CIRCLE ECONOMY | wbcsd

SCALING THE CIRCULAR BUILT ENVIRONMENT

pathways for business and government

EXECUTIVE SUMMARY

The circular economy has great potential to help meet global sustainability targets and the Paris Agreement's goals in particular. The built environment, consuming almost half of the world's resources extracted every year and responsible for a massive environmental footprint, is a fundamental sector in the transition from a linear to a circular, more sustainable world.

Moving towards a circular built environment involves a shift in roles and business models for stakeholders active in this sector. However, barriers related to culture, regulations, market, technology and education are slowing down the transition.

The private and public sector need to create a level playing field in order for circular materials, products and services to become the new normal in the built environment. This requires bold leadership from both companies and policy-makers who have to transform the market (e.g. by introducing new valuation methods) and implement long-term policies that encourage the scaling of circular solutions (e.g. through circular procurement). Standardization, new forms of collaboration and co-creation processes are essential elements in the transition. Digital innovation, education and information sharing can further drive the change in mindset and culture that is needed to turn the circular built environment into reality.

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1. INTRODUCTION

The built environment puts significant pressure on our resources and contributes significantly to global greenhouse gas (GHG) emissions. Transforming the linear built environment into the circular built environment creates huge opportunities to lower the impact of the built environment and to create a sustainable and futureproof sector. We need to accelerate this transition.

1.1 It's time to step up!

Every year Earth Overshoot Day[1] comes earlier. In 2015, research by Rockström and Steffen showed that we exceed four of our nine planetary boundaries on biochemical flows, land system change, biosphere integrity and climate change. We need to act and we need to accelerate change. We are using our earth resources at a pace and quantity that will dramatically change earth and harm its population.

The built environment has a considerable impact on our planet. Approximately 40% of global materials are used for construction. In the European Union (EU), current construction and demolition (C&D) waste accounts for approximately 25-30% of the total waste generated and consists of numerous materials, including concrete, bricks, gypsum, tiles, ceramics, wood, glass, metals, plastic, solvents, asbestos and excavated soil, many of which can be recycled.[2] Rubble produced during the construction and demolition of buildings, which accounts for 26% of the total non-industrial solid waste produced in the United States and 12% of total waste in Europe,[3] includes many recyclable materials from steel to wood to concrete.[4]

The world produces more than 400 million tonnes of single use plastics annually, of which 16% is produced for the built environment.[5] Plastic waste causes vast economic damage. Plastic waste in the Asia-Pacific oceans alone affects tourism, fishing and shipping industries annually by costs up to USD $1.3 billion.[6]

With great dependency on virgin materials, the building sector is challenged by resource scarcity. Global steel demand is expected to increase annually by at least 1.1% through 2030, driven by the demand of emerging economies.[7] For concrete, while the raw materials are generally abundant and found locally worldwide, some materials such as natural sand and lime stone suffer local scarcity. For unbound applications, as well as concrete, we need to extract 30 billion tonnes of sand each year,[8] equivalent to nearly four tonnes per person. The majority of this sand is extracted in river and coastal areas, which increases the vulnerabilities of coastlines, where an important part of human settlements is located.[9] With increasing pressure from society to sustainably source materials, including the use of biobased materials, the building sector needs to find new ways to use and reuse the existing stock of non-virgin materials and to integrate biobased materials into its day-to-day activities.

If no action is taken to improve energy efficiency in the building sector, energy demand is expected to rise by 50% by 2050.[10] To limit global temperature rise to 2˚C as set out in the Paris Agreement, we need to achieve an estimated 77% reduction in total carbon dioxide (CO_2) emissions in the building sector by 2050 compared to today's level. The building sector is the largest energy-consuming sector, accounting for over one-third of the final global energy consumption and an important source of CO_2 emissions.[11] In reality, this estimation is even higher as the energy demand for production of building materials is not included. Moreover, around 20% of global GHG emissions are building-related.[12]

With developments such as population growth, continuing urbanization, climate change and resource scarcity, the sector needs to dramatically change the way it works. The global floor area in buildings is expected to double to more than 415 billion m^2 by 2050.[13] We will need to achieve this growth while operating within planetary boundaries.

Reader's Guide

The circular built environment provides concrete opportunities to help meet the targets as set out in the Paris Agreement and contributes significantly to meeting challenges such as resource scarcity (see chapter 1). Five business models play a central role in the CBE, but to achieve their full potential, we need to change the way we work (see chapter 2). This change not only applies to the characteristics of the CBE, but also to the roles of stakeholders in the building process and the value chain (see chapter 3). We need to tackle five key barriers that prevent scale at a level playing field (see chapter 3). Both the private and public sector have the power to address these barriers, create scale in a level playing field and make the CBE a success (see chapter 4).

Circular economy can be part of the solution of mitigating the impact on the sector while dealing with the challenges posed to the sector.

1.2 Circular economy offers huge potential to develop a sustainable building sector

The circular economy presents huge potential for global economic growth while accelerating society towards a sustainable future. The circular economy (as a whole) is a USD $4.5 trillion opportunity.[14] This benefit is not exclusively reserved to the traditional developed economies. Compared to the current development path, a circular economy development path, could bring India annual benefits of USD $624 billion by 2050 – equivalent to 30% of India's current GDP. According to the Ellen Macarthur Foundation, material saving can result in an annual cost saving of USD $630 billion for the consumer goods that have an average longevity (including construction materials), and material savings of 20% in products with a short lifespan sector (e.g. packaging, also used in construction activities) which equates to cost savings of over USD $ 700 billion.

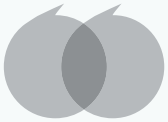
The size of the prize in the circular built environment not only translates into quantities of materials returning to use cycles. It also has an impact on the balance between new build and renovations. Although the latter is often more circular and less costly, it is not always possible. The circular economy ought to be measured in terms of saved material costs, energy costs, water costs, saved spatial resources, reduced accountable externalities and in terms of local job creation, (SME-driven) reuse, repair and refurbishment market.

The size of the prize should also be defined in terms of avoided costs on resource scarcity and the emerging competition for resources. Decoupling economic growth from resource consumption can be an important way forward to safeguard economic development in a world in which resources become increasingly scarce. This is especially the case in resource-scarce regions like the European continent.

Overall, USD $36 trillion turnover is generated in the built environment, contributing 39.6% to global GDP.[15] Total built assets are valued at USD $10.4 trillion with China as biggest contributor and with India as one of the fastest growing built assets economy (with a growth in asset value of 19% since 2014).

The market for circular economy is growing and it is estimated that over the next 10 years, it will boost economic growth by up to 4%.[16] It is estimated that in the UK alone 200,000 jobs may be created by 2030, which could double with further development and implementation of new circular business models.[17]

There is huge potential for reuse of materials. A 1% increase in resource efficiency is worth as much as €23 billion for business.[18] C&D waste provides a massive opportunity. Best performing Member States of the EU recycle about 95% of their C&D waste. 226 million tonnes of mineral waste from C&D in the EU28 is recycled. With 308 million tonnes reported to be generated, 73% is recycled in total in the EU. The circular economy therefore has the potential to reintroduce 293 million tonnes of secondary materials in the EU, if all EU Member States recycled 95% (66 million tonnes more than today).[18] This is an underestimate, as much disposed C&D waste is not reported. Arcadis and IDEA assessed the real quantities at 410 million tonnes, based on average generation figures.[19] This would make the total estimated available quantity 389 million tonnes or 163 million tonnes more than today. Similar percentages and material gains can be expected from comparable markets like North America. The environmental and financial opportunities are substantial.



Companies have to see circularity as a business opportunity. That requires action leadership!

Petran van Heel
Sector Banker Construction & Real Estate, *ABN AMRO*

KEY CHALLENGES IN CLOSING THE CIRCULARITY GAP

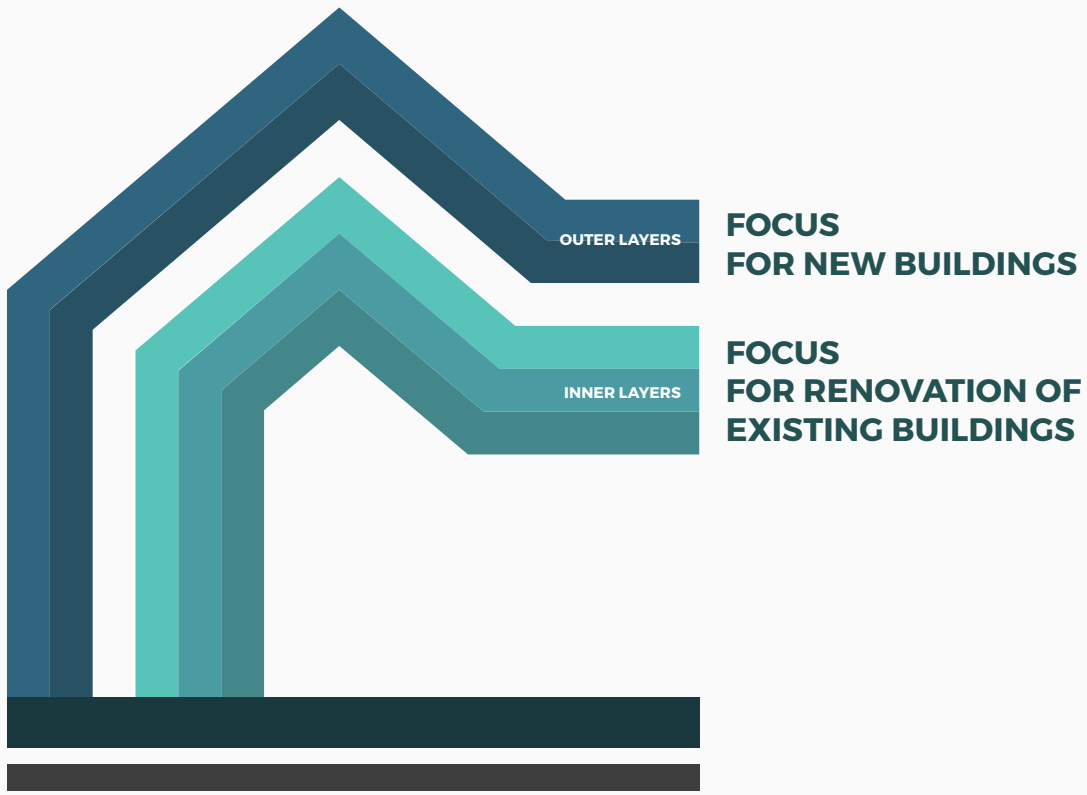
With a global economy that is only 9.1% circular, we are facing a massive circularity gap.[20] The Circular Gap Report (2018) showed that the built environment has a major stake (41.1 gigatons) in the amount of materials that our society consumes (84 gigatons in total), while cycling rates remain low if downcycling, backfilling and incineration are not taken into account. Closing the gap will not only be a matter of reducing material input and cycling more, it will also be crucial to optimize and extend the lifetime of what has already been built.

The challenge to bridge the circularity gap in the built environment can be divided in two. In some regions, especially in western countries, it is paramount to keep and maintain the stock that has already been built. In Europe, for instance, a major opportunity lies in renovating and transforming existing buildings. In other regions, circularity is a matter of preventing the lock-in of materials in new construction. Emerging economies with high rates of urbanization, like China and India, require circular design strategies that aim at optimizing building lifetimes and increasing the possibility of reusing materials at the end of a lifecycle.

The challenges that face are reflected in the layers of a building (described in more detail on page 14). Generally speaking, for existing buildings, it is more important to focus circular strategies on the inner layers (i.e. services, space plan and stuff), such as renovation of installations and refurbishment of furniture. For new buildings, emphasis should be given to designing the structure, site and skin such that a building can optimally serve one or more purposes, facilitate circularity in the inner layers and can be readily disassembled for a new lifecycle. Hospitals, for instance, can be designed for flexibility such that they can be repurposed into a shopping center or apartments, while apartment blocks can be designed in a modular way and easily reassembled. The underlying social layer is equally relevant to both existing and new buildings.

Looking through the lens of the two challenges for current building stock versus new building stock - an important focus of the new Circularity Gap Report (expected in January 2019) - enables businesses and governments operating in different parts of the world to better prioritize the pathways described in this report.

Figure 1. Link between building layers and priority to apply circular strategies



1.3 The linear and circular built environment

- **What is a linear built environment?**

Linear building can be referred to as a take-make-dispose process. It assumes no limit on the availability of (natural) resources. Finite primary (or non-renewable) resources are extracted and used in building materials. These materials become parts of buildings and after the functional life time has expired and the building is demolished, the materials are disposed of, primarily as waste or in low-value applications. In a linear built environment, materials are lost for future use. Improving sustainability is focused on eco-efficiency: maximizing economic gain, with minimized environmental impact (e.g. amount of waste discarded per Euro turnover per product group).

In a linear economy, ownership of an entire building (its construction, content, surroundings, etc.) is transferred from one entity to the next. New owners take over responsibility for all actual and future environmental, economic and social impacts. In each stage of ownership (i.e. planning, design construction, use and demolition) the owners are responsible for their own actions and there is limited notion of the next step and related responsibilities.

- **What is a circular built environment ?**

In a circular economy, resource use is decoupled from economic growth, meaning that economic development no longer requires similar rates of resource consumption. Resources are used more efficiently and the economy becomes less dependent on non-renewable resources. **The circular economy is based on an emerging economic model that covers both techniques and business models to keep materials and resources in use as long as possible, and ideally forever, in a closed cycle of extended use, reuse and recycling.**

Critical components of the circular economy are industrial symbiosis, renewable materials, shared economy, 'product as a service', a close relation between producer and consumer, proximity economics, reuse, recycling and upcycling, urban mining, detoxification of material cycles and sustainable consumption and production.[21]

Opposite to the circular economy are single use, programmed obsolescence, downcycling, legacy substances or loss of value.[22]

DID YOU KNOW?

ENEL is decommissioning 23 of its former thermal power plants in the Futur-e project. ENEL aims to find a new purpose for each of the plants instead of dismantling them. For each location the company initiates a custom made co-creative approach involving the local stakeholders. All the facilities are managed as a single portfolio and best practices for the application of tailor-made redevelopments are shared across sites.

In traditional building projects, working intensively with suppliers is not common practice for architects. In a more circular economy suppliers and architects will need to share responsibilities.

Peter van Assche
Architect, *bureau SLA*

1.4 Circular economy at the core of sustainability

Rather than a target in itself, creating a circular economy contributes to achieving the goals that are set out in the Paris Agreement in 2015 and the and the Sustainable Development Goals (SDGs).[23] Society, environment and economy all stand to benefit, especially when material, water and energy use is all managed in a circular way that reduces impacts on climate.

Organizations from both the public and private sectors have have embraced the SDGs as a frame for their sustainability strategy and ambitions. The circular built environment contributes in several ways and provides an essential framework for achieving the SDGs. The table below provides more details around how a circular economy contributes towards the SDGs.

SDG	LINK TO THE CIRCULAR ECONOMY
3 Good health and wellbeing	The circular economy avoids and removes hazardous substances from material use cycles, decontaminating the economy and allowing recycling without risks to nature and human health (e.g. phasing out asbestos or the use of leaded paints).
6 Clean water and sanitation	Most of the circular economy principles on material reuse, recycling, resource efficiency and industrial symbiosis are equally applicable to water, thus increasing the quality and the accessibility of clean water.
7 Affordable and clean energy	Circular energy solutions result in reduced energy demand. Sharing energy, using geothermal energy, increasing buffering capacity and using of renewable energy sources changes the way we use energy and stimulates clean energy use.
8 Decent work and economic growth	New business models lead to new companies and job opportunities. Circular economy business models in which companies collect or take back, repair and refurbish products are usually more labor intensive than linear models and create additional job opportunities.[24,25] In many emerging economies, waste collection supports a vast informal economy that lacks safe working conditions and fair remuneration.
9 Industry, Innovation and Infrastructure	The circular economy requires large-scale innovations in the built environment. This relates not only to industrial or technical innovations but also to infrastructural innovations. Circular economy is part of the solution, making industry more sustainable and resilient at local and global scale.
11 Sustainable cities and communities	The circular economy, with its focus on local production, repair and leasing and extended producer-consumer contacts, requests a new, small-scale, spatial design to which cities should be adapted.
12 Responsible consumption and production	The circular economy requires that: responsible care for products extends to the use and the post-use phase; that use of virgin materials are minimized; and that programmed obsolescence is phased out.
13 Climate Action	The circular economy can contribute to GHG reduction in many ways. Using secondary materials instead of virgin materials often requires less energy when considering energy associated with extraction. For example, reusing steel instead of having to mine ore and process it into steel can dramatically reduce GHG emissions. In addition to this, circular energy production and water management are key in climate change mitigation and adaptation.

2. THE CIRCULAR BUILT ENVIRONMENT

The circular built environment is in a state of transition. We are moving from a linear to a circular economy. This change will affect all characteristics of the built environment and applies to all layers of a building. This transition will lead to new business models that will drive the circular built environment.

2.1 A transitional state

How do we transform the built environment from linear to circular today and at scale? We are already on our way, as demonstrated by reductions in raw material extraction, implementation of product as a service models and the creation of new financial instruments. Nevertheless, we are in an intermediary phase. Recycling is an intermediary step that can often be considered downcycling: a part or a product used for a lower grade purpose which reduces the (added) value of the material or product. Many larger companies are increasingly adhering to circular principles in the sectors of finance, technology, resource management, client relations and ownership structures. Smaller companies (Small and Medium sized Enterprises or SMEs) and start-ups are more progressive in their business model reforms, more agile in applying new disruptive technologies and market approaches. However they do not have access to large markets and finance as multinational companies do. A circular built environment requires collaborating and finding synergies between SMEs and multinationals to scale up today's efforts.

- **The different dynamics in circular renovation or circular building**

The circular economy is about preserving the added value of existing things, both materials and buildings. Therefore, when possible it is preferred to engage in renovation of buildings to save the added value of its existing elements. Renovation is especially relevant in economies with a vast amount of existing buildings, such as those in Europe or North America. Extensions to existing buildings (e.g. top-up floor or subterranean extensions) can help to address the need for additional living and working space without requiring horizontal expansion.

Renovation becomes a challenge when the structure and design of old buildings does not support refurbishment, reuse or selective deconstruction. Existing buildings may contain legacy substances or hazardous components such as lead paint, asbestos or PVC that hinder its reuse. Likewise, these buildings may be constructed in a way that hinders separation of materials for recycling, such as irreversible adhesives. Their construction may not be adapted to the replacement of the skin. New buildings can, from design to decommissioning, take into account flexibility and possibilities to replace or rejuvenate layers, to select circular materials or to adapt to selective deconstruction at the end of their lifespan.

Newer economies therefore have an advantage if they apply circular approaches in their building activities today, while older and replacement economies will have the advantage of immediate reuse but will need to cope with technical barriers associated with the embedded resources and their harvesting feasibility.

In Europe and Northern America, the transition towards a circular economy takes place in an environment with a very rich building history, rapid urbanization, decreasing birth rate and economies where secondary materials are abundant and the cost of labor is high. In emerging economies, new cities grow rapidly, compounded with high population growth, labour is relatively cheap in comparison to materials and secondary material is scarce. This is a different environment in which the circular economy is developing. These different contexts create different opportunities for business models and implementation of a circular built environment.

2.2 The five emerging business models in the circular built environment

The circular economy offers practical opportunities for a waste-free, resilient economic system. The circular built environment has a strong relation to landscape and ecosystem services as well as technical material cycles. Bio-based and biodegradable materials are applied where relevant and available, while being sustainably produced and sourced. In the circular built environment, buildings are designed to be integrated in the natural, industrial or urban landscape with consideration for heritage and experiential value.

New business models are emerging that enable the transition and constitute the circular economy. Five specific models that are based on the characteristics of the circular built environment have been identified.[26] The table on pages 10-11 outlines the five models and their characteristics.

LUXEMBOURG

The five business models of the circular built environment

CIRCULAR SUPPLIES

Reduce the consumption of raw materials, use non-toxic, high grade materials that can be reused and recycled or procure renewable materials (bio-based or biodegradable).

PRODUCT AS A SERVICE

Deliver a service instead of a product and retain ownership. Monitor and stay in control of raw materials. Relieve clients of the burden and ensure their long-term loyalty.

Circular economy characteristics

Material use minimization

A circular built environment focuses on compact and light-weight constructions that require minimum material usage. Design is purpose-driven. Renovation and partial or full refurbishment is preferred over new construction. New construction is only relevant when old ones need significant improvements that exceed impact of new construction.

The application of life cycle thinking on materials

Avoid life cycle environmental impacts of materials and minimize waste generated during resource extraction.

Circularity in business models

The product as a service business model (PAAS) is a clear example of a new and emerging business model that drives the circular economy. Pay per use models also emerge. Paying for a service rather than a product can be established as a leasing formula or repurchasing clause whereby the ownership of the materials and products remains with the developer or producer. As a result, the residual value of the materials is secured.

PRODUCT LIFETIME EXTENSION

Maintain and extend lifetimes through smart maintenance, repairs, upgrades and renovation.

SHARING PLATFORMS

Combat underutilisation or surplus capacity by sharing products or assets and optimizing their use.

RESOURCE RECOVERY

Use waste from used products and resources and process to make new raw materials and products.

Material lifespan extension and avoiding waste streams

Buildings have a flexible design for multifunctional and continued use. This can be achieved by introducing modular components for future refurbishment. These designs are based on durable materials that increase the technical lifespan of the material and use digital material documentation.

Reuse, maintain and refurbish is preferred over recycling

Reuse relates to several phases in the life cycle of a building: reusing materials in the building design and harvesting reusable materials during deconstruction or refurbishment. It requires more complex stock management and modular (de) construction. Reuse refers to raw materials and products. Reused products (building elements or components like a window or door) typically have a higher value than raw materials.

Industrial symbiosis and sharing economy, co-creation and long-term customer relationships

Sharing materials and industrial symbiosis refers to using waste materials or products of third-parties as inputs for construction projects. Industrial symbiosis opportunities may be found between demolition yards, construction sites and local industry. For example, plaster board may be produced using gypsum created by the chemical industry. Symbiosis and co-creation occurs when two or more companies, often from different industries or sectors, exchange resources (i.e. byproducts, information, assets).

Circularity in material use

Maximum re-introduction of materials in the use cycles after disposal.

This primarily refers to material recycling. Buildings become recipients for recycled materials. Materials are selected on the extent to which they can be recycled without downcycling. This requires excluding materials with hazardous substances that can remain as legacy substance in the material stock.

Extended producer responsibility

The relationship between producer and client does not stop at the delivery of the building or at transfer ownership. The extended responsibility of the producer will have an impact on cost reductions for maintenance and adaptation within the use phase for the occupant and at the end of life.

What needs to change

Circular Supplies

Material use minimisation in the circular built environment

• Before deciding to construct a new building the opportunities for renovation of available existing buildings are examined.

• The design of a building considers (virgin) material use minimization from the first concepts onwards, preferring to maximize the capacity while minimizing surface (compact building).

• Each layer of a building is designed in a way that it can be renewed without destroying or impacting the layers above or underneath.

• Creating multiple functions of build space. Finding and designing a building for more users and reducing the need for more materials than necessary.

What needs to change

• Create awareness on global resource scarcity. Architects need to be enabled to design with focus on resource optimization.

• Avoid surplus material use for non-essential functions.

• Purposefully reduce material use for each layer of a building in design.

Key stakeholders to drive this change are: Architects, building and construction companies

Life cycle thinking for materials in the circular built environment

Alternatives for material choices are evaluated taking into account life cycle thinking. Life cycle assessment (LCA) and life cycle costing (LCC) are two tools that companies can use when implementing life cycle thinking. A hierarchy is applied in which biobased, renewable, local and abundant materials are preferred over fossil-dependent, exhaustible, imported and scarce materials.

What needs to change

• Use of LCA and LCC techniques in evaluating materials before selection, including the cost of replacement and maintenance.

• Use life cycle performance as a selection criterion.

Key stakeholders to drive this change are: Architects, suppliers and vendors

Product as a Service

Business models in the circular built environment

In general, circular business models apply different ownership structures where materials remain in the hands of the seller or where the seller has buy-back obligations. No longer the products, but the service these products offer during their useful life are sold, after which the products return to the producer. Companies expand their services from producer of materials to include construction and maintenance services. Companies emerge that play an intermediary role, such as contract management of a series of service providers within one building.

What needs to change

• Introduce circular business models at both the building and materials level.

• Architects integrate circular business models into their design.

Key stakeholders to drive this change are: All stakeholders in the building value chain

Product Lifetime Extension

Material lifespan extension in the circular built environment

As a building usually survives its initial use, it is designed in view of later adaptation possibilities and built to last.

What needs to change

• In designing the building, consider long-term circular solutions and create flexibility in the design to enable future adjustments.

• Adaptivity should be taken into account by the architect and welcomed by the first client. More structural dimensions may be required so that it can expand, adjust and accommodate various functions over its extended lifetime.

• Select materials that go along with the life time of the layer it is serving (focusing on the durability and CO_2 impact of materials).

• Coordinate the different life spans of all layers prior to construction to avoid unnecessary adjustments once built.

Key stakeholders to drive this change are: Architects, owners and users

The circular built environment

A building is seen as a stock of reusable materials. It is well known where these materials are and how they can be harvested for reuse. The materials are adapted to reuse, and they are mounted in a way that they can easily be disassembled.

What needs to change

• Material selection on use and technical lifespan, with a view on later reusability.

• Use of flexible modular components focusing more on the layers with a lower lifespan while going up.

• Apply building techniques that are not hindering later reuse possibilities.

• Waste companies, demolition companies and waste collectors need to connect for information exchange on the availability and quality of materials.

Key stakeholders to drive this change are: Deconstruction and demolition companies, specialised construction and installation companies and suppliers and vendors

Sharing Platforms

Industrial symbiosis and share economy, co-creation and long-term customer relationships

Sharing materials and industrial symbiosis refers to using waste materials or products of third-parties as inputs for construction projects. Industrial symbiosis opportunities may be found between demolition yards, construction sites and local industry. For example, plaster board may be produced using gypsum created by the chemical industry. Symbiosis and co-creation occurs when two or more companies, often from different industries or sectors, exchange resources (i.e. byproducts, information, assets).

What needs to change

• Collaboration in the value chain, including future occupants and between resource exchanging companies, needs to be included in the business practice of developers and users of built infrastructure.

• Co-creation and integrated design needs to become the convention in new building and renovation projects.

Key stakeholders to drive this change are: All stakeholders in the building value chain

Resource Recovery

Circularity in material use

Maximum re-introduction of materials in the use cycles after disposal.

This primarily refers to material recycling. Buildings become recipients for recycled materials. Materials are selected on the extent to which they can be recycled without downcycling. This requires excluding materials with hazardous substances that can remain as legacy substance in the material stock.

What needs to change

• Use broader criteria to select materials, including their recyclability and usability in their secondary life.

• Use the time between initiating and designing a building to find materials and resources that can be used in the building.

• Regulations and policies need to stimulate the reuse of materials and renewable resources. They should allow for innovative approaches.

Key stakeholders to drive this change are: specialised construction and installation companies, architects, deconstruction and demolition companies, waste treatment companies

Extended producer responsibility

The responsibility of the producer (real estate investors, building company or producers of building materials) continues when an asset is sold, until its final recovery.

What needs to change

• Business relations and responsibilities need to be extended beyond the date of purchase. This can be done through private agreements or legislative intervention.

• New contract structures need to be developed and intermediary organisations need to take up the role of contract managers.

Key stakeholders to drive this change are: real estate investors, building companies and their clients

Information technology is an essential enabler to realize the potential of the five business models

For all five business models, information technology is an essential enabler. We need to better understand what material is available, its quality and when the materials become available for reuse. We need to be able to follow the quality during the use phase of buildings and use this information to retrieve materials from buildings in a timely manner that enables reuse. Initiatives such as Madaster and material passports capture information about the materials in buildings. In scaling the circular economy, standardization of quality criteria and a common language is needed so various initiatives can connect. Connection systems such as digital marketplaces to Building Information Modelling (BIM), LCA databases and standards such as BREEAM, LEED and WELL Building is essential to reach scale.

The circular built environment increasingly supports product as a service business models. Information technology is essential in monitoring the state of materials and products in buildings and enabling quality management for an entire building in which several PAAS solutions are integrated. In itself, this creates new business opportunities.

2.3 The layered complexity of the built environment

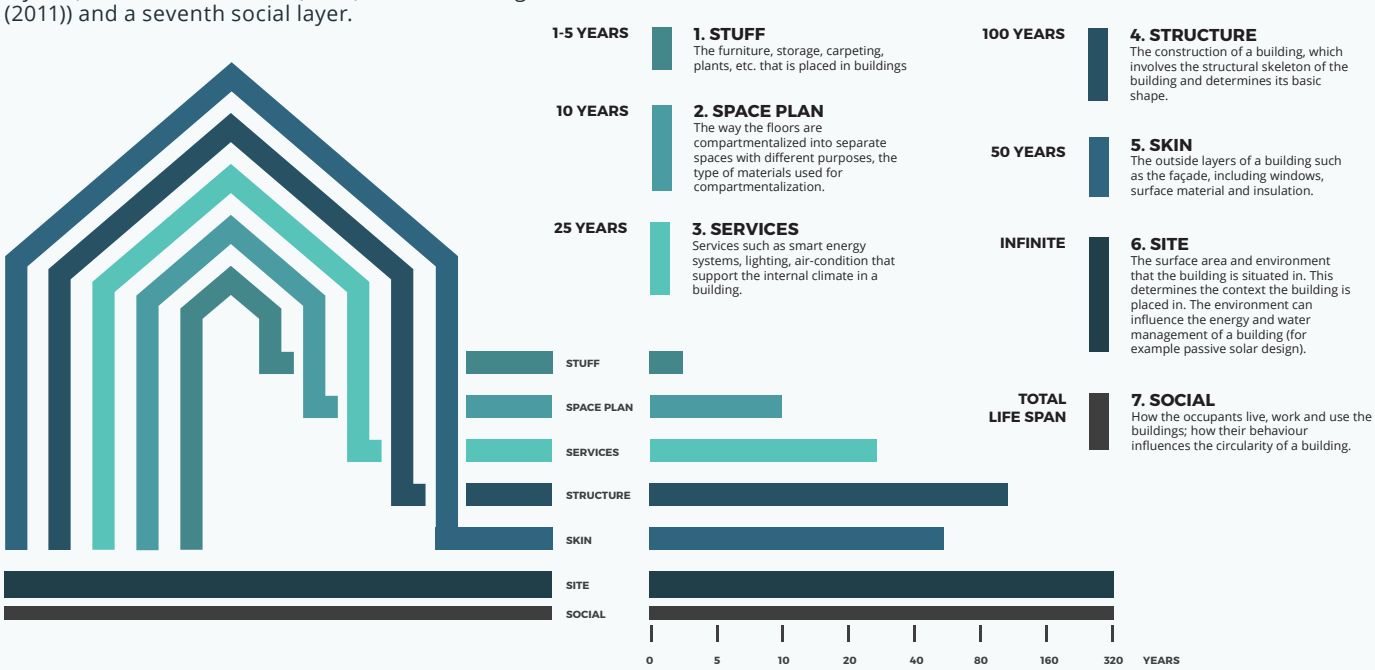
Each building is unique. The variety in market demands, environment, available resources, and local culture determines its identity. Nevertheless, we can identify seven layers in buildings (adapted from the shearing model of Steward Brand).[27] The lifespan of each of these layers is different as stipulated in the figure below.

Thinking about buildings as a combination of layers enables one to understand more tangibly how circularity influences it. Different stakeholders are involved in each layer. For example, architects, engineers and construction companies determine the structure, whereas installation companies determine to a large extend the services. The users and owners most significantly influence the circularity of a building in the use and maintenance phase in the life cycle.

The layers themselves offer different opportunities to increase the lifespan of a building. The outside layers could be replaced or refurbished without touching the lower layers, thus increasing the flexibility and the lifespan of the building. The lifespan of the inner layers should take into account those of the outer layers. When an inner layer needs replacement, it will be subject to limitations of the outer layers. Each layer has its own dynamics and sensitivity. The site should be integrated, the structure should last as long as possible, the skin and services should be accessible and replaceable, the space plan should be flexible, the stuff should be reusable and the social setting should be good for the people living or working in the building.

The design and life cycle of a new building can be entirely circular. All its layers are designed and constructed from scratch. There is a different dynamic in existing buildings. In particular, the inner layers (services, space plan, stuff and social) are renewed or refurbished to expand the lifespan of a building. This may extend to the Skin layer, but in general the Structure layer is left out of scope. Occasionally, structural adjustments may be required, such as reinforcement of structural elements.

Figure 2. Building model consisting of six material layers (after Steward Brand (1994) and David Bergman (2011)) and a seventh social layer.



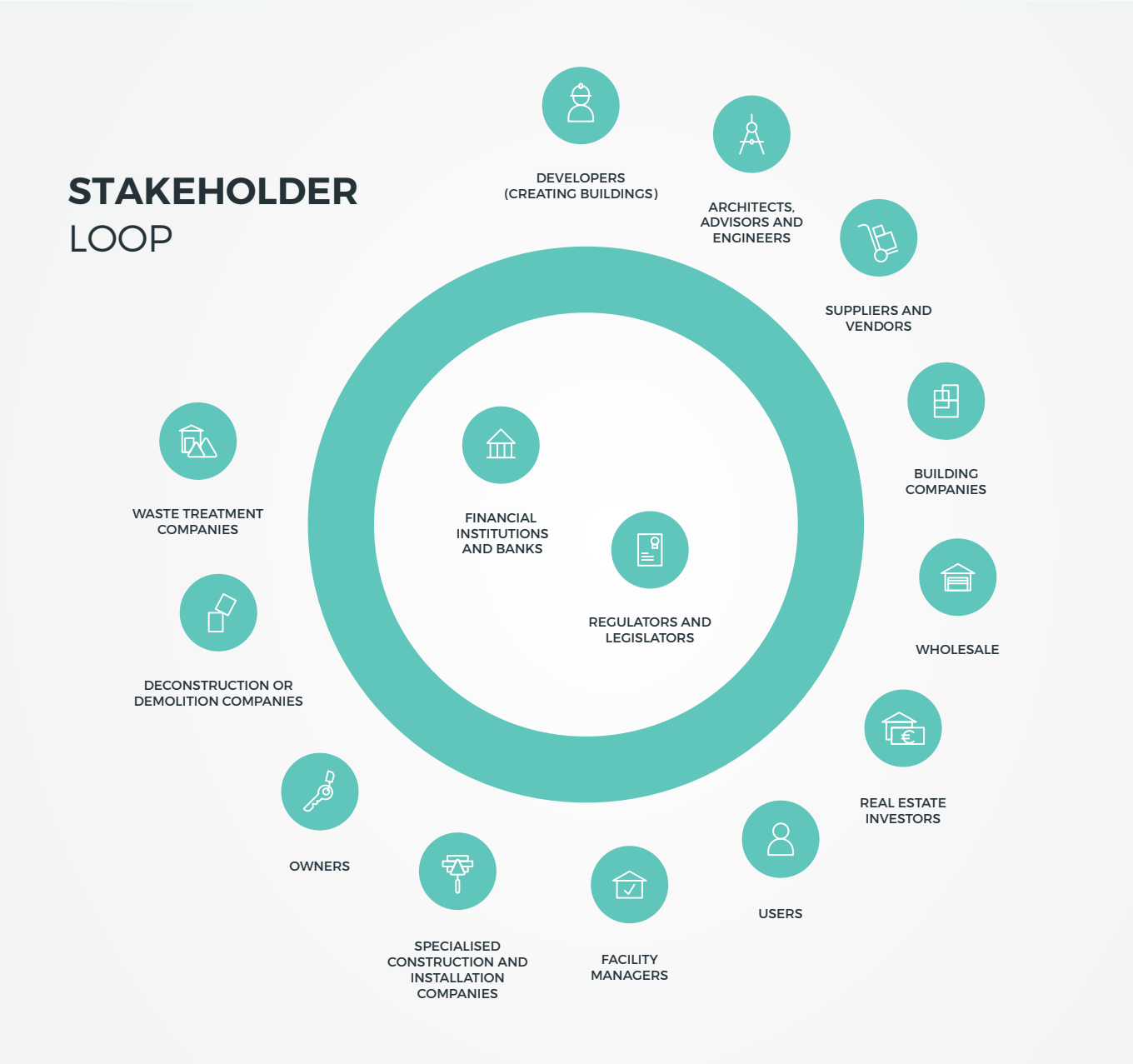
3. CHANGING ROLES OF STAKEHOLDERS AND BARRIERS

The transition towards a circular built environment requires stakeholders to adapt or change their role in the value chain. To accelerate this change, we need to conquer the barriers that hold us back.

3.1 Who is involved in the circular built environment?

Multiple stakeholders are active in the built environment, each with their respective but interlinked roles and interests. The stakeholders and their roles will change in the transition from a linear to a circular built environment. The following stakeholders take a central position in the transition to a circular built environment.

Figure 3. Key stakeholders in the built environment



DEVELOPERS

ARCHITECTS, ADVISORS AND ENGINEERS

LINEAR

Developers construct, redevelop or refurbish buildings. They consider a building as a short term asset. The goal is making a profit. They hire third parties to execute design, construction, maintenance and demolition.

The architects, advisors and engineers are the stakeholders who plan, design, calculate and review the construction of buildings in accordance to a set budget and design requirements.

CIRCULAR

Developers understand the requirements for circularity in the user and decommission phase. They expand the scope in requests for tenders and their activities to support circularity in the use and deconstruction phases. Their role is more complex as a key stakeholder in collaborations for the user and deconstruction phase.

Architects and consultants, together with their clients (e.g. clients developers, design-built contractors) and investors, apply a lifecycle perspective to design. Particularly in the early design stages, they jointly determine new roles of suppliers, building companies and installers.

CHANGE

- Developers will increasingly become part of a collaboration (e.g. in sharing platforms) with a more holistic approach, and as joint effort to reduce CO_2 emissions and the total footprint of a building. Developers will need to use their leverage to convene these sharing platforms and to stimulate integrated design.
- Developers will need to stimulate and support new business models such as product as a service.
- Their actions will increasingly be influenced by certifications and benchmarks such as BREEAM, LEED, GRESB and WELL Building standard among others, despite these systems mainly apply to the commercial market.

- Architects will need to familiarize themselves with new material solutions and options to use secondary materials and reusable products. They need to understand the lifecycle costs involved when their role also includes developing a business case. The availability of existing materials needs to be considered at the start of the design.
- They need to participate in sharing platforms and be aware of resource recovery. Furthermore, a database and market venue (real-time or digital) for reusable material supply and demand is crucial to connect with supply.
- The deconstruction of a building requires full attention in design.

	SUPPLIERS AND VENDORS	BUILDING COMPANIES
LINEAR	A party that supplies goods such as primary resources, building materials and products or that provides services. A supplier can be distinguished from a contractor or subcontractor, who commonly adds specialized input to deliverables. The general contractor is responsible for procuring the majority of the materials. In a linear economy this is mostly cost-driven with limited room for improvement and modifications. Change orders and alterations to the construction documents can turn into planning or capital risk.	A building or general contractor oversees the construction of individual and multi-unit building projects.
CIRCULAR	Suppliers are not only offering and developing new sustainable, non-toxic and renewable (bio-based) or recycled materials but also offer additional services such as leasing or remanufacturing. The extent to which they can expand their business model depends on the type of goods and the country in which they operate. Products will need a material passport or another way to demonstrate their circular profile, source and quality. Suppliers will have to deliver products with such a 'passport' to meet their client demands for transparency. For example, Environmental Product Declarations (EPDs) will include carbon footprint information produced from LCAs.	Building companies integrate additional expertise and services. They become chain director for the project, involving installation companies, wholesalers and others. They may expand their services to decommissioning or to facility management, using their knowledge and data about the building and materials to help the owner use its building optimally.
CHANGE	Suppliers will develop materials, products and services in co-creation and raw materials will become renewable or recycled. Single-use, virgin materials and toxic elements will need be phased out as much as possible. This will dramatically influence innovation. Suppliers will expand their business model to add more service-based solutions, such as resource recovery in products and materials, providing additional services in combination with their products. • Transparent communication about the sustainability performance of products becomes increasingly important (EPDs, LCAs, material passports). • Suppliers will need to better understand the environmental and social impact of their products and be able to communicate this to clients. Suppliers and vendors increasingly provide new guarantees and apply new validation processes to demonstrate the quality of their products.	Activities of building companies expand beyond the construction phase to include maintenance, operation and deconstruction. • Contractors may provide – especially for larger and more complicated projects – BIM models that can be transferred to or used by the building control system. • Contractors reevaluate the different companies involved in the design and build to assure the circularity of the building. • Apart from large builds, contractors will also execute smaller refurbishment projects where they work with reused and refurbished materials. This requires reconsidering existing business models. Extending the use phase of the building becomes a key objective (as opposed to a one-time building project) with an increased focus on user health and well-being.

	WHOLESALE	REAL ESTATE INVESTORS
LINEAR	Organizations, such as distributors, buy large quantities of goods from various producers or vendors and resell these to traders and end clients. The awareness of the sustainability performance of bulk goods is limited due to poor reporting and minimal transparency across the chain of custody.	Investors evaluate the real estate market to build long-term wealth. Sustainability is mainly considered in long-term investments (e.g. by pension funds), but there is limited attention to sustainable aspects on the short-term. Sustainable considerations are typically not part of the risk management systems.
CIRCULAR	Wholesalers become material banks, expanding their role as suppliers to include consulting, leasing or buy-back. Wholesalers then become chain directors.	Real estate investors look at the Total Cost of Ownership and Usage. Investors ensure optimal building performance through smart maintenance and regular renovations. They determine new roles for architects, suppliers, contractors, installers and real estate managers. Real estate investors sell materials to demolition and recycling businesses or construction companies.
CHANGE	The structure of wholesalers changes so they become a provider of circular supplies. These supplies may include reusable or renewable materials and products, diverting away from single-use and downcycled, virgin resources. Wholesalers become a centrepiece of the circular built environment, connecting resources to clients and contributing to sharing platforms. Their activities may expand to resource recovery.	Real estate investors update their business model to include residual material value and product streams. They will apply a broader scope to an investment to better manage risks associated with circular economy. Investors will see a shift in focus from ownership to maintenance and residual value of their assets. Second-hand materials can be considered a technology risk and investors will apply new models to deal with increased risk profiles of circular buildings. Investors need not only invest in a building but also in a stock of materials within it. The valued residual materials and components within the building will become available at end of life.

	USERS	FACILITY MANAGERS
LINEAR	Users view a building as an object that fulfills a spatial need or function. There is a direct relation between client demands and the asset price.	Facility management is responsible for ensuring the operations within a building. They are responsible for contracting of lighting, IT facilities, utilities and waste management.
CIRCULAR	Buildings transcend beyond objects with a single purpose to meet user needs. They become part of the environment. Asset prices are influenced by the level of sustainability of a building. Buildings will be designed to not only serve a specific use, but also create a healthy environment for living and working. As the conception of a building changes, the role of a user may change to include a wider range of activities during the user phase. Current users may become more aware of the needs of the next user of the building.	Facility managers expand their role to obtaining and analyzing data. Data management of the building performance allows Facility managers to recognize patterns and anticipate problems or maintenance needs. Facility managers provide up-to-date inventories to be used in the end-of-life phase of the building.
CHANGE	• The increased understanding of users about sustainability of buildings, circular economy and the impact of material use on the planet fundamentally changes the design, construction, operation, maintenance and deconstruction of buildings. Users demonstrate more sustainable behavior which can be facilitated (e.g. by smart technical solutions and smart building infrastructure) and stimulated (e.g. by smart tools to better manage energy and water consumption). This leads to product life-time extension. Users will engage in co-creation through sharing platforms with architects, investors and developers to achieve tailor-made solutions.	Facility managers will increasingly need to manage data. Their role may expand to manage more contracts with a service providers and lease constructions. The different components of a circular building will be increasingly interconnected and as a consequence, the management of the building can become more complex. New companies enter into the management of contracts. They will be responsible for the contract management of buildings when building systems become servitized. Investors will be more likely to invest in an asset once the complex contract management is secured by these intermediary companies. Facility managers may take up this role.

	SPECIALIZED CONSTRUCTION AND INSTALLATION COMPANIES	OWNERS
LINEAR	These companies sell and install specialty products in both new construction and renovation projects. During the operational phase of the building, these companies perform maintenance and replacement activities.	The owner of a building considers it an asset (both short- and long-term) and wants to guarantee the highest value of the building and operating margin. Maintenance is based on profit. Owners can also be the users of a building and in this capacity act as developer.
CIRCULAR	Construction and installation companies deliver services and keep ownership of (often high-tech) products or services. As they remain owners, they disassemble their products at the end of life and take it back to be refurbished, reused or recycled. They may extend their activities to the decommissioning phase.	Besides design and construction, the value of a circular building is determined by its function, level of circularity and the behavior of its users. As buildings increasingly become a collection of different contracts and providers of materials, the role of owners will evolve from the asset ownership model used in today's linear built environment.
CHANGE	The business model of construction and installation firms may expand to include product as a service, leasing constructions, take-back clauses and demolition services. They need to understand how to recover their resources. When these companies retain ownership, maintenance and decommissioning of their products will become more relevant. As these company remain owners of the products and are responsible for refurbishment, reuse or recycling, they need to better understand the composition of the products and their environmental and social footprint. Material passports are an essential tool to support this. However, these companies will need to spend additional efforts to collect information during operations (i.e. maintenance costs).	As buildings become resource banks comprised of service agreements, the owner's role inherits responsibilities like contract management, data management, provider of smart solutions and support for optimal use.

DECONSTRUCTION OR DEMOLITION COMPANIES

WASTE TREATMENT COMPANIES

LINEAR

Demolition companies bring down buildings, separating bulk waste streams of limited value. Demolition contrasts with deconstruction, which involves taking a building apart while carefully preserving valuable elements for reuse purposes.

Waste treatment companies collect waste to partially recycle, to incinerate for energy recovery or to dispose of in landfills. These companies also collect waste that is not related to demolition of buildings such as paper or household waste.

CIRCULAR

Demolition and recycling businesses become suppliers of materials and elements and advise architects and engineers on material lifespan. They separate the individual elements of a building to prepare them for reuse, refurbishment or recycling aiming to preserve the highest value of these elements (materials, products). They work together with service providers such as installation companies to retrieve valuable elements. On the other hand they either collaborate with traders and wholesalers to sell materials or are an essential stakeholder to provide information to the market about the availability of resources (quantity, quality and timing). They may expand their business to include the role of supplier.

Waste treatment companies play a key role in recycling the materials into new use cycles. They take over the responsibility for waste management from their clients and apply sophisticated technical solutions to separate waste streams into individual components. Waste treatment companies are suppliers of secondary materials. This may be complementary to demolition companies or deconstruction companies or as a joint effort where the waste companies process the waste of demolition companies.

CHANGE

- Demolition companies will increasingly focus on high value resource recovery of materials and are already responsible for phasing out pollution in building resources such as asbestos or leaded paint.
- They will become a supplier of resources and take part in sharing platforms.
- They need to find technical solutions to deconstruct a building into high-value elements in collaboration with architects and construction companies.
- They will need to work on a more integrated value chain that transcends individual phases.

- The position of waste companies will change in the value chain as they further develop into providers of resources instead of the end point caretaker of waste streams. As waste will be separated into different resources, the volumes that are incinerated or dumped on landfill sites will reduce to zero. This can have a huge impact on existing business cases and companies need to adjust.
- Waste companies need to manage resources for full recovery, recycling, reuse, etc, and need to connect to the market to sell their resources that will get a new application.

	REGULATORS AND LEGISLATORS	FINANCIAL INSTITUTIONS AND BANKS
LINEAR	Through legislation and policy, regulators protect users, citizens, companies and employees against unfair and adverse impacts. Regulation and legislation is risk-based. Regulators apply measurements that influence the market but sustain a linear built environment (e.g. taxing labor instead of physical resources)	Financial institutions and banks are key drivers for the economy, applying evaluation and risk models to maximise profit across their portfolio. They support the building sector through investments, loans and other traditional financial banking products.
CIRCULAR	Regulators and legislators implement measures that drive the built environment towards circularity. These measurements encourage innovation and work towards leveling the playing field.	Financial institutions develop new financial instruments that are adapted to the circular economy and characterized by a more complex ownership structure. Financial institutions will expand their services to include consultancy on development of new cases and business models that support clients. One potential service they could offer is market analysis for areas of the built environment that lack a proven return on investment. Financial services will have to adapt their perception of risk. To do so, they will require more insight into processes and possibilities of the circular economy as well as promising entrepreneurs. Financial institutions will have to adjust risk models to address risk associated with the use of secondary materials and products, more complex approval procedures and maintenance risks.
CHANGE	• Regulators and legislators improve awareness about the circular built environment • Drive a co-creative effort to develop legislative measurements that stimulate the circular built environment. Legislation needs to drive market mechanisms aiming at incentives that create benefits for circular solutions over linear solutions. • In their own day-to-day activities, governments (legislators and regulators) need to take a lead on circular-stimulating policies, such as circular public procurement policies.	Banks and financial institutions need to adapt their business model and their products to support the circular economy by: • incorporating the externalities in the risk assessment of non-circular alternatives, • adapting the risk assessments to multiple-ownership structures, • absorb more risk in innovative solutions, • accounting for new financing models like crowdfunding, which are adapted to more innovative businesses. Accounting principles (i.e. IFRS or GAAP) and valuators are key in new depreciation practices and residual value estimation.

3.2 Barriers for the Circular economy

In the previous sections we have discussed the change needed to move from a linear to a circular built environment and the evolution in the role of various stakeholders. As mentioned, elements of the circular built environment are already emerging. Nevertheless, there are barriers that must be addressed to make these elements mainstream. We identify five cross-cutting barriers that apply to the changing roles of stakeholders, the five business models and the characteristics of the circular built environment. Examples of barriers that prevent a level playing field for circular solutions are subsidies for extracting virgin resources or inconsistencies in policies between neighboring jurisdictions.

A. Culture and beliefs

Company culture and personal beliefs influence the pace at which the transition takes place. It can become a barrier when organizations or people are uninformed or unconvinced. Factors that may serve as barriers in this context are:

1. Company culture;
2. Reluctance to collaborate in the value chain due to competitive, cultural or trust issues;
3. The reluctance of consumers to buy 'used' products and materials or pay a reasonable price;
4. Status quo bias, or the comfort of operating in a known and trusted linear system versus the discomfort of a new circular world.

B. Regulations

Legislation and regulations are an important driver for the economy. They influence a level playing field, protect fair trade, address health and safety issues, protect humans and the environment, among other issues. Legislation can stimulate economy, as when new ambitious (long-term) laws drive innovation. As regulations typically follow public opinion, legislation may not always account for a rapidly growing, global trend like the circular economy. Examples of regulatory barriers that inhibit scaling the circular economy in the built environment include:

1. Limited commitments to circular green public procurement;
2. Laws, regulations and technical standards that do not support the innovations that are needed in the circular economy, such as applying re-used products (construction/installation) within a new building;
3. Delays in permitting due to longer approval processes;
4. Lacking consensus within local, national and global governmental bodies (e.g. systematic and consistent approach to waste management).

C. Market

The 'market' mechanism is a key driver and barrier for the circular built environment. Once circular alternatives deliver comparable or better results than conventional solutions, according to market principles (better profits, lower risks and costs, etc.) the transition to a circular built environment is expected to accelerate rapidly. The barriers that are related to the market include:

1. Low virgin material prices;
2. Circularity is scarcely considered in asset valuation;
3. Better understanding of the risks involved in the linear economy compared to the circular economy. Lack of experience can lead to higher perceived risks and reluctance to provide financial support.
4. High upfront investment cost, such as in product innovation or in mobilizing an integrated design process;
5. Limited subsidies or market incentives for secondary materials and products;
6. Lack of market volume or economies of scale for new and innovative circular products.

D. Technology

The transition towards a circular economy also requires innovation to address technical challenges observed today, such as waste stream separation. Developing new technology is resource intense (time, money) and needs a clear business case. Technological barriers to scaling the circular built environment include:

1. Harvesting and supplying remanufactured products;
2. Limited experience with circular design within built environment;
3. Lack of large-scale demonstrations projects and experience with new technologies;
4. Sharing information about the availability, quality, location of circular materials;
5. Lack of data on environment footprint, technical performance, tracking and reuse planning.

E. Education and information

Education about the circular built environment, its implications and expertise involved is needed to align and connect the value chain. The topic is currently known to a limited circle of environmental experts. Scale can be reached when circular economy is an integral part of education, lessons are shared, and actors can build on experience from others. Information sharing is still very limited and is a barrier for acceleration and scaling. Examples of this include:

1. Limited attention to circular economy in architecture studies and design;
2. Lack of education programs in circular thinking for primary and secondary school, vocational and higher technical education;
3. Limited communication about circularity of buildings;
4. Lack of knowledge-sharing in the physical world;
5. Limited sharing of best practices in the building environment and translation to different contexts;
6. No capacity or time for market actors to follow informative courses about the benefits and the approach of circular economy;
7. Different level of knowledge and awareness in the value chain;
8. The lack of consumer and investor awareness and interest in circular economy

- **The five barriers are linked**

The transition towards a circular built environment will lead to a cultural change: our way of looking at the world and the role of buildings in it needs to change dramatically. Cultural change is one of the most powerful drivers, and at the same time emerge as the main impediment.[28]

The cultural change follows the market change that, in turn, is stimulated by regulation. The absence of market mechanisms that favour circular solutions over linear solutions are a key barrier for progress. Stringent regulation hampers much needed technological innovations and lack of awareness prevents large-scale adoption of new ideas and opportunities.

The lack of technology and education similarly slows down the transition. Design strategies will need to change to identify new technological solutions. When technology is integrated into the market, consumer behavior and culture, circular innovations can be scaled if enabled by regulations and the market.

Due to strong links between the barriers, it is complex to resolve a single barrier individually. In a sector that typically solves challenges in a conservative way (culture), where incentives for approaches beyond compliance (regulations) are limited, and that depends on the adoption of suppliers who have limited awareness of circular alternatives, the market will not reach a scale in which circular becomes more favorable than the linear convention today.

Development of regulations and legislation that drives the circular economy further is challenged by the lack of good examples and broad experience with circular solutions. There is no broadly recognized standard on circular design and construction upon which regulations can refer to. Lack of clear and standardized regulations are needed to drive the circular market.

- **Public and private sector collaboration**

There is a responsibility and opportunity for public and private sectors to work together on accelerating the transition towards the circular built environment. Public and private sector must collaborate to organize the market to stimulate circular activities. Regulations and legislation are essential drivers for a more circular-oriented market. This will be explored in the final chapter below.

More circularity in the built environment will deliver increased growth and value for the entire building chain.

Pascal Eveillard
Deputy VP Sustainable Development,
Saint-Gobain

4. THE WAY FORWARD

In the previous chapters we defined the circular built environment, the value chain changes that are needed and the evolving roles of different stakeholders. We identified five barriers that are currently inhibiting the transition. There are two broad stakeholder groups that hold the power to collaboratively to stimulate acceleration of the circular built environment: the private and public sector. Both have an essential role in the creation of the circular market by organizing a level playing field and scale[29].

4.1 The key to the next step in the circular built environment: scaling in a level playing field

- **Cultural change is driven by the market**

In order to change culture and behavior the market barriers to the circular economy must be addressed. Circular alternatives should be economically advantageous (e.g. through price, access to finance, etc.). Circular options must become cost-competitive, convenient and dependable in addition to any environmental benefits.

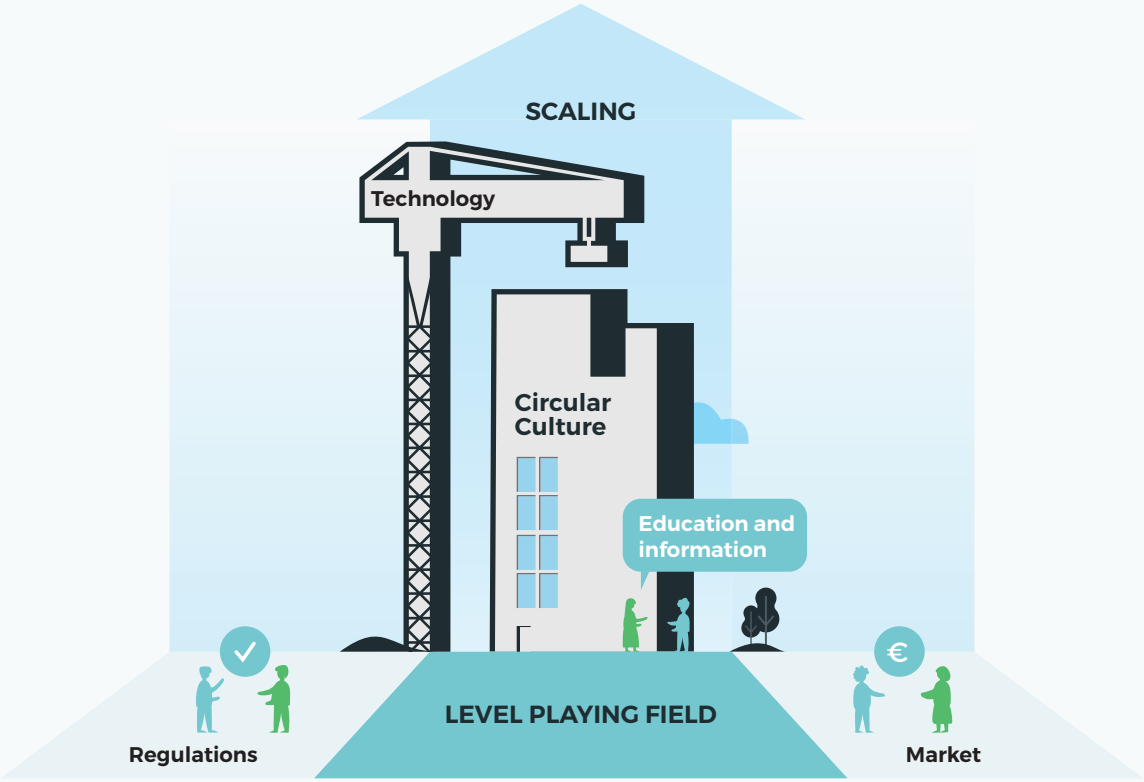
- **The market must favor circular over linear**

Market dynamics must favor the features of a circular built environment. The economic feasibility of the circular economy needs a push to address the urgency of today's environmental challenges. The costs for a circular building as a whole are currently estimated higher than the costs of a conventional building. However, the cost of a circular building is still measured in a linear way: land, material, design and construction costs. The industry must start interpreting costs differently to create an advantage for circular solutions. For example, life cycle costing should be the new normal. Sustainability and energy efficiency have steadily integrated into construction documents and value models. Two examples of sustainability valuation integration are the European Union's Horizon2020 project RenoValue and RICS Redbook.[30,31]

- **Availability and performance of secondary materials are critical to achieving economies of scale and ultimately, lower costs.**

Insufficient secondary resource supply and the technology needed to integrate those materials back into the cycle challenge the feasibility of a circular built environment. In particular, the validation and the technical performances of recycled or reused materials needs more attention. Circular materials and products should meet or exceed the same specifications for their linear counterparts.

Figure 4. Drivers to scale circularity in the built environment



- **Regulations can drive markets and level the playing field**

Market for circular solutions may result from resource scarcity challenges or regulatory measures like subsidies or public procurement policies. Regulations that stimulate the circular economy are most powerful when they are applied in a level playing field, providing equal commercial opportunities for all organizations active in a certain area, region, continent or at global level. When considering the global scale of a circular built environment, a level playing field becomes essential to drive the transition.

How scaling in a level playing drives the circular built environment

- **The importance of scaling**

The transition needs scale. In addition to regulatory interventions, the price for circular solutions is affected by availability and trust. Scarcity of non-renewable resources is expected to drive market prices for building materials. This may create a better market for secondary materials as prices become competitive. However, the supply quantity and quality of circular materials are inconsistent compared to virgin materials. Scaling up of material recovery and recycling are required to improve the market for circular solutions. Recovered materials need to have similar qualities as their virgin alternatives. Collection and processing costs of secondary materials must be comparable with extraction and processing costs of virgin materials. Again, scale and efficiency is needed to make this happen.

Experience and familiarity with circular solutions (e.g. product as a service models) is still relatively limited. There are many initiatives ongoing, but with limited scale and in many cases very context specific.

As society's demographics and priorities change, so does culture. New generations are more open to product as a service innovations, multinational companies have a strong sustainability drive, and cities are taking more responsibility. As adoption of circular built environment principles grows, the economic, environmental and social benefits will become apparent.

Why we need a level playing field

For the private sector, a level playing field is essential for long term planning, investments in innovation and corporate strategy. A unified, global market is essential. A level playing field supports scaling as solutions become applicable in a larger region. The European Union has an opportunity to create a regional, level playing field for a circular built environment.

The level playing field and regulations that support it, should be organized in a way that renewable and secondary materials are more favorable than virgin materials. The built environment will continue to depend on virgin resources throughout the transition. However, a thorough assessment of circular options should be considered prior to specifying materials or products that use virgin, finite reosurces.

What can be done to stimulate scaling in a level playing field?

- **Legislation**

A level playing field can be stimulated by standardized legislation based on a strong, long-term vision. Countries should commit to these regulations and prevent local interpretations or exceptions. Many companies are active in the global arena and will benefit from a unified, international regulatory framework.

- **Criteria and certification**

Scaling can be achieved by integrating circular criteria into standard terms of reference. Circular criteria should become the core of procurement (both public and private sector). It should not be limited to 'green' procurement but should set the standard for all types of procurement. The circular economy should also be integrated in quality certification and labelling. This will also improve competition with primary raw materials.

The European Union's Level(s) framework is a voluntary reporting mechanism designed to improve the sustainability of buildings. Using existing standards and as part of the EU Circular Economy Package, Level(s) provides a common EU approach to the assessment of environmental performance in the built environment. This framework can be used for unified procurement frameworks.

We strongly support a level-playing field where secondary resources are cheaper than virgin resources.

Kim Meulenbroeks
Manager Consultancy, *Renewi*

The Urban Mining Collective (UMC) is a collaboration that uses cities as mines. Partners of UMC work together to realize circular buildings, such as a 100% circular temporary building for the Dutch Design Week. This collaboration crosses the entire value chain, from design to wholesale and banks.

Stora Enso develops and shares design manuals for collaborative use. These manuals help architects and constructors implement circular materials into circular design and construction.

4.2 Both the private and public sector can stimulate acceleration

The private sector and governmental bodies are powerful actors that can jointly help accelerate the circular built environment.

4.2.1 Actions for a leading private sector

The private sector needs to find ways to create scale and to cluster experiences and efforts. The circular built environment requires collaboration across the entire value chain, connecting all phases of a building's life cycle. Consumers are increasingly becoming aware of and demanding circular features. In order to create scale in a collaborative effort, the private sector should focus on the following actions:

- **Collaborate with peers**

Collaboration between peers (industrial symbiosis) is needed to create new technologies in a pre-competitive arena. At the start of any project or process, companies should explore how partners can be part of the solution. This may be identifying circular building materials or sharing water and energy between facilities. By putting circular thinking first, companies create scale and support a different mindset.

- **Scale up collaboration between large green companies and SMEs**

SMEs offer innovative solutions but lack the capacity to scale up. Multinational companies can invest in SMEs or support them in other ways through advice, guarantees, etc.

- **Co-create across the value chain**

Value chain companies will find opportunity in co-creation. Companies will connect with various stakeholders in the value chain and design solutions that relate to the use and users of a building (e.g. Design Thinking). Architects and contractors will work together with demolition and recycling companies to develop efficient technical solutions designing for end-of-life.

Users will also be involved in the process. The users will benefit from better alignment with their demands while material suppliers will depend on them to retrieve the materials in optimal state and value.

Financial institutions should be involved in the entire process to understand the risks and opportunities involved and identify new solutions. Ideal collaboration would see co-creation between those at opposite ends of the conventional building value chain. For example, architects should connect to suppliers, constructors and demolition companies, and vice versa.

- **Develop common standards for circular materials**

To help companies to collaborate, a common standard for circular materials should be considered. Standardization relates to the nature, composition and dimensioning of materials and products. To allow companies to take back materials that are produced by another company, it would be beneficial for products to be developed according to a standard range of specifications that all companies comply with.

Mitsubishi offers an elevator as a service. The elevator can be deconstructed in elements that can be used in another elevator without significant modifications. This requires standard design and dimensions that architects can readily use in their plans. With Mitsubishi's M-Use®, the elevator remains in ownership of Mistubishi. In exchange for an annual fee, Mitsubishi takes care of maintenance and operational management for the owner.

- **Expand product stewardship to include service through new business models**

Companies may improve product stewardship and customer relationships by engaging in service contracts instead of conventional single-transactions. The product as a service model incentivizes companies to improve product lifetime and durability as they take them back at end of use.

Katerra provides not only prefabricated building elements but also construction services for assembly onsite. The company has become an end-to-end building company.

Philips Lighting offers commercial lighting as a service. As opposed to the original business model of selling lamps and ballasts, the company now provides a full service that includes maintenance and operations, smart technologies and take-back.

- **Invest in scaling through pilots**

One of the recurring barriers to take steps into the circular economy is the lack of experience. Small-scale pilot projects are necessary to capture initial learnings without too much investment or costs to the company.

ABN AMRO developed the CIRCL building in Amsterdam as a demonstration of how circular design and construction can be done without compromising function or aethetics.

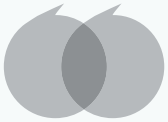
Albron, a catering company, created The Green House to develop a feasible and sustainable circular food concept.

- **Provide non-financial support and invest in education**

Companies should work to improve internal understanding about circular economy principles. The more employees that understand circularity, the more opportunity for scale. Non-financial support can be a first step in helping internal and external stakeholders set up circular initiatives.

- **Integrate circular principles in procurement**

To support scaling up the circular built environment, companies need to start with integrating circular criteria in their procurement strategies (i.e. reduce single-use plastic, transport, waste, etc.) and stimulate suppliers to innovate in open, collaborative discussions. In relation to creating scale for SMEs, large companies can build procurement alliances with SMEs or invest in pilots.



As a sustainable developer, we are continuously on the lookout for future-proof solutions. Recent advances in circularity have largely shaped the way we innovate.

Sandra Gritti
Product Excellence Director,
EDGE Technologies

4.2.2 Actions for leading governments

Government bodies are undoubtedly the most important actors that can support a level playing field at (sub-)national and global scale. They can implement regulatory and financial instruments that facilitate competitiveness of circular solutions while stimulating innovation. Fiscal incentives such as Value-Added Tax (VAT) and a shift from taxing labor to materials can be relevant approaches. Governments can organize design competitions or integrate competition elements in their procurement strategies to stimulate innovative approaches. More specifically, governments can support the transition to a circular built environment by the following actions:

- **Develop long-term vision and ambition, communicate clear targets and hold organizations accountable**

The circular built environment needs a long-term approach, and governments should be leading the transition. The private sector can adapt its long-term strategy to the government's ambitions and adjust risk management accordingly. This vision can be aligned with climate legislation, further creating a level playing field and supports scale.

> The Dutch government has issued a government-wide program for a circular economy aimed at developing a circular economy in the Netherlands in 2050. Many governmental organizations have to meet this challenging goal and integrate circular principles into their day-to-day operations, such as circular procurement criteria. In establishing such a standard the government creates a demand pull for circular supplies such as recycled content.

- **Develop a single, international framework for waste legislation**

Waste and by-products are classified differently according to regional and national regulations. One clear framework for waste legislation that stimulates free exchange of materials and that allows for recycling of materials is needed. Existing regulations need to provide sufficient room to reuse materials that in a linear economy are classified as waste, but with circular innovation can be reused. Existing legislation and regulation that describes the policy for traditional waste activities such as collection, recycling, incineration and landfilling requires updates. Without threatening health and safety of people and the environment, legislation should provide the freedom to use secondary material flows. Landfilling of construction and demolition waste should be banned, requiring these materials remain available in the economy. The level of environmental protection should remain at its actual strength, while markets for circular economy should not be hindered by legislative requirements. The European Commission is working on this challenge through its Communication program on the interface between chemical, product and waste legislation. Increased availability and trade in secondary materials stimulates the market for circular building solutions. For example, using secondary granulates may need an end-of-waste declaration according to European law. This is not always available and procedures are diverging and complex.

- **Include circular criteria in government purchasing standards**

Governments can create scale by including circular criteria as a standard for sustainable purchasing. The public sector is one of the largest clients of the construction sector. For instance, in the Netherlands the government (provinces, municipalities, water boards, ministries) is responsible for more than 15% of all building activity.

When circularity is fully integrated into purchasing criteria, the government can contribute dramatically to scaling the demand for circular solutions.

- **Adjust legislation to stimulate development of new business models**

At continental, national and regional levels, regulations should facilitate the development of new business models. The circular economy requires new ways of doing business. Current legislation does not always enable businesses to adopt these new models.

For example, financial regulations forbid banks from taking risks without sufficient capital backing. This may hinder banks in developing products for circular multi-owner settings.

Even the issuing of building permits fail to carry the creativity and flexibility needed to account for changes due to circular design and construction. Innovative collaborative structures that join various partners in the value chain, such as alliance contracting, Public Private Partnerships and Private Finance Initiatives, need legislative support.

- **Develop more legislation and governmental support to stimulate circular solutions**

Government support for circular solutions is limited or absent in most cases. Governments should consider transferring subsidies from linear resources to circular solutions.

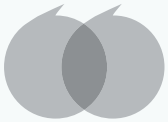
Governments should also identify how they can best stimulate circular innovations locally. Instruments such as revolving funds that support start-ups in their scale up could be useful to kickstart and scale promising innovations. Regulatory instruments should aim at stimulating the market.

In Japan, the recycling infrastructure is co-owned. The law requires consortia of manufacturers to run disassembly plants, ensuring they directly benefit from recovering materials and parts. Manufacturers therefore make long-term investments in recycling infrastructure. Companies that own factories and recovery facilities, let product designers visit their factories to experience how design features impact dissassembly and recovery. Some companies test prototypes to optimize the disassembly process for maximal recovery. It is not only a technical success, but also highly profitable. Japan's reuse and recycling economy was worth £163 billion in 2007 (7.6 per cent of GDP) and employed 650,000 people.[32]

Since Netherlands adopted the objective of being 100% circular by 2050, more than 40% and 50% of architects and engineers participated in circular projects as of spring 2018. Contracting and installation companies participated at rates of 20% and 25%, respectively.[33]

DID YOU KNOW?

DSM-Niaga redesigns products from the ground up, using a simpler set of pure materials to make better products that are 100% recyclable and fully sustainable. Using the expertise of DSM in adhesives, the company develops new fully circular products in co-creation with other companies in the value chain. Their first product was circular carpet. The company is an example of how circular companies expand their focus to seek collaboration with other value chain partners. For example, DSM educates and helps carpenters apply circular design and maintenance techniques to their products, resulting in product lifetime extension.



We need innovative business models. Increasing floor space could ensure additional income and be a model to fund building renovation.

Jari Suominen
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Stora Enso Wood Products

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FOOTNOTES

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THIS REPORT IS PART OF THE FACTOR10 PROJECT OF WBCSD

Factor10 is WBCSD's circular economy project. It brings companies together to reinvent how business finds, uses and disposes of the materials that make up global trade. It's a platform that will help to identify and remove the barriers that exist and create scalable solutions that businesses all around the world can use.

By collaborating on solutions that go beyond business as usual, Factor10 will deliver high-impact, large-scale results where resources are used wisely, processes create the greatest possible value, and nothing is wasted.

In order to reach Vision 2050 in which not a particle of waste exists, eco-efficiency of materials must improve by a factor of 10. This target was previously referenced by the Factor10 Institute in 1994 when they called for the ten-fold improvement in resource efficiency.

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