



CIRCULAR BUSINESS MODELS FOR THE BUILT ENVIRONMENT

ARUP



ELLEN MACARTHUR FOUNDATION

The Ellen MacArthur Foundation was created in 2010 to accelerate the transition to a circular economy. The Foundation’s work across five areas: insight and analysis, business and government, education and training, systemic initiatives, and communication. The Foundation collaborates with its Global Partners (Cisco, Danone, Google, H&M, Intesa Sanpaolo, Nike, Philips, Renault, Unilever) and its CE100 network (Corporates, Universities, Emerging Innovators, Governments & Cities, and Affiliate organisations), to build capacity, explore collaboration opportunities, and to develop circular business initiatives.

CE100

The Circular Economy 100 is a pre-competitive innovation programme established to enable organisations to develop new opportunities and realise their circular economy ambitions faster. It brings together corporates, governments and cities, academic institutions, emerging innovators and affiliates in a unique multi-stakeholder platform. Specially developed programme elements help members learn, build capacity, network and collaborate with key organisations around the circular economy.

CO.PROJECT

Co.Projects are opportunities for formal collaboration between CE100 members. They are driven by members, for members and their focus can range from research initiatives to pilots to toolkits. Co.Projects leverage the CE100 network with the aim of exploring opportunities and overcoming challenges which are commonly and collectively faced by organisations making the transition to a circular economy, and which organisations may not be able to address in isolation.

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INTRODUCTION



Image: 'Circular Building', London Design Festival 2016, R&D project designed and developed by Arup, BAM, Frener & Reifer and The Built Environment Trust. Photo credit: Autex, providers of detachable acoustic fabric made from recycled bottles.

To instil confidence and reduce the uncertainty surrounding Circular Business Models (CBMs) within the built environment sector, this report explores ways CBMs provide added benefits throughout the value chain. By highlighting the value proposition to all stakeholders, it is intended that more companies will see the benefit of contributing to a built environment based on a circular economy.

However, CBMs cannot be achieved without intervention, as in today's economy there are numerous examples of where it is currently perceived as more cost effective and convenient to dispose of resources after their first use rather than re-use them. By taking a systemic view across the whole life cycle of assets, using new technologies and applying advance design approaches, additional value could be created. This value will demonstrate an economic business case for adopting CBMs, as well as providing wider global benefits (financial, social and environmental).

Funders, owners and occupiers will be fundamental to driving a 'circular built environment', by choosing to adopt alternative development strategies, ownerships structures and operations models. However architects, designers, engineers, suppliers, contractors and facilities managers will have a crucial role in creating circular solutions to facilitate a move to CBMs.

The content of this report is applicable to the built environment as a whole, but many of the examples cited focus on commercial building developments. The general principles are the same for other project types, i.e. infrastructure / PPP, although the use periods, ownership models and supply chain interactions differ accordingly.

“The built environment offers a huge opportunity for businesses, governments and cities to play a leading role in realising circular economy without having to wait for the transformation of the whole system. Tangible examples that develop in this space can act as a catalyst for a shift in how our cities and urban areas operate in the future.”

**Casper Jorna, CE100 Programme Lead,
The Ellen MacArthur Foundation**

1.1 FORWARD FROM THE ELLEN MACARTHUR FOUNDATION

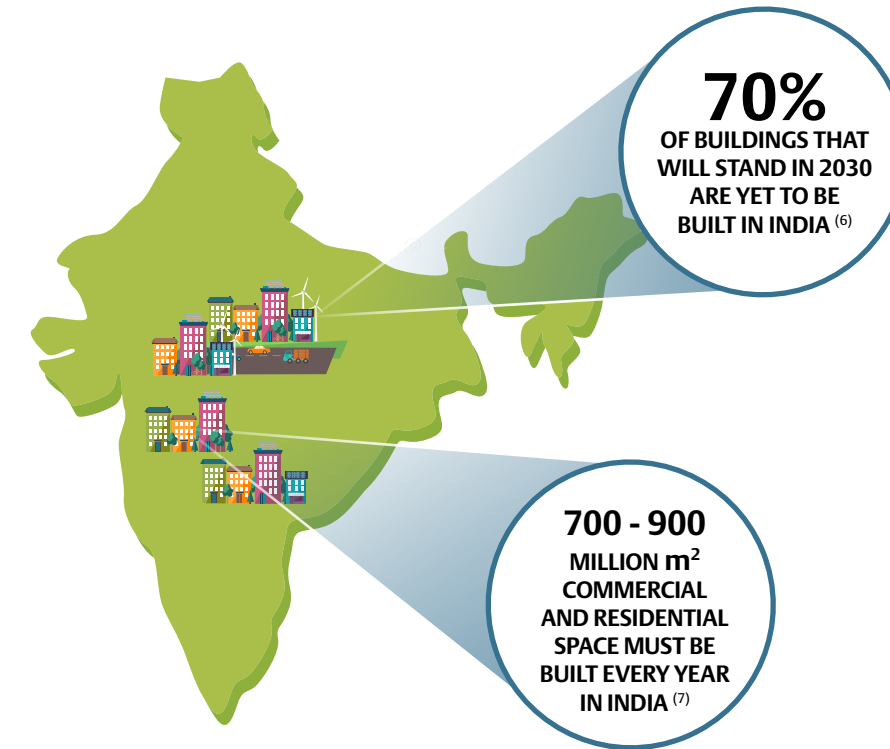
Due to their density and network effects, cities have an enormous potential to decouple high-quality lifestyles from material consumption and negative externalities. These challenges and opportunities will only grow: by 2050, 66% of the global population is expected to live in urban areas, up from 54% in 2014 ⁽¹⁾.

It is perhaps no surprise that the global construction industry is the largest consumer of resources and raw materials of any sector. Fast growing cities have a tremendous opportunity to take advantage of system-level ideas that harness digital technologies to help share vehicles and buildings, track materials and increase access to services. Mature cities also have plenty of scope to improve resource outcomes: 60–65% of European office space, for instance, is under-utilised even during working hours ⁽²⁾. Applying circular economy principles to the design of urban infrastructure can be foundational to providing cities with inclusive economies that work in the long term.

CITIES CONSUME
75%
OF GLOBAL
PRIMARY ENERGY ⁽³⁾

CITIES ARE RESPONSIBLE FOR **70%**
OF GLOBAL CO₂ EMISSIONS ⁽⁴⁾

CITIES CONSUME
75%
OF THE WORLD'S
PRODUCTION
OF NATURAL
RESOURCES ⁽⁵⁾



When discussing the value proposition of circular economy, there is potential for most parties to benefit. However in practice, so far, the client or end user seems the highest benefactor. There are examples of a few large manufacturers or suppliers that have clearly developed their business models by selling performance contracts e.g. Phillips pay-per-lux model. The following years will see a rise in the number of smaller organisations bringing new business models to market. Designers, contractors and suppliers will need to consider longer term relationships, whilst the demolition landscape is set to radically transform, with maximising material/asset value becoming a key deciding factor.

2

CIRCULAR ECONOMY: AN OPPORTUNITY FOR THE CONSTRUCTION INDUSTRY

The circular economy presents existing businesses with opportunities and risks. Work undertaken by the McKinsey Centre for Business and Environment in 2015 identified a potential boost of €1.8 trillion to the EU economy by 2030 ⁽⁹⁾.

At the same time, disruptive innovators are adopting new business models using circular economy principles and transforming established markets with incredible speed. The application of circular economy to the construction industry requires a systems-thinking approach, one which gives an understanding of the whole building lifecycle and the construction value chain, or in other words, understanding the wider context in which development takes place. Only once the value chain is fully understood can the opportunities of the circular economy be realised.

“We live in a world of 7.5 billion people, all seeking a good quality of life. This challenge, coupled with climate change, means our long-term prosperity depends on creating sustainable lifestyles for everyone. We need materials that can be used time and time again. Steel is that product, and the continuous invention of new steels means that it has a key role to play in the future.”

Dr Alan Knight, ArcelorMittal

2.1 CONSTRUCTION INDUSTRY TODAY

The construction industry has traditionally followed a take make dispose process. This has led to a number of challenges that need to be overcome.

THE CONSTRUCTION
AND OPERATION OF
THE BUILT ENVIRONMENT
CONSUMES

60%
OF ALL MATERIALS
IN THE UK ⁽¹⁰⁾

More than 400 million tonnes of materials are delivered to UK sites each year. Of these, 60 million tonnes go to landfill due to over ordering, ordering incorrectly or damage due to poor storage ⁽¹¹⁾.



IN EUROPE,
2.7 BILLION TONNES
OF WASTE WAS
GENERATED IN 2010, AND

ONLY 40%

WAS REUSED,
RECYCLED, COMPOSTED
OR DIGESTED ⁽¹²⁾

CONSTRUCTION AND
DEMOLITION WASTE
ACCOUNTS FOR
APPROXIMATELY

25-30%
OF ALL WASTE
ARISING IN THE EU ⁽¹³⁾

EUROPEANS NEED
BETWEEN

2 & 3

PLANETS WORTH
OF RESOURCES TO
SUSTAIN THEIR CURRENT
LIFESTYLES ⁽¹⁴⁾

Reducing the amount of waste we produce however, is about far more than just ordering the right quantity of materials. Current construction practices have waste built into the design. This is especially apparent where standard material sizes are used, for example sheet materials and traditional masonry.

2.2 BENEFITS OF MOVING TO A CIRCULAR ECONOMY

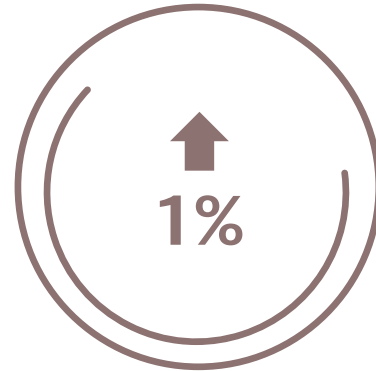
By adopting circular economy business models, the focus will shift to sourcing sustainably, maintaining material productivity over the lifecycle of developments, and reducing losses of non-renewable materials. This will produce financial, social and environmental benefits.

The market for a circular economy is growing and it is estimated that over the next 10 years, this will boost economic growth by up to 4% ⁽¹⁵⁾.

The circular economy will help businesses save on raw material cost as well as waste management costs, in line with the EU Waste Framework Directive. In light of rising landfill tax rates in the UK, reducing the volume of waste going to landfill would result in substantial financial benefits for businesses.

There will be little or no waste to landfill and environments will be enriched by biological nutrients reintroduced into the biosphere through composting and bio-digesters.

Growth will be de-coupled from resource extraction due to closed loops of technical components and increase of sustainable renewable materials. Fewer resources will be extracted thus reducing the impact on the climate.



...IN RESOURCE EFFICIENCY
IS WORTH AS MUCH AS
€23 billion
FOR BUSINESS ⁽¹⁶⁾



200,000
JOBS BY 2030. THIS COULD
DOUBLE WITH MORE
CHANGE FROM CURRENT
BUSINESS MODELS ⁽¹⁷⁾



A CHANGE OF SOCIETAL
MINDSET
IS FUNDAMENTAL FOR THE
CIRCULAR ECONOMY TO
FLOURISH

2.3 VALUE PROPOSITION

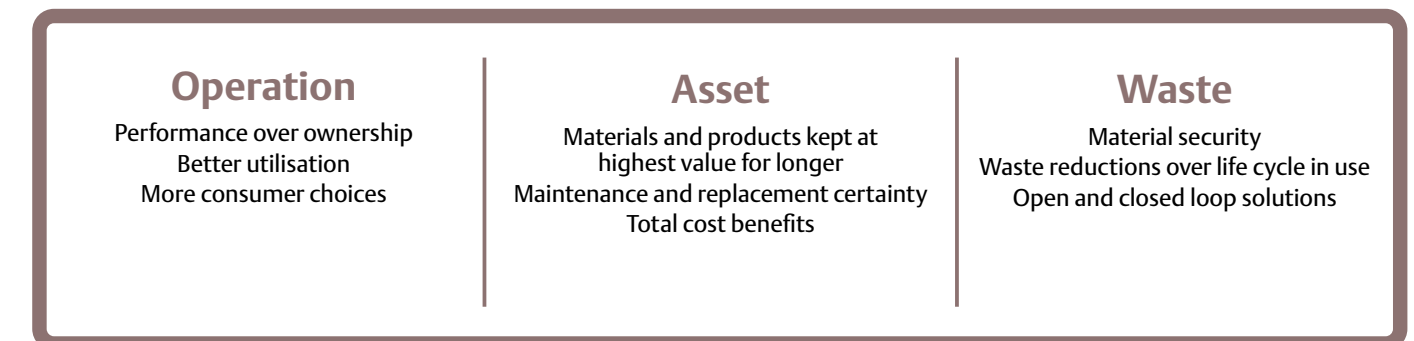
To maximise the value from a circular economy there are several enabling factors which will be needed. Generally these fall into 3 categories - design, information and collaboration. As a result

additional value will be created through the operation, with benefits for the asset value and waste production - as outlined below.

Enabling factors



Expected outcomes



3

IMPLICATIONS FOR THE CONSTRUCTION ECOSYSTEM



Image: ABN AMRO circular pavilion, Amsterdam. Architect: CIE; Contractor: BAM. Image provided by CIE.

At present, there are inefficiencies in construction business models, increasing costs at all stages of the commercial development cycle.

MANUFACTURE

The global economy is spending 30% more natural resources than it can actually afford ⁽¹⁸⁾.

UTILISATION

During their service life, buildings and the built environment assets are not used to their full potential, e.g. it is estimated that office buildings are only used up to 65% of their capacity ⁽¹⁹⁾.

END OF LIFE

The true value of these assets are not always considered because of the cost of maintaining plant, systems, interior finishes, fit out, etc. are often not borne by the same clients. This presents a challenge and an opportunity for the industry to appreciate a product's value in relation to a circular business model (CBM).

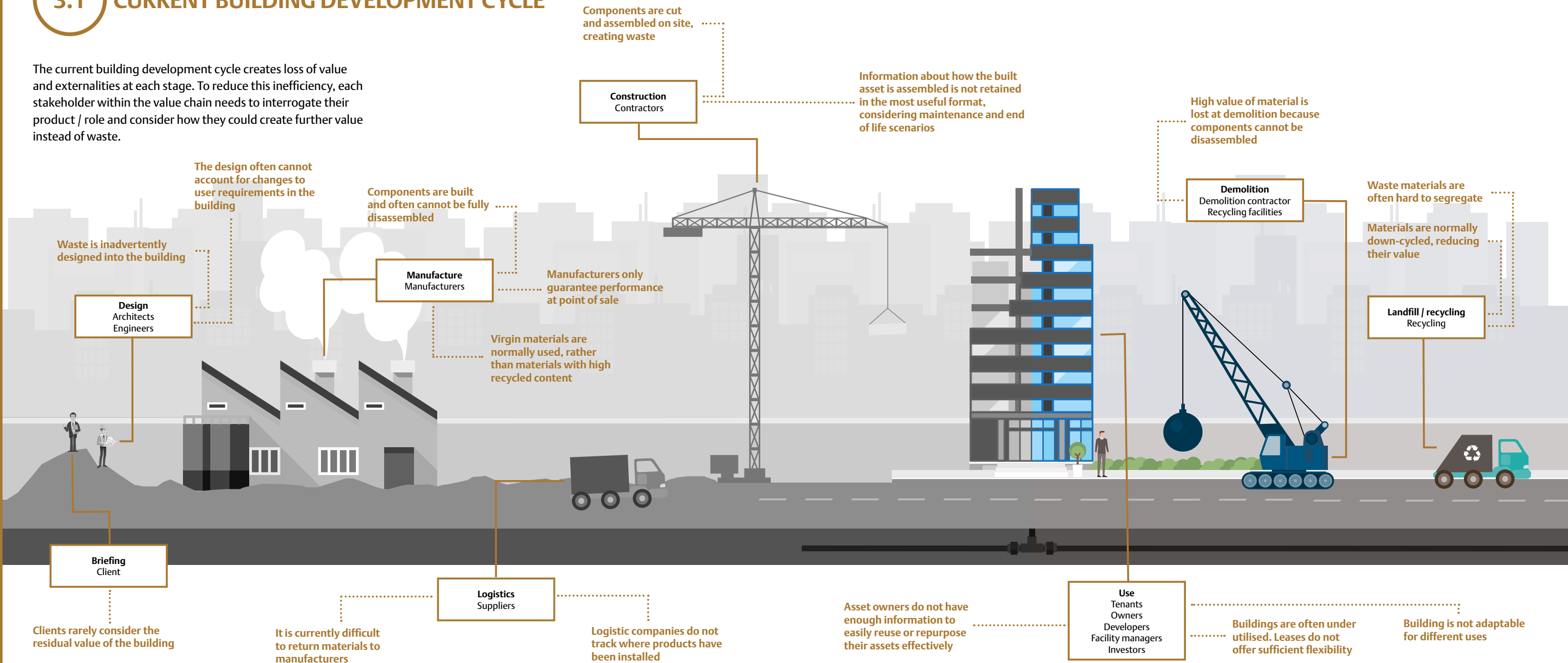
The circular economy when applied to a building development cycle will address these inefficiencies. Arup has investigated the development cycle for a commercial building to understand where circular economy principles will have the biggest impact⁽²⁰⁾. Value is added by increasing the ability of assets to respond flexibly to market conditions, increasing asset use, diversifying income streams and maximising the residual value of a building's materials. Challenges and opportunities exist in meeting initial research and development costs, financing business model transitions and fostering sufficient collaboration between industry actors to achieve and share the potential system-level benefits.

“In my view the most important catalyst for sustainable construction has to be the measurement, management and disclosure of environmental and social impacts throughout the entire supply chain. This should encourage more innovative procurement and contractual models that encourage circular design practices, and a whole life cost approach to design and building practices.”

Julie Hirigoyen, UK Green Building Council

3.1 CURRENT BUILDING DEVELOPMENT CYCLE

The current building development cycle creates loss of value and externalities at each stage. To reduce this inefficiency, each stakeholder within the value chain needs to interrogate their product / role and consider how they could create further value instead of waste.



3.2 BUILDING ECOSYSTEM

Stakeholders throughout the building ecosystem will all play a role in the transition to the circular economy - these include investors, tenants and government.

3.2.1 INDUSTRY COLLABORATION

The potential for the circular economy to change the ecosystem and value chain around the design, construction, operation, renewal and repurposing of buildings is high. In practical terms, it requires designers and investors to take a longer-term view, focusing on the lifecycle of a building and carefully mapping the past, present and future use of materials and components within the wider economic ecosystem.

To do that, suitable material databases – as already used in the automotive and aerospace sectors – need to be created to store the information required to facilitate reuse as well as to demonstrate residual value of materials at the building's end of life. This requires high levels of collaboration and information exchange, as well as tools and incentives that allow investors to receive a financial return on the residual value of buildings at the end of life.

New tools and platforms will support the change; the construction industry is already using Building Information Modelling or BIM, which combines people, processes and technology, to drive efficiency and improve performance.

3.2.2 A NEW ROLE FOR INVESTORS

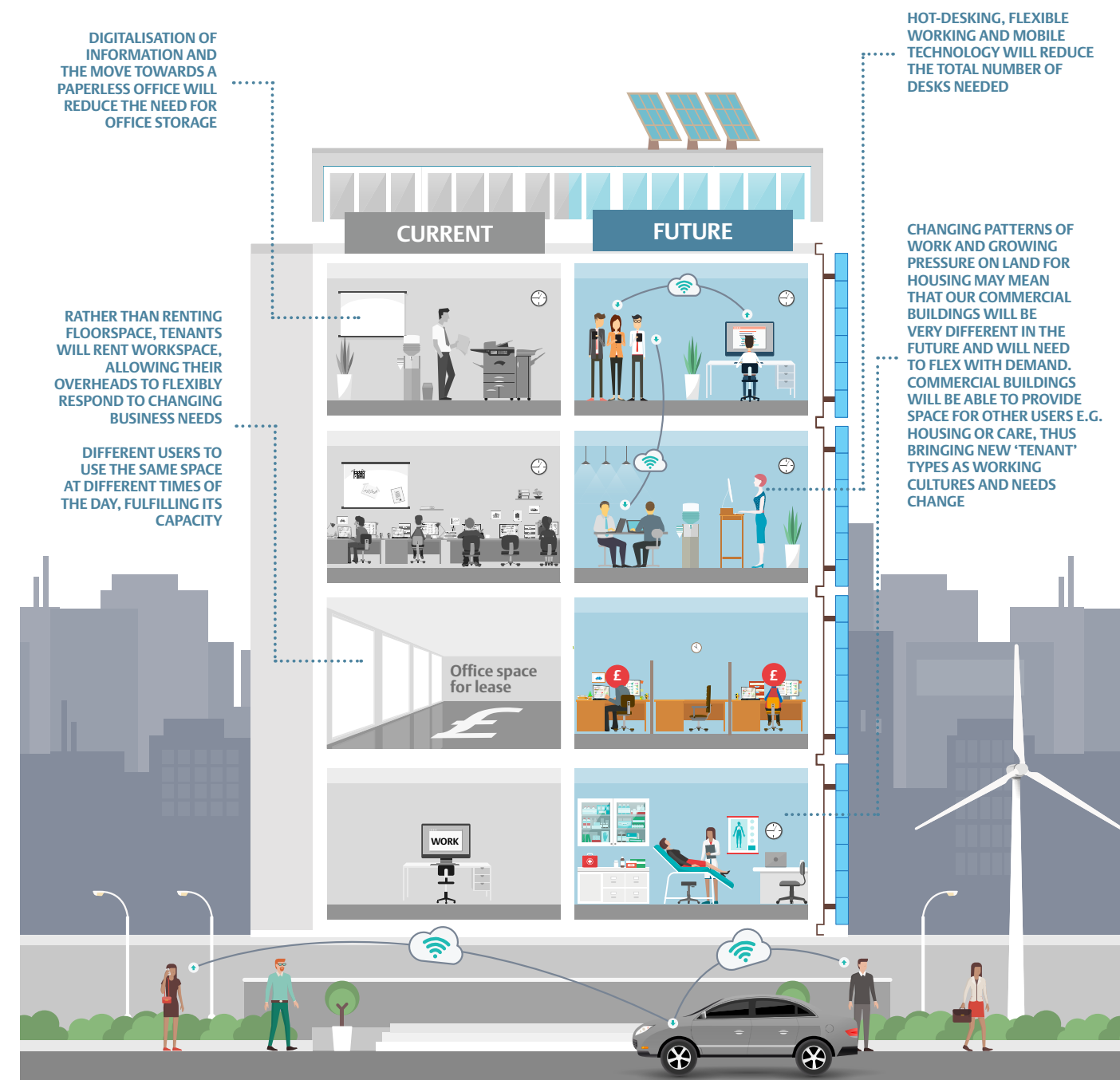
As stated in the Growth Within report⁽⁹⁾, the transition to circular models would involve considerable investments; research and development, asset investments, stranded investments, subsidy payments to promote market penetration of new products and public expenditure for digital infrastructure.

Current financing models use past performance to predict future results. This approach is based on the assumption that existing systems are fit for purpose and does not recognise the investment required to prepare for a more circular way of working. Business leaders looking to adopt circular economy business models need investors who use different approaches to assess value and risk.

Some investors are already preparing to adopt a different approach. Banks such as ABN AMRO, ING, Rabobank and Intesa Sanpaolo are actively looking into how they can exploit this opportunity, while venture capital and private equity firms, such as Ecomachines Ventures, ArcTern Ventures and Circularity Capital, are working with circular start-ups and existing businesses to create the next generation of high-growth, low-impact companies.

3.2.3 CHANGING TENANT REQUIREMENTS

A circular building will be occupied very differently to the equivalent building of today. Exactly how these changes impact tenancy agreements needs to be explored, with input from tenants, agents and building owners.



3.2.4 GOVERNMENT POLICY

The circular economy is becoming of increasing importance to governance groups, with the European Union developing a circular economy action plan for the recovery of valuable resources and more efficient waste management to improve the environmental performance of buildings ⁽²¹⁾.



Government policy has a role to play in easing or restricting the transition to the circular economy. Policies around taxation of consumption, legal structures, industrial strategy and building code regulation need to be reconsidered. For example, in the UK, new construction is exempt from VAT, while retrofit is not, adding a 20% cost burden that could discourage refurbishment projects. However, taxation in Europe is starting to change, in Sweden, the government introduced a lower rate of VAT for repairs on items.



Two Danish Government agencies were involved in creating a policy toolkit that describes a step-by-step method for embarking on the circular economy transition and demonstrates its application through a local case study ⁽²²⁾.



Businesses that engage with government at local, regional and national level will influence how policies are changed to support the circular economy. The Dutch government has been a leader in forming partnerships with business to realise a circular economy. In 2014, they developed a specific circular economy programme – the Realisation of Acceleration of a Circular Economy (RACE). Using design to develop new products and inspire new business models was central to RACE's approach.

3.2.5 FUTURE INNOVATIONS

New technology will play a significant role in moving the built environment towards the circular economy. Building Information Modelling (BIM) is already wide spread throughout the construction industry and has helped to reduced waste in the construction process through the easier management of information from different stakeholders. With the evolution of new technology including digital platforms, product passports, 3D printers and tagging sensors it is clear that future innovation will alter the building lifecycle process.

DIGITAL PLATFORMS

Digital platforms offer an opportunity for stakeholders in the construction industry to collaborate both in the short and long term. There are already numerous websites which allow users to sell and purchase surplus materials from construction projects. However there is opportunity for a platform to be used to track and advertise materials which are currently “locked” in buildings. Then when the building comes to end of life these materials could be purchased by another development, thus enabling circularity for the building materials and components.

PRODUCT PASSPORTS

To enable digital platforms to work successfully, certain information about materials and components will need to be made available. Product passports allow products to have traceability and retain electronic information which can translate to their residual value at end of life. An example of work in this area is the “Buildings As Material Banks” (BAMB) consortium which is working to develop and expand the material passport concept ⁽²³⁾.

3D PRINTING

New technology such as 3D printing may alter the way buildings are constructed and materials are purchased. Instead of traditional purchases for small items, contractors may

download plans for certain components which will then be printed on site. As material research advances, new materials may be used for printing.

TAGGING SENSORS

With the development of smart cities, information will be readily available about the status of components in the built environment, which can facilitate timely refurbishment. This in turn may alter the way contracts are formed as has been demonstrated with the A12 motorway in the Netherlands. Here there is guaranteed payment for the number of lanes open at any given time, which has encouraged the contractor to use sensors in the asphalt to monitor the state of the lanes, and to ensure high standards of material and construction have been achieved from the outset.

“Construction industry models are being reshaped in the context of the Circular Economy, reinventing the business models of the existing conventional players and introducing new actors such as ‘urban miners’. This is largely enabled by intelligent insights from integration of the relevant data.”



Jad Oseyran, IBM

4

CIRCULAR BUSINESS MODELS

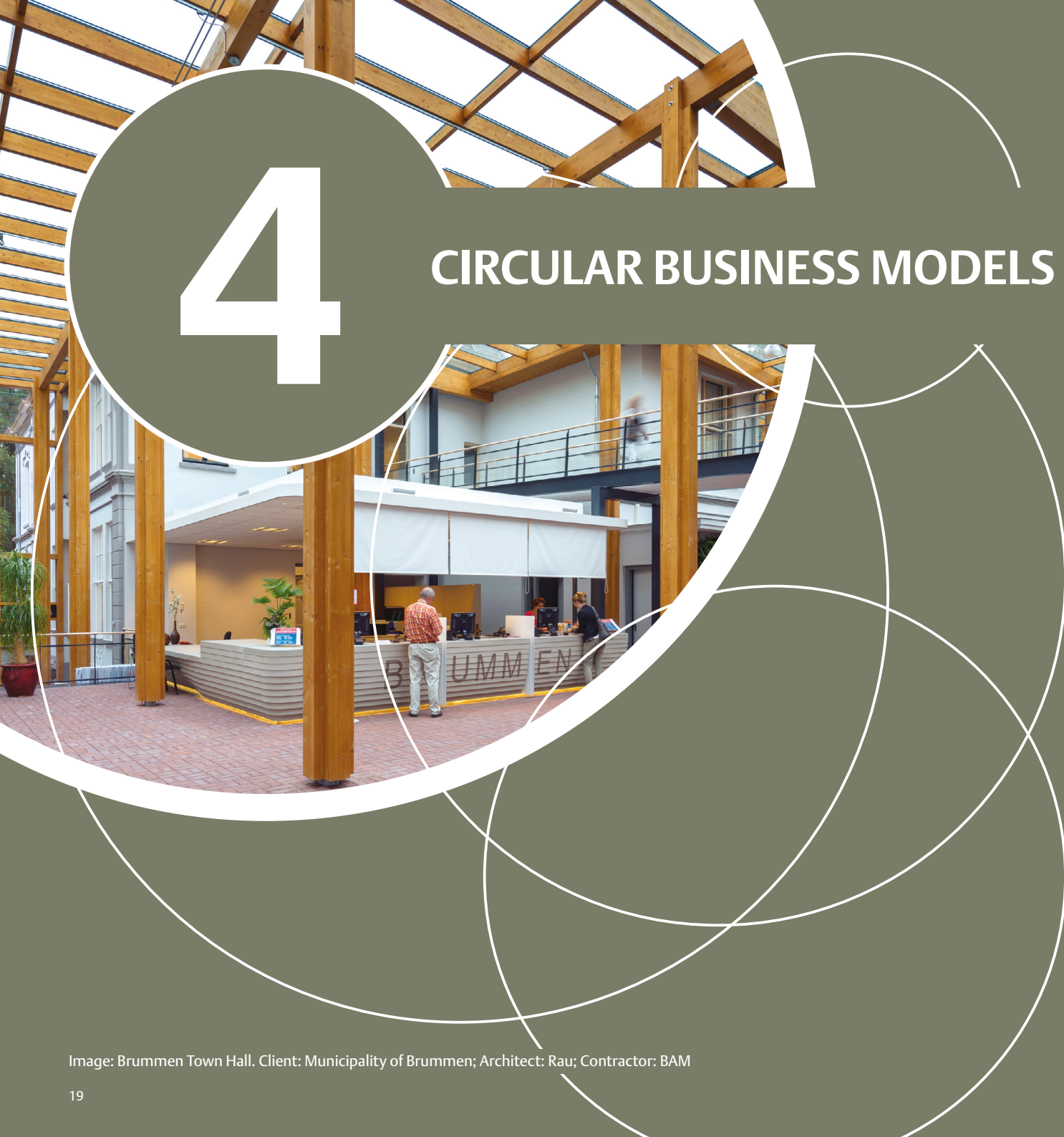


Image: Brummen Town Hall. Client: Municipality of Brummen; Architect: Rau; Contractor: BAM

To support the transition to the circular economy, governance, regulations and business models will play a crucial role.

More importantly circular business models (CBMs) would allow the retention of an asset at its highest value over time and support enhancement of natural capital. Different CBMs will be required at different stages of a lifecycle of an asset and may work independently or collaboratively. Successful implementation of these business models will require action from designers, suppliers, service providers, contractors and end-of-life companies by sharing materials, systems, energy, as well as information and services.

New business models would allow:

- Greater control of resource streams through the value chain so the added value can be identified and captured.
- Innovation through the supply chain so new entities can be generated such as business in waste handling, refurbishment and reverse logistics.
- Enhanced collaboration within the supply chain amongst all actors.
- Creation of services that capture valuable products / resources

“The ROCKWOOL Group is dedicated to driving a sustainable business model in part by changing the industrial approach of ‘take, make, dispose’ to a more circular approach, where products are recycled, upcycled and reused.”

Mirella Vitale, Rockwool

4.1 CIRCULAR BUSINESS MODELS IN THE CURRENT VALUE CHAIN



CIRCULAR DESIGN

This diagram demonstrates that there are multiple circular business models (CBMs) which can be grouped into three categories: design, use and recovery - these relate to the stage of the building lifecycle when they will be engaged.



CIRCULAR USE



CIRCULAR RECOVERY



PRODUCT AND PROCESS DESIGN

These business models aim at providing planning and design for components, systems and ultimately the full asset in order to improve its service life. This includes specific solutions to improve how the asset is maintained, repaired, upgraded and refurbished or remanufactured.

A strategic plan of process through the value chain is required for this business model to increase the reuse potential and recyclability of products, by-products and waste streams.



TRACKING FACILITY

This model aims to provide services to facilitate the tracking of materials, components and parts of a system so that they can be marketed and traded in secondary raw materials markets.



SUPPORT LIFECYCLE

Consumables, spare parts and add-ons to support the lifecycle of long-lasting products.



SELL AND BUY-BACK

In this case, a product is sold on the basis that it will be purchased back after a period of time.



LIFETIME EXTENSION

In this case, the aim is to extend the service life of products, components and systems through engineering solutions including easy disassembly and reassembly, repair, maintenance and/or upgrade.



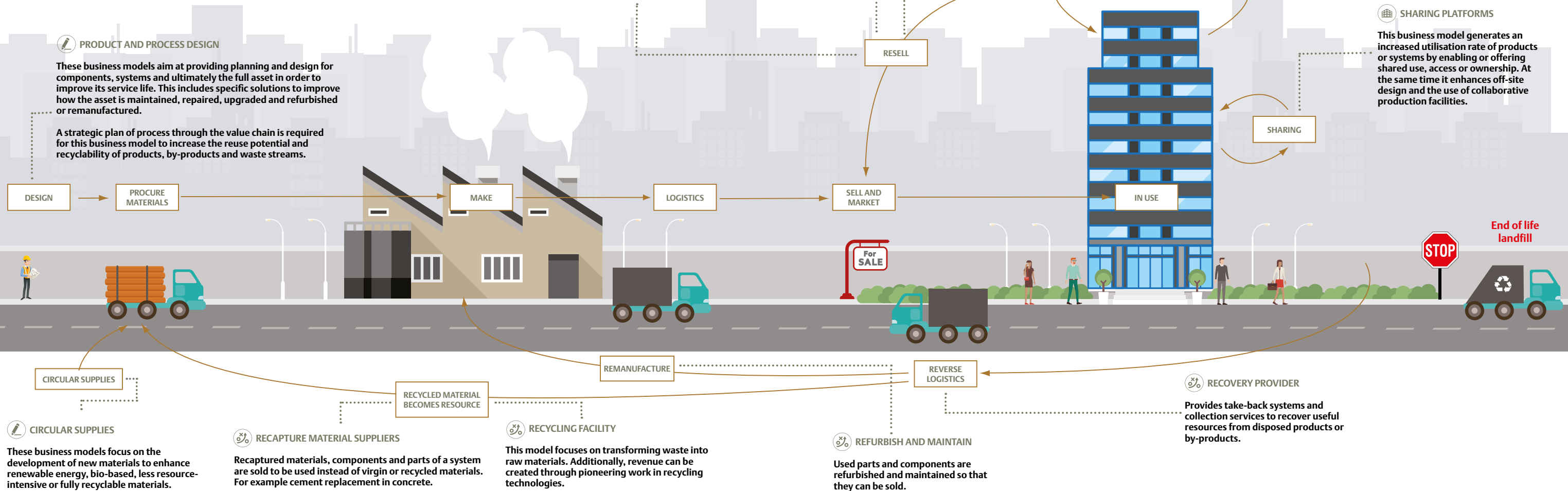
PRODUCT AS A SERVICE

This CBM aims at delivering performance rather than products and the ownership of the product is retained by the service provider. The primary revenue stream comes from payment for performance delivered. This applies most obviously to mechanical plant, lighting, and fit out, but can potentially be extended to all parts of a building and infrastructure.



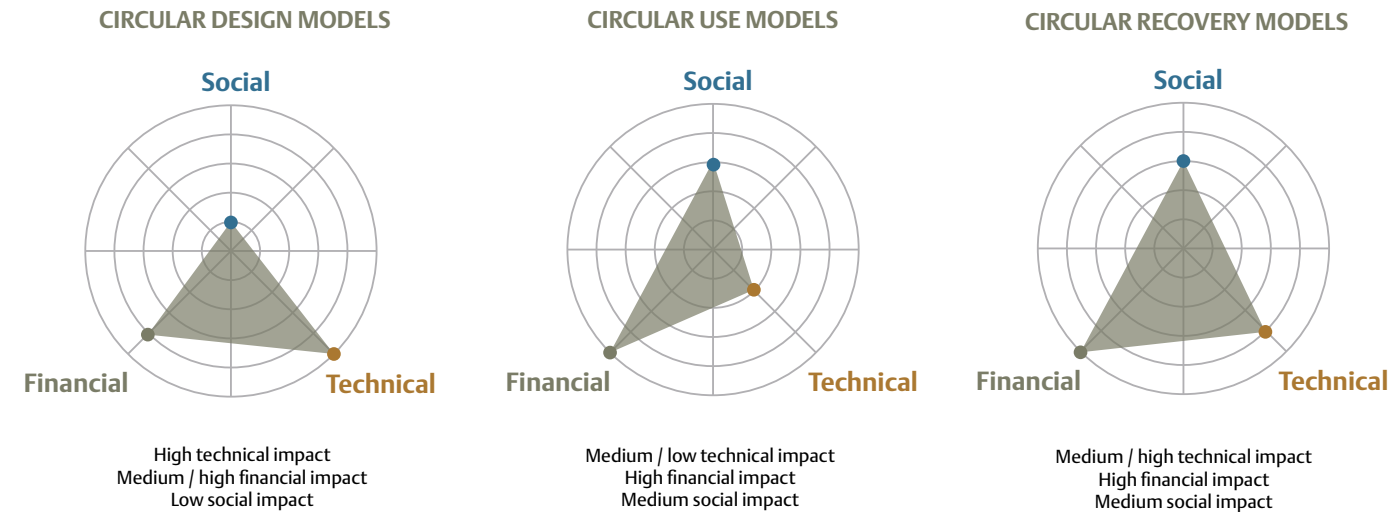
SHARING PLATFORMS

This business model generates an increased utilisation rate of products or systems by enabling or offering shared use, access or ownership. At the same time it enhances off-site design and the use of collaborative production facilities.



4.2 BUSINESS MODELS

Expected impact from a social, technical and financial standpoint for the over-arching business model types:



It is likely that for a circular economy to function these different types of CBM will need to interact and work together. For example, in the case of a light fitting, the 'product as a service' circular use business model means the lighting manufacturer retains ownership of the fittings, and is incentivised to upgrade the fittings over time to maintain maximum efficiency. This in turn should benefit the user as there should be no decline in lux levels and they benefit from up-to-date technology. However, the full circular benefit is only realised if the business model has allowed for product and process design change, so that the light fittings are demountable and upgradable to reduce the use of virgin resources.

No company will work alone in a built environment based on a circular economy and businesses have the opportunity to expand the services they offer or collaborate with others to maximise value.

For example, a business which bases their CBM on refurbishing and maintaining their products may need to partner with a 'tracking facility' provider so they can monitor and record where their products have been installed, and then work with a logistics company to ensure the expired products are returned. Technology will be used to retain data on materials locked in built assets (i.e. Building Information Modelling or BIM).

At each stage of a development life cycle there are opportunities and challenges which need to be addressed. Different stakeholders will be involved in providing the solutions or may need to work collaboratively together.



Circular design

Development and planning phase of a built asset

Opportunity

Products, systems and the entire built structures are designed to last longer with a higher residual value. Therefore they shall be easier to maintain, repair, upgrade, refurbish, remanufacture or recycle with respect to traditional ones.

Additionally, new materials can be developed and sourced, particularly bio-based, that are less resource intensive or fully recyclable. In the same context, new processes are being developed to increase the reuse potential and recyclability of construction and industrial products, by-products, and waste streams.

There is an opportunity for designers to engage with potential partners who may have interest in the development (or parts of) post initial use. This may link with the 'use' and 'recovery' CBMs to ensure the benefit of the design is realised.

Challenges

There are technological, market and operational risks. These include a lack of data for the product performance as well as a degree of uncertainty on the operational costs of the asset.

Market risks are associated with customer acceptance of reused / recycled products. Product obsolescence is often part of the design as customers want the newest model within a short time frame; therefore products are designed with short lifespans. There will need to be a change of mindset to move away from business models based on this principle.

Larger upfront investments, in respect to traditional linear models, will be needed to reduce the need for raw materials, improve the product performance and increase the residual value at the end of life.



Circular use

Operational phase of an asset

Opportunity

These models aim at keeping control over an asset and retaining its value.

Product-to-service models allow a change from manufacturing a product to a number of new opportunities, such as providing leasing and sharing services. Additionally, they include extending the service life of products and components, providing services to facilitate the tracing, marketing and trade of secondary raw materials. This generates new opportunities for companies to both expand the client base through customer loyalty and to increase the long term revenues through additional services such as maintenance, repair, and replacement of parts and components.

Challenges

Assets need to be viewed with a great focus on Operational Expenditures (OpEx) instead of Capital Expenditures (CapEx), which will have obvious consequences on the operating capital and potential implications on taxation. As opposed to a higher ROI - associated to the willingness of customers to pay more for an asset that offers higher performance - circular use models would require companies to operate with lower cash flows due to a longer time for returning from the initial investment. The result is the need for either investors or financiers to be willing to expose themselves to higher loans.

However, financial institutions do not traditionally have sufficiently fine tools to price the risk adequately, which can result in high interest rates or even refusal to grant loans. The risks increase as there are uncertainties related to the future residual value of an asset due to market price fluctuation of raw materials, as well as uncertainties of customers demand and absence of suitable legal structures.



Circular recovery

End of the products service life

Opportunity

Revenue is generated by transforming existing products into new ones adding value, reducing costs, or reducing waste. The development of a platform to enhance reverse logistics is essential in this specific case.

Challenges

These models rely on material reuse / recycling being more cost / time effective than extracting virgin material.

Often the cost and challenge of reverse logistics prevents recaptured materials from being reused.

Although there are fewer financial constraints for these models, the regulatory framework in construction might represent an obstacle. Regulation around waste management, product performance and health and safety all create barriers to recapturing materials. Engagement with regulators will play an important part in the development of these CBMs.



CASE STUDY: NIAGA CARPET

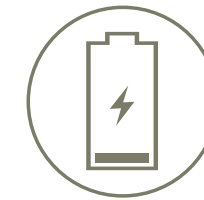


Carpet manufacture has been re-imagined by Niaga. According to Niaga (the word ‘again’ spelled backwards) adding more and more complex combinations of materials to everyday products will not solve today’s product performance, health and environmental challenges. That’s why they developed a carpet production technology to make carpets out of one material only, or two materials bound together with an adhesive that can decouple on demand. This allows carpet producing companies to sell or lease carpets that can be 100% recycled to new carpets after use.

The core of the Niaga product design philosophy is to work with a drastically simplified set of known and pure materials. In effect, carpet producers cannot choose the cheapest possible material for different parts, like latex for glue, or bitumen for backing. This additional cost has to come with some financial benefits to make it work in the market place. These benefits present themselves over the full value chain, so they materialise differently in different countries. The product is being trialled in BAM’s offices in Bunnik in the Netherlands, where the business case will be evaluated.

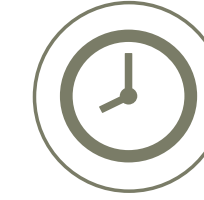
“The innovation challenge of full recyclability resulted in a product that also performs better. For everyone in the supply chain it offers something that has the same look and feel but is easier to handle, safer, and future proof.”

Lukas Hoex, Niaga



90%

Reduction of energy consumption and no use of water compared to traditional carpets



50%

Reduced time for installation of the carpet, thus generating a significant cost reduction



100%

Percentage recyclable without losing volume and materials quality

Benefits to stakeholders in this CBM

	MANUFACTURER	OPERATOR	ASSET OWNER	USER
 LINEAR MODEL	<ul style="list-style-type: none">Consumes approximately 0.7 l water per m² of carpetUses virgin material therefore impacting on raw materials availability	<ul style="list-style-type: none">Faces a costly and time consuming installation	<ul style="list-style-type: none">Faces cost for disposal of traditional carpets	<ul style="list-style-type: none">Uses carpets for longer than their design life span
 CIRCULAR MODEL	<ul style="list-style-type: none">Saves in energy cost as well as less use of natural resources. Uses recycled material with the same performance of virgin one	<ul style="list-style-type: none">Reduces installation time and reduced cost	<ul style="list-style-type: none">Allows flexibility for the asset to be upgraded on demand. Additionally consumer gets a significant discount on their new purchase	<ul style="list-style-type: none">Benefits of full customisation according to tenants needs. Additionally safer environment due to reduced VOCs



CASE STUDY: ABN AMRO PAVILION



The Circular Pavilion in Amsterdam creates an accessible entrance to the existing head office of the ABN AMRO bank and contains conference and catering facilities. ABN AMRO developed the building together with BAM, Architects CIE and co-makers and consultants. The circular pavilion of ABN AMRO is engineered with the aim that all 'lights are green' to continue to (re)use the materials in the future. The building is almost completely remountable. A lot of elements consist of virgin material, which have been selected for low environmental impact. There are reused components integrated into the building and interior design, e.g. Inner walls, doors, cables and fire hose reels, and also old jeans, collected from ABN AMRO employees, which have been used to produce acoustic ceilings.

Design and production are no longer considered separately from each other. It is a process in itself to select the best co-creators and partners. This collaborative approach leads to a better utilisation of expertise.

“The value proposition for the ABN pavilion is that we want to experiment with the circular economy how it works in the built environment and learn from the challenges we run into. The real impact is created by sharing these lessons and inspiring our clients to start with the circular economy.”

Mark van Rijt, ABN AMRO



60%

Good design and collaboration result in up to 60% residual value at end of first life



100%

Higher ROI for asset owners rather than considering only disposal cost



50%

BAM's real estate evaluation methodology has evidenced products with >50% residual values after initial use

Benefits to stakeholders in this CBM

	DESIGNER	SUPPLIER	ASSET OWNER	USER
LINEAR MODEL	<ul style="list-style-type: none"> Facilitates design / procurement packages to increase ROI 	<ul style="list-style-type: none"> Produces system made to fulfill a specific function and for finite service life 	<ul style="list-style-type: none"> Contributes to the depreciation of the asset 	<ul style="list-style-type: none"> Has access to an asset that provides reduced performance over time
CIRCULAR MODEL	<ul style="list-style-type: none"> Plans for adaptability upgradability and reuse Incorporates a real estate evaluation matrix to make key decisions 	<ul style="list-style-type: none"> Jointly with co-makers thinks about residual value, as a percentage of the original materials cost 	<ul style="list-style-type: none"> Invests to increase the residual value of the asset in the future; increasing employee productivity; valuing space flexibility and adaptability 	<ul style="list-style-type: none"> Actively participates in the design and construction phases. Higher operational certainty



CASE STUDY: ARMSTRONG TILES



As early as 2006 Armstrong Ceilings took their first steps toward circular design principles by implementing an end-of-life take-back programme for their own mineral ceiling tiles. Across Europe Armstrong has now taken back over 500,000m² of old ceilings, including those of their competitors, and globally they have recycled over fifteen million square metres. But implementing a take-back programme was not sufficient. Armstrong ensured that their products use materials that are safe, healthy and endlessly reusable as well as adopting manufacturing processes that minimised resource consumption including energy and water.

The next steps for the company are to ensure the development of new products and services that have a positive impact on buildings that can be verified to provide positive health and environmental impacts, retain residual value and can be meaningfully recycled.

Circular Economy thinking is about a vision and a new business model; one that challenges us to innovate and design better products and systems. At Armstrong Ceilings we decided to 'learn by doing' and the knowledge and experience gained along the way has opened up new possibilities and commercial opportunities that has allowed us to move away from the traditional take, make, dispose business model.

Jeremy Sumeray, Armstrong World Industries Ltd.



Reduced cost for manufacturing due to saving in virgin materials and energy



Value of the ceiling is recovered in 1 year



Saving for disposal costs when ceilings are diverted from landfill

Benefits to stakeholders in this CBM



LINEAR MODEL



CIRCULAR MODEL

MANUFACTURER



- Manufactures using high embodied energy virgin materials

- Reduces manufacturing costs due to use of recycled products
- Creates lasting relationships with the asset owners and users
- Reduces products manufacturing costs due to use of recycled products materials

DEVELOPER



- Installs low value products with significant depreciation over time

- Installs products with better environmental profiles, possibly selling assets at a higher value

USER



- Uses a product accepting reduced value through time

- Benefits of a building with a system that offers opportunities with performance contracts as well as material recovery and reuse at end of life

OPERATOR



- Takes back old ceilings as soon as it becomes obsolete realising no value when disposing

- Can take back the ceiling and loop it back into a new cycle

5

A NEW VALUE CHAIN

A new kind of value chain is required for stakeholders in the construction industry to transition to the circular economy.

Traditional business models do not often favour collaboration throughout the value chain because businesses act independently of each other, rarely considering the aims of others in the value chain. Such a complex value chain generally has a staged approach where products and services are the inventory of one company and the receivable of another. Therefore the risks and strengths of a company should be viewed collectively with its value chain.

“The entire value chain need to work together for mutual gain. Products need to be designed with future uses in mind and all members of the value chain need to work with different business models, and levels of incentivisation, to give the client longer term benefit and higher residual value of their asset. So far, we haven’t seen a single solution, but have experimented with several design procurement routes and contractual arrangements – each solution needs to be tailored to its situation!”

Nitesh Magdani, Royal BAM Group

5.1

OPPORTUNITIES AND CHALLENGES ACROSS A CIRCULAR VALUE CHAIN

A circular value chain requires all stakeholders to contribute towards an outcome that achieves the best value for all parties, using components that retain the highest value throughout the lifecycle and minimises losses from the system. Developing integrated value chains could give companies a competitive advantage in the future.

To realise such a step change in the value chain, it is necessary to reduce the unfamiliarity of the stakeholders with the concepts behind the circular economy.

Working with the value chain can reduce the risk of disputes and errors during construction, as well as the use of working capital. Additionally, it allows suppliers to stay close to the client by meeting future expectations and enables developers to stay close to innovation. A number of business models, as discussed in Chapter 4, support this principle by proposing approaches based on leasing, reuse, repurposing and upgrading.



INVESTORS

Current valuation methods assume annuities are continuous and do not account for potential gaps in contracts (e.g. time lag between tenants). Banks therefore have to be aware that there is a risk of building space being unoccupied for some time, which reduces the value of the asset. However, circular design models allow for space to adapt quickly to the demands of new tenants, thereby minimising the period of vacancy. Increased adaptability will allow the asset to be fully utilised, improving the value of the space.

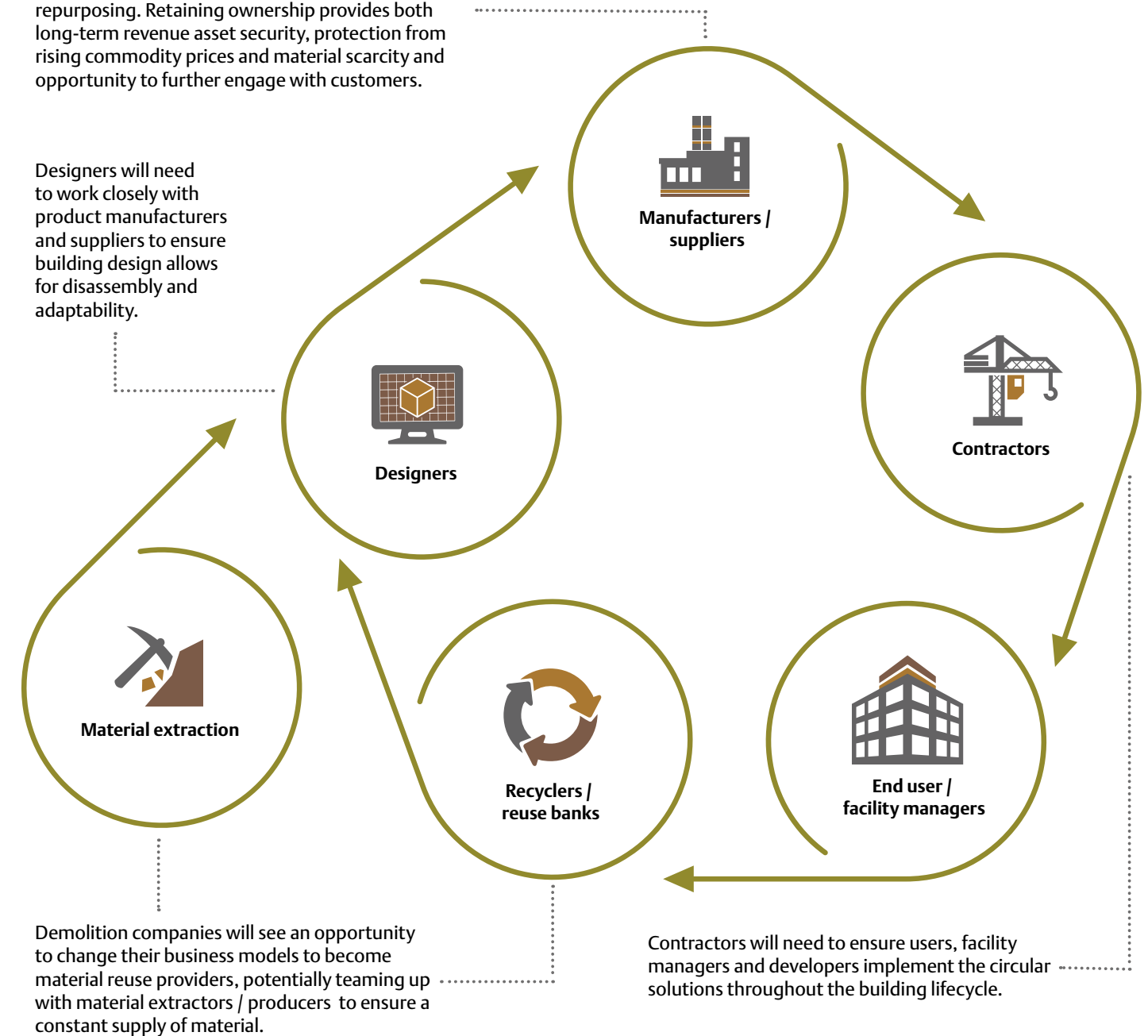


ASSET HOLDERS / DEVELOPERS

Building users and facility managers will benefit from more efficient, productive and adaptive spaces. The developers and asset managers will see increased value in their assets due to these features. The client should be involved throughout the process.

Suppliers and manufacturers have an opportunity to recover materials at the end of a product's life, allowing for a second source of income, through reselling or repurposing. Retaining ownership provides both long-term revenue asset security, protection from rising commodity prices and material scarcity and opportunity to further engage with customers.

Designers will need to work closely with product manufacturers and suppliers to ensure building design allows for disassembly and adaptability.



5.2.1. INVESTORS



Bankers and other investors may need persuading to switch from traditional buy-sell models to longer term investments. Compared to linear models there will be a longer time gap between the acquisition of the asset and the revenue derived from it. This may mean investors will make additional requirements or require higher compensation to offset the lack of data regarding operational and maintenance costs which makes setting contract prices risky. Technology needed to close the loop may not be developed enough either, further increasing the risk. Construction companies often ask banks to put material assets, such as iron used in the shell of the building, on their balance sheets and investors have to remain wary of the possibility that a substitute may enter the market and depreciate the long-term value of the asset.

Financial institutions are not ready for the step change which is required for a circular approach. However, parameters traditionally used for performing due diligence on real estate assets already consider relevant issues such as quality of the construction, residual value, aesthetics of an asset, increased comfort for users as well as potential increased productivity for workers in the case of an office.

Additionally, the model is currently working according to the fiscal position of single stakeholders in the linear value chain. Changing to circular value chains would imply assessing multiple positions before approving a financial operation. Consequentially, an improved IT system with potential increased interest rates to compensate the additional work is required. Since the model will rely on assessing the financial position of each and every stakeholder and mutual contractual positions, limited risks are foreseen in respect to traditional models.

5.2.2. ASSET HOLDERS AND DEVELOPERS



Two of the big issues associated with Circular Business Models are risks and uncertainty. Setting contract prices related to the operation and maintenance of a building is extremely hard to do. This is even more complex when considering the long lifespan of buildings. However, a number of attractive opportunities exist.

Leasing models allow companies to put certain assets in Operational Expenditures (OpEx) rather than in Capital Investments (CapEx). This generally results in smoother operational expenditure and important tax deductions, as operating costs do not qualify as capital assets and therefore do not depreciate over time.

Leasing models also avoid large upfront expenditure and cash may be freed up, allowing customers to redirect their funds to other investments.

In the field of technology, customers already prefer not to invest in products that are likely to be surpassed in a matter of years. As a result, many companies are shifting their IT spending from their CapEx to their OpEx, giving them more flexibility and ensuring availability of systems that are always up to date.

5.2.3. DESIGNERS



The role of designers in the circular economy is likely to become even more relevant in respect to the traditional value chain. They might become a facilitator that integrates competencies and mutual benefits across the different stakeholders. Designers have the opportunity to plan and assess circularity throughout an assets lifecycle by developing innovative and functional solutions.

This includes assessing the land so that it retains the highest value as well as to ensure that it is used at its optimal condition, providing social returns to the local community and environmental benefits. Conducting rigorous Life Cycle Assessment would be the first step to address this.

Design should be incorporated at an earlier stage with other disciplines to ensure that the product is designed for longevity, flexibility, reuse and deconstruction. Designers should discuss the future strategy of the building with local authorities and the asset owners to ensure reconfiguration is possible by using a modular approach allowing for easy disassembly and assembly of components.

5.2.4. MANUFACTURERS AND SUPPLIERS



Challenges in this case relate to the lack of transparency in the supply chain. In a circular value chain, the content of products needs to be known to allow for reuse, recovery and recycling.

Product passports may provide an answer to the need for improved transparency. Currently, most suppliers are reluctant to reveal sensitive data that might reduce their competitive advantage in the market. Knowledge gateways / guardians, as currently used by the Cradle to Cradle certification process may resolve this.

5.2.5. CONTRACTORS



Increasingly contractors take responsibility for performance due to requirements such as Government Soft Landings for public buildings (in the UK) and client guarantees that developments perform as intended. This provides opportunity for engagement with end users, to ensure benefits from circular solutions are realised and develop knowledge about how users operate buildings in reality.

The contractor is at the heart of key decisions and procurement options over the asset lifecycle and will have opportunity to procure circular materials. New technologies such as 'product passports' and data embedded into virtual construction models are needed to give assurance of the legality and quality of these materials.

Contractors already use prefabrication and virtual models to increase efficiency, reduce time and cost spent on site. Further advancements in digital tools will require close collaboration between value chain members, which the contractor could co-ordinate. This may assist contractors to achieve targets for zero construction waste and potentially reduce health and safety risks on sites, using automated or human-assisted machines.

5.2.6. END USERS AND FACILITY MANAGERS



Commercial buildings and their occupiers are a significant source of waste generation; through the use of the building, and from the impact of the materials used in fit-out, alteration and refurbishment. Circular models will reduce the quantity of waste being produced, helping both owners and occupiers reduce their environmental footprint as well as providing an up-to-date working / living environment.

A circular economy approach should allow for the upgrade of systems and plant over time ensuring the latest technology is in use to maximise the operating efficiency of the building and occupant comfort. This is valid for a large number of aspects including lighting, acoustic of plants and HVAC systems.

At the same time, productivity should be boosted by integrating intelligent platforms that improve the integration of functions with the building and its components. Increasing productivity is a key aspect to augment the value of a building and in turn should have an impact on its financial performance, making it attractive to investors.

This is also applicable to infrastructure e.g. relocation of bridges at the Olympic park in London.

5.2.7. MATERIAL EXTRACTION / RECYCLERS / DEMOLITION



The role of demolition contractors is likely to change in a circular economy, with increasing focus on becoming 'disassembly experts' to release materials which will be otherwise locked in the building. There may be more collaboration between them and material extractors / producers to ensure there is sufficient quantities of material for resell, whether it is recycled or virgin.

This change in primary function will bring a series of challenges such as ensuring there is the skills and knowledge to realise the full value of the materials. Engagement with the manufacturers / suppliers will be crucial to understand how individual products should be disassembled as well as providing these actors with an alternative supply of material.

6

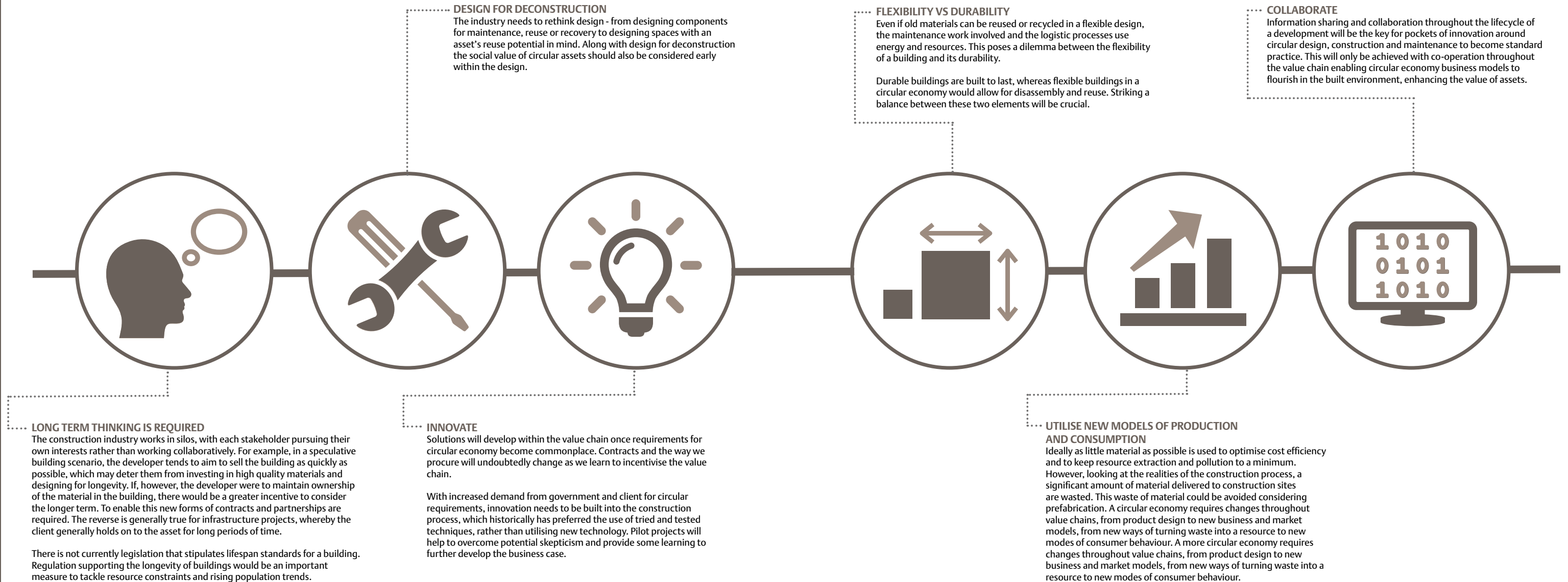
CONCLUSIONS

The complexity of the external environment still works to the advantage of the current linear model. Looking at the construction industry in particular, inherent contradictions pose challenges for the adoption of CBMs. To overcome these contradictions, the value chain needs to take the following points into consideration:

- Long term thinking
- Design for deconstruction
- Innovate
- Flexibility vs durability
- Utilise new models of production and consumption
- Collaborate

“The built environment is hugely complex with many interconnected and interdependent systems. We know that to apply the principles of circular production and operation will result in a more prosperous, liveable and sustainable society, but it will require a radical rethinking of every aspect of the built environment’s production. Circularity changes the very environment in which we live, work and invest.”

Carol Lemmens, Arup



REFERENCES

- (1) United Nations, Population Division (2014). *World Urbanization Prospects: The 2014 Revision, Highlights*
- (2) Miller, N. (2014) *Workplace Trends in Office Space: Implications for Future Office Demand*, University of San Diego; GSA Office of Government Wide Policy (2011) *Workspace Utilization and Allocation Benchmark*.
- (3) UN Habitat (2012) *Energy* [Online] Available at: unhabitat.org/urban-themes/energy/ [Accessed 14 Mar 2017].
- (4) UN-Habitat (2011) *Cities and Climate Change: Global Report on Human Settlements 2011*, Earthscan, London
- (5) UNEP (n.d) *Resource efficiency as key issue in the new urban agenda* [Online] Available at: web.unep.org/ietc/sites/unep.org.ietc/files/Key%20messages%20RE%20Habitat%20III_en.pdf
- (6) NRDC-ASCI (2012) *Constructing Change*, p. 1.
- (7) McKinsey Global Institute (2010) *India's Urban Awakening: Building inclusive cities, sustaining economic growth*.
- (8) McKinsey Global Institute (2009) *Preparing for China's urban billion*.
- (9) Ellen MacArthur Foundation and the McKinsey Center for Business and Environment (2015) *Growth Within: A Circular Economy vision for a Competitive Europe*
- (10) WRAP (2013) *Built Environment Circular Economy* [Online] Available at: www.wrap.org.uk/sites/files/wrap/WRAP%20Built%20Environment%20-%20Circular%20Economy%20Jan%202013.pdf [Accessed 27 Feb 2017]
- (11) Barker, M. (2008) *Time to bin industry's lavish habits* [Online] Construction News, Available at: www.constructionnews.co.uk/home/time-to-bin-industrys-lavish-habits/953199.article [Accessed 14 Mar 2017]
- (12) Ellen MacArthur Foundation (2013) *Towards the Circular Economy Vol. 1: An Economic and Business Rationale for an Accelerated Transition*
- (13) EUROPEAN COMMISSION (2016) *Construction and Demolition Waste* [Online] Available at: ec.europa.eu/environment/waste/construction_demolition.htm [Accessed 25 Feb 2017].
- (14) Gonçalves, E. (2008) *The WWF Pocket Guide to a One Planet Lifestyle*, WWF
- (15) ING Economics Department (2015) *Rethinking Finance in a Circular Economy (Financial implications of circular business models)*.
- (16) EUROPEAN COMMISSION (2016) *Resource Efficiency* [Online] Available at: ec.europa.eu/environment/resource_efficiency/about/key_questions/index_en.htm [Accessed 07 Mar 2017].
- (17) Morgan, J. and Mitchell, P. (2015) *Employment and the Circular Economy: Job Creation in a more Resource Efficient Britain*, Green Alliance and WRAP.
- (18) Gonçalves, E. (2008) *The WWF Pocket Guide to a One Planet Lifestyle*, WWF
- (19) Miller, N. (2014) *Workplace Trends in Office Space: Implications for Future Office Demand*, University of San Diego; GSA Office of Government Wide Policy (2011) *Workspace Utilization and Allocation Benchmark*.
- (20) Arup (2016) *The Circular Economy in the Built Environment*
- (21) European Commission (2017) *Circular Economy Strategy* [Online] Available at: ec.europa.eu/environment/circular-economy/index_en.htm [Accessed 08 Mar 2017].
- (22) Ellen MacArthur Foundation (2015) *Delivering the Circular Economy: A Toolkit for Policymakers*, V1.1
- (23) BAMB (2016) *Enabling a circular building industry* [Online] Available at: www.bamb2020.eu/ [Accessed 17 Mar 2017].

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