

CIRCULARITY
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**shaping our
urban future**

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urban future**



The agenda for sustainable development is urgent and the link between consumption of resources and CO₂ emissions has rightfully gained attention and calls for action.

Construction and urban development leave a large carbon footprint with a high consumption of resources; at the same time there is a need for new housing due to population growth. In Central Denmark Region, we wish to strengthen our circular economy approach and we have done that through the initiative Circularity City to boost sustainable solutions in the construction industry.

I am proud of the results we have achieved through the many strong partnerships between Central Denmark Region and public as well as private companies and institutions. We use these results in our future work and we are happy to share these in other partnerships.



– Anders Kühnau
President
Central Denmark Region

Introduction

Circularity City was a 3-year development project, aimed at boosting a circular economy within the building sector of Central Denmark Region and Denmark in general. The project brought together actors from across the Central Denmark Region to create the circular cities of tomorrow and leverage circular construction and design to accelerate sustainable business growth. The project involved 17 municipalities, over 60 companies, and several knowledge institutions in numerous activities, which spurred new projects and collaborations across the industry, and developed methods and toolkits to enable the further development of circular building practices.

The project was part of the strategic efforts of Central Denmark Region to position itself as a leading business zone for circular economy and involved municipalities as well as private urban developers contributing through construction and urban development projects. These have served as beacons for circular construction in the region. The projects have raised awareness, not only in Denmark but also abroad, and helped to create new business and export opportunities for the region's construction companies.

Circularity City has demonstrated that it is viable to build effectively with circular principles, and thus the following pages can be read as an inspiration to countries, regions or cities who would like to boost circular economy in the building sector.

Partners



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I believe that the cities of the future must be more sustainable and incorporate circular economy. Aarhus has the potential and ambition to be a frontrunner in this endeavour.



– Jakob Bundsgaard
Mayor of Aarhus
Aarhus Municipality

CIRCULARITY

A Circular Future

towards a circular economy



The Circularity City Project

Circularity City has gathered municipalities and private sector frontrunners within the Central Denmark Region to display how circular cities can be built.

Circularity City is designed to boost both supply and demand of circular solutions in the building industry. The project has assembled stakeholders in urban development and the construction industry to develop circular construction methods for actual projects.

collaboration and development projects for both municipalities and corporations amongst other solutions – all with the shared vision of establishing new circular solutions and scaling them, nationally and globally.

During a three-year period from 2017 to 2020, the focus has been to design new innovative, circular solutions in order to create a more positive environmental footprint in the built environment. This has been carried out through value-chain

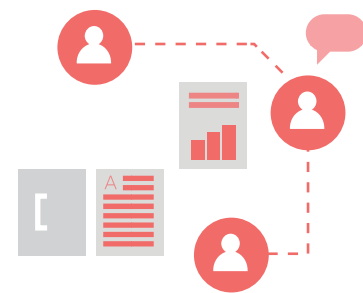
Facts

More than 60 companies and 17 municipalities has been taking part in the circular transformation of the construction sector.



Three Steps to Realising the Vision

Circularity City has assembled relevant stakeholders in the Central Denmark Region to map out opportunities and barriers for a circular economy in the built environment. We have collected regional and global inspirations and best practices in order to create innovative solutions and scale these across the region.



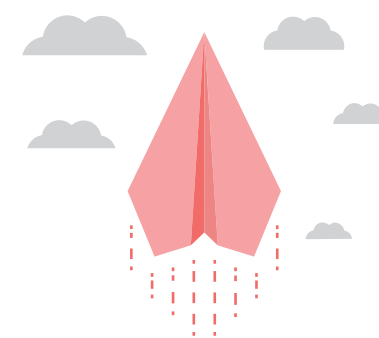
1. Assemble

We have assembled the construction sector around circular building and urban development projects.

We have identified barriers and opportunities that must be addressed to accelerate circular construction.

We have distributed responsibilities to ensure that the right skills and solutions have come into play.

We have integrated companies through collaboration and thus created new opportunities for growth.



2. Innovate

We have helped businesses and builders develop and integrate circular processes.

We have established value-chain collaborations to deliver circular building solutions.

We have developed new circular business models for the construction sector.

We have offered introductory courses to businesses wishing to transition to circular construction.

We have provided financial support for the development of solutions and projects.



3. Initiate and Scale

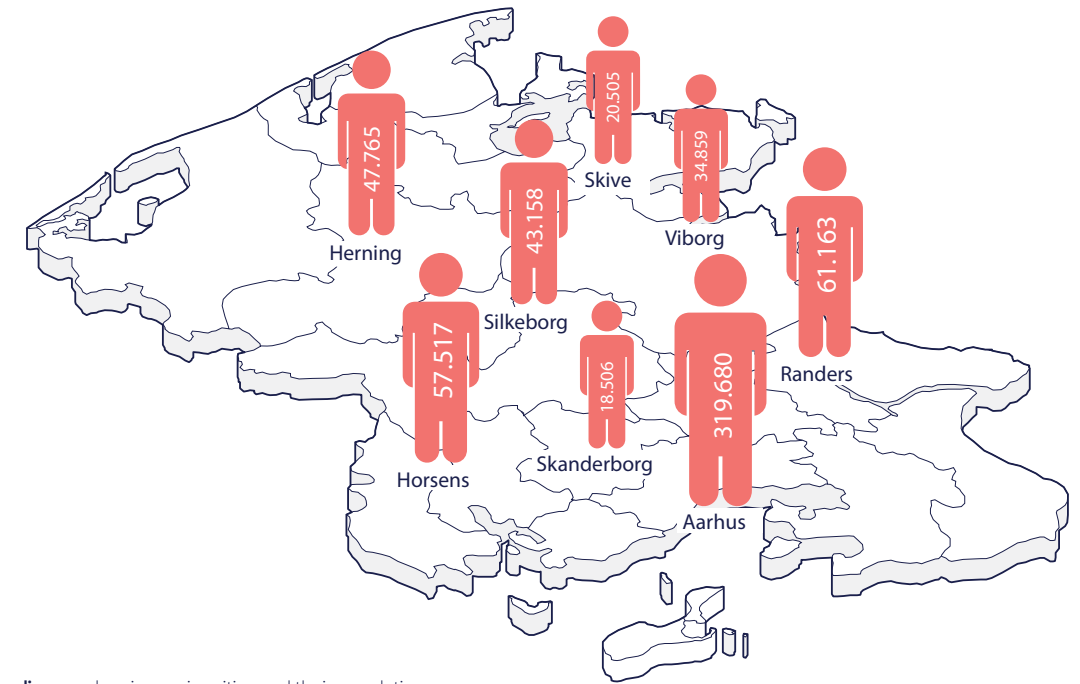
We have proposed circular solutions for construction projects in the Central Denmark Region.

We have been matching circular solutions with building and urban development projects throughout Denmark.

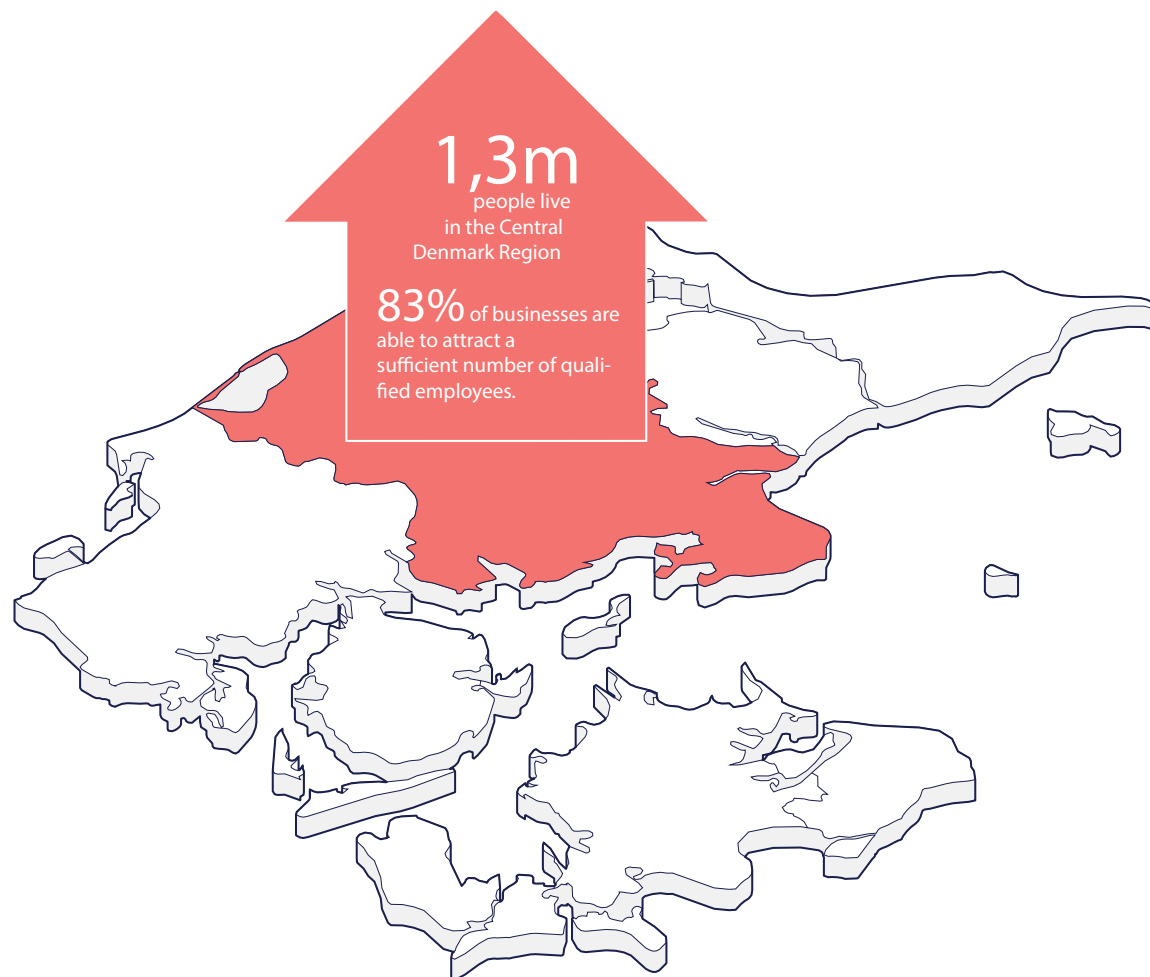
We have brought solutions to cities around the world, with New York as the first destination.

Circular Potential in Central Denmark Region

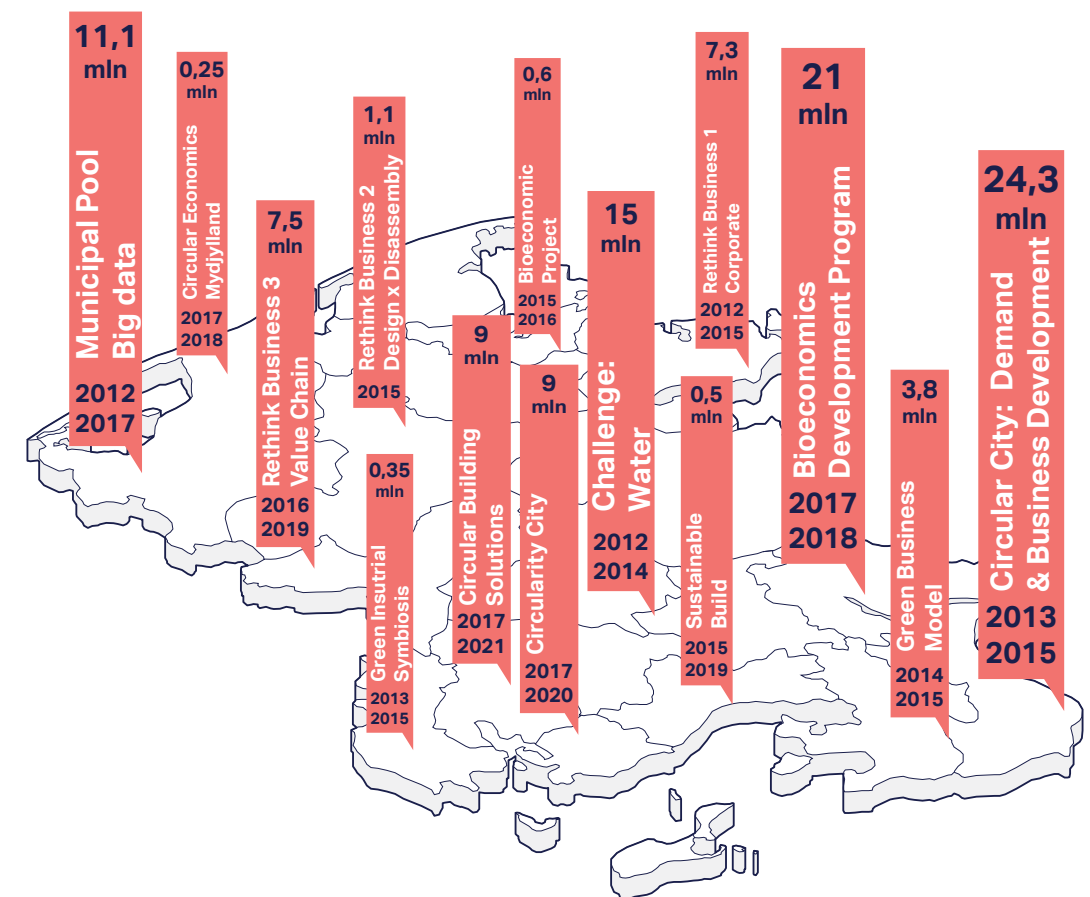
The Central Denmark Region is the second largest in Denmark. Home to 1.3 million people and Denmark's second largest city, the region is a bustling hub with many small and large companies, developers, suppliers and end-of-life contractors. During the past two years these businesses and the public sector have been brought together to create a vision and roadmap for circular regional development.



Population diagram showing major cities and their populations.

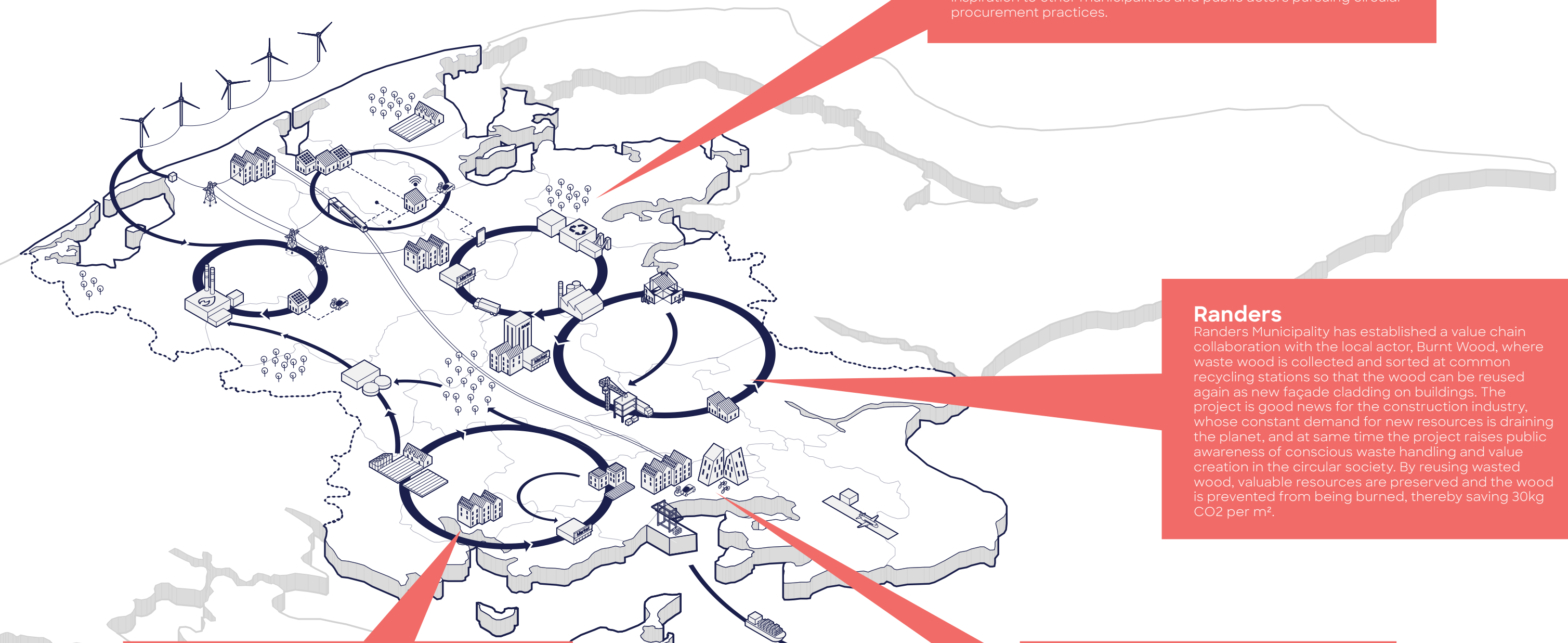


Demographics diagram showing the Central Denmark Region as a part of Denmark



Project diagram showing circular economy projects funded by the region since 2012.

Cities are Taking the Lead



Skive

In Skive Municipality, a new building that will house people with autism will be built to meet high requirements and standards for circular sustainability. With focus on ensuring circular principles, the building will be a strong example for municipalities who wish to ramp up demands for how to build more sustainably. The project in Skive is expected to be finalised in 2020 and already now stands as an inspiration to other municipalities and public actors pursuing circular procurement practices.

Randers

Randers Municipality has established a value chain collaboration with the local actor, Burnt Wood, where waste wood is collected and sorted at common recycling stations so that the wood can be reused again as new façade cladding on buildings. The project is good news for the construction industry, whose constant demand for new resources is draining the planet, and at same time the project raises public awareness of conscious waste handling and value creation in the circular society. By reusing wasted wood, valuable resources are preserved and the wood is prevented from being burned, thereby saving 30kg CO₂ per m².

Horsens

The municipality of Horsens has hosted numerous events aimed at educating local stakeholders about why and how to work with circular economy. To boost the common competences and knowledge related to circular economy in the municipality, courses and after-hours meetings have been held in Horsens, Silkeborg, Skanderborg and Aarhus Municipality. The hope is to experience a new and focused dialogue between all actors in the municipality and the building industry, and it is planned that the events will be spread even further across the regions of Denmark.

Aarhus

In the Lisbjerg Bakke district on the outskirts of Aarhus, 60 social housing units are about to emerge. The project, Circle House, is Denmark's first circular housing project, and its purpose is to disseminate knowledge and know-how about circularity principles to the entire construction sector, as a scalable lighthouse building project offered and constructed on market terms. The Circle House units are scheduled for completion by 2022.

How to internationalize

Sustainability and resource efficiency within the built environment are Danish trademarks, which companies for decades have used to drive the international business development. Of recent years, circular economy is emerging as the next big value driver, which is a stronghold with great international perspectives.



The international momentum for circular economy

For the past three years Circularity City has set out to explore how the existing Danish stronghold can be utilised as a driver to internationalise the circular economy in the built environment. Because both the U.S. and German markets are global powerhouses in the building industry and represent sizable economic opportunities for circular solutions, they were selected as study cases to develop scalable internationalisation approaches.

As part of the broader sustainability agenda, circular practices in the built environment are being adopted gradually and a notable increase in interest can be noted just during the period that Circularity City has been implemented.

A Danish cluster of circular excellence

When it comes to the developing and testing of circular solutions for the built environment, the collaboration in Denmark between municipalities, research institutions and companies has driven the creation of a world-class cluster of excellence: an essential concentration of knowledge that can serve as a future catalyst for international attention and the development of solutions with global potentials.

Assisting companies to explore international potential

Collective international events and individual business development support have been the cornerstones of the Circularity City internationalisation program. The Circularity City events have provided participating companies with a shared circular narrative, multiple platforms to create visibility, and an opportunity to develop new networks. In addition, the access to individualised assistance has enabled product-specific market insights and quicker international commercialisation of circular solutions.

Why look abroad?

There are three critical reasons why Danish businesses should consider directing their gaze towards international markets.

1. Domestic market potentials for circular solutions in the built environment

Depending on product or solution, more favourable market conditions might be found internationally and can provide vital test grounds and business opportunities.

2. Scale and international competitive advantages

Companies have embedded circularity into their business activities with the aim of international growth. In some cases, results must be produced in a sufficiently large scale before they can start to operate profitably. International markets can be an answer to that challenge.

3. International outlook as an innovation driver

For Danish companies who seek inspiration and positioning their circular business, there is a great potential in exploiting the innovation created abroad by foreign companies and knowledge institutions.



Circularity City has worked extensively to enable the building sector to make the circular transition. We have engaged more than 1,000 people, hundreds of companies and almost all the municipalities in the Central Denmark Region as well as the rest of Denmark and internationally.

I am particularly proud of the increased demand for circular buildings by the municipalities and the toolkits we have developed throughout the project.

With the work we have done in Circularity City, we have shown the way, not just to a circular future, but a circular present.



– Søren Bernt Lindegaard
Project Manager
CLEAN



CIRCULARITY CITY

Models for Circularity



5 Models for Circularity

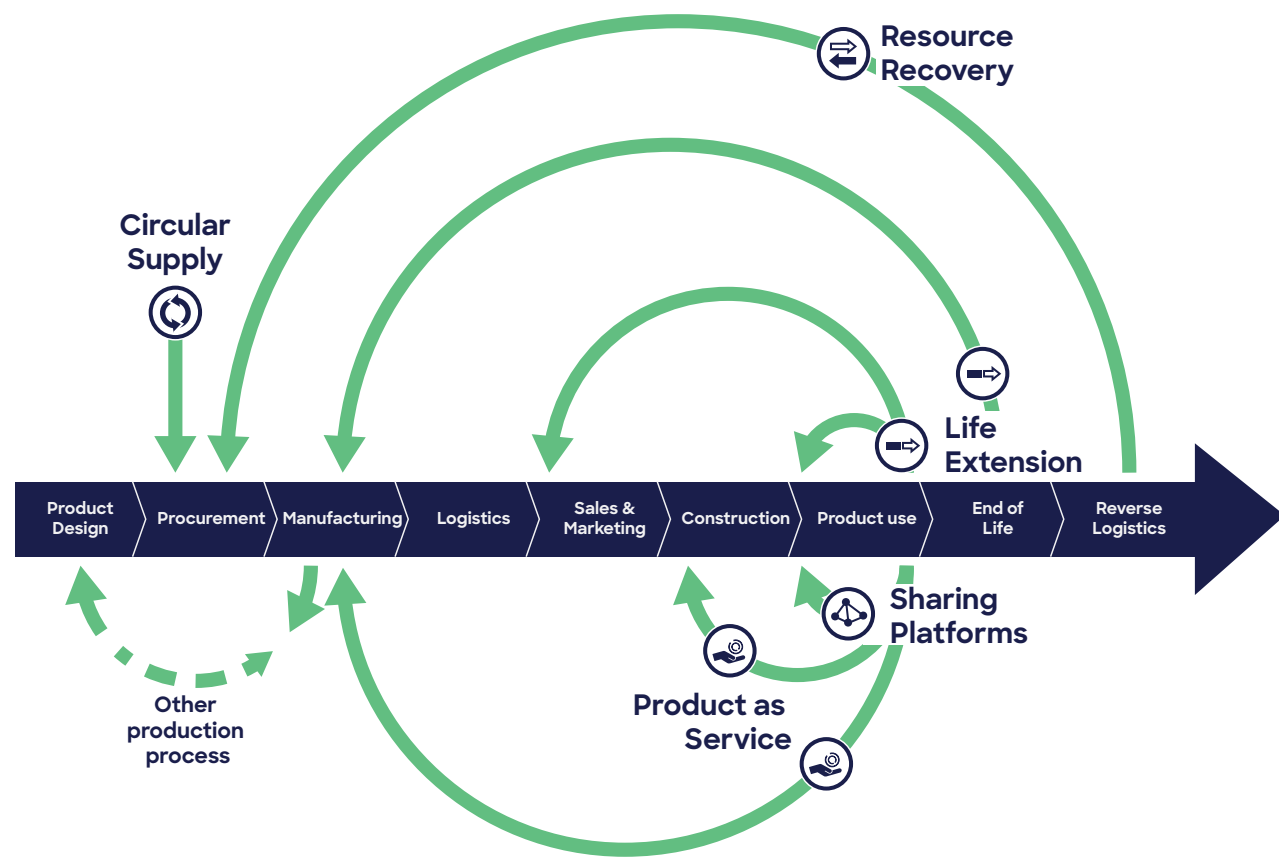
Circular business models are key to the transformation from a linear to a circular economy in the construction sector, and must work alongside design strategies, governance and regulations for the transition to be a success.

Circular business models generate new ways to develop and grow a business while improving planning, creating savings, and leading to responsible material choices¹. The business models are based on a comprehensive life cycle approach and seek to forge new productive partnerships in the construction value chain. One way to implement the model is to create consortiums, which include designers, suppliers, service providers, contractors, and demolition companies, all of whom need to work closely together to forge robust business partnerships.

Circular economy is as much about economy as it is about enhancing resource productivity through optimal sustainable use and re-use of resources. Hence, any business model relevant to the circular economy must focus on value capture and creation.

In the duration of the Circularity city project, a number of businesses in the region have advanced within one of the five key business models as defined by Lacy & Rutqvist. The following chapter will explain the business models, as well as the companies and actors working with them.

The 5 Business Models Are:



1. Circular Supply

Replace virgin raw materials with materials that are renewable or bio degradable.



2. Resource Recovery

Recover discarded products or by-products to recycle or upcycle the materials.



3. Life Extension

Extend the life cycle of a product, or parts of a product, while preserving the original function.



4. Sharing Platforms

Increase the use of a product through new models for sharing, accessibility and ownership.



5. Product as Service

Optimise productivity of a resource or product while maintaining ownership of the product.



1. Circular Supply

Replace virgin raw materials with materials that are renewable or bio degradable.

In this business model, the focus is on supplying fully renewable, recyclable or biodegradable resource inputs that support circular production and consumption systems. In this way, materials retain their quality and

value, securing a steady supply of raw materials for new construction, while companies replace linear approaches and reduce the use of scarce resources and the production of waste.

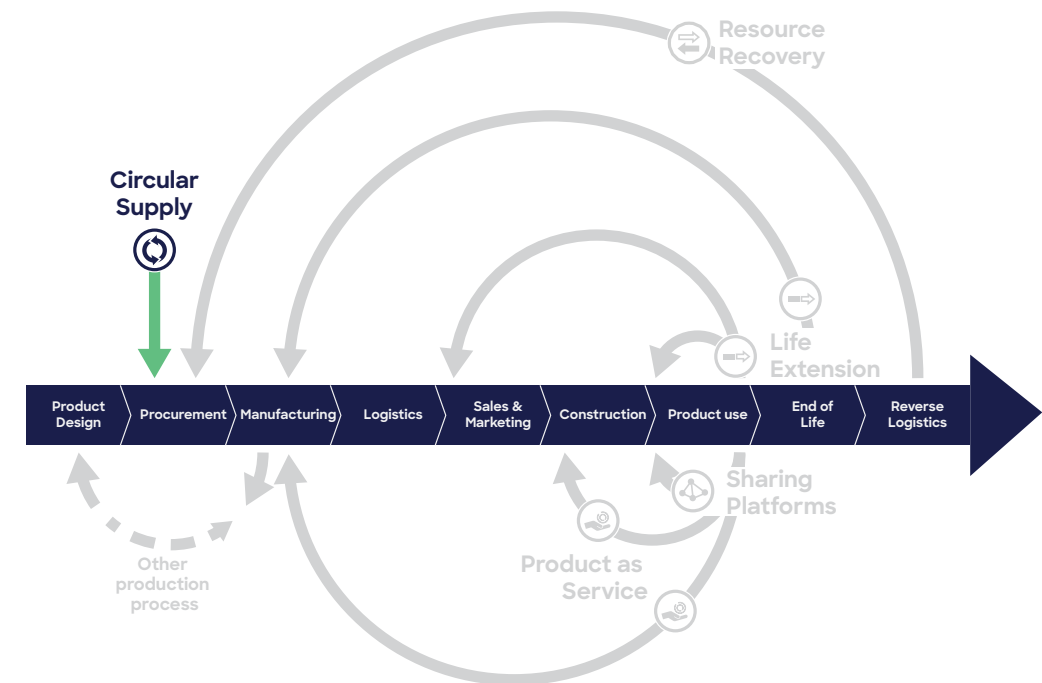


Diagram showing how the 'Circular Supply' model integrates into the process.



“

We are upgrading an abundant natural product, eelgrass, to new healthy acoustic products, which from a circular perspective - will help creating built environments with a negative CO₂ emission.

”

– Tobias Øhrstrøm
Partner
Søuld



Picture: © Søuld



Søuld

Historically, eelgrass has been used in Danish construction practices but today it is a forgotten and overlooked resource. Growing demand for sustainable and circular construction materials is changing that, and eelgrass is experiencing a revival in the Danish construction sector.

The company Søuld has brought traditional building practices into today's construction industry by developing sustainable acoustic mats made from eelgrass. The products are based on fibres from the eelgrass sea plant, which grows naturally along the northern coasts - a renewable resource that can be recycled and is completely free of harmful substances.

Made for circularity

Søuld acoustic products consist of 90% eelgrass plus incorporated thermoplastic (as a fire retardant). The combination is simple, yet innovative. Eelgrass fibres lend the product a heat-insulating, heat-accumulating and sound-absorbing structure, which is both mould and fire resistant due to the natural content of sea salts and minerals in the fibres. The thermoplastic is used as a binder and provides the boards with strength and flexibility. It is also the thermoplastic that ensures that the acoustic boards can be recycled in a circular flow after end of use.

The acoustic products from Søuld comply with standards for Design for Disassembly.

Old traditions and new technology

The eelgrass acoustic mats are based on centuries of experience and use of eelgrass as a traditional building material. Eelgrass acoustic boards are a result of the meeting between a natural, proven and tested raw material and new technologies, which together imbue the product with good technical properties and environmentally positive impacts.

Eelgrass is a naturally occurring plant in Denmark that grows in saltwater along the coasts. The leaves of the plant are released every year in late summer and washed ashore in large quantities, where it can be collected and used for e.g. the production of building materials. Eelgrass has several unique environmental benefits, including containing CO₂ and nutrients from the sea and atmosphere.

Using eelgrass in the building industry can therefore contribute to turning building stock into potential CO₂ banks.

søuld

Søuld
Tobias Øhrstrøm
Partner
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ConTerra

The possibilities for producing bio-based materials in Central Denmark Region demonstrate great circular benefits for the construction sector and can be a key element for a transition to a circular bio-economy in the agricultural sector.

The first step in creating a circular economy in the construction industry is to ensure that the materials we build with can be used again and again. The next step is to produce them from biological resources so that they can be included in the natural cycle when they can no longer be recycled.

building materials. And once such production is established in an area and the market for the products is created, farmers can start growing new crops in order to supply sufficient amounts of biomass to scale up and consolidate this production.

Mapping of bio-resources

In order to get a picture of the potential for producing bio-based building materials in the Central Denmark Region, Minor Change Group and the agro-data company ConTerra have mapped out which bio-resources are available for this, which new crops can be grown to generate more biomass for production, and modelled the economic and environmental impact for agricultural production in the region.

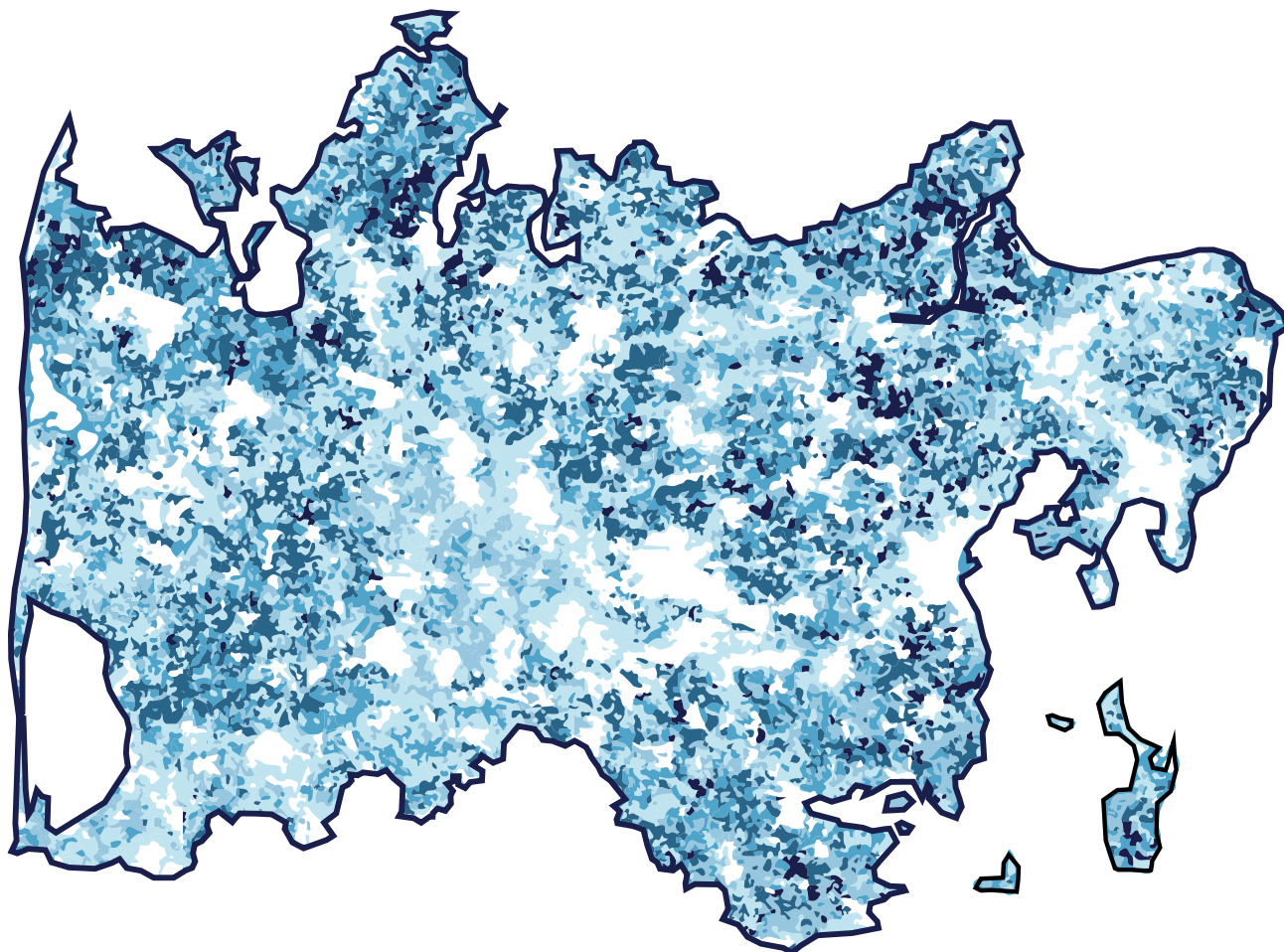
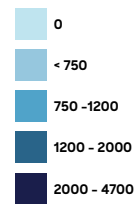
The survey focused on three major scenarios

1. Utilisation of surplus straw from the cultivation of grain for production of building materials.
2. Increased cultivation of grass for bio-refining and extracting proteins, fibres and bio-chemicals.
3. Large scale cultivation of hemp and flax for the production of bio-materials.

Building with materials grown in nature is not new. Wood has been one of the most widely used building materials for thousands of years, and various types of straw have been used for roofs, walls and much more. What is new, is that with modern manufacturing technologies it is now possible to make advanced composite materials from many different types of biomass. This means that many of the residual fractions from agricultural production can come into play as raw material for the production of

The survey indicates that the establishment of bio-based building material production in Central Denmark Region not only supports a circular economy in the construction sector but is also a key element for a transition to a circular bio-economy in the agricultural sector. This is due to the fact that it makes it possible to utilise all fractions of the biomass produced in the fields and makes it profitable to grow new crops that have higher yields of biomass and are much more sustainable to cultivate.

kg available straw resources/ha



Map of available straw resources

waste management



2. Resource Recovery

Recover discarded products or by-products to recycle or upcycle the materials.

This business model relies on reverse cycles for the recovery of embedded value at the end of product life cycles. High-quality resources lend themselves to recycling and upcycling processes that maintain, or even increase, resource value as they are used as input for new construction materials.

The key is recycling value rather than simply volume, as waste from one production cycle can become input for another. One example could be a take-back system, including a collection service to recover useful waste materials from construction sites.

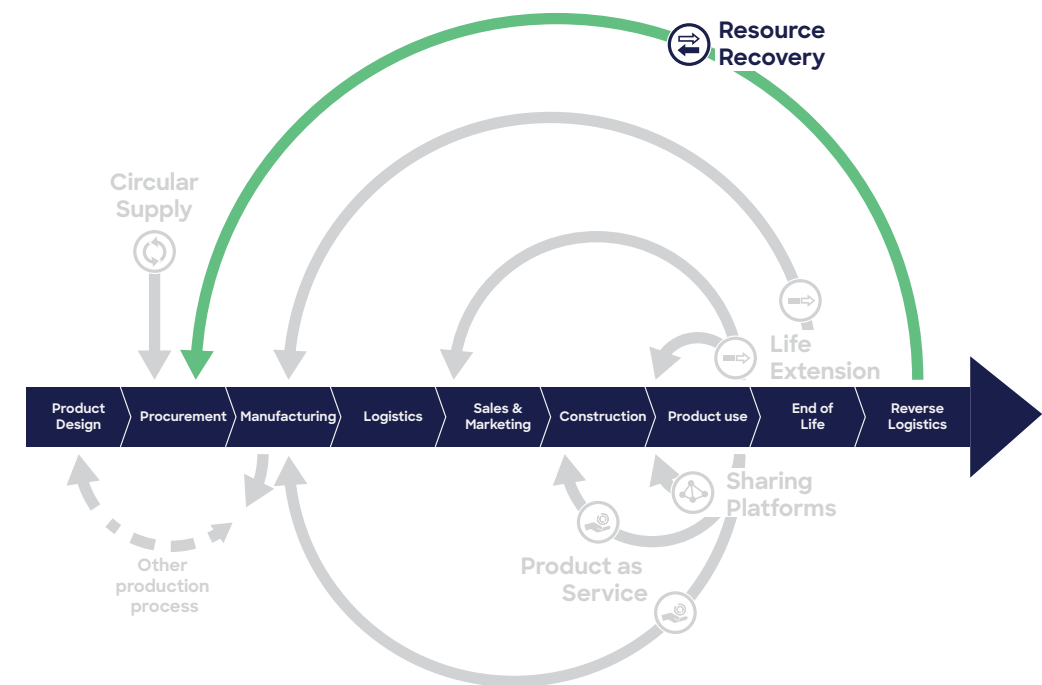


Diagram showing how the 'Product as Service' model integrates into the process.



Søren Jensen

From Waste to Biomaterial is a new circular building material for acoustic panels, insulation and particle boards etc. It is produced by allowing fungal spores to grow in waste streams, such as treated and untreated wood and textiles, thereby replacing conventional environmentally harmful building materials. Søren Jensen Consulting Engineers is behind the idea and the development of the material together with a long list of partners.

Sustainability as a company strategy

Søren Jensen Consulting Engineers is a Danish building engineering consultancy. At Søren Jensen, they wish to challenge the status quo in the building industry. They therefore strive to define and create the buildings of the next-generation which are: 1) regenerative buildings in which the invested financial, social and environmental resources are regenerated during the building's lifespan and 2) user-friendly buildings, where the focus is on the individual experience of functionality, indoor climate and ease of use.

The road to the next generation of buildings is paved with inspirational and artful engineering. Engineering art fulfills the building project's potential by finding the right solutions whilst challenging the status quo. These solutions can, in a creative way, answer social challenges without compromising the quality of the user's experience or the project's functionality. As a part of this aim, Søren Jensen Consulting Engineers strive to challenge the building industry on regenerative building design. In August 2018 they unveiled their DHL pavilion, which they grew themselves using mycelium spores in combination with recycled coffee grounds and virgin hemp materials.

Developing a new regenerative material

From the first experiment they found that the material was programmable and could achieve different characteristics based on growth medium and protocol, and through 2 weeks it could transform and upcycle waste into a formable, biodegradable, high performing building material. The proposal for scaling the material in the building industry won Realdania's "Circular Construction Challenge - Rethink Waste" in February 2019. In a team of 20 partners, representing the whole value chain from waste handlers, universities to design firms and business advisors, the concept was further developed in a 6-month funded innovation process facilitated by the Danish Design Center. The team tested production protocols, design prototypes, material and user tests towards a market introduction. In November 2019, Søren Jensen won Energiforum Denmark Innovation price for the solution.

Today the team is working on the next financing round in which the first local production facility will be developed, and supplementary material testing and design will be carried out to enable a scaled and sustainable integration of the material into the built environment.

A similar project has been funded by Circularity City, to help further development.

The project is a brand new idea for producing circular materials; namely utilizing fungus for insulation in composite walls.

The fungus is used as one of several elements for insulation in the composite walls as they have a unique ability to isolate. But what is also worth noticing is how this type of composite wall and insulation can totally replace existing concrete elements within the construction sector and thereby stands as a great example of how to find new, circular solutions for traditional building materials.



Picture: © Søren Jensen



LORECON

A framework for LOcal REuse of CONcrete



The project

Concrete rubble from the condemnation and refurbishment of buildings represents a large portion of the enormous volume of waste that is produced each year within the construction sector. At the moment, it is either dumped at landfills or is crushed and transported away for use as unbound subbase for roads, parking lots or other infrastructure. However, the concrete rubble represents much higher value if it is recycled as a substitute for virgin gravel in the production of new concrete.

But if the reuse of concrete in new constructions must be feasible, both environmentally and economically, it must be done locally. Otherwise the potential benefits are lost in transportation demands. The focus must be on finding a local synergy and match between production of concrete waste from demolition and the need for raw materials for new construction.

In the Circularity City project, a number of experts and stakeholders within the field of concrete construction have teamed up to define how local recycling of concrete can be organised and structured – and envisaged how it can be realised in the a next phase of the renovation of Gellerup Parken in Aarhus.

The Gellerup Scenario

In phase 2 of the urban renewal of Gellerup Parken in Aarhus, up to eight large building blocks are to be taken down. Each of these blocks contains 3,600 cubic meters of concrete, which, when crushed, amounts to 8,000 tons of potential aggregate for new concrete. In other words, 64,000 tons of concrete rubble will be produced when this project kicks off in approximately a year from now. Which either can be considered as a waste problem that has to be handled at a cost – or as a resource that can be recycled locally to make the handling cost neutral or in the best case even profitable.

Therefore, it is envisaged to establish a temporary transformation site adjacent to Gellerup Parken, make a specific plan for reuse of the concrete rubble in and around Gellerup Parken, and even produce concrete elements on site that can be used elsewhere. The report has recommendations for how this can be set up, which the builder, Brabrand Boligforening, and the assigned contractor can take into consideration when planning the urban renewal.

Read the report here:
<http://www.circularitycity.dk/rappporter/>

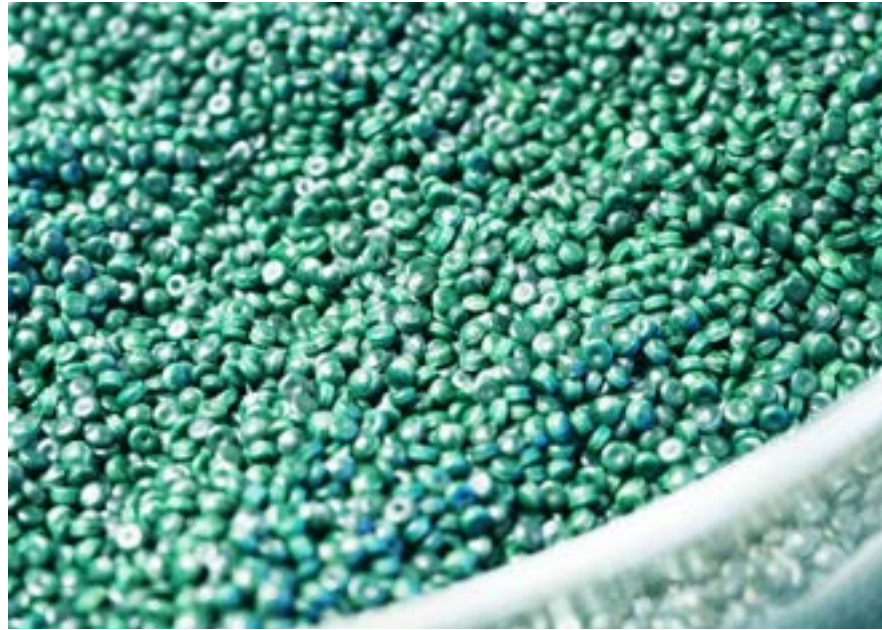


Picture: © Fibo Intercon



Plastix

The company Plastix, based in the town of Lemvig, has found a way to turn one of the ocean's biggest pollutants into all-purpose recycled plastic pebbles, ready to be moulded into new modern products and stunning designs.



Picture: Mater Ocean Chair © Materdesign.uk
designed by Jørgen og Nanna Ditzel

Plastix is a Danish cleantech recycling company specialised in converting fibres, primarily used fishnets, trawls and ropes that would previously have ended up in the ocean or on landfill, into high-grade and virgin-like Green Plastic raw materials.

Innovative Technology

Plastix has developed a unique technology, enabling the mechanical recycling of post-use plastic fibres and rigid plastics primarily from the maritime industry. The mechanical recycling technology is developed through a co-creative process, combining custom-made processing technologies and proprietary adjusted equipment.

The end result, the plastic pellets, are the product of expert proprietary know-how, which enables Plastix to research, develop and produce according to customer-specific requirements.

Manufacturing Green Plastics

The process starts with sourcing primarily fibre plastics in terms of fishing nets, trawls and ropes from an increasing number of ports, net makers, and plastics collectors globally. The company also process and recycle rigid plastics.

Once these used plastic materials arrive at the factory, they sort and fraction them into different types of plastics and colours.

This can be a rather labour-intensive step, as the recyclability of fishing gear and other plastic fibre products is currently not considered by the manufacturers nor users.

After sorting and fractioning, they shred, wash, separate and dry the material. Lastly, fibres are compounded and extruded into new Green Plastic raw materials, also called pellets.

The Green Plastic can then be used for all types of plastic parts, elements and products.



“

Designing for circularity means involving yourself with the full value chain. This is not a task that can be achieved by one company or organisation alone. Creating the ecosystem that will enable circular buildings is what Circularity City is all about.

”

– Lasse Lind
Partner
GXN innovation

“

A burned wood façade made from recycled wood has many advantages. It keeps valuable resources in the loop, you don't have to use paint or other chemicals to maintain the façade and you save CO₂ in the building process. It is quite intelligent.

”

- Anders Mølgaard
 Founder
 Burnt Wood



Photo: © Burnt Wood



Burnt Wood

Randers Municipality and Burnt Wood has recycled waste wood and used it to build a new house. The project is good news for the construction industry, where the constant demand for new resources is draining the planet.

Wood is a formidable construction material, because it stores CO₂ during its entire lifetime. The CO₂ is only released if the wood is burned or decaying. If we use wood in our buildings, the building stores, instead of emitting, tons of CO₂. Therefore, Randers Municipality and Burnt Wood have established a value chain collaboration where waste wood from a recycling station can be used in new buildings. It saves valuable resources and prevents the wood from being burned, thereby saving 30kg CO₂ per m² of build with the eco-friendly material.

Give us your waste wood

Under the headline “Give us your waste wood”, citizens in Randers are encouraged to sort their waste wood into different containers depending on the quality of the timber. The wood is then sorted, cut into pieces and made into façade elements. The façade elements make it possible to use wood in different sizes. After the wood is assembled into façade elements, it is burned. The burning process is a technique used by the Vikings 1000 years ago, which is still in use in

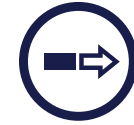
Japan today. The burning process removes the sugar and the water from the wood, preventing the wood from absorbing water and making it impossible for microorganisms to grow on the wood. Consequently, there is no need for paint or impregnation, which are often damaging to the environment. The result is an eco-friendly façade with a distinct identity.

During the project there have also been tests with smaller fractions of wood. The idea was to press the fractions into a form and make new boards of wood from the fractions. This project is still being tested; however, the façade system can be seen live at address: Søndervej 5, Rødvig, Stevns. Here Øko Tømrer has built a new house where all the facades are made with the reused burned wood. Hopefully the project will inspire others to go the same way and reduce the burden on the planet from waste and CO₂.



Burnt Wood
 Anders Mølgaard
 Founder
 kontakt@burntwood.dk

design for resilience



3. Life Extension

Extend the life cycle of a product, or parts of a product, while preserving the original function.

Life extension business models allow for capturing additional revenue based on extending the lifecycle and use of products and assets. Value that would otherwise be lost can be maintained or improved through:

- Direct reuse or resell.
- Repair and/or upgrade for resell.
- Separating products into parts for remanufacturing and/or refurbishing of the product in an upgraded version for resell.

Design for disassembly and adaptive reuse of the built environment can help extend the life of buildings and infrastructure, but demolition companies are also important pieces in the puzzle when it comes to life extension. They are in the prime position to ensure product life extension through new markets in reused and upcycled products.

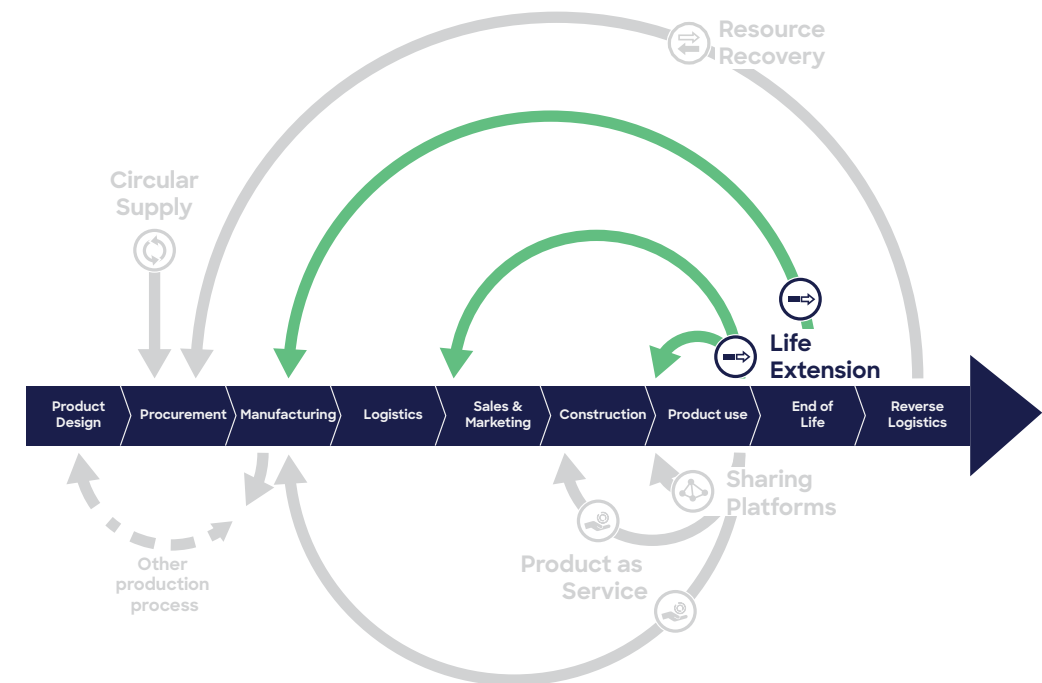
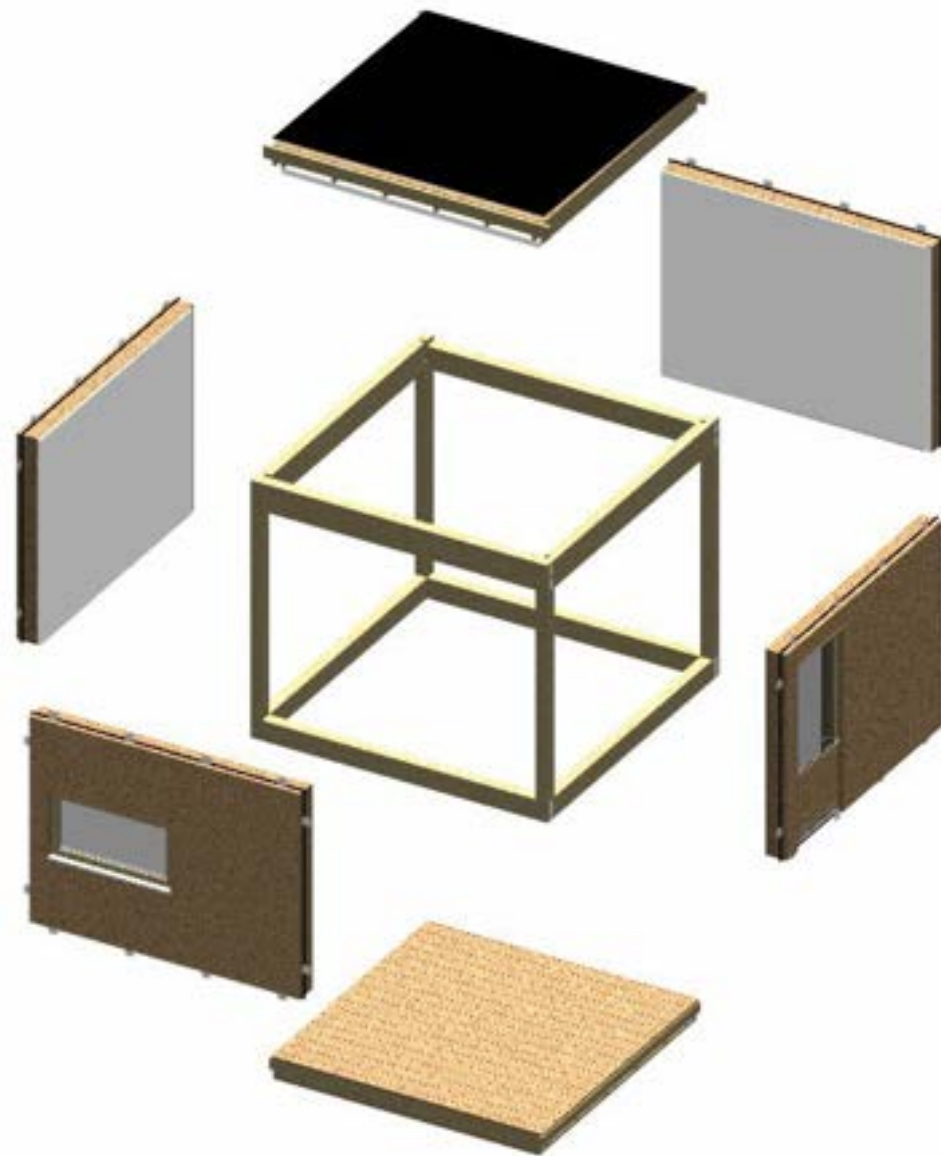


Diagram showing how the 'Product as Service' model integrates into the process.



X-Po Flexi

X-Po Flexi is a building system designed to help create humane housing situations as a better alternative to overcrowded student housing, cold and worn buildings and inhumane tent camps. As a bonus, the units are built around circular principles and are made of sustainable materials.



Imagine a home developed as the principle in Lego bricks. It can stand alone but can also be assembled with other units and customized according to needs and function. This is the idea behind the multifunctional housing, X-Po Flexi, which can be used as study accommodation, shelters for homeless people, small medical centers, offices or as a refugee residence. *“Everybody has the right to architecture”*. This is the motto by Per Hansen, owner of the X-Po Architects who developed the X-Po Flexi building system. It should not be the money that determine if you are entitled to a smart home, Per insists. And by this standpoint, Per developed this multi-family home.

Save money and benefit the environment

X-Po Flexi is built on the principle of Design for Disassembly, where you can separate elements, thus creating more applications. It is easy to replace individual parts of the X-Po Flexi unit, rather than having to discard the entire unit and build a new one. For example, roof, facade and deck elements can be easily connected or removed, making X-Po Flexi one of the most

flexible units on the market and allowing owners to save a lot of money compared to traditional solutions.

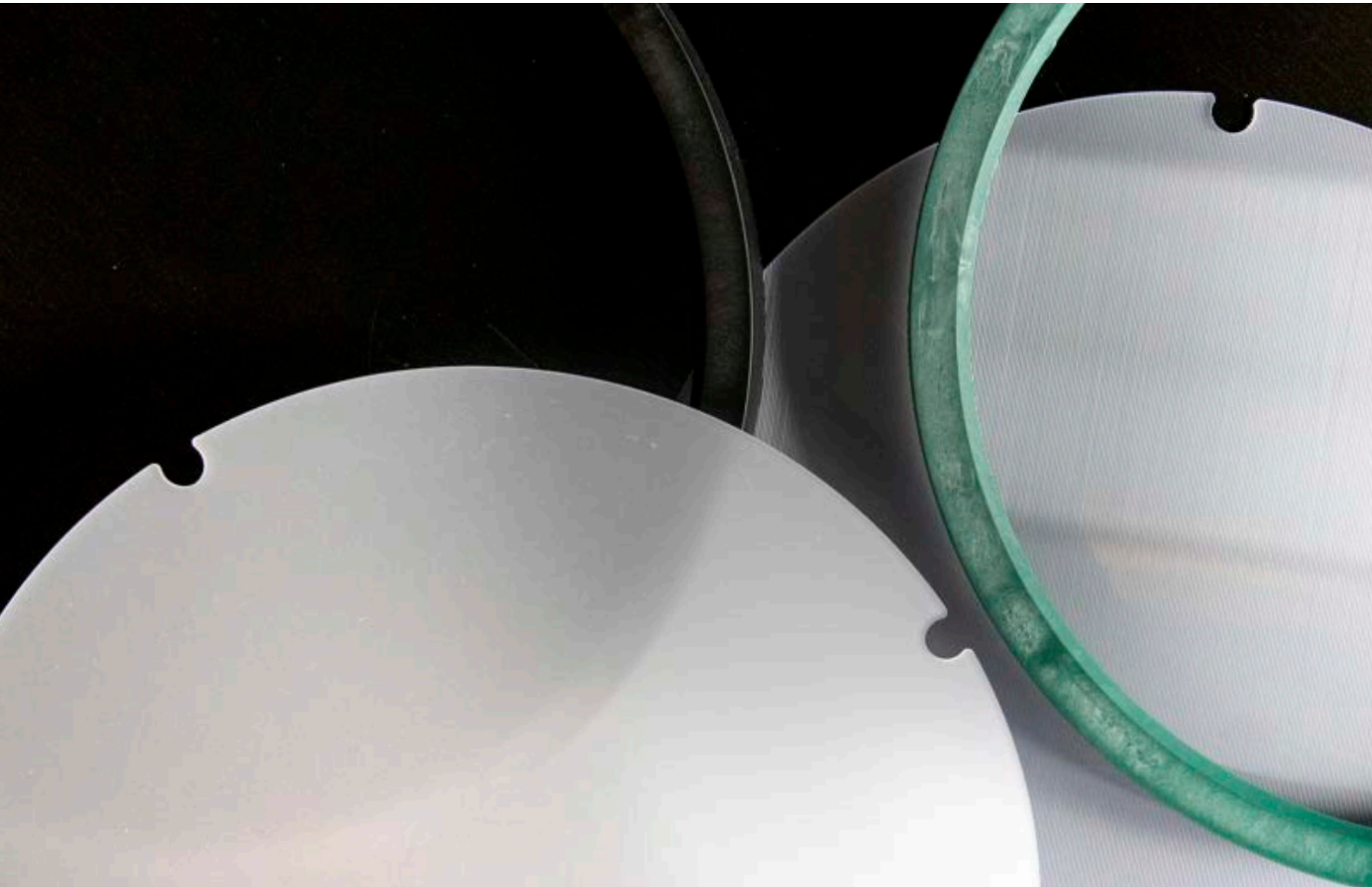
At the same time, X-Po Flexi is designed with a focus on reducing material waste and recycling. It is insulated with sustainable paper wool from CBi Denmark and the facade cladding can be reversed and reused on the other side. The building system is manufactured in sustainability certified materials such as FSC. In addition, several recycling solutions have been envisaged, including the use of incorrectly produced windows as well as facade cladding of aluminum sheets recycled from beer and soda cans, or from plastic sheets recycled from waste plastic. Per Hansen has a desire to future-proof X-Po Flexi and work into a circular mindset. That's why he has partnered with Circularity City and found partners with him to help him along this path. The target for the product in the future is a CO2 reduction of 50-75% compared to comparable conventional housing types and to do water collection on 'green roofs' and incorporate solar cells and geothermal heat.

Did you know..

that by reusing existing LED fixtures, Fischer Lighting uses only 200g of aluminium in contrast to the 2kg used for a new standard fixture?

Source

LCA by Asger Wendt Karl
and associate professor Morten Birkved
Technical University of Denmark



Picture: © GXN Innovation



Fischer Lighting

Fischer Family is a new genre of luminaires with a diverse range of lighting effects. The system is remarkably simple, built with circular principles to prolong the lifespan of an LED lamp while improving the quality of the lighting environment.

Fischer Lighting is a sustainable business in rapid development, launching a unique circular concept by producing modular LED solutions built on existing fixtures, while offering all of the functionality, lighting quality and energy saving technology expected from state-of-the-art LED.

In 2018, Fischer Lighting collaborated with GXN Innovation to create a lighting fixture, Fischer Family, for the circular economy. The system design replaces energy-intensive recessed lamps with high quality LEDs, and can also be implemented in new buildings. The system is remarkably simple, built with circular principles while improving the quality of the lighting environment.

Careful attention has been paid to the design for disassembly and reuse of all components. Each lamp supplied is recouped at the end of its life cycle and metabolised into components or

materials, which are then recycled to make more lamps. The material supply is ethically sourced, screened and vetted for VOCs and red-list chemicals, while components are mechanically or magnetically connected and reused in a continuous life cycle.

The Fischer Family lamp design won the sustainability award, 'The Sustainable Element' at Building Green Copenhagen 2017.

Fischer Lighting have also developed a performance-based financing model that allows clients to pay for the LED retrofitting; savings are therefore realised due to lower energy consumption.

Whitepapers for installation and Fischer's circular take-back policy are available on the company website.



“

Circularity City is an urban condition where all resources and materials are designed for disassembly and embedded in closed loops, which makes it possible to regenerate and reuse them again and again to create new value. That is what we are aiming for.

”

– Hanne Juel
Circular Economy Team
Central Region Denmark



J.Jensen

J.Jensen is creating a direct line of sales from demolition to new build.

As a professional demolition company, J.Jensen has embarked upon a journey to enhance direct recycling from their demolition projects.

By establishing resource hotels adjacent to their large-scale dirt and gravel departments, both private and professional customers can buy anything from used timber, to doors, windows and kitchens, either directly from demolition or unintended leftovers from building sites.

J.Jensen combines its recycling outlet with the sale of paint, to create a one-stop-shop for small-scale professionals and do-it-yourself builders. To enhance awareness, and to make it easy for local customers to access the inventory,

J.Jensen has created a webpage dedicated to the local sales of the recycled materials and products, and are currently pursuing this as an integrated part of their demolition business.



When we are on a demolition task, we select the best products that are then sold on from our departments in Zealand and in Jutland.



- Thomas Kolbeck
District chief
J.Jensen



Picture: © J. Jensen

Circle House in numbers:

- Circle House is 60 social housing units built according to the principles of circular economy.
- The objective is that 90% of residential materials can be recycled without losing significant value.
- The project runs for over 3 years, starting in spring 2017.
- The building is expected to be offered, on market terms, by 2020
- The building is expected to start in 2021 and be completed by 2022.
- The project involves more than 30 companies from the Danish construction industry across the entire value chain.

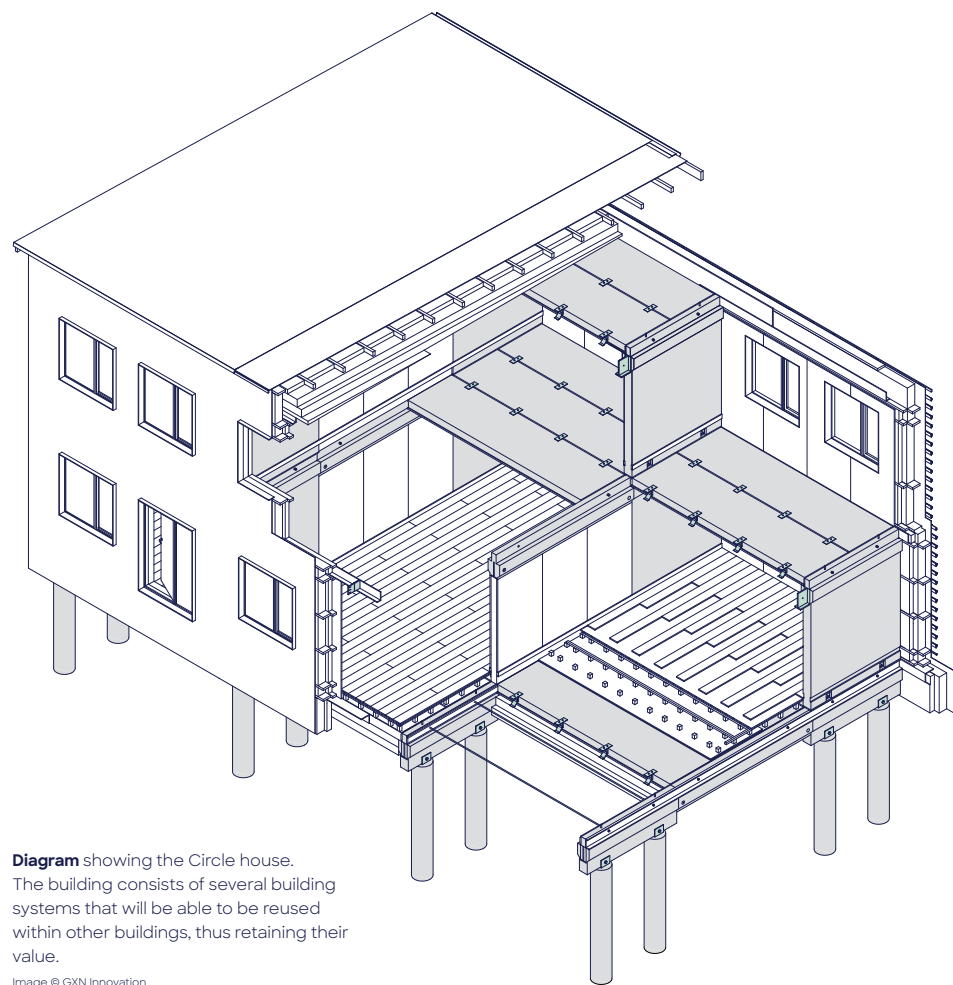


Diagram showing the Circle house. The building consists of several building systems that will be able to be reused within other buildings, thus retaining their value.

Image © GXN Innovation



Circle House

The Circle House project will see the construction of the world's first social housing units built according to circular principles. This means, amongst other things, that the construction can be disassembled, and the elements recycled almost without any loss of value.

The Circle House project consists of 60 social housing units in Lisbjerg outside Aarhus, built for Lejerbo housing association. In addition to serving as housing, Circle House is a scalable demonstration project that will provide the construction industry with new knowledge about circular design, construction, and business.

The project is designed by a Collaboration Studio formed between Lendager Group, Vandkunsten and 3XN Architects. The project was tendered in 2018, construction begins in 2021 and it is expected to be completed during 2022.

Framework conditions and business development

The transition to circular building implies, amongst other things, that components must be produced so that they can be separated. This is not just a technical challenge. Today, necessary factors for enabling the recycling of materials are missing from the built environment value chain. Only a few manufacturers will take back their own used products so that they can be sold again. And the leasing of products, such as seen within the automotive industry, is not yet developed for construction.

There is also a need to renew traditional business models and ensure that legislation supports recycling, in order to accelerate circular construction. For example, it is currently unclear who is responsible for the quality and the materials used in recycled construction. The Circle House project wants to get closer to answers to these challenges. Therefore, the project aims to analyse value chains, business models, business cases and framework conditions. All results and insights are shared through a broad discussion of circular construction throughout the industry; Realdania has supported this part of the work.

Cross industrial collaboration

The Circle House project aims to develop and disseminate knowledge about circular construction across the industry and across existing silos. The project brings together 30 different companies across the entire value chain of the built environment. The goal is a scalable circular 'lighthouse' building project that is then tendered to the market.



“

Circle House will become an important proof of concept that circular construction can be done today.

”

– Kasper Guldager
Architect, Senior Partner 3XN, CEO, GXN

sharing platform



4. Sharing Platform

Increase the use of a product through new models for sharing, accessibility and ownership.

This business model promotes sharing platforms to facilitate cooperation among users, either individuals or organisations. Virtual sharing platforms enable distribution of the surplus supply of materials and utilisation of underused equipment and services.

The model facilitates this either by enabling or offering shared use, access, or ownership. Emerging technologies for additive manufacturing and automated fabrication makes design and fabrication blueprints a shareable resource as well.

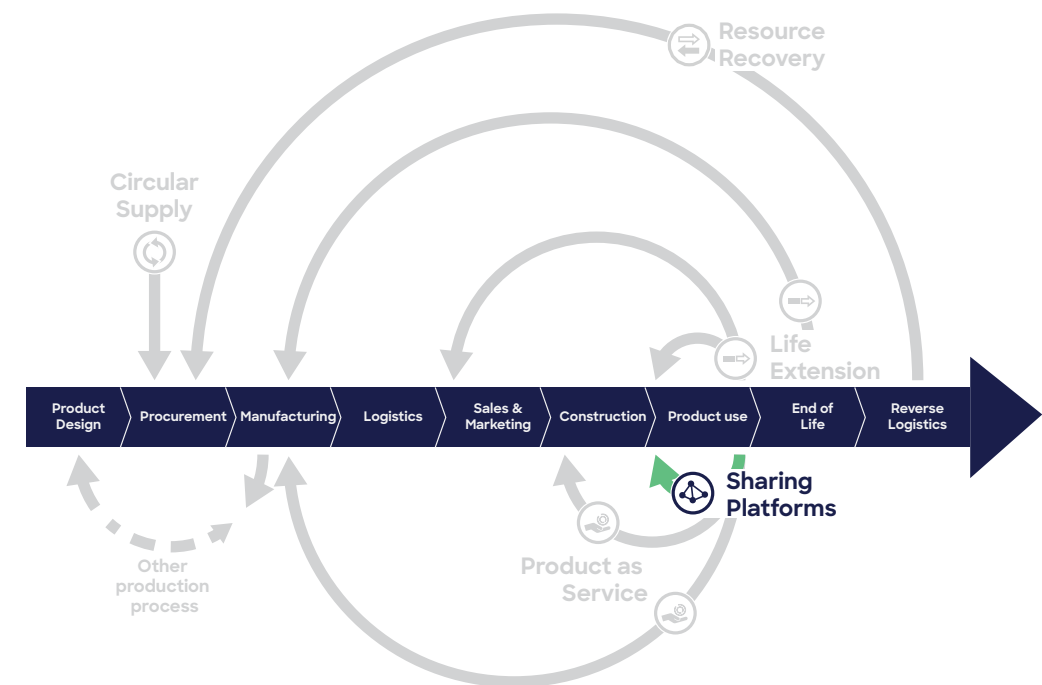


Diagram showing how the 'Product as Service' model integrates into the process.

-Anders Torell
Head of Business Transformation
NCC Industry



It has lowered the costs in the industry and reduced the environmental impact through lower CO₂ emissions and the extraction of fewer raw materials.



NCC Loop Rocks

NCC is the initiator of the Loop Rocks app and has, in collaboration with the Loop Rocks developers, created a free platform for individuals and businesses that allow for smarter matching of supply and demand directly between locations.

An open platform for distribution

Loop Rocks is an open platform and app for smartphones for the distribution of rock, dirt and other surplus building materials between construction sites, businesses and for private clients. With Loop Rocks, supply and demand for surplus materials at construction sites are matched by looping them directly between the sites.

“It has lowered costs in the industry and reduced the environmental impact through lower CO₂ emissions and the extraction of fewer raw materials” says Anders Torell, Head of Business Transformation and Digitization at NCC Industry and Loop Rocks. The app was first introduced in Sweden and a year later to Denmark. Today, there are over 4000 users of the app and NCC expects the number of users to keep increasing.

As a platform for sharing surplus materials for use in the construction industry, Loop Rocks combines two circular business models: sharing platforms and resource recovery.



Image: © NCC Group

- Rikke Ullersted
Co founder
Upcycling forum



In order to turn green strategy into action, we need to work together. We believe that partnerships are the keyword to succeed in turning our resources and materials circular.



Image: © Upcycling Forum



Upcycling Forum

Upcycling Forum is a platform for companies wishing to advance their green strategies to a productive turn over.

Upcycling Forum is a meeting place for companies wishing to promote sustainable growth via collaboration. By connecting production companies, developers and B2C companies, Upcycling Forum creates solutions across industries which are ethical as well as beautiful, functional, innovative and commercial.

Upcycling Forum initiates partnerships by matching companies - helping them to reduce waste by upcycling discarded materials and creating new commercial upcycling products. A number of major international players such as Kamstrup, ISS and Select have joined the Upcycling Forum with the prospect of finding new partners to help their residual products enter a circular path.

The company is founded by Rikke Ullersted and Rasmus Falkenberg and together, they have more than 30 years of experience in design, innovation and product development.

According to Rikke Ullersted, it is a combination of rising commodity prices, waste regulations, and a genuine desire by the companies to be active in the green transition that currently causes companies to seek partnerships in the Upcycling Forum.

“There is no doubt that many companies are starting to realize that the green transition is a sustainable strategy for their future business model, but the strongest motivating factor is the new way of considering their waste as a resource and the new business potential that lies in circular actions” , Rikke Ullerslev says.



GENTRÆ is a concept supported by Realdania's Circular Construction Challenge, where construction site timber is collected, cleaned and sold. The goal is to recover up to 50,000 tonnes of construction site timber annually from ending up as fuel.

www.gentrae.dk



Image: © Enemærke & Petersen A/S



Gentræ

A new circular alternative introduces reused building materials in large-scale retail sale, eliminating ineffective transportation flows, reducing waste handling fees and creating cost value for clients and customers.

On every building site, timber is used in huge quantities as formwork, guardrails, packaging etc, and often ends up as a wasted resource after a short period of use. Today, using reused building materials is not a possibility for contractors, as reused materials are not available in large-scale retail sale, however with GENTRÆ that might change.

A paradigm shift in the building industry

GENTRÆ is a concept which ensures that timber from temporary construction measures at building sites is sorted out of the waste stream and can be sold in Danish building markets as a real alternative to new timber products. By making reused building materials available alongside conventional building materials, they become an attractive and natural choice for constructors and craftsmen, thereby contributing to a paradigm shift towards increased circularity in the building sector.

A cluster of stakeholders

The concept is developed in cooperation with Stark (the largest building material supplier in the Nordics), Solum A/S (Danish waste management company), and Golder Associates A/S (environmental consultant) and is carried out through an App that connects the contractors with the timber pick-up service and distributors.

When picked up from the construction site, the timber is transported to Solum, utilising otherwise empty Stark trucks delivering new materials to building sites. At Solum, the timber is handled by specially trained personnel according to a quality-assured process, after which, the timber is ready to be sold at building material suppliers.



product as a service



5. Products as a service

Optimise productivity of a resource or product while maintaining ownership of the product.

This business model is an alternative to the traditional model of “buy and own”. The focus is on performance rather than products, and ownership usually stays with the service provider. Through various service arrangements, including pay-for-use, leasing, rent or performance arrangements, the product is then used by one or more customers.

Key points

- The customer pays for the exact use of the product by buying a particular performance.
- Supplier and customer agree on the right to use the product for a defined period of time.

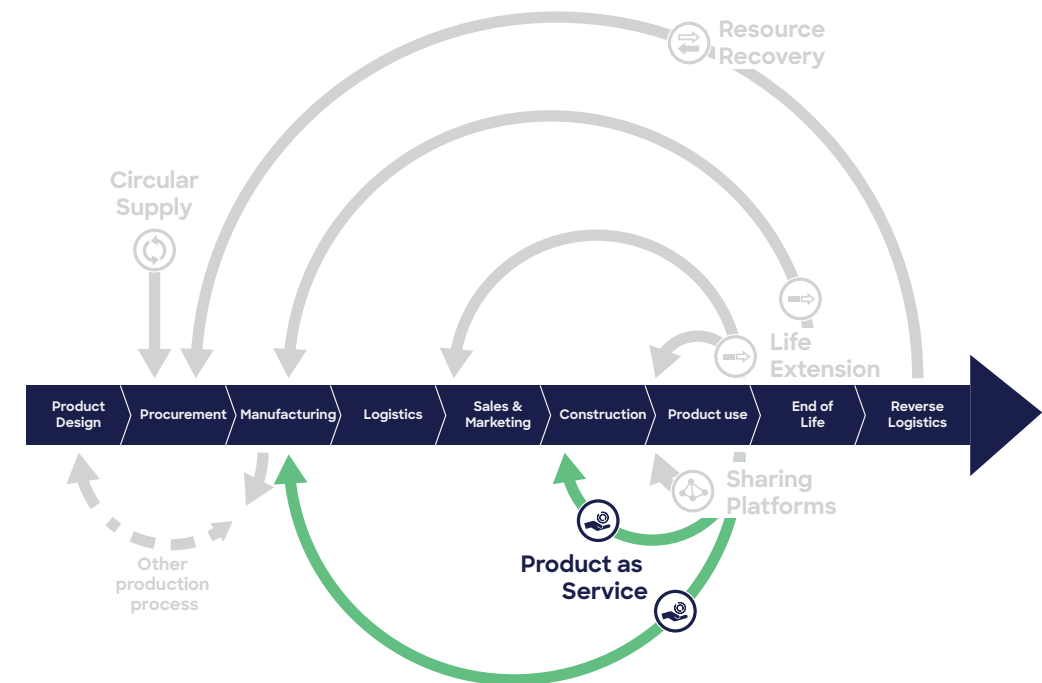


Diagram showing how the 'Product as Service' model integrates into the process.

“ The goal is to have circular economy fully implemented in EGE Carpets by 2020.



Jan Ladefoged, Former Head of CSR
for the article 'Fra kvalitet til Cirkulær Økonomi, 2015
Egetæpper A/S



Image: © Egetæpper A/S



Ege Carpets

Recover by Ege is Ege's take-back system, where used carpets and carpet tiles are collected, refurbished and resold directly in their own webshop.

Founded in 1938 and based in Herning, Jutland, in Denmark, Ege Carpets is a leading European designer and manufacturer of high quality carpets. Ege's carpets contain both biological and technical nutrient materials.

Ege's long-term goal is to develop carpet designs for disassembly, enabling 100% recovery and recycling of materials for new carpet production. The company has therefore developed a three-legged strategy:

Take back system and reuse

Ege offers to take back used carpets from 'business to business' customers, regardless of brand, when buying new. The company offers a service agreement for regular service of the new carpet and eventual take back whenever the customer wishes to change the carpet. Ege provides the 'business to business' customers with equipment for easy collection of used carpets, as well as transportation of used carpets.

When recycling the carpet tiles, their lifespan is extended and fewer resources are used to produce new tiles. Used tiles that are not suitable for sale, as well as

other used carpets and residues, are sold as secondary fuel to the cement industry, replacing fossil fuel like petroleum coke and heavy fuel.

Design for disassembly

The long-term strategy is design for disassembly, ensuring that the materials in their pure components can be recycled. Ege plans to investigate possibilities for designing carpets for easier post-use disassembly and recycling.

As part of this strategy, Ege recently had the majority of their carpet products Cradle to Cradle Certified™. A certification means that everything in the product has been assessed in relation to material health and its ability to be incorporated into a recycling or reuse scenario. This will ensure a high level of traceability and optimised materials.

“ Our vision is to initiate a sustainable development that goes beyond Brdr. Lauridsen and leads to a more circular, healthy and sustainable construction industry.



Brdr. Lauridsen



Brdr. Lauridsen

The craftsmen Brdr. Lauridsen has made it easier for their clients to go green and circular. They have invented a sustainable contract as an alternative to the standard contract. The sustainable contract includes the use of sustainable materials, design for disassembly and improved maintenance.



Image: © Brdr. Lauridsen

Brdr. Lauridsen has embarked on a journey to become one of Denmark's most sustainable craftsmen. They have decided not only to make their own company more sustainable but also to make it easier for their clients to go green and circular. In small booklets they teach their clients how to maintain their facades in the most sustainable matter, minimise waste and choose the right materials.

A greener solution

The circular craftsmen have invented a sustainable contract, which makes it easier for clients to make a sustainable choice when renovating their building. So far contracts have focused on the price of the services and materials delivered. Now the impact on the environment is illustrated and the clients have the option to go with a greener solution.

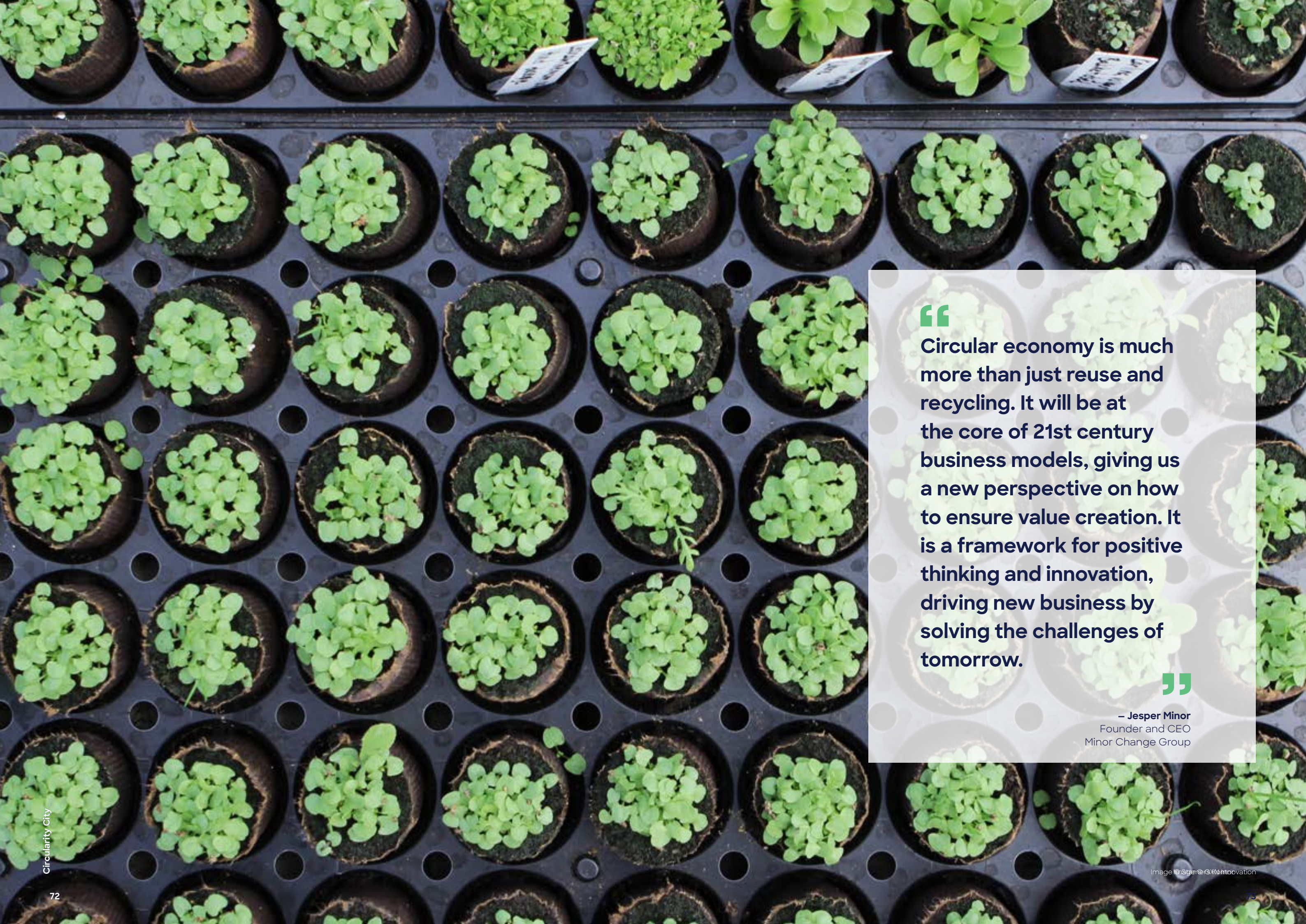
Holistic sustainability

The sustainable contract includes the use of sustainable materials, design for disassembly and improved maintenance. All materials used

are biodegradable, free from harming chemicals and long lasting. The building is built without the use of screws and glue, so all materials can be disassembled and used again in a new project. This saves valuable resources and keep the materials in a constant loop instead of the throw away culture common to the building industry. Brdr. Lauridsen also teaches their clients how to maintain their building to ensure long durability. The clients learn how to distinguish between green products and products harmful to the environment.

A new servicemodel for facades

Finally, Brdr. Lauridsen has developed a service model, where they inspect the façade of a building and maintain it regularly. This ensures that all damage is taken care of at an early stage. The idea is to keep damages to an absolute minimum and avoid replacing materials at a high cost for both client and the environment. Going green and circular suddenly became a lot easier.



“

Circular economy is much more than just reuse and recycling. It will be at the core of 21st century business models, giving us a new perspective on how to ensure value creation. It is a framework for positive thinking and innovation, driving new business by solving the challenges of tomorrow.

”

– Jesper Minor
Founder and CEO
Minor Change Group



Our service and leasing contracts give our customers the best sound level and ensures that the products are returned to us for reuse or recycling. We become trusted advisors who provide sound balance to the organization



- Kurt Braarup Vestergaard
CEO
Tripplex A/S



Image: © Tripplex



Tripplex Acoustic

Tripplex Acoustic, a nordic bank and This Future have made a model for leasing that has the potential to eliminate waste and tie the client and company closer together in a mutually beneficial relationship.

Leasing is a key element in the circular economy, because it extends the life of the product and reduces waste. The manufacturer keeps ownership of the product and has an incentive to extend the lifetime of the product and keep it in a constant loop. The customer, on the other hand, does not have to pay for the whole item at once, and does not have to worry about maintenance of the product. The product becomes a service and in the process company and customer are knitted closer together in a mutually beneficial relationship.

A new kind of contract

TRIPPLEX ACOUSTIC sells acoustic panels to the construction industry and has worked together with a nordic bank and This Future to develop a leasing concept that can be tied to the circular economy. The idea is to lease the acoustic panel to a customer together with a service contract. The service contract involves maintenance and ongoing measurements of the acoustics in the customer's organisation. TRIPPLEX visits the customer regularly and becomes a trusted

partner rather than a manufacturer of a single product. If the measurements show that the sound level has risen to a critical state, TRIPPLEX can offer additional products to balance the sound.

The new business model and the cooperation between a BANK; TRIPPLEX and This Future has resulted in a new TRIPPLEX Product: Soundbox. The Soundbox makes it possible to have a telephone conversation without interrupting the rest of the office. You simply take your phone and your laptop with you and enter the soundproof box. The box is ideal in a modern workplace where many people work together in the same room.

The service model allows the organizations to upgrade or downgrade their acoustics continuously. When the organisation downgrades, the audio box is returned to TRIPPLEX, which can reuse it and thus keep it in a constant loop.

**TRIPPLEX
ACOUSTIC**
Tripplex Acoustic
Kurt Braarup Vestergaard
CEO
kj@trippdex.dk

- Ole Mølby
CEO
Vahle A/S

“ We create a high quality product of true craftsmanship and care about the door. We have always dream of establishing a sustainable service business. ”



Image: © Vahle



Vahle

Vahle manufactures interior and facade doors by uniting craftsmanship, function and design. Vahle is considering establishing a sustainable service business, where facade doors are periodically maintained and renovated for the purpose of an extended lifetime, as well as a take back arrangement.

Maintenance agreements and lifetime extension

Facade doors are generally subject to great wear and tear as well as exposed to sun and rain. They therefore periodically need lubrication, adjustment of handles and hinges or new surface treatment e.g. oiling, new sealing strips etc. By offering maintenance agreements, Vahle can ensure that facade doors visually and technically remain of high quality for a long time. Furthermore, many doors are replaced even though they are not actually worn out. By offering a product upgrade with new door handles, new front and or back plate, new mouldings etc. the door becomes like new.

Take back arrangements, in connection with renovations, mean that Vahle can ensure the renovation, recycling and sale of interior doors, whether in standard or larger special dimensions as often conceived in new construction.

Vahle doors are already designed for disassembly and can be maintained, renovated and updated at customer site, avoiding expensive and resource-

intensive logistics as well as ensuring that most of the door is reused with the original materials. It is a highly sustainable solution within the frame of circular economy, mitigating the need for new doors and minimising impact on the climate.

In practice, these sustainable service concepts can be established in partnership with selected partners, where Vahle, with their accumulated knowledge, is the key partner.



CIRCULARITY CI

A Roadmap for Change

Roadmap for Change

Six principles for taking circularity further

In three years since project kick off in 2016, the Circularity City project has explored the potential of circular economy to drive business development in the Central Denmark Region. This work has produced several tools and tangible learnings and principles for how cities, municipalities, and organisations can accelerate the change towards circular economy in the built environment.

In this section we distil six principles for implementing and scaling circular economy on a city and regional level and contextualize these principles with open-source toolkits and cases showcasing tangible results in the Central Denmark Region.

The principles and toolkits detail how to build capacity across stakeholders in urban development and construction. The project has brought together key stakeholders to create an in-depth understanding of barriers and accelerators for circular building projects while creating local ownership and implementation knowhow around circular economy in cities.

The built environment plays a vital role in the global economy and can be an engine for sustainable innovation and growth. Accelerating the ongoing transition from a linear to a circular economy in cities requires linking circular goals to tangible value. The principles in this section show a way forward for stakeholders wanting to take part in and accelerate the transition.

As part of the exploration and development of the circularity city project, the project consortium has developed 6 strategies for how to advance circular economy across the building sector

BUILD LOCAL CAPACITY

Upgrade local knowledge



MAP PROJECT POTENTIALS

Develop generic tools



DOCUMENT THE VALUE

Local analysis of potentials



INVOLVE THE LONG TAIL

Decision maker and contractors



DEVELOP INDUSTRY STANDARDS

Involve legislative and regulatory bodies



SPUR INTERNATIONAL INTEREST

Support frontrunners



principle 1 document the value



Document the Value

Enable businesses and stakeholders to discover the value of circular building practices

Circularity city has developed tools to enable business and decision makers to assess and discover project specific value creation to be gained from transitioning to circular building practices.

As the preceding chapter shows, circular economy is as much about economy as it is about enhancing resource productivity through sustainable use and reuse of resources. The businesses discussed in these cases have all found innovative ways to turn the five circular business models into localised models for

value capture and creation. Actors looking to implement and scale Circular Economy on a city and regional level do well to heed their example.

This focus on value creation reaches beyond the day-to-day business of circular economy to show the importance for all actors to document value creation. Documenting value creation enable different actors in the fragmented construction value chain to clarify and align incentives.



Diagram Circularity city enabled actors to discover new value



Image: © CLEAN

A case collection for municipalities

The publication collects cases about circular building projects in Danish municipalities. It shows how working with circular principles in municipalities create tangible value in both long and short term and have important positive impacts on municipal economy.

The case collection is addressing municipalities and aims to inspire them to include sustainability and circularity as part of their procurement for buildings projects. It gives easy to use principles and guidelines for how to include circular principles as part of tenders and provides economic incentives for thinking sustainability and resource efficiency into the early planning processes.

The publication includes findings from several circular building cases across the municipalities in the Central Denmark Region. The cases show solutions on everything from buying sustainable materials, recycling materials and making sure the applied materials can be reused, to building more flexible and multifunctional in order to make the buildings adaptable with long life times. The case buildings have not been more expensive for the municipalities than traditional building practice, which illustrates the business case for circular building practices already exist.

From: BAMB 2020,
buildings as material banks



Design for disassembly can reduce investment risks through increased flexibility with a 9% higher value compared to conventional design.



Image: **Park 2020 Amsterdam** the developer has documented several financial benefits from working with circular principles

Investors roundtable

Discussing and documenting value creation with key players in the Danish construction industry

As part of the Circularity City project, GXN Innovation, in collaboration with ARUP, held two Investor Roundtables with the aim of presenting values, challenges and future potentials in circular economy and business development.

The roundtable sessions involved some of the most important real estate investors on the Danish market, and focused on identifying potentials and barriers for a circular transition in the Danish building industry. As a result of these meetings, four trends, five themes and 10 cases were summarised, all of which focus on circular transition within the industry.

From this a series of value creations was mapped, including savings of operation and maintenance, increased productivity from healthy indoor environments and savings in capex from up front leasing models. The material and network form the basis for future discussions within the investor community in the Danish building industry.

principle 2 build local capacity



Build Local Capacity

Enable local stakeholders to work with circularity by increasing knowledge and building networks for collaboration.

Accelerating circular economy in cities presents a high value opportunity for municipalities but also great challenges for the people tasked with bringing this from principle into day-to-day practice. The circular economy departs from business as usual by definition and will require new approaches to collaboration and knowledge management across municipal stakeholders and in the building value chain. Circularity city has undertaken several activities to build knowledge and spur interest in circularity across public and private actors. Building local capacity amongst the actors

who can drive demand for circular solutions is crucial to accelerate the transition. City officials are key players but need help to turn principles into practices that make sense in their specific context.

Capacity building requires scoping of participants to find key actors with the interest and clout to implement circular change. And it requires cross-stakeholder meetings, issue mapping, and organisational analysis to clarify local barriers to circular economy and develop strategic tools to help decision-makers drive through change.

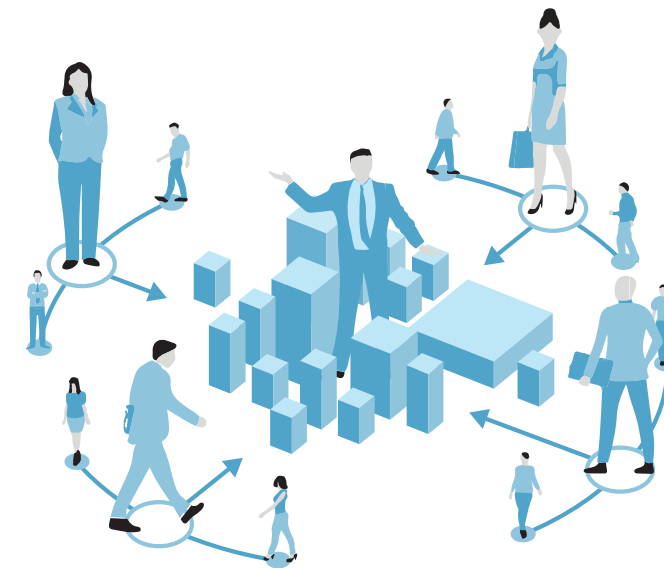


Diagram Circularity city enabled actors to meet each other and share knowledge



Image: © GXN Innovation

Engaging decision makers

Bringing together key decision makers from the Central Denmark Region around circular economy

As part of the project, Circularity City arranged a high-profile network event at the city hall of Aarhus. Guests included key public decision makers, such as the mayor, as well as private investors and consultants from the building sector.

The event, called 'Transforming the City', was aimed at sharing knowledge about the activities and potentials for circular economy in the Central

Denmark Region. The key question posed on the night was this: How can Aarhus become a global frontrunner in the circular economy? The event presented participants with international frontrunners within circular building practices who addressed the attendees about the values of circular economy.

Working coherently towards a position as global leader in the circular economy requires buy in and ambition from key decision makers within urban development. With the event we sought to engage and inspire these actors to ask for and engage with the circular economy.



Image: © CLEAN

Network for circular municipalities

Since 2018, the municipalities in the Central Region Denmark have participated in network activities aimed at creating a more circular built environment.

The Circularity City facilitated network have been enabling municipal actors to educate and inspire each other on subjects such as procurement, building regulations, or urban planning, and how they can become drivers for circular and sustainable change. The idea behind the network has been to get municipalities together on the challenges and promises and thereby making it easier for the individual municipality to put action on the visions of the future cities.

The municipalities have contributed with local employees from various public departments, such as urban planning, construction, waste, sustainability, climate, etc. These activities have introduced new practices into how municipalities will plan building projects, make tenders, manage waste etc. in the future.

The following 17 municipalities in Central Region Denmark have been taking part in the network:

- Aarhus
- Skive
- Horsens
- Randers
- Skanderborg
- Hedensted
- Samsø
- Odder
- Struer
- Holstebro
- Ringkøbing Skjern
- Ikast-Brande
- Herning
- Norddjurs
- Syddjurs
- Favrskov
- Silkeborg

- Marie Lindberg Tefre,
Department Manager
Horsens Municipality

“ We experience a new and focused dialogue between our colleagues about how to do and work with circular economy, also across divisions – and this is really great. ”



Image: © GXN Innovation

Educating local actors

The municipality of Horsens has hosted numerous events aimed at educating local stakeholders about why and how to work with circular economy.

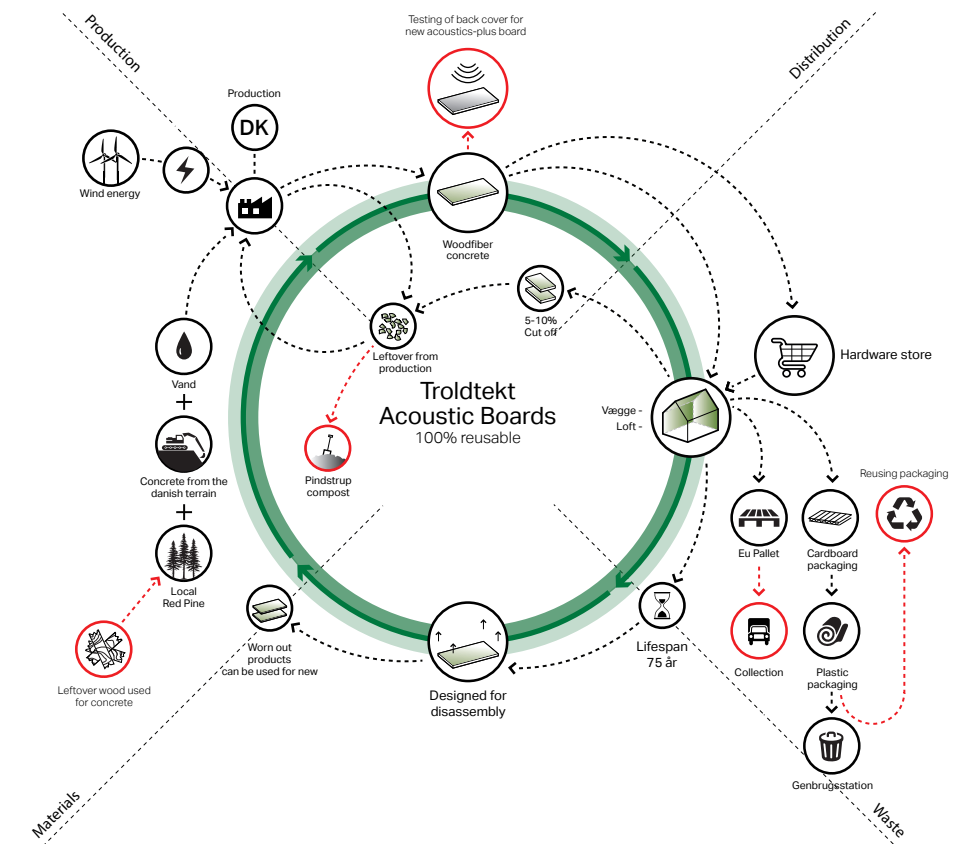
Courses and after-hours meetings have been held to boost the common competences and knowledge related to circular economy in the construction sector. These have been focused on respectively local municipal employees at Horsens Municipality and local craftsmen and contractors. These groups represent two very different stakeholders but are both key players in the transition as well as keen to bring themselves up to speed about circular economy.

For municipal stakeholders, courses have been held at the town hall for relevant employees within e.g. technical and environmental services. For local craftsmen and contractors, after-hours meetings have been held at local hardware stores.

In the municipality, they already sense a change among colleagues following the courses: “We

experience a new and focused dialogue between our colleagues about how to work with circular economy, also across departments – which is really great. “I have noticed how people’s minds have changed; now they even come by with their own suggestions on how we could change for the better” explains Marie Lindberg Tefre, Department Manager in Horsens Municipality.

The hope is to be able to scale the concept to other municipalities and hardware stores thereby expanding the impact and competence boost to other municipal employees and craftsmen. The setup is currently being implemented in Aarhus, Silkeborg and Skanderborg Municipalities.



Inspire manufactures and producers

Knowledge sharing workshops with local manufacturers of building products

As part of Circularity City, a series of workshops involving local manufacturers was facilitated. The idea of the workshops was to share knowledge from frontrunner companies on how to advance and implement circular thinking in the manufacturing of building products.

The workshops were hosted by larger companies with a well-defined stake in the circular economy, inviting smaller and up and coming companies in to share knowledge and ideas, as well as to establish potential new collaborations across the value chain.

As part of the workshops GXN Innovation ran an ideation process to help companies map their resource flows in order to discover underutilised materials and potential synergies between the companies involved.

Image: © GXN Innovation



... it has been interesting to be able to facilitate a project, with the overall purpose to develop a new way of doing public tenders and to inspire other local and national politicians to take lead in building circular buildings.



- Karl Krogshede
Climate Coordinator
Skive Municipality



Image: © Skive Municipality

Circular public tenders

In Skive Municipality in 2017 local politicians decided to pause a building project for more than a year to ensure the right tender procedures were in place for a new building that will house people with autism. These requirements and demands focus on ensuring circular principles and is a strong case for municipalities ramping up the demands for how to build more sustainable.

“The process has been long and intense because no municipalities have ever set up such requirements for implementing circular principles in public owned constructions”, says climate coordinator in Skive municipality Karl Krogshede. This was a challenge as the building project’s budget was already settled.

The move led to many clarifications before the final tender was finalised. Alongside the client consultant Meissner & Sigh, the municipality had to find out which aspects of circular economy to focus on within the project limits. Among other things, the municipality looked at solutions for

indoor climate, outdoor areas for biodiversity, social aspect related to the design, sound and acoustics, as it was of highest importance to take the building users special needs into consideration.

One of the key challenges was how to deal with the circular assessment of the final building with as many circular aspects present as possible.

Today, two years into the process, the final tender document is out, and four contractors are soon ready to pitch their contributions. The project in Skive is expected to be finalized in 2020 and already now stands as an inspiration to other municipalities and public actors pursuing circular procurement practices.



SKIVEKOMMUNE

Skive Municipality
Karl Krogshede
Climate Coordinator
kkro@skivekommune.dk



Image: ©CLEAN

Circular Tender toolit

How can municipalities and other public actors help stimulate circular buildings? The toolkit provides specific principles and guidance on how to define and procure circularity within public tenders for the built environment

The circular tender toolkit was developed as part of circularity by C2C ExpoLAB in cooperation with Minor Change Group.

The toolkit provides in guidance for circular procurement by public organisations in the construction sector, as important catalyst in accelerating the transition towards a circular economy and ensuring positive impact.

The ambition is, that the toolkit will help municipalities stimulate the market for more circular projects, more circular products and more circular application and use. Besides providing guidance, , the toolkit showcases good examples and best-practices. This toolkit offers a method to

apply circular procurement in your own context, by introducing a series of easy to follow steps and generic principles which can support the specific tender process. The toolkit was developed parallel with the actual tender for Circle House, the first circular housing residential building in Denmark.

See more here: <http://www.circularitycity.dk/rapporter/>

“ The central driver of this transition is visionary and courageous developing clients who demand the circular approach throughout the project process.



- Suna Cenholt
Partner, Architect MAA
Pluskontoret Arkitekter



Sustainability circle Multihal i Horsens
© Pluskontoret Arkitekter

Circular building solutions in design and education

A new day-care facility in Horsens Municipality has been chosen as a test case to implement circular building solutions.

In order to build experience for future projects, Horsens Municipality designated a new construction project as a case to develop project material for a circular tender processes. The project contains a new day-care building including a multi-purpose hall.

Horsens municipality formulated circular objectives for the day-care building in close collaboration with their client adviser Pluskontoret Arkitekter and VIA University College. These objectives reflect technical requirements about the building, as well as requests for a built

environment that actively contribute to educating children towards sustainable responsibility through play and learning.

The description contains seven overall circular goals: Reduction of resource consumption, healthy materials, multiuser concept, play and learning, leasing model, innovative technical solutions, and circular principles closely linked to a holistically sustainably designed building based on DGNB criteria.

A conference about the circular day-care facility at Horsens town hall in January 2019 gathered around 100 actors from the building industry, including contractors, building advisors and producers of building materials to share the ambition and intentions about the tendering process. During the day, various companies presented their circular products at the conference, and the participants got the possibility to discuss the latest circular building solutions.

principle 3

map project potentials



Map Project Potentials

Supporting project specific mapping and value creation

Circular solutions are per definition not generic, and so the focus of Circularity City has been to support actors in the industry making circular choices based on specific project contexts.

The transition to circular economy requires holistic approaches and frameworks for project management and execution. As decisions in early project stages have an outsize effect on what comes next, mapping early potentials up front in projects is necessary to support decision-making that can facilitate rather than hinder better ways of using and reusing resources in the building industry.

Potentials should be mapped out across their environmental, social, and economic dimensions in a way that support measuring and improving projects and setting environmental targets in a life-cycle perspective. Understanding business models, incentives and risk appetites for different project stakeholders during early mapping phases is important to ensure that potentials align with incentives in projects. Done right this facilitates a process that not only supporting better decision-making but also help unearth and deal with potential misunderstandings by instituting transparency amongst actors. In turn this can reduce project risks and costly errors further along in projects.

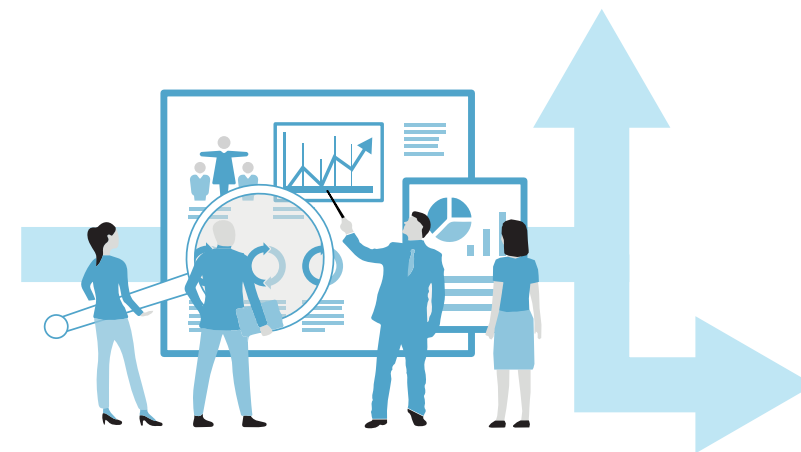


Diagram Circularity city enabled actors to meet each other and share knowledge



In order for the circular conversion of the construction industry to be successful, we will have to redesign the construction process. We need to work with other parties than we usually do, and the skills must be in play in a new order. Some phases - e.g. demolition - will take on a whole new and central role. It takes time to get all the new constellations in place and all parties need to be prepared.



- Nina Koch-Ørvads
Senior Project Manager
Værdibyg

Step 1

Circular potentials in whole building



Step 1 examines to what extent the structure of the building can be maintained. It is completed in the early programming phase and the result can be integrated into building program.

Step 2

Building parts and materials



Step 2 examines reuse potentials for building parts and materials. It is completed in the early design phase to ensure the widest possible range of circular solutions in the project.

Step 3

Match making



Step 3 focus on matching resources with new owners. It is completed in the design and execution phase. To achieve the greatest value creation, matchmaking can be examined early in the programming phase as well.

Decision Support Guide

Mapping and creating circular value in projects seeking transformation of existing buildings.

VIA University College and the Danish Building Research Institute (Aalborg University) have developed a decision support guide for consultants, contractors, developers, and other decision-makers in the building sector, to promote working with circular economy for added value creation in the existing building stock.

The Decision Support Guide facilitates a process for mapping and discussing reuse potentials in existing buildings from full building to individual material levels. Through this process the most valuable solutions for reuse and recycling are pointed out. Possibilities for matching materials for external distribution and resale are also described in the publication.

The purpose of the guide is to incentivise developers and consultants to allocate time and collaborate around identifying circular potentials in existing buildings in early project phases. Through this process, participants can gain a clearer focus and a common understanding of the values of the existing resources in the building for future projects, which otherwise could be lost.

Life cycle assessment (LCA) calculations of selected examples of materials and building parts in the publication supplement and support the process. Illustrated calculation results of different scenarios provide indications and a good basis to make decisions in transformation projects of the existing building stock.

The publication can be found online at - circularitycity.dk/rapporter

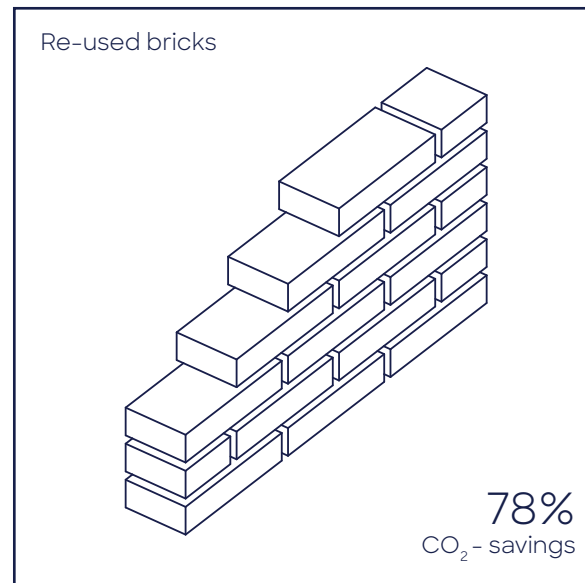


Circular materials help closing the loops and reduce the use of virgin materials and greenhouse gas emissions.

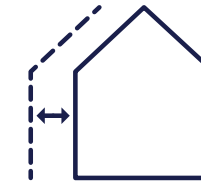


- Kai Kanafani

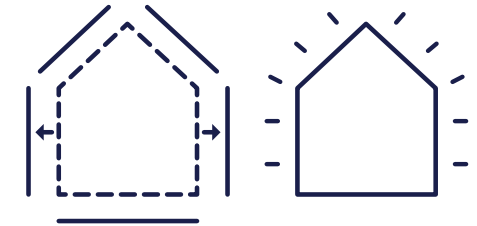
Researcher, architect Ph.d
Danish Building Research Institute



1. Preserve



2. Renovate



3. Demolish/new construction

Calculating value in a life cycle perspective

Should buildings be preserved, renovated, or demolished to make room for new buildings? A Life Cycle Assessment (LCA) provides answers on environmental aspects related to these scenarios. The Decision Support Guide shows how LCA can facilitate comparing of scenarios and provides criteria for evaluating circular building materials.

LCA as decision support

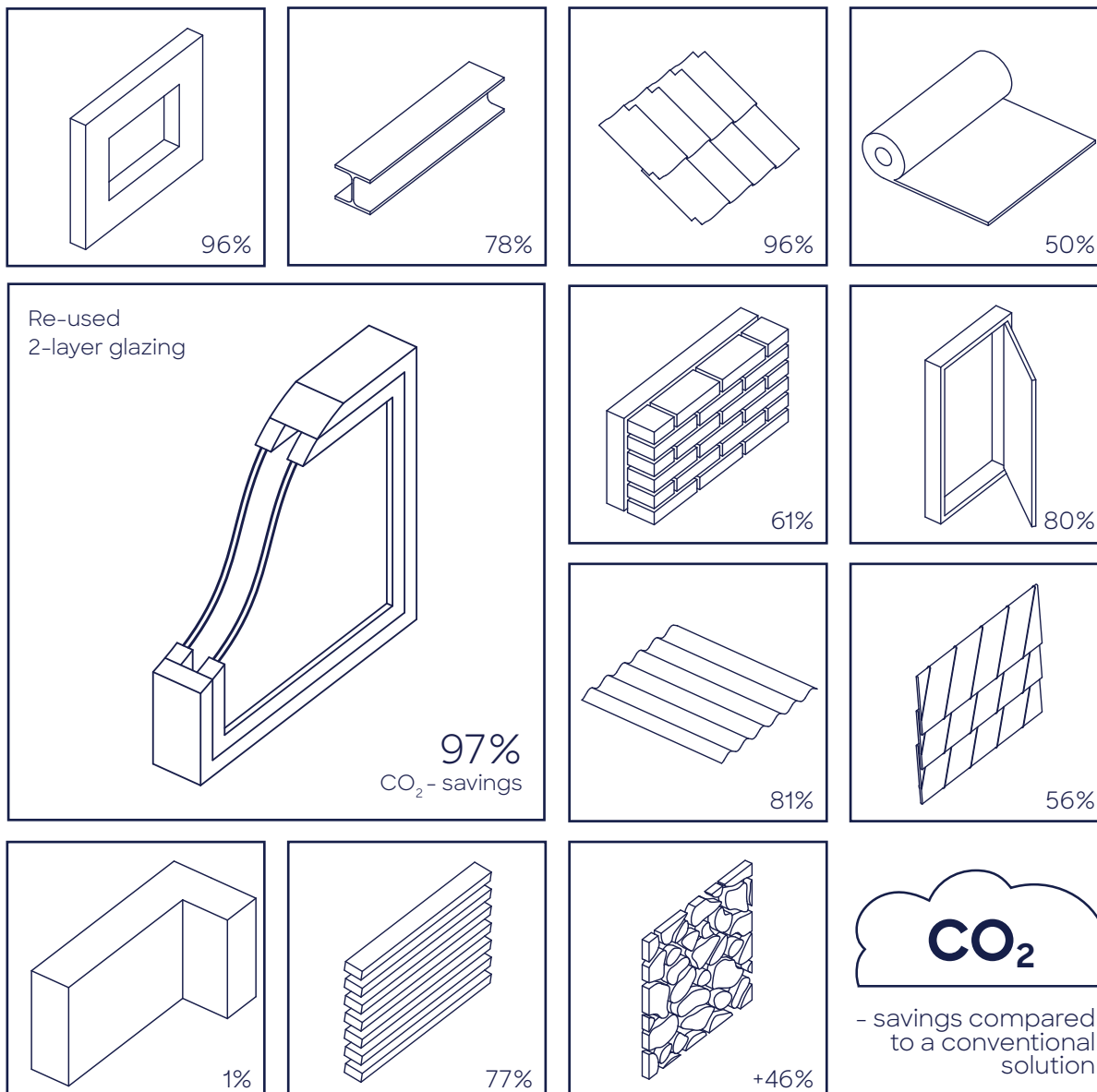
Life Cycle Assessment (LCA) is a standardised method for environmental assessments and is increasingly used in building certification schemes. Currently, LCA-approaches are being implemented in EU and Danish building policy. As a building's embodied material impact today account for more than half of the building's total environmental impact, the traditional focus on operational energy efficiency in buildings will be expanded with a more holistic perspective.

Three scenarios for existing buildings

The Decision Support Guide presents a typical case for clients and consultants: An existing 1950's school is worn down and cannot accommodate present needs. The municipality strives to cut carbon emissions related to their building activities according to its climate policy. The decision between keeping the remaining school without major changes, a deeper refurbishment or a new school building cannot be answered by looking at energy performance alone. Here, a comparative LCA can help quantifying some of the potential environmental consequences related to both energy and materials including carbon foot printing.

Circular building materials

Closing loops and avoiding waste are promising concepts seen from an environmental point of view. But how do circular solutions perform from an environmental viewpoint in the current building sector which is not yet circular? By applying LCA to a series of current circular building solutions, the guide provides assessment criteria and insights for current debates in the building sector and policymaking.





The Decision Support Guide can sharpen the eye of the builder and consultant for values in existing buildings.



- Lars Bak

Department Manager
The Technical and Environmental Department
Skanderborg Municipality



Image: © Skanderborg Municipality

Bakkeskolen as a case study

Testing the Decision Support Guide on municipal building project reveals circular possibilities for the existing building stock as alternative to demolition and new construction.

The municipality of Skanderborg has an ambition to integrate circular economy principles in decision-making regarding the built environment. To inspire citizens and companies to reduce CO2 and increase reuse and sharing, initiatives are formulated in municipal strategies to reduce the environmental impact from new construction projects.

A large percentage of all construction activities are renovations and refurbishments. A focus on circular economy in general, and the exploration on interconnecting construction projects within the municipality, offers new perspectives on how to take advantage of “old” new resources, which otherwise might be lost.

Skanderborg Municipality used the case of Bakkeskolen to test the Decision Support Guide. This was tested in a workshop with participants from various municipal departments in order to gain experience for future projects. The workshop revealed the potential for alternative approaches to decision-making and assessing material value based on the Decision Support Guide.

During the workshop, which was facilitated by VIA University College, the Danish Building Research Institute (SBI/AAU) and Transition, participants were introduced to principles of circular economy along with examples from practice. They were also walked through the Decision Support Guide including examples of LCA calculations. Based on this workshop and subsequent LCA calculation examples, the Decision Support Guide revealed an obvious potential for savings on the environmental impact at Bakkeskolen with careful demolition and reuse of buildings and materials.

principle 4

Involve the full spectrum of actors



Involve the Full Spectrum of Actors

Building volume and impact with small scale contractors and craftsmen

In construction, a small number of large companies and contractors capture large volumes of the market. While these are often, and rightly, the focal point for initiatives for change, a large set of subcontractors, tradesmen, and smaller companies are also crucial to the transition. Circularity City has focused on educating and involving these often overlooked sections of the industry.

The concept of 'the long tail' is used to describe large numbers of products and services that sell in relatively small quantities compared

to the relatively small number of large-scale players in the market. The concept refers to the large volume that exists in the long tail as the accumulation of many small-scale transactions add up. In construction the long tail is represented by the large number of tradesmen, smaller contractors and companies that collectively do a large part of the day-to-day work in construction, refurbishment, demolition, and reuse. Actors seeking to accelerate the transition towards circular cities need to find tools, formats and processes that can harness these crucial actors and enable them to take part in driving the change.



Diagram Circularity city engaged a broad spectrum of small contractors and tradesmen

“ Everyone talks about sustainability, but it is important for the people handling the bulk of our building mass to get descriptive facts and actual useable tools to do so in a circular way.



- Balder Johansen
Founder and CEO
Logik & Co.



Image: © GXN Innovation

Miniguide for craftsmen

A miniguide that clearly articulates circular potentials in construction to crafts- and tradesmen and describes concrete possibilities for – and benefits from – working with circular economy.

A circular toolkit

As a part of the Circularity City project GXN has developed a miniguide for craftsmen and contractors who want to achieve know-how on how to construct sustainable buildings prepared for a circular future. The miniguide is intended as a transportable toolkit that can be used on the job in the specific working situations that craftsman often find themselves in during construction projects.

Simple and useful

The Miniguide is divided into three chapters; 'Minimize your waste', 'Plan your construction process' and 'Purchase with awareness' and demonstrates how the circular mindset can be a conscious choice when working in the

building industry through concise information and practical tips.

These are methods and principles that are already known to have large potential impacts but have not yet been implemented in construction process in a systematic way. With this miniguide we wish to showcase the possibilities and benefits created from working with circular economy.' says architect at GXN, Sarah Sonne Glatz.

Promoting circular work in municipalities

The miniguide has been presented and distributed during information and network meetings for craftsmen and contractors organized by the Municipalities of Horsens, Aarhus and Skanderborg. The meetings have been aimed at equipping local actors for a greener and more sustainable future in the construction industry and have been held in the premises of local STARK hardware stores in each municipality to reach craftsmen and contractors on their home turf.

Download the miniguide at www.circularitycity.dk

principle 5 spur international interest



Spur International Interest

Enabling local circular business to reach a global market

Cities are key in the transition to circular economy. An unprecedented number of people are moving to urban areas, transforming businesses and the built environment in the process. This means that cities have the critical mass required to become powerful engines for sustainable transformation. Circularity City has focused on introducing some of the best solutions and companies to export markets in Germany and the U.S., and thereby sought to accelerate the circular transition globally.

development of new circular products and processes. Solutions developed to meet local demand can be introduced to larger international markets. This means that global markets can become engines for further growth for frontrunners in the industry as the demand for circular urban development matures in the coming years.

As examples from the case collection in this report shows, local markets in cities and their surrounding regions are key drivers for



Diagram Circularity city enabled local businesses to reach a global audience



Image: © Danish Cleantech Hub

Spurring international interest

Danish Cleantech Hub has been working to bring the circular construction agenda to U.S. and German markets through its deep market integration in these countries. The goal is to create strategic growth of business opportunities for circular solutions to the built environment.

Deep market integration

With circular economy being a relatively new concept to many public decision makers, companies, organisations, developers and investors, Circularity City have had a strong focus on inspiring U.S. and German stakeholders. Through a proactive approach to circularity it is possible to become an international initiator in local ecosystems. This position unlocks the possibility of generating local initiatives together with partners, which has the prospect of driving local agendas for circular economy in the built environment.

A broad range of activities can serve this purpose, including sharing of well tested ideas in city-to-

city collaboration agreements, transatlantic think tanks, challenge-based approaches and large-scale conferences.

Circular City Week New York

Circular City Week is a week-long open collaborative festival for circular economy related events created by Danish Cleantech Hub in New York. Activities during Circular City Week emphasizes how circular practices and innovations can transform urban industries, including the built environment. The festival serves as a driver for circular knowledge sharing and solution sharing in New York City and the 2019 event was the biggest circular economy event in the U.S. with more than 2000 attendees. Circularity City Week provides Danish circular businesses with a global platform and can be used to showcase Denmark as a global circular economy frontrunner. By engaging in the week, companies have gained new opportunities for local market integration through increased visibility, new networks and positioning themselves in a new and large foreign market.



Image: © Danish Cleantech Hub

Creating visibility abroad

Developers, architects and other potential circular solution users cannot demand solutions they do not know exists. Visibility is key to turning national interest into demand for solutions abroad. Working actively to build visibility for Danish solutions abroad, a competitive advantage is created.

The Danish sustainable narrative

Circular solutions in the built environment are a part of a larger narrative about the Danish transition towards a green economy and high-performance buildings. By making circular solutions part of a holistic and well-tested narrative, new circular products and ideas gain credibility abroad. In many cases, circular solutions have benefitted from being positioned as the next generation of innovative and sustainable concepts from Denmark.

As a part of the Circularity City project it has been possible to showcase new products that independently would have had a difficult time attracting attention and thereby using the

platform of the project to inform potential clients, customers and partners about the benefits and innovative approach applied.

Knowledge sharing events

International events have been a core activity in Circularity City. To exemplify, the Circularity City Product Awards invited circular product designers and manufacturers in Germany and in the Nordics to showcase their ideas. Six finalists presented their ideas at the NordBAU conference in Germany. The finalists included ØkoTømrer, Gamle Mursten, Ege Carpets, Randers Municipality, EcoCocon and Komproment. The winners were also exhibited at the Material Health Symposium in New York City.

The event series Design for Circularity was hosted in New York City and included four separate workshops. Focusing on office furniture, material choices, redesign and buildings as material banks, circularity was presented to the building professionals from diverse and new angles. Danish participants included Komproment, Gabriel, Horn Bordplader, ROCKWOOL, Fischer Lighting, Magnus Olesen, Gamle Mursten, Wehlers, Ege Carpets and Thors Design. Gamle Mursten, Wehlers, Ege Carpets and Thors Design.



Image: © Danish Cleantech Hub

Visiting new markets

Collective export activities enable Danish companies to identify foreign market opportunities. By lowering the barrier for participation, more and smaller companies can also take advantage of the international interest and visibility Circularity City created.

Exploring export opportunities

Circularity City has enabled Danish companies to familiarize themselves with business opportunities and market demand for circular solutions for the built environment.

Participants have had a unique opportunity to receive practical insider information, exchange professional experiences and best practices, start their networking building and learning local value drivers, while simultaneously being able to promote their solutions. Consequently, Danish companies have been able to develop their business strategy with attention to foreign market

potentials and explore market interests.

Two delegations to New York City

A total of 14 Danish companies have participated in the two delegations that have been organized to New York City. Programs have focused on building material manufactures and interior design companies, who in a variety of ways have started working with the circular economy. Activities and the program were designed to support both companies who are already active in the U.S. and those who are considering a market entry.

The activities included lunch & learns with benchmarking American architectural firms and engineering companies, visibility and network building events, showroom tours, meetings with sales agents, and experts within local legislation, certification and communication. For several of the participating companies these delegations have generated viable sales leads and export openings in addition to market insights.



Image: © Danish Cleantech Hub

Individual corporate assistance

Market entry and expansion can be much smoother with individualized help from export experts – especially when products are new to a given market. Meeting the right local partners that understand a product's circular value proposition is proving vital for success.

Developing strategies that fits the market

Strong relationships with foreign stakeholders will help Danish companies position themselves favourably in a foreign ecosystem. Individual meetings are one of the best ways to build relationships across borders and engage relevant partners, clients, representatives and customers. Circularity City has enabled participating companies to tap into the Danish Cleantech Hub network and benefit from local expertise and knowledge about market opportunities and strategies.

Meeting programs and fact-finding tours

More than 10 companies have received individualized assistance in the U.S. through Circularity City and more than 40 individual meetings have been arranged. Fact finding tours – which are three-day intensive and tailored meeting programs – have been a cornerstone in the U.S. market entry strategy development for companies like Komproment and Transition. Through these fact-finding tours participating companies have found local business partners, sales representatives, and identified potential first orders. Both companies would likely not have taken on new market opportunities was it not for the individual corporate assistance provided.

principle 6 set new industry standards



Set New Industry Standards

Developing a common language for circularity in buildings

What do we talk about when we talk about circular cities? How do we measure circularity in building projects? Which metric and methods can municipal actors use to formulate tenders and drive demand? Currently these questions are difficult to answer, as we need industry-wide standards to encapsulate the meaning and metrics required for developing and evaluating circular construction practices.

Standards introduce a common language that allow stakeholders to communicate and pass on information in a shared way. They reduce uncertainty and are key to establishing a common foundation for the handling of materials, reuse,

design for disassembly, take back and much else required to accelerate the transition to more circular cities.

Standardisation in the field of Circular Economy is necessary to develop frameworks, guidance, supporting tools and requirements for the implementation of activities of all involved organisations, to maximize the contribution to sustainable development.



Diagram Circularity city helped establish shared language and standards for circular building practices

- Kåre Stokholm Poulsen
Head of Innovation
GXN



Shared principles and proven practices are key tools for advancing circular economy in the construction industry. Circle House Lab functions as a forum for frontrunner companies to share and debate these, and an open source knowledge repository for the industry at large.



Image: Studytour at demolitionsite
© GXN Innovation

Circle House Lab

Circle House Lab brings together more than 80 circular frontrunners across the building industry to develop future Danish and European circular building standards.

Circle House Lab aims to accelerate the transition to circular economy in the Danish building industry. As the name indicates, the project is a laboratory. Members commit to share and debate practical and experimental circular solutions and introduce new frameworks for collaboration across the industry.

The knowledge gained in Circle House Lab will be starting point for development of a European standard for circular processes and products. The project is supported by Realdania and MUDP and runs from spring 2019 to summer 2021.

Circle House Lab will process and develop standards within six key topics for circular construction. All topics will be treated through three types of activities:

Laboratory days

During laboratory days each topic is treated through study trips, best practice cases and

collaborative workshops. The topics will be processed through an alternating flow between speeches, presentations of best practice and discussions to map out and clarify challenges and practical solutions.

Green papers

Challenges and solutions discovered during laboratory days will be analysed and distributed through Green Papers for each of the six topics. Each Green Paper will be distributed through industry organisations and partners of Circle House Lab, aiming to share knowledge with the full building industry.

Circle house summit

Once a year the international Circle House summit will be hosted at BLOXHUB. The summit will bring together building industry companies, research institutions, industry organisations, students and media. Essential discoveries from laboratories and key points from Green Papers will be presented and discussed in an international forum.

The knowledge and discovery from Circle House Lab will be shared through Green paper and on the webpage - bloxhub.org/circlehouselab

CIRCULARITY CI TY recap



Next steps

Continuing development for circular cities

With increasing global focus on the climate crisis, the negative environmental impact of the building sector is coming under scrutiny. Since we began the Circularity City project in 2017, we have seen a growing interest and demand from politicians and business communities in Denmark to finding the circular solutions of tomorrow. The Circularity City project has now ended, but the projects, companies and people involved in the project remains active and engaged in the continuous development a circular built environment.

At the time of writing, numerous political and research-based activities are under way in Denmark, and many of the businesses and organisations mentioned in this publication are working hard to further develop and scale their circular products. We invite anyone who is interested in advancing circularity in the built environment to get in touch with the project consortium, or the companies and organisations presented in this book.

midt
regionmidtjylland

Bring ideas to life
VIA University College

clean
INNOVATING GREEN SOLUTIONS

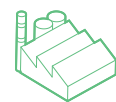

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2ndHandTegl	Outer Core
Aalborg Portland	Papiruld Danmark
Amorim	Peikko
Bardon AB	Plastix
Bewi Synbra Technology	Rheinzink
Bollerup Jensen	Rockwool
Carlo F. Christensen	Saint Gobain // Gyproc
Caverion	Scan Underlay
CBI Danmark	Sepatec
Climate Recovery	Small Planet
Consolis	Tarkett
Consibio	Thermocell
Convert	Thors Design
Derbigum	Triplex
Dovista A/S	Troldtekt
Egetæpper	Tåsinge Elementer
ENKL	Vahle
Ergo Floor	Velfac
Fibo Intercon	Velux
Fisher Lighting A/S	Wehlers
Gaiawall	Wellfarmed
Gamle mursten	Xella
Gutex	X-Po Arkitekter
Haki	
Horn Bordplader A/S	
Hunton	
InnoTherm	
Isolenawolle	
Kebony	
Kvadrat/Really	
Nature Impact	
Nordic Flex House	

CONTRACTORS



Buus Anlægsgartner
E. Anker & Søn
MT Højgaard
NCC
RGS Nordic
Øko Tømrer

DEMOLITION



Kingo Karlsen
P. Olesen og Sønner
Tscherning

INVESTORS



Boligforeningen Ringgården
Domis
Lejerbo
NREP
Pension Danmark

MUNICIPALITY

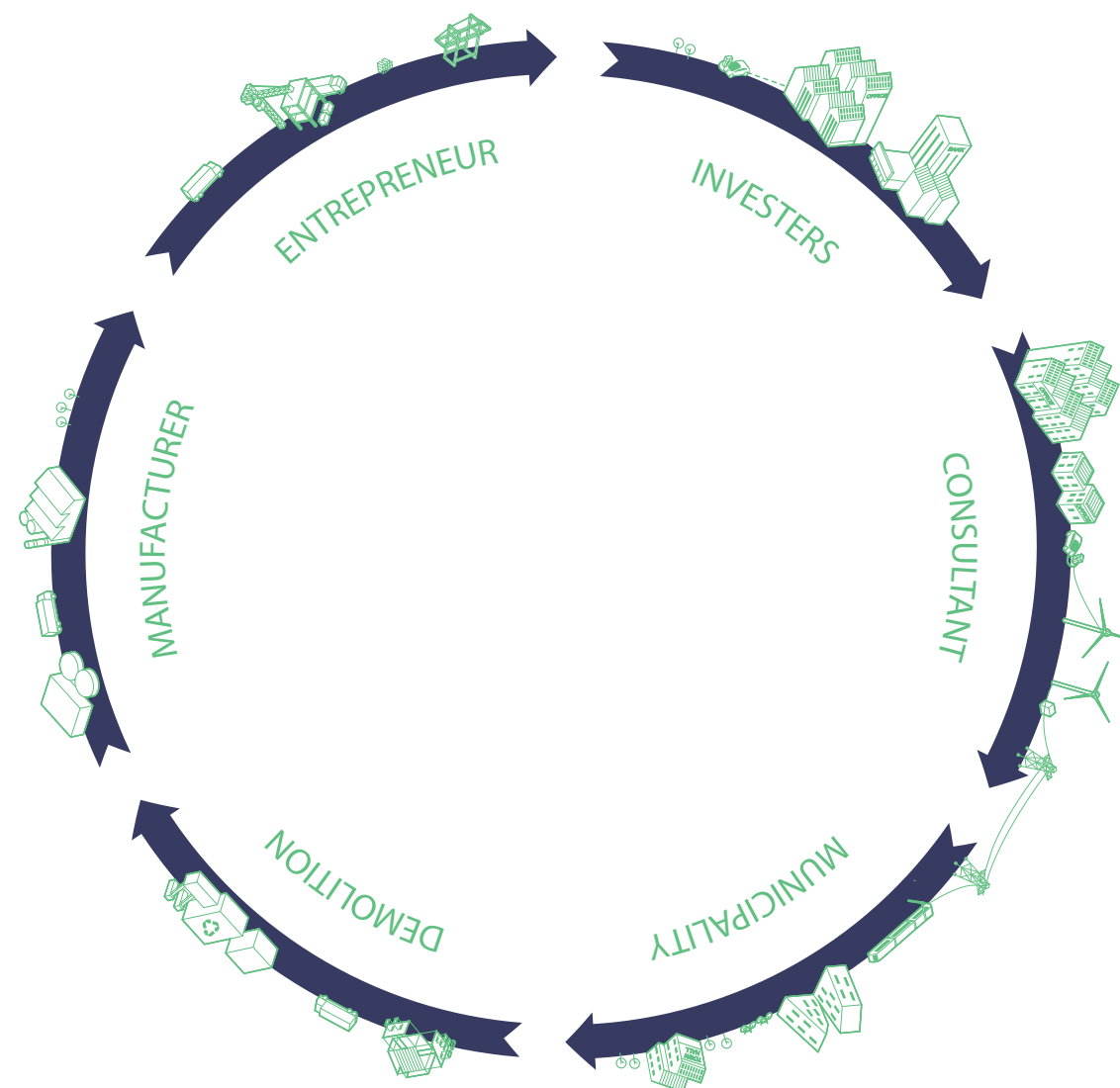


Aarhus Kommune
Horsens Kommune
Randers Kommune
Silkeborg Kommune
Skanderborg Kommune
Skive Kommune

CONSULTANT



Arup	Grundfos
Bureau SLA	Hildebrandt & Brandi
Ceverion	Horten
CINARK på KADK	Advokatpartnerselskab
ConTerra	Ingeniørhøjskolen i Aarhus
Dansk Beton	Lauritzen Advising
Dansk Byggeri	Lendager Arkitekter
Dansk Standard	Loop Architects
Energy Skive	Meissner og Sigh
Foreningen for Byggeriets Samfundsansvar	Miljøstyrelsen
Four Squares	Møller og Grønborg
	Orbicon
	Overtreders W
	Pluskontoret Arkitekter
	Realdania
	Responsible Assets
	Ringgården Housing Association
	Sustainor
	Transition
	Vandkunsten



More than 60 companies and 17 municipalities have been a part of Circularity City, and many more have worked partly within the framework of the project. On this list we have collected the actors who have been working directly as a part of Circularity City within the last three years.

CIRCULARITY
CI **REGION**
MIDTJYLLAND