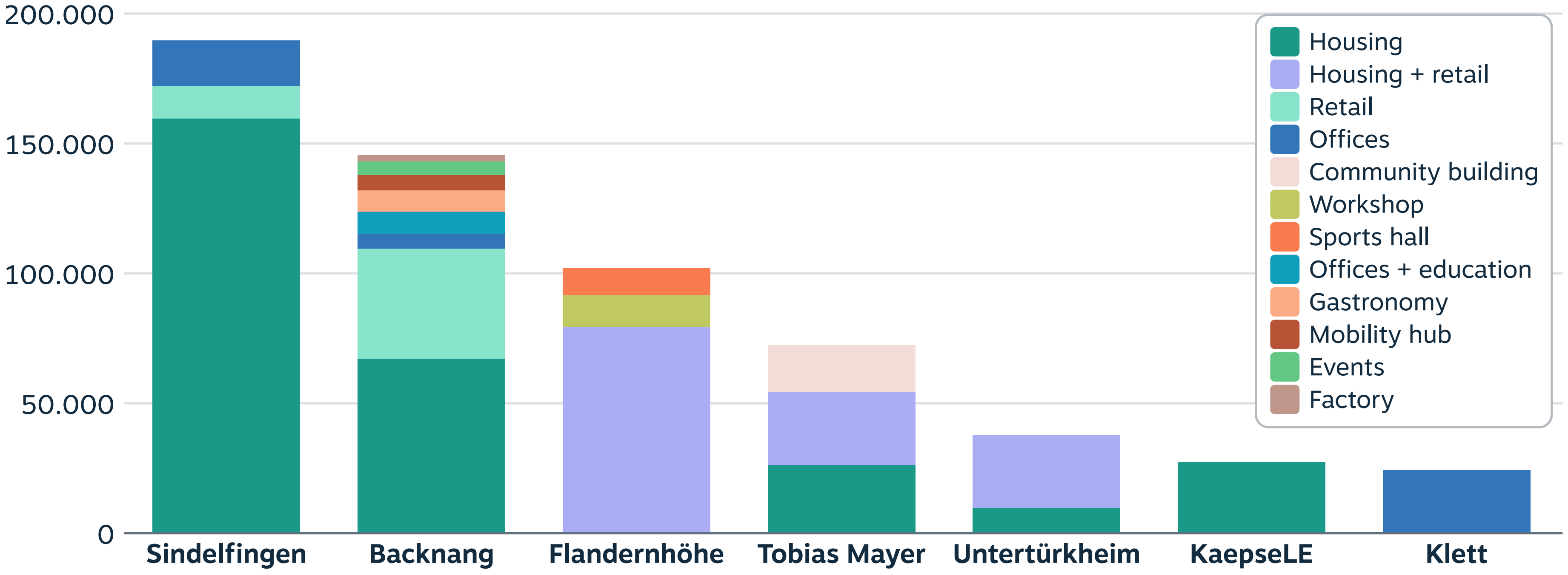


Figure 2 *Typologies per project for construction and renovation in square meters.*

Urban mining scan

SANKEY DIAGRAM

The material flows that result from new construction, renovation and demolition are visualized in a Sankey diagram. A Sankey diagram is a type of flow diagram that visualizes the flow of resources or materials through a system. The key feature of a Sankey diagram is that the width of the lines is proportional to the mass of the flow they represent. By using a Sankey diagram the order of magnitude is easily visible and hotspots for impact reduction can be identified.

Figure 3 shows all material flows connected to new construction, renovation and demolition activities for the selected IBA'27 projects. From the left side the building materials that are required for construction and renovation enter the different projects. The materials that are released due to renovation and demolition leave the projects on the right side of the Sankey diagram. This way, the largest material flows can be identified overall as well as per project. It is also possible to determine the reuse potential for materials within and across projects.

Urban mining scan

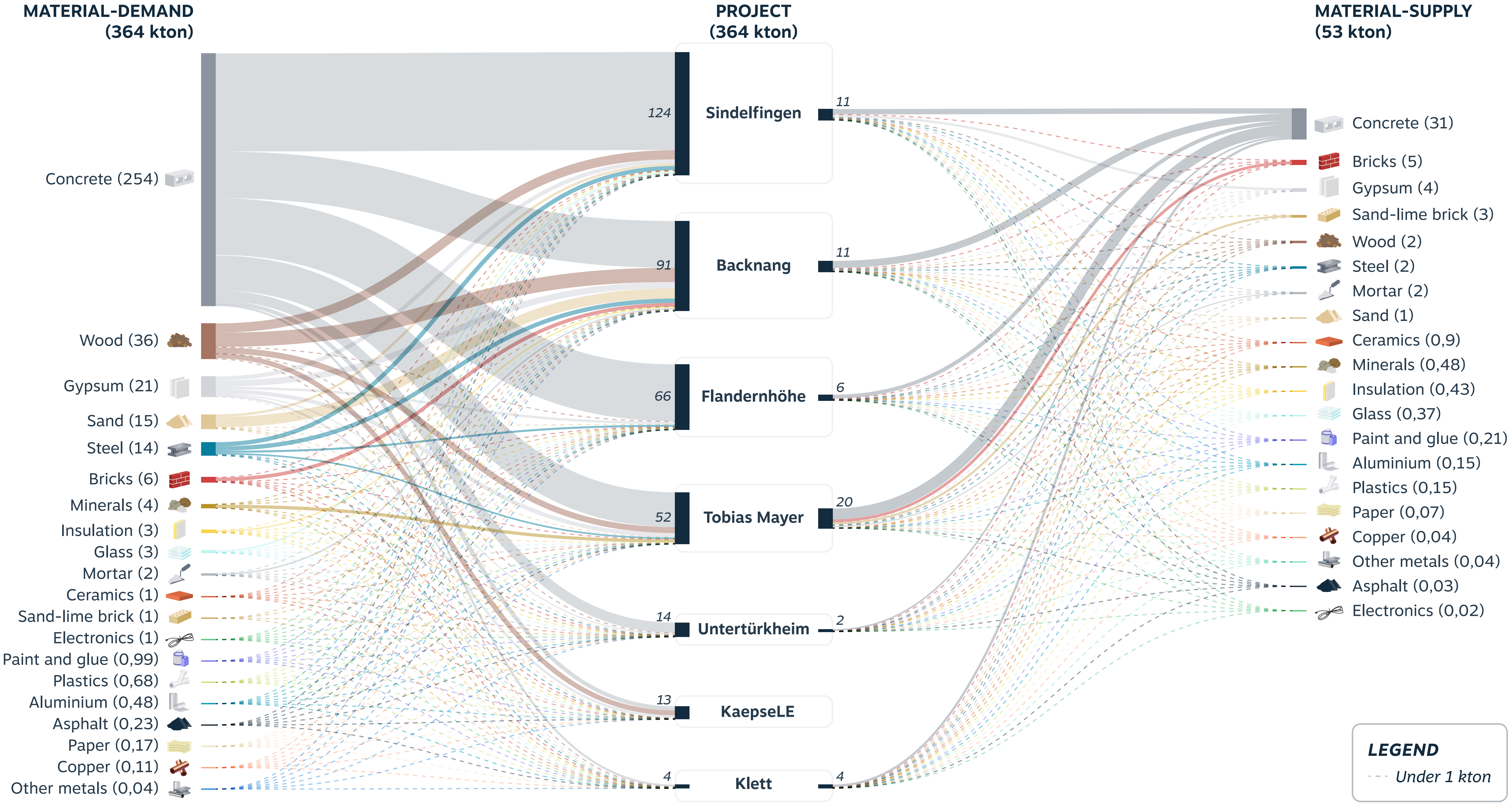


Figure 3 *Urban mining scan for the selected projects in kton.*

Urban mining scan

INFLOW OF MATERIALS

The left side of the diagram shows the mass of building materials that are required for new build and renovation activities of the different projects. In total 364 kton of materials are required for the (re-)construction of the buildings.

70% of the demand for building materials are concrete. Concrete is used mainly for the foundation and main supporting structure of new buildings. The most concrete is used in the projects Sindelfingen, Backnang, Tobias Mayer and Flandernhöhe.

Wood is the second most used building material across the different projects. 10% of all construction materials are estimated to be wood. While some projects have a small share of wood, other projects replace some of the main construction materials with cross-laminated timber and thereby have a relatively larger share of wood, e.g. Sindelfingen and Backnang.

Other materials that are needed for construction and renovation include gypsum (6%), sand (4%) and steel (4%).

Light materials, such as e.g. plastic have a low mass, and therefore do not appear prominently in the diagram.

OUTFLOW OF MATERIALS

The right side of the diagram shows the building materials that become available as the result of demolition and renovation activities of the seven selected projects. In total 53 kton of building materials flow out of the projects during their development.

More than half of the outflowing materials are concrete. Most concrete becomes available through the Tobias Mayer project. Projects like Sindelfingen and Backnang also yield a large amount of concrete.

The second largest outflow of materials are bricks. Conventional bricks and sand-lime bricks constitute a total of 15% of the outflowing materials.

Gypsum, wood and steel are also materials that become available to a lesser degree.

REUSE OPPORTUNITIES ACROSS PROJECTS

The outflow of building materials constitutes 15% of the required building materials. Notably, around 70% of these incoming materials consist of concrete, and more than half of the freed materials are also concrete. This highlights the continuing importance of concrete as a construction material as well as an opportunity to recycle the most commonly used building material.

After concrete, wood is the second most widely used material, making up about 10% of incoming building resources. This highlights its growing importance in sustainable construction. While some projects, such as Sindelfingen and Backnang, already have a clear focus on biobased construction, other projects in the portfolio may follow their lead and apply biobased building materials as well.

The amount of freed-up bricks is nearly equivalent to the amount needed for new projects, suggesting an excellent opportunity to close the loop on brick use across the different projects.

In the Tobias Mayer project the outgoing building materials are 38% of the required building materials. This is the project with the largest share of freed materials, indicating the potential for efficient material management to significant reductions in waste.

Urban mining scan | Sindelfingen

The redevelopment of the Sindelfingen hospital area, as part of IBA'27, focuses on transforming the 1960s-built hospital complex into a lively new city district. Following the relocation of the hospital operations to a new clinic, the plan envisions creating a vibrant community that combines housing, workspaces, education, and recreational areas. A key aspect of the project is retaining and repurposing many of the existing buildings, which aligns with sustainability goals and circular economy principles by reducing the need for new construction and preserving embodied energy. The plan also incorporates green spaces, aims to improve local mobility, and proposes an environmentally friendly, car-free neighborhood layout.

The design supports flexible uses of the buildings and integrating the natural woodland surroundings. Up to 700 housing units will be created, hosting around 1,500 residents. 111.300 m² are to be newly built, 78.300 m² are to be renovated.

Urban mining scan | Sindelfingen

In total 124 kton of material is required for the renovation and transformation of the existing structures as well as the new construction. 9% is required for renovation, while the remaining 91% are required for new construction. There is a supply of building materials through renovation which amounts to a total of 11,1 kton of materials. This means that the inflow of materials can consist of a maximum of 9% reused/recycled materials from the Sindelfingen development itself.

The embedded impact of the Sindelfingen development can be related to renovation by 76,8% and to new build by 23,2%. In total the embedded emissions amount to 37,6 kton CO_2 eq.

The potential impact of reuse for the transformation of SIndelfingen is high in absolute terms, since there a significant amount of building materials are required for the new construction as well as the renovation, both of which also have a relatively high impact.

However, because the project concerns a transformation, reuse within the project may prove to be challenging. Therefore sourcing building materials from outside the project, from other iBA projects or beyond, may be necessary to harvest this potential impact.

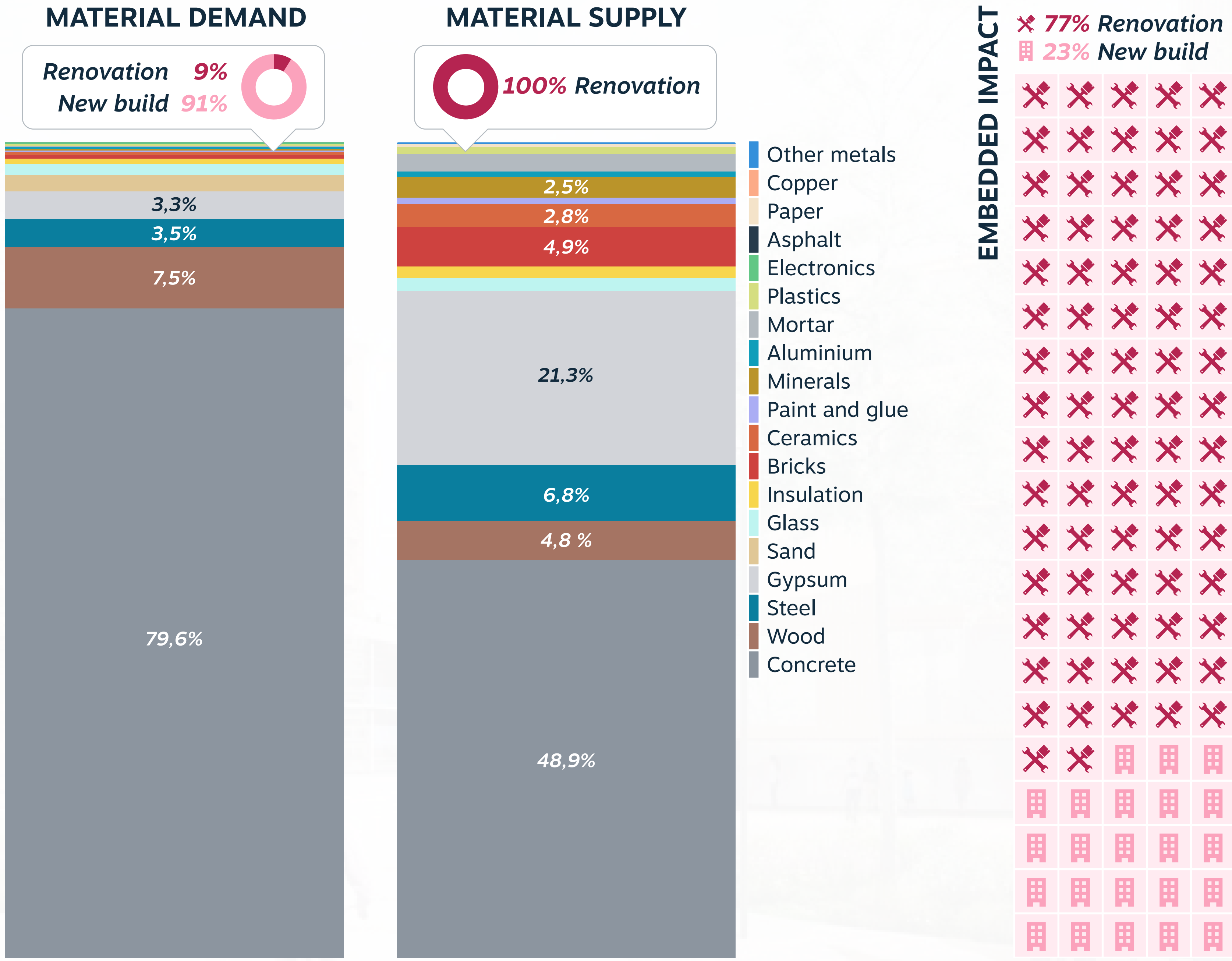


Figure 4 Material demand, supply and embedded impact.

Urban mining scan | Backnang

In Backnang the former industrial area near the Backnang train station is transformed into a sustainable and circular urban district. Key aspects include repurposing old factory structures, integrating renewable energy systems, and promoting mixed-use spaces that prioritize resource efficiency. The design emphasizes modular construction and adaptable buildings that can be disassembled and reused, aligning with circular economy principles.

In total 114.532 m² are to be newly built, and 30.858 m² are to be renovated. This means 18 buildings are to be renovated, while a similar number of buildings are to be demolished. The plans include future functions such as housing, retail, gastronomy and event and workshop spaces.

While the relatively large share of renovation in the Backnang development already implies a circular use of materials, there are additional reuse opportunities connected to the outflow materials related to demolition and renovation activities, and the materials that are required for the new construction of buildings.

Urban mining scan | Backnang

In total 90,6 kton of materials are required for the construction and renovation of the Backnang project. 10,9 kton of building materials are released as the result of demolition and renovation. The supply of building materials thus theoretically covers 12% of the total demand for materials. For specific building materials this theoretical share is higher, namely as high as 26% for bricks.

The total embedded CO_2 emissions of Backnang amount to 31,3 kton. The impact of the new construction can be attributed primarily to new build activities. The materials required for new build contribute to 94,7% of the embedded impact. For Backnang, the impact of renovation per square meter is five times as small as the impact of new build.

The renovation/transformation activities in Backnang contribute significantly to reduce the impact of the development. Also the impact for the new build activities is relatively low due to the focus on biobased building. However, considering the outflow of materials there is an opportunity for reuse within the Backnang project.

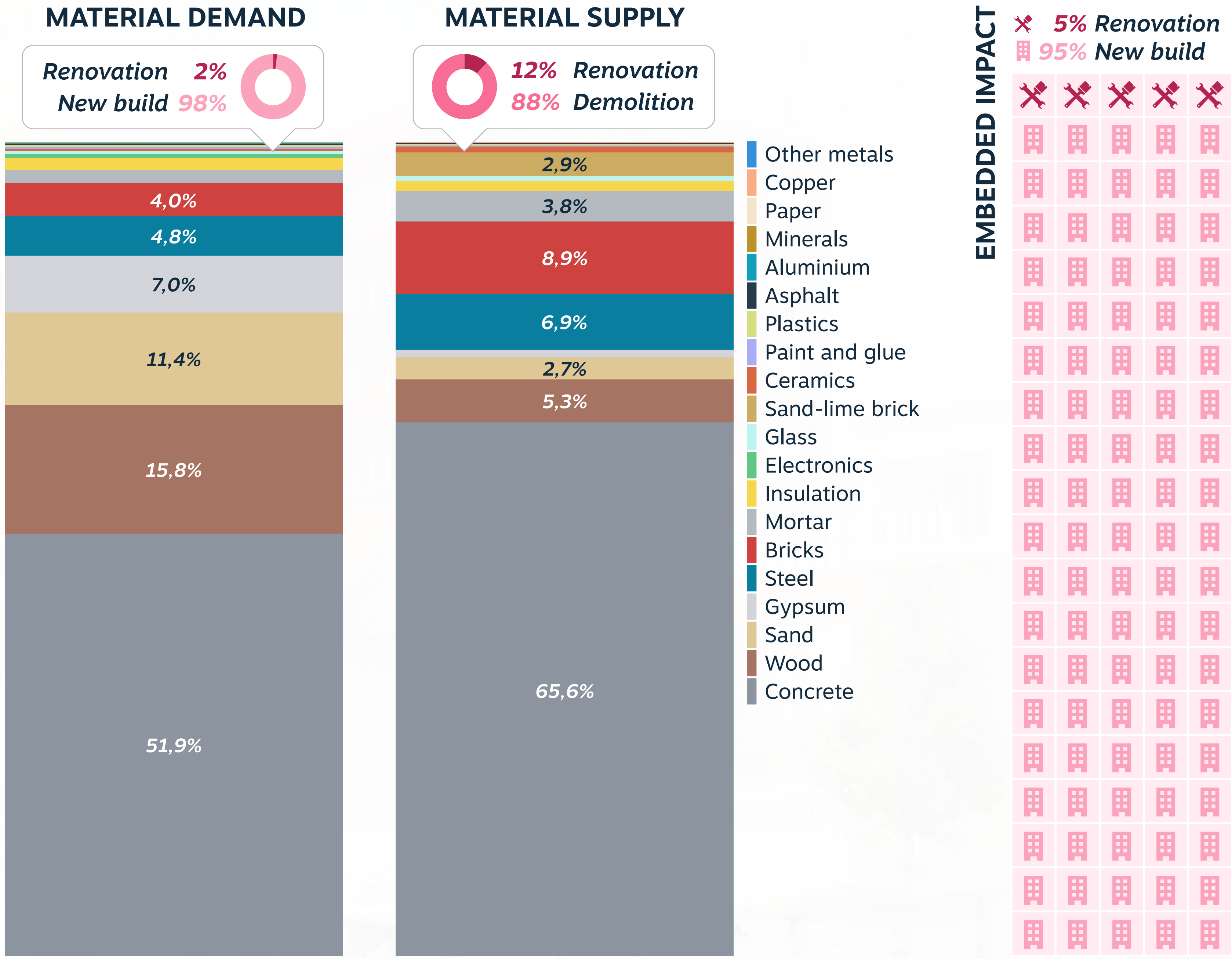


Figure 5 Material demand, supply and embedded impact for Backnang.

Urban mining scan | Flandernhöhe

The Flandernhöhe development transforms the site of a former university campus in Stuttgart into a sustainable residential neighborhood. The project emphasizes circular construction by reusing existing university structures and materials wherever possible, while designing adaptable buildings that can be modified or dismantled for future flexibility.

As part of the development 37.200 m² are to be newly built. 64.985 m² of existing buildings will be renovated. Only one building is planned to be demolished. Most of the square meters will thus be realised through the means of renovation of the existing structure. The new development will consist of functions such as housing, retail, sporting and workshop facilities.

Repurposing the former university campus is a circular approach to the development of this area. The outflow of materials through renovation offers additional opportunities for reuse in the new construction.

Urban mining scan | Flandernhöhe

In total 65,8 kton of materials are required for the new construction and renovation activities at Flandernhöhe. 5,6 kton of materials are released through demolition and renovation. The supply of building materials thus theoretically covers 8,5% of the total demand for materials. This share is especially high for gypsum, wood and bricks, which makes reuse particularly promising for these materials.

At Flandernhöhe 79,7% of the embedded impact stem from renovation activities and 20,3% from new build. In total the embedded impact amounts to 14,2 kton CO_2 eq.

While repurposing of the former campus is a circular approach as such there is a large opportunity for the development to make use of the benefits of reuse to lower the impact of the development.

By embracing circular practices, in particular for high potential materials such as gypsum, wood or bricks, the impact can be further reduced. Additionally, there are not yet any ambitions for the project with regards to using biobased building materials. This practice could further lower the impact of the project.

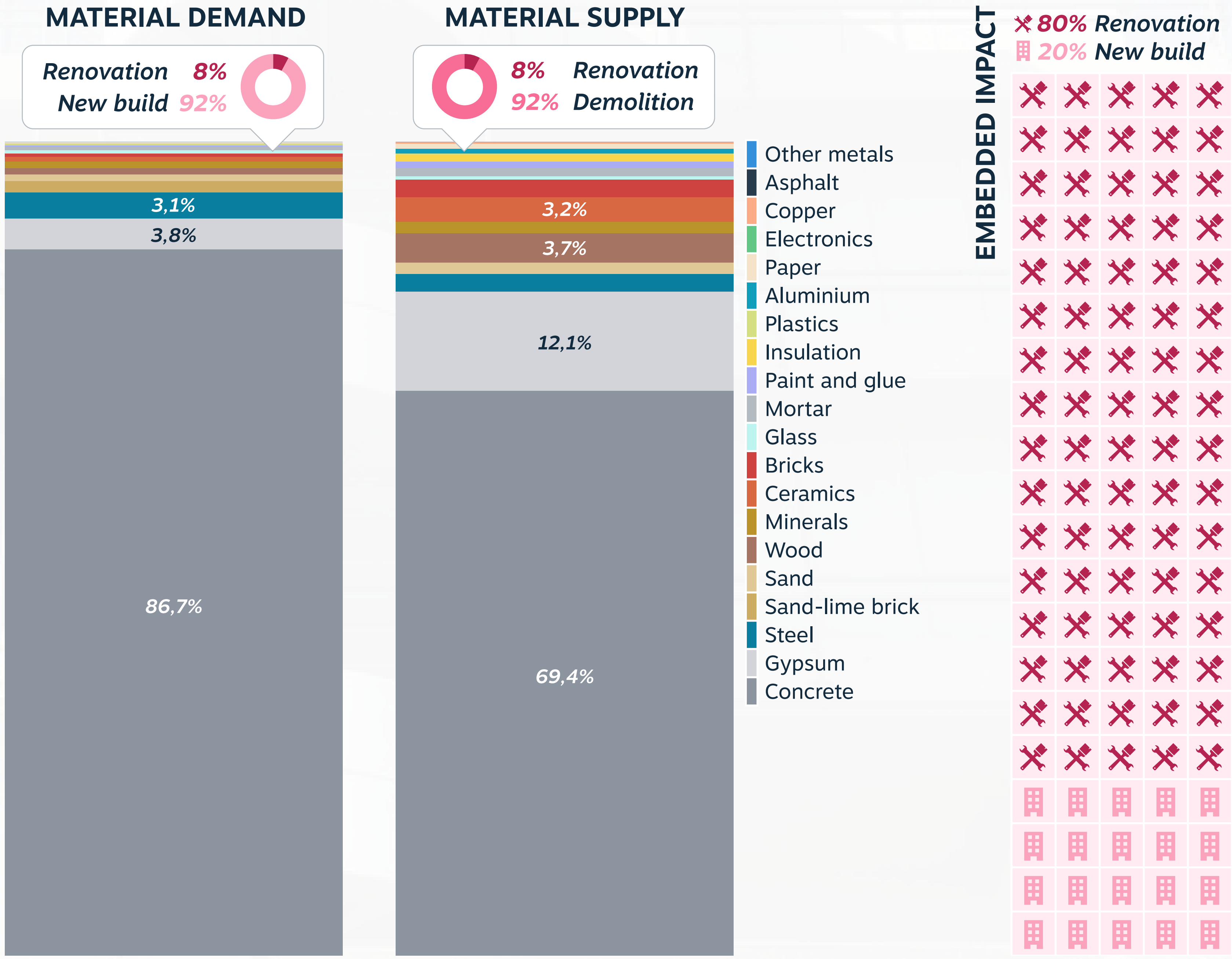


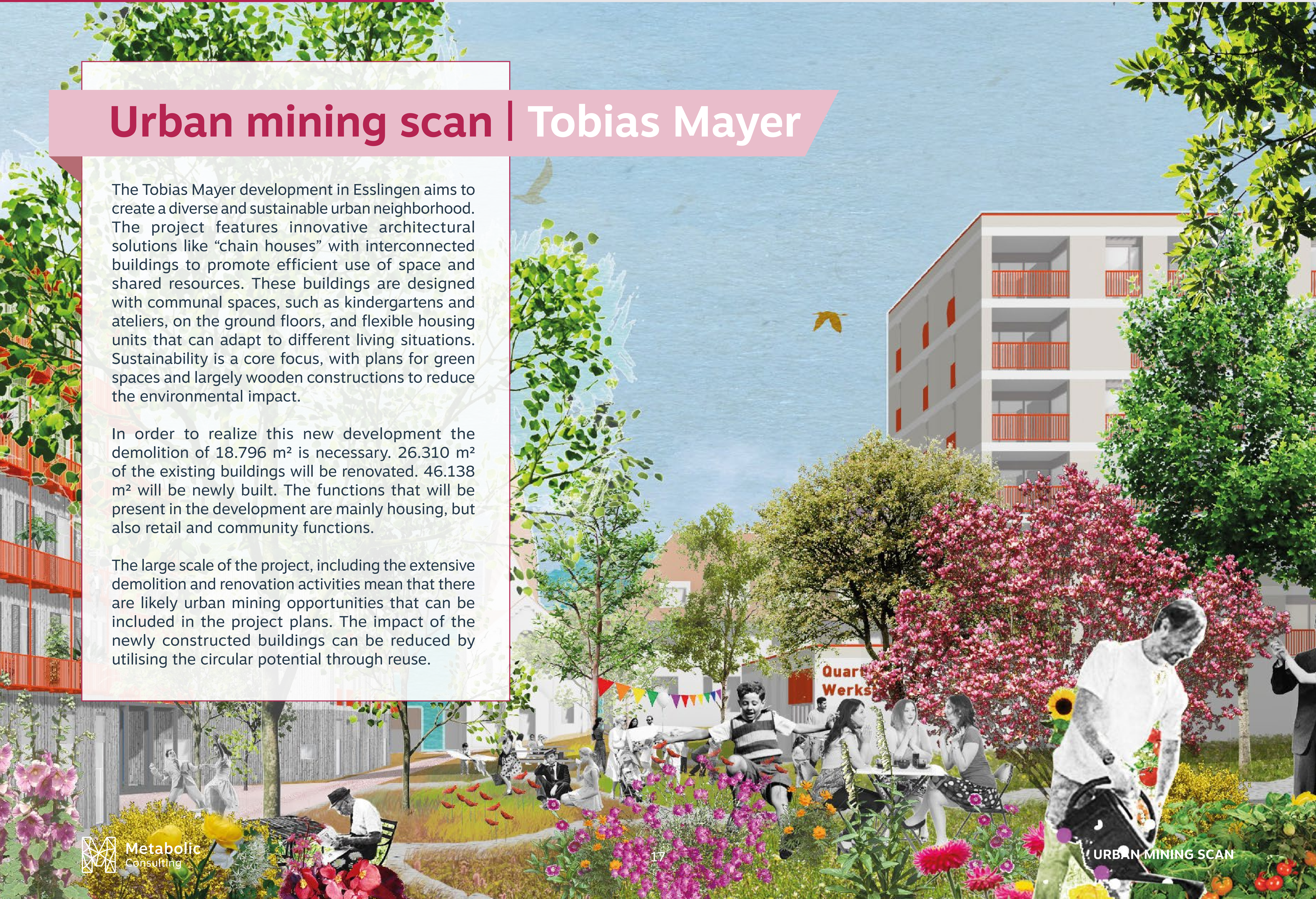
Figure 6 Material demand, supply and embedded impact for Flandernhöhe.

Urban mining scan | Tobias Mayer

The Tobias Mayer development in Esslingen aims to create a diverse and sustainable urban neighborhood. The project features innovative architectural solutions like "chain houses" with interconnected buildings to promote efficient use of space and shared resources. These buildings are designed with communal spaces, such as kindergartens and ateliers, on the ground floors, and flexible housing units that can adapt to different living situations. Sustainability is a core focus, with plans for green spaces and largely wooden constructions to reduce the environmental impact.

In order to realize this new development the demolition of 18.796 m² is necessary. 26.310 m² of the existing buildings will be renovated. 46.138 m² will be newly built. The functions that will be present in the development are mainly housing, but also retail and community functions.

The large scale of the project, including the extensive demolition and renovation activities mean that there are likely urban mining opportunities that can be included in the project plans. The impact of the newly constructed buildings can be reduced by utilising the circular potential through reuse.



Urban mining scan | Tobias Mayer

In total 52,1 kton of building materials are required for the project, of which 96,9% can be related to new build and 3,1% can be related to renovation. Demolition (93,2%) and renovation (6,8%) activities release a total of 19,8 kton of building materials.

This means that for Tobias Mayer the theoretical share of secondary materials is high, namely 38%.

The embedded impact of Tobias Mayer development is 14,7 kton CO_2 eq, of which 91% can be attributed to new build and 9% can be attributed to renovation.

The large amount of materials that are released in the Tobias Mayer project mean that there is a potential for exploring circular opportunities that require a larger scale, such as e.g. the recycling of concrete. Further, Tobias Mayer may be a suitable project to test the use and logistics of urban mining hubs, that can be used to store second hand building materials.

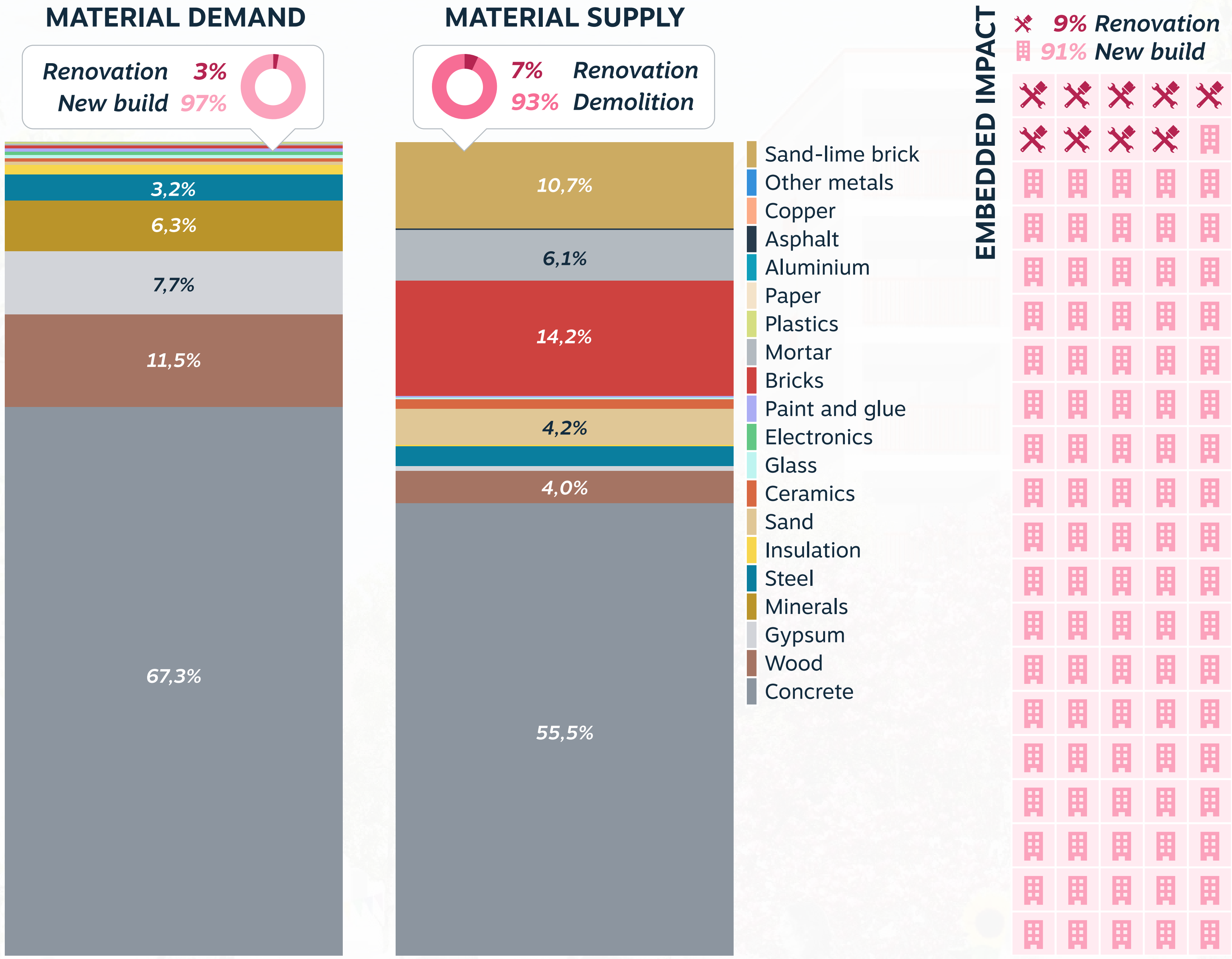


Figure 7 Material demand, supply and embedded impact for Tobias Mayer.

Urban mining scan | Untertürkheim

The Untertürkheim development, part of IBA'27, aims to create a sustainable and vibrant urban district on the banks of the Neckar River. The project, "Wohnen am Fluss," emphasizes innovative housing typologies that incorporate environmentally friendly construction methods. The site, currently occupied by industrial buildings, will be transformed into a mixed-use neighborhood with housing for around 300 residents. The design also integrates adaptive reuse of existing structures and promotes community spaces to foster a lively riverfront environment. A significant focus is on sustainability, including ecological materials and circular construction practices to reduce waste and extend building lifespans.

The project includes renovating 28.252 m² of existing buildings, and building an additional 9.694 m². Demolition of existing buildings is not part of the project. Functions in the newly developed area will include housing, as well as retail.

By renovating the existing buildings a circular approach is taken. However, additional circular potential may be available through the integration of urban mining practices in the project.

Urban mining scan | Untertürkheim

In total 14,3 kton of building materials are required for the new build (78,6%) and renovation (21,4%) activities of the Untertürkheim development. The supply of building materials stems from renovation only and amounts to a total of 2,5 kton. This means that there is a theoretical reuse potential of 17,5%.

Renovation is a significant part of the Untertürkheim development, meaning that a relatively large share of the embedded emissions can be attributed to renovation, namely 44,8%. New build accounts for the remaining 55,2% of embedded emissions. In total the development emits 4,1 kton of CO_2 eq.

Due to the large share of renovation in the Untertürkheim project it may be interesting to explore how the reuse of materials that become available through renovation may be organized. Concrete recycling is more promising on a larger scale, but the recycling of gypsum, wood, and bricks offer circular potential for the Untertürkheim project.

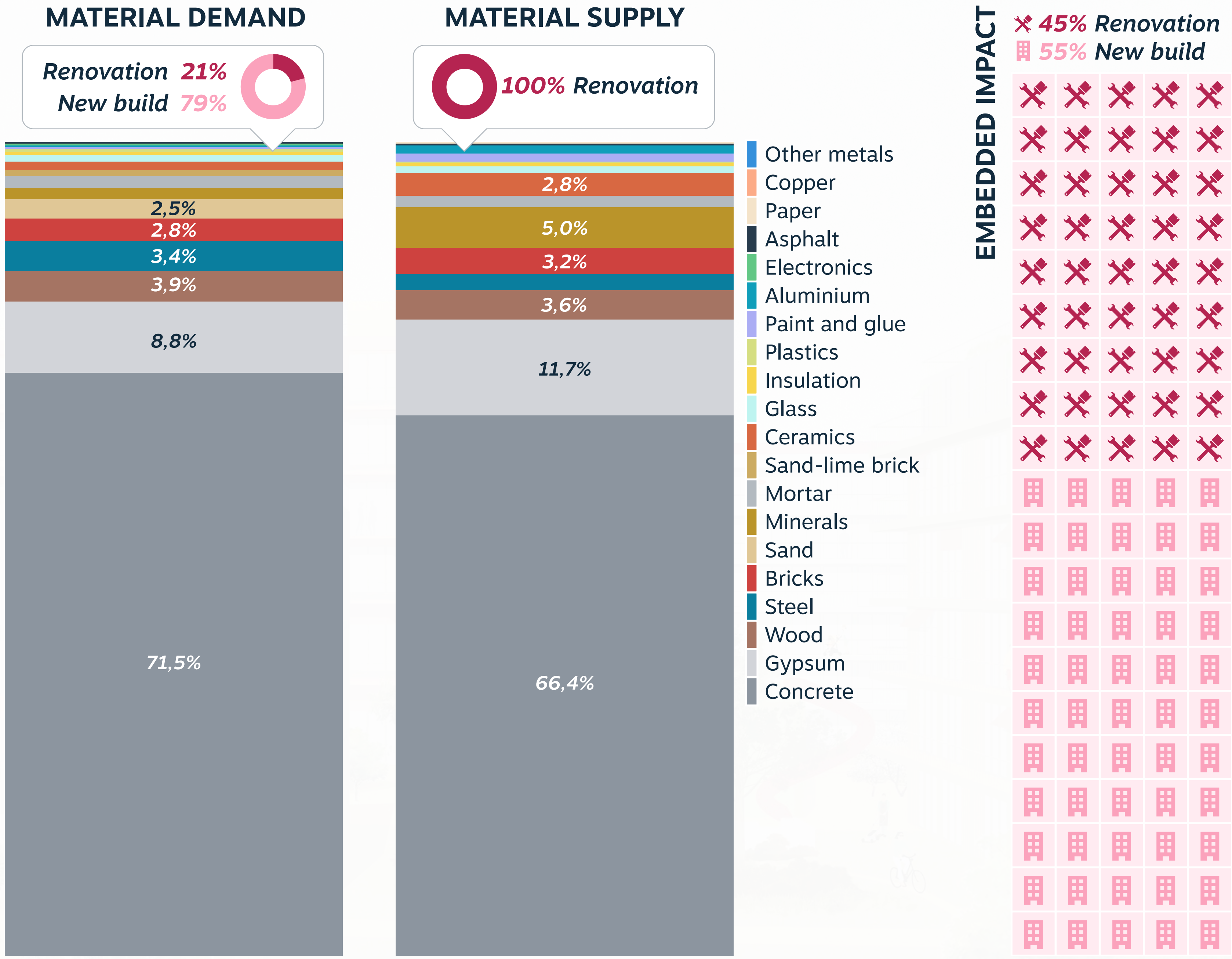


Figure 8 Material demand, supply and embedded impact Untertürkheim.

Urban mining scan | KaepseLE

The KaepseLE project is an innovative housing development in Leinfelden-Echterdingen focused on sustainability and circularity. The name “KaepseLE” is an acronym for “climate protection and adaptation through emission-free construction, plant integration, material cycles, and energy interconnections.” The project emphasizes affordable, eco-friendly housing using modular timber construction and recycled, locally sourced materials. It incorporates green façades, roof gardens, and nature-integrated courtyards.

KaepseLE is a greenfield development for housing, which will realize a total of 27.389 m². Since it is a greenfield development there will be no renovation or demolition activities.

Urban mining scan | KaepseLE

In total 13,1 kton of materials are required for the construction of the KaepseLE development. KaepseLE is the only project among the selected projects for which the largest share of required materials can be attributed to wood, namely 38,2%. Concrete is the second most used material, with 31%. Also gypsum is a much used material (18,5%).

The entire embedded impact of the KaepseLE development amounts to 5,3 kton CO_2 eq. Due to KaepseLE's focus on biobased building the impact per square meter for the new construction is relatively low.

Because there are no renovation or demolition activities as part of this development there will be no project specific urban mining opportunities in order to increase the circularity of the project. For achieving circular construction aims with regards to specifically the use of secondary construction materials the project relies on the supply of materials from outside the project.

The analysis of the outflow of materials of the other selected projects give an indication of the types of materials that may be available in Stuttgart area in the next 10 to 15 years. The project plans for KaepseLE can thus anticipate on this supply by integrating it in the plans for the development. Other circular strategies can also successfully be applied for this project, such as biobased insulation, wood construction, and disassembly potential.

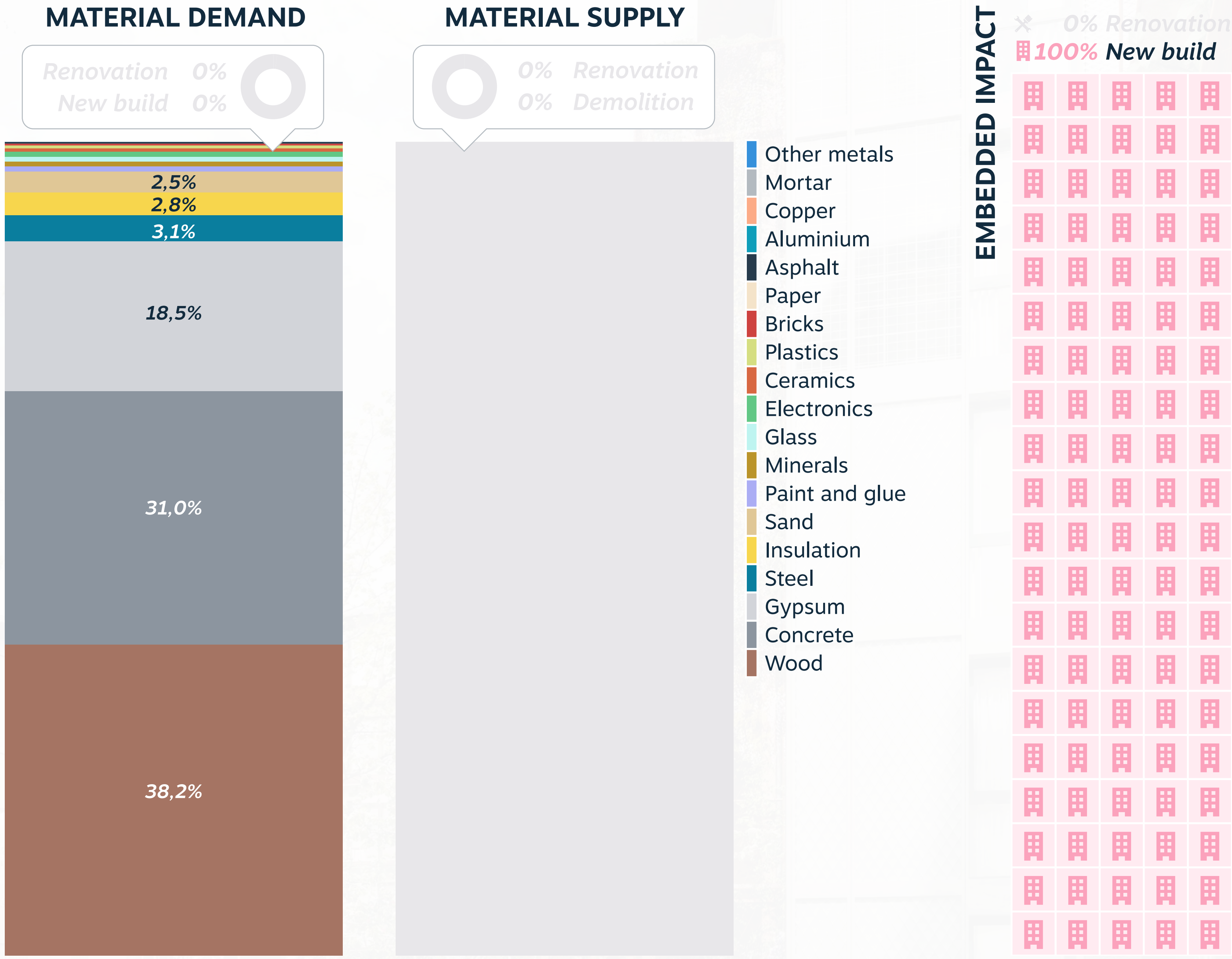


Figure 9 Material demand, supply and embedded impact for KaepseLE.

Urban mining scan | Klett

The Klett Area development focuses on transforming Stuttgart's central and highly trafficked hub into a more vibrant, sustainable, and connected urban space. Key features include mixed-use buildings for offices, and cultural spaces, fostering a lively urban atmosphere. Sustainability and circularity are central, with plans for energy-efficient designs, renewable energy integration, and flexible, modular construction that allows buildings to be adapted or dismantled.

The focus of the project lies on the renovation of the existing buildings. 22.156 m² are to be renovated. The demolition of six buildings means the demolition of a total of 3.126 m². The development adds six newly constructed buildings as well, adding 2.167 m² of new construction. The development mainly encompasses offices with some cultural or communal spaces as well.

Renovation is a important part of the development, which contributes to making the realization of the renewed office area circular.

Urban mining scan | Klett

The renovation and new build in Klett requires 3,8 kton of building materials. 45,8% of these materials are needed for the renovation of the existing structures, while the remaining 54,2% are required for the construction of new buildings. 3,6 kton of building materials are released through demolition and renovation, meaning that there is a theoretical reuse potential of nearly 100%.

72,7% of the embedded impact of the Klett development can be attributed to new build, and 27,3% of the emissions can be attributed to renovation. In total 2,1 kton of CO_2 eq. are emitted. Per square meter new build is many times more CO_2 intensive than renovation.

In comparison to the other selected projects Klett is a relatively small scale project. At the same time, there is a large match between the inflow and outflow of building materials in terms of quantity and type of materials, meaning that Klett has a very large circular potential. The small scale of the Klett project may mean that implementing urban mining practices, possibly in the form of a living lab, might allow Klett to function as an urban mining lighthouse project.

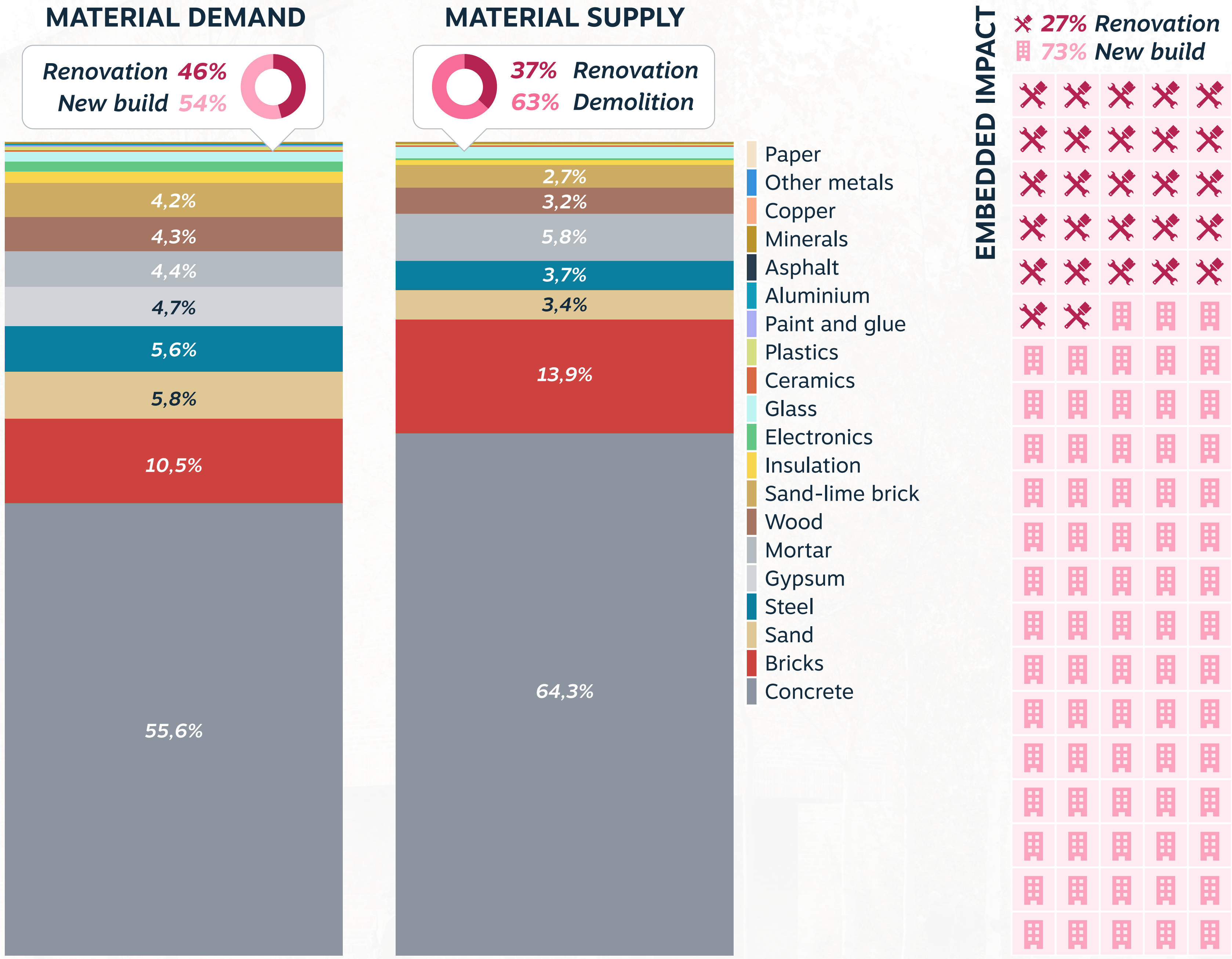


Figure 10 *Material demand, supply and embedded impact for Klett.*

02 Hotspot analysis

Inflow of materials

Figure 11 shows the mass of building materials in different building elements that are required for the construction or renovation of buildings on the left side. On the right side it shows the embedded CO_2 impact of the building materials. In total 109 kton of CO_2-eq. are needed to build and renovate the buildings.

The largest share of building materials is required for constructional floors. This is mainly reinforced concrete. The impact of these floors is relatively smaller, but still constitutes the largest share of CO_2 impact.

The second largest mass of building materials is in constructional or solid walls. Also here the main material is reinforced concrete. Again the share of CO_2 impact is relatively smaller.

Some building elements have a share in the CO_2 impact that is many times larger than the mass in which they are required. This is true especially for electricity systems. However, it is important to note that most of this impact can be related to solar panels, which in turn generate renewable electricity and compensate for the embedded CO_2 emissions within just a few years of usage.

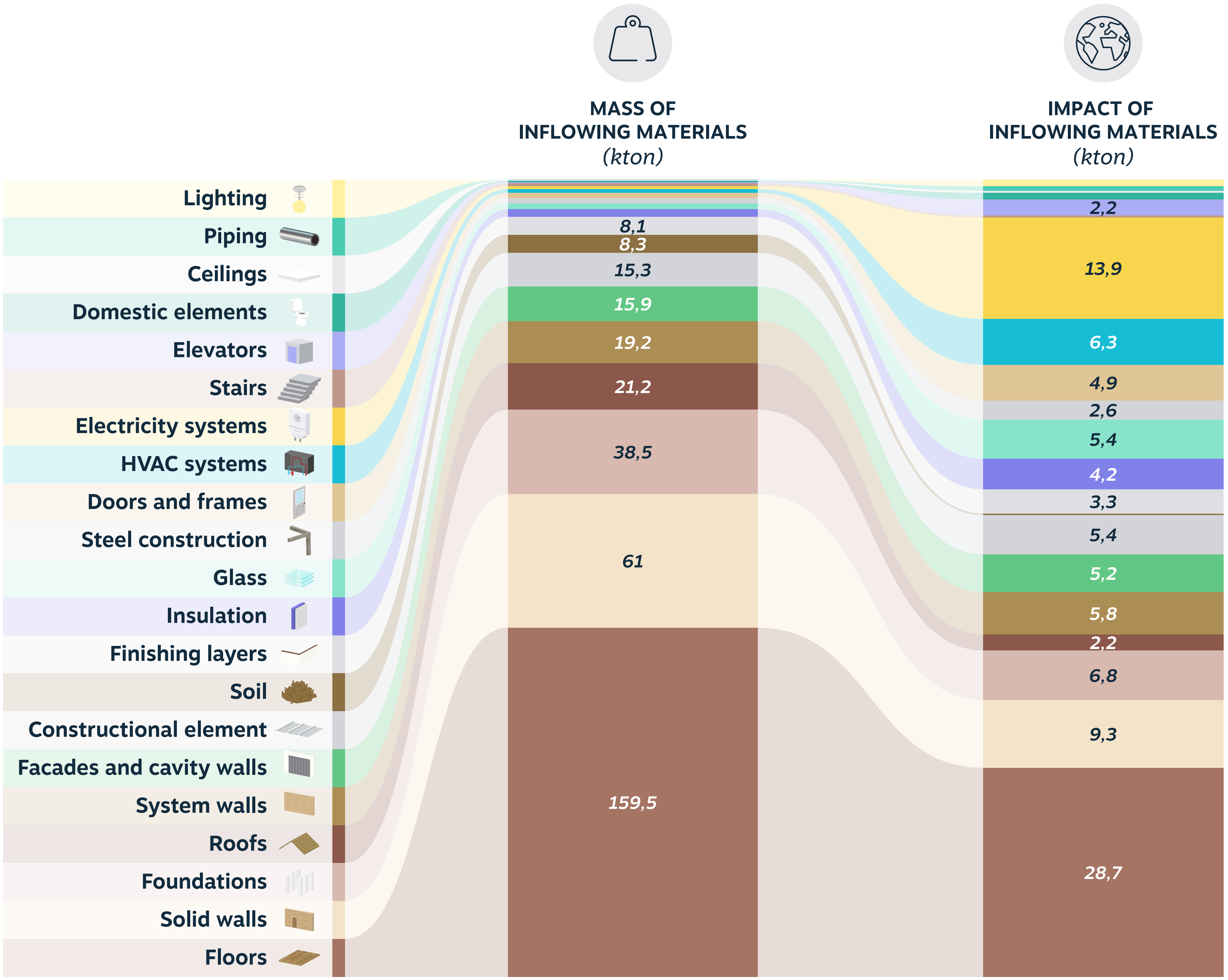


Figure 11 *Inflow of building materials | Mass and phase A impact.*

Outflow of materials

Figure 12 shows the building materials that are released as the result of demolition and renovation activities as part of the building elements on the left side. On the right side the potential reduction of CO_2 emissions is shown of these materials were to be reused through urban mining practices, also per building element.

A large mass of materials is released as part of constructional floors, walls and foundations. This concerns mainly reinforced concrete, of which the embedded CO_2 impact is relatively small compared to its mass. Nonetheless the most impact can potentially be reduced by recycling concrete structures. Doors and frames have relatively large impact reduction potential compared to their mass. The bricks that are released through the demolition or renovation of cavity walls or facades have a large mass, but also a large potential for emission reduction.

Urban mining practices can reduce the embedded CO_2 emissions of the developments. Potentially this can reduce the need for primary materials by a theoretical maximum of 18% (in mass) and would then reduce CO_2 emissions by 17,2 kton CO_2 eq., which is a reduction of 15,8%. However, it is important to note that this potential is only indicative, as it is unlike that all of the released building materials can in fact be reused. Nonetheless, it does show that there is a significant potential for urban mining practices to contribute to the reduction of material use as well as CO_2 emissions that should not be left untapped.

VALUE RETENTION STRATEGIES

Not all products are equally suitable for reuse, for example due to low quality or remaining technical lifespan, connections that are difficult to dismantle or low value as opposed to the costs of reuse. We therefore differentiate between three different value retention strategies that can indicate the most likely and most high value application of the different elements. These strategies are linked to the value hill model, as detailed in Appendix C.

Direct reuse	A number of products are suitable for direct reuse and do not require any specialized or labor- intensive processes. A quality check and possible repair may be sufficient to make these products suitable for a new purpose.
Repurpose / remanufacture	Some products may either be used in a different function than their original function (repurpose) or need some adjustments in order to restore their original functionality (remanufacture).
Recycle	A large portion of the products is only minimally suitable for reprocessing and repurposing at the product level. Therefore, these are considered at the material level and can provide circular materials through recycling processes.

Outflow of materials

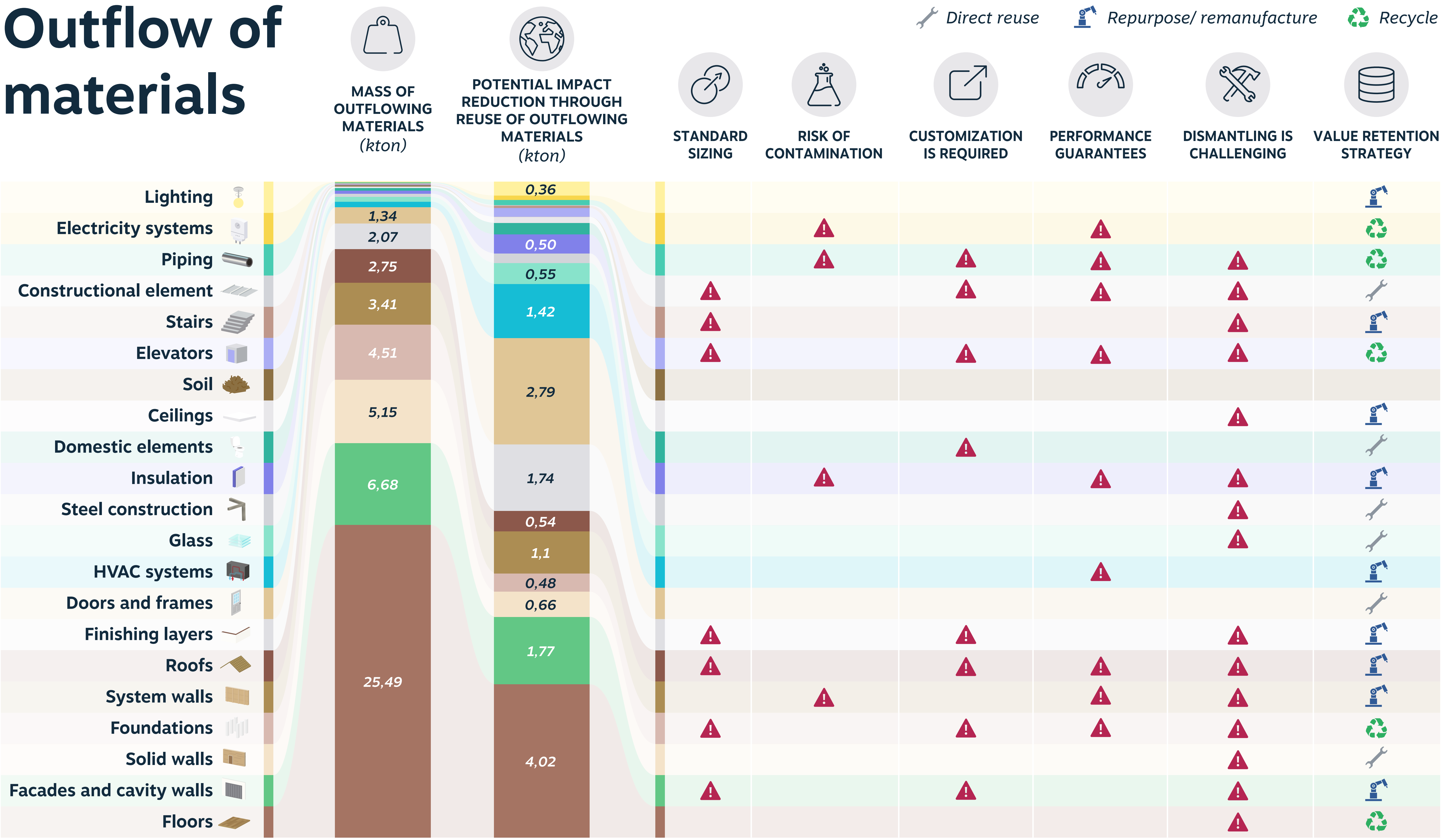


Figure 12 *Outflow of building materials | Mass and impact reduction potential through reuse.*

Outflow of materials

Non-standard sizing can limit reuse due to compatibility issues in new projects. Elements with high standardization, such as steel construction, system walls and floors, tend to be more adaptable for reuse, but dismantling may still pose challenges. Certain materials may pose health risks if contaminated, complicating all of the value retention strategies. Elements with a high contamination risk include piping, insulation, and HVAC systems. This is particularly challenging with regards to older elements or those exposed to harmful substances. Highly customized elements are less adaptable to new contexts, reducing their reuse potential. Highly customized elements, such as elevators, foundations or roofs, are often difficult to reuse or repurpose, particularly if they have specific dimensional or performance requirements. Elements such as elevators, HVAC systems and piping, may have specific performance or regulatory standards that can expire or vary, limiting reuse.

Items with strict regulatory standards may therefore be harder to reuse in new contexts due to liability or performance concerns. Components that are hard to dismantle without damage are often difficult to reuse. Structural elements in older buildings, such as foundations or roofs, are challenging to remove intact are also hard to reuse efficiently, as they may need to be broken down, reducing their value or function. Here the most suitable value retention strategy is recycling. These different constraints mean that direct reuse is best suited for modular elements with standardized sizes and conditions that allow them to be reused with minimal alteration.

Examples include doors and frames, system walls, steel constructions, and lighting. Elements like piping, elevators, HVAC systems, and domestic elements can often be adjusted to meet new specifications or remanufactured for a different function. Recycle is best suited for materials of elements that are difficult to reuse or remanufacture but have high recyclability, such as steel constructions, glass, piping, and solid walls (concrete). Recycling is generally a last-resort option, but it is often the only option for foundations and certain finishing layers due to their composition.

In order to interpret the realistic potential and the opportunities to make use of this potential we detail three elements or materials that are either easy-to-implement or lead to high-value impact in terms of the reduction of CO_2 emissions.

Concrete

Since concrete constitutes a large share of the required materials and is also the material that becomes available most, it has a large circular potential. Crushing old concrete structures allows for the reuse. Old concrete can be used as an aggregate in the production of new concrete, reducing the need for primary raw materials such as sand and gravel. Innovations such as the *smart crusher*, also allow for the recovery of unactivated cement.

Bricks and roof tiles

There are various possibilities for applying circular principles to used roof tiles and bricks. For example, they can be recycled into gravel for tennis courts or used as filler material for gabion baskets. Additionally, the bricks or tiles can be used as boundary markers. Bricks can also be recycled into new bricks. However, the most circular option is to directly reuse bricks and ceramic roof tiles as a replacement for new ones.

Wood

This intervention includes reuse and remanufacturing of wooden beams and frames, whereby wooden floor and roof beams, as well as frames, are reused after dismantling or processed into semi-finished products for a new application. There are various possibilities for applying circular principles to wooden products. For example, different types of reclaimed wood can be de-nailed, cleaned, and sold as semi-finished products. Sturdy wooden support beams can be reused and applied in various products.

Timeline of outflow of materials

Figure 13 shows when the outflowing materials will be released per type of material as well as per project.

In the upcoming years until 2030 there is a steady release of materials, constituted mainly of concrete, but also bricks and gypsum to a lesser degree. In 2030 the largest amount of materials will be released. This is because the two largest projects of the selected projects are scheduled to commence demolition and renovation activities. In reality, these may be more spread out over the years following 2030. Some projects, such as Tobias Mayer already have a more detailed planning for the renovation and demolition of the different construction sites. Materials released by the activities of Tobias Mayer are therefore continuously become available over the coming 10 years.

This overview can be used to gain an understanding of when certain materials will become available for reuse and allows projects to include this in the design and planning process. It also shows which projects require a more detailed planning in order to include the outflowing materials as inflow in other projects.

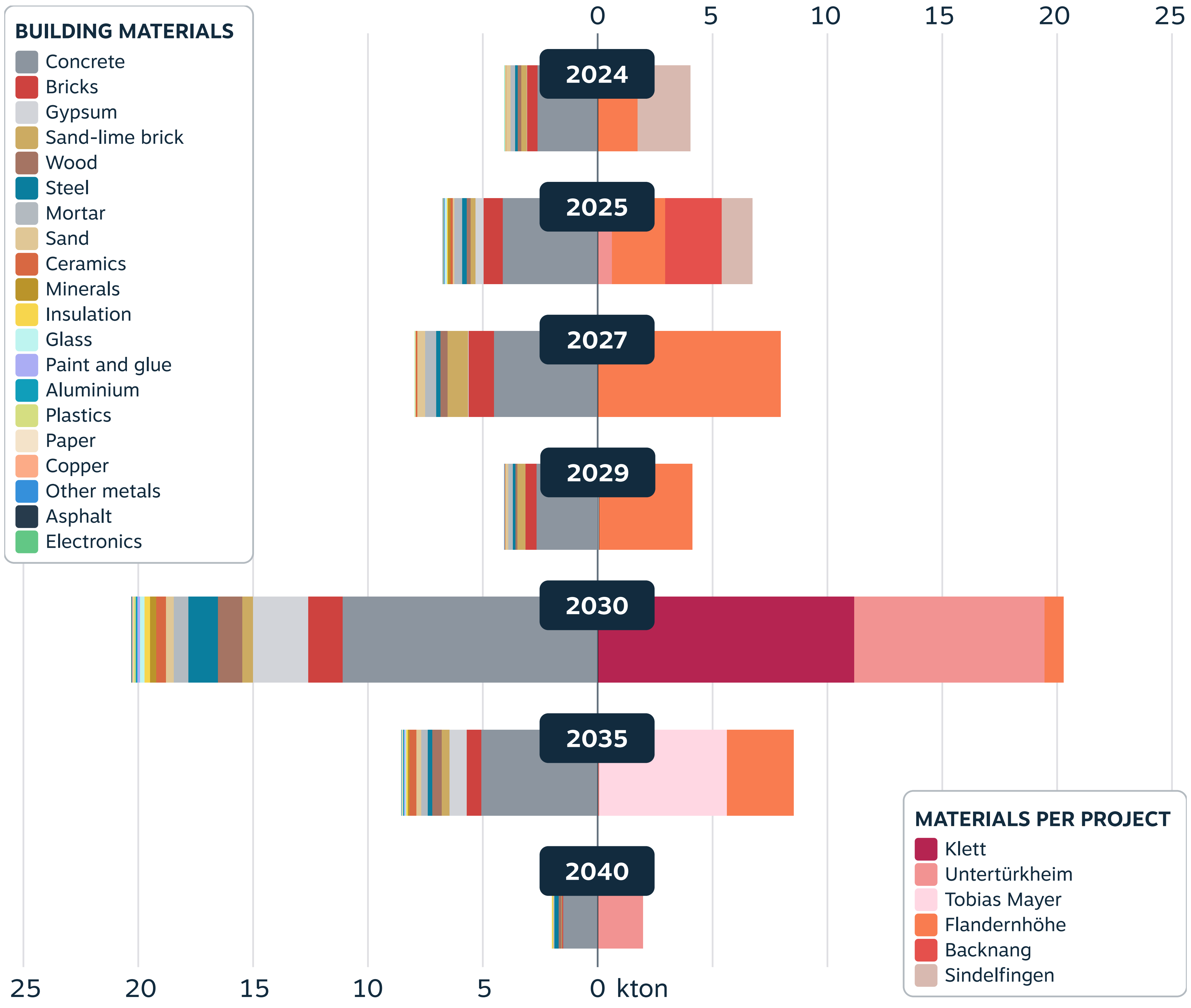
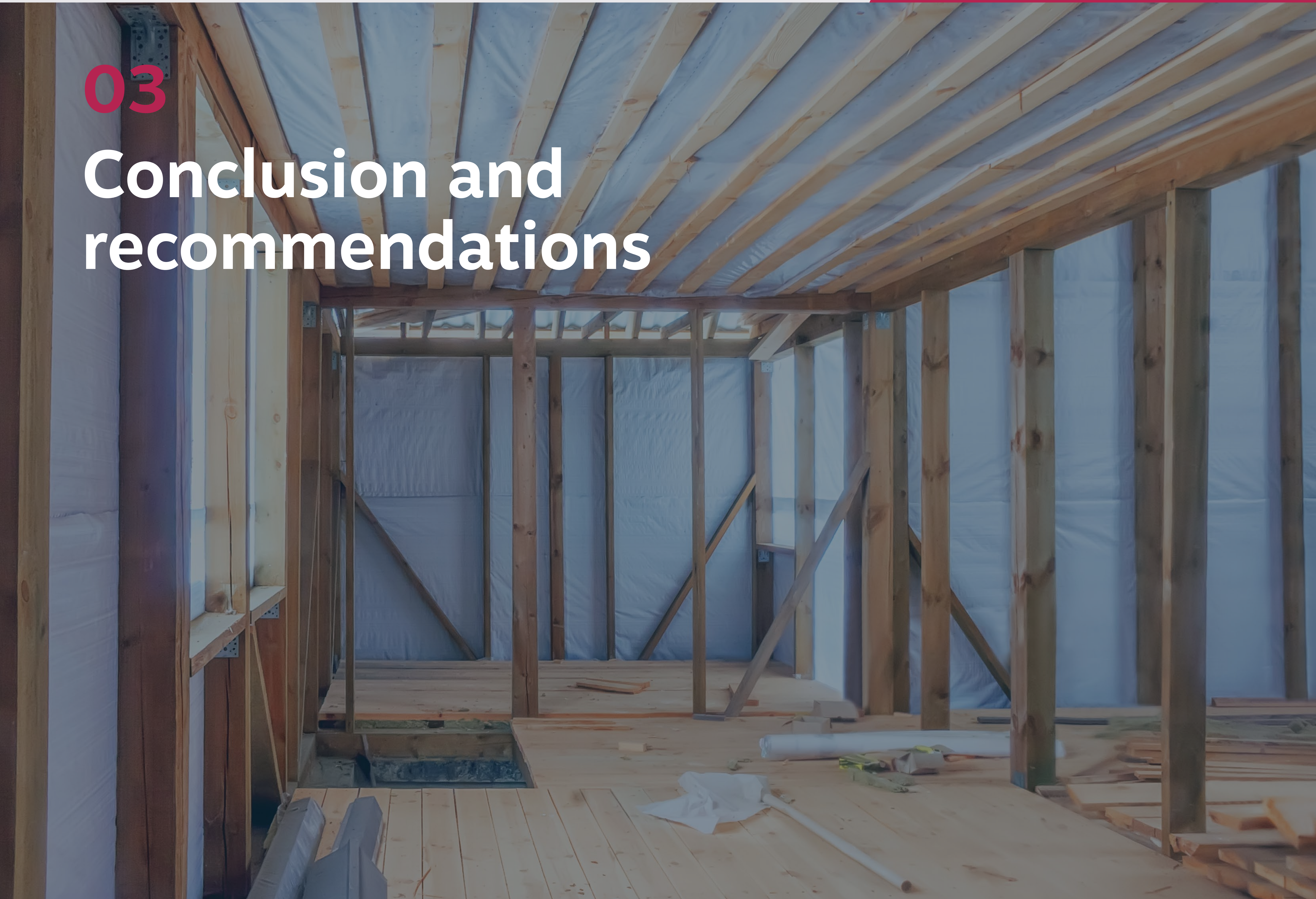


Figure 13 *Outflow of building materials per year and per project in mass.*

03

Conclusion and recommendations



Conclusion

This urban mining scan offers valuable insights into the circular potential of various IBA'27 projects, presenting an opportunity to enhance sustainability and resource efficiency across the portfolio. By utilizing this analysis, IBA'27 can formulate a circular vision for the projects and establish specific circular KPI's. These insights allow IBA'27 to assess the infrastructure needed for effective urban mining practices, such as setting up storage hubs or concrete recycling facilities.

The project-specific urban mining analyses allow for the selection of projects with **the highest potential for material reuse**. For instance, the large-scale Tobias Mayer project offers a promising platform for testing innovations that benefit from greater scale, such as concrete recycling. This could potentially be combined with other substantial projects, including Sindelfingen and Backnang.

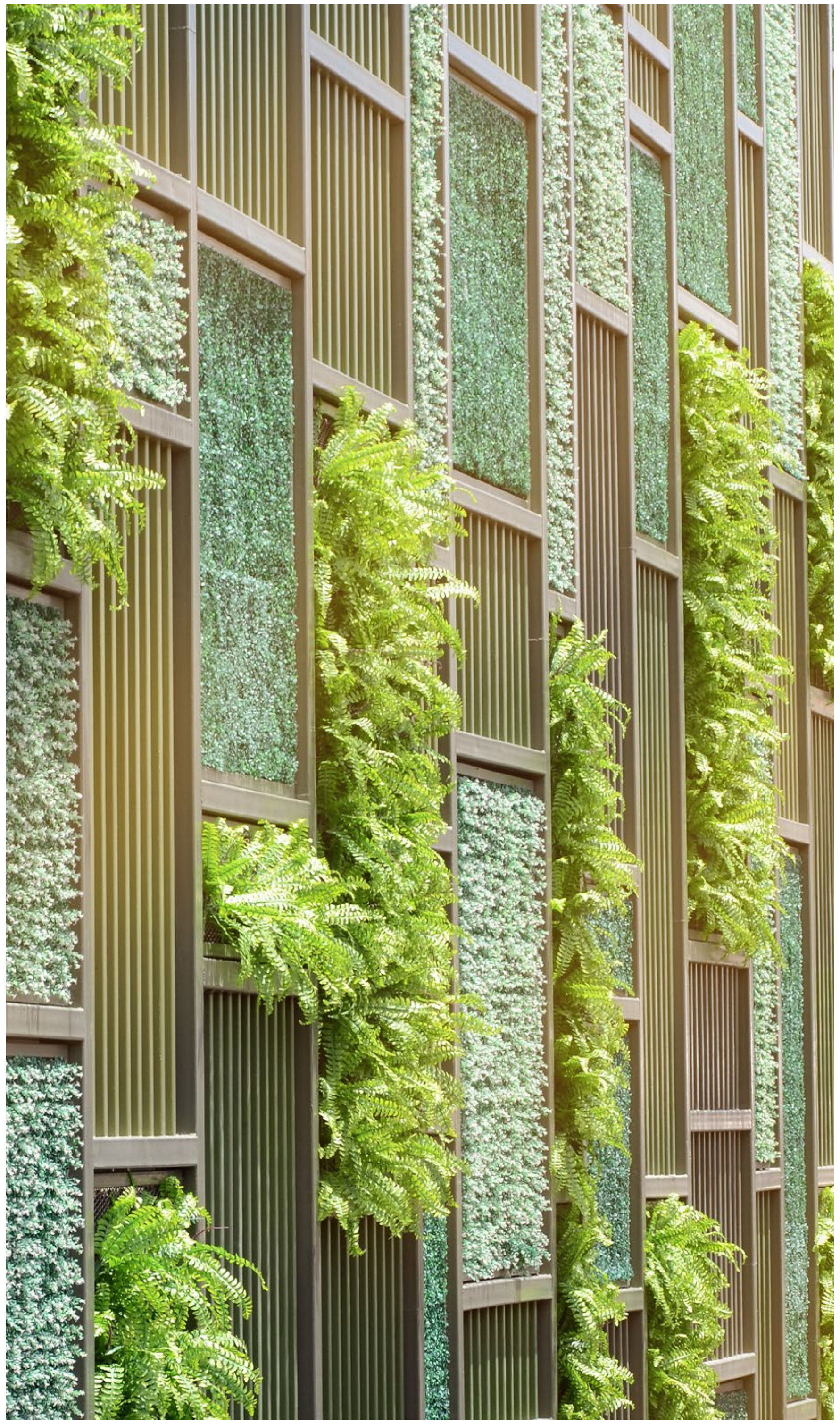
Smaller projects also demonstrate unique potential; the Klett project, though small in scale, shows an excellent match in material in- and outflows, making it suitable as a **"living lab" for circular innovations**. This project could be a testing ground for developing and refining circular processes in a controlled, smaller environment.

Meanwhile, the Untertürkheim project, focused exclusively on renovation, is well-suited to explore **reuse opportunities for materials sourced from renovation activities**.

Finally, the greenfield KaepseLE development, which emphasizes circularity from its inception, offers an ideal platform to **explore project synergies**. By adapting its material demands to align with the materials anticipated from other IBA'27 projects, KaepseLE could demonstrate how greenfield projects might harmonize with a circular economy vision.

A key focus of IBA'27' could be the large-scale recycling of concrete, which represents both the primary material released through demolition and the primary need for new builds across projects. Establishing concrete recycling facilities will allow high volumes of this material to be collected, processed, and re-integrated into new constructions. For example, recycled concrete aggregates can be used in the foundation layers of new buildings or as structural material in non-load-bearing walls, significantly reducing the demand for new concrete and associated carbon emissions.

On a smaller product scale, there are additional opportunities for impactful material reuse, particularly through salvaging high-value materials such as bricks, roof tiles and wood. Reusing bricks from demolished structures, for instance, preserves the aesthetic character of the region's architecture. Similarly, reclaimed wood beams can be incorporated into new building interiors as exposed ceiling features or flooring, while salvaged roof tiles can maintain visual continuity with existing style.



Recommendations

Based on the outcomes of the urban mining scan several recommendations can be made.

Develop a circular vision

IBA'27 can leverage insights from the urban mining scan to set realistic reuse targets. This will allow each project to establish achievable goals that are aligned with the overarching circular vision. The urban mining scan shows that 53 kton of building materials are released in the selected projects. Our previous work at Metabolic shows that approximately 35% of the released materials can be used through urban mining. This means that a realistic ambition for reuse for IBA'27 projects could lie somewhere around 5% reused/recycled materials.

Create a comprehensive material inventory

Use the urban mining scan as a stepping stone to establish an inventory of building elements and materials across all IBA'27 projects to continuously identify shared resources and potential synergies. This inventory will support scaling opportunities, cross-project integration, and strengthen collaboration with stakeholders. In particular, developers, construction companies, and local authorities will benefit from a centralized database that can aid urban mining practices and indicate the potential for physical urban mining infrastructure (e.g., a wood mill or smart crusher for concrete). A circular construction hub may be useful for public engagement and raising awareness about the potential of urban mining.

Set prioritized material flows

Identify key material flows (e.g., bricks or wood) for each project. Encourage project teams to take ownership by choosing specific materials to focus on; assessing their viability for reuse, processing, or innovative applications. This fosters targeted learning and helps to develop best practices that can later be replicated across other projects.

Engage stakeholders in tendering and design

Establish urban mining requirements in tendering processes demolition, renovation and new construction. In new construction, specify criteria that prioritize the reuse of key materials. This approach helps institutionalize circular practices in procurement, allowing IBA'27 to shape market practices and encourage circular material use.

Integrate learnings into policy frameworks

The long-term success of circularity in IBA'27 projects can influence regional development standards and policies. Insights from this approach can guide future city planning efforts, embedding circular principles within the Stuttgart region's regulatory frameworks and supporting a sustainable urban development model that could inspire further regions.

These recommendations can be seen as the next steps based on the urban mining scan.

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Page 37: An adaptation of the Value Hill Model to integrate the 9R framework by Metabolic (Achterberg, Hinfelaar & Bocken, 2016).
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Appendix

Appendix A | Assumptions

DATA NORMALISATION

Building typology

The building typologies as provided by IBA were classified into one of the following categories: community, events, factory, gastronomy, housing, housing + retail, mobility hub, offices, offices + education, retail, sports hall, workshop.

Floor space (m² GFA)

Table 1 specifies how the floor space of the buildings was determined in the cases in which this was not provided by IBA.

Materials

Based on the materialisation information provided by IBA building profiles were selected that approximate the concerned building as well as possible (also see appendix B).

		DEMOLITION	RENOVATION	NEW BUILD	NOTES
Backnang	m² GFA	Measured on Google maps	Measured on Google maps	Provided by IBA	
	Materials	Based on cohort and function	Custom renovation profiles	Custom biobased profiles	
Flandernhöhe	m² GFA	Provided by IBA	Provided by IBA	Provided by IBA	
	Materials	Based on cohort and function	Custom renovation profiles	Profile selection based on info	
KaepseLE	m² GFA	n.a.	n.a.	Provided by IBA	
	Materials	n.a.	n.a.	Custom biobased profiles	
Klett	m² GFA	Average of the other projects	1.731 per building	361 per building	Overall 12.553m² (divided over renovation/new build based on photos and plans)
	Materials	Based on cohort and function	Custom renovation profiles	Profile selection based on info	
Sindelfingen	m² GFA	n.a.	All existing GFA subdivision housing/working	Total GFA - existing GFA subdivision housing/working	
	Materials	n.a.	Custom renovation profiles	Biobased profiles	
Tobias Mayer	m² GFA	Average of the other projects	1.315,5m² per house	1.315,5m² per house (L-Haus and Kettenhaus provided by IBA)	57m² GFA per inhabitant 38 houses 1.000 inhabitants
	Materials	Based on cohort and function	Custom renovation profiles	Profile selection based on info	
Untertürkheim	m² GFA	n.a.	Provided by IBA	Measured in plans	
	Materials	n.a.	Custom renovation profiles	Profile selection based on info	

Appendix B | Methodology

DATA ANALYSIS

Building profiles

The buildings that are part of the selected projects were linked to building profiles that specify the units of a certain material per m². These profiles were adapted in order to reflect the typology and the materialisation of the actual buildings. However, it is important to note that this link is only an approximation of the materialisation of the buildings and does not reflect reality. If a certain building is considered for an urban mining approach it is essential to assess the actual materials and their state for the specific building.

CO_2 emissions

In the analysis of the CO_2 impact of materials, we focus on the embedded CO_2 impact. This refers to emissions generated during the production and transportation of raw materials or products (this is also referred to as the the phase A impact). The units/ m² from the building profiles per used material are linked to impact factors from the Dutch “Nationale Milieu Database”. Any potential local difference in performance in the area of CO_2 emissions is not reflected here. For the CO_2 emissions that can be saved due to reuse we assume a emissions reduction of 80%.

Appendix C | Value hill model

The value hill model is a strategic framework that helps organizations transition from a linear to a circular economy by visualizing value creation, retention, and restoration throughout the lifecycle of products. It identifies different stages in a product's journey (uphill (design and production), on top (use and maintenance), and downhill (end of life and recycling)) to guide organizations in optimizing resource use and preventing waste.

Figure 14 shows an adapted version of the value hill model integrated with the 9R framework* to visualize the different strategies for value retention. These strategies encompass the entire life cycle of building products, from extraction and production to use and eventual disposal. Value is added as the product moves "up" along the supply chain. Circular services keep the product in use at its highest value through repairs or modifications for extended lifespan.

The R-strategy of rethink can be applied during the "uphill" phases of the value chain by adopting practices of redesign, reducing material intensity, and preventing certain material applications. When a product starts to "descend," this is done as slowly as possible, so that the products can still hold value through refurbishment, remanufacturing, or by reusing materials for other high-value applications. Once a product or component reaches the end of its useful life, infrastructure is available to recycle materials.

The value hill thereby gives priority to efficient resource management. This is linked in particular to the "uphill" part of the model. Industrial symbiosis can be applied to promote cooperation between companies in different sectors for the reuse of by-products, which fits into the "downhill" part of the model. Especially in the "downhill" part of the model it is essential to take into account the existing robust regulations for waste management and recycling and to explicitly include these in the application of the Value Hill Model. The Value Hill Model is useful when exploring the circular potential of construction projects. It gives priority to the reduction of used material, through interventions such as the renovation of buildings, as well as the reduction of waste, e.g. through the high-value reuse of building materials through urban mining.

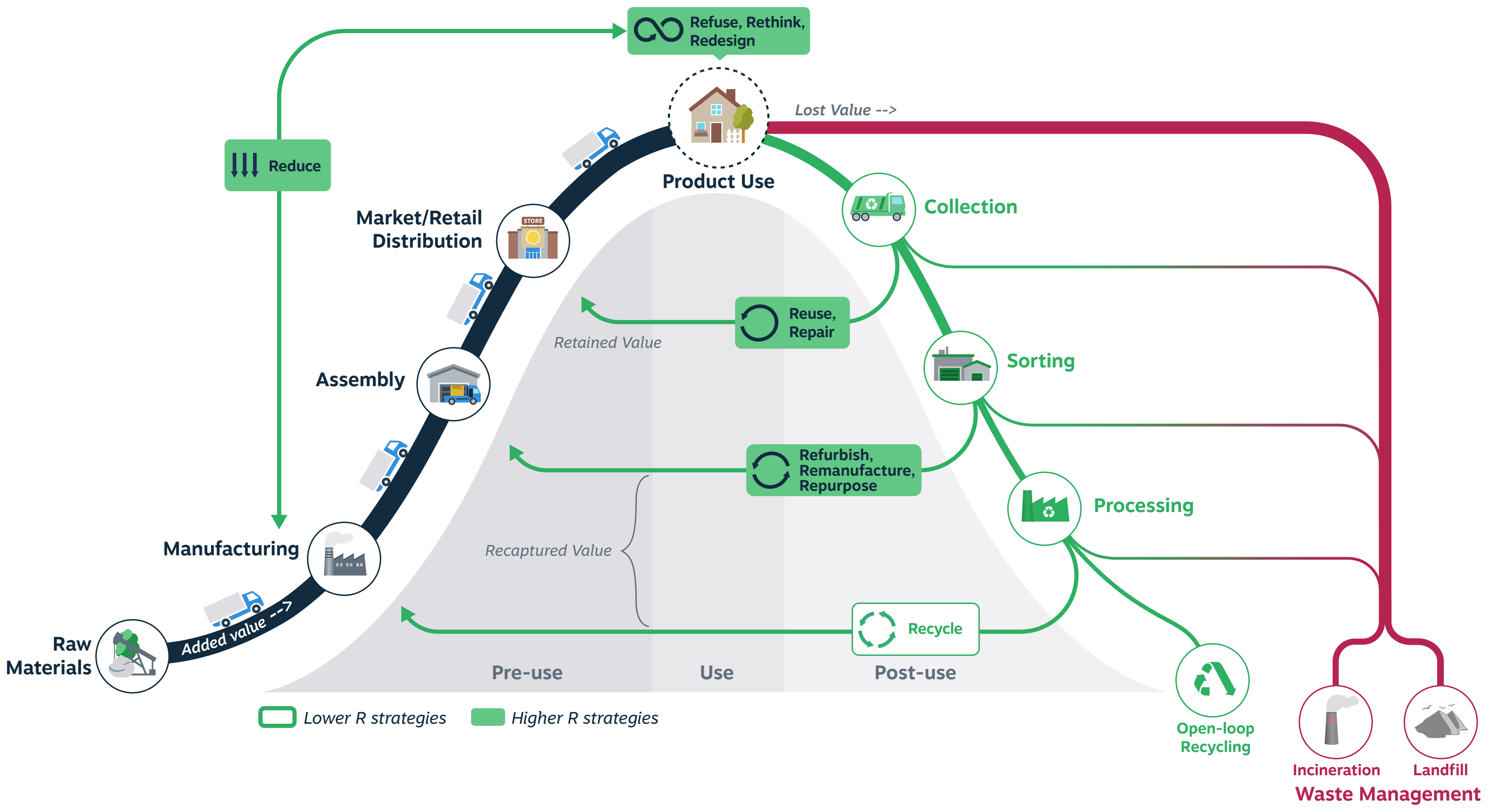

Figure 14 *Value hill model.*

**The 9R framework is a circular economy model that describes nine strategies for retaining value in products and materials, ranging from Refuse to Recycling.*

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