Circular buildings

Strategies and case studies

A publication by the Circular Construction Economy Transition Team

Triodos Bank. Photo: Ossip van Duivenvoorde

Contents

ARE YOU …
A DEVELOPER
A LENDER
A BANKER
A USER
A FACILITY MANAGER
AN OWNER
AN ADVISER
AN ARCHITECT
A VALUER
A BUILDER
A CONSTRUCTOR
A SUPPLIER
A DEMOLITION CONTRACTOR
A WASTE PROCESSOR
OR SOMEONE ELSE INTERESTED IN CIRCULAR CONSTRUCTION?

… THEN THIS PUBLICATION IS DEFINITELY FOR YOU!

‘Nationally, but certainly also regionally, more and more is happening’

Helen Visser
Programme Manager at Duurzaamheid Bouwend Nederland

The term ‘circular’ is hot, especially in the construction sector. But it also leads to a lot of discussions. How do you define circular construction, how do you measure circularity, what is a circular design or a circular invitation? And how do you record material data in such a way that it can be used for future purposes with optimal effect?

Although there is still a lot of discussion about the above questions, the objectives in the Circular Building Economy Transition Agenda are widely recognised by many parties within government, business, science and education:

- 50% of the final target to be achieved by 2030;
- 2050 a fully circular construction economy.

The construction sector has been focusing on more sustainable use of materials for years, but the actual transition to a circular construction economy is yet to take place. Many chain partners are needed to make this important transition. Examples include demolition companies, the supply industry, construction wholesalers, lenders, property investors, architects, (government) clients, the (developing) construction industry, the central government, science and education.
From their position, construction companies can further reduce primary resource consumption by designing buildings with lighter structures, which can be used for multiple purposes and that can be easily dismantled after demolition. And to use materials and building components that are as circular as possible.

Construction companies are dependent on a versatile and demonstrable supply of circular building materials, among other things. In addition, it is important that clients purchase ‘circularly’. This can be achieved, for example, by awarding circularity in tenders and taking this into account in such a way that companies include the circular use of materials in projects with maximum effect. This allows them to distinguish themselves in the market with circular innovations.
Several bottlenecks impede the development towards actual circular construction. These can only be solved through collaboration between the aforesaid parties in the construction sector. Bouwend Nederland is therefore pleased that representatives from within the Circular Construction Economy Transition Team, CB’23 and the BTIC are working on solving bottlenecks.

Apart from all the discussions and bottlenecks that need to be resolved, a lot is possible already. Right now, today! Nationally, but certainly also regionally, more and more is happening. The continuous sharing of acquired knowledge is important, so people can learn from each other. I would therefore certainly recommend viewing the tips and links in this publication and keeping an eye on www.circulairebouweconomie.nl.

Circular residential/working complex in Nijmegen (Orga Architect). Photo: Ruben Visser

Get started with circular construction today

A safe and healthy living environment is important for everyone. This makes the urgency of making the Netherlands circular by 2050 greater than ever. A significant challenge lies ahead, especially for the construction sector. The aim of this publication is to inspire everyone throughout the construction column, both on the supply and demand side, to get started with circular construction. You can read what the concept is and what steps you can take. We link theory to practice with facts, backgrounds, case studies and interviews with enthusiastic builders, designers and experts.

Circularity is becoming more and more common. In our language, but also in construction practice. Not surprisingly, because the principles behind circular construction are obvious. We stop depleting natural resources, emitting hazardous substances and polluting our living environment. Instead, we will reuse materials, reduce our waste stream and build sustainably and future-proof.

New ways

It sounds so obvious. However, the transition from a linear to a circular construction practice does not happen by itself. We have to abandon the way we worked for countless decades and look for new forms of collaboration, with different market models and new actors. There are still many questions that need answering. How exactly do we measure circularity? How do we map the properties of materials? What does an optimal circular invitation look like? It will take some time before all the answers are there. But that should not prevent us from taking the next circular step.

The only way to move forward is to get started. More and more parties are getting involved, both on the commissioning and executing side, and are already experimenting a lot and with success. They investigate how they can apply their enormous knowledge and skills in the new, circular reality. No one knows exactly where we will end up, or how we will get there. We learn by doing. We still

Doekle Terpstra, chairman Techniek Nederland:
"Circularity is a transcendent theme, which in my view goes beyond sustainability. I can already see some good examples in the industry, where a lot of thought has gone into how to apply circular thinking. In 2020, the average installer or the average engineering contractor isn't yet engaged in circularity. Yet you can see frontrunners really making strides. Yet in daily practice, it's an incredibly unruly and complex subject. Clients too must steer us in this direction and help us on our way. We do have a lot of innovative power, but circular thinking is still an abstract concept. The trick for our members is that they first share the lessons learned."

have 30 years to complete the circular transition. That seems like a lot, but there is no time to lose!

Challenge

Many people still mainly associate the term circular construction with reuse. The Building Agenda and the Circular Construction Economy Transition Team use a broader definition of the term circular construction.

Our definition of Circular Construction:

to develop, use, and reuse buildings, areas, and infrastructure without unnecessarily depleting natural resources, polluting the living environment, and damaging ecosystems. Building in a way that is economically sound and contributes to the well-being of people and animals alike. Here and there, now and later.

The challenge is therefore to build without emissions and without depleting and burdening the living environment. This requires a new way of thinking and acting. It makes the transition to a circular construction economy not only a technical, but above all a social and economic change. One in which everyone who still takes something to the refuse container or dump asks themselves: is there another way?

Case studies

This publication maps out previously acquired knowledge about circular construction and makes it accessible. We discuss the definition of circular construction and what it means in practice. We describe recognised circular strategies and theories to emphasise the full potential of circular construction. And we will discuss the multiple values that circular construction can bring to society as a whole. We make all this specific with case studies of projects that apply circular principles. The perfect circular project does not exist, so it is certainly not our intention to make a sum of the best circular projects in the Netherlands. However, it is our intention to give a series of good examples of how clients and contractors implement the theme in practice.

In addition, this publication contains many quotes and interviews with inspired builders, designers and experts. All this in the hope of inspiring everyone in the construction column to get started with circular construction not tomorrow, but today.

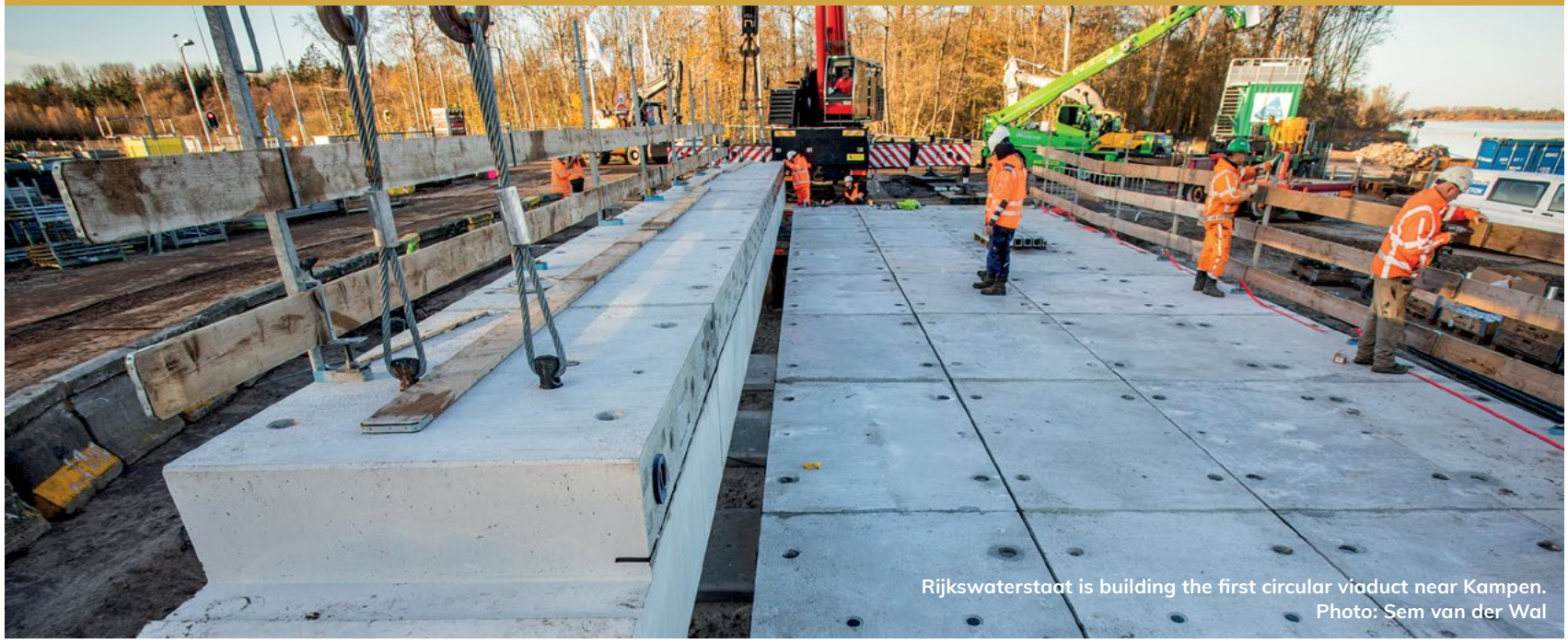
Circularity and the civil and hydraulic engineering industry

Circularity is a broad topic. Where possible, the construction sector tries to work together as much as possible. A large part of this publication applies to the construction sector as a whole and can be an inspiration for everyone.

In doing so, we must also recognise that the sectors have their own dynamics and that there are specific issues per sector. For example, in civil and hydraulic engineering it is more often about raw materials. Examples include the use of sand as a freely applicable form of raw material. The footprint is determined by the transport of sand and materials. This is much less the case in residential and non-residential building, which mainly concerns products and elements that contain raw materials. Typically, the amount of products and elements used for buildings is much greater than in the civil and hydraulic engineering industry.

That is why in this publication, a deliberate choice has been made to focus on residential and non-residential construction and to leave the civil and hydraulic engineering industry out of equation. This does not alter the fact that the civil and hydraulic engineering industry too is taking significant steps with regard to circularity. Some that we would like to mention include:

- The Inspiration Book published by Rijkswaterstaat for an integrated approach to circular design. This contains optimal circular solutions through involvement of all stakeholders and disciplines throughout development process.
  You can download the publication from the Ministry's website
- The publication Circular design in the MIRT process contains action perspectives for policymakers, advisers, designers and managers.
  You can download the publication from the Ministry's website



Rijkswaterstaat is building the first circular viaduct near Kampen.
Photo: Sem van der Wal

‘Use your common sense’

“Do what you can.” Elphi Nelissen, professor of Building Sustainability and chair of the Circular Building Economy Transition Team, wants to pass on that message to everyone involved in circularity. “The corona crisis is leading to a mind shift where we realise that we cannot continue on the same footing. We must accelerate towards a sustainable and future-proof living environment. Even though it’s not yet possible to do everything completely circular at the moment, we can try to work as circular as possible.”

Nelissen hopes that the economic downturn as a result of the corona crisis will not lead to a large-scale cutback in the construction industry. “Because we need everyone right now. A large number of circular projects from which we can learn a lot are currently in the pipeline. This gives us much more knowledge of how circular construction works in practice, what it costs and what it yields. The market can benefit from that experience as well. So we have to prevent delays as a result of a recession in the construction industry.”

Waste heap

According to her, it is important to think about the circular future with construction project. “A lot of attention is currently being paid to the energy transition in the built environment. It’s very important that we carry out these circularly as much as possible, otherwise we will miss the boat. For example, by using biowaste material and waste products from other industries for insulation. Take the textile industry, for example. There’s a huge mountain of textile waste that is already producing insulation material. If we promote and accelerate initiatives like that, we kill two birds with one stone.”

Detachable

The Transition Team is currently working on further details of important preconditions for circular construction, such as a materials passport and a uniform benchmark. But the market should certainly not wait for that, she emphasises. “Just try to work as circularly as possible. I deliberately don’t say 100% circular, we may not have all the tools and all the knowledge for that at the moment. Use your common sense.”

“The first question a client should ask: is the project really necessary? Because the less we build, the better. After that, you can start thinking about the technical aspects. Is there an old building nearby that you can get materials from? What bio-based materials can you use? So preferably use a wooden instead of a steel structure. And how can you make the design as detachable as possible, so that it can be taken apart again when it’s demolished? So don’t weld, but use bolts for connections. And find out how you can make the project as energy-efficient as possible, because we believe energy is a raw material too.”

More creative

According to her, clients can be a lot more creative in their circular tenders. “Clients, especially government bodies, want to be able to account for and coordinate everything. However, a tender cannot be assessed completely circularly at the moment. Does that one entry have 98 points or 97 points? Another way is to make a relative assessment. For example, by appointing a panel of experts who weigh the various projects on the basis of their knowledge and experience. And you can do that according to the tendering rules you know. And in general, that produces very good results.”

Elphi Nelissen: ‘Just try to work as circularly as possible. Use your common sense.’

About circular construction

Technical and economic progress has brought great prosperity since the beginning of the Industrial Revolution. By standardising, mechanising and industrialising work, we have been able to make our lives much more pleasant, at least most of us here in the western world. The basic model of the economy this is based on is linear and goes from raw material extraction, production and use to disposal or incineration. It has now become clear that our raw materials and the resilience of the living environment are becoming exhausted. It is time for a new model: the circular economy.

Linear economy, current economy

The foundation for economics and today's liberal capitalism was laid by Adam Smith. He is best known for the invisible hand concept and the idea that rational self-interest together with competition lead to economic prosperity. He described all this with a great sense of nuance in his book An Inquiry into the Nature and Causes of the Wealth of Nations, published in 1776, often referred to simply as The Wealth of Nations.

This linear model has therefore been in use for some time. It served us well for centuries and to this day, we generally don't give it much thought. However, in Adam Smith's era, there were less than a billion people in the world. The world economy was 300 times smaller than it is today. Thinking about economics has naturally developed in those two centuries. Economist Paul Samuelson is seen as the founder of today's modern economy after World War II. At the time he published his Economics, there were three billion people on earth and the world economy was one-tenth the size it is today. Subsequently, for decades we further optimised the system based on growth of the gross national product.

The world population has now grown to 7.8 billion people. The UN expects that another 2 billion people will be added to earth's population by 2050 and that almost all of them will aspire to our current Western lifestyle. This means that an important assumption of the linear model, namely that raw materials and our living environment are inexhaustible, is gradually no longer valid.

That does not come as a surprise. Models are always a simplified representation of actual

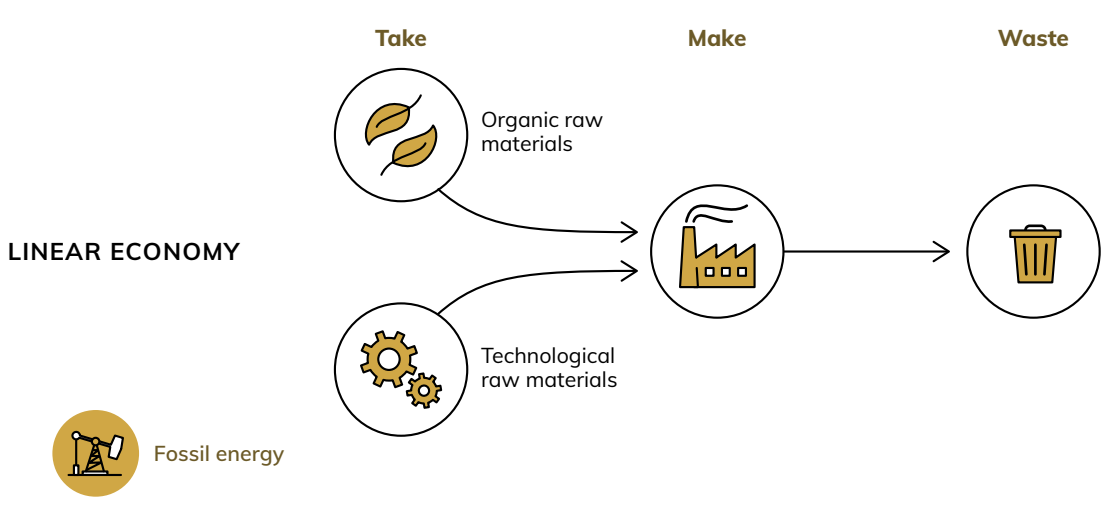


Figure 1 Linear economy

reality. If circumstances change too much, assumptions can become invalid. That is when the old model needs an update. And that is the case here as well. The economy and world population have grown so large that we can no longer assume an Empty World, one in which you do not have to account for the amount of raw materials that are extracted from nature and the waste and emissions that are pumped into the environment.

That is why in the 1970s, also in the Netherlands, following the images that Apollo 8 brought with it of a small planet Earth, the report of the Club of Rome, the oil crisis and environmental scandals such as Lekkerkerk, Volgermeer and Coupépolder, the model of a circular economy emerged. Economist Herman Daly was the first to elaborate on this in Steady-state Economics, based on the assumption that we as humans no longer live in an Empty World, but a Full World.

Companies had previously noted that, in the context of the security of supply of raw materials, it is important to consider where they come from and to invest in substitution options to be able to absorb price fluctuations. Encouraged by governments, some companies have found that it pays off to reduce the quantities of raw materials required by means of resource management and to reuse raw materials. This makes it feasible to produce a quarter less waste and save 30% in costs. The Covid-19 pandemic too is an important impetus for governments to rethink global logistics production chains.

Circular economy

We are therefore looking for ways to shape the necessary upgrade to a circular economy and to develop this further for the built environment. The term 'economy' refers to the best possible use of scarce resources. Or as economist Daly puts it more specifically: minimising our claims on nature while maximising output for the well-being of humanity.

The Ellen McArthur Foundation (2013), many say a leader in the field of circular thinking, argues that this circular economy is restorative and regenerative in design with the aim of keeping products, components and materials at their highest level of utility and value at all times. Following McDounough and Braungart, the Foundation distinguishes between technical and organic cycles. The element of regeneration or value creation is what also appeals to many in the philosophy of McDounough and Braungart (2002).

Circular construction is a way of building in which, at different scale levels and in all phases of design, production, assembly, management, maintenance, disassembly, (re)use and transformation:

- the total use of materials is minimised;
- reuse of parts and materials is maximised at the highest possible level;
- loss of value is prevented;
- and value creation is maximised.

These objectives are not isolated. In the context of the circular economy, they are often linked to other social issues, such as depletion of the earth, declining biodiversity, shortages caused by demand from developed countries in other parts of the world, or the ambition to improve the working conditions and social circumstances of employees or to boost the local economy.

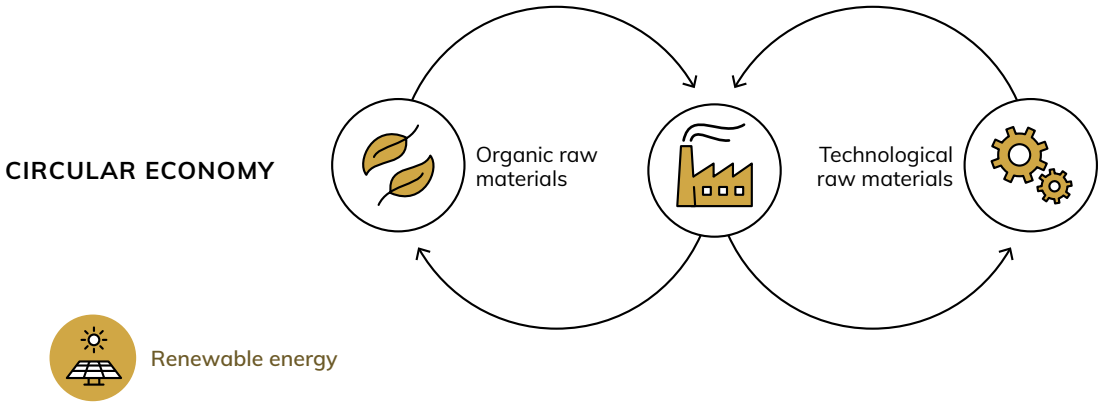


Figure 2 Circular economy (Braungart & McDonough, 2002)

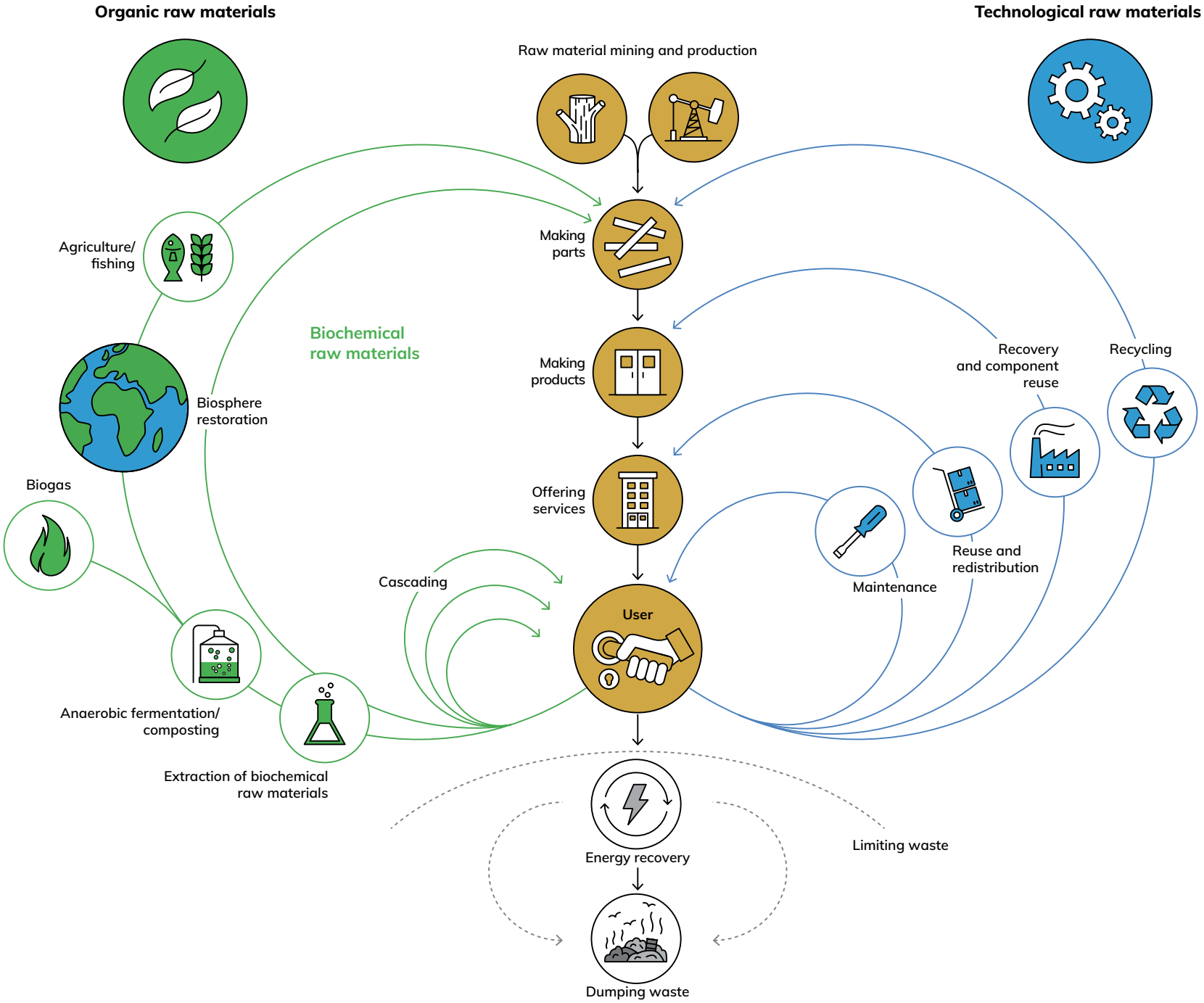


Figure 3 The butterfly model of the Ellen McArthur Foundation (2012)

Organic cycle

Nature lives in cycles. Molecules are mostly composed of nitrogen, hydrogen, carbon and oxygen atoms and then reused in a different composition to build other living cells that collectively form a piece of skin, a hair, a nail, a hoof or organs. Together, these are bodies and species that are part of ecosystems. Like nature, we too use all kinds of natural nutrients in our economy. These nutrients can easily be included in ecological cycles, be part of nature again and then be part of the built environment for a while. This concept is also known as the bio-based economy.

Technical cycle

The technical, inorganic or non-renewable materials form their own cycles. When they emerge from the earth's crust, the so-called lithosphere, these materials also complete cycles, such as sand, iron and aluminium. However, these cycles have a very different time scale than the organic substances. They can span millions or even billions of years.
It becomes problematic if we mix substances that we have made ourselves, such as plastics, with organic cycles. Under the influence of weather conditions, among other things, plastics disintegrate into microplastics and then easily mix into ecological cycles. The result is that birds and fish eat this, but we too ingest these substances because we eat these animals or accidentally swallow a snowflake or, because microplastics end up in products such as sea salt, which we use to put on our meals.

Thinking in cycles, closing cycles

Historically, thinking in cycles has always been the foundation of our society. Historians studying economics therefore say that, in retrospect, the current linear economy will turn out to be a relatively short period in our history. In fact, our societies, like all other animal species on earth, have been part of ecological cycles for centuries. The trick is now to transform all substances alien to nature, production processes and waste processing processes that we have devised in such a way that our actions fit into cycles again.

Some people argue that we should start looking at everything from a circular point of view. If the term economics refers to efficient use of scarce capital then, reasoning from that viewpoint, you should work with the interest of the different capital flows to ensure a good future for yourself and others. In any case, this means not eroding the total capital and preferably allowing it to grow.

Two cycles

Atto Harsta, Aldus bouwinnovatie: "When you talk about circular construction, you talk about two cycles. But often, we only consider the technical cycle. People say: 'we want something that fits the circular economy and something like bio-based construction'. No, the bio-based branch is one half of the circular economy. If we are really going to build in a circular way, it means you are sourcing raw materials from the technical cycle. In addition, you supplement with renewable products from the organic cycle. You can accelerate this with a symbiosis.
According to Harsta, clients must enforce circular construction in the market. "Almost all tenders contain circular components, but to what extent are they taken into account? As clients, corporations and semi-governments, let's invite tenders based on circular construction."

Haut as a signature

At Lingotto, environmental friendliness is paramount. The project developer distinguished itself previously by using a recycled building front in a project, but is now permanently putting itself on the circular map with the Haut residential tower. Bob Jansen uses circularity where possible, this pragmatic developer says.

Lingotto has never really been a forerunner when it comes to sustainability, Lingotto partner Jansen explains. “But aspects like flexibility in buildings, densification, multifunctional buildings and redevelopments are in our DNA. A striking building by the developer is Multifunk on IJburg, which was completed in 2006. Jansen: “You can either live or work in it. It’s flexible in its use. The building front is made of recycled tires. The word circular didn’t even exist yet.”

Incidentally, Jansen is averse to trend words such as circularity and sustainability. “The danger is that you start thinking in boxes and you have to be careful about that. The same thing is happening with the energy performance coefficient (EPC). Of course you have to standardise, the process becomes quantifiable and easier to control. But before you know it, your buildings are covered with solar panels and people obsessed with completing checklists, while an overall vision is missing. People now often think in terms such as BENG or ZENG. And so you quickly lose sight of elements such as greenery, ecology or biodiversity. Before you know it, people are only busy applying high-tech systems that couldn’t be further away from the concept of circularity.”

High-tech or low-tech

Lingotto builds both high-tech and low-tech buildings. For example, they developed ‘De Spakler’ at Spaklerweg. It is the first energy-neutral residential tower in the Netherlands. Jansen: “It is high-tech sustainability with a lot of solar panels. But we also made a low-tech residential tower. Haut is a much more sustainable building with a much better CO2 balance than De Spakler. Yet Haut’s EPC is 0.12... which is in fact not that special. That also makes the circular discussion difficult because which characteristics do you find important as a client?”

Ideal material

Haut is a sustainable landmark in Amstelkwartier. The wooden residential tower was created in collaboration with Team V Architectuur and Arup. Once the decision to build with wood was made, a thorough study was made. Jansen: “Wood is sold to the outside world as the ideal material, because you build faster and easier. But in an innovative project like this, it wasn’t that easy.”

This was due to several causes, Jansen outlines. For example, the area-planning framework provided by the municipality turned out not to be suitable for timber construction. “The shape of the building and its location next to the railway track with associated vibrations made construction very complicated. The wish was to make the residential tower completely out of wood, but the tolerances weren’t met. Ultimately, a concrete core was opted for and for the rest wood. This in turn had significant consequences for the detailing, because the differences in settlement between concrete and wood had to be carefully examined.”

Haut tastes like more

Lingotto is definitely on the map as a circular developer with the landmark Haut. Jansen: “In the future we will be building more with wood, that’s for sure.” Haut was built with a prefabricated system of cross-laminated timber and offers 51 luxury apartments in the free sector. The building is expected to be completed in 2021.

Bob Jansen: “When you talk about urban planning, the neighbourhoods that are currently on the drawing board will have an impact towards 2050. Consider whether you can use wood as a substitute for concrete and steel. We should think more about where the materials come from and what their impact is.”

Circular strategies

There are many different principles you can use to achieve a circular approach to a construction assignment. Applying all principles at the same time is not possible. It therefore helps to gain an overview of which principles are in place and in which context they are relevant. Hence a number of models are presented here that are helpful in structuring these principles. Based on this, the right combination of principles can be put together into a circular strategy that fits the assignment and context. They are the Circularity ladder, Stewart Brand's 6S model and the circular construction matrix model.

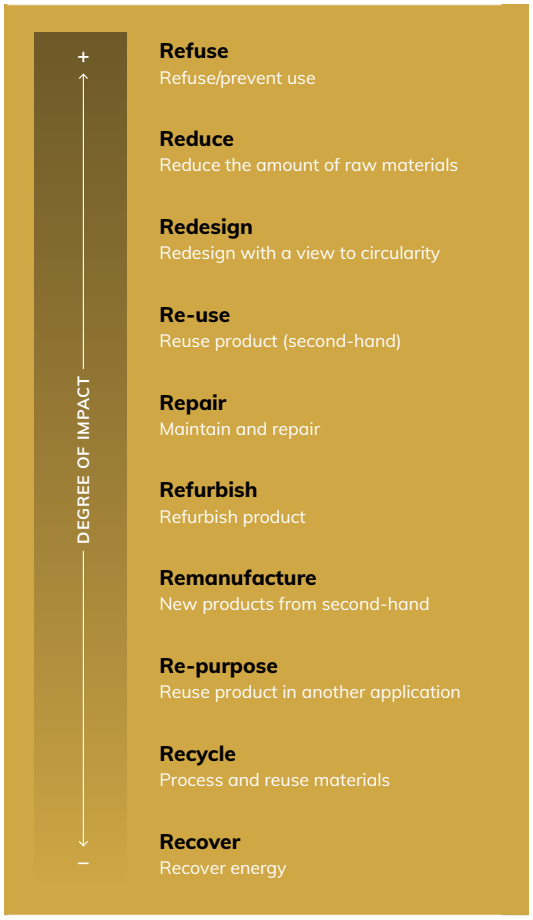


Figure 4 The Circularity Ladder (PBL, 2015)

Circularity ladder

The Lansink ladder, also referred to as the waste hierarchy, was established in 1979 in the context of waste management. The aim was to be able to give priority to the processing method with the least impact on the environment. This ladder consists of the rungs prevention, reuse, sorting and recycling, incineration and landfill. Jacqueline Cramer built on this and eventually developed the circularity ladder, or the 10R model. The various parts have been further refined, adding rungs to the ladder. As a result, more principles in the context of resource management have been identified. This is because reuse and recycling can manifest itself in different ways.

This brings the ladder to the next ten rungs: refuse, reduce, redesign, reuse, repair, refurbish, remanufacture, repurpose, recycle & recover. There is a sequence in this arrangement. Most gains can be made at the top of the ladder, by avoiding resource consumption. Recycling and recovery are at the bottom of the ladder, but are sometimes the best solution when there are no other options.
Many buildings were not designed or produced from a circular point of view. This means that buildings and the associated products, as well as production, have to be redesigned. This is to enable disassembly and high-quality reuse later on. Coming up with ways to dismantle existing buildings and systems that were not designed for this purpose has developed into an altogether new profession.

6S model

Property investors are increasingly looking at future-proofing. Buildings should be adaptable and changeable. Or, as Stewart Brand puts it, a building should be designed for different usage scenarios. The 6S model of Brand is widely used because it clarifies that the different parts of a building do not all last the same time. The different layers and their average lifespans are:

The 10 Rs as a conceptual model

Robert Koolen, Director of Strategy & Policy at Heijmans: “The strength of the 10R model is that it’s a conceptual model and forms a good departure point. You can ask an organisation whether something is recyclable yes or no, but there are many more steps that are relevant and that you should be asking about as well.”
Koolen takes the flexible accommodation of single-person households, the Heijmans One, as example. “If you start wondering what it is made of, wood or steel, you are already assessing the property. Whereas the circularity lies in the fact that this is a flexible, small living concept so you don’t have to build other things.”

Stuff	5-15 years
Space plan	5-20 years
Services	5-30 years
Skin	30-60 years
Structure	60-200 years
Site	> 200 years

Buildings are usually designed with a specific purpose in mind. It needs to accommodate the business process of a certain company or there must be room for a number of new households. However, how these organisations and people use their buildings changes over time. With the advent of the computer, suddenly space had to be found in buildings to install all kinds of cables, services and switches. A young couple has children and converts the music room into a baby’s room. Some changes can be accommodated within the existing structure, so that only the layout and furnishings are adapted. Other changes in requirements mean having to renovate or having to consider new housing. Consciously thinking about the different lifespans of the

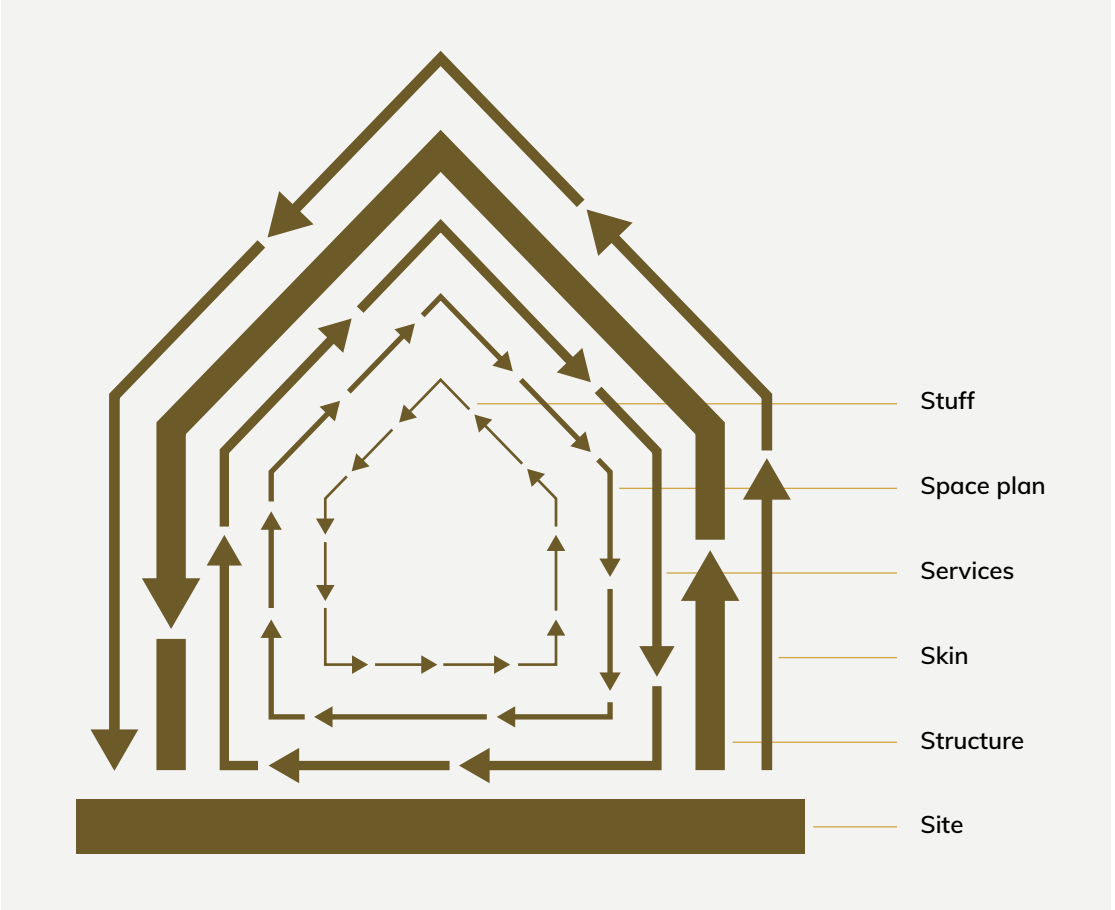


Figure 5 6S-model (Brand, 1994)

From Open Building to 6S

Brand (1994) based his model on the four layers by architect France Duffy and expanded them to six layers. This way of thinking offers designers perspectives not seen previously, requiring them to develop ways that help anticipate future changes. The concept dates back to the 1960s and the ideas of Open Building. These ideas reemerged in the Netherlands in the 1990s.

Circulare pioneer

A pioneering institution in the field of the circular economy is the Ellen MacArthur Foundation. The foundation is named after the British founder, a well-known sailor. She founded the organisation 10 years ago to accelerate the transition to a circular economy.

Read more about the Ellen MacArthur Foundation

different layers and separating the layers within the building increases its changeability. This ultimately allows the building to remain in use for longer.

The circular construction matrix model

Circular construction means that the way we design, produce, assemble, use, manage, maintain, disassemble, transform and reuse must be rethought at all scale levels. So not only at building level, but also how we deal with the location and what this means at component level and material level. The various principles you can use for this can be clustered according to four lines of approach: (1) reducing the use of materials, also referred to as dematerialisation or decoupling; (2) rethinking product and production design; (3) recycling and upcycling, which addresses reuse in all its facets; and (4) value thinking, the lens through which you look at possibilities to add value at different scale levels for building users and the environment.

Decoupling

Decoupling, or dematerialisation, is the magic word in EU strategy and UN policy on the subject of a circular economy. The aim is to increase our well-being while reducing material use. The UN distinguishes three forms of decoupling (see figure 7).

Natural materials prevent overheating

By mid-2020, the construction sector will be obliged to reduce the risk of overheating in a home. Patrick Schreven, owner of Ecoplusbouw, is working on Ecodorp Boekel. He explains that no cement is used in the construction. The foundation is made of glass foam, covered with polymer concrete and a wooden floor. It is insulated with hempcrete, the roof is made of flax and the walls are made of wood. Schreven: “By using natural materials, you prevent overheating in a home. Natural materials often have a much higher heat-accumulating capacity and therefore remain cool for longer. This potentially prevents the need for air conditioning.”

Foto: Ecoplus-bouw.nl

	DECOUPLING	PRODUCT AND PRODUCTION DESIGN	RECYCLING AND UPCYCLING	VALUE CREATION
MATERIALS	Reduce Eliminate Robust Light materials	Innovate Redesign Non-toxic substances Mono-material	Recycle Maintain Cascade Upcycling	Biobased materials Healthy materials Local materials Biomimicry
COMPONENTS	Light-weight Multi-functional Long service life	Standard sizes & connections Adaptable Lean production	Reuse product Super-use Repair and refurbish	Daylight Bio-engineering
SYSTEMS	Light-weight Passive systems Long service life Multiplicity	Modular design Changeable Demountable design Lean production Standard-components	Reuse system Super-use Repair and refurbish	Renewable energy Water buffer High air quality Bio-engineering High water quality
BUILDING	Refuse Multiplicity Passive systems	Adaptive design Integrated design Unbundling of systems Demountable design Design with excess	Transform Building as materials bank Repurpose	Precious building Future proof Climate adaptive
LOCATION	Sustainable land use Geothermal energy	Local production Removable foundations	Urban mining Phyto-remediation Industrial Metabolism	Constructing a community Food production Strengthening local ecosystems

Figure 6 Matrix model for Circular Construction (Oostra, 2020)

From the energy transition, we know that saving is an important first step. In principle, the same applies to materials. Deciding against building new, referred to as refuse, or by building with less material, referred to as reduce, automatically reduces the environmental impact. After all, an additional advantage is that, if fewer raw materials are needed, the amount of energy required to mine, harvest or make these materials suitable for reuse also decreases. Other additional emissions, such as those of nitrogen or formaldehyde, also decline. To reduce the amount of materials needed for a certain purpose, you can of course also extend the life of products. Other principles that help reduce resource consumption include: eliminate and multiplicity.
Whereas in the event of reducing you investigate whether you can do with less material in order to still achieve the same performance, you delete things completely when eliminating. Examples include the casing of a column or a system, or protective material that you would use during the execution.

Multiplicity was introduced as a counterweight to short-lived architecture by MVRDV architect Nathalie de Vries. It focuses on the ability of buildings to transform, create value and contribute to quality of life. It can be used at the level of buildings and building components. An example in the field of multiplicity is the Tainan Spring in Taiwan, a transformation project by MVRDV opened at the beginning of 2020, in which a shopping centre struggling with poor vacancy levels was partly demolished and recycled for 99%. The old shopping centre has been left visible as a stark reminder and to reuse the ruin as a kiosk, shop or event space. The concrete frame of the former shopping centre

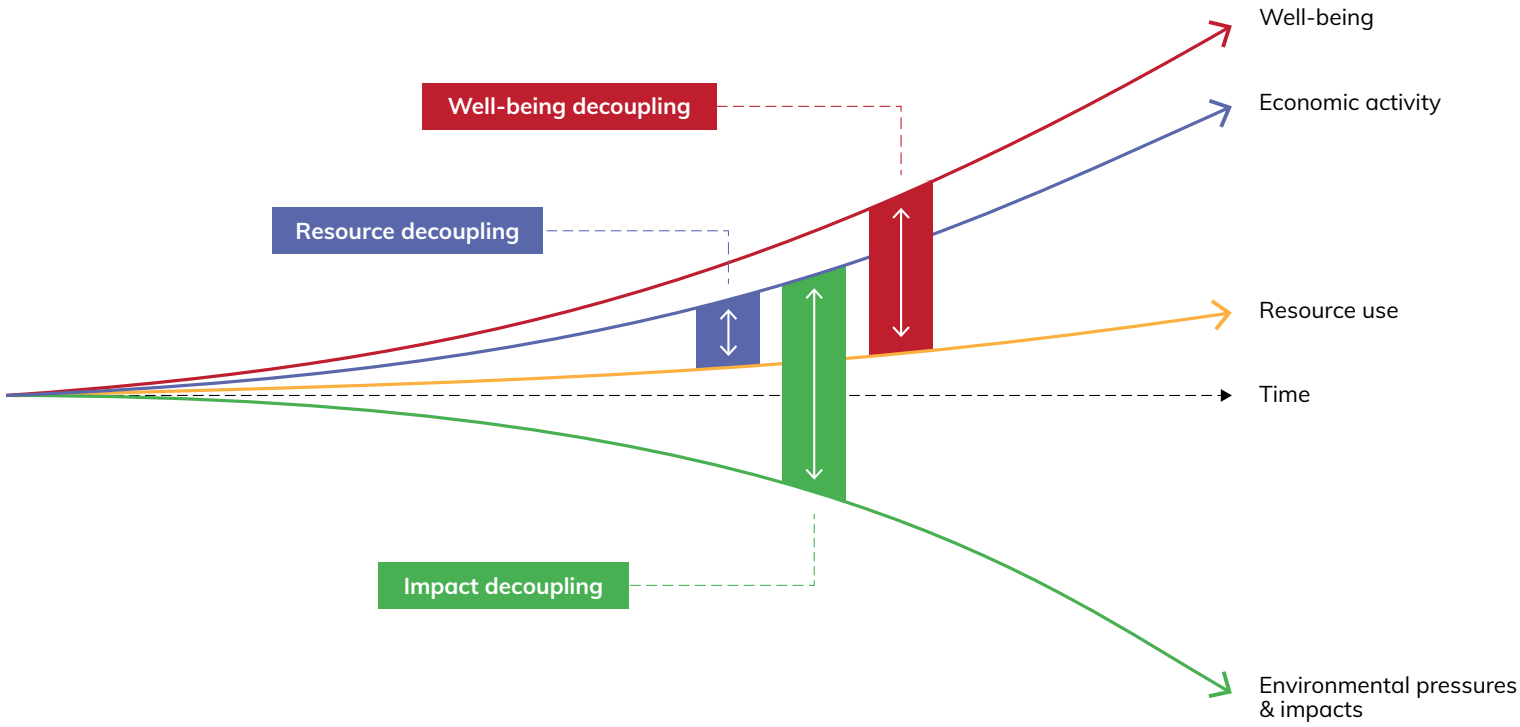


Figure 7 Three forms of decoupling (UNEP 2019)

has largely been reused and provides the basis for shops, kiosks and other facilities. The ruins with open underground parking garage further provide space for playgrounds, water, an event site and a stage for performances. The addition of water is in keeping with the history of the site; a water network once ran here, one of the main supply routes for the Taiwanese sea and fishing industry. By creating a new site with water, this part of the city will cool down and the use of air conditioning is expected to decrease. The entire set-up is surrounded by young plants that will grow into a fully-fledged park in the coming years.

BLOEI: Tool for circular projects

BLOEI is an instrument that the Dutch Government Property Management Agency (Rijksvastgoedbedrijf) has developed as a tool for a circular project strategy.
BLOEI stands for:
Manage or harvest
Lowest resource and environmental impact
Designing with a circular strategy
Economic and cooperation models
Recording information

BLOEI unites all circular principles to make an integral assessment in the event of a new construction or renovation. The 5 themes can be completed per building layer. BLOEI is part of KOERS Circular Rijksvastgoedbedrijf.

Product and production design
The intention to apply used elements reduces the influence of the designer. In a linear world, a designer determines how he wants the building to look and function. All choices are aimed at realising this vision within the constraints of budget, programme and location. Circular design means that architecture is more determined by what is available. This produces different visions. Products may look less cool and only be available to a limited extent. And what does this mean in terms of maintenance and management?

Until now, buildings were rarely designed with disassembly and reuse in mind. Circular construction imposes additional requirements on architects and contractors. The design, engineering and implementation largely determine how flexible, adaptable and future-proof a building becomes, but also how circular it will be. The associated building components will also have to be redesigned. When performance requirements of the building change and building components are adapted, the various components will have to be suitable for high-quality reuse. In addition, the design significantly influences the impact of the production process, which will have to be revised as well.

This approach includes many circular principles that are used in industrial product development, a sector that already paid attention to circularity earlier. This concerns principles such as ‘detachable design’, ‘standard components’, ‘detachable connections’ and ‘modular design’. It is important to consider whether and how materials should be combined. Composites made by fusing two different materials together make reuse difficult or completely impossible. The principle of ‘non-toxic substances’ also falls within this perspective. By choosing the right materials and detailing well, it is possible to avoid the use of carcinogenic or irritating additives. This increases the possibilities of the product or material for reuse. Examples include coatings that often contain toxic substances to protect the underlying material against weather influences and fungi. These substances burden the environment and make reuse more difficult because they are potentially harmful to our health.

Recycling and upcycling
Reuse primarily concerns the use of materials and products that are already available and do not have to be specially made for the building. Thinking about the production of the necessary parts themselves, thereby facilitating the reuse and upcycling as much as possible in the future, is part of product and production design.

It is important to reuse as many products as possible and to at least find secondary raw materials from which the necessary building components can be made. The challenge is to reuse products at the highest level possible. It is best to use a product that represents more value than any previous application. The corresponding principles: ‘upcycling’ and ‘superuse’.

'Upcycling' is defined as the recycling of material in a way so that it retains and/or builds value. It should be regarded as the opposite of downcycling.
'Super-use' is a design approach by Rotterdam based 2012 Architecten, now renamed Superuse Studio's, based on the search for discarded materials, with the aim of identifying their reuse potential and converting their characteristics into added value for new uses in products and buildings.

To facilitate reuse, supporting instruments and organisational forms are needed. This was the reason for Superuse Studio's to develop harvestkaart.nl, a marketplace for professional upcyclers.

Another example is the establishment of a number of logistics hubs within the framework of Cirkelstad. Such as Buurman in Rotterdam and Utrecht and RataPlan in Amsterdam, The Hague and Delft, among other places. Used building products are refurbished and then used again in other construction projects in the region.
Creating such hubs leads to a reduction in the overall demand for primary raw materials. In addition, it reduces energy consumption and CO_2 emissions.

If building components are reused in the same region, CO_2 savings thanks to fewer transport movements can be doubled to 50-60%. This is particularly beneficial in regions where the roads are already congested, such as around major cities. In a pilot project in London, it reduced construction traffic movements by 68%. That is significant, especially when you consider that 30-40% of all road traffic is construction-related.
The principles of 'repurposing' and 'transformation' can be applied at building level. In the case of 'repurposing', there is a new purpose for an existing building, while in the case of 'transformation', in addition to a new purpose, the external appearance of the building is changed by means of, for example, a new front, wing or rooftop extension.

Value creation
The fourth perspective focuses on matters of added value, such as improving the quality of the living environment. In short, this approach focuses on value thinking. These can be different types of values for building users, owners and/or for the environment. The most obvious is the financial and economic value. Other examples include residual value, quality of the living environment or environmental values, social and cultural value.

In our current economic system, financial and economic value is central to just about everything we do. It concerns the value of the property itself, but also the (economic) value that

Forum for the future

The British NGO Forum for the Future was founded by a number of companies, including Unilever, Sky and M&S, and has members such as Amazon UK, Interface, 3M and Capgemini. They convert their companies on the basis of the Five Capital Model, which of course contains Financial Capital (money and financial investments), but also Manufactured
Capital (products, property, etc.), Human Capital (talents and human potential), Natural Capital (natural resources, raw materials and services) and Social Capital (all institutions and human relationships that jointly form society). Reporting is conducted through the principles of the International Integrated Reporting Council (IIRC). This is a global coalition of regulators, investors, standardisation bodies, accountancy firms, academics and NGOs, among others. The coalition advocates communication about value creation as an important step in corporate reporting.
Read more about Forum for the Future

the building provides to the immediate environment and the development of the region. Furthermore, it can become interesting for investors to look at the residual value at different levels. For example, consider the value of the building when no longer in use, but also the value that the different functional parts represent when the building is taken apart. This concerns, for example, the wall components, the installation systems, stairs and glass partitions.

The importance of social value is receiving more and more attention these days. This concerns the value for the building users, customers, but also the value for society as a whole. It can contribute to the fulfilment of wishes that exist in the neighbourhood, such as safety, the need for local green areas or employment. It can also enhance environmental values, such as improving air quality, generating sustainable energy, strengthening local ecological cycles, preserving landscape values and biodiversity. In addition, cultural values can be enhanced by realising an architectural image or giving a place identity.
Finally, a link between functional and aesthetic value can lead to a building that is pleasant to use. This allows people to become attached to the building, likely making them willing to go the extra mile to preserve it for the long term and transform it rather than demolish it: the principle of 'beloved building'. The subject of value thinking is discussed in more detail in this publication in the chapter 'Circular construction: more than a transition in technology'

Alliander office: a leader in recycling

During the renovation of Alliander Duiven, 80% of the material (such as ceiling plates and toilet bowls) was reused or processed into raw materials for other products. What could not be reused immediately, such as metal and glass, has been processed by the industry in thirteen different waste streams. The bituminous roofing material was returned to the factory, where it was processed into new roofing material and then reapplied to the roofs. The wood for the new inner wall consists of waste wood, sourced at the adjacent waste plant. Read more about this project

Value creation with design

The idea that design creates value has always been part of the design theory. This has been made explicit by scientists and designers working on the basis of the Design-to-Value, Design-for-Values or value-sensitive design concepts. The latter theory is based on the idea that design principles are related to ethical, moral, social and political values.
The term regenerative design was introduced by John Lyle, a landscape architect, as early as the 1970s. The idea is that the needs of society are integrated through a system approach into natural processes that restore, renew or revitalize energy and material resources. He and his student McDonough worked on the realisation of the Adam Joseph Lewis Centre for Environmental Studies in the US (2000). Walter R. Stahel, a Swiss architect, working on ideas similar to Lyle, came up with the term cradle to cradle. McDonough and Braungart popularised the idea of value creation through their book Cradle to Cradle; Remaking the Way We Make Things (2002).

New horizon: don't demolish but harvest

The circular economy creates new business models. New Horizon tapped into something that wasn't there yet, but that was in fact in demand. The company dismantles buildings with the aim of harvesting as many materials as possible for reuse, called urban mining. With this, the company supplies a huge range of building materials with a demonstrably lower environmental impact. The materials further carry all regular qualifications.
Read more about New Horizon

Designing systems with the circularity disk

At the end of 2019, the knowledge platform in installation technology TVVL, launched the Circularity Disk, a design strategy for designing systems as circularly as possible. The drive was developed based on the R strategy. The Circularity Disk is a practical step-by-step model (such as a Trias Energetica) that helps experts design systems by asking the right questions and looking for solutions. Three steps are distinguished.

The first step (blue disc) looks at the stage of life of the building or complex.

In the second step (green disk), we look at reducing the environmental impact of material use.

The third step (orange disc) looks at the circular potential of used raw materials or components for the future.

Step 1 - Blue circle

To design a circular building system, complete the steps of the design tool for each phase of your project as indicated in the blue circle (design, operation, etc.).

Step 2 - Green circle

Consider the material use of the systems:

RETHINK Is the system part really necessary? Can you leave it out or use less of it?

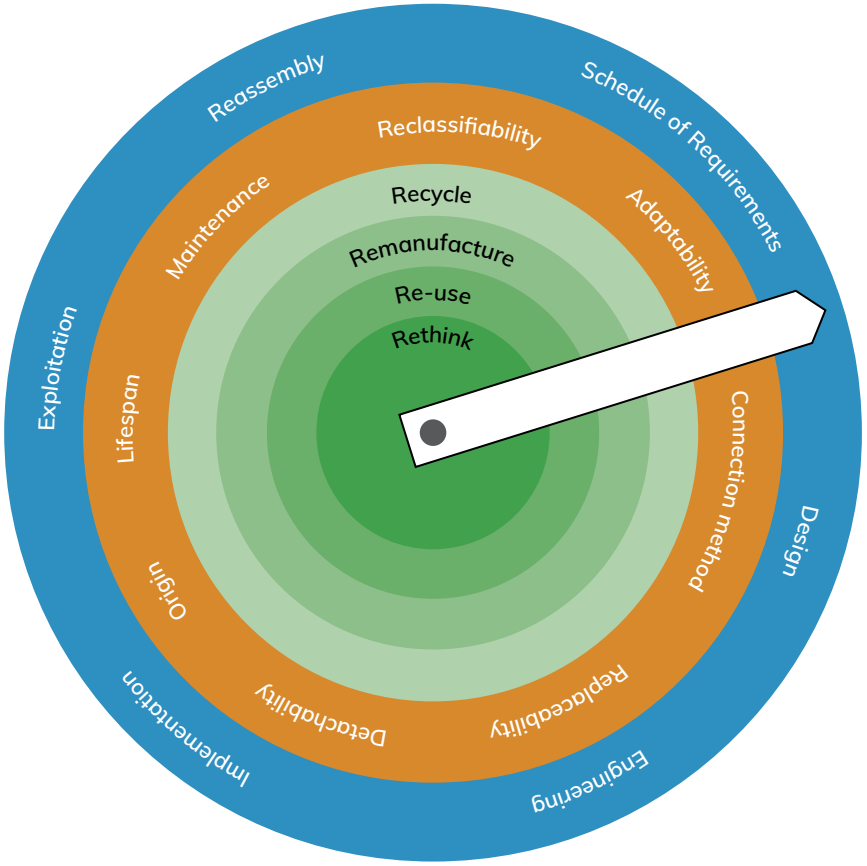
REUSE Can you use a used product for it?

REMANUFACTURE Can you use a refurbished product?

RECYCLE Can you use a product that consists of recycled materials?

Step 3 - Orange circle

Maximise the potential for circular use of materials in the future. On the basis of 8 parameters, you determine, among other things, whether the design or product is adaptable, reclassifiable or maintainable.



‘Palace for next to Nothing’ as a mind changer

In 2009, Anke van Hal, Professor of Sustainable Building and Development warned, that the ‘old economy’ is working towards its own demise by depleting natural resources. That had to and could be done differently. She introduced ‘The Merger of Interests’ strategy. Now, more than ten decades later, that vision is more topical than ever.

The message about the urgency of sustainable construction has not changed, but the vision has. Anke van Hal, Professor of Sustainable Building and Development at Nyenrode University: “I used to believe that the solution to implementing sustainability mainly lay in the combination of technical solutions and having sufficient financial scope. But for at least fifteen years now, my focus on technology and money has shifted to a focus on people. Sustainable construction is mainly about people. About representing people’s interests.”

Three factors

The task ahead is a considerable one. “In the period up to 2030, we need to make 1.5 million homes more sustainable. Whether they are tenants or private home-owners, it’s important not to see sustainability as a goal, but as a means.”

Van Hal: “Basically, you shouldn’t think that people want something because it’s sustainable. You have to meet their basic needs. It takes more than technology or money. In addition to these two factors, the third factor is human emotions and human behaviour. You have to

find out what people want and then meet them with your sustainable toolbox. People do want to become more sustainable, but they almost always find other things more important. The trick is to realise what people really think is important through sustainability interventions. This way, the knife cuts both ways."

Behaviour in practice

"You do need to be tuned into that. A good example where the win-win wasn't spotted: during a zero-on-the-meter renovation project in North Holland, residents were unexpectedly enthusiastic about a renovation of their homes after seeing a model home. The project team thought it was because they had taken residents' needs into account so well and decided to take it one step further. During the renovation, a new front was placed in front of the old one. This in turn created a wide windowsill that made it necessary for residents to shorten their curtains. Thanks to a technical intervention, this was no longer necessary. However, the residents weren't at all happy with this intervention, because it turned out to be the wide windowsills that had enthused them. In their eyes, these made their homes more pleasant. The energy savings were a bonus, but the wide windowsills had won them over."

Image

In Van Hal's view, sustainability should therefore not be seen as a goal in its own right, but as a means. A means to be able to live more pleasantly when it comes to home renovations. Parties therefore do not have to communicate directly to users that they are working on sustainability. Van Hal: "For example, Ikea wants to be fully circular by 2030. However, the extra quality, the fact that a product is circular, is not their unique selling point. The key to buyers is that they get a reliable product that is not too expensive and whether that's circular doesn't matter."

Driver

According to Van Hal, a TV programme such as 'Palace for Next to Nothing' is a driver for the circular economy. "Because it shows that products that used to be considered shabby can be incredibly beautiful. This really helps making people more aware. In this programme, the extravagant bon vivants Frank and Rogier transform people's houses into a dream home, on a minimal budget and with creative solutions. They have made the thrift store hip. You also saw similar trends in organic food. A health food store used to be a sad store with bruised apples. Now, they're trendy shops."

Fun factor

Van Hal believes designers and entrepreneurs who make sustainable products meet the needs of their customers as effectively as possible can make a big difference in the circular economy. "If you build a circular house, it must above all be an insanely good house. That was the beauty of the Cradle-to-Cradle philosophy. Upcycling, making products better than they were, that's what it's all about. My colleague André Nijhof often says we often move from consuming to consuming less from an environmental point of view but according to him ,it should be about improved consumption. And that's exactly it."

Above all, we mustn't forget to use the knowledge gained from the past and to always pursue these mergers of interests, Van Hal explains. "That requires a lot of cooperation. When sustainability becomes something people want, you've won half the battle. Of course it's still rather complicated, but that's the key if you want to make something successful."

Tips from the essay 'The Third Success Factor'

- Invest time to get to know potential cooperation partners.
- Start a dialogue with residents (what are their wishes, dreams and concerns?).
- Work on quick wins to gain trust and support. Because in the rush to achieve policy goals and achieve results, that crucial first step is quickly forgotten, resulting in resistance.

Read the essay 'The third success factor in making neighbourhoods natural gas-free' at aardgasvrijewijken.nl

Download the Merger of Interest 2.0 at Nyenrode.nl

Approaching circularity pragmatically

Development, design and construction go well together with circularity, according to cepezed in Delft. The office recently developed, designed and realised Bouwdeel D(emontabel), which is considered an example project for the circular economy (Read more about this project 👁). Menno Rubbens: "Putting something together isn't that hard, but try to do it in such a way that you can take it apart again."

Architects are increasingly embracing circular construction, but many architects do not have much influence on the construction process, Menno Rubbens, Director of cepezedprojects explains. "I recently drove through the Spoorzone area in Delft. Loads of houses are being built there with tunnel formwork. This production method comes from contracting and the concrete industry. Oh, it's super-efficient, you can't argue with that. But if you want to move towards circular construction, it's not the best way. I can tell you now that in ten or twenty years, you will have a problem with all those long narrow rooms. I always say: 'cast-in-place concrete is very flexible until it cures.' You won't be able to create an extra staircase or something later on."

Room to fail

In terms of flexibility, the construction sector can still learn something, Rubbens believes. "The mono-functionality in zoning plans doesn't help much. I can see some additional freedom, but I often have discussions with municipalities about whether something is an office space or a business space. It would be great if there was some more room for experimentation. It's easy to put the blame on the government, but I don't want to play that game. Construction is good at looking for the cause of problems other than itself. It's always someone else's fault. But I can see many opportunities for creative and innovative entrepreneurs."

Rubbens believes that right now, the construction industry is not equipped to structurally incorporate innovation and to develop new things that are allowed to fail. "Because if you create enough margin, you build up a financial buffer for research and innovation for when something is a little less successful. Right now, we're being building too much on existing techniques and processes."

Industrial construction

The current construction methods are therefore outdated, Rubbens explains. "Making a building on site with mud, sand, water and stones is medieval and not efficient. Those on site get back problems or someone falls from the scaffolding. We need a smarter, more efficient and cheaper approach and more quality. This results in industrial construction. At cepezed, we consider a building as a kit of parts. You manufacture the parts off site, they arrive just-in-time at the construction site, are assembled and you have your building."

The aim is not to work with adhesive or other permanent connections, but that is quite difficult in practice, Rubbens acknowledges. "The aim is to use products that can be disassembled later and retain their value for a prolonged period of time. Cross Laminated Timber (CLT) is a good example. These are glued pieces of wood, which ultimately results in a product with better properties than the separate pieces of wood from which it is composed."

Hybrid solutions

The discussion about how we should move towards circular construction is important. But that discussion shouldn't become too dogmatic, Rubbens says. "Not all buildings have to be made of wood or steel only. I believe in hybrid solutions and that you use steel because it's the most

Menno Rubbens: “Ultimately, you want to create buildings that are pleasant to use, with a pleasant indoor climate and proper daylighting.”

efficient solution at that time. To change construction across the board, you need to implement circularity step by step.”

Dismantling plan

And there are some real gains to be made there, Rubbens tells. “As a client, for example, you can make a dismantling plan mandatory. That’s a simple step and you can include it in tenders or even in (local) legislation tomorrow. The central question then becomes: ‘If a building has to be (partially) dismantled after say ten years or so, how are you going to organise that?’ In that case, after those ten years, it is useful to have a booklet available explaining how you can (partly) disassemble the building.” That way, you kill two birds with one stone. “You’re documenting your building better and you force developers and designers to think about this. A dismantling plan can also be organised quickly.”

Quick scan circularity

In addition, a quick scan for circularity in tenders is an effective tool, Rubbens believes. “If you are a government body and you tender a school, you can compare the participating parties and see how they have thought about dismantling, what percentage of your building is made of recycled material, what percentage of the material can be reused in another building and lastly, what percentage of the material can be recycled into another raw material. There are basic models for this, giving clients a clear picture of the participating parties. This method was applied very efficiently by the Government-Owned Property Agency when assessing the various submissions for the tender of the Temporary Court of Amsterdam in 2014 and can also be used for other projects.”

Flexible and adaptive

Ultimately, you want to create buildings that are pleasant to use, with a pleasant indoor climate and proper daylighting, Rubbens says. “It’s about making buildings robust to the extent they can last forever. The challenge is to make them so flexible and adaptive that they can be easily modified or disassembled and possibly relocated by future generations.”

Circular construction: more than a transition in technology

Circular construction is often about technology: circular design and circular materials. However, to accelerate and make circular construction 'the new normal', it is important to also look at the economic side of things. This concerns economic themes such as thinking in terms of total cost of ownership, assigning residual value to products, the challenges associated with high costs of labour and multiple value creation. Circular construction creates a new set of (long-term) values that make the concept even more interesting.

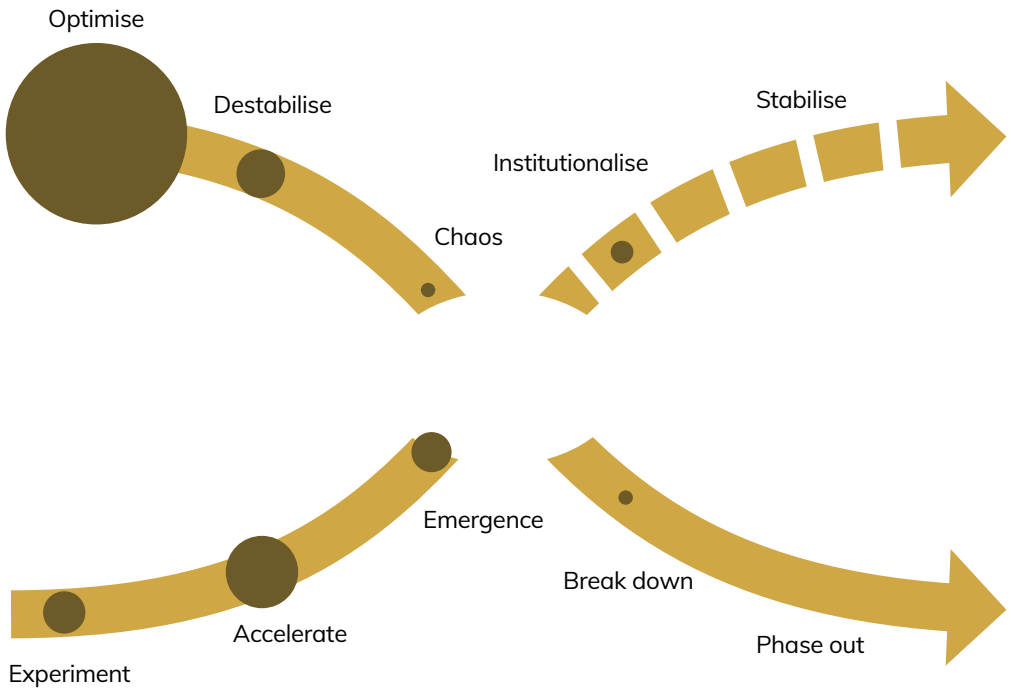


Figure 8 Transition curve Circular economy (Loorbach and Maas, 2017)

The transition curve

The transition to a circular construction economy means we are abandoning the current, linear way of working. It is a process in which building up the new and breaking down the old system go hand in hand, as outlined in the Transition Curve of Loorbach and Maas (Figure 8). In the transition phase, the business case of circular construction must become more attractive than that of linear construction. This means we must not only look at the technical side, but also at the economic side and the economic rules that determine the business case.

The value of circular construction

Compared to the current linear way of building, it may seem that circular construction sometimes turns out to be more expensive. It may require an extra investment in healthier materials that can be reused in the future. Or extra investments in labour to reuse

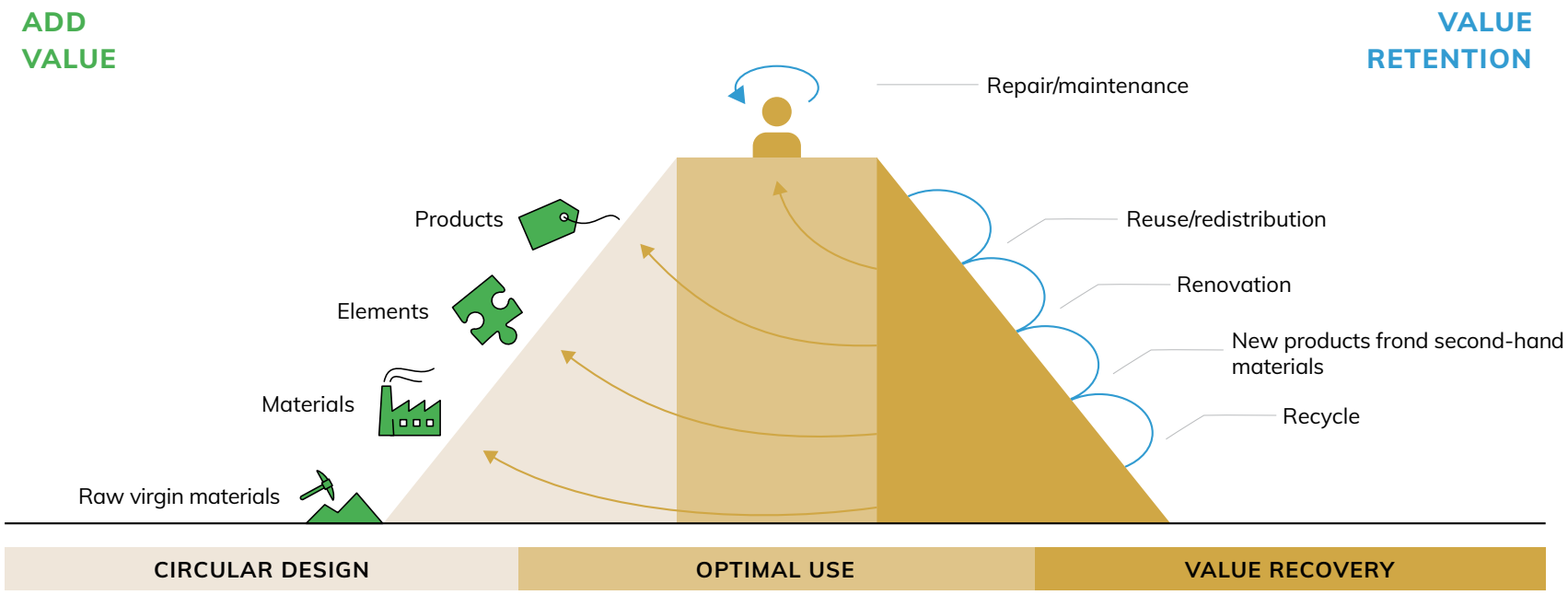


Figure 9 Value Hill (Circle Economy, 2016)

(building) materials from other buildings. However, the business case turns out very differently when taking into account other values.

For example, reduced maintenance and replacement costs during use, or the residual value of the materials at the end of the first use cycle. In addition, other (non-financial) 'values' arise, such as less pollution, lower CO_2 emissions and a healthier living environment (more about this later in this chapter).

Value retention is the key in a circular economy. But to maintain value, value must first be created. The Value Hill offers a clear overview of the different circular strategies in relation to value:

Circular design
A circular design is important for value creation. When using virgin materials, the idea is that they retain their value as much as possible. This can be done by designing the 'products' in such a way that the value of the 'product' and the components is retained as much as possible during the use phase. For example, you can design a building with a flexible layout, but you could also install the inner walls in a building with 'dry' connections. If virgin materials are used, they should be 100% recyclable. All this with the aim of preserving value and preventing waste.

Optimal use
Next, the challenge is to stimulate 'maximum use' by extending the lifespan of buildings and building elements. At a building level, this means actively looking at the possibility of renovation instead of new construction. At the level of building elements, this means the building element must be used with maximum effect, perhaps in another building but with the same purpose. Circular revenue models can be used to promote this (read more 👁).

Value recovery
Lastly, the challenge is to retain value as much as possible. This can be achieved by looking at the possibilities of reuse at building level, building element level, component level, and lastly, at material level. The idea behind value retention is that buildings, building elements, components and materials represent

an economic (residual) value after their first use phase.

Although the Value Hill provides a clear framework for value retention in the circular economy, there are still quite a few challenges in the construction sector. For example, the costs of labour in the Netherlands are relatively high, which means that labour-intensive reuse options often find it difficult to compete with factory-produced new products. And so far, there is no unambiguous method for determining the (residual) value of used building materials.

Circular business and revenue models

New business and revenue models are needed to realise a circular construction economy in which buildings, components and materials are reused to a high standard. In discussions about the circular economy, often no clear distinction is made between circular business models and circular revenue models. A business model is the way in which an organisation creates (broad) value and a revenue model is the way in which an organisation earns its money. When we project this onto the Business Model Canvas (Osterwalder et al., 2005), the business model is the entire canvas and the revenue model is the Revenue Streams block (Figure 10). Whereas a linear business model is based on single use of raw materials (take-make-use-dispose), a circular business model ensures economic value creation by continuing to (re) use products and materials over time. A circular revenue model (e.g. lease, pay-per-use) is then the way in which an organisation creates income as a result of this lifespan extension, or through high-quality (re)deployment of buildings, parts and materials.

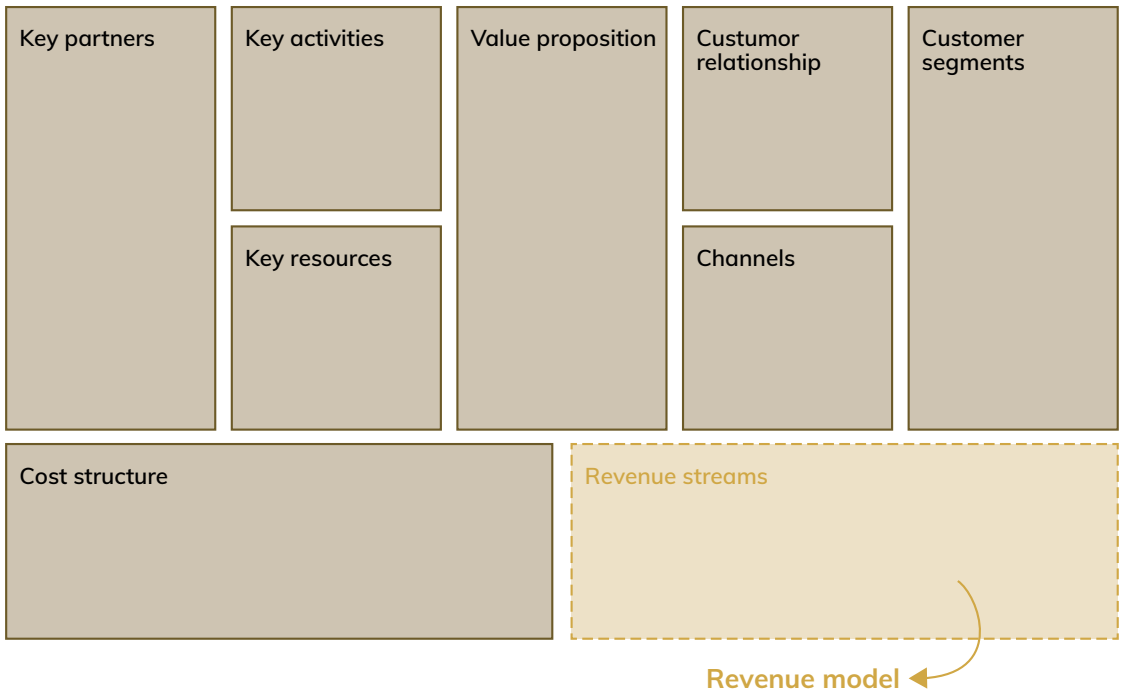


Figure 10 Business versus revenue models (Osterwalder et al, 2005)

However, a circular revenue model is only scalable if there is a financial win-win for both the suppliers and the user or owner of a building. For this, it is necessary to give the manufacturer, supplier or developer a (financial) incentive to retain their responsibility after delivery of the part or building product.

When a supplier in the construction industry opts to design its entire business operations in accordance with the principles of a circular economy, it is referred to as a 'Circular Business Model'. When the same supplier also markets the circularly produced building components with a revenue model that guarantees their circularity, it is referred to as a 'Circular Revenue Model'. Circular business models and circular revenue models are therefore applied synergetically. Only then will there be a contribution to a circular economy.

Circular revenue models

In the past few years, the construction industry has been experimenting more an more

with applying circular revenue models. Some examples are:

- Signify, Trilux and LEDLease all sell 'light' as a service, instead of bulbs;
- Mitsubishi rents out lifts with a residual value, as part of which the customer also pays for the number of vertical movements (pay per use);
- Alkondor has an experiment in which a building front is leased;
- cepezedprojects has developed the Temporary Court of Amsterdam as a building product and does not write it off in the first use cycle with the idea that the building (or its components) can be given a second life elsewhere.

The idea behind all these revenue models is that the manufacturer, supplier or project developer bears extended responsibility for its products or buildings. This way, the revenue model creates a financial interest, in theory, for the manufacturer, supplier or project developer to deliver a high-quality product that represents long-term value at building level, product level, component level or material level. For example, the producer, supplier or project developer can generate income from a product in the long term by marketing it in a lease model; or may opt to enter into a buy-back agreement, which makes it possible to resell the product or parts thereof in a new cycle of use.

A distinction can be made between revenue models in which ownership of the product rests with the owner/user of the building (e.g. extended warranty, maintenance contract, buy-back scheme), and revenue models in which ownership of the product rests with a third party (e.g. lease, rental, performance contract). That third party can be either a supplier, a developer or a lender.

Research shows that in this phase of the transition, circular revenue models are best applied to the services and space plan building layers, partly because of their relatively short functional lifespan. As regards the services building layer, additional opportunities exist for extending producer responsibility and involvement thanks to the incentive to reduce operational costs (e.g. applying more energy-efficient lighting leads to a lower energy bill).

In the financial field, an essential question arises when applying all these revenue mod-

Standard deed makes financing solar panels easier

There are various hiccups in the case of large solar panels on commercial roofs. What does the standard deed regulate? Maarten Jan Noordzij, co-founder/owner of ZonXP explains: “For the financing of the solar power system, the lender sets the condition that a right of mortgage is established. Often, a mortgage has already been established on the building itself and sometimes, a mortgage involves several underlying banks. However, the lender of the solar panels wants to be sure that the system is and remains his collateral. The standard deed regulates that. This deed states that a so-called ‘change in priority rank’ takes place. From a legal point of view, the right of superficies to the solar panels established later in practice takes precedence. Therefore, if the building has to be sold, the solar power system remains out of the equation. Before that standard deed was available, such a change of priority had to be arranged with all parties separately. That could take months. Although we had come a long way in that entire process, we’re now eager use the deed. It’s easy to refer to in negotiations with banks and building owners. The fact that we use this model deed of the Dutch Banking Association also sits well with foreign parties.”

Read more about the standard deed for solar panels

els, namely who has an interest in the circular aspect thereof. For example, a circular revenue model can lead to a reduction in maintenance costs, which is interesting for a building owner. This is especially relevant when investment and operating budgets are linked. Unfortunately, in the current economic reality, circular revenue models cannot always compete with the traditional ‘purchase’ model. This is partly due to the fact that the opportunities of circular products (e.g. residual value) are still not taken into account enough in financing proposals and that the risks of circular revenue models (e.g. increase in balance sheet total, contract financing) are still weighted too much. Furthermore, clients still apply short investment horizon, which impedes thinking in terms of total cost of ownership.

In addition to the financial aspect, there are other challenges in applying circular revenue models. In the legal domain, verification is a common barrier, especially in revenue models where the ownership of the product rests with a third party. From a legal point of view, verification comes into play when ‘a smaller, in itself independent matter, becomes part of a larger matter’ and is firmly and permanently connected to that larger matter. For example,

a front can become part of the building. This makes it more difficult to assign the front its own value. Ways to circumvent this are currently still complex: it requires setting up a separate land registry entity or applying the right of superficies. In many of the aforesaid revenue models, such an arrangement is es-

pecially interesting for a supplier when looking beyond one lifespan. A long-term vision is essential in this regard.

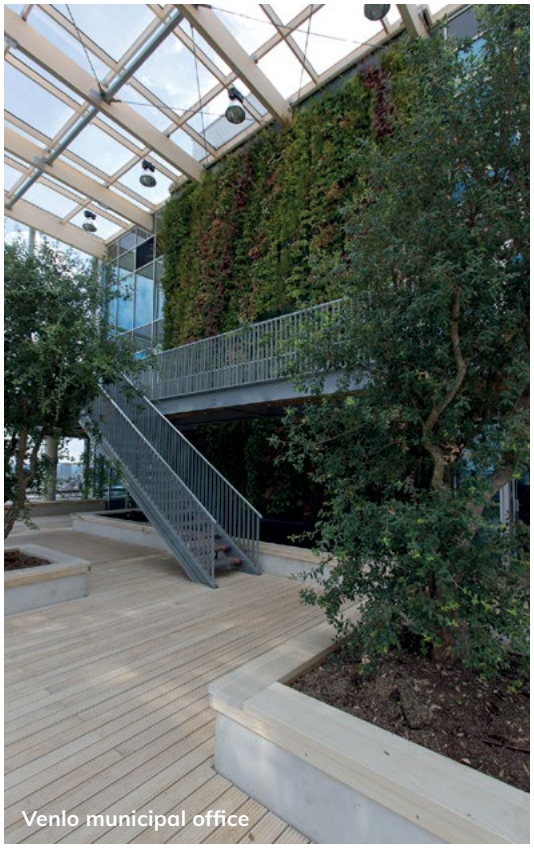
Multiple value creation

The circular economy is not only about financial value, but also about other forms of value and value retention. By mining as few new raw materials as possible, the environmental impact is reduced. Extending the lifespan of buildings, building elements, components and materials results in reduced production and associated emissions (including NOx, CO_2). Avoiding toxic substances such as VOCs as much as possible creates a healthier living environment.
In addition to minimising the negative impact, there is also the possibility to work towards positive impact; for example, the development of green roofs, which attract local biodiversity.

All this comes under the denominator of 'multiple value creation', in which things that are traditionally not valued are nevertheless included. They can even be valued financially, for example, by providing insight into the environmental costs and benefits, and perhaps even including these in the price. This can lead to secondary and non-polluting material use (e.g. reuse) gaining a financial advantage over virgin or polluting material use. However, this requires a level playing field in which environmental costs can be passed on and in which the consumer pays for the 'actual price' of a product.

The value of circular property

Ideally, a circular office building or home would represent more value than a non-circular office building or home. In terms of energy, homes with better energy labels are often assigned a higher value right now; as yet, the rental streams determine the assessed value for offices. Unfortunately, right now, there are no circular standards that affect the formal (assessed) value of property. However, a first step has been taken recently to assign a (residual) value to materials using the so-called Wearthy method.


Venlo municipal office

Where to start?

The ideal image of the circular economy is that it is economically more attractive to build circularly. Only then will the transition really accelerate. Despite the challenges in the current phase of the transition, such as the high costs of labour and the lack of a CO_2 price, completing the business case of circular construction is certainly possible.

For example, it is attractive to reuse existing building materials, certainly when the dismantling of the 'donor building' and the construction of the new building are optimally aligned, both in terms of time and location (limiting logistics costs). Another trend is that parties are increasingly thinking in the long term and are investing in circular buildings that will retain their value in the future. Another good example of actively searching for 'multiple value creation' is the Venlo municipal office (see also p. 64), in which the improved internal air quality has led to a lower sickness absence rate of 0.9% per year. The green lungs of this building also ensure better air quality outside the building.

Collaboration with chain partners, lenders and local authorities is often an important means of bridging the challenges of the circular business case. What would be the impact of regulations and tax incentives? For example, lowering the cost of labour, a carbon tax and removing double VAT on secondary building materials?

Cross-linking streams for an optimally performing system

When Lidl came across professor Andy van den Dobbelsteen, the latter was initially hesitant. Delft University of Technology has now developed a circularity roadmap for Lidl, joint graduation projects have been completed and Lidl Zero has been launched, the most sustainable supermarket in the Netherlands. The collaboration will even be continued.

Lidl Nederland had gained experience with energy-efficient distribution centres and approached Delft University of Technology to see whether an energy-supplying supermarket and fully circular business operations were within the realms of possibility. Andy van den Dobbelsteen, professor of climate design & sustainability at Delft University of Technology: “When Lidl came my way, I was critical. But they turned out to be genuinely interested and they wanted to be circular objectively. They strive for innovation and further development and that makes things interesting for us.”

High quality requirements

Lidl has 420 stores and 19,000 employees in the Netherlands. The company wants to be a sustainable and future-oriented business. Their range is built around private brands, which are subject to high quality standards during production. This vision manifests itself, among other things, in the purchase of climate-neutral eggs from Kipster. On this sustainable, climate-neutral farm near Venray, the chickens forage in a well-lit shed, there are trees and fresh air, because any particulate matter is captured. The chickens are fed feed made from residual streams, exclusive of any ingredients that are also suitable for human consumption. The second Kipster stable for Lidl in the Netherlands is now under construction.

Mass for the supermarket

Van den Dobbelsteen: “Luuk Graamans, who had recently graduated with me, mapped out how the processes at Lidl work and where CO2 emissions are created. As part of the approach, the major processes throughout Lidl Netherlands were examined, including the regional distribution centres, local supermarkets, property and transport. Ultimately, we zoomed in on buildings and how they will become circular in the future.”

During the construction of Lidl Zero in Woerden (read more about this project ), piles were used that can store both heat and cold. “A supermarket doesn’t have that much mass, so you can use the subsurface for climate stability, which then acts as a heat and cold buffer. And that is more efficient storage than batteries or water tanks.”

The cooling has also been well thought out. “The refrigerators don’t have separate equipment, but it is a continuous system controlled centrally. Furthermore, an apparently simple measure such as double glazing has been applied in the refrigerator doors. That makes a big difference in your energy consumption.”

Lidl has been using LED lighting in all its supermarkets for years. The 1,766 solar panels on the roof and on the large carport in the car park generate sufficient energy to supply electricity, cool the products and heat the office and retail spaces. And then there is still electricity left to charge electric cars.

Roadmap

Van den Dobbelsteen is proud of the result and his students. “My role was quite limited, I mainly fulfilled an inspiring and guiding role. With

the roadmap, we looked at what the low-hanging fruit is to make Lidl carbon neutral fairly quickly, and from there how they can become energy neutral. You can still use fossil fuels, but that must be compensated with sustainable energy. You then go to fossil-free by switching off gas and running your transport on electricity, hydrogen or biofuels. Finally, the step towards circularity. This means that energy flows, water flows and material flows and the products sold form a circular system."

The energy-producing supermarket in Woerden is a fact. But the real challenge, according to Van den Dobbelsteen, lies in the inner-city areas. "Nick ten Caat, a graduate of mine, has examined an Amsterdam supermarket that is locked in by apartment buildings. Solar energy is hardly available and the cooling demand of a supermarket is high, which also leads to the emission of residual heat. Nick has come up with a system for this in which the apartments share an energy system with Lidl. The residual heat from the supermarket feeds the surrounding homes. The roofs of the apartments will be reserved for solar panels and greenhouses that produce food. Such a project is the next step that we will be working on with Lidl."

Heat recovery

The government can still take some steps, concludes Van den Dobbelsteen. "We pay for wastewater and we pay for the waste material we present to municipalities. But we don't pay for waste heat. Considering climate change and the Urban Heat Island effect, I think the discharge of waste heat should also be taxed. That means you have to try to recover all the heat. For a supermarket such as Lidl, it means the supermarkets become part of mini-networks in order to be able to use their residual heat effectively."

Another measure in which the government could take a step is the flow of materials. "In the Netherlands, we mainly still think in terms of materials when it comes to circularity. A take-back and reprocessing obligation by suppliers would be a positive development. They would have to reuse or recycle their own products. Fortunately, you can see that happening more and more now."

Andy van den Dobbelsteen: "We pay for wastewater and we pay for the waste material we present to municipalities. But we don't pay for waste heat. The discharge of waste heat should also be taxed."

On to 2050

The Netherlands circular by 2050 is one of the government's spearheads. The aim is to reduce the depletion of raw materials by making existing production processes more efficient. Maximum reuse is an important pillar in this, but also, for example, the use of bio-based materials: raw materials from plants, trees and food residues. These can be extracted without permanent damage to the environment. The challenge is to develop new production methods and to design new products as circularly as possible.

Government-wide ambition

The nationwide programme 'The Netherlands Circular by 2050' outlines how we can achieve this goal. In the Raw Materials Agreement concluded in 2017, a large number of government and industry parties support this ambition. This means there is broad support for actually realising the circular economy.

Governments too make an important contribution to achieving the objectives. From 2023, all tenders from the government, at a national, provincial and municipal level will be circular, unless this is not (fully) possible. From 2030, all public procurement will be circular. Since 2018, new buildings must be delivered energy neutral. Recycled or reusable materials and raw materials are used as much as possible in new constructions and redevelopments.

Circular Construction Economy Transition Agenda

The construction and infrastructure sector is one of five sectors that currently consume a lot of raw materials and that has the potential to make the transition to the circular economy. Our buildings and infrastructure, in other words our roads, bridges, dikes, railways and sewers still consist of large quantities of, often heavy, materials such as stone, concrete and steel. The extraction, processing and transport thereof place a heavy burden on the earth. The switch to a circular construction economy is inevitable. This task is complex, but also offers opportunities. Construction can take big steps and achieve visible results quickly.

The Circular Construction Economy Transition Agenda describes the strategy to achieve a circular construction economy by 2050. This agenda was drawn up by the Transition Team, which includes experts from science, government and market parties. The Transition Team visualises the process as a mountain climb. We want to get to the top, but we don't know the exact route yet. First of all, we have to make an inventory of what we need to get going and make sure our base camp is set up. The ambition is that the base camp will be in order by 2023. By then, all instruments, tools and conditions must be ready to reach the next stages on the way to the top: a fully circular construction economy by 2050.

Circular Construction Economy visualises the strategy towards a fully circular construction economy as a mountain climb with a fully equipped base camp in 2023.

Circular Construction Economy Transition Agenda

For the period 2018 to 2023, the Transition Agenda contains 4 spearheads and ten action points:

Spearhead 1: market development

- Action point 1: first series of innovative products and services for circular construction
- Action point 2: a concrete demand for circular products and services, for example in public procurement
- Action point 3: accurate knowledge and an action plan to halve CO_2 emissions in construction by 2030 and to eliminate them completely by 2050
- Action point 4: a plan to make the existing housing stock plus one million extra homes as circular as possible in ten years
- Action point 5: sufficient incentives for R&D, experiments, prototypes and concrete projects

Spearhead 2: measuring

- Action point 6: common language and tools to interpret and measure circularity in projects

Spearhead 3: policy, legislation and regulations

- Action point 7: no inhibiting, but stimulating legislation and regulations
- Action point 8: international positioning and collaboration

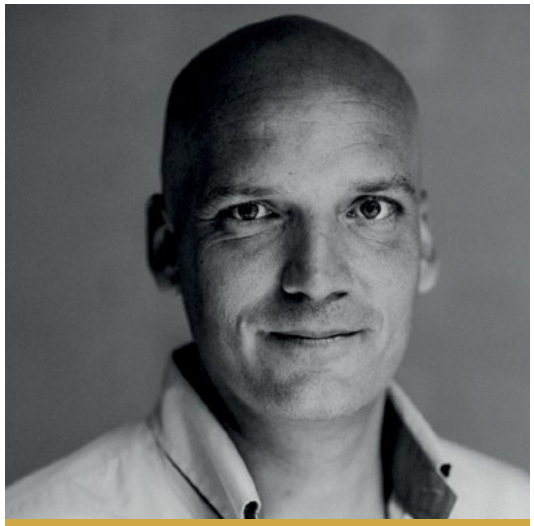
Spearhead 4: knowledge & awareness

- Action point 9: knowledge, experience and tools with enough people and the right people in the total construction chain
- Action point 10: understanding, support, recognisable benefits, awareness

CB'23 and BTIC

To achieve the goals of the Transition Agenda, parties on the supply and demand side must enter into agreements about the rules of the circular construction economy. That is why Platform CB'23 was established. This platform connects all links in the circular construction chain, both within the civil and hydraulic engineering sector and in residential and non-residential construction: from manufacturers to demolition contractors, from clients to implementing parties and from large contractors and SMEs to start-ups. The platform contributes to the transition to a circular construction sector by building and sharing knowledge and by identifying obstacles and putting these on the agenda. The aim is to draw up national, construction sector-wide agreements on circular construction before 2023.

Another important organisation is the Building and Technology Innovation Centre (BTIC). This bundles innovation request from the government, innovation needs from the market and research projects from knowledge institutions in public-private, long-term knowledge and innovation programmes. A more efficient, bundled innovation process means that innovations to solve major social challenges can be realised quicker and on a large scale. The relevant ministries, sector organisations in construction and technology and knowledge institutions (technical universities, Netherlands Organisation for Applied Scientific Research (TNO) and universities of applied sciences) are united in the BTIC. Circular construction is one of the major focal points of the BTIC.



Daan Bruggink
ORGA Architect

"Soon, it will be much more about materials and health. Circularity is the overarching part that concerns cycles. We should not focus solely on circularity. In the current practice, everyone focuses only on energy. It's much broader than that. It's about materials, people and health. In the coming years, due to the scarcity, the emphasis will increasingly be on materials, and the impact, as in what materials do to people's health, will also receive more and more attention."

Thomas Bögl
LIAG architecten

"Towards 2050, I can see a role for small agencies that operate at the interface of architecture, robotics and AI. They'll be developing innovative production methods for the construction sector. Examples include robots that do not create traditional brickwork, but that stack. In other words, ways to attach parts to each other so you can separate them again in, say, thirty years' time. Because circular construction is also about dismantling."

Robert Koolen
Heijmans

"Thinking about circularity will have crystallised by then. We'll be making truly circular products. By then, the markets will be more mature and we'll be able to close the circles. We'll have made a shift in design. You don't design based on what you can come up with, but on the basis of which materials are released and which materials are available."

EXPERTS ON THE ROUTE TO 2050

Menno Rubbens
cepezed

“I share the optimism that construction will be completely circular by 2050. Although we still need to make progress. It’s not rocket science, you know. I mean, implementing circularity is not a technical issue, it has become a cultural issue. It’s new, it’s different, people don’t really know how they’re going to earn back their money and through what. So the obvious thing is to keep doing what you did before.
To make a difference, the key lies with the investor, among others. The investor has a long-term interest with an important task to finance projects. The return will be somewhat lower return in the short term, but higher in the long term because they’re circular.”

Mieke Oostra
University of applied sciences of Utrecht

“The last thing you should do is be put off by the change in system that circular construction entails. We’ve delayed things long enough. What’s important now is that we accept the challenge together. By ‘together’, I don’t just mean fellow companies, but all parties within the chain. It’s often said that clients should take the first step by including circularity in their tenders. But based on traditional specifications, contractors too can sound the alarm and make it clear to the client that things can be done differently and better, more circular. The main thing is that all chain partners, lenders and governments work on the same mindset in the field of circularity.”

Andy van den Dobbelsteen
Delft University of Technology

“My work revolves entirely around the year 2050. By then, we will hopefully have a completely carbon-neutral living environment, in which all products and materials are used to the maximum and the living environment is much cleaner. If you look at construction, it’s much more about prefabricating and reprocessing products that were supplied once and that have been taken back. This makes the industry much cleaner. The sector will soon be more intelligent and also be much more computer-controlled. All this is technically driven but above all, I hope we’ll have a pleasant, healthy, nature-inclusive living environment. Living in the sustainable city of 2050 will be much better.”

From idealism to realism

Not talking too much, but simply doing it and also showing how you can make a difference, is the motto Hilbrand Katsma, Regional Director of Van Wijnen Noord en Oost, lives by. Keywords are: affordability, energy neutral or energy supplying, circularity and scalability.

"In 2011, Van Wijnen realised the conventional approach in construction was no longer sufficient, Katsma explains. "We're committed to a major transition in the run-up to our goal of 100% future-proof by 2025."

The developing builder from Gorredijk saw future staff shortages looming. "We had to switch from fossil to renewable energy and there were also plenty of demonstrable factors that pointed to a lack of building materials." Things had to change, Katsma thought. He realised innovation starts with awareness and urgency and that was the departure point for getting started.

Widely supported vision

Katsma: "At the time, we opted for a BIM and a Lean implementation to optimise our processes. Based on our vision that the customer should always come first, we started to enrich our models and develop home products. Around 2015, we mapped out all raw materials. This makes achieving your circular goals more transparent. We linked this to Key Performance Indicators to be able to objectively measure the company's performance. After that, we started connecting all domains to arrive at a broadly supported vision of a circular economy."

Katsma: "I believe in tackling the source. By fighting symptoms, you can gain some percentages, but real gains are made by implementing a system change at component level, at resource level and at process level. It's about courage and nerve and it's okay if things go wrong sometimes."

Small groups for maximum results

The initial idea was therefore to make a baseline measurement to see where the company was at with its home products. "That proved quite difficult. An off-the-shelf certified benchmark was not available. We discovered the Building Circularity Index through Alba Concepts. After the first measurement, it turned out that we arrived at 18% circularity for customised projects. Over the past four years, we have kept measuring our product development and are now exceeding 70% circularity. We keep improving continuously."

You can have the desire to be circular as an organisation, but your employees and co-makers all have to sing from the same hymn sheet, Katsma explains. "We've learned that you need to provide some evidence and then use that evidence to get a group moving. We like to keep the processes small. In product development, we work with groups of a maximum of three. The process must be small and fast in which the outcome fuels a greater purpose."

BIM insights

The suppliers too must also be willing to think along, Katsma says. "But that isn't always easy. In 2012, we started doing everything in BIM and invested heavily in that. This in the hope and expectation that other parties would see the benefits of this as well. But we now notice that the parties are going back to 2D. They find it difficult and some feel they are doing it for us. But that's of course not the point. By using BIM, you gain much more insight into the complexity of a building and you can add requirements from imminent legislation regarding material passports and private quality assurance. Unfortunately, the other parties don't always see the usefulness and necessity of it."

Foto: Martijn Heemstra

Hilbrand Katsma: ‘We like to keep the processes small. In product development, we work with groups of a maximum of three.’

Loskade

Loskade is a project on the former sugar factory site in Groningen. It is a breeding ground for circularity. Until 2030, this pop-up residential area serves as a living lab for revolutionary solutions. Van Wijnen uses the site to look for innovative solutions for external wall and roof finishings, installation solutions and energy generation and storage.
There are 46 houses in which people live. Loskade is detachable, movable, demountable and benefits from a smart grid. A new type of coating has been applied to the wooden walls, developed using biomimicry. The attractive part of this biocoating is its self-repairing capacity. In the event of damage, the living biocoating will regrow in the exposed areas.plekken.

Fine Living

The year 2025 is the dot on the horizon for Van Wijnen. “As far as we’re concerned, from that moment on, there’ll be no more waste from our processes and products. On balance, we don’t want to have a CO2 footprint anymore by 2030. That’s a major ambition, but whichever way you look at it, you have to move from idealism to realism.”
This resulted, among other things, in the industrialised, circular housing product Fine Living. “We build the modules in-house. By building in a conditioned environment, you have more control over your process. It’s a demountable concept. The parts are geared to each other. No cement, sealant or PUR is used.”

Fine Living is regarded as the top segment of home products. “We regard the Fine Living products as a forerunner of the rest. We’re trying things out, test things, create prototypes and make things to scale. We apply the technology and the processes and the products we use in these in tailor-made projects.”
Version 1.0 of Fine Living was launched in 2016. Now, four years on and many lessons later, Fine Living 3.0, the circular version, has been launched. The venue was De Loskade in Groningen (see box). Katsma: “It’s a very appealing, scalable solution that’s affordable. Affordability, circularity and scalability are central to all this with safety as the number 1 priority.” In addition, we’ve got an infinite number of architectural options to design our projects in a unique way.

Advantages of industrialisation

The advantages of prefabricating a house in the factory are clear, Katsma explains. “We want to use this to meet the enormous need for housing and you exclude more and more risks by doing this. For one house, we went from 115 working days to seventy, then to sixty and now to fifteen. The process is much more about logistics. In one day, we built a complete house and two apartments with six people. The remaining fourteen days are spent on finishing.”

We no longer think in terms of delivery, but in terms of completion. “We find it unacceptable that we deliver a building with imperfections, three is the maximum. In residential construction, it now regularly happens that there are no points on the snag list at all.”

Case studies

Completely demountable administrative courts

Via a Design, Build, Maintain & Remove (DBMR) assignment, the Dutch Government Property Management Agency realised the Temporary Court in Amsterdam.

The new building on the site of the existing Parnas complex at Parnassusweg forms the Temporary Court. This allowed a large part of the judicial system to continue during the five years in which a new permanent accommodation was developed on the same plot. The interim character of the building doesn't take anything away from its representativeness and quality when it comes to matters such as equipment, complex logistics, acoustics, comfort and safety. The client has focused on preventing waste and maximising the residual value after this initial period of use. The building designed by cepezed is therefore easily adaptable and offers possibilities for varying purposes and users.

At the end of its life, this building can be completely dismantled and reassembled and used elsewhere. The contractor, a combination of cepezedprojects and Du Prie, remains the owner of the building and responsible for relocating the building.

This will in fact happen in 2021! Dismantling and rebuilding early 2022.

Read more about this project

Air-purifying indoor gardens

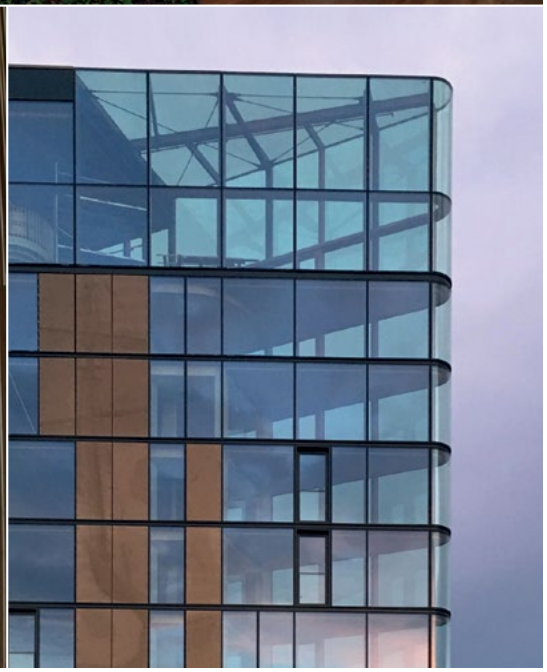
The Municipality of Amsterdam wanted a building with an extraordinary appearance at the head of Java island on the river IJ. And they succeeded in that through Hotel Jakarta, a 30-metre high building with wood as the main building material.

By presenting Hotel Jakarta, WestCord Hotels and SeARCH architecture and urban planning won out of five alternative proposals. The luxurious four-star hotel, with nine layers of innovative timber high-rise buildings and energy neutrality, earned a BREEAM excellent certificate. And thanks to a green certificate from RVO.nl, the hotel was eligible for green financing and thus the hotel chain pays less interest on their loan.

Thanks to the use of wood and prefabrication, 176 prefab hotel rooms, equipped with a balcony, bathroom and technical systems were realised in less than three weeks. Each hotel room is a separate module of CLT cross-laminated wood, finished with a concrete floor on top of the wood. The stacked wooden modules form the load-bearing structure.

In the building, inner gardens act as a thermal buffer. In collaboration with Hortus Botanicus, architect Bjarne Mastenbroek created a subtropical indoor climate that
is comfortable for both plants and humans.

Read more about this project



Circular (de)mountable office building

On the site of the former Technology Museum at Ezelsveldlaan in Delft, a non-monumental building made way for a circular office building developed, designed and realised by the architectural firm cepezed, specifically for companies in the creative industry.

The building on the same site where cepezed itself has its offices, should become an exemplary project of the circular (construction) economy in Delft. The office building is constructed entirely from a prefabricated steel structure and also prefabricated laminated wooden floors of Laminated Veneer Lumber (LVL) elements. The easy-to-remove floor screed on this is made of mineral grains and plaster fibreboards. The front is largely transparent, with vertical strips of slats that can be opened for natural ventilation. The new building consists of four floors of approximately 200m², each which can be let separately.

Construction started in May 2019 and was completed in the same year. This was made possible thanks to some well-considered preparation and close, integral collaboration between all disciplines, from the project development branch to the architecture and interior designers and the construction team for the realisation.

Read more about this project

Discovering new uses

The Upcycle Centre in Almere is much more than a roofed civic amenity site; it is a conversion point. A circulation point where people from practical training and social work initiatives give objects and materials new possibilities for use.

Since the Upcycle Centre must be a beacon for the transition to a circular economy, the design principle was to build as circularly as possible. The foundation is made of construction rubble. Old banisters and benches from a demolished swimming pool and a sports hall have been incorporated into the front of the recycling centre. The beams and steel roof construction come from a demolished printing firm. Rainwater is used for the toilets and cleaning. Heat pumps and solar panels make the building 100% energy neutral.

Because it was also a requirement to make the building as flexible as possible, all parts were screw-mounted. The recycling platform can be disassembled and benefits from a flexible construction from modular Modulo Milieustraten concrete elements of 70% eco-granulate. This way, it will always be adaptable and movable in the future.

Read more about this project

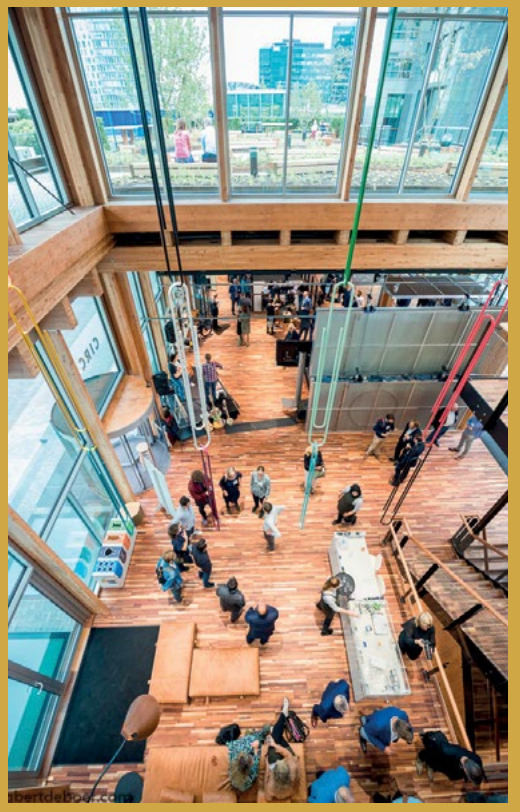
Easy to change designated use

Through Circl, client ABN AMRO makes a circular statement. It is a meeting centre with a public roof terrace and catering facilities at Amsterdam Zuidas.

At the start of 2015, the project architect had not even heard of the term circular. “But we were soon convinced that we had to take this route. A change in the building must be possible without having to demolish half of it,” Hans Hammink explains, senior project architect at Architekten Cie. Assembled components have been used that do not require any sealant. The reuse of materials also plays an important role. This living lab aims to continuously and easily adapt to changes during its lifespan. And so today, you can have lunch, meetings and attend lectures in the pavilion in an environment in which recycled window frames have been used. The sound is insulated with the help of used jeans and the banisters, cable ducts and fire hose reels have had a previous life as well.

Read more about this project

Photos: CIRCL



A lesson in circular construction

Foto's: Egbert de Boer

Biosintrum, the circular knowledge centre in Oosterwoldet is based on the bio-based economy that does not use fossil fuels as a raw material, but biomass.

Biosintrum, with a GFA of 1,000 m², includes offices, classrooms, a restaurant and a theatre. The energy-neutral building uses 80% recyclable bio-based materials, including a laminated wood structure made from larch trees from the Drenthe forests, grass slabs for the ceilings, HSB frontages, Accoya wall frames and a floor in which elephant grass has been processed. Toilets are flushed with rainwater. A de-centralised treatment plant of Afmitech Friesland from Joure purifies the wastewater.

The municipality engaged local entrepreneurs in the realisation of the building. Installation contractors Bakker took on the complete mechanical and electrical engineering concept. Finding economical, circular and sustainable systems took some extra effort. Recyclable plastic and steel pipes and a water-carrying VRF system allowing to regulate the temperature per room contribute to the building's outstanding BREEAM score.

Read more about this project

The most sustainable teaching building

With a BREEAM score of 96.01, Atlas, the main building of Eindhoven University of Technology (TU/e), ranks top of the list of the most sustainable educational buildings in the world.

The building dates from 1963, has sixteen floors and boasts a floor surface area of 44,000m². The renovation has reduced the building's CO_2 emissions by about 80%, while the number of users has more than doubled. This has been achieved, among other things, by the highly insulating glass wall and the absence of a gas connection. Heat and cooling comes from the university's campus-wide heat and cold storage system.
Part of the cooling comes from the outside air, through windows that open automatically. When needed, Atlas' floor-to-ceiling windows slide out at night to cool the building and purify the air. The 4,400 connected Philips TrueLine LED light fittings have built-in IoT sensors. Half of the light fittings register daylight and movement and can dim light intensity. The data can be used to improve workplace occupancy levels in the building and to optimise cleaning planning.

The building is also a Living Lab of the Intelligent Lighting Institute of the Eindhoven University of Technology (TU/e). With the lighting system, 4,000 users can regulate the light intensity themselves. This may prevent the winter blues, the ILI researchers think.

Read more about the light system

Student units at breakneck speed

No fewer than 232 students are moving into the Keramus residential complex at the Vaartsche Rijn canal in Utrecht. The project was built in ten months with modular units by Jan Snel. Sometimes at a rate of no fewer than 16 homes per day.

Jillis Kinkel, architect, was closely involved throughout the entire process. From the first initiative, the design (including the interior) up to and including delivery. The building contains 232 independent student homes and 900m² of creative activity on the ground floor, communal roof terraces, an indoor communal bicycle shed and a parking basement.

The module consists of a steel cage construction with a concrete floor and timber frame walls and ceiling. The external dimensions measure 3.2 by 7.7m and the net floor area is 21m². The units are separated from each other by an air cavity on either side. An EPC of zero turned out to be infeasible because there is little space for PV panels and because each includes many self-contained systems in addition to a shower and toilet.

Read more about this project

Permanent temporary school building

Although the Amsterdam International Community School (AICS) is housed in a temporary, modular school building, it has the appearance of a permanent accommodation. BurtonHamfelt Urban Architecture used the expertise of unit builder De Meeuw to realise at this circular concept.

Until the 2023-2024 academic year, Esprit Schools will accommodate approximately 550 students in a temporary location in Amsterdam South-East and relocate to the former ING bank building De Zandloper thereafter. Architect Burton Hamfelt developed a modular school that can be easily reused at low cost and without any loss of quality.
Schools in this concept can easily shrink or expand, as desired. At the same time, it remains affordable and sustainable. All parts fit in a circular cycle. They can be disassembled, stored or reused. The permanent appearance has been achieved after a careful study of its use and by striking the perfect balance between busy, learning-focused spaces complete with a centrally located two-storey lecture hall.

Read more about this project

Standard for new supermarkets

The energy bill of the Lidl supermarket in Woerden remains zero euros thanks to the innovative linking of climate technology, product cooling, energy storage and solar panels.

The circular character of the Lidl outlet in Woerden is particularly apparent in its energy system. The building has 1,766 solar panels on the roof and carports of the car park. Innovative piles serve as heat and cold storage and the residual heat from the cooling systems establish the right in-store climate. As far as Andy van den Dobbelsteen is concerned, professor of climate design & sustainability at Delft University of Technology and closely involved in the development of Lidl Zero, this building is the standard for new supermarkets. He thinks it is quite an achievement that the usually separate systems have been merged here. This is still a difficult process for many fitters and contractors.

The supermarket chain has expressed the ambition to make its construction projects completely carbon neutral by 2022. Lidl has already installed a total of more than 88,000m² of solar panels on its buildings. Since December 2018, all stores are natural gas-free and new stores are delivered with an A++++ energy label.

Read more about this project

Also read the interview with Andy van den Dobbelsteen

Circular construction gives energy

In November 2015, grid operator Alliander opened a fully circular renovated office in Duiven. The building supplies more energy than it consumes and more than 80% of the materials have been recycled.

The circular renovation merged several buildings into a single office for 1,550 employees, more than twice as many people as before. The Atrium is an interplay of light and space. A total of 20,800 plants grow in the green walls that purify the air in the interior space. The materials passport lists, among other things, the rubble of the old concrete wall that has been finely ground into granulate for the concrete floor. Furthermore, the wood for the inner wall is internal waste wood. Insulation of the walls is partly made from recycled cotton, from old work clothing. The toilet bowls and sinks have been refurbished and reinstalled.
VolkerWessels Vastgoed was awarded the contract and entered into a DBMO (Design Build Maintain Operate) contract for 15 years. They guarantee the building will deliver the promised energy performance.

Read more about this project

Straw bales for passive house

“As an energy consultant, I’m obliged to build an energy-efficient house,” writes Robert de Bourgraaf from Goes in his blog about Zonnehuis in Geersdijk, Municipality of Noord-Beveland.

“I want to use the passive standard and pay very close attention to the environmental impact of building materials. Straw and wood fit perfectly within the circular construction concept.” De Bourgraaf opted for a timber frame structure filled with straw bales for the walls and cellulose flakes for the roof. The exterior finish consists of inland wooden wall parts and roof tiles.
A passive building benefits from extremely low energy consumption thanks to its strong insulating properties, a pleasant indoor climate thanks to balanced ventilation with filters and a negligibly low heat requirement.
Architect and urban planner Martijn Jansen used straw bales as normative building blocks in his design. The front of the house on the south side is very open and more closed at the back. This allows a pleasant indoor climate, with minimal use of technology.

Read more about this project

Circular, modular and ready-made

The sustainable modular building system of Finch Buildings is 'plug and play' and can be adjusted to changes in market demand, residents' wishes or to the environment. The modules are energy neutral, movable and can be fully reused. Finch Buildings produced 38 residential studios for housing corporation Woonwaard in Alkmaar, which were erected at Bergerweg in Alkmaar.

The solid timber studios of Finch Buildings are intended for young people aged 18 to 28 and will be operated permanently in various locations. The houses are built entirely from Cross Laminated Timber (CLT) and built modularly in the factory before being transported to the site. The houses could be produced at a rate of two per day and installed at a rate of ten per day. As a result, the construction time of the entire project (from ground work to completion) took less than three months. About 478 tons of CO_2 is stored in the wood used in this project. Another 568 tons of CO_2 were saved during construction. As regards the wood, five trees are replanted for every three trees used.

The applications of the system are endless: from a studio, a one or two-bedroom apartment, an office or care apartment to a complete hotel. The modules can be linked and be stacked up to seven layers high, or higher with an auxiliary construction. The modules are delivered with a choice of bathroom, kitchen, window frames, heating, floor finishing and home automation.
By making the units from wood, the developers claim the creation of a healthy and comfortable living climate thanks to the moisture-regulating effect of the material. The strong insulating properties of wood means the demand for heat is less.

Read more about this project

Resurrected from former district office

The circular new building of Emergis child & youth in Kloetinge by care institution Emergis has reused materials as much as possible. The raw materials for this clinic were sourced through the dismantling of the former district office of Rijkswaterstaat in Terneuzen.

The exterior frames, interior doors, wall cladding, the wooden floorboards and paving bricks were all given a new purpose. The particulars encountered by those involved in the process have been put together in a learning bundle. The available materials thus determine the design. This makes the architect's role different.

An extensive materials passport with photos is necessary to be able to reuse materials as much as possible, to determine the value and to estimate the lifespan.

A circular economy requires a change of ownership of a product to a product-as-a-service. "However, for now, legislation makes it impossible to use service contracts for permanent building components attached to the land when building the clinic," Emergis writes.

Read more about this project

Foto's: Eddy Westveer

Discover what it can all be

Stichting Grondvesten and Superuse Studio's have designed and realised a new pavilion at Buitenplaats Brienenoord Eiland, with the aid of constructive elements from a storage unit present on the site. This way, the parts of the old building on the island, which served as a summer campsite for years, were given a new destination.

Based on a Harvest Map listing the available materials, Superuse Studio's, and architectural firm, designed a new multifunctional building built by volunteers. Recycled beams, boards and frames now form a playful open building 'Buitenplaats Brienenoord', in which 90% recycled material is used.
The summer camps are now coming back to the island. In addition, organisations can rent the site for office retreats, theatre or rehearsals. "You name it", initiator Rineke Kraaij explains in an article in NRC Handelsblad newspaper. "But not for weddings or similar events, it needs to be themed."

Read more about this project

View the photo series

Foto's: Riccardo De Vecchi

A healthy experience

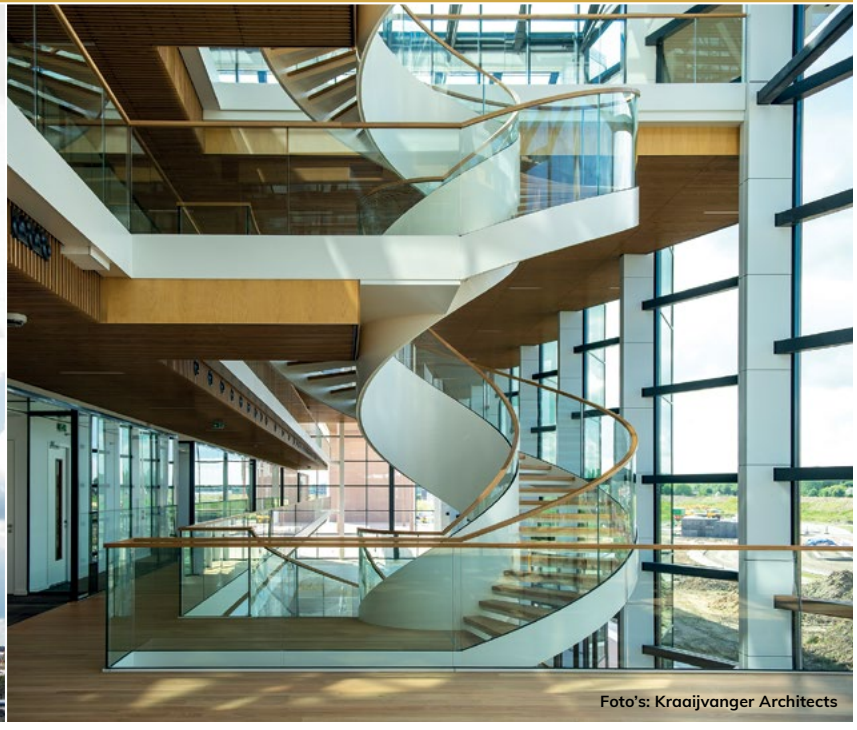
The new Van Gelder Groente & Fruit building in Ridderkerk, designed by Kraaijvanger, involves a super-efficient production process and is designed to make the innovations of this process visible. More than 95% of all materials in the building are certified and have the maximum BREEAM score of MAT 5, and benefit from a sustainable, circular choice of materials.

Different disciplines, such as production, transport and experience are all united in a single building. Behind a huge window that looks like a vertically placed greenhouse roof at the front lies the experience centre. A vegetable greenhouse in bloom is an eye-catcher. The production and distribution hall lie behind it. A presentation kitchen is located in a large greenhouse space at the top of the building. The warehouse process is almost completely mechanised in this 32,000m² building.

Cooling systems contribute to the outstanding BREEAM-NL certification. The building is virtually gas-free and is cooled by means of an energy-efficient and environmentally-friendly cooling system with natural, environmentally-friendly refrigerants. The heat released during this process is used to defrost air coolers and to heat offices or water.

There is a bus stop in front and an orchard at the main entrance, there are several charging stations for electric cars and every workplace benefits from daylight.

View the photo report of this project



Foto's: Kraaijvanger Architects

Self-sufficient and water and air purifying

In 2016, the municipality of Venlo opened its new municipal office, built according to the Cradle-to-Cradle (C2C) circular principles. Not only is the building sustainable, it also contributes to people, the environment and the economy.

The building produces more than 60% of its own energy, does not use gas and is therefore carbon neutral. The investment of 3.4 million euros in sustainability measures delivers a saving of 16.9 million euros over its 40-year useful life. The business case generates a positive cash flow after the first year already.

The building purifies rainwater to reduce the consumption of clean drinking water. In addition, the green front of the building purifies the air to the outside, while a greenhouse on the roof provides natural ventilation. The interior of the office has 'green walls' that regulate humidity, oxygen levels and acoustics. Thanks to the large windows and solar panels, the building makes efficient use of the sun, an important source of energy.

Read more about this project

Pavilion with added value for the environment

The Dutch Government Property Management Agency did not want to leave an urban development gap at The Green House site, but create a project that would contribute to social liveliness and safety. That is why it made the pavilion part of the tender for the redevelopment of the former Knoop barracks adjacent to it.

Consortium R Creators (Strukton, Ballast Nedam, Facilicom, cepezed and Albron) subsequently formulated the ambition to create a circular catering pavilion, including circular business case and operation. The Green House, designed by cepezed, can be completely disassembled and reassembled. As many materials as possible have been reused, such as the smoked glass front panels from the old Knoop barracks. After 15 years, the pavilion can be placed elsewhere and the vacant land can be used for a different purpose.

The pavilion offers catering, work and meeting accommodations and sustainable innovations. This way, the pavilion provides direct added value for the environment. The Green House aims to reach and inspire a wide public and thus contribute to a broad social involvement with regard to circular thinking and acting.

Read more about this project

New living room for Tilburg

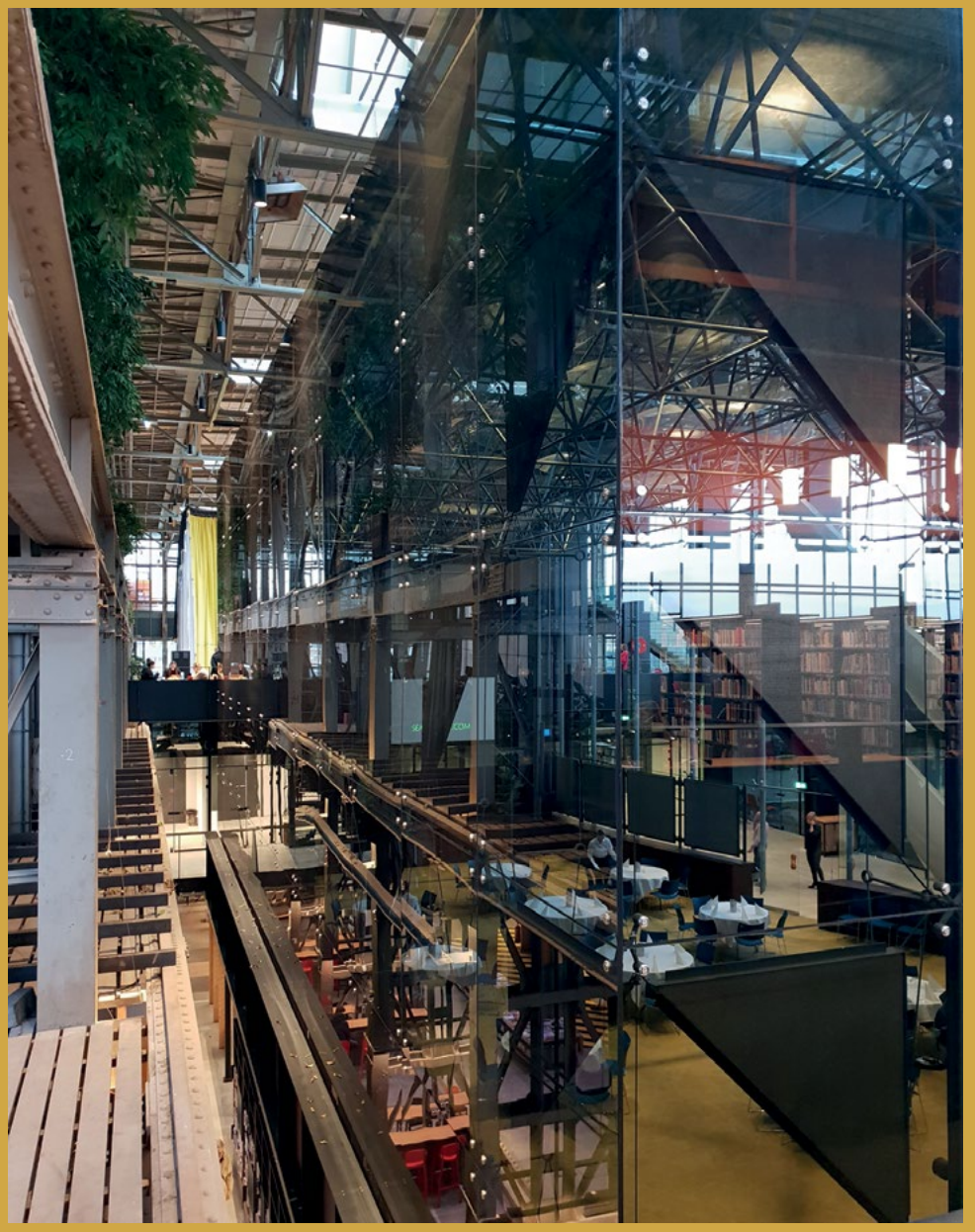
LocHal, a former locomotive warehouse unit next to the Central Railway Station, is the new public city forum of Tilburg. The building, designed by Civic Architects, now accommodates the public library, co-working spaces, conference rooms and a glass hall from Amsterdam.

The enormous hall has a homely character thanks to the special layout and enormous movable walls of textile. To meet the heat demand sustainably, a sophisticated climate concept with three climate zones was developed based on the 'heating the people, not the space' principle.

Seats on the stairs are heated and cooled and the offices and library have their own sub-climate as well. Three 'VKT' air-conditioning units by OC Verhulst meet the specific climate requirements in the building. This creates a flexible and comfortable climate without having to wrap up the monumental shell.

The building contains a glass hall that served as a music hall in the Beurs van Berlage building in Amsterdam from 1990 to 2014. At the intercession of the designers, the hall was not demolished at that time, but dismantled and stored for repurposing. The Municipality of Tilburg won the tender to reuse the building for the symbolic amount of one euro.

Read more about this project



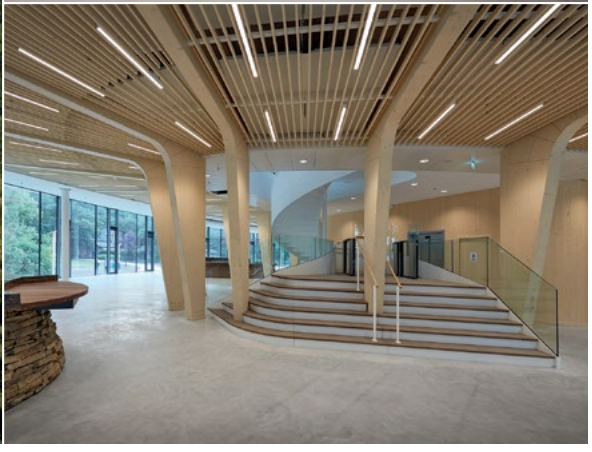
All materials reusable

Triodos Bank Nederland sets the bar extremely high in terms of sustainability and quality. Hence the bank's new office in Driebergen is demountable; you simply unscrew it again.

A completely wooden shell rests on a concrete foundation. Wooden floors, wooden shafts and wooden columns. The new office consists of three towers of two, three and five floors, enclosed by a completely glass external wall and covered with green roofs. RAU Architecten regards a circular building as a temporary combination of products. The building is therefore literally screwed together with 165,312 screws. It can be disassembled at the end of its life. Components and materials are accurately documented for reuse in Madaster, the 'materials register' launched by RAU in 2016 to facilitate reuse in construction. The building, carefully integrated into the landscape, was awarded the BREEAM Outstanding certificate.

Read more about this project

Photos: Bert Rietberg/Ossip



Local reuse

Three pilot homes made from demolition material from old high-rise flats are part of the SUPERLOCAL circular area development in Parkstad Limburg in Heerlen. This should ultimately lead to the construction of approximately 130 new homes and the layout of the public area.

Different recycling methods are being tested in three pilot homes. Dismantling a building that was not designed for this turned out to be more difficult than expected. The biggest challenge for Dusseldorp, the demolition contractor, was the weight and size of the concrete shells, but after a few attempts, large parts of the shell were ultimately lifted out of the flat for reuse.

The concrete was broken up on site and processed into recycled concrete, resulting in 85% recycled granulate that was used for the foundation of the three circular homes and the concreting in of external and structural walls in the circular houses. The wood, local slate, brick blocks made from recycled concrete, all variants are tested for feasibility in the pilot homes.

Read more about this project

Hemp ready for housing



The world's first hemp prefab house in Oude Pekela is a stepping stone to the larger work for Dun Agro, hemp factory. With the production capacity of the current factory that produces prefab hemp panels, 500 homes can be built per year.

The hemp house is made up of timber skeleton elements filled with a hemp mixture that are used for the walls and roof of the house. The factory mixes hemp wood with slate lime and water. After three months of natural drying, these very light panels can be assembled directly at the construction site.
Thanks to its advantageous properties, the hemp mixture can be used multifunctionally. It represents bearing capacity with strong thermal and acoustic insulating properties. It is vapour-permeable, making use of plastic foils superfluous. Facilities such as pipes for gas, water and electricity are incorporated in the elements.

Read more about this project


Foto's: Freddy Stötefalk

Active House in Schiedam by architect Reimar von Meding. Photo: Ossip van Duivenbode

Websites

The Circular Construction Economy
Bundling of information about the activities of the Circular Construction Economy transition team.
www.circulairebouweconomie.nl/

Platform 31
Independent knowledge and network organisation Platform31 spots trends in the city and region.
www.platform31.nl

Platform CB23
The platform connects all initiatives, pilots and knowledge related to circular construction across the building industry.
www.platformcb23.nl

Circular entrepreneurship
Circular entrepreneurship is the matchmaking platform for circular entrepreneurs.
www.circulairondernemen.nl

Cirkelstad
Cirkelstad facilitates public and private parties in the circular and inclusive construction sector.
www.cirkelstad.nl

PIANOo
The task of the procurement expertise centre of the Ministry of Economic Affairs and Climate Policy is to professionalise procurement and tendering at all government bodies.
www.pianoo.nl/nl/themas/maatschappelijk-verantwoord-inkopen-duurzaam-inkopen/mvi-themas/circulair-inkopen

Other

Construction and Execution
Platform and trade magazine for construction, infrastructure and technology. It focuses on governments and the construction, infrastructure and technology sectors.
www.bouwenuitvoering.nl

Cradle to Cradle: Remaking the Way we Make Things
McDonough, W. & M. Braungart North Point Press, 2002.

Built Sustainably
National integrated knowledge platform for decision-makers within the construction and proeprty sector in the field of sustainability.
www.duurzaamgebouwd.nl

How Buildings Learn: What Happens After They're Built
Stewart Brand. Penguin Books 1995.

Guide to Sustainable use of materials
This practical guide to sustainable use of materials with examples and concrete tips was commissioned by Bouwend Nederland, 2019
https://www.bouwendnederland.nl/actueel/nieuws/7486/handvat-duurzaam-materiaalgebruik-helpt-sector-bij-verduurzaming

Circular stations
Essay by Mieke Oostra, lecturer of New Energy in the City at the University of Applied Sciences Utrecht, 2019
www.spoorbeeld.nl/inspiratie/circulaire-stations-0

Guide to Circular Procurement in 8 Steps
Developed for public clients by Copper8 together with Rijkswaterstaat.
www.copper8.com/wp-content/uploads/2019/02/E-book-Circulair-Inkopen-in-8-stappen-Copper8.pdf
https://wegwijzer.gdci.nl/

About this publication

The Publication was commissioned by the Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, RVO) and compiled for the Circular Construction Economy.

Text: Gerard Vos with contributions from Mieke Oostra and Cecile van Oppen / Text example projects: Ronald van Bochove / Editing, final editing and proofing supervision: PACT Public & Media Affairs / Design and layout: Studio de Marcas, Arnhem

The cover photo is an artwork by Don Satijn from the Dream Cities series, supplied by Galerie Rotor. Photo: Johannes van Camp

September 2020