DGNB
Deutsche Gesellschaft für Nachhaltiges Bauen
German Sustainable Building Council

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# Circular Economy

## Closing loops means being fit for the future

**Green Solution House**
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# Contents





# Preface

In recent years, the term "circular economy" has become increasingly widespread and has now also become a relevant topic in the construction sector. The concept behind the circular economy is very promising: the appreciation, material recovery and reuse of resources is intended to ensure their availability and quality for future generations. The circular economy is thus an elementary component of sustainability and transfers it to the economic system and its individual sectors.

We already know that "business as usual", i.e. economic activity that follows a linear pattern, is no longer possible in view of current climate change and resource scarcity and in times of increasingly critical geopolitical dependencies. The DGNB therefore intends to make an active contribution to highlighting the potentials of a circular economy in the construction sector and to promoting its implementation and integration into the building practice. This guideline provides the various target groups in the construction and real estate sector with specific approaches, solutions and tools so that, building on existing knowledge, they can make their contribution to the implementation of the Circular Economy. Architects and planners will learn, for example, how to identify and use the right adjustment screws in order to integrate the concept of the Circular Economy right from the start. Manufacturers are given a basis to deal intensively with tomorrow's changing customer wishes and requirements in order to belong to the pioneers of a future-proof construction industry. We would also like to give all other interested readers suggestions for dealing with this exciting and multifaceted topic to positively shape the future of our built environment.

With the introduction of circular economy bonus points in the DGNB system version 2018, the concept of responsible use of resources - as anchored in the DGNB's basic understanding - was given even greater weight. Circular economy solutions at the building level can thus be measured and evaluated for the first time within the framework of certification. Fast spread of a presumably new concept always brings the danger that this is seen as a trend and marketed as such, and therefore becomes a burden without the actual added value being understood and incremented in practice. The resulting potential and effects would therefore remain unused. In order to avoid this, building on their previous activities DGNB will follow up this topic in the coming years more intensively, build up knowledge and disseminate it. With this background, the DGNB is currently working on the development of a new certificate for the deconstruction of buildings. This addresses the sustainability aspects that are desirable in the deconstruction and demolition of buildings in order to anchor them more firmly in the consciousness of the construction and real estate industry. This certificate may be required by cities and municipalities, for example, and can be used as an instrument of communication and quality with regard to the end use of buildings.

Fundamental change in an industry as diverse as construction can only take place with a common understanding and the same objectives. We see ourselves on the one hand as drivers of new topics, but on the other hand also as a platform dedicated to continuous learning from and with each other. Building on existing knowledge and making new insights available to others is an essential basic understanding in order to achieve concrete and reliable results in the short term. We want to support the sharing of knowledge in order to find and use the right levers and to "think from the end". Therefore, we call upon each individual to contribute their own expertise and that of others in order to advance the circular economy in the construction sector.

Only together can we develop a positive culture of critical feedback, learn from our own mistakes as well as from the mistakes of others and thus continuously improve ourselves. We look forward to work with you on small and large steps to implement a sustainable and future-proof built environment in the sense of the circular economy.

# 1. Importance of the circular economy

### HOW DO WE DEFINE THE CIRCULAR ECONOMY?

The concept of the circular economy is based on the "cradle-to-cradle" school of thought, which aims to not only minimise one's own negative impact or negative environmental footprint, but rather to provide a positive contribution. By recycling raw materials and using them as the basis for new materials or products, the creation of waste is avoided.[1]

When describing cycles, a fundamental distinction can be made between a biological sphere, in which health-compatible and compostable resources are continuously renewed, and a technical sphere, in which resources are improved and restored through human influence.[2]

With its report "Growth Within", published in 2015, the Ellen MacArthur Foundation made a significant contribution in the wider debate around the circular economy. Building on the cradle-to-cradle school of thought, it describes the circular economy as follows:

"The concept is characterised, more than defined, as an economy that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times."[3]

**»Celebrating our Human Footprint: A Building like a Tree – A City like a Forest«**

Theme of an exhibition by Prof. Dr. Michael Braungart at the Venice Biennale of Architecture 2016[6]

### THE CONCEPT OF THE CIRCULAR ECONOMY

The circular economy is based on the three principles of the Ellen MacArthur Foundation[4], which can be implemented as follows:

1. Value finite resources and control their stocks and material flows.
   Dematerialise value, use renewable raw materials, replace finite resources and recover used resources

2. Improve raw material yields by closing cycles while always maintaining the highest possible value of the raw materials.
   Close cycles, share benefits, use instead of owning, extend lifetime, repair products, reuse, refurbish, recycle materials, avoid waste

3. Ensure the effectiveness of the system through consistent consideration of externalities.[5]
   Consistently include external consequences for humans (e.g. health, justice) and the environment (e.g. pollutants, emissions).

The DGNB builds on this definition of the circular economy and wishes to contribute to a far-reaching consensus and to the dissemination of this basic understanding.


### STARTING POINT: THE LINEAR BUSINESS MODEL

The globally widespread linear economic system is based on a life on credit. It is based on the use of finite resources and leads to the increasing scarcity of resources through increasing consumption and population growth, environmental problems getting worse and global injustice increasing drastically.

Especially the decreasing availability and the ever more expensive extraction of resources lead to an increase in raw material costs and an increasing distributional imbalance. At the same time, raw materials that are landfilled or incinerated after use contribute to massive environmental problems.

### REMAINING GLOBAL $CO_2$ BUDGET AT CONSTANT $CO_2$ EMISSION LEVEL (1332 TONNES/SECOND)[8]

**in the 2°C-scenario:**
approx. 1,170 Gigatonnes (Gt) $CO_2$

**26 years**

**1.5°C-scenario:**
approx. 420 Gigatonnes (Gt) $CO_2$

**9 years**

Presentation based on: Mercator Research Institute on Global Commons and Climate Change (MCC), status: December 2018

### RESOURCE CONSUMPTION

If resource consumption everywhere in the world were as high as in Germany, 3 planet earths would be necessary to meet the needs of all people.

If the average global resource requirement were taken as a basis, it would still need 1.7 planet earths to meet the demand.[7]

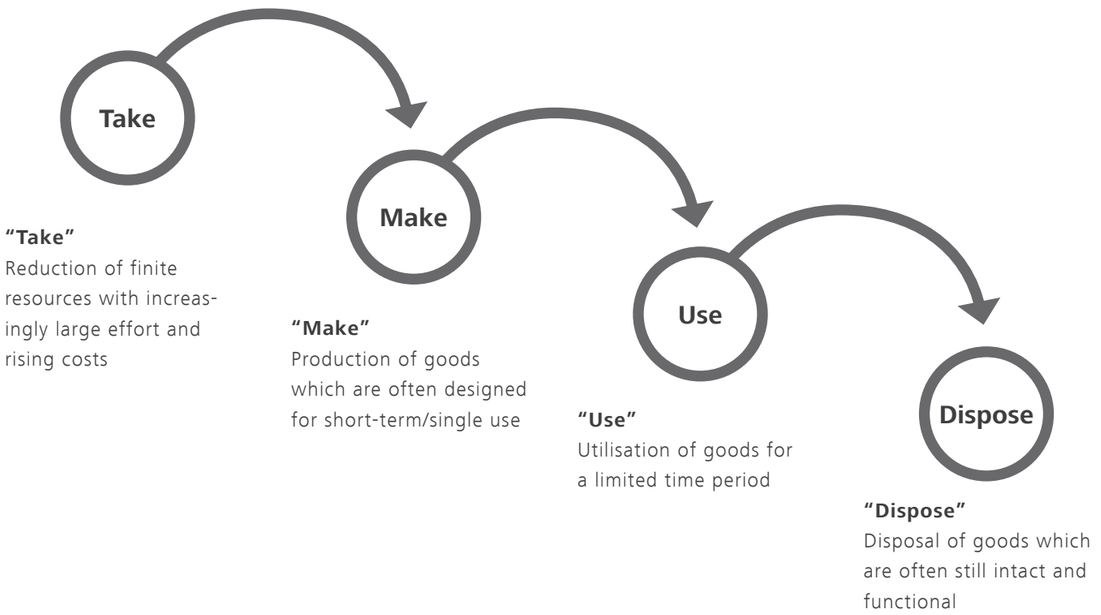
## THE LINEAR BUSINESS MODEL SHOULD NEVER HAVE BECOME ESTABLISHED - WE NEED AN ESSENTIAL NEW MINDSET

In the linear model (see fig. 1) finite resources are extracted at significant expense and processed into goods which often provide for a once-only short period of use. If these goods no longer meet certain specifications, they are disposed of even though they may still be fully functional and urgently needed elsewhere. The reasons for this include the following:

- the shift from values such as durability towards constant availability and demand for newer models,
- regulatory requirements that make it difficult to pass on- or reuse parts, or
- storage costs, which outweigh the disposal costs.

This system is not designed for sustainable growth and scaling and can therefore not function in the long term. For this reason, this system is now increasingly reaching its limits. Natural resources are not endlessly available and there is evidence that their extraction, processing and disposal has devastating impacts on humans and the environment. For example, it degrades areas, destroys important habitats, reduces biodiversity and pollutes drinking water and soil. The resulting environmental impacts are immense, and at the same time the remaining global $CO_2$ budget is continuously decreasing. This results in geopolitical tensions and dependencies, which in turn can lead to conflicts and wars, as can already be seen in the example of the extraction of rare earths. Current climate events such as storms, floods and periods of drought make the consequences of our (non-) actions ever more tangible for each and every one of us.

**FIGURE 1:**
**LINEAR MODEL**




Nevertheless, the debate within society on climate protection measures and sustainability does not yet consequently include external effects and environmental follow-up costs. There is no other explanation for why the wast of resources is not further limited or why the emission of climate-damaging greenhouse gases is still not appropriately priced in.
If one considers the current prices for recycled materials and current landfill costs, they do not reflect the environmental follow-up costs yet. As a result, secondary raw materials may even be more expensive than primary raw materials.[9]
It can be assumed that this will not remain the case, but that a holistic and realistic view of the problem will prevail in the long term through the inclusion of external effects. This knowledge, however, is usually not taken into account in today's building design and product development.

**»By internalising external costs, rising raw material prices can be exptected in the medium term due to a shortage of the 'ecologically available' raw material supply.«** (translated by DGNB)

Federal environment agency (2017): Factsheet environmental raw material availability[12]

The report "Linear Risks" published in 2018 by the organisation Circle Economy, the World Business Council for Sustainable Development (WBCSD) and others, shows possible risks regarding factors of market, operation, business and legal which are associated with continuing to apply the linear business model. Among others these include

- Dependency on fluctuating raw material prices,
- Possible regulatory measures with associated penalty payments as well as
- Market displacement through to new types of business models or technologies due to a growing demand for sustainable solutions.[10]

At the same time, however, the report also illustrates how the consideration of "true future costs" can already be of benefit today for sustainable and future proof investment decisions. Early consideration of the risks therefore offers the opportunity to turn them into opportunities.[11]

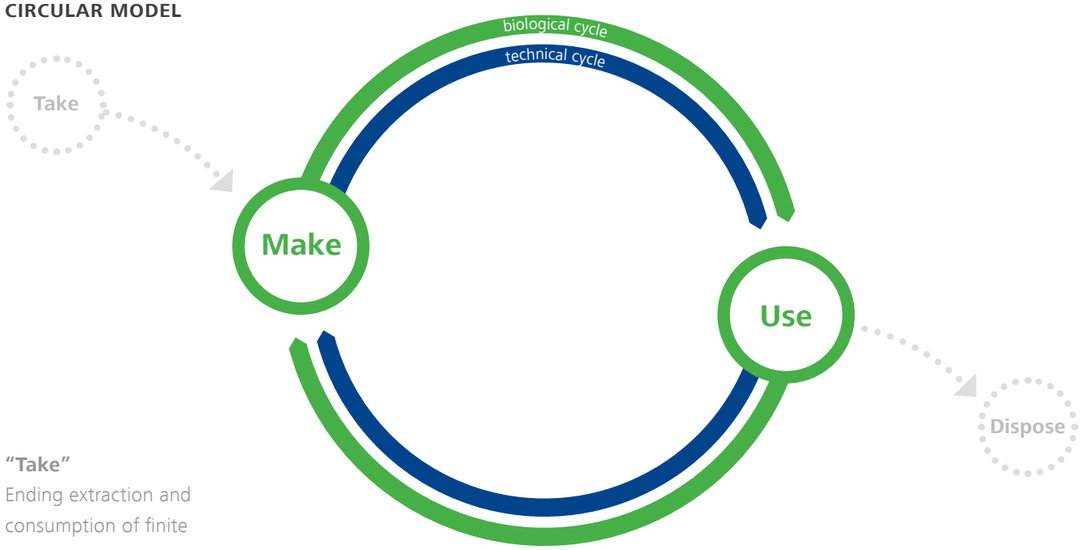
www.circle-economy.com/report/linear-risks-how-business-as-usual-is-a-threat-to-companies-and-investors

The publication and dissemination of case studies and success stories, but also the tangible effects of climate change can lead to growing consciousness and therefore as a result also readiness of individuals to act. Where previously a rather passive attitude prevailed, often accompanied by the feeling of powerlessness in relation to an established system, alternative multi-stakeholder business models reveal new scopes for action and design options. This can result in a dynamic situation, which leads to fundamental rethinking and therefore real change.

## THE CIRCULAR ECONOMY IS LOGICAL - BUT HOW CAN THE CHANGE SUCCEED?

Instead of extracting resources regardless of their finiteness as before and disposing of them again after a short period of use, we should focus on preserving quality and the resulting possible recycling between the phases of production and use. (see Fig 2).

**FIGURE 2: CIRCULAR MODEL**




**"Take"**
Ending extraction and consumption of finite resources

**"Make"**
- Maintain the quality and value of the raw materials used at the highest level.
- Reduce the number of processing steps and complexity
- Retain comprehensive use/reuse options
- Only manufacture products which can be returned into the cycle

**"Use"**
- Maximize service life through high repair friendliness (while at the same time ensuring the greatest possible efficiency)
- Increase intensity of use through diverse use options
- Ensure adaptability and flexibility
- Planning and stating usage times

**"Dispose"**
Stop producing waste and recycle raw materials if equialent use is no longer possible



**»Our world economy is only 9.1 % circular, leaving a massive 'Circularity Gap'.«**
Circle Economy (2018)[20]

Many people are already aware of this connection, but if they are asked about their own actions in line with the circular economy, there is usually a direct reference to the fact that this cannot be implemented due to the legal framework conditions without, for example, creating a competitive disadvantage. The objection is justified, since the responsibility cannot be "shifted" to individuals, whether the consumer, the building owner the manufacturer or the architect. However, if one looks at developments at European and national level, it becomes clear where the journey will take us in the future. The potential of the circular economy has been recognised.

Already in 2011, the European commission therefore demanded a decoupling of economic growth from the use of resources as well as increased recycling, greater reuse and saving of resources within the "Roadmap for a resource-protecting Europe".[13]

What sounds like changes in the distant future has now not only been integrated into timetables and strategies at the national level as well as at the level of the European Union, but has also found its way into concrete laws and regulations.

### EU

In December 2015 the European Commission released a "Circular Economy Package" including an action plan, where the transition to a circular economy* is described as a central lever for a "sustainable low-$CO_2$ resource efficient and competitive economy"[14]. Specifically the following target was formulated:

> "The transition to a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised, [...]"
> European Commission (2015a)[15]

The European Commission indicates, that at EU level "waste prevention, eco design, re-use and similar measures [...] could generate net annual savings of EUR 600 billion or 8 % of the annual turnover of EU companies, while at the same time reducing greenhouse gas emissions by 2 to 4 %."[16] In addition, the potential for creating new and secure jobs is rated high.

In May 2018, ambitious recycling targets were set for packaging and municipal waste by 2030 and 2035 respectively, as well as incentives to prevent waste and promote product stewardship. The new regulations also provide for a gradual phasing out of landfill.[17]

> "Landfilling of waste makes no sense in a circular economy and can pollute water, soil and air. By 2035 the amount of municipal waste landfilled must be reduced to 10% or less of the total amount of municipal waste generated." European Commission (2018 a): Press release 22.05.2018[18]

In the field of waste management, four amending directives entered into force on 4 July 2018 as part of the EU waste package, which must be implemented by the Member States within a period of two years. These include the waste framework directive (EC/2008/98), the directive regarding packaging and packaging waste (94/62/EC) and the directive regarding landfill of waste (1999/31/EC).[19]

* For the German translation of the term "circular economy", European commission uses the term "Kreislaufwirtschaft". This term however has often been used synonymously in the German-speaking world with the term waste management. In order to prevent misunderstandings, for this reason DGNB avoids the term "Kreislaufwirtschaft".

## GERMANY

At a national level, the previous understanding of the term Kreislaufwirtschaft has been extended with central aspects of the circular economy: The German Resource Efficiency Programme II (ProgRess II, 2016) aims under the term "resource-efficient circular economy" not only to avoid waste, but also to strengthen product responsibility, to tap into recycling potentials that have not yet been leveraged, and to extract secondary raw materials from anthropogenic repository. (urban mining, see page 12).[22]

Dt. Ressourceneffizienzprogramm II (ProgRess II), 2016
www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/progress_ii_broschuere_bf.pdf

### The Waste Management Act (KrWG)

The implementation of the requirements of the European waste framework directive (EC/2008/98) into national law in Germany among others arises together with the law for promote the circular economy and ensuring environmentally compatible waste management (Kreislaufwirtschaftsgesetz, KrWG).[23]

"A circular economy in the sense of this law is the avoidance and utilization of waste."
(Art. 3 para 19 KrWG)[24]

"The preparation for reuse, recycling and other material utilization of nonhazardous construction and demolition waste with the exception of materials occurring in nature [...] from 1 January 2020 at the latest must be at least 70 % by weight." (art. 14 para. 3 KrWG)[25]

All in all, these are only the first steps on the long road to a fully implemented and lived circular economy, and it is essential for the success that the same rules apply for everyone. Nevertheless, these developments can provide guidance for those who do not want to remain in the status quo, but want to keep future-proof and would like to prepare themselves for future regulations.

The transition towards the circular economy will not only radically shake up all existing economic structures, but rather derive much greater benefit from them. At the same time, it will not work without change. The circular economy is based on the principle of quality-oriented sufficiency, and through aspects such as avoidance and waste reduction also challenges consumer society - as it functions in its present form. The question of growth must be solved in ways other than those that already exist and decoupled from the use of resources. Particularly in view of the fact that the Western economic model is widely regarded as a global model and exported to other regions and continents, it is essential to base this model on circular principles, renewable energies and climate-adapted construction. Especially emerging and developing countries have great potential for implementation in this respect.

**»We call this opportunity growth within because the circular economy focuses on getting much more value from existing economic structures. The circular economy offers a new growth paradigm that Europe would largely control so Europe would face less pressure to compete with low-cost countries in a global marketplace.«**
Ellen MacArthur Foundation (2015)[21]

These and other questions are covered by the "Building Sense Now" joint initiative of the DGNB and the IFC (International Finance Corporation, part of the World Bank group).

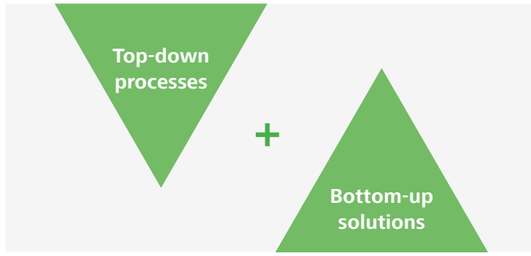
www.buildingsensenow.com/the-idea-of-building-sense-now/

## HOW CAN WE SUPPORT THE TRANSITION?

It is therefore a matter of actively transforming the existing system by bringing about a fundamental rethink, but also by clearly defining the individual areas of responsibility and thus action.

To this end, it is crucial that we use and share existing knowledge, that we participate in the creation of new solutions and jointly develop them further. It is often worth looking back. We can learn from existing solutions and adapt them to current conditions. Less can be more; perhaps the simplest, less complex solution is the most appropriate. By questioning the status quo and rethinking existing solutions, we can help make Circular Economy solutions the best and most logical option. We should dare to try things out and create experimental spaces where we can learn from mistakes.

There are many individuals and initiatives that are already doing this. At the same time, new business models are constantly being developed that recognize this as a great added value. In order to enable scaling, these bottom-up solutions must be accompanied and supported by the appropriate top-down processes, be it regulations and laws, economic incentives and subsidies or other measures.




Last but not least, we must spread the existing knowledge and anchor it as a central component of teaching. Everyone can make a contribution to this, because the circular economy concerns us all.


© DGNB

# 2. The circular economy in the construction sector

## 2.1 Why do we need the circular economy in the construction sector?

A glance at the data on waste generation, energy and resource consumption as well as the emissions caused by the construction sector quickly makes it clear: The impact of construction on our environment, on the climate and therefore on our entire planet is immense.

In view of the fact that globally available resources are finite, it is becoming increasingly important to keep the raw materials once taken from the earth in a high-quality condition and to use them for as long as possible. Instead, more and more new resources are introduced into new buildings and consumer goods, which usually remain in or "store" them for many decades. Instead of disposing of these at the end of life, the building stock and also the goods produced by man are increasingly being considered as a central source of raw materials. In this context one speaks of "urban mining" or the anthropogenic (i.e. man-made) stocks.

> "Urban Mining regards our immediate habitat as a raw material source. In the widest sense, it is about the extraction of valuable materials from all those sources that have been created by human hands such as buildings, infrastructure, durable consumer and capital goods and much more. Urban mining thus extends the dictum “waste is raw material” found in the classical recycling industry."[26]

The EU-wide public survey "Public Consultation on the Circular Economy", conducted by the European Commission in 2015 in the run-up to the adoption of the circular economy package, reveals the potential for the circular economy in the construction sector.

When asked which sectors should be prioritised for future EU activities in the circular economy sector, more than one fifth of the responses and thus the most votes were cast in the area of "construction/demolition and buildings" (22.25 %).[27]

### NUMBERS AND FACTS FOR GERMANY

**Waste generation:**

- The emergence of construction and demolition waste in Germany in 2016 amounted to just under 223 million tonnes, equivalent to **54 % of the total waste generated in Germany.** Compared to the previous year, the volume of **construction and demolition waste increased by 6.6 %**.[28]

**Greenhouse gas emissions:**

- **Buildings** are responsible for up to **30 % of** Germany’s greenhouse gas emissions.[29]

**Energy consumption**

- **36 %** of final energy consumption in Germany **is accounted for by the building sector** (heat and electricity).[30]

**National raw material extraction:**

- Just under half (**49.7 %**) of the raw materials extracted in 2015 in Germany **were construction minerals** (517 million t of a total of 1041 million t).[31]
- The total amount of **raw materials** extracted in Germany **decreased** by 15 % between 2000 and 2015. In the same time period, however, **imports of goods rose by 23 %**.[32]

**Private consumption of raw materials:**

- In terms of private consumption of raw materials, the **consumer field of "housing"** was the most significant in 2011 at around 30 %, closely followed by the consumer field of "food". In the field of housing, minerals and fossil fuels are the key raw material categories.[33]

**Anthropogenic stocks:**

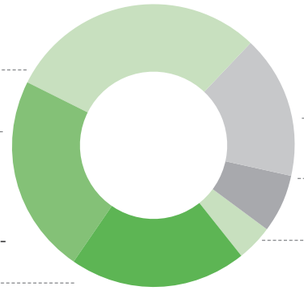
- According to calculations by the German Environment Agency, **51.7 billion tonnes of material were in anthropogenic stock in 2010.**[34]
- The **increase** from 1960 to 2010 amounts to **80 %.**[35]
- The net increase in stocks (NAS) **per year and inhabitant** is approx. **10 tonnes**.[36]
- The **material value** of the entire anthropogenic stock is estimated at **1,300 billion Euros**.[37]
- The **construction sector** accounts for the **largest share** of the anthropogenic stock: **Residential and non-residential buildings bind 55 %** of the stocked masses (mainly mineral materials) [38]

## 2.2 What are the levers for implementation within the construction and real estate sector?

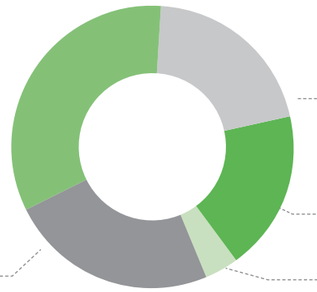
In order to identify the potential of the circular economy in the construction sector, the DGNB conducted a survey among its members*. The majority of the participants saw the potential of a circular economy in the ecological as well as in economic and social field.

### DGNB SURVEY

**"What do you consider to be the most important elements of a circular economy business model respectively of circular economy in the construction sector?"** (Multiple responses possible, 74 answers in total)




**"From your point of view, what is most important to about a transition from a linear to a circular economic model and to drive forward circular building practices?"**
(Multiple responses possible, 54 answers in total)




Source: DGNB, own survey (March to May 2018)[39]

*24 persons took part in the survey. The survey is therefore not representative of all DGNB members.



### EU SURVEY

In the EU survey "Public Consultation on the Circular Economy" mentioned in Chapter 2.1, the product level is examined in more detail. Similar key topics are identified here.

Information and results of the study can be found at the following link: http://ec.europa.eu/environment/consultations/closing_the_loop_en.htm

**The importance of individual product characteristics for promoting a transition to the circular economy**

Among other things, the importance of individual product characterisitics for promoting a transition to the circular economy should be assessed. All the properties surveyed were classified as "very important". However, the most frequent votes for "very important" were cast for the following properties:[40]

**63.2 %**
Recycling capability: e.g. deconstruction, separability of the components, information regarding chemical substances contained

**59.5 %**
Minimising environmental impacts over the life-cycle

**51.7 %**
Durability/longevity

**51.2 %**
Repairability: Product design that promotes the possibility of maintenance and repair

**Main actions to promote circular economy principles in product design at the EU level**

With regard to the importance of individual measures to promote the circular economy in product design, the most frequent responses to "very important" were as follows:[41]

**43.3 %**
Establish binding rules on product design (e.g. minimum requirements for "durability/longevity")

**42.3 %**
Promote and/or enable economic incentives for eco-innovation and sustainable product design (e.g. through rules on extended product responsibility for manufacturers)

**39.5 %**
Promote the consumption of green products

### KEY TOPIC "CONVERSION AND DECONSTRUCTION-FRIENDLY PLANNING"

It can be deduced from the results of the surveys that the respondents attribute great relevance to the aspects of recycling and deconstruction-friendly planning, repairability and longevity both at the design and product/material level. In addition, a holistic consideration of costs and external effects, covering the entire life cycle and thus also the end of life, is central. For the implementation of these aspects, there is a need for incentive systems for manufacturers and for clear legal framework conditions for the circular economy.

### KEY TOPIC "(SPACE)SHARING"

In the survey among DGNB members, the topic of "sharing" was also seen as a possible element of the circular economy in the construction industry, albeit to a lesser extent.

**Using the levers for implementation**

In order to tap the potential identified in this way, the DGNB held a series of workshops on the subject of "circular economy" together with experts from the construction and real estate sector as well as from the waste management sector.

The following workshops took place in 2018:

- "Circular Economy – Shared Spaces"
- "Circular Economy – Construction"
- "Circular Economy – Deconstruction"

In the workshops, challenges and possible solutions were discussed for the respective key topic, examples of implementation were compiled and central fields of action and impulses for planning were developed, which are presented in Chapter 3 in the form of a toolbox for implementing the circular economy in the construction sector.

Due to the relevance described above, the existing potential, but also the knowledge still to be built up for the implementation of a circular economy, chapter 3.1 "Conversion and deconstruction-friendly planning" forms the focus of the toolbox in terms of content. Chapter 3.2 "Multi-use of areas" was chosen as the second main topic of content for this guideline, as the DGNB believes that it already offers many planning implementation options for promoting the circular economy today, in that it can contribute on the one hand to the revitalisation and re-utilisation of unused building areas and on the other hand to a reduction in further land and resource consumption.

**Relevant levels linked to the construction sector for the implementation of the circular economy**

Of course, the topic of circular economy in the construction sector is not limited exclusively to these two main topics and does not end with the building or property line. Instead, many other levels and aspects are associated with successful implementation in the construction sector. The connection with these levels is briefly outlined below, but is not comprehensively described in this guide.

**OUTLOOK ON POLITICS AND PROCESSES**

Chapter 1.1 shows that the change towards a circular economy requires political support and that top-down processes such as regulatory provisions, economic incentives or support programmes are necessary for successful implementation.

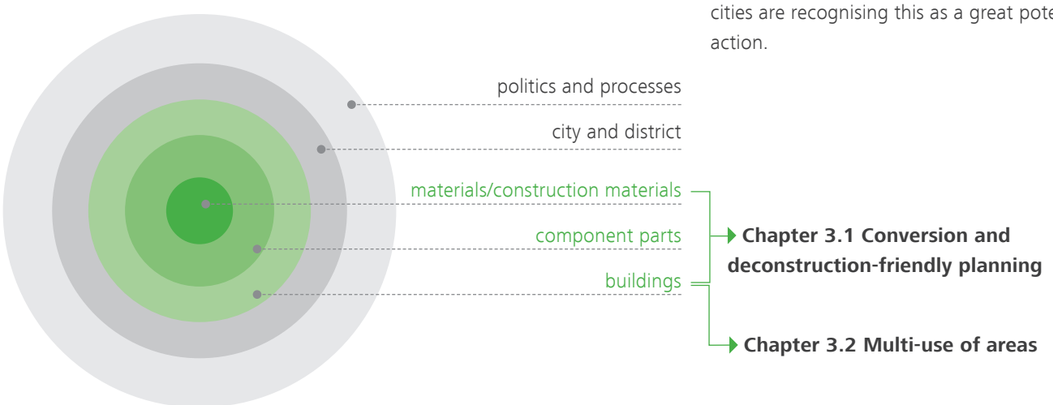
Beyond the political and legislative processes, the topic of digitisation is also of great importance: How can digital technologies support change? What processes and competencies will be needed in the future? How can the individual actors be linked? How can sensitive information be protected and access rights regulated? What effects will digitisation have on existing processes and working methods in the construction sector?

The present publication does not deal specifically with the subject of digitisation, but its relevance becomes clear both in connection with conversion and deconstruction-friendly planning as well as with the multi-use of areass.

**OUTLOOK ON CITY AND DISTRICT**

The city level is of great importance with regard to the issue of circular economy, since many circular aspects can be realised either particularly well or even exclusively at the city or municipal level.

The city can, for example, help to ensure that existing local initiatives working for the implementation of the circular economy are supported in their activities by the city. The city can also actively drive the process of change itself. More and more cities are recognising this as a great potential for action.




The activities of the cities of Amsterdam and London are presented here as examples, which, according to their own statements, would like to take on a pioneering role with their strategies for the circular economy.

**IMPLEMENTATION EXAMPLES:**

**"Towards a Circular Economy in Amsterdam"**
**Amsterdam, NL**[42]

- In 2015 the city of Amsterdam set itself the goal of becoming a "fully circular city" by 2050 at the latest.

**Concrete objectives:**

- Separation of 65 % of domestic waste until 2025
- Reduce the consumption of primary raw materials by 50 % until 2030
- Carry out detailed analyses to identify the core sectors for the implementation of the circular economy in Amsterdam as well as a study regarding the potential for the creation of jobs
- Publication of reports and extensive information material in cooperation with the organisation Circle Economy

https://journey.circularamsterdam.com/circularamsterdam#156340

**"London's Circular Economy Route Map"**
**London, UK**[43]

- In the report "Towards a circular economy - context and opportunities" published in 2015, the LWARB (London Waste and Recycling Board) identified the built environment as one of five focus areas for the implementation of the circular economy in London.
- In 2017, the "London Circular Economy Route Map" was published, setting out the vision for a circular London and outlining key challenges and recommendations for action for the five focus areas.
- According to the report, the circular economy offers London a potential net benefit of up to £7 billion by 2036 (of which £2.8 billion could be achieved by implementing the route map) and the potential for 12,000 additional jobs.

https://www.lwarb.gov.uk/what-we-do/circular-london/circular-economy-route-map/

In addition to overarching strategies and goals, many other issues play a role at the city and municipal levels, but also at the district level:

What will mobility and energy supply look like in a circular economy? How will private transport develop? Will electromobility prevail and can the necessary energy demand be met by renewable resources alone? Will the problem of inner-city logistics be solved by means of cargo wheels or other innovative forms of mobility?

Will we buy and own fewer goods in the future? To what extent will the idea of the "sharing economy" play a role in the implementation of the circular economy? How will the many existing approaches for sharing land, mobility, goods, food, energy, etc. develop in the future? Will the business models emerging in this area be sustainable in the long term?

Chapter 3.2 of this guide deals with the issue of multi-use of areas. Beyond this, however, there are already many other approaches from the building sector which have recognised the aspect of renting or hiring out as a business model and have developed this into a service, as the following example of Schiphol Airport shows.

**IMPLEMENTATION EXAMPLE**

**Schiphol Airport, Amsterdam NL**[44]

- Implementation of the "Lighting as a Service" business model, in which the provision of light is purchased as a service, while the service provider remains the owner of the luminaires and the necessary technical equipment and is therefore also responsible for possible repairs and the replacement of lamps.
- According to the Royal Schiphol Group, the implementation of this model, in collaboration with Cofely and Philips, has made lighting more energy-efficient and resource-efficient through the reusability of the systems, increased service life and reparability, and reduced usage costs.

https://www.schiphol.nl/en/schiphol-group/page/circular-lighting-in-departure-lounge-2/

## 2.3 Circular economy in the DGNB System

The responsible use of resources has been a central concern of the DGNB from the outset. For this reason, a large number of aspects that contribute to a circular economy in the construction sector have been anchored in the DGNB system since the first version in 2008. For example, the life cycle-oriented planning of buildings, including environmental impacts and the consumption of finite resources over all life cycle phases, has always been a central component of certification with a particularly high proportion of the overall assessment (criteria "ENV1.1 Building life cycle assessment"). The criteria of the first version of the DGNB system (criteria "TEC1.6 Ease of recovery and recycling") also included the ease with which buildings can be dismantled and recycled, which, in addition to ensuring the greatest possible reduction and efficient use of the natural resources used, should also ensure their continued use by future generations. Further use and recycling of raw materials once they have been introduced into the building industry presupposes that hazardous or harmful constituents are largely reduced and avoided in order not to harm people and the environment, either now or in the future (criteria "ENV1.2 Local environmental impact"). In addition to these, the other DGNB criteria also make an important contribution to a sustainable, healthy and increasingly circular built environment.

With the 2018 version of the DGNB system, circular economy bonuses were also introduced, making it possible for the first time to make concrete, progressive solutions for promoting circular economy at the building level assessable and measurable within the framework of certification. By awarding bonus points, which have a positive effect on the certification result, incentives are created and experimental spaces created to develop new solutions and promote innovation. As part of the revision of the DGNB system for districts, these bonuses will also be transferred to the district level and further developed accordingly.

https://www.dgnb-system.de/en/system/version2018/criteria/


© DGNB

### TABLE: CIRCULAR ECONOMY BONUSES IN THE DGNB SYSTEM

| CRITERIA NAME | CONTRIBUTION TO A CIRCULAR ECONOMY | SCORE |
|---|---|---|
| **Land use** | Brownfield redevelopment:<br>Land that is subject to low-level or significant contamination is considerably improved by properly disposing of the soil and sediment on the land. | CE bonus: +5 points (lightly loaded), +10 points (heavily loaded) |
| **Life cycle cost** | Reuse:<br>It can be demonstrated that a significant proportion of building components have been reused in the building or used in line with business models based on the idea of a circular economy (e.g. performance contracting with a strategy for recycling or reuse). | Maximum CE bonus: +10 points, per implemented circular economy solution 5 bonus points. |
| **Flexibility and adaptability** | High intensity of use:<br>For at least 50% of the building's usable area, area usage concepts that allow for a higher intensity of use (in the form of a higher number of users or different usage times) have been implemented. | CE bonus: +10 points |
| **Commercial viability** | Circular economy users, tenants or hirers:<br>At least one company/party actively contributes to a circular economy as users/tenants/hirers of the building. This occurs in the building itself or at the site by means of joint material flow management or similar forms of collaboration with another company/party within the near vicinity of the building. | CE bonus: +10 points |
| **Use and integration of building technology** | District-level solution for renewable energy:<br>To cover the energy demand in the building that arises from the running of the building and from user actions, energy that is generated in the surrounding district/in the immediate vicinity from renewable energy sources (at least 10% of the energy demand arising from the running of the building) is always used. Alternatively, energy that is generated in the building or on its land from renewable energy sources is fed to the district/the area in the immediate vicinity (at least 10% more than the energy requirements arising from the running of the building). | CE bonus: +10 points |
| **Use and integration of building technology** | Energy system that provides ancillary services to the electrical grid:<br>The building provides significant storage capacity (based on approx. 10% of the building's total energy requirements) for the purpose of grid compatibility or uses integrated energy and load management. | CE bonus: +10 points |
| **Deconstruction and recycling** | Reuse or material recycling:<br>Building components are reused in the building or building components are used for which there is documentary evidence to show that the materials from which they are made are currently recycled into comparable products. | Maximum CE bonus: +20 points (1 point per component) |
| **Deconstruction and recycling** | Eliminating building components:<br>The building is designed so as to completely eliminate building components that are usually installed for this purpose. The solution presented is a feasible one that significantly and demonstrably eliminates the need to use raw or secondary materials. | Maximum CE bonus: +10 points (1 point per component) |
| **Mobility infrastructure** | Mobility sharing:<br>The building has designated mobilitysharing parking spaces that are easily accessible or very near the building's entrance. Alternatively, the building is located within an area in which a freefloating car-share service operates. | CE bonus: +10 points |
| **Sustainability aspects in tender phase** | Recycling materials:<br>The invitations to tender do not specifically forbid the use of mineral recycling materials; with regard to the building products, the reuse or use of secondary materials is explicitly recommended or required by the invitations to tender. | CE bonus: +10 points |
| **Construction site / construction process** | Waste prevention on the construction site:<br>Innovative concepts, construction methods or technologies that significantly reduce the amount of waste generated are used on the construction site. | CE bonus: +10 points |
| **Access to amenities** | Facilities that cater for people's day-to-day needs and provide meeting points for interaction:<br>In or near the building, innovative amenities or provisions for the building's users or other people are built or provided, such as allotment gardens and beehives (urban farming), or spaces are provided on a permanent or regular basis for trading skills or services with others in the community, e.g. temporary trading spaces/pop-up shop premises, repair cafés, community meeting places. | CE bonus: +10 points |

## OUTLOOK: FURTHER APPROACHES TO MEASUREING THE CIRCULAR ECONOMY

In the current discussion about the circular economy, the topic of measuring and monitoring the circular economy is becoming increasingly relevant. The ecological and economic advantages of circular economy can be verified by means of life cycle assessments and life cycle costings. Numerous other approaches, strategies, tools and parameters for measuring and mapping the circular economy are currently being developed and tested at both national and international level. These range from alternative economic parameters and novel indicators for measuring material flows to company-related circular economy strategies and specific measures of circular economy aspects at city or building level. Three approaches are listed below as examples:

- **"Monitoring Framework for the Circular Economy" (European commission)**
  Framework for monitoring progress within the area of the circular economy. The development of individual indicators at EU and national level can be viewed online.
  Factsheet: http://ec.europa.eu/environment/circular-economy/pdf/monitoring-framework-factsheet.pdf

  Indicators: https://ec.europa.eu/eurostat/web/circular-economy/indicators/monitoring-framework

- **"Level(s) – A common EU framework for key sustainability indicators for office and residential buildings" (European commission)**
  Level(s) is a voluntary, EU-wide reporting framework for the assessment of the environmental performance of office and residential buildings and is intended to promote their comparability. Level(s) provides a step-by-step approach to life cycle assessment.
  http://ec.europa.eu/environment/eussd/buildings.htm

- **"Circularity Indicators Project"**
  As part of the Circularity Indicators Project of the Ellen MacArthur Foundation, indicators were developed to assess the circularity of products. Companies can perform this analysis using a tool developed by Granta Design.
  In addition to other indicators, the "Material Circularity Indicator" (MCI) is calculated, which examines the material flows arising in connection with a product and evaluates them with regard to the circular economy.
  https://www.ellenmacarthurfoundation.org/resources/apply/circularity-indicators

Furthermore, scientific work also deals comprehensively with the topic of circular economy. The existing approaches cannot be comprehensively presented here, but their diversity makes one thing clear: in future, new indicators and indicators will be necessary in order to adequately reflect the circular economy and to monitor its development. It will also be necessary to examine in the medium and long term to what extent the newly developed indicators actually contribute to a circular economy and whether rebound effects may arise that require countermeasures.

**Publications of other Green Building Councils (GBCs) regarding the topic of circular economy**

- DK-GBC: „Cirkulær Økonomi og DGNB"
  http://www.dk-gbc.dk/publikationer/cirkulaer-%C3%B8konomi-og-dgnb/

- L' Alliance HQE-GBC France: „Cadre de définition de l'économie circulaire dans le bâtiment"
  http://www.hqegbc.org/publications/?page=2&dossier=

- GBC España: „Informe de posicionamiento de GBCe sobre Economía Circular"
  http://gbce.es/recursos/informe-de-posicionamiento-de-gbce-sobre-economia-circular/

- UKGBC: „Circular Economy Research Survey"
  https://www.ukgbc.org/ukgbc-work/circular-economy-research-survey/

- Dutch GBC: „A Framework for Circular Buildings"
  https://www.dgbc.nl/circulairegebouwen

- Irish GBC: „Towards a circular economy in Construction"
  https://www.igbc.ie/resources/towards-a-circular-economy-in-construction/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# 3. DGNB Toolbox – Implement the circular economy now!

When it comes to integration into practice, arguments are - as in the discourse on the subject of sustainability - regularly put forward for the circular economy which justify a hesitant implementation with supposedly high costs or too little support from legislation.
Within its publication "No More Excuses", The DGNB looked at these and other preconceptions, and identified the need for immediate action (further information on the publication can be found here).

In the form of a toolbox, this guide now shows the individual actors involved in the construction process how the circular economy concept can already be implemented in the construction industry today, using concrete fields of action and pragmatic solutions at building, component and material level. The proposals presented represent a wide range of possibilities from which the actors can make targeted use depending on the project. It is particularly important to the DGNB that the individual measures can be implemented according to their responsibilities in order to put an end to the previous linear transfer of responsibility through the entire chain of actors. After all, sustainable construction can only succeed if everyone fulfils his or her responsibilities and uses the corresponding potential. This is the only way that individual measures can result in an improved, larger whole - every contribution is important and counts!

The toolbox is accompanied by implementation examples that illustrate the multitude of ideas and initiatives that already exist in the area of circular economy. This, too, is a basic concern of the DGNB, which builds on what already exists so that no time is wasted on permanent redefinitions or demarcations. Finally, planners and building owners are given a checklist with questions that they can ask themselves about the appropriate consideration of the circular economy in the individual planning phases.

For a successful implementation it is central that we fundamentally change our attitude and understand circular economy as a fundamental and self-evident design premise. It is therefore important for planners to start the design process when deconstructing the existing building stock, to understand it as a source of raw materials and to integrate what already exists into the planning of something new.
It is equally important to ensure that the building is easy to dismantle, easy to recycle and flexible for subsequent use, so that the materials used can continue to be used and recycled after the end of their useful life. Manufacturers, on the other hand, should promote the longevity and durability of their products over a defined period of use, as well as increased repairability and the availability of spare parts, and should provide for the return of their products.

**»We need a material turn - now. «**
Deutsche Gesellschaft für Nachhaltiges Bauen – DGNB e.V.[45]

The toolbox is structured as follows:





## 3.1 Conversion and deconstruction-friendly planning

Note: The contents of this chapter are based on the results of the DGNB workshops "Circular Economy Construction" and "Circular Economy Deconstruction". The speakers and participants of the workshops are listed on page 59.

In the context of the DGNB survey, the topic "Conversion and deconstruction-friendly planning" was classified as very relevant. The aim of the circular economy is to reuse components, products and building materials for as long as possible and then to recycle them to a high standard. Waste that has to be disposed of is thus largely reduced and avoided as completely as possible in the long term. The terms used in these guidelines to describe the end of use of components and materials refer to the DGNB criteria "TEC1.6 Easy of recovery and recycling", in which the recycling and disposal paths are described in detail as the basis for the evaluation of easy recycling within the framework of certification.

**TABLE: RECYCLING AND DISPOSAL PATHS ACCORDING TO DGNB CRITERIA TEC1.6**

| NO. | RECYCLING AND DISPOSAL PATHS | DESCRIPTION | QUALITY LEVEL |
|---|---|---|---|
| 1 | Avoidance | Parts that are normally used as standard in a structural element are not used, or significantly fewer structural elements are used for an entire building component group than is normally considered to be standard for the specific use. Example: No ceiling covering, no upper surface covering. | CE bonus - avoiding use of building components |
| 2 | Reuse | The building component/ building subcomponent/ construction product remains unchanged in the building (for the Renovated buildings scheme) or is (after minimal retrofitting) already reused. Alternatively: A take-back guarantee or leasing system exists for the building component/building subcomponent/construction product. | CE bonus - reuse or material recovery |
| 3 | Material recovery to create a comparable product | With currently available technology, the material in the building component/ building subcomponent/construction product can predominantly be reused, providing an equivalent building component/ building sub-component/construction product. To do so, a loss-free cycle must be ensured via established logistics. Alternatively: A take-back guarantee or leasing system exists for the building component/ building subcomponent/construction product. | CE bonus - reuse or material recovery |
| 4 | Material recovery in building construction | With currently available technology, the material of the building component/ building subcomponent/construction product can predominantly be recovered, enabling it to be used for production of a new building component/ building subcomponent/construction product for building construction. | Quality Level 2 |
| 5 | Material recovery | With currently available technology, the building component/ building sub-component/ construction product can predominantly be used as a secondary raw material for use outside of building construction. | Quality Level 2 |
| 6 | Energy recovery | With currently available technology, the building component/ building sub-component/construction product is predominantly used as a substitute fuel in a production building (e.g. a cement plant or an in-house cogeneration plant) or in a waste incineration plant, enabling recovery of its energy. | Quality Level 1 |
| 7 | Backfilling | With currently available technology, the building component/ building sub-component/construction product is predominantly used as a substitute for other backfill materials for backfilling (residual) cavities. | Quality Level 1 |
| 8 | Disposal in landfill | With currently available technology, the building component/ building sub-component/ construction product is predominantly disposed of in landfills (landfill class 1). | Quality Level 0 |
| 9 | Disposal as "hazardous waste" | With currently available technology, the building component/ building sub-component/ construction product is predominantly disposed of in class 2–3 landfills or in separate disposal facilities. | Quality Level 0 |

DGNB criteria "TEC1.6 Ease of recovery and recycling"
www.dgnb-system.de/de/system/version2018/kriterien/rueckbau-und-recyclingfreundlichkeit/

## 3.1.1 Strategic fields of action for reuse and material recovery

In the following sections, the paths of reuse and recycling are examined in detail one after the other and possible fields of action for the various actors involved in the construction process are identified. The ecological, economic and socio-cultural potentials are first of all listed together for both ways.

**Potentials of reuse and material recovery**

### Environmental

- Reduction of "grey energy"
- Reduction of emissions to air, water and soil
- Reduction of resource consumption
- Reduction of land consumption (extraction and landfill areas)
- Avoidance of waste

### Economical

- Avoidance of increasing disposal/landfill costs
- Independence from future price fluctuations as a result of lower resource availability
- Growing market potential:
  Reuse is currently still a niche market in terms of construction practice, but the market segment is expected to grow as demand increases in the future. Currently, the supply of reusable components and building materials is generally based on component exchanges and similar initiatives, which can be the starting point for further market development. Continuous expansion would enable scaling and make reused components accessible to a wider mass. The market segment offers great potential for new business models and job creation.

### Socio-cultural

- Local added value:
  Increasing reuse and recycling has the potential to create local jobs and should be accompanied by training of professionals.
- New understanding of building culture:
  An increase in the appreciation of buildings and individual components can lead to an increasing identification of the user with the built environment. The new role of the architect includes an increased communication of the value of the built environment.

**»If the enormous consumption of resources in construction is to be reduced to a sustainable level, construction will have to undergo a paradigm shift. [...] it will also be necessary to conceptualise the loop potential of buildings by way of a design parameter.«**

Anja Rosen (Manual of Recycling, Edition DETAIL 2019)[46]

### REUSE

The reuse of building materials and components offers great potential in all three pillars of sustainability (see above). In practice, however, implementation usually fails because of the inner attitude of the actors involved in the construction process and the building users, since components that have already been used are often automatically associated with a lower quality. Other obstacles are the existing uncertainty and ignorance regarding the legal situation regarding the reuse of used components and building materials and the fact that existing processes are often not yet economical and therefore not yet scalable. In addition, there is an availability problem today: the corresponding materials or products are not always available in the required quantities with the same quality levels.

The reuse of components on a small scale or in the private sector can usually be covered by component exchanges with regional warehouses. In the area of historical components and for the use of selected individual pieces, historical building material dealers are also available as contact partners. In both cases, reuse must be included in the planning process with sufficient time in advance in order to find suitable materials and prepare them appropriately for use in the project.

Should the demand for reusable components grow, the current possibilities for meeting demand will not be sufficient. In order to promote reuse on a larger scale, the use of system components with standard formats is therefore beneficial, which considerably facilitate further use compared to individual single components. A further advantage of the renewed use of serially manufactured components is that under certain circumstances large quantities become available and that at best it is easier to check which ingredients are contained in the component.

**Where are the limits of reuse?**

Despite all the advantages presented, reuse should not become an end in itself. Particularly in the case of components that are statically or fire-protection relevant, reuse is currently limited due to the challenges mentioned above. The reuse of components and building materials must be considered on a project-specific basis and its usefulness, cost-effectiveness as well as any residual risk must be checked. It is therefore necessary to consider the costs and benefits individually. For example, reprocessing for reuse or necessary transport may be very energy-intensive under certain circumstances and be based on the use of fossil fuels, or reused components may only have a very short service life in individual cases, so that recycling may be preferable to reuse. In any case, the further use and material recovery along the waste hierarchy should be checked in detail before disposal. For scaling and systematisation of reuse, it is also necessary that it is promoted and demanded even more by legislation and that the implementation of existing laws and regulations is consistently monitored.

**SIDE NOTE: CURRENT CHALLENGES FOR BUILDING COMPONENT STOCKS & -EXCHANGES:**

Building component exchanges are receiving and selling points for well-preserved components. They usually consist of a physical component warehouse, which is often supplemented by a digital marketplace. Both regional and decentralized concepts exist.

- Regionally operating companies usually have centrally accessible warehouses with hall and outdoor space requirements and aim to consciously save transport costs. Regional networking, addressing and marketing must be intensively pursued.
- The services offered range from component sifting and removal to the procurement of regionally typical materials, transport and reassembly.
- The personnel and cost expenditure for communication, removal and transport of the components is very high. The economic efficiency often results only from additional services in the building trade such as disposal, building consultation or partial decoring.
- A possible expansion of the business model could be made possible by cooperation with all parties involved in construction (building stock exchanges, architects, demolition companies, employment agencies, etc.).

**IMPLEMENTATION EXAMPLE COMPONENT STORES AND EXCHANGES**

**bauteilnetz Deutschland**

- Linking all the relevant stakeholders for reuse
- Overview regarding component exchanges and component catalogue for used components in Germany

http://www.bauteilnetz.de/

**MOVECO**

- Cross-border online marketplace for the reuse of raw materials and building products (Danube area)

https://danube-goes-circular.eu/

**Restado**
https://restado.de/

**IHK recycling exchange**
https://www.ihk-recyclingboerse.de/

**Rotor DC/Rotor Deconstruction (Belgium)**
https://rotordc.com/

**BauKarussell (Austria)**
http://www.repanet.at/baukarussell/

**Cycle Up (France)**
https://www.cycle-up.fr/

Three concrete fields of action can be identified for reuse. The respective challenges as well as the resulting tasks and necessary steps for the stakeholders involved in the construction process are described below.

## FIELD OF ACTION: TAKE A STANCE FOR CIRCULAR ECONOMY

### CHALLENGES

So far, acceptance of reused components rather in the private sector, major reservations regarding quality

### TASKS

Create a different point of view and actually implement a design for conversion and deconstruction:

**Educate and set new trends**
Explain the positive features of reuse and remove concerns regarding quality; overcome the image of "waste"

**Cooperation between the relevant stakeholders already at an early planning stage**
The appropriate use of reused components in specific projects requires increased cooperation between planners, manufacturers, marketplaces for building components and other stakeholders from the start of the project.

**Put sustainability into practice**
Sustainability, which is often anchored in corporate strategy, should be more strongly implemented in practice, e.g. by offering services that include the reprocessing of components for reuse. Then the aspect of reuse can also be used for communication.

### NECESSARY STEPS FOR

**Planners**
Involve and educate future users from the outset; act as mediator and involve all stakeholders relevant for facilitating reuse in the early planning process

**Public sector**
Cities and municipalities can act as role models and should promote and implement reuse wherever possible

**Manufacturers**
Consider new business models in the area of reuse, add service features to the portfolio

## FIELD OF ACTION: IMPROVE THE LEGAL SITUATION

### CHALLENGES

**Uncertainty regarding legal situation**
- Lack of information with regard to existing legislation
- Major concerns about liability and warranty

### TASKS

**Assistance and educational services needed**
- Provide information and clarity regarding the current legal situation: Offer reliable guidance on component reuse (including liability and warranty issues)

### NECESSARY STEPS FOR

**Legislators**
Formulate and communicate clearer rules regarding the reuse of components (e.g. via laws, regulations, fee systems); educate and monitor implementation

**Manufacturers**
Evaluate new forms of warranty (e.g. assumption of warranty for selected components after reprocessing by the manufacturer)

**Planners**
Make use of training opportunities; inform about current legal situation

**Organisations and associations**
Provide continuous education and training to manufacturers and planners on the legal requirements and possibilities

## FIELD OF ACTION: OPTIMISE PROCESSES

### CHALLENGES

Processes for reuse often not yet economically viable, as they have not yet been established due to low demand

### TASKS

Tension field between economic risk, future viability and sustainable business strategy:

**Optimise processes**
Develop and test solutions for existing barriers (e.g. high logistical effort for transport, loading/unloading and storage of components for reuse, material control)

**Make information available**
Facilitate future deconstruction by documenting information for further use and material recovery and making it available on site directly at components or building materials (e.g. via RFID, BIM, building/material passport, etc.)

**Bring supply and demand together**
Create central trans-regional marketplaces or platforms that enable systematic reuse

### NECESSARY STEPS FOR

**Deconstruction companies, recycling companies and disposal companies**
Establish higher-level take-back processes in cooperation with manufacturers; train employees

**Manufacturers**
Invest in the optimisation of deconstruction and take-back processes at an early stage and thus ensure an early market entry; examine the advantages of modular or serial production

**Public sector (or similar stakeholders)**
Act as a role model and support the future deconstruction with digital tools, if necessary create trans-regional platforms

## MATERIAL RECOVERY

If a building loses its original function, it is demolished. If a possible reuse of the components/partial components/ construction products has been excluded, the material recovery represents a possible scenario. In order to enable later use or recycling, building and demolition waste must be collected and transported separately in accordance with the industrial waste ordinance.

### Gewerbeabfallverordnung (GewAbfV) § 8 Para. 1

"[...] producers and owners of construction and demolition waste [must] collect and transport the following waste fractions separately and give priority [...] to preparation for reuse or recycling:

1. Glass
2. Plastic
3. Metals, including alloys
4. Wood
5. Insulation material
6. Bitumen mixtures
7. Gypsum-based construction materials
8. Concrete
9. Bricks
10. Tiles and ceramics"[47]

### Deconstruction practices on the construction site

Current legislation already includes requirements for the separation and sorting of waste. However, there is still a considerable gap between theory and implementation in practice. On-site waste management often poses major challenges for construction site personnel, whether in terms of separating and documenting the waste produced, complying with regulations for its removal from the construction site or third-party contamination of collection containers. It is therefore imperative that the implementation of the regulations is promoted by means of instructions and that practitioners receive comprehensible recommendations.

These must be adapted to the concrete challenges on the construction site. For example, paint systems for sorting building materials can help to avoid language barriers. Proactive education and training of site personnel can lead to a better understanding of the consequences of one's own actions and help prevent unintentional misconduct.

However, educational measures must not only be implemented during the deconstruction phase, but must also be given priority during the construction phase of the building. An important aspect here is in particular the knowledge of the relevance of the pure separability. The ease with which a building can be dismantled and recycled is often limited by time or cost pressures or by the lack of understanding on the part of the building contractors through the use of construction foams, protective lacquers or adhesives.

### Redemption notices, product responsibility and increase of recycling rates

When it comes to recycling, the responsibility of manufacturers for their products ("product responsibility" in the sense of §§ 23 to 27 KrWG) is often referred to immediately. The Waste Management Act (Kreislaufwirtschaftsgesetz, KrWG) offers the possibility of laying down requirements for take-back and return obligations for certain products (KrWG Part 3 § 25). Declarations of withdrawal by manufacturers are correct and important, but both the planners and the deconstruction companies must also be held responsible. Thus, for example, for high quality recycling, the separation by type as well as the actual separation by type on the construction site is of central importance. In addition, planners can specifically inquire whether return declarations are available and prefer manufacturers who offer them.

Take-back declarations by the manufacturer are, however, only effective if they show that the taken-back products or building materials are actually recycled and which recycling method is chosen. The willingness of manufacturers to take back products is presumably higher than previously assumed, but there is great uncertainty regarding the actual obligations to be fulfilled by manufacturers. A uniform, binding template for take-back declarations in the construction sector could provide valuable guidance here. For other products and sectors, such as vehicles, batteries or packaging, such regulations have been in place for years.[48]

In order to establish comprehensive manufacturer take-back processes in the long term, it is essential that manufacturers understand take-back as a fundamental component of their product design process from the outset. The willingness to take back one's own products testifies to holistic product design and high quality and prepares manufacturers today for future developments.




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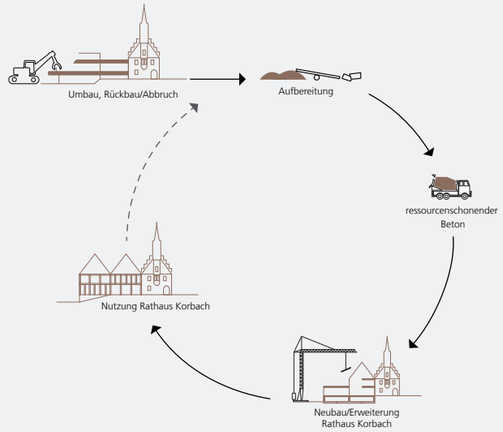
# "Urban Mining Konzept Rathaus Korbach"

**Building-owner:** Stadt Korbach, Hessen, DE
**Architecture:** ARGE agn heimspielarchitekten, Ibbenbüren/ Münster, DE
Christian Thomann, Marc Matzken
**Concept:** Anja Rosen, Harald Kurkowski
**Client:** Land Hessen (HMUKLV)
**Completion:** 2021



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## PROJECT

- Deconstruction of the 1970 Town Hall extension, which was not worth renovating, and construction of a new building on the same site. Selective demolition with subsequent local recycling of the mineral demolition materials
- Case study for covering the demand for recycled stone aggregates for the concrete components of the new building by demolition of the existing structure
- New construction planning in line with recyclability

## POTENTIAL

**Ecological potential:** Protection of biodiversity by avoiding opencast mining
**Economic potential:** Development of processes to promote the circular economy in times of resource scarcity
**Socio-cultural potential:** Promoting the acceptance of recycling in society through fair-faced concrete facades with brick recyclate
**Market penetration potential** Model project of the Federal State of Hesse for the development of a guideline for resource-saving construction
**Market penetration potential:** Potential for integrating the concept into district- and urban development concepts; anchoring in public perception as a challenge

## IMPLEMENTED CIRCULAR ECONOMY ASPECTS

**Material recovery** Approx. 5,400 tons of concrete from the ceilings, beams and columns of the existing building can be used up to 50 % as recycled Type 1 stone aggregates for the supporting structure of the new building. 23 tons of brick breakage flow into the facade of the new building. The fine particles fill the construction pit on site.

**Avoidance**
The avoidance of plastering due to the use of high-quality fair-faced concrete and the avoidance of composite waterproofing of the components in contact with the ground due to the use of water-impermeable concrete guarantee recyclability at the end of the life cycle.

**Repairability and ease of deconstruction**
"Closed-loop" roof covering as standing seam zinc covering, insulation detachably attached, also largely made of secondary raw materials (glass wool/foam glass).

HESSEN
Hesse ministry for environment, Climate protection, agriculture and Consumer protection

Integrierter Klimaschutzplan Hessen 2025

**Author Case Study: Anja Rosen**

The obligation to take back their products presents manufacturing companies with major challenges, particularly in terms of logistics (provision of storage and transport areas) and the reintroduction of the waste delivered into production. Cooperations with deconstruction, recycling or disposal companies that enable the introduction of efficient and standardised recycling processes could help to remedy this situation. The dialogue between product manufacturers and recycling or disposal companies must be conducted as early as possible, otherwise the possibilities of high-quality recycling are often limited.

## IMPLEMENTATION EXAMPLE FOR MANUFACTURER TAKE-BACK SYSTEM

**Nationwide return system for Ytong- and Multipor-remains by Xella and Interseroh**

In addition to building materials, Xella customers order a construction site kit consisting of big bags, coded closure tapes, a return slip and information material.

- The material is collected by the customers at the construction site according to type, sealed with the coded tapes and made available on pallets.
- The Big Bags are collected by Interseroh and made available to the Xella production sites.
- There, the section remains are milled and is used again in production.[51]

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**Scaling of recycling**

The introduction of higher-level take-back processes and an increase in the actual proportion of recycled materials will, however, only take place when the amount of construction waste increases. According to the German Environment Agency, these will increase significantly in the future:

> **»By 2050, it is becoming apparent that throughout Germany a far greater quantity of building materials, about one and a half times the amount, will flow out of the existing residential building stock than will be introduced into it anew. In the long term, the building stock will thus become a source of raw materials.«** [53] **(translated by DGNB)**
>
> German Environment Agency (2016): Stoffstrommanagement im Bauwesen

Further information from the German Environment Agency:

https://www.umweltbundesamt.de/en/publikationen/ermittlung-von-ressourcenschonungspotenzialen-bei

**The following current developments i.a. can contribute to a scaling of recycling**

- According to the Circular Economy Act, from 1 January 2020 at least 70 % of non-hazardous construction and demolition waste is to be prepared for reuse, recycled or sent for other material recycling (KrWG § 14 Para. 3).
- In the European framework Level(s), both an overall list of all materials used according to four types of material and the quantity of all construction and demolition waste (divided into hazardous and non-hazardous waste) for all phases of life are required. This framework forms the basis for possible future legislative instruments.

"Level (s) – A common EU framework key sustainability indicators for office and residential buildings", 2017[52]

- Another important instrument are tenders that do not exclude recycled building materials in advance. In the DGNB criteria "PRO1.4 Sustainability aspects in tender phase", a circular economy bonus is awarded if mineral recycling materials are not explicitly excluded in the tender.

DGNB criteria: https://www.dgnb-system.de/en/system/version2018/criteria/sustainability-aspects-in-tender-phase/

> **»On average, despite continuous improvement since 2004, recycled materials meet only about 10% of the EU's raw material needs.«**
>
> European Commission (2018b)[54]

- **Saving potentials through recycling**
  A detailed description of the ecological savings potential of individual building materials cannot be given here. However, life cycle assessment databases such as Ökobau.dat or EPDs (Environmental Product Declarations) often provide detailed information on these (modules C and D). The "Recycling potentials of building materials" are described in detail in the Manual of Recycling.[49]

**Obstacles**

As early as 2014, the European Commission described the following market failure in its communication on the efficient use of resources in the buildings sector: Large-scale recycling of construction and demolition waste is currently countered by the fact that market prices for building materials made from primary raw materials do not reflect actual costs, since, for example, the costs of environmental damage are not included in price formation. For example, recycled material may be more expensive than new material. In addition, the supply of secondary materials is not yet in line with existing demand.[50]

Another obstacle is the lack of understanding and transparency about the environmental impacts and costs of disposal to a builder or owner. With the life cycle assessment, planners also calculate the environmental impacts of the end of life, for example as part of DGNB certification. Unfortunately, in few projects the results of these analyses are appreciated or understood by planners. Also, a life cycle cost calculation according to ISO 15686, which is also the basis for the life cycle cost calculation required for DGNB certification, could be used to calculate the disposal costs and possible residual values. So far, however, few building owners or planners have attached importance to such analyses. Transparency about environmental impacts and costs of the end of life would be an incentive for building owners to attach more importance to recyclable and recycled building materials and could lead to greater demand in the medium term. Especially in the case of mineral building materials, backfilling or landfilling are therefore still frequently the preferred alternatives.

**Hazardous substances and pollutants and building documentation**

A further key obstacle to high-quality recycling is often the lack of transparency regarding the pollutants and hazardous substances used in the building (also applies to reuse). Since detailed material analyses are very time-consuming and, above all, cost-intensive, they cannot be carried out across the board. This often leads to more material being classified as hazardous than necessary and deposited in landfills after extensive deconstruction. Before deconstructing, a competent expert should therefore be involved, who assigns the components to the waste fractions, in particular with regard to any harmful and hazardous substances that may have been used.

As far as future deconstruction is concerned, appropriate, recycling-oriented building documentation should always be drawn up, stating which materials, in what quantity and at what point in the building were used. This makes it easier to identify substances that are currently classified as unproblematic but will prove to be harmful in the future. Currently, various approaches to building documentation via material and building passes are being developed.

## IMPLEMENTATION EXAMPLES:

**"Buildings as Material Banks", EU**

- Project funded under the European Union's "Horizon 2020" research and innovation programme
- Development of "Material Passports" ideally linked to BIM (Building Information Modeling)

https://www.bamb2020.eu/

**Madaster Platform, NL**

- Project funded under the European Union's "Horizon 2020" research and innovation programme
- Catastre that records materials in real estate: Collection and structuring of data on the used resources of buildings, creation of material passports

https://www.madaster.com/de

## STRATEGIC FIELDS OF ACTION (MATERIAL RECOVERY)

Four specific fields of action can be identified for material recovery. The respective challenges as well as resulting tasks and necessary steps for the stakeholders involved in the construction process are described below.

### FIELD OF ACTION: OPTIMISE DECONSTRUCTION PRACTICE

**CHALLENGES**

Lack of instruction on existing legal requirements; implementation of the requirements on the construction site

- Legal disposal requirements often not known or insufficiently known
- Separation and disposal of material flows is complex (number of collection containers, regional price differentials, bureaucratic effort)
- Language barriers, time pressure

**TASKS**

Instruction and training of employees on the construction site:

- Recommendations for action and concrete assistance in implementing legal requirements
- Implementation of the Commercial Waste Ordinance (GewAbfV)

**NECESSARY STEPS FOR**

**Legislators**
In coordination with construction companies, formulate recommendations for action that are tailored to the current challenges; monitor compliance with the GewAbfV; include deconstruction planning in HOAI (German Fee Structure for Architects and Engineers)

**Construction companies**
Carry out trainings and qualification of the employees

### FIELD OF ACTION: ASSUME PRODUCT STEWARDSHIP AND ESTABLISH TAKE-BACK CONCEPTS

**CHALLENGES**

Lack of orientation for manufacturers on the obligations associated with take-back concepts

- In the past: Dissemination and idealisation of apparently advantageous solutions without sufficient consideration of possible negative consequences during deconstruction (e.g. composites: longevity, but usually lack of separability)

**TASKS**

Counteract future mistrends through education and by intensively dealing with deconstruction:

- Holistic product design: Increase the willingness for implementing take-back concepts by including the consideration of take-back solutions in the design process
- Provide education: Independent bodies to establish clear rules on producer responsibility; facilitate the verification procedure for manufacturers through standardisation (e.g. higher-level certificates or overviews of take-back concepts)

**NECESSARY STEPS FOR**

**Manufacturers**
Establish the possibility of a future deconstruction as a fundamental premise for product design; avoid inseparable composites; prepare for future developments in a timely manner

**Legislators**
Demand product stewardship and consistently monitor the implementation of existing laws and regulations; consistently make use of legal opportunities [e.g. Waste Management Act (KrWG)]

**Deconstruction companies, recycling companies and disposal companies**
Support manufacturers through higher-level take-back processes

**Organisations and associations**
Give manufacturers orientation by providing a template for a take-back declaration that documents the take-back process as well as the recycling and disposal path

### FIELD OF ACTION: INCREASE RECYCLING RATES AND THEIR DEMAND

**CHALLENGES**

Lack of instruction on existing legislation

- The possibility of reuse or material recovery as well as the use of secondary construction materials is already required by the EU Construction Products Regulation (EU regulation No. 305/2011, Annex I)
- Recycling rates are not further defined; material recovery with loss of quality is not reported in the statistics
- Undesirable developments on the market (prices for recycled materials, split incentives in the value chain)

**TASKS**

Instruction and information:

- Increase demand through education: Encourage further and advanced training of planners and point out existing opportunities
- Recycling rates: Differentiated consideration of the individual construction materials is necessary taking into account ecological, economic and social criteria

**NECESSARY STEPS FOR**

**Legislators**
Monitor the implementation of existing regulations; differentiate waste statistics more precisely with regard to recycling and disposal paths; include in HOAI the additional effort in the planning phase for increasing recycling rates

**Organisations and associations**
Provide information and instruction on the challenges and opportunities of recycling with the help of specific material examples

**Planners**
Establish the examination of the use of secondary raw materials as a standard within the design process; reduce concerns and reservations regarding recycled materials

### FIELD OF ACTION: AVOID HAZARDOUS SUBSTANCES AND POLLUTANTS AND DEMAND DOCUMENTATION

**CHALLENGES**

Identification of pollutants and hazardous substances

- Lack of transparency with regard to the materials used; time-consuming and cost-intensive material analyses
- Avoid material flows being contaminated with possible pollutant components in the recyclate and thus shifting the problem into the future

**TASKS**

Introduce transparent sources of information for buildings and use alternative materials:

- Documentation: Provide and document information on material recovery options
- Material alternatives: Replace materials containing pollutants and hazardous substances with materials that are considered non-critical
- Separability: Allow removal of layers potentially containing pollutants. For harmful and hazardous substances that are to be avoided, see DGNB criteria "TEC1.6 Ease of recovery and recycling". Future-oriented requirements regarding harmful and hazardous substances can be found in the DGNB criteria "ENV1.2 Local environmental impact"

**NECESSARY STEPS FOR**

**Universities, training/ educational institutions, sources of specialised information**
Inform about material alternatives and make them widely accessible (see DGNB Navigator, WECOBIS)

**Planners**
Inform building owners; provide recycling-oriented documentation

**Legislators**
Demand that pollutant analyses for current deconstruction projects should be specifically geared to recycling

**Building owners/investors**
Seek advice on hazardous substances and pollutants

## 3.1.2 Impulses and examples for practical implementation in planning

Suggestions and ideas are compiled within the following overview, which make integrating aspects of the circular economy in design easier. It is intended to provide inspiration for a new approach and give food for thought. Due to the multitude of new developments and concepts, which are constantly appearing in connection with the circular economy, the list can only be a snapshot. Therefore it serves more as a dynamic, continuously growing collection, which everyone can contribute to.

**Annex I of the EU building product directive (Eu-BauPVO) basic requirements for structures are defined, which include the sustainable use of natural resources:**

"7. Sustainable use of natural resources
The structure must be designed, installed and demolished in such a way that natural resources are used sustainably and in particular the following can be insured:
a) the structure, its building materials and parts must be possible to reuse following demolition ought to be recycled;
b) the building structure must be durable;
c) environmentally friendly raw materials and secondary building materials must be used for the structure."

EU building product directive (Directive (EU) No. 305/2011, Annex I): https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32011R0305&from=DE][55]

## Construction level

### FLEXIBLE BUILDING STRUCTURE

**IMPULSES**

**Skeleton construction**
- Steel or wood construction

**Usage-neutral construction**
- Functionality retained for further use
- if req. structural reserves
- Flexible layouts
- High room heights
- Flexible facade

**EXAMPLES**

**Project: Neckarbogen SKAIO, Heilbronn, DE**
- Kaden+Lager Architects
- In execution (planned occupation March 2019)
- At 34 m, the highest wooden house in Germany
- Environmentally sustainable residential construction, project sponsored by the European fund for regional development (EFRD)
- Is located in the Neckarbogen district of Heilbronn (DGNB platinum pre-certificate)

**Circular Economy aspects**
- Wood hybrid construction: Supporting structure primarily inward; socket level, stairs and lift shaft in steel reinforced concrete
- Sustainability as an accompanying element during design, future deconstruction integrated into design
- Flexible layouts
- High degree of prefabrication

Source: https://www.leben-am-neckar.de/skaio/
Further information at: http://www.kadenundlager.de/projects/skaio/




### MODULARITY

**IMPULSES**

**Prefabrication of components**
- Reduction of construction time in situ/on-site
- Reduction of waste generation
- Facilitation of design
- Serial formats make future reuse easier (e.g. piles, slab ceilings)

**EXAMPLES**

**Product: CRAFTWAND ®**
- Product of Massiv Forest Products
- Modular wall system in solid oak elements
- Use as dividing wall, room separator or furniture

**Circular Economy aspects**
- High flexibility and fast installation, conversion and removal of the modules thanks to a specially developed integrated fixing system (dowels, bolts)
- Waste reduction
- System can be reused after the use phase

Source: www.craftwand.info/de/
Further information at: https://blog.dgnb.de/craftwand/

### LEARNING FROM ROLE MODELS

**IMPULSES**

**Combination of traditional/historic building methods and materials with modern technologies**
- Traditional building methods were generally intuitively suitable for deconstruction and allowed high quality reuse of the components and materials used.
- Modern technologies can support in taking the advantages from traditional building methods and reinvigorating them. They allow the application of prefabricated modules and make design easier.

**EXAMPLES**

**Project: Zero Emission Pavillon, Hamburg, DE**
- Partner und Partner Architects
- Temporary room installation: Climate week Hamburg, 2011

**Circular Economy aspects**
- Use of organic materials (municipal tree cutting waste together with other biodegradable structural aids) for support structure and envelope
- Room framework based on SimpleTec
- Waste reduction: virtually completely compostable
- Material recovery: Floor covering in recycled carpet tiles

Source: http://www.partnerundpartner.com/projekte/zero-emission-pavillon-hamburg-2011/

## LEARNING FROM ROLE MODELS

### IMPULSES

**Learning from temporary structures**

- Temporary structures such as pavilions, exhibition setups or similar generally designed for fast and easy deconstructing as well as for reuse of the components

### EXAMPLES

**Project: People's Pavilion, Eindhoven, NL**

- bureau SLA & Overtreders W
- Temporary building: Dutch Design Week, 2017

**Circular Economy aspects**

- Design for deconstruction: Connections without connection materials which damage the main material (such as bolts, adhesives, and so on)
- Reuse: All materials (apart from facade) loaned, including from residents, and returned undamaged after deconstruction
- Material recovery: Facade tiling specially made of recycled plastic waste from the residents of Eindhoven
- Waste avoidance

Source: https://www.bureausla.nl/project/peoples-pavilion/?lang=en

## JOINING TECHNOLOGY

### IMPULSES

**Using traditional connections**

- Principle of material-immanent connections
- Principle of load securing
- Allocation of liability
- Principle transfer

### EXAMPLES

**Examples of traditional connections and their advantages for the circular economy**

**Support construction**

- Single material connections (e.g. tradition wood connection such as dovetail)
  Advantages: This effort for sorting during deconstruction, completely separate recovery of the material

**Roof**

- Roof covering with additional load security
  Advantages: Secured against wind suction despite loose laying, allowing unmixed material recovery of roof structure layers
- Adhesive attachment of loft sheeting
  Advantages: No penetrations, easily undone, easy to repair

**Roof coverings/external wall coverings**

- Use overlapping principle for water run-off
  Advantages: Additional sealing materials unnecessary, easy deconstruction, unmixed material recovery of the components possible (shingles, roof tiles)

Source: Annette Hillebrandt
Further traditional connections cf. Manual of Recycling, Riegler-Floors, P./Hillebrandt, A.: "Detachable Connections and Constructions", p. 42 ff., Edition Detail 2019

## JOINING TECHNOLOGY

### IMPULSES

**Promoting separability**

- Avoidance of connections which cannot be undone: bonding, filling
- Creation of connections which can be undone: clamping, filling, loose laying, inserting

### EXAMPLES

**Examples of connections which can be undone and their advantages for the circular economy**

**Basement insulation**

- Foam glass gravel under the base plate or in geotextile bags in front of walls
  Advantages: No bonding with the subbase, completely unmixed recovery of insulation material and subbase material, direct reuse possible
  (www.misapor.ch)

**Facade**

- Dry stacked tile system without grout or mortar.
  Advantages: Fast assembly and deconstruction, unmixed material recovery of the masonry stone (www.daasbaksteen.com/en/Facade-systems/ClickBrick/page.aspx/67)

**Internal fit out**

- Loose-laid carpet tiles
  Advantages: Quick to undo and unmixed material recovering (important factor with low service life or fashionable interiors)
  (www.desso.de)

Source: Annette Hillebrandt
Further traditional connections cf. Manual of Recycling, Riegler-Floors, P./Hillebrandt, A.: "Detachable Connections and Constructions", p. 42 ff., Edition Detail 2019

## REPAIRABILITY AND EASE OF MAINTENANCE

### IMPULSES

**Enabling repairs**

- Guaranteeing accessibility

**Ensuring use comfort**

- With easier accessibility, exchange, conversion or repair can be done during ongoing operation
- Waste from deconstruction is avoided


Installation wall cabinet
**Objekt:**
Oskar-von-Miller-Forum
**Architect:**
www.thomasherzogarchitekten.de

### EXAMPLES

**Examples for ease of repair and advantages for the circular economy**

**Technical systems and installations**

- Surface-mounted installations
  Advantages: Easier exchange, repair, conversion
- Routing pipes through wall cupboards ("service cupboard")
  Advantages: Easy to implement, low costs (life-cycle costs, maintenance, service costs)

Source: Annette Hillebrandt

## Material level

### MATERIAL SELECTION

#### IMPULSES

**Fully utilising available variety of materials**

- Develop new types of material and test
- Extend the application options for existing materials

**Waiver**

- Reduction of material use in layer structures
- Reduction of complexity through lower number of used materials

#### EXAMPLES

**Researchproject: MycoTree**

- Research on the options for application of new types of biological construction materials
- Process for sustainable construction at Karlsruhe Institute of Technology, Future Cities Laboratory Singapore, Block Research Group at the ETH Zürich

**Circular Economy aspects**

- Development of new materials: Structural components in mycelium bound agricultural waste (mushroom roots)
- Extension of the applications of flexurally weak materials, alternative materials; application of modern digital methods to find geometries

Source: http://nb.ieb.kit.edu


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### REUSE, MATERIAL RECOVERY AND COMPATIBILITY FOR RECOVERY

#### IMPULSES

**Reuse and material recovery**

- Reuse of materials
- Use of construction products in secondary raw materials

**Future material recovery and reuse options to be identified and promoted**

- Avoidance of composite which cannot be separated
- Mono-materiality, homogeneous material selection
- Use materials which retain their value, avoid materials which do not have the potential to be recovered (no extension of the "dead-end")
- Use reusable and/or recyclable materials and improve future chances of deconstruction

#### EXAMPLES

**Project: Circular Building, London, UK**

- Arup, Frener & Reifer, BAM, The Built Environment Trust
- Temporary building: London Design Festival, 2016

**Circular Economy aspects**

- Ventilation system in recycled materials
- Use of reusable and recyclable materials
- Use of connections which can be undone
- Maximum prefabrication

Source: http://circularbuilding.arup.com/

### ABSENCE OF POLLUTANTS

#### IMPULSES

**Preparing capability for returning into material cycles**

- Avoiding problematic materials
- Using alternative materials with lowest possible pollutants and hazardous substances
- Documenting materials and location used

#### EXAMPLES

**Project: WOODCUBE, Hamburg, DE**

- Architectural agency
- Creation as part of the international construction exhibition in Hamburg (IBA), 2013
- 5-storey residence
- German sustainability prize: Nomination for the DGNB prize "sustainable construction" 2013

**Circular Economy aspects**

- Avoidance of construction materials which may be biologically unsuitable for the building, avoidance of foils, glues and adhesives
- Bio-recyclable
- Regenerative electricity and thermal energy

Source: https://www.iba-hamburg.de/projekte/bauausstellung-in-der-bauausstellung/smart-material-houses/woodcube/projekt/woodcube.html

## USE OF INFORMATION SOURCES

### IMPULSES

**Gather information, query databases**

- Construction products and construction material databases
- Material databases/libraries (physical or digital)

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### EXAMPLES

**DGNB Navigator**

- Online platform with construction product information (e.g. environmental impact) relevant for sustainability and building certification as a basis for decision-making
- Bridge between construction products and the DGNB certification system

www.dgnb-navigator.de

**WECOBIS**

- Environmental construction material information system of the German Federal Ministry for the interior, for construction and homes in cooperation with the Bavarian architects chamber
- Information portal for environmental and health aspects during material selection for construction

www.wecobis.de/

**material library**

- Cooperation project of Bergische Universität Wuppertal and MSA Münster School of Architecture, founded by Prof. Annette Hillebrandt and Anja Rosen
- Collection and exhibition of hand samples to promote holistic material understanding for the purposes of research, education and inspiration
- Addition of online-database

www.material-bibliothek.de

**Material library of the Karlsruhe Institute of Technology, faculty of architecture**

- Physical and digital collection of construction materials for education and research, content collated by the professor of sustainable construction
- Three relevant topic areas: Construction materials in waste, construction materials from cultivation and building materials from local regional resources

www.arch.kit.edu/einrichtungen/Materialbibliothek.php



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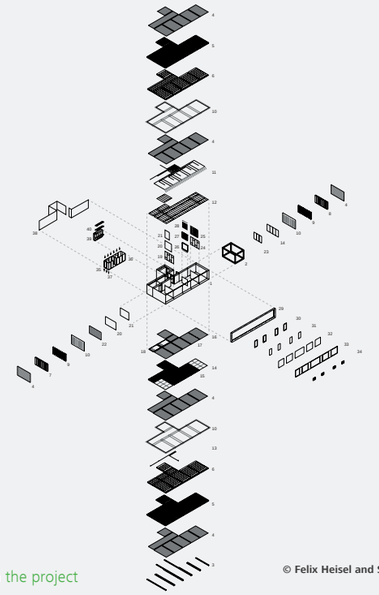
# Urban Mining & Recycling (UMAR)

Experimental unit within the NEST research building of Empa (Dübendorf, CH) suitable for the circular economy

**Concept, design and property planning:**
Werner Sobek with Dirk E. Hebel and Felix Heisel (Stuttgart and Karlsruhe, DE), 2018



© Felix Heisel and Sara Schäfer

Further information on the project
www.nest-umar.net

### PROJECT

- Application of only pure sorted, pollutant-free and fully reusable and recyclable or composting materials
- Use of only reversible dry joining methods; dispensing with glue or chemical (wet) connections
- Materials will be routed back to their biological and technical cycles after deconstruction (planned for 2023)
- Development of solutions suitable for the circular economy through close cooperation of all designers and manufacturers

### POTENTIAL

- **Environmental potential:** Activation of the city mine as a resource, prevention of new waste through closed cycles
- **Economic potential:** new business models based on the "Product-as-a-Service" principle
- **Socio-cultural potential:** Creation of a societal paradigm shift through demonstration of closed material cycles
- **Market penetration potential:** high all products are available in the market. Project is intended to stimulate and check materials, construction methods and processes suitable for the circular economy

### IMPLEMENTED CIRCULAR ECONOMY ASPECTS

**Reuse**
E.g. rented door handles (RotorDC), copper facade from previous hotel roof

**Material recovery**
E.g. bricks laid without water from building waste (StoneCycling), glass ceramic plates (Magna)

**Avoidance**
E.g. uncoated wood, switches without cables

**Repairability and ease of deconstruction**
E.g. all connections are reversible and easily accessible, modular construction, clamped seals instead of silicone

**New materials**
E.g. fungus mycelium as insulation material/carrier layer, 3-D printed stainless steel tap

**Author Case Study: Felix Heisel**

## 3.1.3 Checklist for your project: Conversion and deconstruction-friendly planning

In summary, the following checklist provides an overview of relevant questions which building owners and planners should consider in the course of the entire planning process with regard to deconstruction. Obviously, the complexity of this process and the existing dependencies on location, typology, etc. in construction projects cannot be adequately mapped here. The checklist is therefore neither complete nor exclusive, but should serve as an orientation and impulse for planners and support them in considering and integrating deconstruction capability in the respective planning and life phase.

## Determinination of basics/Pre-planning

### INFORM THE BUILDING OWNER ABOUT THE ADVANTAGES OF A CIRCULAR BUILDING PRACTICE

**Comparison of a circular building practice and a conventional construction method**

☐ Can I convince the client by informing him about the aspects of risk avoidance and safeguarding the future (with regard to future developments), health (freedom from pollutants), comfort (user comfort and rebuildability) as well as disposal problems?

☐ Can a recycling and deconstruction-friendly building method , i.e. the use of sustainable and as pollutant-free as possible building materials as well as a flexible and separable construction method, be defined as a premise for planning?

### APPLYING SUSTAINABILITY AS A DESIGN ELEMENT AND VALUING EXISTING BUILDINGS

**Promoting visibility of sustainability in the built environment**

☐ By retaining elements of the existing building (if any), can I achieve identification with the building and create lasting value?

☐ Does the planning of the deconstruction of any existing building substance aim at maximum use and material recovery? (Note: A corresponding certificate from the DGNB is currently being prepared.)

☐ Can my building serve as a role model for other planners or building owners?

**Examine the reuse of components, construction elements and the application of secondary raw materials at the beginning of planning and ideally integrate them into a holistic concept**

☐ Have I included all the experts in the planning process who can contribute to a circular building practice?

☐ Can we already identify possible areas in initial planning discussions that allow the application of reused components or secondary raw materials?

☐ As a planner, do I have sufficient product knowledge?

### CONSIDER TAKE TIME AND COST FACTORS AND CHECK EXISTING OFFER

**Check availability of used components**

☐ Which quantities are available or required?
- Which specific applications are there in the project to use them?
- For small quantities or for use in the private sector: Is there a component exchange, that can provide information and has suitable components in stock?
- For the historical sector: Can historical building material dealers supply the required components?
- Are there buildings in the region that will soon be recovered?

☐ Are there system components from series production with formats suitable for the project?

☐ Is it already known before the expansion where and how the component will be used in the future?

☐ Are certain components or materials already reused by manufacturers?
Alternative: Can manufacturers recycle reused components and restore the warranty for these components?

**Check the availability of secondary raw materials**

☐ If building materials to be recovered exists: Can it serve as a secondary raw material supplier for the new building at the same location? Is it possible to recycle the mineral demolition materials at the construction site or in the vicinity?

☐ Can my demand for secondary raw materials alternatively be covered by (regional) trading centres for secondary raw materials or other offers?

**Check the possibility and meaningfulness of using the available components and secondary raw materials in the specific project**

☐ Are any demolition materials to be recovered from the existing stock technically suitable for recycling in new buildings?

☐ Have I identified the most relevant components and materials (criteria: mass, replacement quantity, material value) and examined the use of alternatives for them?

☐ Does the use of alternatives make sense after weighing up the costs (i.a. requirements, service life, availability, costs) and benefits?

**Calculate costs considering the complete life-cycle**

☐ Did I provide the client with a life cycle cost calculation as a basis for decision-making? Does this also take into account the disposal costs during operation (conversion, modernisation, change of tenant)? (Note: For methodology see the DGNB system for Buildings and Sustainable Interiors)

## Design and implementation planning - on the building level

### PREPARE AND INCLUDE FUTURE DECONSTRUCTION IN THE DESIGN AS BEST AS POSSIBLE

**Consideration of the deconstruction hierarchy within the design ("thinking form the end") and provision of the following scenarios, which can be used after loss of the original function of the building**

☐ Have I prepared future reuse and material recovery as comprehensively as possible?

☐ Does my planning make it possible to separate components and building materials according to type and recover them in a high-quality way? (Assessment according to DGNB criteria "TEC1.6 Ease of recovery and recycling" or similar instruments, e.g. Level(s) see p. 30)

☐ Have I carried out a life cycle assessment and ensured that the environmental impacts are kept as low as possible, especially if further use is unlikely and/or recovery of the components and building materials is not possible?

☐ Have I planned in such a way that the removal and replacement of components that are frequently replaced (e.g. interior walls, floor coverings) can be carried out as smoothly as possible?

**Provide for recycling-oriented documentation**

☐ Is the creation of a material or building passport planned?

☐ Does the documentation (in analogue or digital form) include the following aspects?
- Material flows (quantities, bill of materials)
- Installation location (location/component/layer structure; for this also see DGNB criteria "ENV 1.2 Local environmental impact")
- Service life
- Possible recycling and disposal paths including identification of pollutants and hazardous materials
- Connections with other components or layers
- Product data sheets of the actually installed products and materials

☐ Can I apply BIM in planning and, after completion, hand over an "as-built" model to the client or facility manager?

## Design and implementation planning - on the construction level

### CHECK AND REALISE IMPLEMENTATION POSSIBILITIES

**"Building more simply"**

☐ Have I reduced the complexity of my construction project as much as possible, e.g. by orienting myself on traditional joining techniques and/or temporary buildings?

☐ Is the construction planned to be use-neutral and and does it allow a high degree of flexibility with regard to further use?

☐ Has the number of layers been reduced to the necessary minimum?

**Separability**

☐ Is the construction actually easy to deconstruct and can the materials be separated by type? Are the fasteners accessible? Can the connections be loosened again after years of building use?

☐ Can the number and types of fasteners be reduced to a minimum?

**Modularity**

☐ Can selected components be prefabricated?

☐ Can standardised, serial formats be used that promote further, later use (possibly supported by digital possibilities)?

**Repairability**

☐ Are the installations easily accessible (e.g. via a service cabinet/shaft) so that conversion, repair or replacement can be carried out during operation? Are repair instructions available from the manufacturer?

For concrete impulses and examples for practical implementation in planning see Chapter 3.1.2

## Design and implementation planning - on the material level

### CHECK AND REALISE IMPLEMENTATION POSSIBILITIES

**Comparison of lifetimes and sequence of possible renovation measures**

☐ Have the service lifes of the building materials applied been coordinated so that no intact building materials or components have to be damaged in future renovation measures?

**Monomateriality**

☐ Have I limited myself to as few different materials as possible and are these coordinated with each other? Have I taken the environmental impacts into account and prepared a separation by type if materials have to be combined?

**Pollutants and hazardous substances as well as the quality of the materials used**

☐ Are the materials used valueable and do they generally enable high-quality material recovery at a later date?

☐ Are the building materials used as low in pollutants and emissions as possible? Do they not contain any ingredients for which a prohibition perspective exists? (Note: For the evaluation of a possible restriction of recyclability by harmful and hazardous substances see the DGNB criteria "TEC1.6 Ease of recovery and recycling")

☐ Do the manufacturers of the installed products take them back after the products' end of life? If so, do the take-back declarations indicate the probable recycling path? Do processes already exist for manufacturer take-back? Has appropriate logistics been set up or planned?

For concrete impulses and examples for practical implementation in planning see Chapter 3.1.2

## Tender and awarding phase

### DEFINE CLEAR REQUIREMENTS

**Formulate objective**

☐ Has the client formulated a clear objective (e.g. "No waste leaves the construction site") on which the planning, tendering and awarding of contracts is based?

**Include aspects of reuse, material recovery and recycling in the invitation to tender**

☐ Have I integrated the reuse of components and the use of secondary raw materials into the tender? (Note: The DGNB criteria " PRO1.4 Sustainability aspects in tender phase" shows various ways of integrating recycling-oriented requirements.)

☐ Have I integrated the aspect of material recovery into the tender (e.g. via a detailed description of the planned reversible fasteners and construction methods in the individual items)?

☐ Can I tender selective deconstruction with the aim of recovering mineral demolition waste and formulate the strict separation of the recyclable material groups and, if necessary, laboratory analyses within the deconstruction bill of quantities?

☐ Can I specifically exclude pollutants (e.g. by integrating requirements according to DGNB criteria "ENV1.2 Local environmental impact" into the individual service items of the tender or by using certified products)?

**Include manufacturing, deconstruction and recycling companies**

☐ Can I motivate or even oblige deconstruction companies to cooperate with (local/regional) recycling companies via the call for tenders and can I contribute to intensive coordination between the project participants? Alternative: Are there regional deconstruction companies that carry out recycling themselves (e.g. for mineral demolition materials on the construction site or in the immediate surroundings)?

**Demand documentation of product knowledge**

☐ Does the tender include the obligation to prepare recycling-oriented documentation?

## Construction supervision and documentation

### CHECK THE IMPLEMENTATION OF THE PLANNING

**Ensure correct construction and documentation**

☐ Is it ensured that, in the event of any prior selective deconstruction, the waste is separated according to type at the construction site and given priority to reuse or material recovery (monitoring compliance with the commercial waste ordinance)?

☐ Is it ensured that only components and products were installed in accordance with the invitation to tender? Was the deconstruction capability restricted during the construction phase (e.g. due to time or cost pressure)? Has all information on component and material properties as well as on possible further use and recycling paths been documented in accordance with the products actually installed?s?
(Note: The DGNB criteria "ENV 1.2 Local envionmental impact" requires monitoring of implementation on the construction site by means of a suitable process and corresponding protocols.)

☐ Was the product or component also labelled on site if possible (e.g. by RFID or other labelling)?

☐ Were all changes to the planning documented accordingly?

## Commissioning and use

### PROMOTE ACCEPTANCE

**Create acceptance among users and other stakeholders**

☐ Can I increase acceptance among users through proactive communication and promote building use in line with planning (e.g. through introductory events, user guides, explanation of the concept of reuse)?

## Conversion/Deconstruction

### PREPARE THE HIGHEST POSSIBLE MATERIAL RECOVERY

**Question demolition**

☐ Can deconstruction be avoided through conversions and/or renovation?

**Prepare for further use and material recovery**

☐ Can a later use be determined for a large part of the materials before deconstruction and thus an appropriate further use or recycling be prepared?

**Request expert assessment**

☐ Can the proportion of the demolition waste to be disposed of in landfills be reduced by a competent expert assigning the components to the waste fractions before deconstruction?

## 3.2 Multi-use of areas

Note: The contents of this chapter are based on the results of the DGNB workshop "Circular Economy - Shared Spaces". The moderators and participants of the workshops are listed on page 59 .

The multi-use of areas, also known as "Spacesharing" is one of the areas of the circular economy with great potential (see chapter 2.2).

**Terminology and definitions**
Within the scope of the DGNB's understanding, the term "Spacesharing" describes the aspects of the multiple use of areas within buildings and of areas of the building-related exterior space. The multiple use of areas can refer to different types of buildings and rooms. The aim of multiple use is to reduce land consumption and make more intensive use of existing buildings.

To be distinguished from the term Spacesharing is the term "Shared Spaces", which refers to the equal use of urban space by different road users such as pedestrians, cyclists and motorists.

Like many other Circular Economy approaches, dividing areas is not a new idea, but is already accepted and widespread in many areas of everyday life. The motivation for multiple use can arise, for example, for reasons of efficiency, for example when common infrastructure and supply areas such as kitchens or sanitary facilities only have to be created once and care and maintenance can be divided among the users. However, social aspects can also play a role if social contacts are established through the joint use of areas, if the neighbourhood is revitalised by longer periods of use and greater diversity, and if there is a stronger exchange with the social environment. In the private environment, selected areas have already been shared for many years or decades, for example kitchens, gardens and common rooms in flat-sharing communities, student dormitories or multi-generational houses.

For reasons of efficiency, a common use of certain areas has also been established for commercial areas. In shopping centres, for example, there is usually a mall in addition to the rented shops as a common area that provides catering and supply areas. In industrial estates, not only canteens, day-care centres or the existing infrastructure are shared, often there are also higher-level concepts for logistics and energy supply.

What is new, however, is the multitude of innovative concepts and implementation possibilities for multiple use of space, for example in the form of coworking spaces with integrated cafés or in the form of short-term rentals for temporary services such as repair cafés. On the other hand, a changing attitude in society is also noticeable, shifting the focus from owning to sharing space and goods.

The DGNB has promoted the multi-use of areas in its certification system right from the start. Measures to increase the accessibility of buildings (e.g. publicly usable open-air facilities at the building, publicly accessible catering facilities or the letting of premises to third parties) and to increase the variety of uses ensure that the daily useful life of the building is extended and that more people can participate in the use of the building. This in turn promotes user identification with the neighbourhood and the built environment. The 2018 version of the DGNB system also rewards the multi-use of areas with two circular economy bonuses..

**Circular-Economy-Bonus:**
**High intensity of use**

For at least 50 % of the usable area in the building, area utilisation concepts have been implemented that allow a higher intensity of use (through a higher number of users or different utilisation periods).
(DGNB criteria “ECO2.1 Flexibility and adaptability”)

**Circular-Economy-Bonus:**
**Facilities for daily needs and for interaction**

In or around the building, new services for building users or external parties are made available and implemented or planned, e.g. food plantations, beehives (urban farming), or areas are offered constantly or regularly for neighbourly exchange of services, e.g. temporary trading areas, repair cafés, neighbourhood meetings.
(DGNB criteria “SITE1.4 Access to amenities”)

www.dgnb-system.de/de/system/version2018/kriterien/

**Focus on more intensive use of existing buildings**

In order to reduce the use of areas, new buildings offer a variety of possibilities to facilitate multi-use, e.g. by planning the use of areas neutrally or by separating communally usable areas from private areas. These solutions should now be taken into account in new construction projects and pushed forward. The appropriateness of the area required should always be questioned.

At the same time, the temporarily unused building stock should be utilised more intensively in the sense of the circular economy. There is therefore great potential for multi-use in existing buildings. It is precisely here that new solutions need to be developed and that sustainable buildings enrich the urban space and contribute to a lively, mixed and long-term accepted district in which all users feel comfortable. To achieve this, the concept of "space" must be rethought and new offerings created. In the future, it should no longer be the people who have to adapt to the space around them. Rather, the built environment should adapt to the current, constantly changing needs of people. Areas must therefore be flexible enough to absorb even changes in the distant future that are not foreseeable today. We thus need spaces in which the future can move in and may also move out again.

Especially planners and architects have a great lever to fulfil their social task and responsibility and to support this change by putting the corresponding architectural concepts into practice. If this results in a range of innovative offers, users can gradually be motivated to question their own behaviour, try out Spacesharing offers and convince themselves of the advantages.

## POTENTIAL OF MULTI-USE

### Environmental

- Low area consumption, densification
- Increasing energy efficiency
- Reduction of $CO_2$-emissions
- Reduction of resources
  Note: These potentials only exists if the multi-use actually results in a reduction of the individually used area. However, rebound effects can counteract this (see below)

### Economical

- Cost savings for users due to higher utilisation capacity of the areas and sharing infrastructure
- Intensification of the use of buildings and areas and associated profits for suppliers
- New site qualities through revitalisation and mixing of the neighbourhood and extension of periods of use
- Emergence of new markets
- Simplification of market entry for new players

### Sociocultural

- Increased networking of society and promotion of cooperation
- Increasing identification of users with the built environment and the direct social environment through greater participation
- Possible uses for financially weak actors
- Stability due to thorough mixing

## LIMITS

Criticism is voiced with regard to the multi-use of areas in connection with the risk of rebound effects. What is meant by this is that the creation of new offers for the multi-use of areas instead of an actual reduction in the area utilised leads to an increase in consumption and the opposite of the desired effects occurs from both ecological as well as economic and social points of view.

For example, the cheap and convenient online rental of private apartments could generate an additional volume of travel. In other areas, too, such as mobility, the availability of a car via car-sharing providers could lead to a situation in which a journey is made by car instead of by public transport.

With regard to Spacesharing, this may mean that users understand common areas as additional areas that supplement the existing space on offer (e.g. through guest rooms) without, however, reducing their previous individual space requirements. From an economic point of view, innovative offers can lead to an increased profit orientation; areas or goods previously lent free of charge could be rented to the highest bidder. In addition, the emergence of new markets, for which there has been no demand to date, can quickly transform existing structures and destroy established markets. Social consequences are also already becoming apparent, for example with more space being made available for short-term, exclusive letting, thus making less affordable living space available. If the sharing of space does not always go smoothly, conflicts can also arise with the immediate environment, for example with neighbours or operators of adjacent commercial areas.

### Unleash the potential

In order to unleash the advantages of multi-use of areas and at the same time to avoid the occurence of rebound effects as far as possible, it is conceivable, for example, to control the existing supply. In this context and in order to counteract possible undesirable developments on the market, clear legislation and generally accepted rules are required, for example with regard to any liability issues that may arise.

Finally, the flexibility of the existing area is crucial for the successful implementation of multi-use of areas. But here too there are limits. For example, a certain building typology cannot keep any number of usage options open and cover all conceivable future functions. This makes little sense and could possibly lead to a loss of building culture. Rather, it is necessary to find and use synergies that exploit the potential described above and enable efficient use of the built environment. Therefore, even in the case of multi-use of areas, it must always be meaningful and must not be made an end in itself.



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# Reallabor Space Sharing

With "Reallabor Space Sharing" new models of space utilisation and intensification of utilisation through multi-use are being researched and tested in a practical way.
The project, which was initiated in 2015 by the Stuttgart State Academy of Art and Design under the project lead by Prof. Matthias Rudolph, is a research project funded by the "Ministerium für Wissenschaft, Forschung und Kunst Baden-Württemberg" as part of the regional programme "Stärkung des Beitrags der Wissenschaft für eine nachhaltige Entwicklung".

## PROJECT

- Possibility of temporary or regular use for all users, uses and times
- Efficient use of space through parallel and successive multi-use
- Implementation of different forms of use thanks to flexible basic equipment and existing supply structure
- Brokering via external digital offer and booking platform

## POTENTIAL

**Environmental potential:** reduction of area consumption, energy demand and traffic congestion

**Economic potential:** added value through more efficient use of existing buildings; reduction of use fees

**Socio-cultural potential:** access to affordable, temporarily usable space in a central location for all user groups; space for encounters and interaction

**Market penetration potential:** potential for integrating the concept into district and urban development concepts; anchoring in public perception as a challenge

## IMPLEMENTED CIRCULAR ECONOMY ASPECTS

**Reuse/further use**
Revaluation and profit increasing use of empty spaces to benefit owners and society

**Multi-use**
Making more intensive use of existing buildings and avoiding use-free periods by opening for all users, uses and times

**Reduction of area usage**
Concept for urban re-densification in conurbations

REALLABOR › SPACE SHARING ‹

abk— Staatliche Akademie der Bildenden Künste Stuttgart

For further information on the project and to download the handbook"Space Sharing - one Space fits all" (available shortly) see: www.abk-stuttgart.de/forschung/forschungsprojekte/reallabor-space-sharing.html

**Author Case Study: Prof. Matthias Rudolph**

## 3.2.1 Strategic fields of action for multi-use of areas

The key challenges and requirements for multi-use of areas as well as specific recommendations for action for individual stakeholders are presented below:

### FIELD OF ACTION: TAKE A STANCE FOR CIRCULAR ECONOMY

**CHALLENGES**

Acceptance for multi-use currently not yet equally present among all populatin groups:

- Use of flat-sharing communities and coworking spaces frequently tends to be more common among younger users

Mono use:

- Areas are currently often only used for a certain function and only at certain times

**TASKS**

Create a different perspective and establish new concepts and lifestyles:

- **Educate and set new trends**
  Educate potential users and providers about the potential of multi-use and about possible risks
- **Establish multi-functional concepts**
  Promote and develop already existing, functioning concepts (e.g. promotion of concepts for integrative housing or multi-generational living); learn from sharing concepts outside the building sector
- **Intensive cooperation of the relevant actors for meaninful multi-use**
  Increased project-related cooperation of all relevant interest groups (e.g. owners, users, intermediaries such as municipalities or representatives of digital platforms) taking into account the particularities of individual business models of multi-use

**NECESSARY STEPS FOR**

**Public sector**
Cities and municipalities can act as role models and promote projects that increase the potential for multi-use

- Control existing services e.g. via municipal platforms
- Create incentives for companies, landlords, property owners and investors to use synergies and promote them through public relations (e.g. for sharing concepts in the business-to-business area, at industrial sites)

**Planer**
Promote and expand acceptance of multi-use through architectural solutions; involve all stakeholders at an early stage

**Organisations, federations and associations**
Provide continuous education work and create further initiatives for the use of sharing services

### FIELD OF ACTION: IMPROVE THE LEGAL SITUATION

**CHALLENGES**

Unresolved legal framework:

- Multi-use of areas currently a legal grey area, uncertainties regarding liability issues

**TASKS**

Clarification of the legal framework conditions and subsequent information offers:

- **Reduce the obstacles to increased implementation of multi-use of areas by expanding legislation and formulating generally applicable rules**

**REQUIRED STEPS FOR**

**Legislators**
Formulate and communicate clearer laws and regulations regarding the multi-use of areas; provide information and control functions

### FIELD OF ACTION: OPTIMISE PROCESSES

**CHALLENGES**

Processes for the practical implementation of multi-use are often not yet economically viable, as they have not yet been established and standardized due to low demand

**TASKS**

Simplify space sharing offers through digital tools:

- **Bring supply and demand together**
  Creation of digital trans-regional platforms or databases (possibly via service providers) that enable systematic multi-use of areas and allow scaling
- **Optimise processes**
  Increase benefits by reducing the effort required to use sharing services (sharing as the easiest and most convenient option)

**REQUIRED STEPS FOR**

**Public sector, companies and initiatives**
Provide trans-regional platforms that bring together users and providers using digital tools; offer supporting documents (e.g. model contracts, house rules, liability regulations)

## 3.2.2 Checklist for your project: Multi-use of areas

The following checklist shows possible planning approaches for the implementation of multi-use, which were compiled in the workshop "Circular Economy - Shared Spaces" using the example of office buildings. These are neither complete nor exhaustive, but serve as inspiration and orientation. In addition, the checklist is intended to support clients and planners in dealing with certain aspects of multi-use at an early stage in the planning process (both for new buildings and for conversions) in order to keep future options for usage open. The questions for office buildings can partly be transferred to other uses and individually adapted as well as supplemented by existing sharing concepts from other areas.

### CREATE CONDITIONS THAT ENABLE FLEXIBLE USE

**Include further usage options in planning**

☐ Can the area be used beyond its intended purpose? With office buildings e.g. for
- Trainings and evening courses
- Movement courses
- Exhibits, receptions

☐ Are areas available for use other than the current or intended use (to what extent and over what time period)?
- Short-term, regular or constant
- Short, medium or long-term

☐ Is one of the following usage models suitable for the existing or intended area?
- Alternating use: The current or intended main use is supplemented by secondary use outside of business hours.
- Simultaneous use: The existing or intended area is available in parallel for various types of use.

☐ Can synergies be created, (if so, to whom could a possible offer be directed)?
Differentiation e.g. according to
- organisational form: associations, commercial enterprises, public authorities, private individuals, etc.
- purchasing power: low price segment, medium price segment, top segment

**Create the structural prerequisites for rooms that can be used in a variety of ways**

☐ Can the option for future multi-use be established or kept open by structural conditions?
Possible parameters are e.g.
- Security (access outside business hours, access control, separation of "public areas" for subletting)
- Access to sanitary facilities
- Possibility of individual room conditioning for parts of the building even in the evening or at night respectively on weekends
- Flexible basic equipment
- Sound insulation
- Escape routes
- Fire safety
- Site-specific qualities, e.g. central location, mobility, synergies on site

### PROVIDE RELEVANT INFORMATION TO MATCH SUPPLY AND DEMAND

**Deploy central parameters to a higher level platform**

☐ Are all central parameters listed or queried on the platform used in order to bring supply and demand together as optimally as possible? Possible parameters are e.g.
- Spatial conditions and usage options
- Area quality
- Utilisation periods
- Number of users
- Facility management and existing or required infrastructure (including technology and supply areas)
- Public transport connection
- Special usage requirements

☐ Can these parameters be added flexibility later on in the platform (required parameters are generally not possible to predict in full and may differ depending on project)?

**Promote the awareness of the offer and simplify its use**

☐ Can existing platforms be used for the multi-use of areas?

☐ Is the platform used user-friendly and laid out in a simple manner?

☐ Can documents be provided as templates for support? Possible documents are e.g.
- Formulation of house rules for signature by the user
- Liability regulations

# 4. Further information and platforms

Further information on the circular economy and platforms with compilations of best practice examples

**DGNB website**
The Platform of the DGNB on the topic of Circular Economy, including the latest voices of experts and the possibility of downloading individual elements of the DGNB Toolbox.
https://www.dgnb.de/circulareconomy

**Circular Economy Package of the European Commission**
In December 2015, the European Commission adopted a Circular Economy Package, including an action plan for the EU, aimed at creating a more circular economy. In January 2018, this was complemented by a further package of measures to implement the action plan.
http://ec.europa.eu/environment/circular-economy/index_en.htm

**European Circular Economy Stakeholder Platform**

- Initiative of the European Commission and the European Economic and Social Committee (EWSA)
- Compilation of good practices, strategies and knowledge around the topic Circular Economy

https://circulareconomy.europa.eu/platform/en

**MOVECO platform**
The objective of the MOVECO EU project is to promote the transition towards a circular economy in the countries of the Danube region. The project results are summarised in a "toolbox" which includes the following elements:

- Promotion of the cooperation on the topic of circular economy, e.g. in concrete ressearch or practical projects.
- Online marketplace for the reuse of raw materials and building products
- Circular Toolbox: Training and information material (especially for SMEs), literature lists as well as information on financing and promotion
- Backgrounds on expanded manufacturer responsibility and overview of all existing manufacturer take-back systems

https://danube-goes-circular.eu/

**Ellen MacArthur Foundation**

- Circular economy publications and learning materials
- Tools for implementing and compiling of best practice examples

https://www.ellenmacarthurfoundation.org

**Circle Lab**

- A platform operated by the Circle Economy organisation that collets and provides knowledge to promote the transformation to the circular economy

https://circle-lab.com/



# 5. Outlook

This guide provides building owners, planners and other interested parties with an overview of the challenges, but above all of the associated potentials and tasks that the various players in the construction and real estate industry will face in the future in connection with the circular economy. In the form of a toolbox, the contents of which were developed together with experts in a series of workshops, concrete possibilities for the implementation of the Circular Economy in the construction industry are presented. The toolbox, which is dedicated to the topics "Conversion and deconstruction-friendly planning" and "Multi-use of areas" and is accompanied by implementation examples, comprises strategic fields of action for various actors, recommendations and impulses for planning as well as checklists for projects for builders and planners.

It becomes clear that a successful implementation of the circular economy in the building industry requires that it is not an end in itself, but is understood holistically. In addition, its principles must be consistently integrated into the planning, construction and deconstruction process over the entire life cycle. In order to actually close the cycles in the construction industry, it is of particular relevance that planning and implementation go hand in hand and that the raw materials brought in at the end of the use of buildings are actually returned to the cycles.

With the introduction of the circular economy bonuses in the 2018 version of the DGNB system, the DGNB has made an important step towards incorporating the circular economy into building certification.

The next step is to transfer the bonuses to the district level. In addition, this guideline shows that it is central to promote the reuse of buildings and to bring the deconstruction of buildings more into the focus and awareness of the actors involved in the construction process. The DGNB is currently devoting itself to the latter with the development of a certificate for the deconstruction of buildings.

The multifaceted topic of circular economy cannot be presented conclusively in a single publication, which is why this guideline is to be understood more as a snapshot of a topic that is continuously developing. In the next stage, the approaches described must be increasingly implemented in practice, tested over the long term and continuously improved. There must be room for experimentation in which existing approaches and solutions can be questioned and new methods and technologies tried out. Emerging trends must be observed and critically evaluated.

An essential step towards spreading the word about the circular economy is the networking of all actors involved, the exchange among each other and learning from each other. Circular economy must be integrated into teaching and the existing and emerging knowledge must be shared.

The DGNB sees itself as a platform for bringing about and advancing the change towards a circular economy together with the various players in the construction and real estate industries.

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**Supporting Chapter 3.1 Conversion and deconstruction-friendly planning:**
The content of this chapter is based on the results received as part of the DGNB workshops "Circular Economy - Construction" on 13 June 2018 in Stuttgart and "Circular Economy - Deconstruction" on 21 September 2018 in Cologne. The initiator for the workshop in June was a presentation on the topic of "cycles" by Prof. Annette Hillebrandt, the concepts of which have been added into this chapter. As part of the workshop in September, a presentation was made by Ann-Kathrin Denker on the topic "Deconstruction in practice", as well as ideas around the topic of reuse from Ute Dechantsreiter.

The workshop "Circular Economy – Construction" was carried out by Martin Prösler. The workshop "Circular Economy – Deconstruction" was carried out by Dr. Anna Braune.

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**Supporting Chapter 3.2 Multi-use of areas:**
The content of this chapter is based on the results received from the framework of the DGNB workshop "circular economy - shared spaces" on 9 May 2018 in Stuttgart. The idea for the workshop came from the presentation "Mehrfach: Nutzen" from Regierungsbaumeister Dipl.-Ing. Achim Schröer, which will be published shortly*. Further input from Prof. Matthias Rudolph provided detail around the practical implementation of Space Sharing.

The workshop was carried out by Martin Prösler.

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# German Sustainable Building Council – DGNB e.V.

Founded in 2007, today DGNB is Europe's largest network for sustainable building, with around 1,200 member organisations. The objective of the association is to promote sustainability in the building and property sector and to create awareness in the wider public sphere. With the DGNB certification system, the independent non-profit organisation has developed a planning and optimisation tool for the assessment of sustainable buildings and districts, which gives assistance in increasing real sustainability in construction projects. The foundation of the DGNB system rests on a uniform definition of sustainability which encompasses the environment, people and the economy to equal degrees. More than 3,000 persons in 30 countries have been qualified as experts for sustainable building via the DGNB Academy training and development platform.

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