

Circular city transformation

- 5 pathways and 15 actions towards circular
urban environments



UN17 Village - the first building project ever to interpret all of UN's 17 sustainable development goals into concrete actions.

How to become Europe's most sustainable city?



From urgency to agency.



Leuven City is part of the EU mission '100 Climate-Neutral and Smart Cities by 2030'. How can it meet the target?

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Executive summary

In this Urban Insight report by Sweco, “The circular city transformation - 5 pathways and 15 concrete actions towards circular urban environments”, we demonstrate how cities should leverage their roles as innovation hubs, economic centres and accessible spaces to set an example of how to design out waste, regenerate natural systems and keep products and resources in use.

It's the cities, where two thirds of the world's population will live, that need to be the frontrunners in the urgent and necessary transition from a linear to a circular system.

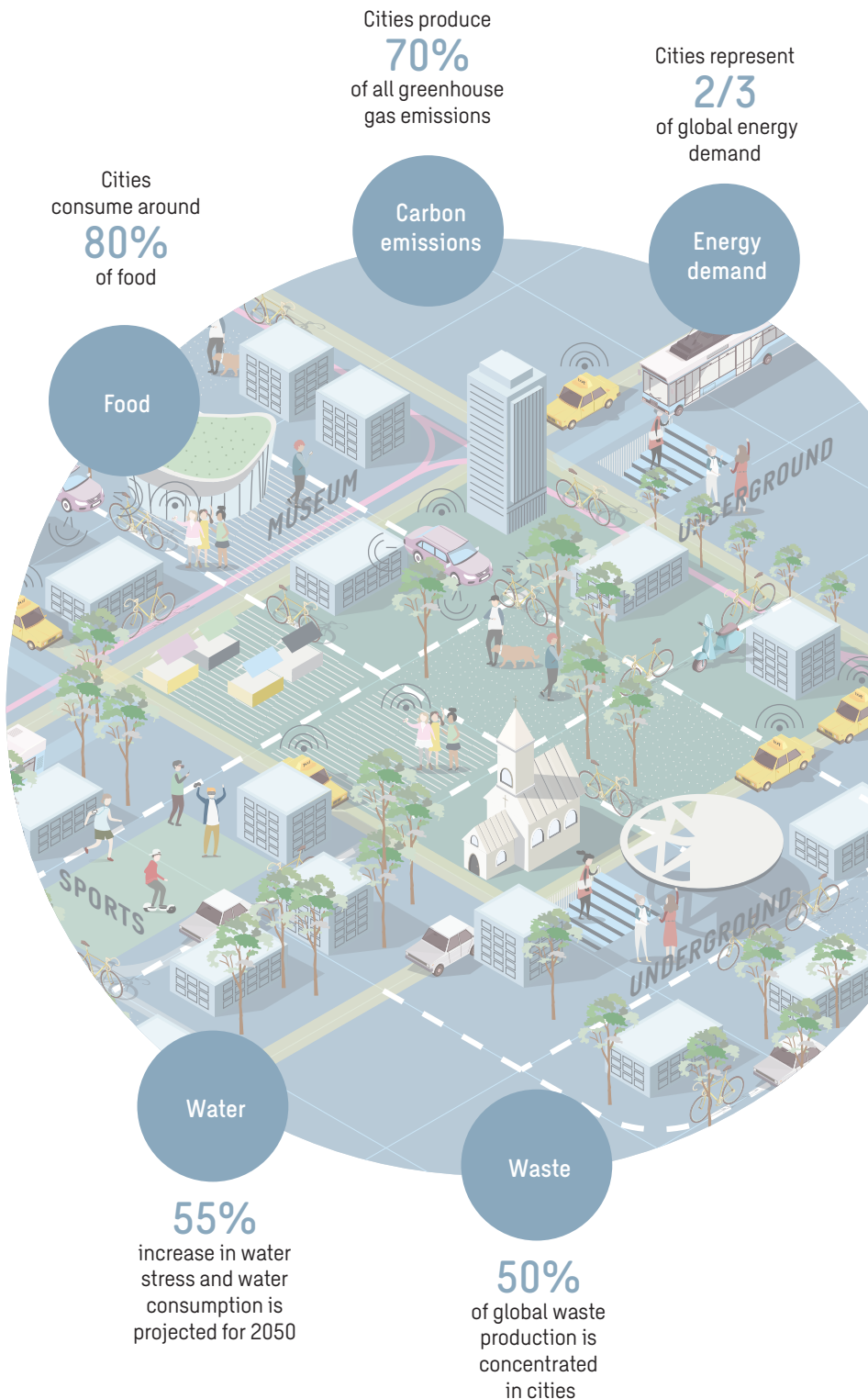
Today 20 of 27 EU member states have a government plan for the circular economy as part of the European Green Deal. Pioneer cities such as Amsterdam and Glasgow are solid proof that circularity can be applied on a large scale.

To help your city make the shift and turn visions into reality, this report showcases projects and suggests five pathways for the circular transition: mindset shift, ecological resilience, track trace and connect, governance measures, and systemic thinking.

Through a new European calculation from Sweco's experts, we show how urban symbiosis can become a reality in 2040 in a circular Swedish city of 90,000 inhabitants, with cities saving as much as 75% of their total energy needs compared to today.

At the end of the report, we present a checklist with 5 pathways and 15 concrete actions for a circular city transformation.

Let cities lead the transition towards circularity



The progressive transition to a circular economic system is an indispensable component for the future cities of Europe.

This report has taken a closer look at the city level and what could be achieved by implementing circular systems.

A recent study by Sweco shows that future cities can save as much as 75% of their total energy needs reduce carbon emissions by 97% compared with today.

Applying circular economy principles across the EU economy has the potential to increase EU GDP by an additional 0.5%, corresponding to more than EUR 77 billion by 2030 and creating around 700,000 new jobs.³⁷

Introduction

For fifty years now, Earth Overshoot Day has marked the date when humanity's demand for resources over the year exceeds what the earth can renew in that same year¹. After that date has passed the global community starts using natural resources borrowed from future generations.² Over the last decade, the date of the overshoot day has been creeping up the calendar every year, occurring earlier and earlier, although at a slowing rate.³

Around 2.5 billion more people will be living in cities by 2050. In this Urban Insight report, we show that although cities are part of the overshoot problem,⁹ they can take the lead in the transition to circularity and gradually start to function within our planetary boundaries.⁸

Circularity is the way forward for cities to instead be part of the solution through a systemic and holistic approach that can deliver social, environmental and economic benefits to society.⁷ It is estimated that a global transition from business-as-usual and the adoption of nature-based solutions could generate USD 10.1 billion annually in business opportunities and 395 million jobs by 2030.^{5,6}

In this report we show that we can save as much as 75% of the total energy needs in the future circular city, according to our experts' scenarios and calculations. The key is a system perspective that makes it possible to share resources, energy and means of transport through cooperation across sectors and property boundaries. We call it urban symbiosis.

However, despite the urgency of the issue, research shows that the circularity gap is becoming wider – the global economy is becoming less circular, from 9.1% circular in 2018 to 8.6% in 2021.¹⁵ In 2020, we reached another concerning milestone as the mass of human-made things – from construction to consumable goods – exceeded the weight of all living beings and biomass on earth.¹⁶ At the same time, the linear economy is also responsible for a variety of urban challenges such as higher unemployment, air pollution, housing shortages, traffic congestion, supply chain instability and more.

At the city level, well-known strategies such as reuse, repair and recycling can grow steadily and gain critical mass.⁴ However, to achieve a real transition, we need to move away from individual interventions towards coordinated action that can promote systemic synergies.⁵ We need to address the transition as a multi-stakeholder process that considers and integrates different actors such as local government, urban planners and developers, designers, communities, businesses and service providers.

Cities play a significant role in the circular transition, and they need to stop fostering a linear mindset as a standardised practice. Instead, cities should leverage their roles as innovation hubs, economic centres and accessible spaces to set an example of how to design out waste, regenerate natural systems and keep products and resources in use. They should also focus on how to translate these principles to different dimensions, such as spatial quality, social inclusion, ecology and economic growth.¹⁷

To clarify the opportunities, challenges and actions, this report will showcase projects and suggest five pathways for the circular transition: mindset shift, ecological resilience, track trace and connect, governance measures, and systemic thinking.

The sharing economy, material life cycle, ecological infrastructure and other efforts in European frontrunner cities highlight the broad considerations that must be planned for in a city's journey to circularity.

This journey starts with you, but it doesn't end with you. It's about creating urban symbioses where all stakeholders come into play.

Together, we can shift from urgency to agency, paving a pathway for European cities to achieve circularity.

This report addresses multiple UN Sustainable Development Goals, with a particular focus on:



Pathways for becoming a circular city

Each chapter in this report represents a pathway to becoming a circular city. Each one highlights five pathways that we have identified as fundamental processes for developing a thriving, liveable and resilient¹⁷ circular city.

Pathway 1 **Mindset shift – the city as a shared space**
From refuse to reuse and recycling. Working with behavioural change.

Pathway 2 **Ecological resilience – the city as an ecosystem**
Closing the loops and focusing on ecological regeneration.

Pathway 3 **Track, trace and connect – the city as the driver of change**
Monitor and manage material flows, and facilitate stakeholder engagement.

Pathway 4 **Governance measures – lessons learned from circular cities**
Clear targets, value sharing and circular businesses as enabler. A circular waste system strengthens a city's economy, creates jobs and enables innovation.

Pathway 5 **Systemic thinking – the next steps**
The importance of a holistic approach. Nothing is wasted and every resource is reused.



The city as a shared space

At the city level, the circular transformation affects how we plan our built environment. For example, the development of buildings and plots is mostly undertaken within their geographical confines, with little attention to their neighbouring surroundings and wider conditions. Landowners, developers and municipalities play an important role here. Such an attitude limits the development potential of a site and the opportunities to generate enough critical mass for circular systems. More than a technical barrier, it poses another challenge for the transition: the need for a behavioural shift, from atomistic and fragmented practices to shared and integrated action.

Even though technical considerations are obviously crucial in our journey to circularity, the issue – and the required efficiency gains – are too complex to be tackled by technical innovations only. The overarching processes and design choices are fundamental.

Accordingly, we argue that an essential part of the solution is generally overlooked: the social aspect.¹⁸ To create a circular environment, it is crucial to plan, design and build

in a strategic way that supports society's adaptation to a more circular lifestyle. Cities must work towards a circular area development strategy to encourage neighbourhoods to upscale their circular strategies and to incentivise behavioural changes.

Circular area development

The Dutch district of EVA Lanxmeer is a good case in point. It is an area that was developed in partnership with the municipality, residents and other stakeholders. Through this systemic approach, a sharing economy in the neighbourhood emerged spontaneously.²⁰

The specific design of the built environment, shared green spaces, jointly maintained urban farm and collective development process resulted in a sense of belonging for both the neighbourhood and the collective.²¹

Circular design principles, multi-use spaces and sharing possibilities for a city's mobility and work-life needs are the first step in transitioning to circular area development.²²

What does a city with no waste look like? If we built a city from scratch, what would we do differently?

Alastair Carruth, circularity expert, Sweco

Benefits of circular design

Environmental

Smaller houses can promote more sustainable living, because less space = less materials = less energy use = less waste = less emissions.

Social

When the concept of shared living is implemented the right way, it can foster a strong sense of community which prevents loneliness and provides help when needed.

Economic

Sharing helps to cut expenses, since not everything needs to be purchased by individual households. And smaller houses are generally cheaper, offering underserved groups the potential to own their own comfortable and well-equipped home.

Shared mobility

In terms of mobility, a shared city can increase the added value of open spaces, making room for ecological and pedestrian structures.

For example, car sharing means less production of new vehicles, less demand for parking spaces, less pollution and no need for oversized streets – thus promoting more healthy environments, room for shared gardens, water retention or whatever the city needs.¹⁹ With shared mobility, you can develop cities that are centred around people's needs and shared values rather than focusing on private vehicles and unsustainable mobility.²³

Shared living

Although co-living for the sake of circularity might sound like a big sacrifice, in reality it offers great opportunities

around social, economic and environmental aspects for a diverse group of citizens.²⁵

A study of Dutch property development shows that 18% of the millennial target group was open to sharing facilities, a fairly substantial number. Those most opposed to sharing cited lack of privacy and having to create schedules and rules for sharing, reasons that can't be avoided.²⁶

The study also states that the people open to sharing are specifically open to sharing with family and friends. In our view, this underscores the need to create a cohesive social structure among new residents and foundation for collaboration before shared facilities are implemented.²⁴



Visualisation: Area development in Wickevoort, the Netherlands, illustration by AM.

Client: AM
Designer/Architect: Studio PROTOTYPE, M3H Architects, MIX architecture
Location: Cruquius, the Netherlands
Role of Sweco: Civil engineering

The pioneers

The eco-village Wickevoort estate, the Netherlands

In the Wickevoort estate, approximately 1,000 houses will be built in a sustainable way. A combination of private and shared facilities, this is an example of how sustainable living can be incorporated in successful business models and bridge the gap between 'eco-villages' and traditional urban development. Sweco was brought in as engineering consultants to support the development of the eco-village. Examples of circularity in the project are self-sufficiency through urban farming, sharing space, facilities and mobility. Residents endorse the sustainable core values by actively applying for housing and are motivated to upkeep the shared facilities.

Co-living district

The co-living district of Wickevoort in the Netherlands aimed to address both social and sustainability challenges. The district approached sustainability in a broad way, considering the physical as well as socioeconomic aspects of the challenge.²⁷

As a result, the district features several circular solutions that not only serve its residents, but visitors to the area and the municipality. These groups can all see what an example of sustainable living looks like in their city.²⁸

Circular solutions in the Wickevoort district:

- Self-sufficiency: urban farming, energy neutral.
- Sharing economy: sharing spaces, facilities and mobility options.
- Multi-use spaces: shared buildings are used for multiple purposes, such as a healthcare centre during the day that becomes a yoga studio in the evening.
- Climate adaptation: There is plenty of green space thanks to the space saved by sharing and multifunctionality.²⁹



Cork City in the Republic of Ireland, a visionary image. Illustration: Will Fox, senior visualisation & graphics consultant.

An engineer imagines Circular Cork

Sweco has developed a future study on what Cork City in the Republic of Ireland might look like in 80 years' time, 2101. Sweco's re-thinking of Cork takes into consideration climate change mitigation and is powered by innovative, creative and sustainable solutions.

Imagine transforming the linear economy into one where the circular economy gives us the tools to tackle climate change and biodiversity loss together, while addressing crucial social needs. It gives us the power to grow prosperity, businesses, jobs, and resilience, while cutting greenhouse gas emissions, waste and pollution. Circular economy is a systemic approach to economic development designed to benefit businesses, communities, and the environment, based on three principles:

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems

The aim is transforming the city of Cork into a resilient, productive and self-sufficient urban area that generates its own electricity from renewable sources such as wind turbines and solar panels within or close to the city. Buildings will aim to share energy resources, generating as much power as they consume.

The concept is based on a number of pillars: Creativity, Sustainability, Ethical, Sustainability, Environment, Health, and Social and Cultural. These pillars deliver circular solutions for water resources, renewable energy, climate adaptation, transport innovation and green infrastructure, each of which contains specific projects that can be pursued.

Client: Engineers Ireland competition
 Designer/Architect: Sweco Ireland
 Location: Cork, Ireland
 Role of Sweco: Architect



Circular city district Näringen, Gävle, Sweden. Illustration: Sweco Architects.

Circular City District Näringen, Sweden – A proposed circular retrofit and urban development in Gävle

Gävle municipality commissioned Sweco, alongside three other firms, to create proposals for fulfilling the vision for Näringen, an industrial estate in the city centre, to become Europe's most sustainable city district, with 6,000 new flats. Sweco's task was to design a city where circularity is the modus operandi. The proposal draws on results from Sweco's Urban Insight report "Building the future through circular data"⁴⁰ and estimates significant savings of carbon dioxide equivalents by reusing existing buildings, materials and green areas as part of the process. Delimiting and safeguarding areas that should not be touched by demolition are vital in reducing costs and impacts on the environment in city development projects. Whilst existing structures may not be considered 'top class' in aesthetic terms, as much as 90-100% of buildings and materials on site could

remain untouched, thereby providing valuable spaces for cultural activities, small-scale industrial production, innovative startups, NGOs and cooperative initiatives. These represent the backbone and 'urban nerve' in the new logic that circular economy represents. To facilitate community-building and stakeholder interaction, Sweco's proposal includes a wide range of spaces and resources that can be shared. Innovative digital twin sharing platforms and cooperative marketplaces will ensure that the neighbourhoods become completely circular, under the motto that "almost nothing leaves Näringen".

Client: Gävle Municipality
Designer/Architect: Sweco
Location: Gävle Municipality, Gävleborg, 150km north of Stockholm
Role of Sweco: Architect

Our circular city in 2040 - when the vision of urban symbiosis becomes reality

The circular cities of the future can save as much as 75% of their energy needs, according to, scenarios and unique calculations from Sweco's experts. The key is a system perspective that makes it possible to share resources, energy and means of transport through cooperation across sectors and property boundaries. We call it urban symbiosis.

Sweco's experts have calculated the value of energy-efficient architecture and new construction, locally produced, shared and stored energy, fully shared mobility, locally produced food and a maximised urban agricultural system with waste used to generate biogas as well as AI and digital twins for optimisation and visualisation.

The circular city's total energy needs per sqm in 2040 will then be only a quarter of what it is today. (Heat + electricity = 113 KWh/sqm in 2020 and only 28 KWh/sqm in 2040).

We base this calculation on the Näringen Circular City District, a proposed circular retrofit and urban development in Gävle, Sweden, with 6,000 homes. It can be seen as a generic case for a medium-sized Swedish city that needs to expand and at the same time reach the climate goals. We have assumed that the population will reach approximately 90,000 in 2040.

75%

energy savings compared to today's levels

97%

reduction in climate emissions

2.7

tonnes of food grown per year supports the towns' food needs



Biogas derived from food waste generates enough energy to meet local schools' total energy needs

60%

Reduction of energy requirement compared to a traditional building without solar panels





Visualisation: Sweco and Mandaworks.

Scenario for a maximised, resource-efficient and circular city in 2040:

- **Through wise design** choices in the early stages of house construction, we avoid large amounts of carbon dioxide emissions at the design stage. A residential building with facades and a lightweight wooden frame emits, for example, half as much carbon dioxide as a corresponding house with a prefab concrete frame and brick facade (170 kg/sqm compared to 370 kg/sqm, Sweco's C3 tool shows).
- **Energy-efficient architecture** and sound district planning enable sustainable behaviour patterns and minimise emissions. With combi panels on all unshaded roofs, as well as solar cells on the district's unshaded facades, we reduce, for example, the energy requirement by roughly 60% compared to a traditional building without solar panels.
- **By planning for the district** to produce both food and biogas, we contribute to the city's nutritional and energy needs leading to significant gains. This provides the capacity to locally grow around 2.7 tonnes of food per year. The benefits of local food production are numerous. On the one hand, the district's and the city's entire needs for useful crops and food supplements are met in the form of what we call future food, for example fish farming. The food waste from urban food production could cover, the local school's total needs for electricity and heat. (Up to 800MW is generated, which covers the energy needs of a school of 7500 sqms in 2040.)
- **We will achieve a 97% reduction** in carbon emissions, when walking, cycling and electric mobility services have become the norm in 2040. By promoting walking, cycling and a new form of collective, zero-emissions and electrified transport, we will reduce car driving to 200km/month, which is an 80% reduction compared with the current situation. This meets the family's everyday needs 24/7 and has become the obvious choice for both passenger transport and goods transport. Drone lanes for goods up to 2kg are used at certain scheduled time intervals and are additionally supplemented with new electric bicycle vehicles.
- **Sharing has become the norm**, and borrowing rather than owning is a given. Cars, cargo bikes, drones and electric bicycles are examples of a new kind of electrified vehicle fleet that is at hand but not owned by the individual. An AI-based responsive service ensures that the family has round-the-clock access to carpooling and public transport. Perhaps continuous, self-driving 12-seater buses will be available that move slowly through the neighborhood towards the station.
- **Using a holistic approach** when looking at the district as a resource hub has become self-evident. The system perspective provides economies of scale and new conditions through actor collaboration and urban symbiosis, for example through 'energy communities'. We start from a system approach that can be optimised through synergy in terms of all flows, needs and resources: heating, electricity consumption, electricity charging needs, transport needs, local food production, biogas....all with the support of AI.

The calculations for a circular city in 2040 were carried out as part of the project AIFOOD – AI for a sustainable food chain from farm to fork (funded by Vinnova, the Swedish Innovation Agency)

The city as an ecosystem

Humans are the only living beings on this planet who understand what waste is.⁶ Every other living creature is part of a cycle, where nothing is wasted and every resource is reused.³⁰

On 29 July 2021, according to the Global Footprint Network (GFN), humanity's demand and extraction of natural resources outpaced the rate at which the planet regenerates them during a single year. Here the emphasis is on the shrinking biocapacity of ecosystems (predominantly forests, wetlands and groundwater reserves) to sustain our production-distribution-consumption paradigms. While the economics of linearity are obviously at play, another aspect is often overlooked – ecological regeneration.

To plan for a healthy amount of urban greenery, the 3-30-300 rule was raised as a suggestion by Cecil Van Konijn-

dijk, professor in Urban Forestry at UBC: Everybody should be able to see three trees from their home, live in a neighbourhood with at least 30% tree canopy (or vegetation) cover, and be no more than 300 metres from the nearest green space that allows for multiple recreational activities.

The self-sustaining metabolism of a city

We can think of circular urban planning as analogous to an ecosystem's metabolism. The fundamentals are defined by a self-sustaining system with no waste, where the transformation processes take place through the exchange among different systems that define the city's ecology.

On the one hand, cities are in a constant exchange with the biosphere, which performs many of the necessary functions cities need to operate. On the other, the presence of natural capital as a unique variable within urbanisation is

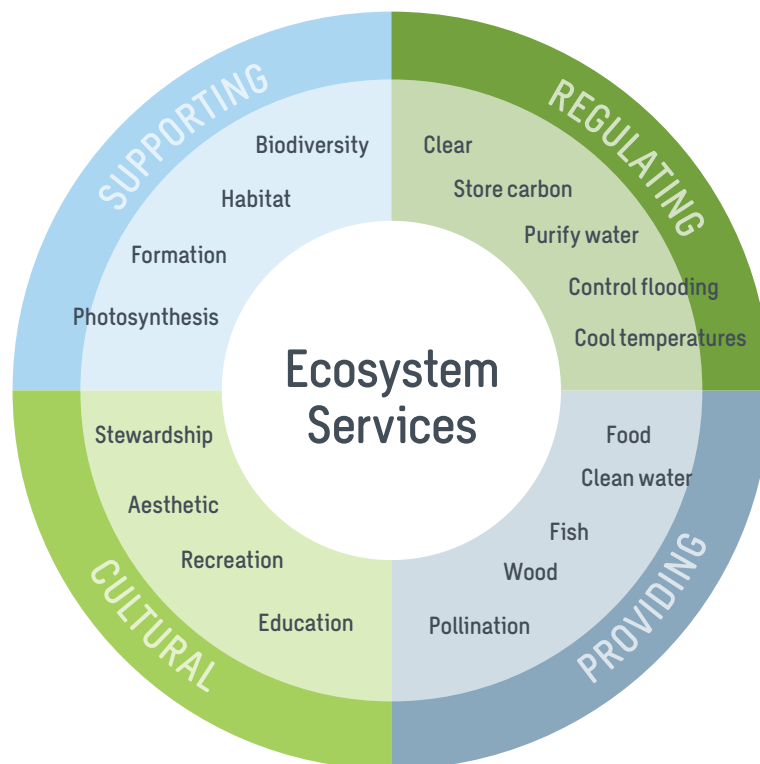


Figure 3. Ecosystem services. Adapted from 'The Millenium Ecosystem Assessment', 2005. Schematically illustrated in the following figure, these range from resource provision and recreation through to climate risk mitigation and adaptation.

an indicator of an urban region's capacity to deliver much-needed ecosystem services. Put differently, natural capital is a fundamental system in an urban region's metabolism and, as such, the planning, design and engineering of cities and their infrastructure should be about connecting them with their natural foundations.

The role of ecosystem services in a resilient city

Why is nature valuable to us? Seemingly obvious, this question lies at the core of all attempts at sustainable and resilient spatial development. The Millennium Ecosystem Assessment (MEA),³¹ the Economics of Ecosystems and Biodiversity (TEEB)³² and other recently developed tools enable cities to understand the myriad services that natural systems can provide to us.³⁴

Traditionally, technical innovations have aimed to replace ecosystem services with human-made counterparts, such as sewage and electricity infrastructure. While these were groundbreaking in improving our health and well-being in an era of industrialisation, they promoted a technocratic view that prevents us from understanding the benefits of a more natural approach to problem-solving.

We need to integrate natural ecosystems in our cities to capture great values, such as the potential of vegetation to purify air or contaminated water, or water detention and retention for preventing flooding. Providing scope for green and blues infrastructures through streets, public spaces and buildings is also part of health-promoting cities that offer a better quality of life.

The pioneers

The Urban Waterbuffer – reuse of rainwater

One example of a solution pertaining to the hydrological cycle is the Urban Waterbuffer project in Rotterdam.³³

While urbanised areas increasingly face the challenges of flooding or water shortages caused by droughts, managing urban rainwater remains a struggle.

The Urban Waterbuffer aims to filter and reuse rainwater in urban areas through calculated redirection, retention and purification.³⁴ Here, circularity entails the use of ecosystems to regulate water flows and human-induced contamination, and to reuse purified water. In the project, the urban surface that is subject to runoff stress is linked with the subsurface via an ecological buffer zone. Stormwater is directed to vegetated zones that remove contaminants and then transported and stored in the subsurface, which also adds to groundwater reserves. The water is then ready to be harvested and reused for various urban functions.

Proof-of-concept testing has revealed multiple benefits of such circular measures in addition to directly addressing a particular hazard or concern. For one, the circular solution provides valuable flood management and water supply services. It also leverages ecosystems to expand green areas in urbanised regions, promoting further benefits to society.

This project exemplifies the potential of the circular economy to both manage ecological and anthropogenic material flows (for example, residential, commercial and industrial sewage and contaminated water) and to enrich the spatial quality of the built environment and the various ecological systems at play.³⁵

Three ways to increase biomass in the city:

Make a nature value inventory on city level

Create an action plan for ecosystem services

Install green eco-terraces on all new buildings

Blue-green urban living at the Mindemyren Canal, Norway

The area of Mindemyren, close to central Bergen, will undergo an almost total transformation during the next few years. Today, the area is heavily trafficked and consists of unappealing buildings. The aim is to create an attractive and inspiring green urban area. In addition to being a local floodway, the top canal will facilitate fish migration and blue-green urban living. The culvert underneath will be built to handle a 200-year flood.

New urban spaces will be created with a focus on blue-green infrastructure and smooth mobility for pedestrians and cyclists. Swecos experts have designed a unique man-made canal, bringing a hidden river back into the

open. The river was culverted into pipes and will now be released back into a natural channel. Sweco provided a cross-functional team with expertise from technical water and wastewater engineering, urban design and biology. The result? A canal that contributes positively to city life, is suitable for the movement of sea trout between seawater and freshwater, and meets the need for climate adaption by serving as a floodway in the event of increased rainfall.

Image: Sweco / Bergen Light Rail
Client: Bybanen Utbygging AS
Designer/architect: Sweco
Location: Bergen, Norway
Role of Sweco: Design and engineering

Visualisations by Sweco.

Bringing a hidden river into the open – contributing positively to city life, shaping a healthy living environment, and meeting the need for climate adaption.



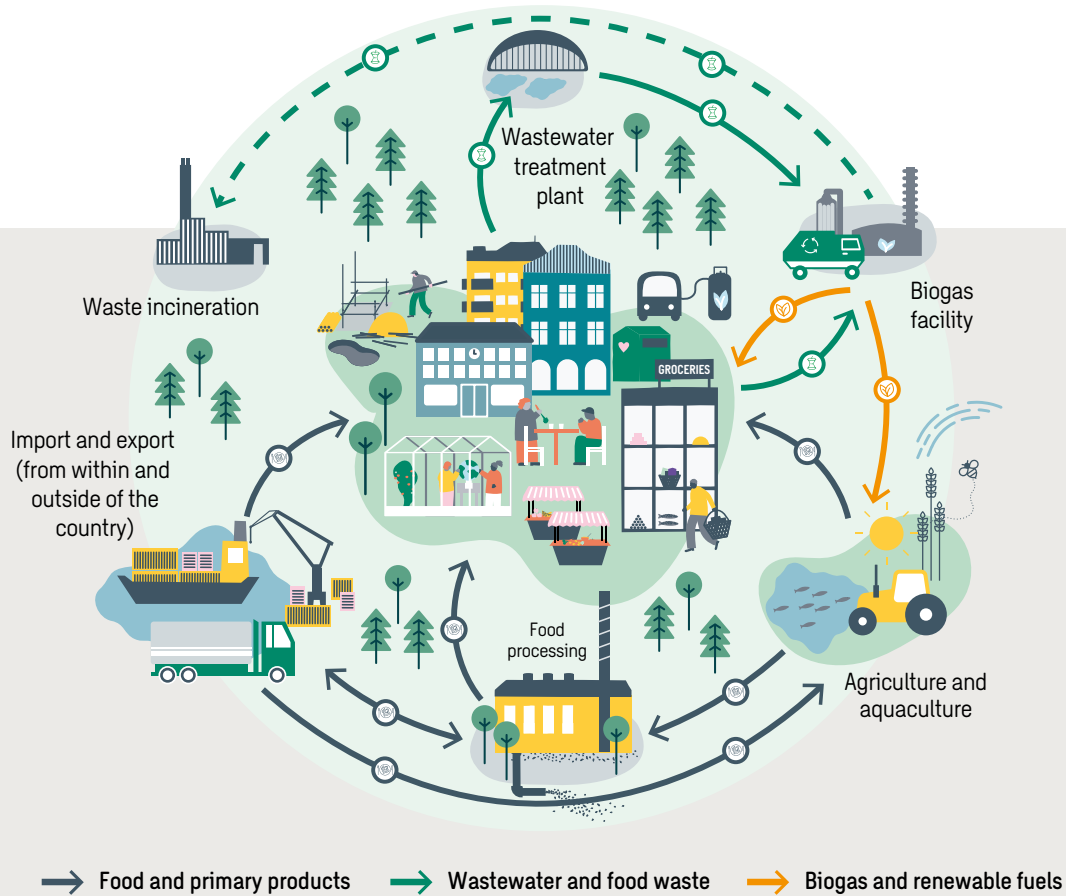


Illustration: Environmental Management for Gothenburg City, 2022:03 A sustainable food system from a circular economy perspective.

Circular food system in Gothenburg, Sweden

The Environmental Administration in the City of Gothenburg has produced proposals for a sustainable circular food system. They look at what needs to be done to achieve a sustainable local food supply for the Gothenburg community, while reducing the environmental impact on the wider world.

A long-term sustainable food system requires transforming all of society, and there are many factors to take into account. More circular flows and locally produced foods can contribute to a sustainable food supply. A knowledge base is also needed to identify complex connections and to identify paths that take us towards a sustainable local food system.

To understand the current situation and to take leadership in identifying solutions, the city commissioned a mapping exercise which was carried out by Sweco. It mapped, visualised and quantified flows of food resources in, through and out of the Gothenburg area, including consumption and waste disposal. The calculations enabled climate impact

and financial calculations to be made. Actions to help the city on its path towards a circular food system were then mapped with the expected CO₂e and financial savings compared against the baseline.

Client: Gothenburg City
 Location: Gothenburg, Sweden
 Role of Sweco: Food system mapping, visualisation, quantification and recommendations

The projections estimated that the proportion of food produced locally could be increased from around 1% to 40%, achieving savings of around EUR 2 million and 75,000 tonnes CO₂e per year and around 5,000 new jobs.



In Gothenburg, there is a lot of agricultural land and they are also at the forefront of urban farming. If you maximise the area where it is possible to grow circularly and measure what could be produced, it is clear that Gothenburg can become self-sufficient in vegetable production.

Emma Danielsson, Sustainability Manager Sweco

The city as a driver of change

Did you know that one-third of all city waste that flows through Europe today comes from demolition?³⁶ What tools would a circular city need to access that waste, and turn trash into cash? In this chapter we zoom into two tools that cities can use to become circular. These tools enable the coordination of chambers of commerce, municipalities and other stakeholders and resource flows to improve public awareness, accessibility and connectivity. We end the chapter by describing four tools that enable innovation and circular economy.

Benefits of the transition towards circularity

The progressive transition to a circular economic system is an indispensable component of the future cities of Europe. A report from the World Economic Forum shows that applying circular economy principles across the EU economy has the potential to increase EU GDP by an additional 0.5%, corresponding to more than EUR 77 billion by 2030 and creating around 700,000 new jobs.³⁷ So the business case is clear, both for circular cities and individual companies, since manufacturing firms in the EU spend on average about 40% of their expenses on materials. Closed-loop models can increase their profitability while protecting them from resource price fluctuations, as seen during the pandemic.³⁸

From trash to treasure

A circular waste system strengthens a city's economy by keeping money and materials circulating throughout the local area.³⁹ At the same time, it creates jobs in different industries, both for smaller and larger communities, whether urban or rural.

Implementing such systems requires a network that can coordinate the links among resources, production and consumption to promote circular flows. Digital tools can increase the necessary connectivity within the system and facilitate monitoring processes, stakeholder relations and cyclical resources.⁴⁰ Some examples of circular economy tools include materials passports, smart logistics and systemic mapping.

Potential market and innovation

Building on the EU's common market and the potential of digital technologies, the circular economy can strengthen the EU's industrial base and foster business creation and entrepreneurship among SMEs.⁴¹ Innovative models based on a closer relationship with customers, mass customisation, and the sharing, collaborative economy will not only accelerate circularity but the dematerialisation of our economy, making Europe less dependent on primary materials.⁴² It foresees the further development of a sound monitoring framework contributing to measuring well-being beyond GDP.⁴³

Creating new jobs

RECYCLING
creates an average of ten times more jobs than trash.

COMPOSTING
creates at least twice as many jobs as landfills.

REUSE
creates as many as 30 times more jobs than landfills.



Selected cities for the EU mission towards 100 climate-neutral cities

On 28 April 2022, the EU Commission announced the 100 participating cities which will receive its support in achieving the goal of Climate-Neutral and Smart Cities by 2030. Cities play a vitally important role in achieving climate neutrality by 2050, the goal of the European Green Deal. They take up only 4% of the EU's land area, but they are home to 75% of EU citizens. Furthermore, cities consume over 65% of the world's energy and account for more than 70% of global CO₂ emissions.

Our concept image of the circular city is consistent with EU's major initiative for 100 climate-neutral cities by 2030:









- Co-living and multi-purpose buildings, activating unused space.
- Consider the concept of urban planning as analogous to an ecosystem's metabolism.
- Enhanced and shared walking and cycling facilities. Most of these facilities will be equipped with solar panels and photovoltaic cells capable of generating renewable energy.
- Engineered water and wastewater solutions that combine urban design and biology, creating urban symbiosis.
- As much as 90-100% of buildings and materials in the cities remains preserved and untouched.
- Every city should have its own material bank and resource flow mapping.
- Youth are included and have an important say in urban planning.



 **EU Cities**



Cities from associated countries

-  **Albania**
Elbasan
-  **Israel**
Eilat
-  **Montenegro**
Podgorica
-  **Turkey**
Istanbul
Izmir
-  **Bosnia**
Sarajevo
-  **Iceland**
Reykjavik
-  **Norway**
Oslo
Stavanger
Trondheim
-  **United Kingdom**
Bristol
Glasgow

The pioneers

Tools enabling circularity

Sweco RECLAIM (Recovery Long-term Asset Inventory Management) is a prototype programme in the Netherlands that predicts the demolition of buildings within the next 10 years. The objective is to visualise a potential material bank within a geographic area, such as a city. Through projection into the future, it gives designers more time to investigate materials and possibly work them into new projects. It essentially enables cities to be regarded as material banks which can be redeployed elsewhere, using digital processes and flows in and around the city system.

Circular cities as carbon sinks

C3, or the Carbon Cost Compass, has been developed by Sweco to help planners make decisions that will have major cost, material and climate impact implications. It identifies cost and climate impacts in new property projects, thus enabling cities to visualise such impacts, steer activities towards more circular methods, and achieve optimal results for the whole lifecycle of new developments.

Creating product banks

Loopfront is Norway's largest circular platform for building materials and interiors, from both the construction and demolition industries.⁴⁴ Before digital platforms like this,

digitalised material inventory reports were not possible. By digitalising the process via an inventory app and then publishing the resources to a website, the resources are made available and accessible to everyone in the city. The app is synchronised with Loopfront's product bank, which provides key figures for climate savings when reusing inventory products. The data can also be made public, which has been a way to nudge new stakeholders to be part of the platform.

Making material recycling possible – anywhere

The second tool we want to highlight is Trashpresso. This machine compacts the recycling process into three steps: size reduction, purification and reshaping. Trashpresso overcomes the distance and energy barriers by showing that slowing down, regeneration, recycling and reuse are possible everywhere.⁴⁵ Putting this in a city perspective would save a lot of waste and a lot of space. Although it operates at a smaller scale than a traditional plant, Trashpresso can still recycle up to half a tonne of plastic waste a day. This is equivalent to the consumption of a 10,000-strong community, according to the company behind the invention, Miniwiz. So far, Trashpresso has been operating in London and Milan, but has not yet been used in any of the Nordic countries.⁴⁶



Making symbiosis happen in Finland

A key goal in Alholmen Industrial Park is zero waste to landfill by 2030. The park comprises nine industrial and 53 service companies, directly employing almost 2,000 people. The purpose and objective of the analysis was to map the current state of the park's material flows and interactions, outline potential future directions, and identify actions that would mark the start of a transformative journey towards greater circularity Sweco was involved as a contractor undertaking the mapping and circular assessment. This assessment was based on information provided and interviews of companies based at the park. The exercise

identified a number of actions that were needed, including an anchor organisation, a coordinator or orchestrator for symbioses and projects, collaborative partnerships, and a common development framework using agreed ambitions and indicators of success for all the organisations.

Image: Jakobstadsregionens Utvecklingsbolag Concordia Ab

Client: Jakobstadsregionens Utvecklingsbolag Concordia Ab

Location: Jakobstad, Finland

Role of Sweco: Contractor undertaking the mapping and circular assessment

Alholmen Industrial Park circular economy assessment. Jakobstad region, Finland.



In Alholmen Industrial Park a key goal is zero waste to landfill by 2030.



Eco-terraces contributes to a green and inclusive city. Illustration: Sweco Architects.

Steps towards a circular economy at city district level

The City of Gothenburg and its real estate subsidiary Älvstranden Utveckling know well how the circular economy impacts urban development. After all, they are partners in Sharing Cities Sweden, a national programme on the role of the sharing economy in speeding the climate transition in cities during 2017-2021.

To better understand the mechanisms that can foster stakeholder interaction and generate street-level activity and urban identity through non-commercial means, Sweco Architects was commissioned for a study. The result is a work model for urban symbiosis and circular economy in seven steps, with examples of how to share resources, services (skills/time), data and surplus energy in a city district through community-building and stakeholder interaction.

Client: Älvstranden Utveckling AB

Location: Gothenburg, Sweden

Role of Sweco: Research and Innovation within the framework of Sharing Cities Sweden, funded through Vinnova, the Swedish Innovation Agency and Viable Cities.

Features in the circular neighborhood

- **Subscribe to your neighbourhood!**
Share services and resources, such as education, food and mobility.
- **Eco-terraces lay the foundation for a green and inclusive city.**
Promote biodiversity, rainwater reuse, urban farming and meeting places.
- **A common neighborhood currency.**
A common local currency or a point system makes it possible for both money and labour to function as means of payment. You can therefore choose to use money or your sustainability points to use services offered in the neighbourhood.

Accelerating the transition to a climate neutral Leuven through collaborative partnerships and innovation.

The secret to Leuven's success is its radical embrace of the power of collaboration. In Leuven, people work together and form a thriving innovation ecosystem, from government, academia, industry, and civil society. The city's approach involves empowering isolated initiatives by facilitating their collective organisation towards a common vision in order to tackle challenging issues like climate change.

Evidence of Leuven's culture of collaboration can be found in the way its city-wide climate network Leuven 2030 drafted and is implementing its Roadmap 2025 · 2035 · 2050, a comprehensive document laying out what is needed to reach climate neutrality.

The Roadmap consists of 13 programmes. The Circular Economy Programme, Leuven Circulair, is structured around five strategic objectives:

- 1 Circular entrepreneurship in Leuven
- 2 Circular construction
- 3 Repair, share and reuse
- 4 Sustainable and circular consumption
- 5 Data, monitoring and policy

For each objective, targets and actions are set out and defined in close collaboration with key stakeholders, united in the Leuven Circular platform.

The focus for Leuven is on upscaling to generate maximal impact by facilitating new local value chains in a systemic approach while engaging citizens to be actively involved in the transition. Developing of the Circular Economy monitor and leveraging the city's own policies, such as procurement and building regulations, remain high on the agenda.

In 2020, Leuven won the European Capital of Innovation Award. Recently, it was nominated by the European Commission for the mission '100 Climate-Neutral and Smart Cities by 2030'.

With Leuven Circular we are creating a context in which citizens and stakeholders are fully empowered to contribute to the shared dot on the horizon: becoming a climate-neutral city. Key in our approach is radical collaboration, learning by doing, storytelling and impact.

David Dessers, alderman for Circular Economy, City of Leuven



Image: Leuven City Center_Rector de Somerplein © KEV&CAM

UN17 Village

A project with a unique approach to sustainability that will set new standards for sustainable construction. UN17 Village in Ørestad, in southern Copenhagen, will be the first project ever to incorporate all of UN's 17 sustainable development goals into concrete actions in one building project.

A beacon for sustainable housing

UN17 Village will be constructed in reused building materials with a minimum of degasification. When the project is completed, it will meet some of the highest standards for achieving physical and mental health. UN17 Village fits in the narrative of the city as a resilient ecosystem, since it will use 100 % renewable energy sources and be able to collect 1.5 million litres of rainwater per year for recycling and recreational use. In addition, UN17 Village will further develop the area's landscape qualities by focusing on the recreational use of water, planting, biodiversity and wildlife.

Sweco is involved as architects in the UN17 Village project. The village covers an area of 35,000 sqm, and a diverse range of 535 homes will house 1100 people, meeting the highest standards for social, economic and environmental sustainability. The project is a laboratory for creating and sharing circular building solutions of the future based on the UN SDGs.

To implement the sustainability goals, the project grouped them into six key areas: biodiversity, community, health, materials, water and energy. 300 sustainability initiatives were discussed during development, of which 200 were implemented.

Savings resulting from the project include 320 tonnes CO₂e from using a lightweight, biobased facade instead of concrete, 130 tonnes CO₂e from using lightweight wooden interior walls instead of concrete, and 157 tonnes CO₂e by using wooden floor separation instead of concrete.

Client: NREP
Designer/Architect: Lendager, Sweco, SLA
Location: Ørestad, southern Copenhagen
Role of Sweco: Architect

Thinking through the innovation process and knowing that this is not going to be a normal project is important.

Martin Schultz Nielson, Investment Lead, UN 17 Village, NREP





Børnehuset Svanen

Børnehuset Svanen will be the world's first circular kindergarten – a children's house for the future based on the past and a pioneering project for sustainability.

The school is being built as a circular building, where part of the materials from the former Gladsaxe School are recycled, minimising waste volumes and reducing CO₂. Sweco was involved as architectural and landscape architect consultant in this project.

This solution redefines today's construction methods and is an inspiration for the future. It is a beautiful meeting

between architecture and a visionary municipality. It shows what a government agency can achieve if it is willing to fight for the right solutions. It shifts the bar for what is possible in a municipal urban context and gives an entire area a new image, in the words of its nomination for the Danish Design Award 2021.

Client: Gladsaxe Kommune

Designer/Architect: Sweco Architects Denmark

Collaborators: NIRAS, Tscherning, Ason A/S, Aksel V. Jensen A/S
Rådgivende ingeniører and Lendager

Location: Gladsaxe, Denmark

Role of Sweco: Architectural and landscape architect consultant

Lessons learned from circular cities

To highlight the urgency, some EU member states have begun to formulate government plans for the circular economy.¹

- 20 of 27 EU member states have a government plan for the circular economy.
- 26% of them were published in the past two years.
- 58 % of them were published in the past year.

Two European cities, Amsterdam and Glasgow, have collaborated with stakeholders to make progress on implementing their own successful circular economy strategies.³

AMSTERDAM

When it comes to transitioning to a circular economy, Amsterdam is a global leader.⁴ In 2017, the city received the World Smart City Award thanks to its pioneering approach to circular development, particularly its efforts to generate electricity locally, reduce fuel consumption and recycle waste more efficiently.⁵

Value sharing

As with any economic transition, businesses and institutions must be able to take an active role in the circular transition process. The City of Amsterdam serves as a facilitator, creating the right conditions for development, accelerating research and data acquisition, and working together with businesses and partners like the Amsterdam Institute for Advanced Metropolitan Solutions and the Amsterdam University of Applied Sciences.⁶

Circular neighbourhoods

Amsterdam's city government has also decided to make circular, innovation-oriented purchasing the new standard. For example, the rapidly developing area of Buiksloterham will be fully circular. The district will feature a biodigester, which will be maintained by the Waternet network. In this way, Buiksloterham will serve as a test case for how to maximise the recovery of energy (gas and heat) and resources from wastewater. There are also many other, smaller-scale circular initiatives throughout the city. For example, the Betondorp ('concrete village') area was recently renovated using recycled concrete.⁷

More uphill than expected

A recent study showed that actual material use in Amsterdam is 61 times higher than previously thought. Material use is currently still increasing, and a trend reversal is needed to achieve the goal of using 50% less primary abiotic material by 2030. In addition, new estimates suggest that the ecological impact of material use is greater than previously thought. The CO₂ emissions from consumption (scope 3) outweigh all other types of emissions in Amsterdam. At the same time, support for solutions is strong among the people of Amsterdam.

GLASGOW

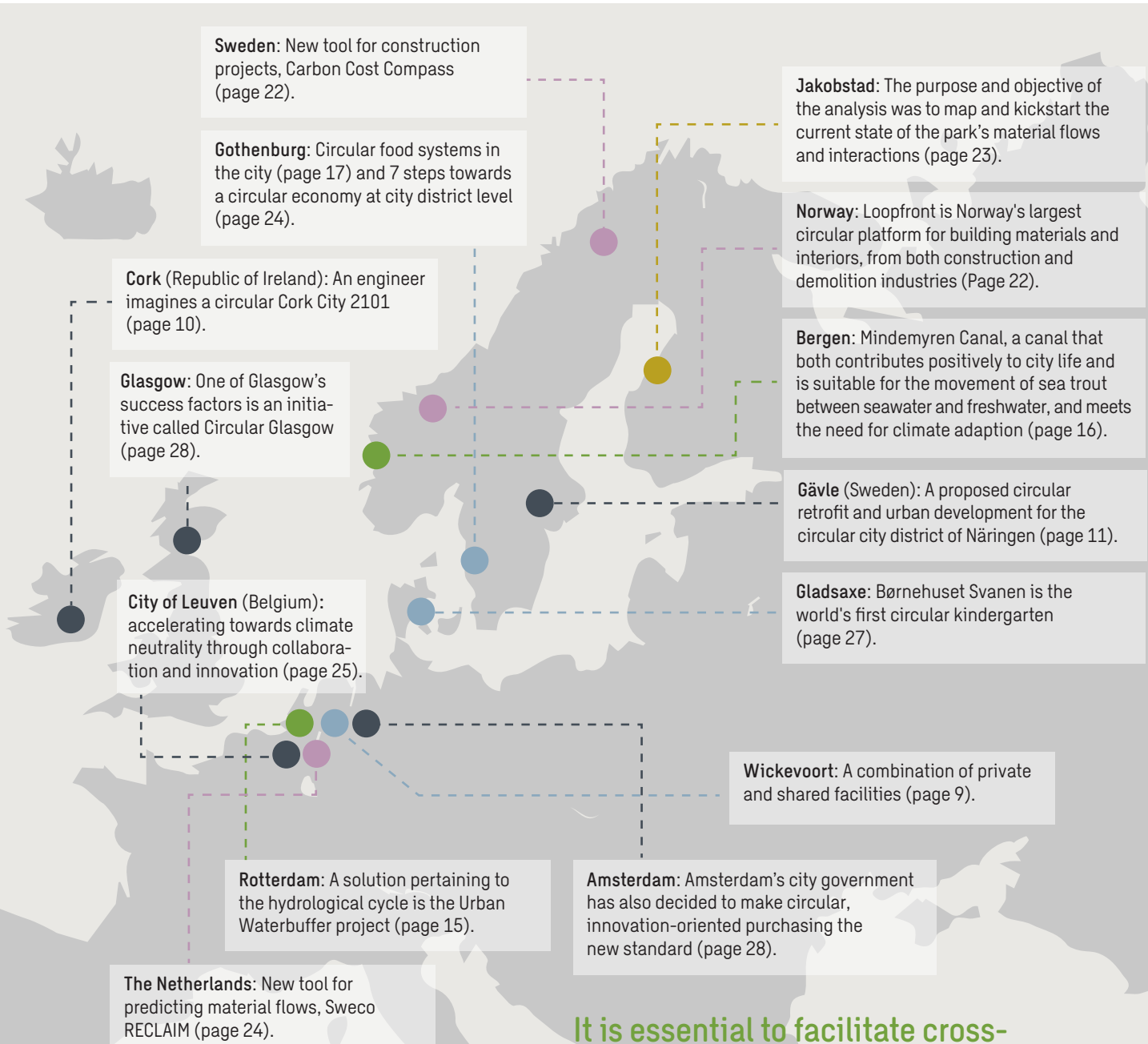
The city of Glasgow is addressing the complex issues entrenched in the mindset of a throwaway society.⁸ The concept underpinning the circular economy is not a new one: "making things last" and "mend and repair" were common mottos of generations past. The principles of creating locally, extending the life of materials, taking care of and repairing items, and ultimately reusing wherever possible all support the city at its most basic level.⁹

Circular businesses as enabler

One of Glasgow's success factors is an initiative called Circular Glasgow. The initiative emerged from the Glasgow Chamber of Commerce, working alongside key partners Zero Waste Scotland and Glasgow City Council. Open to businesses of any size, it is a network whose members share ideas about how to develop businesses across the city interested in how a circular economy can support business growth and climate change targets.¹⁰ Its circular advantage payback for businesses and society is expressed in four benefits: reputation, revenue, resilience and relationships.

EUROPE

In April 2022, the European Commission announced 100 cities participating in the EU Mission for climate-neutral and smart cities by 2030. These cities can use the checklist as one of the tools to accelerate the needed transition.



Sweden: New tool for construction projects, Carbon Cost Compass (page 22).

Gothenburg: Circular food systems in the city (page 17) and 7 steps towards a circular economy at city district level (page 24).

Cork (Republic of Ireland): An engineer imagines a circular Cork City 2101 (page 10).

Glasgow: One of Glasgow's success factors is an initiative called Circular Glasgow (page 28).

City of Leuven (Belgium): accelerating towards climate neutrality through collaboration and innovation (page 25).

Rotterdam: A solution pertaining to the hydrological cycle is the Urban Waterbuffer project (page 15).

The Netherlands: New tool for predicting material flows, Sweco RECLAIM (page 24).

Jakobstad: The purpose and objective of the analysis was to map and kickstart the current state of the park's material flows and interactions (page 23).

Norway: Loopfront is Norway's largest circular platform for building materials and interiors, from both construction and demolition industries (Page 22).

Bergen: Mindemyren Canal, a canal that both contributes positively to city life and is suitable for the movement of sea trout between seawater and freshwater, and meets the need for climate adaption (page 16).

Gävle (Sweden): A proposed circular retrofit and urban development for the circular city district of Näringen (page 11).

Gladsaxe: Børnehuset Svanen is the world's first circular kindergarten (page 27).

Wickevoort: A combination of private and shared facilities (page 9).

Amsterdam: Amsterdam's city government has also decided to make circular, innovation-oriented purchasing the new standard (page 28).

It is essential to facilitate cross-sector collaboration.

Marion Guenard, Senior Officer, Circular Development, ICLEI

How do we scale the activity that we are seeing? Bold leadership will be critical for moving from urgency to agency.

Alison McRae, Glasgow Chamber of Commerce

- Mindset shift
- Ecological resilience
- Track, trace and connect
- Government measures
- Systemic design thinking

The next steps

For fifty years now, Earth Overshoot Day has marked the date when humanity's demand for ecological resources exceeds what the earth can regenerate in that same year. We hope that with this report, we have inspired you to take the recommended pathways to become a circular city and help make Earth Overshoot Day obsolete.

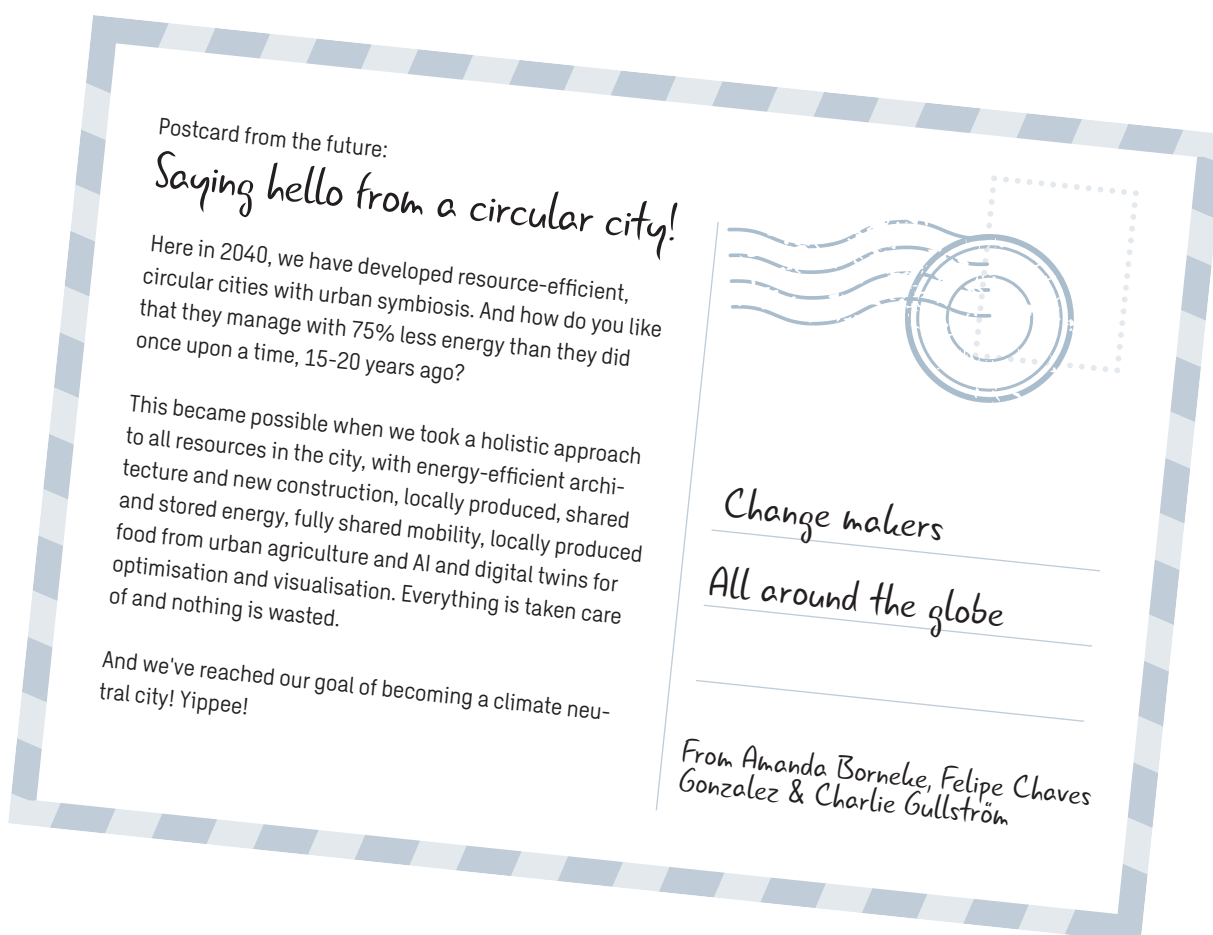
From refuse to reuse and recycling

We highlight the importance of a holistic approach to the transition in complex systems like our urban environments. By taking a broader perspective, you can leverage a greater variety of opportunities that can function in tandem with the transition. It is fundamental to address distinct contexts and scales, different resources and stakeholders, and the multiple circular strategies that can be adopted, from refuse to reuse or recycling.

Approaches for creating circular cities

Throughout this report we present strategies, actions, tools and references that offer a range of holistic approaches for creating circular cities and reveal processes that are often neglected in technology-oriented development. These approaches can address several parts of a resource lifecycle to reduce the need for primary materials and cycle our waste streams through innovative ways of living, planning and building.

Examples include shared spaces, infrastructure and services; ecological infrastructure that highly values ecosystem services and is a natural part of the urban fabric; social accessibility and empowerment opportunities derived from circular initiatives and processes; and digital tracking and tracing of material flows through monitoring platforms that can manage the circularity of resources and the multistakeholder network.





Behavioural changes

We must carefully consider strategies that address behavioural changes, such as a willingness to share spaces, resources and infrastructure instead of individual ownership (to “narrow down” resource consumption). Instead of short-term plans, we should envision future-proof strategies that can extend our use of resources, such as modular design, cradle-to-cradle, and processes that facilitate reuse, repair and remanufacture (to “slow down” resource usage). Alternative and regenerative resources should be explored to limit extraction of primary materials, such as water reuse, renewable energies and urban mining, which sources materials from construction and demolition (to “regenerate” resources and natural systems).

Collaboration within the multistakeholder network

Lastly, the connection between resources and stakeholders throughout the system has to be well coordinated in order to close cycles – strategies here rely heavily on collaboration within the multistakeholder network where synergies can be explored. To this end, digital tools and platforms as well as mapping instruments should be developed to facilitate coordination of data among stakeholders, for example for residual energy exchange, material reuse and recycling and other uses (to “cycle” resource flows). To achieve a real transition

we need to move away from individual interventions towards coordinated action that can promote systemic synergies. We need to address the transition as a multi-stakeholder process that considers and integrates different stakeholders.

Together, we can shift from urgency to agency, paving the way for European cities to achieve circularity. To show the huge potential of a fully circular city we have shared our unique calculations for a mid-sized Swedish city in 2040 where urban symbiosis cuts its current total energy needs by 75% .

Along the way, best practices, case studies and guides are presented to support cities in replicating good practices and enabling them to work together to overcome barriers. Together, we can develop and deploy solutions and become early adopters of the policies and practices to get to climate neutrality. This is how we avoid Overshoot day, and design cities for what we now refer to as ‘circulents’.

‘Consumers’ consume goods, often with a sense of finality. But ‘circulents’ participate in circular activities, such as sharing and reuse.

Checklist – start designing your circular city

■ Mindset shift – The city as a shared space

Address lifestyle, information and social responsibility. Instead of waiting for someone else to take action, ask yourself "how can I help?" We need a shift in our consumption and production patterns – from a focus on doing less harm to creating added value. See yourself as a circulent rather than a consumer.

ACTIONS

- Create knowledge exchange events for educational outreach
- Promote shared services (utility infrastructures, mobility, goods) and spaces (living and working facilities)
- Promote reuse before constructing new structures, by incentivising the adaptation of existing buildings and infrastructures

■ Ecological resilience – The city as a resilient ecosystem

Develop nature-based solutions that regenerate natural systems in order to increase the capacity of our environment. This mitigates climate hazards and promotes health and well-being in cities.

ACTIONS

- Regenerate natural systems and expand ecological structures through the urban environment
- Use ecological systems as urban infrastructure for provisioning, regulating and providing cultural services
- Promote bio-materials

■ Track, trace and connect – The city as a driver of change

Monitor and manage material flows, and facilitate stakeholder engagement among different industries, locations and scales. Digital tools and platforms can facilitate real-time mapping of resource flows and help to determine context-specific alternatives for waste reduction, such as to narrow, slow, regenerate and cycle resources.

ACTIONS

- Create a platform that connects stakeholders so they can track, trace and monitor material flows through the city
- Develop tools to map, measure and monitor resource availability within the city, region or country
- Design benchmarking tools and indicators to assess and evaluate the progress of actions

■ Government measures – The city as a facilitator

Regulate and facilitate the implementation of a circular system through policies and instruments, from top-down to bottom-up approaches. Legislation, subsidies and innovative business models incentivise and promote the implementation and management of circular strategies.

ACTIONS

- Put regulations in place for controlling waste production and incentivise circular resources
- Create innovative instruments for institutional, knowledge and financial support of circular practices
- Work out a circular economy roadmap at the city or regional level to define the contextual strategies for your specific location

■ Systemic design thinking – The next steps

Take a systemic approach to design, from local to regional scales, and envision how to integrate individual stakeholders, spatial components and resource flows. From underground to above-ground infrastructure, open spaces and buildings, the spatial layers must enable synergies between resource flows and the relevant end users and stakeholders.

ACTIONS

- Think through scales – from local to regional
- Incentivise stakeholder engagement
- Promote circular area developments (neighbourhoods and districts)

About the authors

Feel free to contact us with your questions and thoughts.

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Amanda Borneke is a circular economy specialist and sustainability consultant based in Sweden. She is passionate about making cities for circulents and not for consumers. Amanda has been involved with a wide range of projects in circular transformation including offices, residential and industrial developments. Her focus is on transforming city planning to fit both people and the planet. She is a Certified Circular Leader by Regeneration 2030 and received the Clarence-Moberg Award of 2021.



Felipe Gonzalez is an architect and urban designer. He is currently the Local Expert Leader in Circular Economy, Sweco Belgium. Experienced in addressing complex urban and societal issues in different locations around the world, he specialises in inclusive urbanism, circular economy, systemic thinking, and spatial economic planning. Felipe promotes circular and systemic thinking by exploring the relationships between spatial conditions, resource flows and the relevant stakeholders, transitioning from local to regional scales.



Charlie Gullström is Research and Innovation Lead at Sweco Architects, Sweden. She is an architect and a researcher with expertise in circular cities, urban innovation and the sharing economy. Current projects explore stakeholder collaboration and circular economy models at neighbourhood scale, to facilitate shared assets and resources and reduce energy use, through urban symbiosis. She uses value-based methodologies and participatory design to support cities in achieving climate neutrality hand in hand with social sustainability goals, as part of the EU's Cities Mission 2030.



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AIFOOD Study

The calculations for a circular city 2040 were carried out as part of the project [AIFOOD](#) – AI for a sustainable food chain from farm to fork, funded by Vinnova, the Swedish Innovation Agency.

Contributing experts

The 2040 City study was led by Charlie Gullström and a multidisciplinary team of Sweco experts in architecture, urban design, mobility, energy and urban food production: Anna Hessle, Christina Englund, Karin Hurtig, Carlos Viktorsson, David Lindelöw, Isak Eklöv, Martin Bringner, Magnus Lindén and Fredrik Karlsson in collaboration with Swegreen, a Swedish urban tech company.

References

Literature, Data and Statements

- 1) IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.
- 2) World Resource Institute (WRI), 2021: How the Circular Economy Can Help Nations Achieve Their Climate Goals. van Veldhoven, S. Schmidt, C. November 5, 2021.
- 3) Natural Footprint and Biocapacity Accounts, "2022 Edition".
- 4) Earth Overshoot Day, "Country Overshoot Days".
- 5) Ellen MacArthur Foundation, Universal Circular Economy Policy Goals (2021): Wed, 27 Jan 2021.
- 6) Ellen MacArthur Foundation, The Nature Imperative: How the circular economy tackles biodiversity loss (2021): Tue, 07 Sep 2021.
- 7) European Commission - Competence Centre on Foresight. (2022-04-27). Urbanisation in Europe.
- 8) European Commission - Competence Centre on Foresight. (2022-04-27). Growth of Asia and Africa urban population:
- 9) OECD (2020), The Circular Economy in Cities and Regions: Synthesis Report, OECD Urban Studies, OECD Publishing, Paris.
- 10) World Bank (2010), World Development Report 2010.
- 11) IEA (2016), "Cities are in the frontline for cutting carbon emissions", International Energy Agency.
- 12) UNEP (2013), UNEP-DTIE Sustainable Consumption and Production Branch, United Nations Environment Programme.
- 13) FAO (2020), Urban Food Agenda, Food and Agriculture Organization.
- 14) OECD (2012), OECD Environmental Outlook to 2050: The Consequences of Inaction, OECD Publishing, Paris.
- 15) Circle Economy. (2022). The circularity gap report 2022. Amsterdam: Circle Economy.
- 16) Pappas, S. (2020, December 9). Human-made stuff now outweighs all life on earth. Scientific American.
- 17) Ellen MacArthur Foundation, Cities and Circular economy: Why are cities important in the transitioning to circular economy? (2022-04-27).
- 18) Drift for transition: Resources and circularity (2022-04-27).
- 19) Gehl, J. Rogers, R. 2009. Cities for People. Publisher: Washington (DC); Covelo. Island Press, London.
- 20) Lanxmeer, EL. 2022. Interview with the district Eva Lanxmeer from the Dutch research team. Interviewed by Romy Mathot and Marieke Koomen.
- 21) Lombard Odier, The 10 steps to a circular economy: Rethink (2022-04-27).
- 22) Lombard Odier, The 10 steps to a circular economy: Repurpose (2022-04-27).
- 23) Maakoosterwold, nieuws: Sweco project Oosterwold wint omgevingswet trofee (2022-04-27)
- 24) Bouwfonds Gebiedsontwikkeling, Hoe willen millennials en starters écht wonen? (2022-04-27).
- 25) Bajeskwartier, duurzaam: Sustain the sustainable (2022-04-27).
- 26) Sweco, the Netherlands: actueel Sweco project Oosterwold (2022-03-21).
- 27) Wickevoort, Wickevoort project: Samen genieten van Landgoed Wickevoort (2022-04-27).
- 28) Sweco, The Netherlands: Stadswijk Bajeskwartier (2022-04-27).
- 29) Sweco, Urban Insight: Expert interview about increased sustainability (2022-04-27).
- 30) Global Footprint Network. (2021). Nowcasting the World's Footprint & Biocapacity for 2021 (Report title and report number).
- 31) Millenium Ecosystem Assessment. Ecosystems and Human Well-being: Synthesis. 2005. Island Press: Washington, DC.
- 32) TEEB, The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations, ed. P. Kumas. 2010, Earthscan, London and Washington.
- 33) Urban Waterbuffer project, KWR: <https://www.urbanwaterbuffer.nl/>
- 34) KWR. (n.d.). The Urban Waterbuffer.
- 35) Urban Waterbuffer: Integrated solution for flooding and drought in the city.

- 36) European Commission, Buildings and construction (2022-04-27).
- 37) Cambridge Econometrics, Trinomics, and ICF (2018), Impacts of circular economy policies on the labour market.
- 38) World Bank (2018), What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. COM(2019) 640 final.
- 39) European Commission, The EU green deal (2022-04-27).
- 40) Sweco, Urban Insight: Report 1 – Towards Circularity (2022-07-16): <https://www.swecourbaninsight.com/building-the-future-through-circular-data-tools-for-mining-the-green-gold/>
- 41) European Commission, The benefits of the European Green Deal (2022-04-13).
- 42) European Commission, Delivering the European Green Deal (2022-04-02).
- 43) European Commission, Renovating buildings for greener lifestyles (2022-04-13).
- 44) Loopfront, Vi gjør det enkelt å samarbeide med andre aktører: Hvordan fungerer det? (2022-04-27).
- 45) MINIWIZ, Upcycled goods: Solution (2022-04-27).
- 46) Borneke, A. 2022. Literature study: Government plans in circular economy within EU. Sweco Urban insight.
- 47) Eurocities, Cities: Amsterdam (2022-04-27).
- 48) Eurocities, Cities: Glasgow (2022-04-27).
- 49) Circle economy, Developing a roadmap for the first circular city: Amsterdam (2022-04-27).
- 50) City of Amsterdam, Policy: Circular economy (2022-04-27).
- 51) Gemeente Amsterdam. 2016. The Circular Innovation Programme 2016-2018, INNOVATIE & CIRCULAIR. R uimte en Duurzaamheid, Economie, Facilitair Bureau, Ingenieursbureau, Grond en Ontwikkeling, Ruimte en Duurzaamheid en CTO office.
- 52) Gemeente Amsterdam. 2016. The Circular Innovation Programme 2016-2018, Strategie. R uimte en Duurzaamheid, Economie, Facilitair Bureau, Ingenieursbureau, Grond en Ontwikkeling, Ruimte en Duurzaamheid en CTO office.
- 53) Ellen MacArthur Foundation, Circular examples: The business community kickstarting circular cities and regions in Scotland (2022-04-27).
- 54) Glasgow City Council. 2020. Circular Economy Route map for Glasgow 2020-2030.
- 55) Circular Glasgow, The Circular Economy and Net Zero (2022-04-27).
- 56) World Economic Forum, The Future of Nature and Business, <https://www.weforum.org/press/2020/07/395-million-new-jobs-by-2030-if-businesses-prioritize-nature-says-world-economic-forum/>

Urban Insight

By Sweco

Urban Insight by Sweco is a long-term initiative that provides insights about sustainable urban development, seen from a citizen's perspective. The initiative is built on a series of reports, based on facts and research, written by Sweco's experts. The initiative provides society and decision-makers with facts needed to understand and meet current and future challenges.

This report is part of a series of reports on the topic Action Towards Circularity in which our experts highlight specific data, facts and science that are needed to plan and build safe and resilient future urban environments.

Find out more by visiting our website:
swecourbaninsight.com

Visualisation: Børnehuset Svanen in Denmark is the world's first circular kindergarten. Read more about the project in the report.