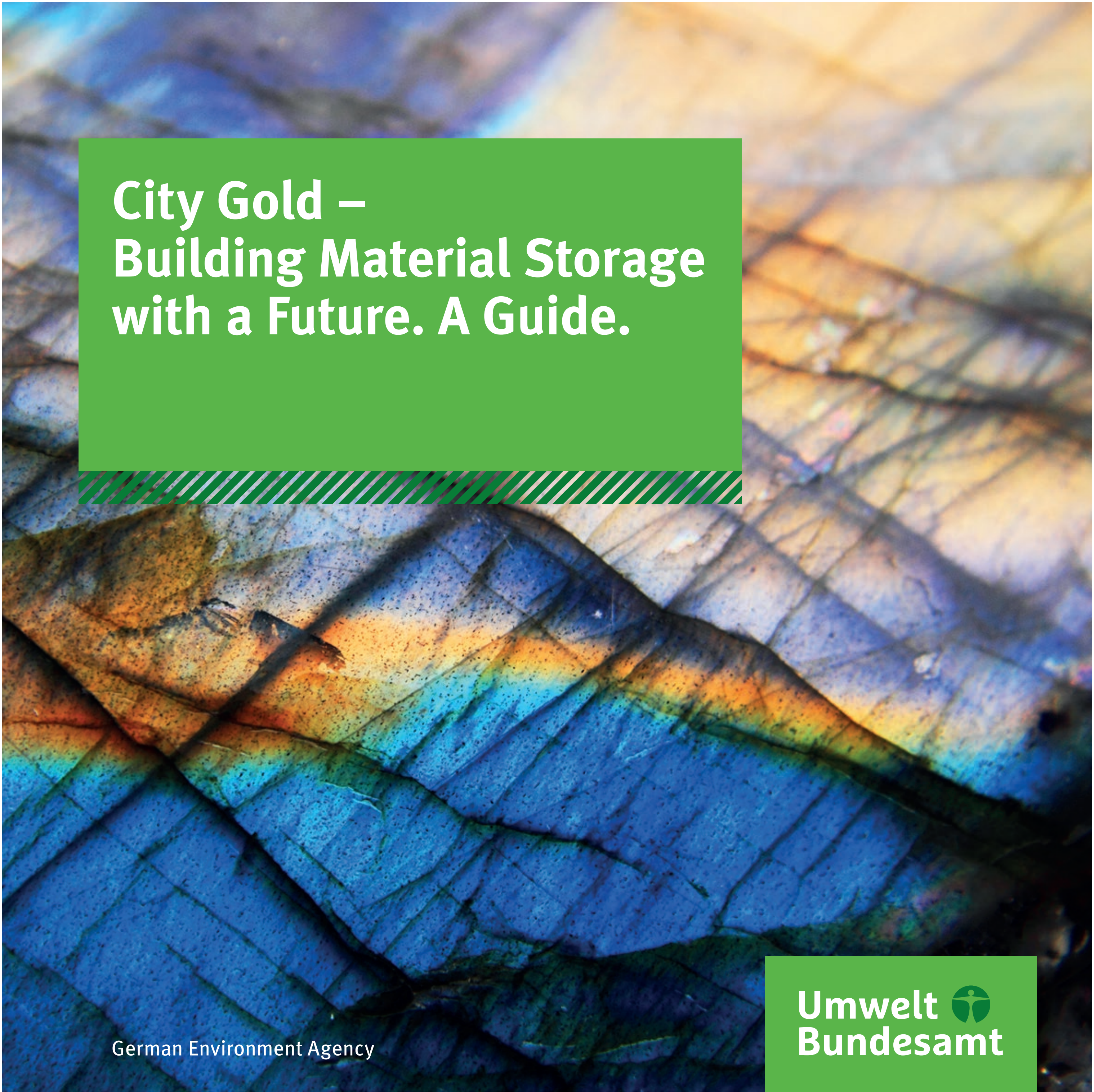

City Gold – Building Material Storage with a Future. A Guide.

German Environment Agency

Umwelt Bundesamt

Imprint

City Gold – Building Material Storage with a Future. A Guide.
Results of the Project Mapping of the Anthropogenic Stock III

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As at: February 2022
2nd Edition

FOREWORD

The anthropogenic stock in Germany is a treasure trove for meeting our raw material needs that are growing every year. With the strategy of urban mining – extracting secondary raw materials from buildings, infrastructure, vehicles, and other durable goods – this treasure trove can be used ever more successfully and systematically.

Urban mining saves primary raw materials and robustly reduces environmental impacts along the entire value chain. It is a necessary means to expand the raw-material base for the Energiewende (energy transition) and Verkehrswende (transition in transportation) as well as for the other major key technologies of the 21st century following good environmental, labour, and social standards. Resource conservation, climate protection and securing raw materials go hand in hand.

The German Environment Agency launched the project series Mapping the Anthropogenic Stock (KartAL) in 2011 to improve the knowledge and decision-making basis of the secondary raw materials industry and to improve the quality of urban mining in Germany. Within the third project in this project series, two guidelines were developed that are intended to convey potentials, challenges, and solutions for optimized urban mining. In the present publication, this is done using the example of mineral building materials.

At this point, I would like to express my sincere thanks to all those involved in business, administration and science whose willingness to engage in dialogue has contributed significantly to these important findings.

I wish you a stimulating read.

Prof. Dr. Dirk Messner
President of the German Environment Agency

The project Mapping of the Anthropogenic Stock III (KartAL III)

The strategic project series on the anthropogenic stock

In recent years, the German Environment Agency has implemented a number of projects on anthropogenic deposits in Germany. With the help of these technical and methodological foundations and approaches, the course is to be set for successful urban mining. In this context, the dialog-oriented research project Mapping of the Anthropogenic Stock III – Establishment of material flow management with the integration of recycling chains to qualitatively and quantitatively increase the recycling of metals and mineral building materials (KartAL III, FKZ: 3716 35 3230), which is summarized here, has made a systematic and participatory contribution to further developing the circular economy into a resource-conserving material-flow economy.

Material groups in focus and central questions

The project focuses on two groups of materials:

- Mineral construction and demolition waste: Concrete, sand-lime bricks, porous and lightweight concrete, bricks, flat glass, insulating materials, gypsum building materials, plasters and mortars, tiles and ceramics.
- Base and special metals: brass, zinc, tin, aluminium, magnesium, rare earths in magnets, and stainless steels and their alloying elements.

These material groups were investigated by Öko-Institut (metals) and ifeu Heidelberg (construction minerals) with regard to the following questions:

- Where are sensitive value-adding stages in the circular economy of the respective materials?
- What influences prevent high-quality recycling?
- How can problematic situations be resolved in a promising way?

Dialogue forums

To discuss and answer these core questions, six dialogue forums were held for both material groups with selected experts from business, administration, and science. These events had an emphatically interactive character. Work was carried out intensively in small groups, and opinions were constantly incorporated through participant voting. In this way, the project could prioritise the most important points and reach an understanding with the participants on a broad level. The success of this participation format was confirmed at a large closing event.

Volume flow forecasting with the DyMAS model
The work was supported by comprehensive volume flow forecasting in order to identify relevant waste streams whose improved recycling could have a major positive effect on resource-saving value chains. This forecast includes modelling of future developments for the materials under consideration, considering important trends such as electromobility or changes in construction methods. The expected return flows of materials from the anthropogenic stock and the influences of technologies and losses on recovery potentials are thus represented. For this work, the project partner Ifu Institute used the DyMAS system (Dynamic Modeling of Anthropogenic Stocks), which has already been successfully applied in previous projects on anthropogenic stocks under the German Environment Agency. Within the framework of this project, the model was adapted and refined for the material flows under consideration.

"Ambitious recycling management begins at the demolition site: selective dismantling ensures the best possible recycling of the individual materials and guarantees the removal of contaminants and pollutants. Qualified demolition companies are happy to make their contribution with up-to-date know-how and suitable technology."

RA Andreas Pocha | Deutscher Abbruchverband e. V. | Managing Director

“If the political framework conditions for a comprehensive Circular Economy are set and also implemented, the recycling industry will be strengthened, and perspectives will be re-defined. We are happy to face this challenge.”

Stefan Schmidmeyer | German Federal Association of Secondary Raw Materials und Entsorgung e. V. | Managing Director

“The Circular Economy will only prevail if the building materials that come from the already existing material cycle are also preferentially demanded. This is where the public sector is called upon to set an example. Berlin is meeting this challenge with a decidedly environmentally friendly procurement policy.”

Dr. Benjamin Bongardt | Senate Department for the Environment, Transport and Climate Protection | Head of Division

Buildings as Raw Material Storage

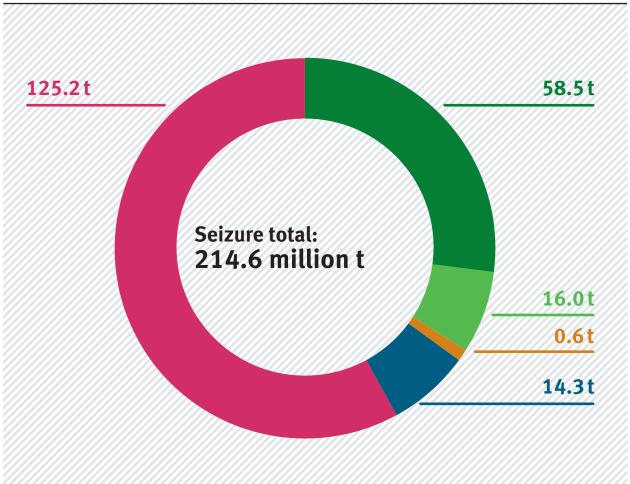
The anthropogenic stock consists of the most frequently used building materials in building construction. In building construction, houses and building walls are made of concrete, bricks or sand-lime bricks, as well as aerated concrete, which has also been used for several decades. Plaster and mortar grout protect the masonry units and are inseparably connected with them. In addition to windows, facades are also increasingly made of flat glass. Gypsum building materials are used in particular for interior finishing. Tiles and ceramics are a small but essential component of residential and commercial buildings. Stone and glass wool are also of mineral origin and, with a market share of over 50 %, are the most commonly used insulating materials in buildings.

Each year, building construction waste alone accounts for around 60 million tonnes of these materials which are subsequently taken out of 'storage' – and the trend is rising. Over the years the increasing resource awareness and scarce landfill capacities have led to development of alternative disposal routes and establishment of an effective recycling economy. Nevertheless, the recycling potential of building materials is not yet sufficiently exploited.

Figure 01

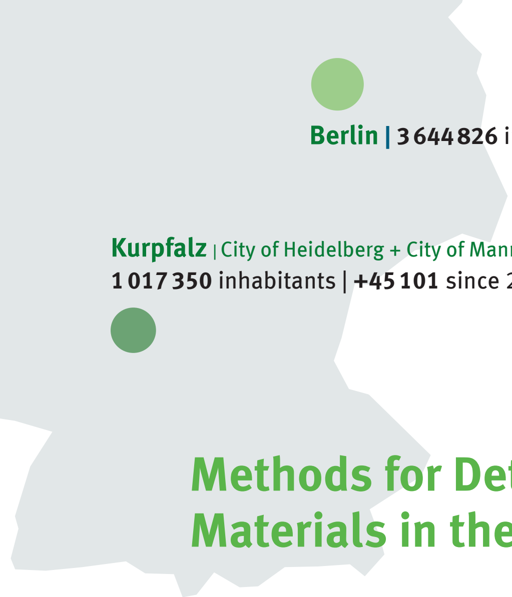
Construction waste generated in Germany in 2016

The volume of waste is rising steadily – the construction industry generates more waste than any other sector of the economy.



- 27.3 % | Construction waste (concrete, bricks, tiles, ceramics and mixed construction waste)
- 7.4 % | Road debris
- 0.3 % | Gypsum-based construction waste
- 6.7 % | Construction site waste
- 58.3 % | Soil and stones

Source: Mineral Construction Waste Monitoring 2016



Berlin | **3 644 826** inhabitants | **+269 604** since 2012 | **891** km^2 | **1 510 736** employees subject to social insurance contributions

Kurpfalz | City of Heidelberg + City of Mannheim + Rhine-Neckar District
1 017 350 inhabitants | **+45 101** since 2012 | **1 315** km^2 | **459 583** employees subject to social insurance contributions

Methods for Determining the Available Recycled Building Materials in the Model Regions Berlin and Kurpfalz

The development structure and the composition of the anthropogenic stock differ significantly from region to region, as is seen in the sample large city Berlin and the suburban area Kurpfalz. In order to be able to describe these regions, different statistics had to be consulted and evaluated.

Census data are available for residential buildings; surveys on buildings and the housing situation are conducted at regular intervals by state statistical offices. The data on population developments and the demand for living space hence form the basis for estimating the development of this building stock.

Data on commercially used buildings is much more difficult to obtain. Key indicators must be used that are derived from scientific studies and urban models and refer, for example, to parameters such as employees subject to social insurance contributions and the specific space requirements for the different workplaces in the various sectors. For example, to estimate the future development of the building stock, the development of the construction volume in Euro is used as an indicator. Since there are studies on the building materials used for the various types of residential buildings and for commercial(-like) buildings, these reported changes in building materials can be used as a basis for calculating the building volume. In addition, it is possible to make estimates of the associated mass flows of different building materials.

A similar approach was taken to survey material storage and estimate material flows for traffic routes and other infrastructure. Key indicators per unit, linear meter, m^2 or inhabitant were converted, for example, to existing information on network lengths. Material flows were derived, for example, from information on renovation rates or network expansion targets.

Building Materials in Buildings and Structures Forecast to 2030

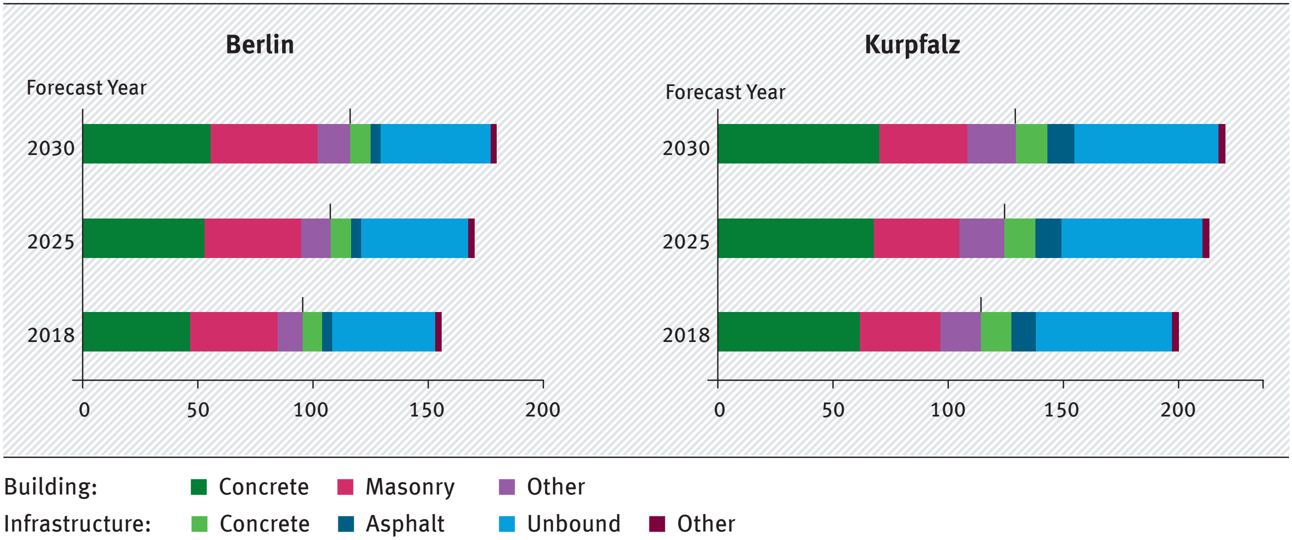
The inventory – current and future

The largest portion of the material stock from buildings is contained in residential buildings. In the Kurpfalz, 76 % of the masses can be found here, in Berlin 80 %. Of these, 45 % in the Kurpfalz are in single family detached and duplex houses. The proportion in Berlin is significantly lower at 15 % in such private homes. There are also significant differences in the material stocks contained in other infrastructure. In the Kurpfalz, for example, 51 % of the material stock is in the transport routes, while in Berlin it is only 31 % (Fig. 02).

Figure 02

Construction materials used in buildings and infrastructure in 2018, 2025 and 2030

left: Berlin; right: Kurpfalz – in tonnes per inhabitant



In Berlin, the stock consists of ~66 % buildings – in the Kupfalz, the stock is divided roughly in half between buildings and infrastructure.

Source: ifeu Heidelberg

Building fabric preservation increasingly determines the building material flows

The annual construction of new buildings is expected to decline by 2030 in line with the decreasing population forecast – somewhat more strongly in the Kurpfalz than in Berlin. Maintaining the structural integrity of buildings and, in particular, the infrastructure will therefore increasingly determine future demand for building materials. In addition to concrete and masonry, materials for unbound layers and, in the Kurpfalz region, asphalt are also in demand. The volume of construction waste remains relatively constant or is increasing slightly. In the Kurpfalz region in particular, the ratio of raw materials from the materials cycle is therefore gradually increasing relative to demand.

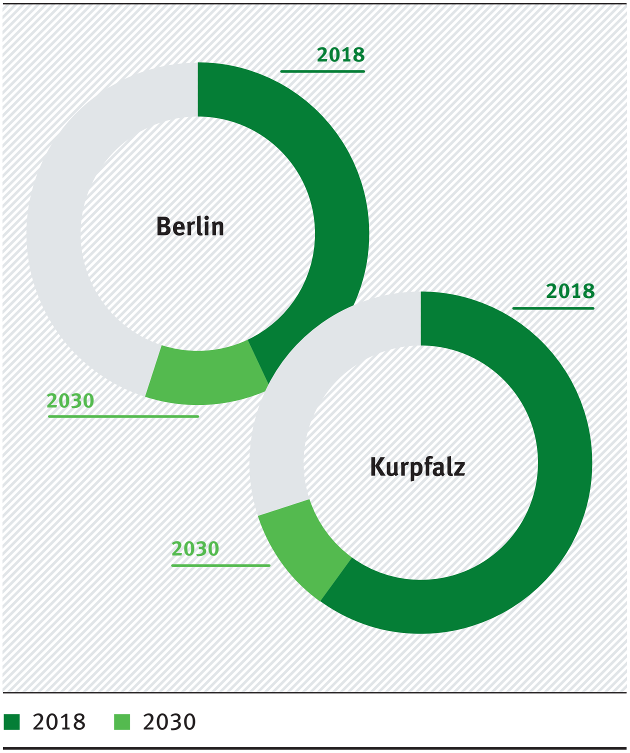
More recycled-content building materials through perspective recycling

If construction waste is ambitiously recycled in the future, more materials could be made available from it that can be used as raw materials for producing construction materials for buildings and not only in civil engineering. Ready-mix concrete is a perfect example. In purely mathematical terms, a considerable proportion of these concretes can be produced as recycling-concrete (Fig. 03). Some of the aggregates used can be obtained by processing old concrete and masonry and thus from the material cycle. Shortages of recycled-content construction materials for road and street construction are not expected. Demand can be covered by materials that have so far been disposed of in simple earthworks. Also the on-site processing of road construction materials and direct reuse can help meet demand.

Figure 03

Wasted potentials for the production of R-clay: for R-concrete production: In 2018, 45 % of the concrete in Berlin could already have been produced as resource-saving concrete. However, the amount of R-concrete actually produced was 0 %.

In the production of R-concrete, 40 % of the aggregate is obtained from recycled old concrete and and masonry.



Source: ifeu Heidelberg

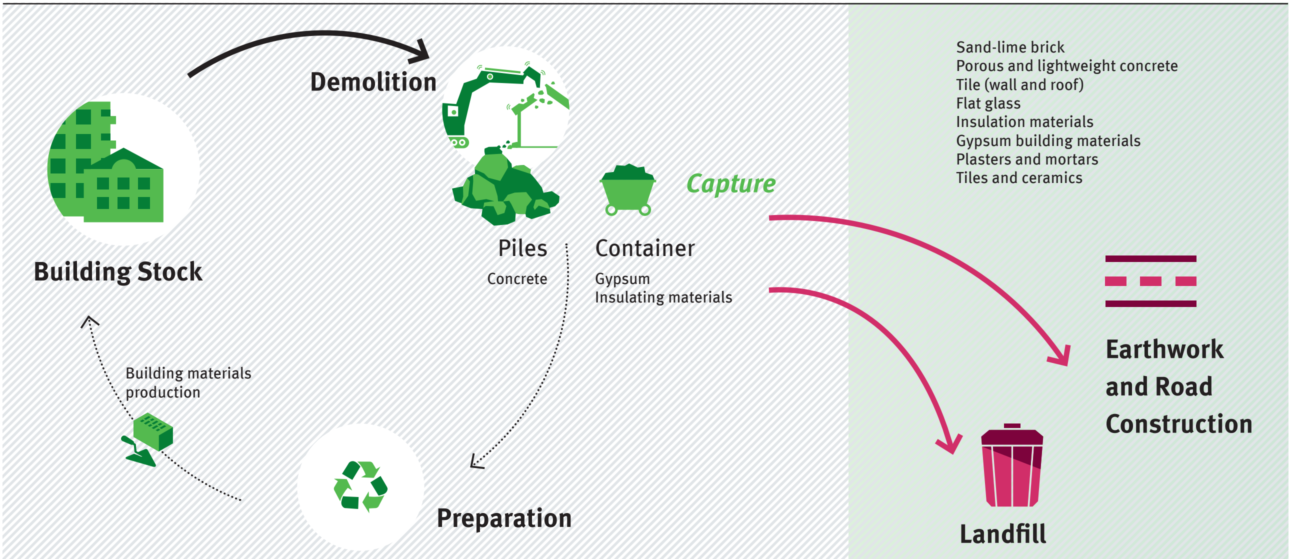
Circular Economy Today and Tomorrow
Making Use of the High Recycling Potential!

Construction waste coming from buildings and structures is not yet commonly recycled into building construction. Recycling is mainly carried out in road construction and earthworks, although relevant amounts of construction waste are suitable for recycling if collected free of hazardous substances. The structural engineering requirements in earthworks are low: the building materials collected in the mixture can be processed using simple and inexpensive methods; however, there is no sustainable use for the value-giving aspects in the waste. So far, separate collection of construction waste only takes place if the materials are not otherwise suitable for use in civil engineering (especially gypsum building materials)

Figure 04

Recycling of construction waste today

Concrete and masonry construction materials from buildings are mainly recycled in road construction and earthworks – there is insufficient sorting of construction materials. Gypsum building materials and insulation materials are collected separately, but are not processed.



Source: ifeu Heidelberg

or must be disposed of separately due to their hazardous properties. Cheap disposal capacities prevent feeding the waste into processing plants and thus the production of high-quality recycled-content building materials.

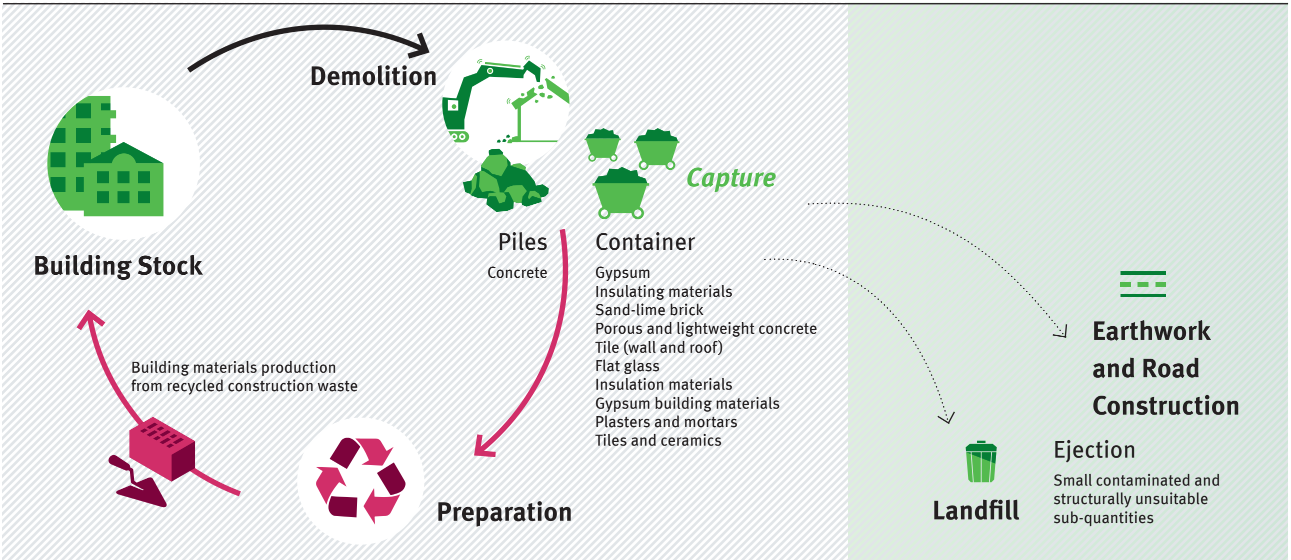
It is necessary to rethink this scenario: Mineral construction waste is a valuable raw material that can replace natural stone. The prerequisite for this substitution is the comparability of the construction and environmental properties.

It should be noted that the circular economy only succeeds if the composition of the waste is tailored to the recycling target. This requires an ambitious selective dismantling process, which provides the building materials sorted by type and free of impurities. The goal is the production of recycled-content building materials that reliably maintain defined properties over large mass flows. In this way, natural stone deposits are conserved, land consumption for quarrying is reduced and transport emissions are cut.

Figure 05

Circular economy construction

The collection and processing of construction waste is carried out according to type and is tailored to the recycling objective – construction materials are kept in the economic cycle at a high level of quality.



Source: ifeu Heidelberg

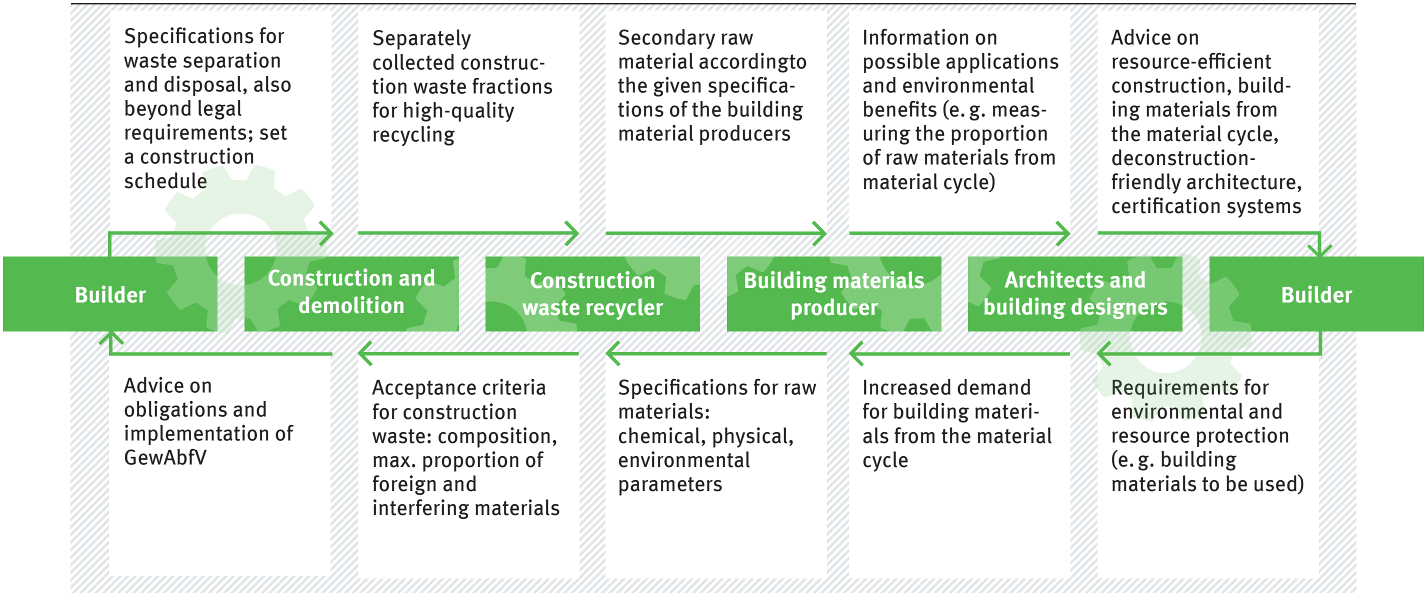
Promoting and Demanding a Circular Economy – The Gear Principle

The building materials industry has traditionally been strongly linked to raw material extraction companies, which often belong to the same group. For a long time, there were no business relationships between waste management companies and the building materials industry. The realization that primary raw material deposits are finite and that new development areas are subject to strong competition for use is increasingly leading to efforts by the building materials industry to develop alternative supply routes. Initial cooperative efforts are leading to knowledge exchange and demonstration projects that are bringing building materials based on secondary raw materials to the market.

Figure 06

Actors in a circular economy for the construction sector – tasks and interfaces

The cooperation of all players involved in construction and disposal is the prerequisite for a functioning circular economy.



Source: ifeu Heidelberg

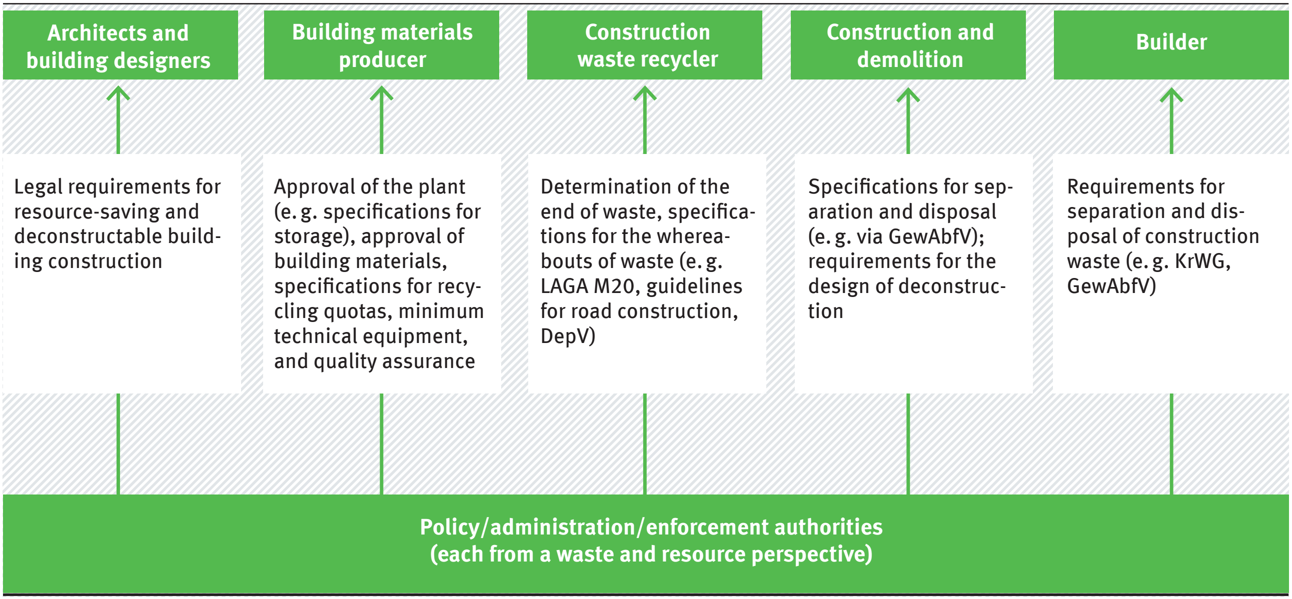
In terms of construction volume, public institutions are relevant clients in building construction and civil engineering. They can set important market incentives and, through their tendering practice, act as role models for the implementation of resource policy goals. However, the public procurement agencies do not sufficiently implement the requirements and targets that are already obligatory.

The state of Berlin is setting a positive course. As part of the administrative regulation "Procurement and Environment", performance sheets are constantly being drawn up that formulate minimum requirements for the procurement of products, including for civil engineering. Since these performance sheets are always completed in consultation with the authorities issuing the invitations to tender, they are highly accepted by the state's contracting authorities. There are also good examples of good practice at the level of cities and municipalities. For example, the Office for Building Construction and Building Management of the city of Karlsruhe has decided to use recycled concrete in its construction projects. According to the city's procurement instructions, this may also be associated with additional costs.

Figure 07

Influence of politics and administrative authorities on the actors of the circular economy

Although waste legislation and procurement guidelines already require resource-oriented tendering and awarding, such aspects are almost always missing from the specifications for public contracts.



Source: ifeu Heidelberg

The Second Life of Building Materials What are the Recycling Options?

Waste concrete – used as recycled aggregate in concrete production – substitutes natural stones such as gravel and chippings. Due to their high gypsum content, gypsum boards and moulded gypsum are much more suitable for gypsum recycling than screed, plaster or aerated concrete blocks. Gypsum recycling plants have been establishing themselves since 2015, with 5 plants in operation across Germany by the end of 2019. Glass elements from doors, windows and facades are melted down in the production plants and reshaped into flat glass. Flat glass cullet is also used in the container glass industry: the industries compete for the valuable secondary raw material, the use of which saves energy in particular. Glass and rock wool can only be recycled separately from each other – a joint return to the respective production process is not possible.

Roofing and masonry tiles are popular building materials for reuse due to their historic charm. Furthermore, roof tiles are suitable as raw material for vegetation substrates and as a bulk building material in gardening and landscaping. Lava, pumice and clay are substituted. Bricks must be free of plaster and mortar in order to be used as planting substrates. Sand-lime brick fulfil the structural-physical properties as a component of unbound layers in road and path construction. However, the strength of aerated concrete is not sufficient for this purpose. Research projects suggest suitability as a secondary raw material for recycled-content masonry blocks and recycled-content mortar. The masonry building materials are all suitable as a component of type 2 aggregate in recycled concrete. For tiles, ceramics, and plaster and mortar, no high-quality recycling routes are currently available. Plasters containing gypsum have to be removed from the material cycle due to the negative environmental impact of sulphate.

Use in the original production is technically possible

Concrete
Waste containing gypsum
Flat glass
Mineral wool

Alternative recovery routes required

Roof and masonry bricks
Sand-lime bricks
Aerated concrete
Tiles and ceramics
Plaster and mortar

Framework Conditions for a Circular Economy

So far, a material cycle has only been established in the first steps for the building materials concrete and gypsum. These developments are regionally limited to individual plants, although the use of old material in significant proportions is technically possible. Without relevant adjustments in the production processes, consistent product properties are guaranteed.

Product status for recycled building materials

If a comprehensive circular economy is to develop, raw materials from the material cycle must be released from requirements under waste legislation. Otherwise, their use while still bound to waste requirements would mean significantly increased approval and administrative costs for the building materials industry, combined with lengthy and costly restructuring. The use of waste as a raw material is also associated with a loss of image and thus a threat to the marketability of building products. Regulations about releasing materials from being categorised waste do not necessarily have to formulated in lengthy processes at the European Union or national levels. As the example of Baden-Württemberg shows, such changes in categorisation of materials have been achieved by decree for building materials used in the unbound sector (earthworks or road and path construction). The gypsum industry has achieved individual solutions for each supply relationship.

Quality guarantor: Quality-controlled recycled building materials

Up to now, the recyclers have traditionally produced construction material mixtures for frost protection and ballast base layers under road surfaces in accordance with the generally applicable TL SoB-StB 04 standard. Nevertheless, these construction materials often find little acceptance due to a lack of information. Although the regulations seek to define building materials according to their properties, even old concrete is usually categorised as a base material. In individual regions, both good practical examples and building owners can be found who categorically exclude their use. The manufacturers of building materials are thus confronted with different specifications within their own supply area. This makes a uniform and cost-effective production strategy more difficult.

Installed and qualified quality-controlled frost protection layer from the material cycle

Deconstruction and Disposal Require Qualified Planning

The way in which demolition and dismantling measures are carried out has a decisive influence on the quality of the waste fractions. However, conventional construction methods do not yet consider aspects of the deconstruct ability of components and building materials. This makes separate collection more difficult. Qualified planning ahead of the construction project enables selective deconstruction, which provides the materials separately from the construction site and is the prerequisite for high-quality recycling. The exact design of deconstruction is always a case-by-case consideration and depends on the type of building, the usage history, and the construction method. The slight increase in costs due to the involvement of a demolition consultant is offset by increased planning reliability. Disposal costs and schedules can be calculated more reliably in advance and adhered to.

Detect and discharge pollutants through preliminary exploration

The first step in pollutant detection must be the preparation of a pollutant report by qualified specialist planners. Based on the results, a second step is to develop a deconstruction and disposal concept to determine how the gutting, the actual demolition or deconstruction of the building as well as the waste disposal are to be carried out. This ensures that components contaminated with harmful substances are collected separately and removed from the material cycle and that recyclable construction waste is collected separately by type. In particular, the discussion surrounding possible asbestos contamination of demolition waste makes it clear that demolition must be preceded by a comprehensive investigation of the pollutants and, if necessary, their removal.

The Commercial Waste Ordinance specifies in detail the separation of construction waste

The GewAbfV obliges waste producers and owners to collect the most common building materials separately and to recycle them as a matter of priority. A deconstruction and disposal concept must meet these requirements by specifically indicating construction waste fractions that must be collected by type. Mixtures of construction waste may only be produced in justified exceptional cases. The type of facility in which these mixtures are to be disposed of is also regulated by the ordinance. Violations of the separation requirement can be punished with fines of up to €100000. Nevertheless, practice shows that the requirements are regularly not sufficiently fulfilled. Enforcement of waste legislation at the construction site is inadequate. As a rule, the municipal waste authorities only take supervisory action if there is a suspicion of violation. The reason for this is, among other things, the precarious staffing of supervisory authorities.

The occurrence and the whereabouts of the construction waste must be documented by the building owner in its role as the waste producer. The documentation must be presented to the competent authority upon request. Building owners should contractually already agree in the planning phase who is responsible for preparing the documentation.

Out of the Stone Age – Processing Technology is not yet up to Date

For the building materials industry, it is important that the properties and qualities of building materials are not jeopardized using secondary raw materials. The processed materials must therefore have properties that are as close as possible to those of the primary raw materials they substitute. To achieve this, a change in thinking is required on the part of the construction waste processors: the processing procedure must be designed to meet the requirements of the customer and the planned sales channel.

Processing technology is still as in the stone age – with crushing and screening. The separation of building material mixtures by type is not possible with the current state of the art. Investments in technology and know-how are required to improve separating impurities and foreign materials.

Technical solutions are available; in other sectors of the recycling industry, automated separation technologies have long been the state of the art. In the field of construction waste sorting, however, their use is rarely economical. Only in isolated cases are innovative processes installed. Positive examples are the use of a colour identification system for targeted sorting of elements with predefined properties (e. g. red brick) or the wet processing of soils and construction waste for separation into different particle size classes.

An innovative process: production of plant substrate by automated colour sorting. Automated optical colour sorting takes place in the coarse fraction. The separated red and yellow bricks are then crushed and used as granules for producing plant substrates.

At the research level, further processing methods are being tested. Thermo-mechanical methods or electrodynamic fragmentation are innovative digestion methods that separate material composites from each other along the interfaces, e. g. cement from the aggregate in concrete. The BauCycle project successfully used a hyperspectral camera to sort construction waste according to chemical criteria. Concrete, bricks, sand-lime bricks and gypsum could be separated selectively and with high purity.

Incentives for Using Resource-Saving Building Materials

Labelling of building materials with recycled content

If resource-conserving building materials are required in contracting processes, it must be possible for the client to understand and evaluate the positive properties of the products offered. Product labels or other verifiable and certified information is therefore required. Although the production processes for gypsum, flat glass and glass wool already make use of considerable proportions of secondary raw materials, the producers do not provide appropriate product labelling. They fear that this will not be accepted by customers. In recent years, the transportation industry has developed criteria to enable certification with the Blue Angel eco-label. At the same time, a certification system for sustainably produced concrete and its supply chain was launched in 2017.

Stimulating demand through building certification schemes

Since greater resource efficiency of building materials and their use is not per se associated with immediate economic benefits or, in case of doubt, is more costly, certification systems are needed that reward builders for using resource-conserving building materials. In Switzerland, Minergie-Eco has opened up a significant market share for recycled concrete. The design of the German certification systems (BNB, DGNB) does not yet allow any comparable incentive effects.

Minergie-Eco certification system in Switzerland: 50 % of the concrete used in a building must be R-concrete. Unless the nearest deliverable concrete plant is further than 25 km away

Reduce Transports and Relieve the Environment

Construction waste masses accumulate for disposal primarily in cities and metropolitan areas and thus in regions where construction activity and demand for construction materials are concentrated. This is especially true for the bulk construction materials for road and path construction or the raw materials for the asphalt and concrete industries. However, this important environmental advantage is lost in practice.

Reduction of transport emissions due to close proximity of reprocessing operations

The companies specializing in the processing of mineral waste masses are often unable to locate close to the centre of waste generation, since in cities and metropolitan areas it is very difficult to find suitable sites. Reprocessing operations traditionally must be large and cost-effective in view of the throughputs involved and be in an environment that is relatively insensitive to noise and congestion emissions. Old industrial and commercial sites are currently being redeveloped for primarily new urban neighbourhoods and are no longer available for industrial use. Here, urban, and regional planning are called upon to keep areas open for these industries as well when considering competing claims for use.

Transport costs too low to be a motivator

The example of shipping gypsum waste to other European countries shows that transport costs do not represent an obstacle to accepting cost advantages from distant processing. Even in Germany, transport distances of several hundred kilometres are no longer uncommon. Road-bound heavy-load transports are comparatively inexpensive in Germany, not least because the legal framework conditions, such as permitted payloads and driving and rest times, are too rarely checked. In Switzerland, the circular economy benefits from road tolls, which are a significant cost factor.

Waste masses that only occur in small quantities on construction sites, but must be kept separate for high-quality recycling, require their own logistics solutions to enable bundling. Here, environmental policy is also called upon to support and test practical solutions.

Building with Vision: Buildings must become Recyclable

Even ambitious and strongly hand-guided deconstruction fails due to material and construction compounds that cannot be fully separated. Their use has become more and more common in recent decades, and current existing structures cannot be changed retroactively. Today's problems, however, are a reminder to consider the selection of building materials and their degradability and recyclability in the design of structures. Often, there is a lack of expertise in this area.

The architecture and civil engineering curricula lack teaching units on the circular economy, recycling-friendly construction and the processing of construction waste. The topics are only touched on at most, but not dealt with in depth. Conclusion: the planning actors do not receive any basic training in this area during their studies. The obligation to provide further training for civil engineers and architects is the central starting point for expanding the level of knowledge in the short term. The chambers of commerce have an influence on the range of continuing education courses, because the teaching institutions as well as the courses themselves require recognition. So far, the situation is analogous to that of training: there is hardly any knowledge transfer in the field of circular economy construction. However, if the subject area is offered, the demand is high! Courses are booked up in a very short time.

Recyclability must become a prerequisite for building material approval

Building materials must not only fulfil static properties but also increasingly meet higher climate protection requirements. Bricks filled with insulating materials will confront processors with a mass flow consisting mainly of insulating materials and requiring a processing line equipped with the appropriate processing technology. Carbon or textile concrete is an example of a building material development that attempts to meet the increasing demands for resource-saving construction. If structural steel can be substituted as the usual reinforcement, concrete walls become significantly slimmer, as the heavy covering with concrete for the purpose of corrosive protection can be dispensed with. According to the current state of the art, such construction is at the cost of a lack of recyclability. The building materials do not contribute to increasing resource productivity.

The question of recyclability must therefore be answered at the latest when materials need approval. This is in line with both the precautionary principle and the product responsibility of manufacturers according to Recycling Management Act. Up to now, criteria of this kind have not been taken into account in the approval process. The responsibility for disposal is thus placed on the end-user or the waste management industry of the future.

Buildings as Raw Material Storage: are their Potentials being Exploited?

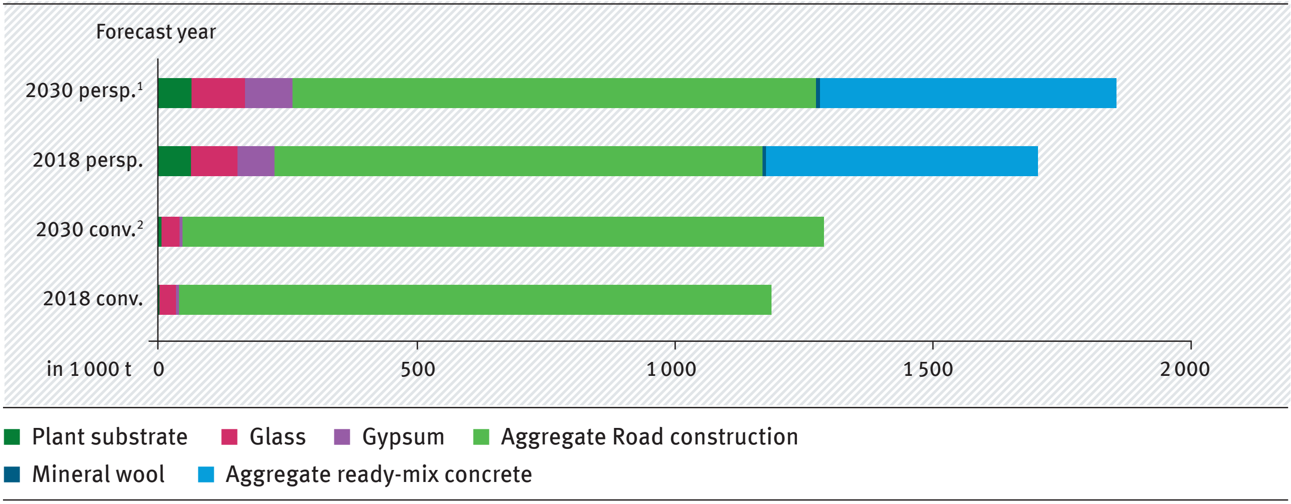
The following applies to both regions studied in this project: the return of building materials from anthropogenic storage to the economic cycle does not sufficiently take place. The value-creating potential of the built materials is insufficiently utilized. Therefore, the opportunity to replace primary raw materials and to conserve resources is lost.

The sales channels of the processed materials are limited to use in civil engineering. In Berlin, 97 % of the demolition waste taken from the material stock is used as road construction material. This corresponds to around 1.1 million tonnes per year. If dismantling and processing were optimized for this purpose, an additional 0.5 million tonnes could be used annually to produce construction materials for building

Figure 08

Availability of demolition masses in Berlin that are available to a material cycle, depending on the processing techniques used.

The demolition masses taken from the material stock and made available to the material cycle will hardly increase until 2030. The decisive factor is the design of the processing. The results for the Kurpfalz region show a similar picture.



[1] conv. = conventional, [2] persp. = in perspective

Source: ifeu Heidelberg

construction. The proportion of recycled materials that can be used in building construction can be increased to 45 %.

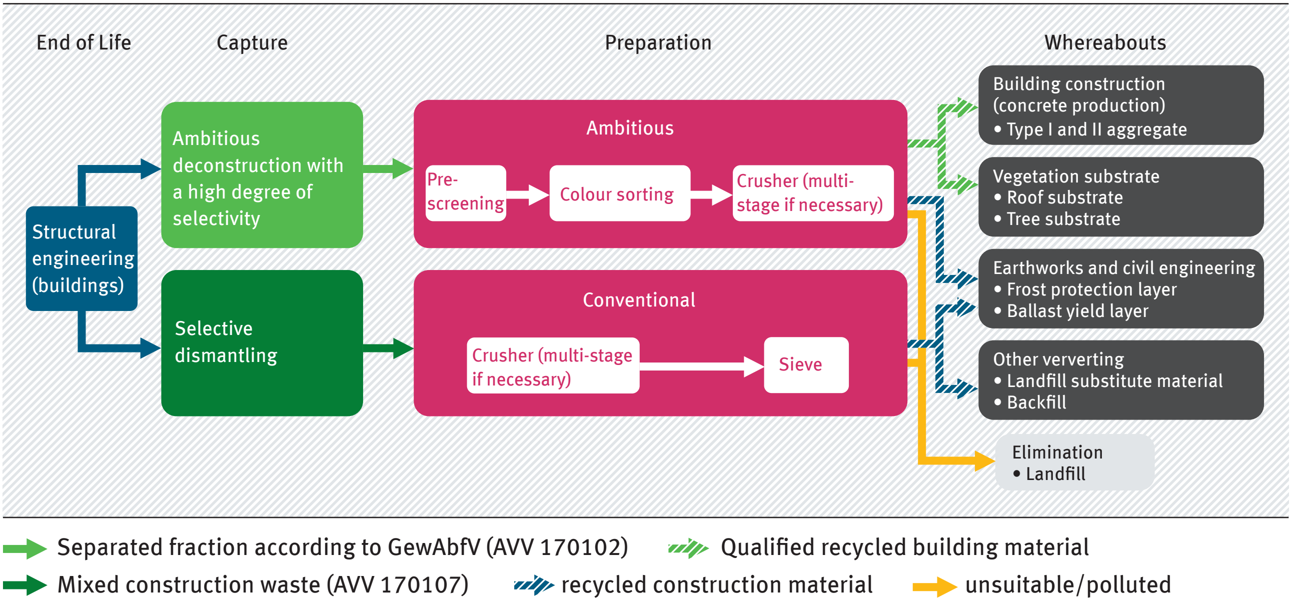
Contributions from the construction waste processors

The availability of secondary raw materials for building construction will only increase if such building materials can be provided to and processed at the construction site. Selective dismantling and sorted collection in conjunction with more ambitious processing technology are necessary. Sorting techniques can be used that have long been state of the art in other areas of the recycling industry. Processed materials can only meet the quality requirements of building material producers if the building materials are better separated from one another and contaminants and impurities are reliably removed. The interfaces between the players are important: based on the requirements for the finished products, defined quality levels must be achieved in the preliminary stages.

Figure 09

Recycling routes using the example of reclaimed masonry bricks

The graph shows the current whereabouts of masonry bricks that are conventionally processed. Ambitious processing technology is required for use as a vegetation substrate and as aggregate in concrete.



Source: ifeu Heidelberg

Conclusion

1. The classic sales channels in civil engineering must be supplemented by possible applications in building construction. This is the only way that construction waste can be recycled to a high standard and recovered in high quantities.

2. The processing of construction waste in qualified plants is a prerequisite for high-quality recycling. Scarce storage capacities strengthen the competitiveness of the processing.

3. Building materials may only be approved if their recyclability has been proven. This promotes the circular economy and strengthens the product responsibility of manufacturers.

4. The obligation to keep waste separate and to give priority to qualified processors in accordance with the GewAbfV are not being implemented adequately. Enforcement by the supervisory authorities must be expanded rapidly. Controls are to be carried out by checking documentation during the construction phase and after project completion.

The still poor image of recycled building materials does not do justice to the quality of the processed materials and the quality assurance systems! The lack of acceptance leads to weak sales markets. In addition, the production of high-quality recycled building materials is in competition with low-processing and low-cost disposal options. It is the task of politics to develop framework conditions that guide the construction waste masses according to the waste hierarchy.

Clients of construction services can actively demand the use of resource-saving building materials and de-constructible construction methods. In the case of demolition measures, a deconstruction and disposal concept can be used to specify requirements for the design of deconstruction and the disposal of waste. Contractual agreements on the selectivity of deconstruction are also useful because a definition of the term “selective deconstruction” does not yet exist. A uniform understanding would require a binding definition and its introduction via the state building codes. Motivation and professional support must also come from architects and civil engineers. Appropriate advisory services by specialist planners must be expanded in all departments.

If the public sector becomes active as a building owner, the tendering process could be carried out in such a way that laws, ordinances and guiding principles are implemented in an exemplary manner – even if there is no obligation to do so. Lighthouse projects create confidence in new technologies and promote the development of a market. The awarding of contracts for services, which up to now has been based almost exclusively on price, must be expanded to include environmentally oriented award parameters. According to German law § 16d EU VOB/A, this ispermissible, provided that the evaluation matrix is made available to the bidder in advance.

All stakeholders involved in the construction process can support the development of an effective circular economy by consistently incorporating resource-saving aspects into their daily work.

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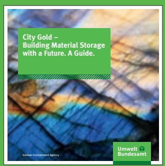

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