



FROM PRINCIPLES TO PRACTICES:
**FIRST STEPS TOWARDS A
CIRCULAR BUILT ENVIRONMENT**

ARUP



INTRODUCTION

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Right: Venlo City Hall

The built environment has a crucial role to play in the global economy, creating prosperity, innovation and growth.

Construction is one of the largest sectors of today's global economy, representing 13% of GDP and employing 7% of the world's working age population.¹ We also know that the world's urban population is growing rapidly: in the next 30 years, more than two-thirds of the world will live in urban areas, increasing from 55% today.² As a result, the size of the built environment is set to double, putting increasing pressure on urban systems such as water, energy and waste networks.

Although recent decades have seen many improvements in the energy efficiency of buildings and the liveability of cities, the built environment we live in today continues to be designed around the linear 'take-make-dispose' model, in which materials are sourced, used and then disposed of as waste. This approach results in significant structural waste (see Figure 1) and has contributed to making the built environment one of the world's largest consumers of resources and raw materials, and a major producer of waste and carbon emissions. Construction and demolition accounts for 25–30% of all waste generated in the EU³, for example, while cement and steel production for construction account for close to 10% of global CO₂ emissions.



Above: People's Pavilion, Dutch Design Week 2017, Eindhoven



Figure 1: Structural waste in the built environment ⁴

Adopting circular economy approaches in a high-growth, high-waste sector like the built environment presents a tremendous opportunity for businesses, governments and cities to minimise structural waste and thus realise greater value from built environment assets.⁵ In a circular economy, renewable materials are used where possible, energy is provided from renewable sources, natural systems are preserved and enhanced, and waste and negative impacts are designed out. Materials, products and components are instead managed in loops, maintaining them at their highest possible intrinsic value.

A circular approach employs three main principles:



Implementing these principles in the built environment through use of new technologies, business models and partnerships, could lower industry costs, reduce negative environmental impacts and make urban areas more liveable, productive and convenient.

The transition to a circular economy will require the application of systems thinking and new approaches to the way we design, operate and maintain built environment assets. Such thinking can be seen as a natural extension of the holistic approaches already applied by architects, engineers and urban planners.

As part of promoting overall system health, a circular economy presents new opportunities for growth that is distributed, diverse and inclusive; generated from organisations small and large, local and global, private and public. This fosters a thriving and resilient ecosystem of enterprises, which helps to create and share value across the built environment industry.

The greatest opportunities are realised when circular economy thinking is applied to strategic decision making. For example:

- new approaches for tenancing buildings could deliver greater returns for commercial property investors
- new models of tenure which require long-lasting durable materials, such as build-to-rent, are already proving attractive to developers⁶
- eliminating harmful materials from buildings can improve occupant health and productivity⁷
- urban planning and construction could integrate new technologies and nature-based solutions to create neighbourhoods more resilient to the impacts of climate change

Awareness of these opportunities and others is growing. Yet while existing frameworks offer principles and philosophies, they do not explicitly demonstrate how stakeholders in the built environment can change the ways in which they develop, finance, procure, design, construct, operate, maintain, and repurpose services and assets in order to enable this transition. There is therefore a need to translate these principles into workable practices in the built environment.

This project, a collaboration between Arup and the Ellen MacArthur Foundation titled *From Principles to Practices*, begins that translation. The project is split into two phases. Phase 1 has informed proposals for who needs to lead and what their first steps might be, which are summarised in this report. Phase 2 will test the added value that new circular investment models can bring to the built environment.

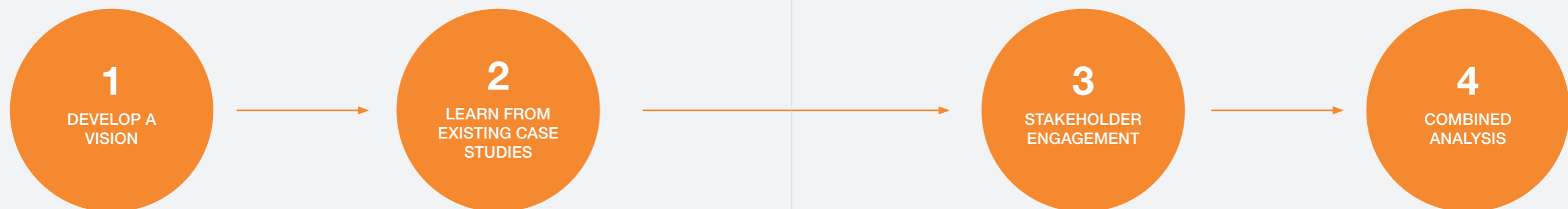
PHASE 1 METHODOLOGY

The aim of Phase 1 was to identify the key barriers, opportunities and enablers of implementing circular economy practices.

Our first step was to envisage what a circular economy in the built environment might look like, and to understand the current state of play with regard to circular economy in the sector. This allowed us to draw out key insights as to where the greatest opportunities lie for taking the first steps towards a circular built environment.



Above: Bosco Verticale, Milan



We first set out our vision to describe what a circular economy could look like in the built environment, based on knowledge and experience to date. This vision will form a reference piece against which the outcomes of Phase 1 and 2 can be compared.

From innovative new bio-based construction materials to service-based business models and asset sharing platforms to low-energy retrofits, many elements of circular economy thinking have already been applied in the built environment. To learn from this existing body of work, we selected 116 case studies that employ circular economy elements and categorised them based on their scale, application of circular building blocks and ReSOLVE levers (see Glossary). We also scored them on potential economic, environmental or social impact compared to business as usual.

We analysed the results to demonstrate the current state of circular economy application in the built environment and compared this against our vision to identify further opportunities for implementation.

We conducted over 100 interviews across five cities in Europe including Aarhus, Amsterdam, Berlin, London and Milan. We were supported by 3XN Architects and GXN Innovation for the Danish interviews. Engagement covered eight stakeholder groups: policymakers, investors, construction clients, designers, contractors, suppliers, end-of-life contractors and built environment users. We also undertook a number of ‘wild card’ interviews with stakeholders of particular interest or importance that did not fit into a stakeholder category.⁸


We then completed a thematic analysis, identifying the themes and sub-themes for each research area (grouped by barriers, opportunities and enablers), providing insight into areas requiring further analysis.


By combining the results of the case study and stakeholder engagement activities, we identified barriers preventing the implementation of circular economy principles in the built environment, as well as potential opportunities and their enablers. From this, we determined key actions that would enable stakeholders to begin the transition to a circular economy in the built environment.


VISION


How will a built environment operating on circular principles actually differ to the one we have today?

A circular built environment embeds the principles of a circular economy across all its functions, establishing an urban system that is regenerative, accessible and abundant by design.

- 

Support human well-being and natural systems
Human living standards, health and well-being are improved, and natural systems are restored. Building occupants have improved outcomes in health and productivity. Material abundance comes without environmental degradation.
- 

Guided by systems thinking
Decisions made across the built environment value chain are guided by feedback-rich and data-driven models that will account for interactions between buildings, infrastructure, users and the biosphere, as well as change over time. The models consider economic, environmental and social outcomes.
- 

Leveraged by digital technology
Digital technologies provide accessible platforms to facilitate asset sharing and the management of buildings and materials. Smart apps and innovative practices virtualise many services currently rendered by the built environment as more people shop online and work from home.
- 

Holistic urban planning
The overall design of space supports resilient and thriving communities with new business models to stimulate growth, and address congestion and pollution. Nature becomes part of urban areas, improving air quality, moderating extremes of temperature and supporting human well-being.

- 

Continuous material cycles
Building occupants and infrastructure operators are responsible for tracking and returning construction materials (in the quantity and quality received) to suppliers for reuse. Use of looping, non-toxic materials reduces pollution and virgin material consumption.
- 

Design for maintenance and deconstruction
Buildings are designed to enable maintenance, repair and reuse at all life cycle stages (including operation and end-of-service). Techniques such as modular construction minimise waste generation during construction and deconstruction stages.
- 

Flexible productive buildings
Buildings meet their own energy and water needs while waste generation is dramatically reduced thanks to circular products. Internal utilisation rates increase thanks to shared, flexible and modular spaces.
- 

Integrated infrastructure systems
Integrated water, energy and waste networks prioritise natural systems and can be used more intensively as smart management flattens peaks, making use of capacity available throughout the day.



Figure 2: A vision for a circular built environment

KEY INSIGHTS

BARRIERS, OPPORTUNITIES AND ENABLERS OF A CIRCULAR BUILT ENVIRONMENT

The combined analysis of case study research and stakeholder interviews revealed an industry-wide appetite for translating circular economy principles into practices. The following key themes emerged, common to all five cities and stakeholder groups, as essential to combatting common barriers and facilitating the transition to a circular built environment.

COLLABORATION

It is clear from the analysis of existing initiatives that circular products and approaches are not widespread in the built environment. Most stakeholders said this is partly due to the fragmented nature of the industry, which prevents implementation of circular building blocks by separating decision-makers from the long-term consequences of their decisions; the so-called split incentives problem.

Collaboration around common preferred outcomes is required to respond to this. Collaboration helps build trust and increase engagement between supply chain partners throughout the process, from design to construction and beyond. This in turn will help all actors, both in the private and public sectors, to realise greater economic value from a more systemic, whole-life cycle industry approach. Only by changing design and procurement processes, for example through use of Design Build Operate Maintain (DBOM) contracts (see Feature 1), can we effectively align incentives and create opportunities to invest in mutually attractive commercial propositions.

KNOWLEDGE

Our research suggests that stakeholders throughout the value chain remain insufficiently familiar with how circular economy principles do or could operate in the built environment. While almost all of those interviewed recognised the benefits of a circular economy in other sectors, such as fast-moving consumer goods and the automotive industry, few were able to clearly articulate how to capitalise on these benefits in the built environment. Crucially, few stakeholders were able to describe the first steps they might take to initiate their transition to a circular economy.

Therefore, there is a substantive need for greater dissemination of knowledge throughout the industry, with a focus on signposting the steps necessary to make the transition.

Right: Venlo City Hall



POLICY

Creating a policy environment that incentivises and facilitates more circular behaviour is essential to the transition; all those interviewed for this study noted the importance of policy. Existing regulatory policies, such as overly prescriptive waste regulations, were also cited as barriers to the adoption of circular economy initiatives. There are significant opportunities to foster a regulatory environment that favours and facilitates the development of circular economy initiatives, for example, through public procurement. The industry can support policymakers by providing an evidence base to inform and guide them. Collaboration between the private, public and third sectors will also help to drive this process, providing data and evidence in the form of commercial scale projects, for example through the formation of public private partnerships (see Feature 2).

LEADERSHIP

Almost a third of our interviewees cited leadership as necessary to accelerate the transition. Leadership has played a critical part in the delivery of existing circular built environment projects, such as Venlo City Hall. The Municipality of Venlo committed to employing Cradle to Cradle® principles, creating markets for companies and suppliers who share these ambitions. The importance of leadership has also been noted by the New Plastics Economy initiative⁹, which aims to bring about a circular economy for plastics by effecting systems level change. Leadership from frontrunners has proven crucial - the UK, France, and Chile, for instance, all now have ambitious circular economy strategies for plastics, and 13 leading global companies have committed to 100% reusable, recyclable or compostable plastic packaging by 2025. These first movers are acting as beacons that others are willing to follow.

FINANCE

From analysing the interviews, finance was three times more likely to be seen as a barrier than an opportunity or enabler to circular built environment projects. In other sectors, entrepreneurs are a major driver of rapid change. One of our interviewees, an experienced incubator of start-ups, explained that the built environment is not conducive to a start-up culture, notwithstanding exceptions like The Collective and Airbnb. The misalignment between business planning cycles and built environment asset life-cycles is seen as a particular challenge.

We assert that finance can be an enabler of rapid change in the built environment, but that it needs investment opportunities that recognise the built environment's specific challenges; in Phase 2 we aim to put this assertion to the test.

WHO NEEDS TO LEAD?

Who will lead the transition and what do they need to do to get started?

Stakeholders at every stage of the built environment value chain have a role to play, yet our interviewees disagreed about who should make the first move, with many suggesting that other groups in the supply chain needed to act first. We suggest the responsibility initially lies with the stakeholders who have the greatest capacity to influence decision-making, set direction and catalyse action throughout the supply chain, namely:

- **Policymakers** – particularly public-sector policymakers at all levels of government
- **Investors** – private investors, institutional investors, public-sector investment, banks and other lenders
- **Construction clients** – commercial and residential developers, infrastructure and building owner operators

These stakeholders have control over the business models and contractual frameworks in which built environment assets are created and operated. Their actions can maximise impacts at all scales along the value chain. By setting a target around waste and material reuse, for example, policymakers send a signal to the whole market, causing stakeholders from designers to waste managers to alter their behaviour.

WHAT COULD BE THEIR FIRST STEPS?

Key insights from this analysis suggest that these ‘first movers’ could focus on the following steps to help initiate the transition to a more circular built environment:

Policymakers

- 1 Work with the industry to develop a supportive multi-level policy framework
- 2 Use policy levers such as public procurement to spur demand for circular solutions
- 3 Convene and facilitate public private partnerships to develop scalable projects

Investors

- 1 Engage in public private partnerships to develop scalable projects
- 2 Support research into new valuation techniques that eliminate structural waste and maintain or enhance value

Construction clients

- 1 Lead public private partnerships to develop scalable projects
- 2 Develop an evidence base demonstrating the value of a circular built environment

All three stakeholder groups noted the need for public private partnerships to develop commercial, scalable projects. Scalable projects will help demonstrate the potential benefits to be realised from eliminating structural waste, while new partnerships will help align incentives. Together they will also generate the evidence base needed to inform policy, and will start to put legal and administrative processes in place to support and embed circular practices.

In the next section of this report we examine the role and potential of the three stakeholder groups in more detail.

“If there were more “manuals” that describe actions and not concepts, this would encourage faster development of circular economy.”

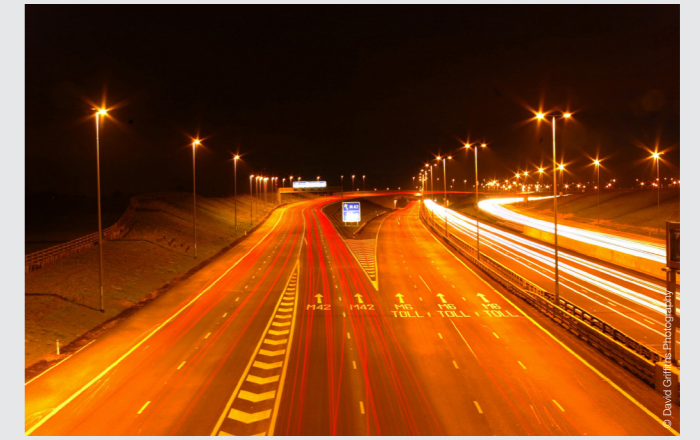
Jenny Pfau, Senior Scientist/
Project Manager, EPEA
Hamburg

“We can’t all do this the same way. Every company needs to examine their own processes to understand how they can make a transition towards a circular economy”

Nikolaj Callisen Friis, Architect,
Lendager Group

“Everybody could and should adopt a leadership approach which means that you’re pushing the boundaries of what’s possible.”

Mike Putnam, Non-Executive
Director, Skanska



FEATURE 1 DESIGN BUILD OPERATE MAINTAIN CONTRACTS

A Design Build Operate Maintain (DBOM) contract is an integrated procurement model where the responsibility of designing, constructing, operating and maintaining a facility is held by a single entity. DBOM contracts help to facilitate a life cycle driven approach to design, procurement and operation in the built environment, realising maximum value from resources. For example, designers are incentivised to deliver designs that respond to commercial objectives accounting for the whole asset life cycle.



FEATURE 2 PUBLIC PRIVATE PARTNERSHIPS

Public private partnerships are long-term contracts where the private sector designs, builds, finances and operates a project with public benefit¹⁰. Public private partnerships come by different names in different countries and can take many contractual forms. In this study, the term is used in a broad sense to refer to any collaboration between public and private sectors with the aim of delivering preferred outcomes to all parties. The private sector needs partnerships with government to identify enablers and create favourable conditions for the transition.

FIRST MOVERS IN DETAIL

POLICY MAKERS

CURRENT PRACTICE

Globally, policies that will enable the circular economy are gaining momentum, such as those found in Denmark¹¹ and the European Union¹². However, implementation of these policy frameworks have been delayed due to the limited evidence base available to inform them, and an ongoing debate about how ambitious targets should be.

At the city level, municipal policymakers have begun to embed circular economy principles in city strategies and roadmaps. Gemeente Amsterdam (the Municipality of Amsterdam) is one such example (see Feature 3).

There are still obstacles to overcome. The current built environment is characterised by multiple stakeholders operating in silos and lacking incentives to collaborate, making it difficult to get buy-in for circular solutions. Half of the policymakers interviewed also cited a lack of awareness of the circular economy concept and its systemic nature within policy institutions. Finally, just over 40% of policymakers felt regional diversity in policy created inconsistent messaging and confusion for built environment stakeholders.

THE FUTURE

In our vision for a circular built environment, policymakers create a policy environment that facilitates the implementation of a circular economy. They set direction, remove barriers and create space for innovation, targeting specific outcomes such as resource productivity. This includes a shift towards life cycle assessments of building and infrastructure, and the prescription of standardised metrics for circular economy reporting.

One third of our interviewees identified an opportunity for policymakers to lead by example through circular public procurement. Municipalities, for example, could earmark public land for circular economy partnerships with private developers.¹³

In addition, there is also a clear opportunity to overcome institutional silos between different government departments, fostering collaboration through clear, unified messaging and targets that promote a circular built environment.

FIRST STEPS

The most important first step is identifying policy changes to support a circular economy transition, as cited by 70% of the policymakers interviewed. This could include the development of national, regional and municipal policy frameworks, the creation of economic incentives such as VAT reductions on circular economy services and assets¹⁴, the specification of more circular public procurement measures, or the convening of partnerships with private-sector organisations to catalyse collaboration.

Within planning policy, requirements covering demolition strategies, specification of construction materials, proportions of reused and reusable materials, and mandatory life cycle cost calculations could all play a part in supporting circular economy adoption. The Ellen MacArthur Foundation's Toolkit for Policymakers provides further information and support for policymakers (see Feature 4).

Policymakers noted the need for examples of commercial scale projects and industry leadership to provide an evidence base to inform the development of policy. Just over 40% cited the importance of creating real projects in scalable sectors to demonstrate the benefits of a circular economy approach and generate greater political interest and momentum. A third of policymakers also suggested leadership from influential industry stakeholders as a way to drive the agenda politically and publicly, with a focus on initiatives that do not require fiscal policy.

70%

of policymakers interviewed cited identifying the policy changes that support the transition as the most important first step.

“For each component of the circular economy we defined what the role for the market is and what should additionally be ours. We interact with the market by listening to societal needs and facilitate, kick-start, stimulate and regulate the market accordingly.”

Eveline Jonkhoff, Strategic Advisor for Sustainability and Circular Economy, Gemeente Amsterdam



FEATURE 3 CIRCULAR GEMEENTE AMSTERDAM

Gemeente Amsterdam, the municipality government of the city, is pioneering the transition from a linear to a circular economy. The city has defined its role in the transition clearly; it seeks to make the city a living lab for smart, circular innovation, commissioning research into likely benefits, collecting and sharing data and facilitating collaboration between research institutes, start-ups and corporations. It uses public procurement to kick-start circular services.



FEATURE 4 THE TOOLKIT FOR POLICYMAKERS

The Toolkit for Policymakers¹⁵, developed by the Ellen MacArthur Foundation, aims to support policymakers who have decided to accelerate the transition to a circular economy. It offers a step-by-step methodology to explore circular economy opportunities, quantify their impact, identify barriers preventing these opportunities, map and prioritise the policy interventions to overcome these barriers and engage relevant stakeholders. The Toolkit may be used by policymakers as a first step to help identify which policy interventions can be leveraged to accelerate the transition to a circular economy in their policy area.

INVESTORS

CURRENT PRACTICE

The investment community is yet to fully engage in circular built environment projects. Instead, circular economy exemplar projects are typically funded by public or private organisations solely through internal capital budgets. The Alliander Head Office, for example, which was delivered based on circular principles and has a proven positive economic value case, was funded fully from Alliander's capital investment budget (see Feature 10). Another precedent is the Forth Replacement Bridge, or Queensferry Crossing, a project fully funded by the Scottish Government, which saved GBP 1 billion from its budget through creative reuse of the existing bridge (see Feature 5).

Investors interviewed for this study identified twice as many barriers as opportunities to a circular economy transition. This suggests more work needs to be done to demonstrate the benefits of a circular economy to the investment community. Half of the investors cited a lack of confidence and clarity in circular economy investment opportunities as a barrier. Their concerns included uncertainty of how circular economy business models might work, and scepticism of whether the business case would stack up or how contracts might need to change.

The nature of the construction industry itself was cited as a barrier by 40% of the investors interviewed. Specific comments range from challenges around low margins to conservatism, low innovation rates, industry fragmentation and an unwillingness to collaborate.

THE FUTURE

In our vision, built environment investors use new investment models that unlock additional value by eliminating structural waste and mobilising the latent longer-term value of assets. This means that high operational cost, inflexible and non-deconstructible buildings attract lower valuations than cheaper-to-run, flexible and deconstructible alternatives. Buildings designed to stay at a high value over time depreciate more slowly, maintaining value on balance sheets for longer. Investors make decisions based on total expenditure (TOTEX) rather than capital cost (CAPEX), supplemented by next-generation environmental, social and governance (ESG) metrics, for example, consumption-based carbon footprints.

Of the investors interviewed, 30% regarded collaboration as critical for realising win-win circular economy business propositions. Increased collaboration between the industry and investment community directly impacts on design choices, leading to the creation of higher value, more socially-useful, multi-functional spaces delivered at lower cost.

FIRST STEPS

Delivering commercial scale projects is a crucial first step, as cited by a third of investors. Projects that test elements of a circular economy approach at full scale will help to demonstrate technical and commercial viability. While 30% of investors noted a role for policymakers to facilitate these projects by creating incentives, updating regulations or mandating change via public procurement and pre-competitive collaborations – as stated previously, this is countered by policymakers, who have called for the private sector to show leadership through commissioning commercial, scalable circular projects.

To catalyse the delivery of these projects, a third of investors suggested new valuation techniques are needed. Collaborative research is required to support these activities, defining the tools and data required to facilitate better valuations of assets over a project's entire life cycle, for example, looking beyond purely financial metrics to broader ESG considerations to judge success (see Feature 6).¹⁶ While ESG investing is becoming increasingly important, its take-up in the real estate sector remains patchy. This is despite real estate often being a longer-term investment, increasing risks from future tightening of environmental regulation.¹⁷

The investor community has a vital role in making this research relevant to their sector's needs. This will be explored in more detail in Phase 2 of the research project.

50%

of investors interviewed cited a lack of confidence and clarity in circular economy investment opportunities as a barrier.

30%

of investors interviewed regarded collaboration as critical for realising win-win circular economy business propositions.

“Data is the thing. We all know what is instinctively right, but the evidence is difficult to find.”

Stewart Smith, Managing Director, Advisory & Transaction Services Occupier, CBRE

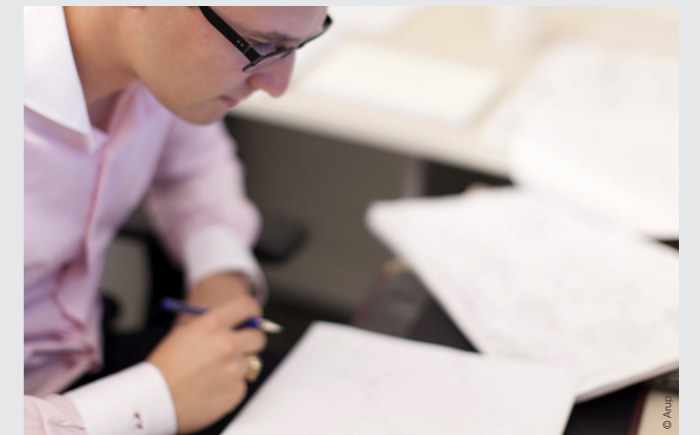
“We think that the systemic cooperation and agreement amongst all stakeholders along the value chain will bring added value to the projects thus generating a more appealing financial opportunity for the investor.”

Massimiano Tellini, Global Head – Circular Economy, Intesa Sanpaolo



FEATURE 5 FORTH REPLACEMENT BRIDGE

The proposed scheme to replace the 50-year old Forth Road Bridge in Scotland with a larger bridge was challenged by Arup. Instead, a new concept to retain the old bridge for light traffic was proposed, meaning a smaller new bridge was designed. This avoided the consumption of significant material resources and resulted in project cost savings of GBP 1.7 billion. An advanced structural health monitoring system, which was simple to operate and made up of approximately 1,000 sensors, was developed for installation on the new bridge. It gives advanced warning of structural problems and allows for targeted inspection.



FEATURE 6 ENVIRONMENTAL, SOCIAL AND GOVERNANCE INVESTMENT

Environmental, social and governance (ESG) investing is the consideration of sustainable and ethical factors alongside financial considerations in an investment strategy. Issues covered include:

- Environmental – energy, water and waste efficiency, embodied carbon, indoor air quality, greenhouse gas emissions
- Social – working conditions, health and safety, accessibility
- Governance – bribery and corruption, subcontractor selection and monitoring, investment fund governance¹⁸

CONSTRUCTION CLIENTS

CURRENT PRACTICE

Our research revealed that case studies which considered circular economy principles from project inception were rare; those that did were often showcase pilot projects or temporary installations. A small number of individual commercial scale projects included elements of circular economy thinking, such as Sky's 'Believe in Better Building' (see Feature 7).

Our analysis suggests that construction clients actively involved in educating themselves about the circular economy and pursuing its opportunities find it hard to unlock its potential. Half of our interviewees cited legal and procedural complications associated with taking a new approach as a barrier to circular economy adoption. This is evident in highly regulated sectors like infrastructure, where the regulatory environment precludes a move away from the linear mindset by limiting clients' influence over contractual processes and financing models. Closely related to this is the rigidity of current contract terms on liability and responsibility, which restrain innovation and the adoption of new approaches.

In the face of these structural barriers, a third of the construction clients spoken to note that their customers are not demanding circular solutions, meaning that they have to lead rather than follow the market.

THE FUTURE

In our vision, whole-life value is used to assess design decisions on all projects. Construction clients instruct the design and construction of their assets with consideration for the whole-life cycle, facilitated by DBOM contracts. The operation of these contracts is defined in terms of whole-life economic, environmental and social metrics. The result is a built environment consisting of healthy assets with long-term value. Clients' assets last longer and are capable of changing use more quickly, affordably and frequently than they do currently.

Over half of the construction clients interviewed agreed that greater collaboration could inspire new ways of thinking, working and delivering value. Opportunities are also identified in the operation of assets and the sharing economy, particularly if circular economy approaches are adopted at scale across sectors or portfolios.

FIRST STEPS

A first step for construction clients is to bring all stakeholders together in partnerships to enable more collaborative project delivery and facilitate knowledge sharing, concurred half of the interviewees. Construction clients can show leadership in this respect by setting new expectations for circular procurement and clearly communicating these to the supply chain. This approach identifies shared outcomes and creates a working environment that allows mutual benefits to be realised.

A quarter of construction clients interviewed stated they would consider adopting new circular approaches, provided they are demonstrated on low risk elements of projects in the first instance. Some interviewees mentioned building typologies they considered lower risk, for example, social housing, while others made the distinction between shell-and-core components (high risk) and fit-out (low risk). Another important step, for clients as well as investors, is to identify the financial opportunity inherent in built environment assets that are longer lasting, more flexible and provide a healthier environment for users. Part of this will come down to better dissemination of knowledge and increasing awareness amongst clients around the value and benefit of building circular (see Feature 8).

Of the construction clients interviewed, half pointed towards policymakers as enablers of the transition. As described previously, policymakers need evidence on which to base policy design; construction clients are well-placed to start creating that evidence. By working with policymakers through any of the emerging circular economy collaboration platforms and establishing links through public private partnerships, clients will have the opportunity to connect with those able to change regulations or introduce incentives to make the circular economy transition an industry-wide, systemic shift.

25%

of construction clients interviewed stated they would consider adopting new circular approaches, provided they are demonstrated on low-risk elements of projects in the first instance.

50%

of our interviewees cited the legal and procedural complications associated with taking a new approach as a barrier.

“There is no doubt in my mind that the circular economy will come. It is important for us to drive development in this area to ensure that we understand what kind of solutions we can provide, once clients realise that this is the new paradigm.”

John Sommer, Director of Strategy and Business Development, MT Højgaard Group



FEATURE 7 BELIEVE IN BETTER BUILDING

Sky's Believe in Better Building demonstrates the use of a glue-laminated (glulam) timber frame and cross-laminated timber slabs to construct a net zero-embodied carbon multi-storey building. Arup's design focused on off-site fabrication and modular construction. Adaptive fittings create flexible spaces which allow for transitions between office, breakout and event spaces. The building incorporates rooftop PV and a site-wide biomass combined cooling, heating, and power system to reduce the building's CO₂ emissions by 40%. The design aims to optimise the health and well-being of the building's occupants using natural ventilation, day-lighting and safe materials selection.



FEATURE 8 COMMUNICATING THE BUSINESS CASE

Working with Ellen MacArthur Foundation's CE100 network, Arup and BAM identified circular business strategies for the built environment, and in some cases quantified the benefits. For example, good design and collaboration can result in building materials retaining 60% of their original value at the end of first life.¹⁹ The strategies; circular design, circular use and circular recovery, are a starting point for developing circular real estate investment products. To accelerate progress, we need to estimate the value and understand how to adopt these strategies on construction projects (see Next Steps - Phase 2 overleaf).

NEXT STEPS - PHASE 2

A first step towards delivering commercial, scalable projects is the development of bankable investment models that realise the added value of a circular economy business approach.

Phase 2 of *From Principles to Practices* intends to create these models and test them on real projects. We recognise that the development of these new models will require consideration of the following:

- **Relationships** – in a circular built environment, new relationships will be needed at each stage of a project. New contracts will be needed to govern these relationships
- **Valuation** – we will need to update the ways we calculate the value of built environment assets in order to capture the value created by a circular model
- **Key influencers** – beyond the stakeholder groups considered in Phase 1, there are influencing groups, such as real estate agents, who leverage value creation in our sector; they will play a key part in new circular investment models

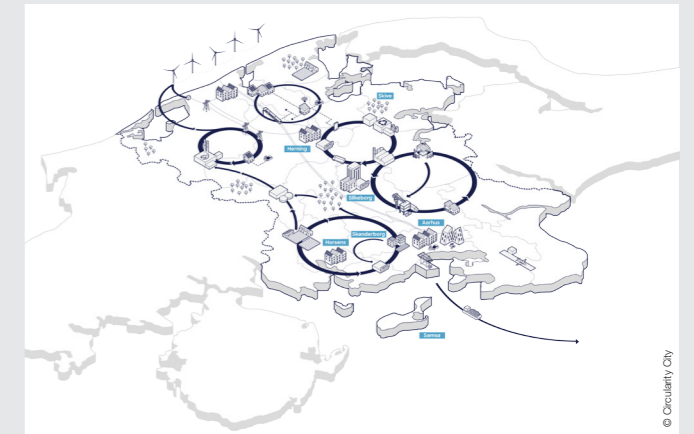
We will seek to quantify these new relationships, using economic analysis to estimate net economic benefit and investment returns. We will investigate how improved environmental and social changes can be captured in valuation techniques in addition to how the role of key influencers will shift.

Asset typologies have different investment characteristics, for example, hospital construction versus commercial office development, and the investment environment varies between jurisdictions. In Phase 2, we are therefore interested in considering several asset typologies located in different cities.

We know from Phase 1 that public and private sector partners will both need to contribute to this study, and that collaboration is essential if we are to successfully bring together disparate stakeholder perspectives as demonstrated by the Circularity City project in the Central Denmark Region (see Feature 9).

The outcome will be a tangible model for realising circular value from built environment assets, with robust economic estimates for the potential of our new approach. We are confident that there is a positive economic case for circular economy adoption, as there was for Alliander HQ (see Feature 10).

We conclude this report with an invitation and a call to action. We invite the built environment industry, particularly policymakers, investors and construction clients, to help us develop these new models, implement them on commercial, scalable projects, and demonstrate the benefits of a circular model to the industry. Our aim is to go beyond discussing principles and start implementing practices.



FEATURE 9 CIRCULARITY CITY

The Circularity City project will accelerate urban transformation in the Central Denmark Region. The aim is to develop commercial scale building projects, to pave the way forward for design, resource streams, tenders, and organisational frameworks that support circular construction. During 2017-2020, the Central Denmark Region will assemble stakeholders from the construction value chain, to collect ideas, identify needs and develop solutions. The project will stimulate market activity by facilitating circular public procurement and municipal partnerships, while providing technical support to policymakers and businesses. The end goal is to accelerate the transition towards circular cities by demonstrating that it is viable to build effectively with circular principles at scale.

“Current business models weren’t put together with circular economy in mind. We need forms of contract that are output based, that are collaborative and that have early involvement. We need all three.”

Mike Putnam, Non-Executive Director, Skanska

“Identifying pilot buildings to collaborate on with stakeholders has the biggest potential to change the way the sector works.”

Thomas Schwillig, Berlin Senate Department for the Environment, Transport and Environmental Protection

“I think the real creative thing lies with people who don’t naturally work together but ought to.”

Alan Knight, Head of Sustainable Development and Corporate Responsibility, ArcelorMittal



FEATURE 10 ALLIANDER HQ

Alliander HQ in the Netherlands could be perceived as a new build. However, it is a re-working and extension of an existing building, where 92% of the materials labelled as ‘circular’. Originally built 30 years ago to accommodate 600 people, the expansion in 2015 has allowed for a further 900 occupants. RAU Architects’ design focused on the use of material passports and reduction of resource use; 90% of the building materials from the existing building being reused or remaining on-site.

GLOSSARY

CIRCULAR ECONOMY BUILDING BLOCKS

The four building blocks are the requirements on a systemic level for the circular economy to emerge. The definitions below are consolidated versions of those developed by the Ellen MacArthur Foundation:

- **Circular economy design** – building core competencies in circular design to facilitate product reuse, recycling and cascading. Areas important for economically successful circular design include material selection, standardised components, and design for easy end-of-life sorting. Examples include:
 - design for reuse, repair, remanufacturing and recycling
 - passive design
 - Cradle to Cradle Certified™ building materials
- **New business models** – the shift to a circular economy requires innovative business models that either replace existing ones or seize new opportunities. Examples include product-as-a-service and asset sharing enabled by digital platforms. Examples include:
 - product as a service
 - performance based contracts
 - DBOM contracts
- **Reverse cycles** – products, components, and materials need to be looped or cascaded back into industry or the natural environment. This requires delivery chain logistics, sorting, warehousing, and even molecular biology and polymer chemistry. Examples include:
 - take-back schemes
 - material passports
 - extraction technologies
- **Enablers and favourable system conditions** – for widespread reuse of products and materials to become commonplace, market mechanisms will play a dominant role, but important support will come from policymakers, educational institutions, and leaders of public opinion. Examples include:
 - collaboration
 - leading by example and driving scale
 - access to financing

RESOLVE

ReSOLVE levers identify six strategies for those wanting to seize circular economy opportunities. The definitions below are adapted (due to subsequent updates and amendments to reflect the built environment) from the ReSOLVE framework, which was developed by the Ellen MacArthur Foundation, SUN and McKinsey Center for Business and Environment:

- **Regenerate** – regenerating natural capital by safeguarding and increasing the resilience of ecosystems, or by returning valuable biological nutrients safely to the biosphere. Examples include:
 - green corridors
 - urban farming
- **Share** – maximising assets utilisation by mutualising the use of assets, or by reusing them. Examples include:
 - on demand office space
 - reuse of structural steel
- **Optimise** – optimising system performance by prolonging asset use periods, reducing waste during production, or optimising the logistics system through implementation of reverse logistics. Examples include:
 - sensors for predictive maintenance
 - industrial eco parks
- **Loop** – keeping assets in cycles by refurbishing, remanufacturing or recycling. Examples include:
 - building refurbishment
 - recyclable insulation with recycled content
- **Virtualise** – displacing resource use by delivering virtual services. Examples include:
 - video conferencing
 - embedded sensors for testing
- **Exchange** – selecting resources and technologies wisely by shifting to renewable energy and material sources, using alternative material inputs, replacing traditional with advanced technical solutions, or replacing product-centric delivery models with new service-centric ones. Examples include:
 - 3D printing
 - façade leasing



Above: Berlinovo, Berlin

STRUCTURAL WASTE

The under-utilisation of high value assets such as cars and buildings due to the way that certain markets currently operate, for example the predominance of each person or family owning their own car. Indeed, analysis has shown that the average European car is parked 92% of the time. Looking at the built environment in Europe as another example, during construction, 10-15% of building materials are wasted and 35-40% of offices are not used even during working hours⁴.

FINANCE

Finance is the amount of capital provided to an organisation with the expectation that the amount will be repaid along with a certain percentage of interest. Finance can be provided by governments, financial institutions like banks, or investors like venture capitalists, business angels, shareholders etc. The most common forms of finance include debt, equity, leasing and credit.

MODULAR CONSTRUCTION

Modular construction comprises manufacturing building components, and sometimes whole buildings, off-site as transportable pieces. This improves quality as much of the work is completed in factory conditions. The building is then assembled on-site, in such a way that users are unable to determine whether the modules meet. This method has the potential to considerably reduce cost, time on site and waste generated compared with traditional on-site construction methods.

LIFE CYCLE ASSESSMENT

A tool for the systematic evaluation of the environmental aspects of a product or service through all stages of its life. If implemented well, it is a valuable means to evaluate different options at a given point in time. It should be noted that, while a useful tool, it should be used with care and complemented by other forms of assessment as it does not take into account system level effects.

REFERENCES

¹ <https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/reinventing-construction-through-a-productivity-revolution>

² <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>

³ <https://www.usgbc.org/articles/ifc-and-world-green-building-council-announce-global-partnership-accelerate-green-building->

⁴ Norm Miller, Workplace Trends in Office Space: Implications for Future Office Demand, University of San Diego, 2014; GSA Office of Governmentwide Policy, Workspace Utilization and Allocation Benchmark, 2011; Flexibility.co.uk, Shrinking the office; IEA Statistics © OECD/IEA (<http://www.iea.org/stats/index.asp>) Energy Statistics and Balances of Non-OECD Countries, Energy Statistics of OECD Countries, and United Nations, Energy Statistics Yearbook; European Commission, Service contract on management of construction and demolition waste, 2011.

⁵ <https://www.arup.com/publications/research/section/circular-economy-in-the-built-environment>

⁶ <https://www.chapmantaylor.com/insights/uk-residential-how-to-capitalise-on-the-opportunity-of-prs>

⁷ <https://green.harvard.edu/tools-resources/research-highlight/impact-green-buildings-cognitive-function>

⁸ Examples of wild card organisations included a law firm, research organisation and collaborative demonstration project.

⁹ <https://newplasticseconomy.org/>

¹⁰ <https://www.gov.uk/government/collections/public-private-partnerships>

¹¹ <http://en.mfvm.dk/focus-on/circular-economy/>

¹² http://ec.europa.eu/environment/circular-economy/index_en.htm

¹³ http://urd.verdus.nl/upload/documents/URD-CONTEXT-Report-2_Amsterdam-Buiksloterham.pdf

¹⁴ <https://circulatenews.org/2016/09/sweden-give-tax-breaks-repairs/>

¹⁵ <https://www.ellenmacarthurfoundation.org/publications/delivering-the-circular-economy-a-toolkit-for-policymakers>

¹⁶ A survey found that 68% of global institutional investors find integrating ESG metrics into their portfolios significantly improved. Reference: Performing for the Future, State Street Global Advisors, April 2017: <https://www.ssga.com/investment-topics/environmental-social-governance/2017/esg-institutional-investor-survey-us.PDF>

¹⁷ <https://www.theinvestor.jll/news/asia-pacific/others/real-estate-impact-esg/> accessed 22/06/18

¹⁸ http://www.risklab.com/media/151208_esg_in_real_estate.pdf

¹⁹ Arup and BAM, Circular Business Models for the Built Environment, 2017: https://www.ellenmacarthurfoundation.org/assets/downloads/ce100/CE100-CoPro-BE_Business-Models-Interactive.pdf

PROJECT TEAM

ARUP

Arup is the creative force at the heart of many of the world's most prominent projects in the built environment and across industry. With over 80 offices in 34 countries Arup has more than 14,000 planners, designers, engineers and consultants delivering innovative projects across the world with creativity and passion.

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The Ellen MacArthur Foundation was launched in 2010 with the aim of accelerating the transition to the circular economy. Since its creation, the charity has emerged as a global thought leader, putting the circular economy on the agenda of decision-makers across businesses, governments, and academia. The charity's work focuses on five interlinking areas: insight and analysis; learning and training; business and government; systemic initiatives; and communications.

www.ellenmacarthurfoundation.org
[@circulareconomy](https://twitter.com/circulareconomy)



3XN Architects and GXN Innovation create buildings that challenge conventions while advancing a Scandinavian tradition of functionality and beauty. GXN is driving design innovation in materials, behaviour and technology, and with projects such as 'Building a Circular Future' and 'Circle House', the company is taking a lead in the circular economy.

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