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# Closing the loop – the circular economy, what it means and what it can do for you

9 circular economy tools
70+ corporate case studies
Industry 4.0 outlook

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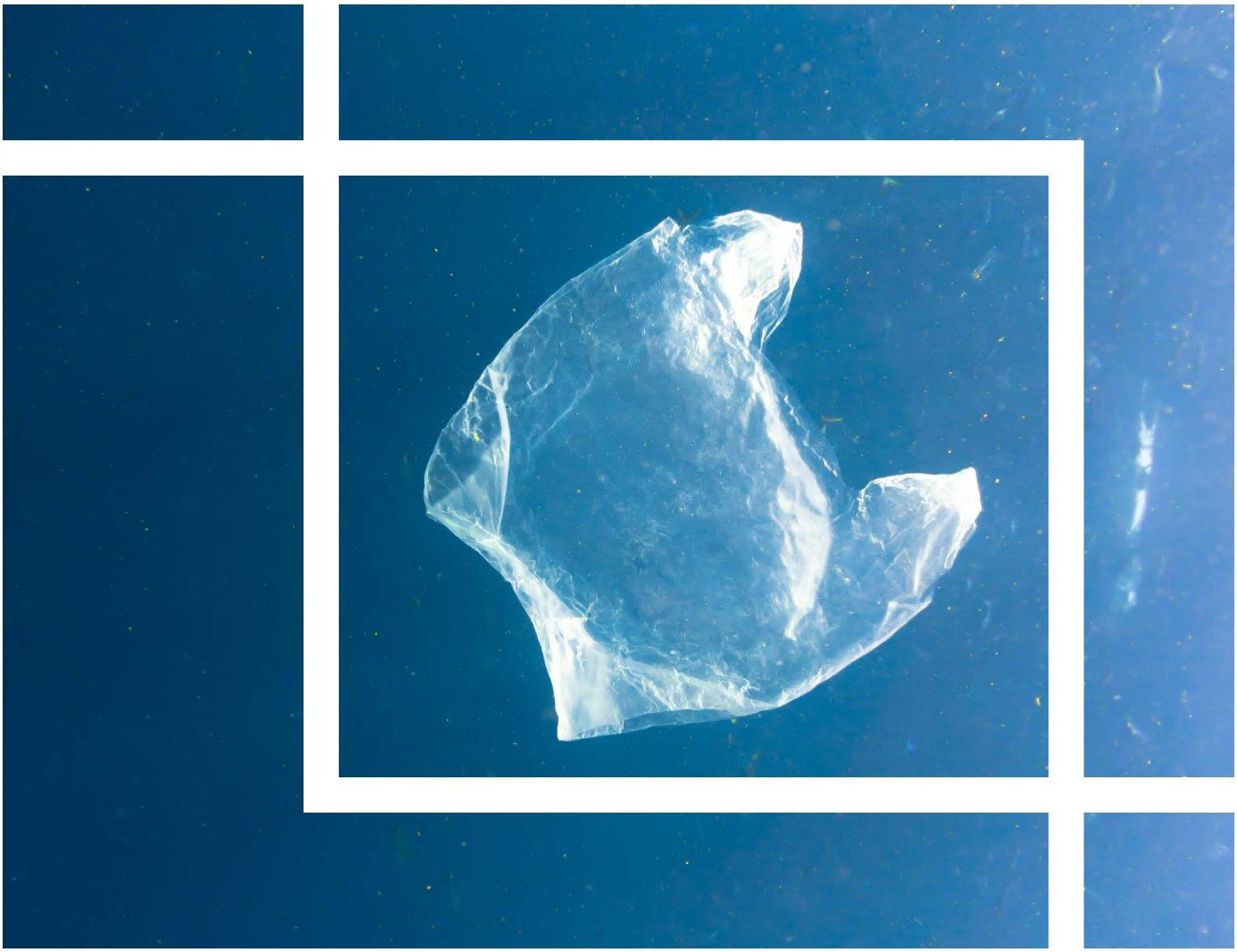
# Contents

# Introduction

Have you ever wondered what the world would be like without waste? Did you know that according to estimates, only 1 percent of materials used in manufacturing processes remain “in use” six months after the product is sold? So what happens to the remaining 99 percent? And did you know that almost half of the world’s top 100 companies have already adopted a concept that aims to ensure that the materials used by them remain constantly in use? The concept in question is the circular economy, which in response to new, sustainability-seeking consumers, the increasingly critical decline in stocks of raw materials, and the major new technological breakthroughs brought by the fourth industrial revolution, have filtered through from academic research projects into the strategies of large corporations in recent years. It’s no wonder that numerous governments, from China to Europe, are making efforts to assist the transition to a circular economy, both through subsidies and through legislation.

The circular economy is a system in which there is no waste, and where the products of today are also the raw materials of tomorrow. It is referred to as circular, because unlike today’s – usually linear – system, where we manufacture products, use them and discard them, in a circular economy the products don’t end up in the garbage, but are fed back – in their existing or processed form – into the manufacturing process. You may immediately think of recycling, selective waste collection and numerous other examples from recent years. These tools were certainly milestones in the development of our attitude towards waste, but – due to the degradation of materials over time, and the limited opportunities for use – they do not, in themselves, represent a complete solution. What is needed is long-term thinking, to ensure that we already know, during the process of product design, what will become of the product after the user discards it.



The circular economy, therefore, is more than just recycling. It is an economic model that spans supply chains and sectors, and redefines the process of product design, manufacturing and consumption, thus opening up new, unexploited (secondary) markets for companies. To let the examples speak for themselves, we will introduce local and international circular economy initiatives from 6+1 industries, seeking the answers to questions such as:

- What initiatives turned the world's second-most polluting sector, the textile industry into a pioneer of the circular economy?
- How is the food industry trying to prevent half of all food – or three quarters according to some estimates – ending up in the garbage?
- How can the ecological footprint of our electronic devices be reduced without having to forego the innovations offered by the newest products?
- What changes are affecting the automotive industry – an industry that uses 60 percent of the Earth's stocks of lead - and transportation in general?
- Is it true that "energy is not lost, but merely transformed" when applied to the operation of energy-sector companies?
- How can our built environment, our "products" with perhaps the longest life cycle – designed to last 50-100 years – be sustainable, and how can rubble be turned into a "palace" again?
- Are smart cities also circular cities?

In addition to presenting over 70 corporate case studies, we considered it important to highlight the way the technological solutions of the fourth industrial revolution are making circularity easier and quicker, and – with time – the norm.

Some of the issues we examine are

- How can waste be reduced and maintenance made more efficient with the Internet of Things (IoT) and data analysis?
- Can robots sort waste better than people?
- What changes will additive manufacturing and 3D printing bring in terms of material use?
- What is the current state of the art of materials technology in recycling?

We are not setting out to decide whether the circular economy is a passing fad, a utopian ideal or a new economic paradigm, but we do see that the idea of the circular economy, waste reduction and the more efficient use of resources, as a trend, is gaining more and more traction globally. Whatever the future brings, the companies presented in this publication demonstrate that the circular models, in addition to being sustainable, can also boost companies' efficiency, reduce costs, and stimulate R&D and innovation, giving the pioneers a competitive advantage. Will you be among them?

# The rise of the circular economy and its tools

## From sustainability to the circular economy

We leave behind an average of almost 560 kg of rubbish per person every year.[1] Whether or not we want to do something about this, the tasks ahead of us are far from simple. For years, we've been hearing in the media and in the workplace about sustainability, and the various initiatives driven by individual and corporate social responsibility, such as litter-picking, selective waste disposal or donations. While such initiatives might be capable of successfully solving one or two local problems, truly comprehensive sustainable solutions spanning multiple products and sectors require an approach with broader horizons.

The circular economy is one that integrates the tools mentioned above, propagates them at a systemic level, and takes them to a higher level. Its objective is to cut down on waste and the use of resources through the transformation of the products' life cycles.

In the circular economy there is no waste: today's products are tomorrow's raw materials. This creates a closed loop or cycle. Can this be achieved across the board? Is a 100% waste-free future possible? What is really circular, and what is just a marketing slogan? Is it circular to buy a Swiss watch that your grandchildren will also wear? If you compost everything? Or if you have your shoes repaired instead of buying a new pair?

Since there is no precise answer to most of the questions, we will do our best to present a selection of initiatives of a circular nature, and show how varied these initiatives are: some simple, some affecting a great many business processes, some confined to a single company and some spanning whole sectors, some that break waste down to its molecules, and some that sell the "waste" on after only minimal transformation.

There are many different interpretations of the circular economy, so it's not always possible to be certain what is circular and what isn't. Moreover, the issue has far-reaching implications – just take the differences in our resource, energy and waste management practices and their varied consequences: these aspects and related areas deserve a separate analysis of their own and thus are not examined in this publication. Rather than describing existing, established practices, our aim is to provide an overview of what kinds of new, innovative, forward-looking – and also circular or sustainable – solutions are gaining ground.

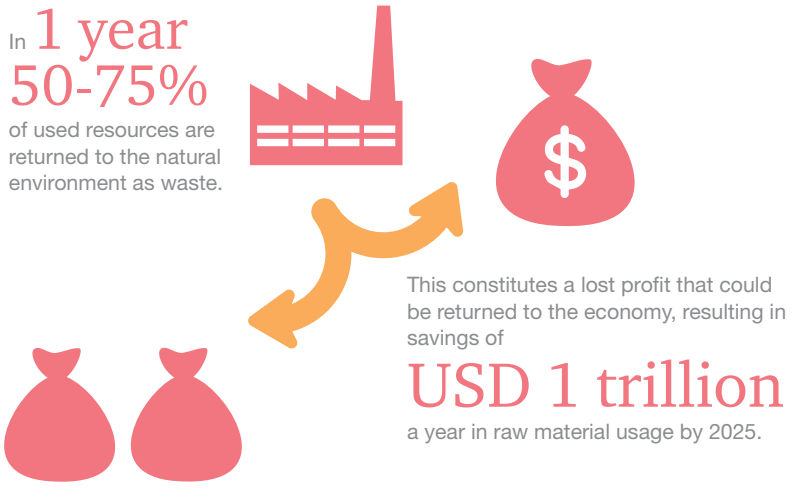
### Sustainability

We need to travel back in time three decades, to the UN's Brundtland Report of 1987, to find the first truly coherent definition of sustainable development:

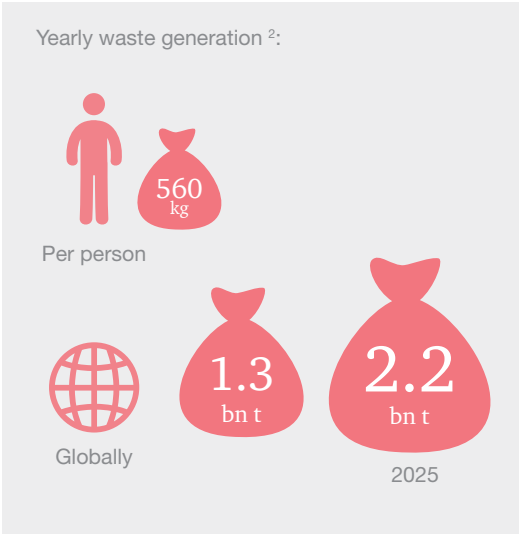
> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
>
> **Brundland Report, UN, 1987**

It is essential to treat sustainability as the sum of three closely interconnected areas, namely the economy, society and the natural environment. To achieve sustainability, these three areas must be in symbiosis, without having a harmful impact on one another. To put it another way, the main purpose of sustainable development is for social, economic and environmental development to reinforce each other, and for none of them to be detrimental to the two others.

1 The data is based on the per-capita waste generation of OECD countries in 2012




*Source: World Resources Institute (WRI)*




## CSR

Corporate social responsibility, or CSR, can also be a corporate vehicle for promoting sustainability, which ensures that, as well as their economic interests, companies also take the environmental and social impacts of their operation into account, and make efforts to reduce their negative impacts in these fields. A growing number of companies are proclaiming their commitment to sustainability, often in an institutionalised fashion, enshrined in their CSR or sustainability report.

*Ventures that are classed as business entities of interest to the public and exceed the threshold values defined in Section 95/C of the Accounting Act must prepare a "Non-financial statement", in which – among other aspects of their operation – they are required to disclose information relating to environmental, social and employment issues.*

*In June 2017, the European Commission took further steps to boost the sustainability of large corporations and transparency in this regard: Communication from the Commission 2017/C 215/01 – Guidelines on Non-Financial Reporting expresses the expectations with regard to the non-financial information disclosed in financial statements. The new regulations encourage corporations to disclose their ESG (Environmental Social and Governance) indicators in a way that makes them suitable for comparison, thus enabling a broader cross-section of society and decision makers to learn about the environmental and social impacts caused by corporations.*

**See: the paragraph of Section 96/C of Act C of 2000 (Accounting Act) relating to non-financial statements**

**The battle of the economies: linear versus circular**

All products have a lifecycle. During the first industrial revolution, this lifecycle became increasingly linear. In other words the economy produced raw materials, transformed them and then discarded them. The circular approach, by contrast, extends the lifecycle with methods that include the re-use, re-manufacturing or recycling of products. With the help of modern technology, circular economy is capable of creating added value and making economic processes more efficient. It uses solutions that allow companies to create added value with materials that had previously incurred costs for them as waste, and thus increases profitability as well.

The global megatrends – such as the shortage of resources, technical breakthroughs and the coming of age of new generations – are creating an environment in which it is considered wasteful for products to end up in landfills. Companies that recognise the unexploited potential in extending the lifecycles of products and materials will be able to enter new markets, save costs, and increase the trust placed in them by their consumers.

PwC Hungary is committed to a circular future – both in terms of our own processes and in the course of working together with our clients, we place particular emphasis on incorporating a sustainable approach to our business.

**Ádám Osztovits**
PwC Hungary
Partner, Advisory Leader

2 The data is based on the per-capita waste generation of OECD countries in 2012.

Consumers who are prepared to pay a higher price:

for products that are organic or made from 100% natural raw materials

42%

for products that are environmentally friendly or made from sustainable raw materials

39%

for premium-quality, socially sustainable products

31%

# The rise of the circular economy

The circular economy is not a new idea; it has been widespread in academia for decades now. The idea of decrease on the quantity of waste and resource usage has been in the public consciousness for a long time too, so why is the circular economy starting to really emerge only now?

There are three major trends behind the phenomenon, which together are the drivers of the circular economy:

1. changing consumer needs,
2. resource shortage,
3. technological breakthroughs.

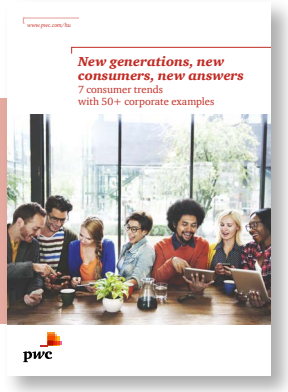
## 1. Changing consumer needs

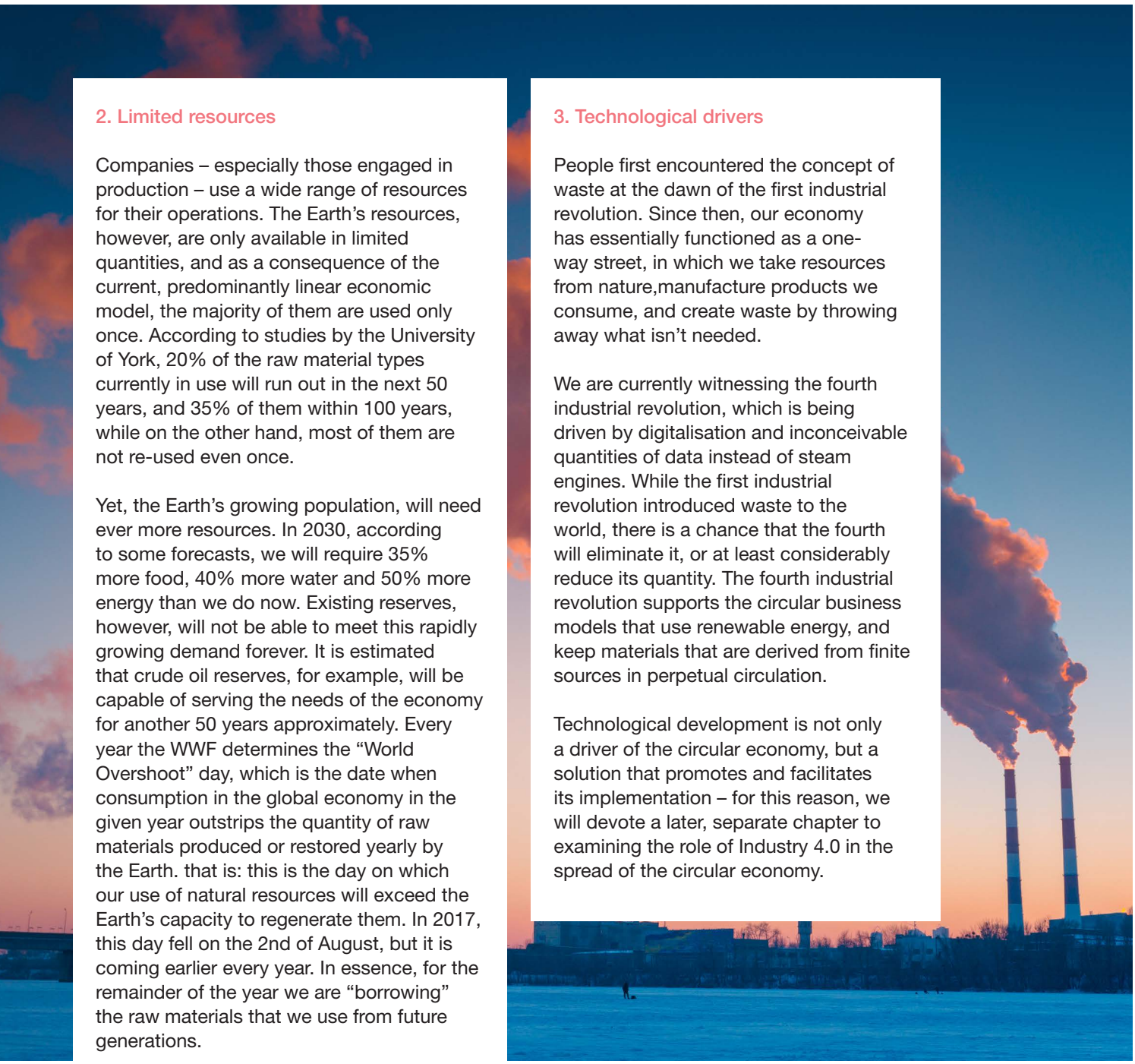
Numerous surveys have recently concluded that the degree of sustainability of a company's operations is increasingly important for consumers when making their purchases. According to Nielsen's 2016 global survey, 39% of respondents were prepared to pay more for products made from environmentally friendly or sustainable materials, and 31% for premium, socially sustainable products. Unilever's survey of 2017 reached a similar conclusion: one third of consumers take the brand's environmental and social impact into consideration when making purchasing decisions.

Sustainability is especially important for generations Y (20-35 years old) and Z (15-20 years old). The younger generations are increasingly making an effort to create value for the whole of society. Accordingly, they are no longer satisfied with impressive advertising slogans, but expect companies to back up their words with actions, and operate responsibly. They also pay far closer attention to the environmental performance of companies, both when purchasing products and when choosing an employer. This is crucial for companies, as these young people will make up the future cohort of adult consumers with purchasing power.

On the other hand, consumer preferences are also linked to the cost-cutting nature of the circular economy. Based on research by Euromonitor International, consumers are increasingly choosing methods that also happen to be environmentally friendly, such as sharing economy solutions, or the purchase of recycled, pre-owned or long-lasting products, because they allow them to save considerable costs.

**Recommended reading:** PwC's study entitled *New generations, new consumers, new responses* provides a detailed exploration of the new consumer trends shaping our purchasing decisions.





## 2. Limited resources

Companies – especially those engaged in production – use a wide range of resources for their operations. The Earth's resources, however, are only available in limited quantities, and as a consequence of the current, predominantly linear economic model, the majority of them are used only once. According to studies by the University of York, 20% of the raw material types currently in use will run out in the next 50 years, and 35% of them within 100 years, while on the other hand, most of them are not re-used even once.

Yet, the Earth's growing population, will need ever more resources. In 2030, according to some forecasts, we will require 35% more food, 40% more water and 50% more energy than we do now. Existing reserves, however, will not be able to meet this rapidly growing demand forever. It is estimated that crude oil reserves, for example, will be capable of serving the needs of the economy for another 50 years approximately. Every year the WWF determines the "World Overshoot" day, which is the date when consumption in the global economy in the given year outstrips the quantity of raw materials produced or restored yearly by the Earth. that is: this is the day on which our use of natural resources will exceed the Earth's capacity to regenerate them. In 2017, this day fell on the 2nd of August, but it is coming earlier every year. In essence, for the remainder of the year we are "borrowing" the raw materials that we use from future generations.

The steady decrease in the quantity of raw materials is not only problematic because of the shortage of resources, but also causes extreme fluctuations in raw material prices, which in turn affects companies negatively in financial terms. The average price of metals, for example, having remained constant throughout the 20th century, increased by 176% between 2000 and 2014. According to the World Economic Forum's survey, more than 20% of companies worry about the shortage of raw materials.

## 3. Technological drivers

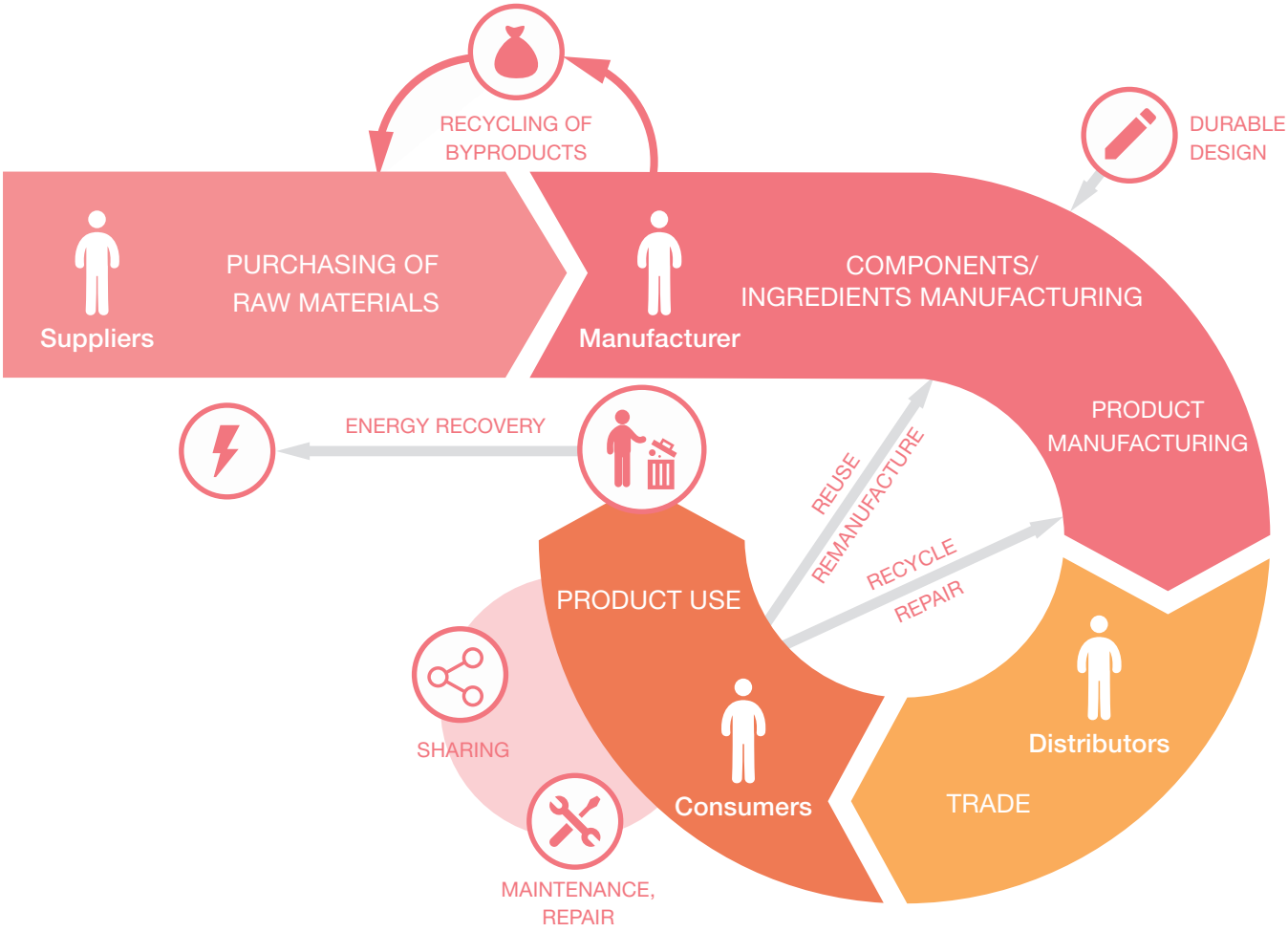
People first encountered the concept of waste at the dawn of the first industrial revolution. Since then, our economy has essentially functioned as a one-way street, in which we take resources from nature,manufacture products we consume, and create waste by throwing away what isn't needed.

We are currently witnessing the fourth industrial revolution, which is being driven by digitalisation and inconceivable quantities of data instead of steam engines. While the first industrial revolution introduced waste to the world, there is a chance that the fourth will eliminate it, or at least considerably reduce its quantity. The fourth industrial revolution supports the circular business models that use renewable energy, and keep materials that are derived from finite sources in perpetual circulation.

Technological development is not only a driver of the circular economy, but a solution that promotes and facilitates its implementation – for this reason, we will devote a later, separate chapter to examining the role of Industry 4.0 in the spread of the circular economy.

# Tools of the circular economy
## The circular economy – more than just recycling

It's easy to associate the circular economy with recycling, and recycling with the selective disposal of plastic, paper and metal waste. Although the spread of selective waste disposal is an important milestone on the path to a (more) waste-free world, in what follows we will demonstrate that the circular economy is about so much more than just recycling! What makes it more is that its tools are present throughout the value chain, from product design through the manufacturing process, to the way they are used by consumers. Moreover, these tools vary in terms of who is responsible for them within the value chain: the supplier, the manufacturer, the consumer – or possibly all of them together. Most of the tools are not new – their strength lies in the fact that they are used in concert by the participants in the value chain.



## **Tool:** Sustainable design

Sustainable design is the first step toward becoming circular and it means that enterprises take into consideration the whole life-cycle of their products, even during the planning phase, while choosing the necessary raw materials and functions. Moreover, they are striving to make its economic footprint as minimal as possible. There are three significant ways to do this:

- **Design of durable products** – design of products, which can be used for ages or even decades, owing to the high quality of the raw materials. The sales of these products requires a completely new positioning and marketing strategy for FMCG products.
- **Modular design** – the product is designed in a way that the components can be accessed and changed when there is a sudden failure.
- **Sustainable materials** – Usage of materials, which are extremely durable – so that customers don't need to purchase 10 products every 10 years, but only one – or sustainable, can be simply recycled and, in an ideal scenario, they are even biodegradable

**Player in the value chain:** manufacturer, product developer

## **Tool:** Sharing

It's been less than a decade since the sharing economy burst into public consciousness, together with companies like Couchsurfing, Airbnb or Uber, through which consumers are able to share their idle capacities with others via digital platforms.

The growth of the sharing economy, enabled by technological development, has also diminished people's need to own things – the advantages of use without commitment has come into the spotlight. Sharing-economy solutions reduce the quantity of waste by creating a situation in which – if the sharing actually takes place – fewer products are needed.

**Value chain participant:** consumer

**Recommended reading:** PwC's study entitled *Sharing or Paring? Growth of the Sharing Economy* explores this issue in greater detail.


## **Tool:** Maintenance, repair

The useful life of manufactured products that are already in use can be extended through maintenance and repair. The usefulness of a product can be preserved through maintenance, and restored with repair.

Maintenance is a deliberately structured, regular activity, during which critical points are inspected at periodic intervals, in order to prevent the occurrence of malfunctions or accidents. Industry 4.0 equips industrial appliances with sensors, so that maintenance and repair works can be scheduled to balance out the use of resources and maintain capacity at the highest level.

Maintenance services can also be leveraged by manufacturers: through the provision of after-sales services and the manufacturing of spare parts, up to three times more turnover from one-off sales can be achieved.

**Value chain participant:** manufacturer, consumer, merchant

### **Tool:** Renovation

By renovating used or in-use products, the original function and essential attributes will be retained, but the whole will be packaged in a "renovated dress". Similarly to repair, the objective is to restore the original use value, and in this case it takes longer.

Aesthetic renovations, such as house renovation, are also included in this category. The example illustrates well the purpose of the method: new facade evokes the original, novel condition, while retaining the original function.

**Value chain participant:** manufacturer

### **Tool:** Remanufacturing

The goal of remanufacturing is to extend the life-cycle of the product with using minimal resources. The minimum is to restore the original usage level, but often new products can be created during the process. What does this look like? The product is broken down into elements, those elements are reconditioned, and the process ends with reassembly. Technical design, quality control, and testing play significant roles in creating a new product, and recycling requires 85% less energy consumption than creating a new product, not to mention the reduced waste emission and raw material demand.

**Value chain participant:** manufacturer

### **Tool:** Recycling

We are all recycling through separated collection of paper and bottles. Just as the circular economy is more than recycling, recycling is more than separated waste collection. In the case of upcycling a totally different product is created than the original one, without breaking it down into elements - for example, furniture is made of an old skateboard. In contrast, during downcycling the material is broken down - in effect we can use it as a poorer material - for example clothes will become carpet.

**Value chain participant:** consumer, manufacturer

### **Tool:** Recycling during the manufacturing process

Recycling can also play a role in manufacturing: if by-products and scraps can't be avoided during the manufacturing process, there are several methods for using or reusing those materials as well.

**Value chain participant:** manufacturer

### **Tool:** Reuse

We are talking about reuse if the product - after the original user discarded it - finds a new owner. Although it is reusing as well when we give away our clothes - the realisation of reuse is market-based. Let's think of second-hand shops or used car dealerships etc. Technological development does not necessarily require distributors and warehouses with retail space: it is enough to create an online platform, where consumers can sell their old things (for commission).

**Value chain participant:** manufacturer, consumer, merchant

# Fortune Global 500 – how circular are corporations?

To determine how embedded the concept of circularity is in the day-to-day operation of corporations, we took a look at the first 100 companies in the Fortune Global 500 list. Some 89% of these corporations publish a sustainability report or an equivalent CSR report. Overall, these reports are scattered across a broad spectrum in terms of both their level of detail and their length.

Almost half of the corporations, at 44%, also had a circular economy concept or strategy in place. In contrast to the variability of the sustainability reports, the picture is more consistent when it comes to initiatives related to the circular economy: the corporations typically described the use of the circular economy tools at their disposal, the benefits of their use, and how they fit into their business model.

A comparison between the individual sectors reveals a mixed bag. In terms of initiatives related to the circular economy, fast-moving consumer goods (FMCG) manufacturers and vehicle industry companies are at the cutting edge, while the oil industry, financial services and health sectors are the least "circular"; although these sectors also have some exemplary corporations that embed the concept of the circular economy into practice.

## The financial sector and the circular Economy

A comparison of the individual sectors has highlighted another interesting phenomenon: the biggest contribution of financial service providers to the circular economy lies not in their own circular operation, but in the fact that they finance companies that are putting the principles of circularity into practice. The European Investment Bank has a particularly prominent role in the sector: during the past five years it has participated in the financing of projects related to the circular economy to the tune of EUR 2.4 billion. Besides this, the bank also supports small and medium-sized enterprises whose business models are based on the circular economy concept through the provision of technological and financial advice.

Figure 2
What can companies already on the path to circularity expect? Circular operation is more than sustainability, with its benefits realized in multiple business processes, in the short, medium and long term.


*PwC Global Sustainability Team, 2017*

# Industry ROUNDup

## Industrial symbiosis – connecting industries at new levels

One industry's waste could turn out to be another's raw material: while a company is unable to reintroduce its waste and byproducts into its own value chain, there might be companies in other sectors that can make use of it after minimal changes.  Research into how resource sharing and the flow of materials and byproducts between industries can be encouraged and implemented stretches back to the 2000s.

Industrial symbiosis is no longer just an academic theory with the potential to promote circularity, but a solution that is already being put into practice among corporations. International Synergies Ltd. has been working for a decade to catalyse industrial symbiosis between countries, cities and corporations, and they also have a presence in Hungary, working with the National Industrial Symbiosis Programme and IFKA Public Benefit Non-Profit Ltd. for the Development of Industry, in the context of the European Commission's Life+ environmental programme. Their objective in Hungary is to utilise industrial waste. To this end they hold workshops to identify the synergies between companies, after registering the resources used and the types of waste generated at these companies.

Industrial symbiosis can be achieved in an industrial park, where the companies are close to each other, but it can also span whole sectors (and geographical regions). The next infographic takes examples of real-life collaborations between different industries to demonstrate what creative solutions are possible for feeding a given type of waste back into the value chain.





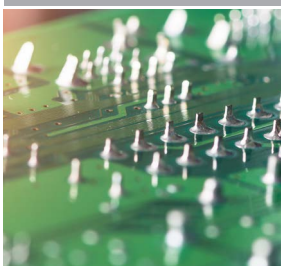


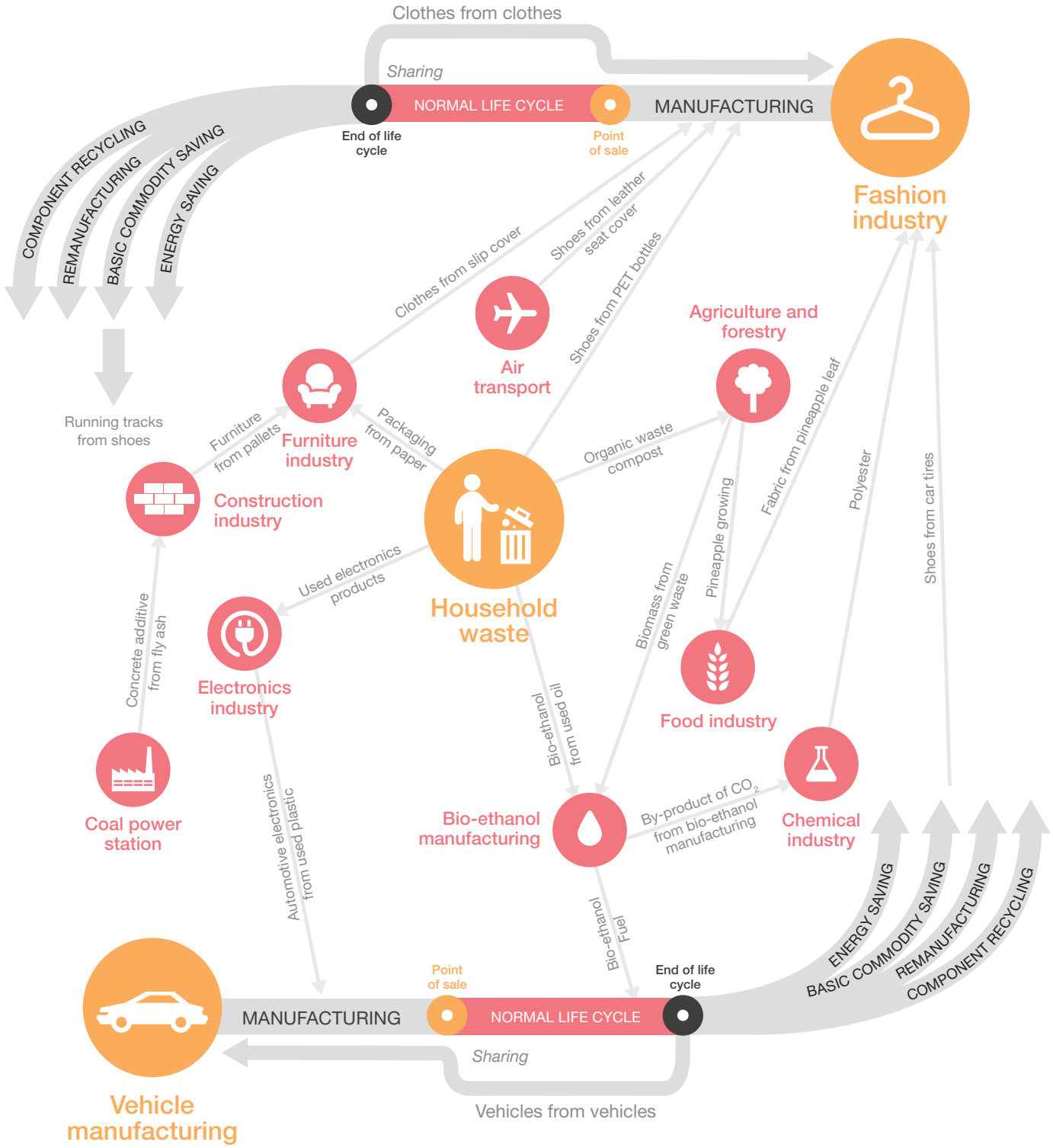




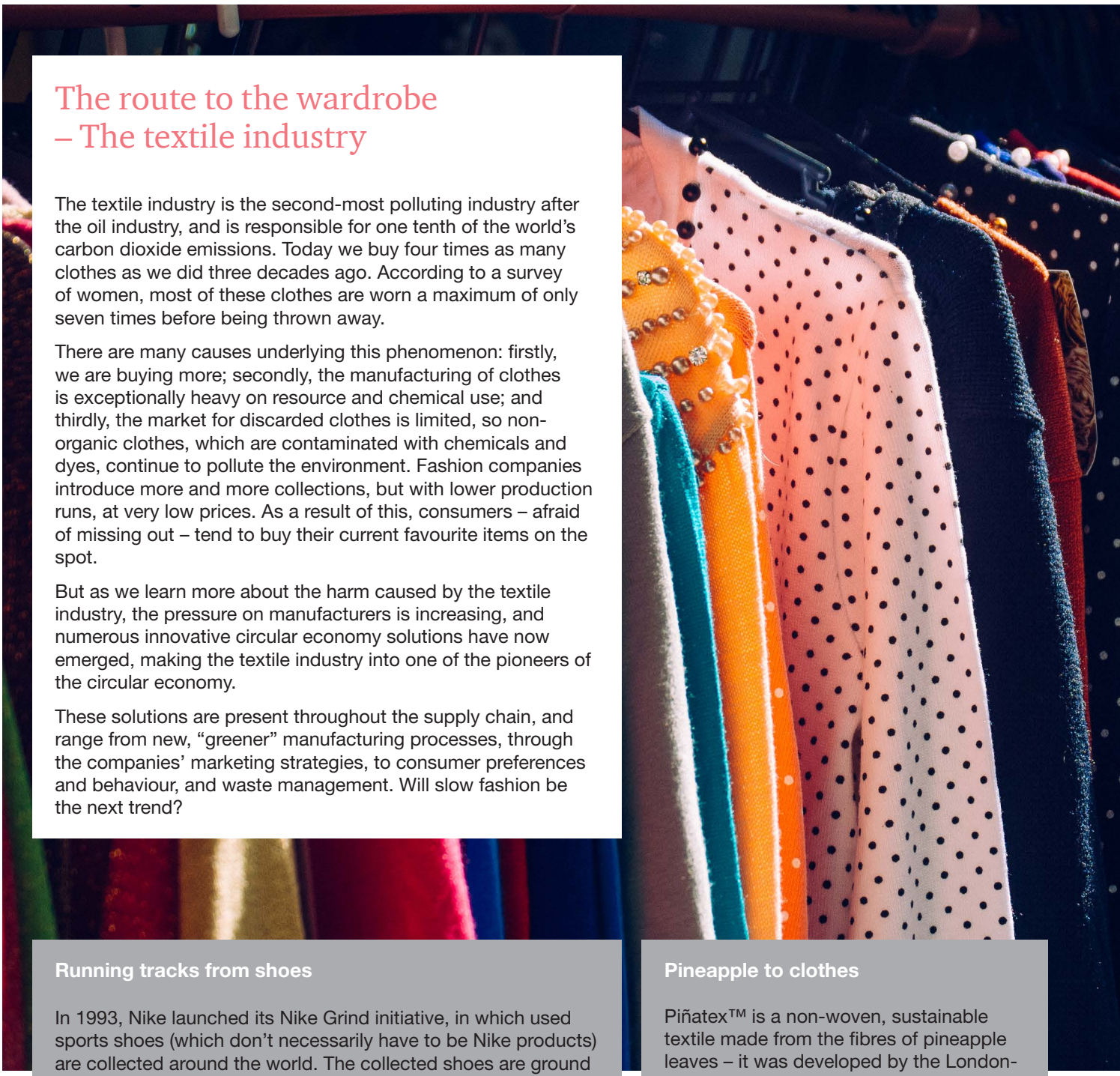




Figure 3
Industrial symbiosis




The next few pages show the circular-economy initiatives of 6+1 industries, focusing in particular on their diversity and innovative potential. For each case study we indicate which circular-economy tools are used. Our aim with the presented case studies is not necessarily to show companies with 100% circular operations, but to demonstrate what first steps can be taken on the path towards a more sustainable – and also more circular – operation. So let's see what new solutions are taking hold from the textile industry to urban development initiatives!



# The route to the wardrobe – The textile industry

The textile industry is the second-most polluting industry after the oil industry, and is responsible for one tenth of the world's carbon dioxide emissions. Today we buy four times as many clothes as we did three decades ago. According to a survey of women, most of these clothes are worn a maximum of only seven times before being thrown away.

There are many causes underlying this phenomenon: firstly, we are buying more; secondly, the manufacturing of clothes is exceptionally heavy on resource and chemical use; and thirdly, the market for discarded clothes is limited, so non-organic clothes, which are contaminated with chemicals and dyes, continue to pollute the environment. Fashion companies introduce more and more collections, but with lower production runs, at very low prices. As a result of this, consumers – afraid of missing out – tend to buy their current favourite items on the spot.

But as we learn more about the harm caused by the textile industry, the pressure on manufacturers is increasing, and numerous innovative circular economy solutions have now emerged, making the textile industry into one of the pioneers of the circular economy.

These solutions are present throughout the supply chain, and range from new, "greener" manufacturing processes, through the companies' marketing strategies, to consumer preferences and behaviour, and waste management. Will slow fashion be the next trend?

### Running tracks from shoes

In 1993, Nike launched its Nike Grind initiative, in which used sports shoes (which don't necessarily have to be Nike products) are collected around the world. The collected shoes are ground up, and the resulting pieces are sorted by material using a special process, to be used for the manufacturing of surfaces for sports grounds. They have partnered with many innovative companies, and as a result of joint research and development, the shoes can be recycled almost in entirety and used to manufacture up to eight different types of playing surfaces, from running tracks through basketball courts and baseball fields. Since the programme's launch, 28 million pairs of shoes have been reincarnated as sports playing surfaces.

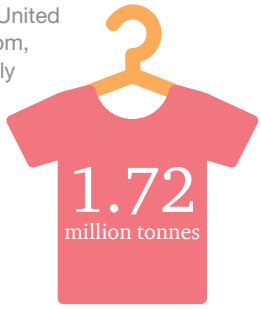
**Tool:** recycling

### Pineapple to clothes

Piñatex™ is a non-woven, sustainable textile made from the fibres of pineapple leaves – it was developed by the London-based venture Ananas Anam. Pineapple leaves, incidentally, are a byproduct of the pineapple harvest. The business model benefits pineapple growers by providing them with extra income, and designers by enabling them to create designs using a new, innovative and sustainable material.

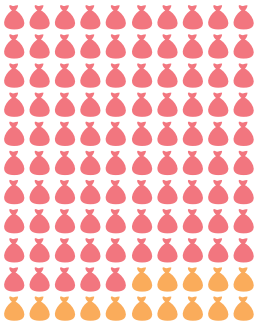
**Tool:** sustainable design

In the United Kingdom, annually




of new fashion items are sold.

Only one fifth of clothes donated to charity are (re)used or sold.



The plastic micro-fibres that are shed by synthetic clothes and end up in the water supply account for

85%

of the waste (originating from manufactured products) found on beaches

### A Swedish pioneer of the circular textile industry

The Swedish H&M, one of the world's largest fast fashion manufacturers, has unveiled an ambitious new vision: by 2030 they aim to become fully circular and use only sustainable materials. In 2013 they launched their "Bring it" campaign, with the aim of encouraging shoppers to bring their used clothes to the shop, and they are then returned to the loop by their partner I:CO, using various circular economy tools: items of good quality are re-donated, while the others are either passed on for re-use (for example as rags/ other material) or recycled (made into thread). Only 1% of the collected materials cannot be worn, used or recycled. These are used to generate energy. So far they have salvaged 40 000 tonnes of clothing globally, as the campaign is running in all the H&M stores around the world.

**Tool:** recycling

### Bluesign – choose the blue!

The Swiss company Bluesign® offers a comprehensive solution spanning the textile-industry value chain, making it possible to reduce the ecological footprint at every level. The textile-industry value chain is typically complex and opaque, and flows of material are difficult to track. Bluesign® recognised that by documenting material flows and the transactions between the players involved, significant sustainability problems and risks can be recognised in good time. They track all the raw materials used in the course of product manufacturing, as well as the manufacturing technology itself, with respect to every participant and supplier in the process. During the audit of the processes, raw materials are grouped into three categories: those in the blue can be used safely, "grey" materials require special care, and the use of materials designated "black" is prohibited. In this way, hazardous materials are not even incorporated into the products, while they work closely with the factories to ensure that materials in the grey categories are used properly, and help them make the switch to alternative – blue – materials.

**Tool:** sustainable design

### The joy of decluttering

The average American household contains USD 7,000 worth of stuff that nobody uses, and the average American throws away approximately 30 kilogrammes of clothing every year – Stuffstr's vision is for not a single dollar's worth of stuff to lie around gathering dust or end up in the garbage. Stuffstr is an application that allows users to photograph their used/ unwanted items, and sell or donate them via the app. But what makes Stuffstr more than just an online platform for the sale of used products is its exceptional user-friendliness: firstly it only shows us items that are nearby, making it easier to find them a new owner, and secondly it is linked up to a variety of online stores.

(Amazon, Craiglist, Stuffhopper), and companies engaged in the removal of donations (Deliv, Give Back Box), so there are masses of channels, which make it easy to get rid of all your unwanted clutter.

**Tool:** sharing

# From the farm to the bin – what are we (not) eating? – The food industry

At least a third of food intended for human consumption – or half according to some analyses – ends up in the garbage, while 800 million people in the world are starving. It is estimated that per-capital food waste in the EU amounts to 146-200 kg a year, and the bulk of this waste, or 53% is generated in households, and 30% during the manufacturing process.

In the food industry, as in other sectors, there are opportunities for reducing waste throughout the value chain. In the process of raw materials production, agricultural technology, storage and logistics have a major role to play, being points at which substantial losses can occur. Sustainability can be boosted at several levels of the manufacturing process: with the more efficient use of resources (water, energy), or possibly through product and manufacturing innovations that help reduce the amount of wastage or byproducts generated. Byproducts should be usable in the manufacture of new products; and with regard to the logistics and sales of products, appropriate storage and the careful planning of ordered quantities are of key importance.

Consumers have just as much of a role in reducing food waste as the agricultural and manufacturing industries and the supply chain, as 53% of food waste is generated in households. This could be reduced, for example, by conscious shopping, appropriate storage, or the donation of surplus foodstuffs.

It's interesting to note that, while in developing countries the main cause of food waste is a lack of appropriate agricultural technology, storage facilities and business know-how, in medium and high-income countries it is mainly the lack of coordination between participants in the value chain, less conscious consumer behaviour, and high food-industry standards that cause the problems.

The food industry is special from the perspective of circularity. Here, where manufacturing waste and byproducts are concerned, the aim is for them to be reintroduced to the manufacturing process, while in the case of products that have reached consumers (owing to the nature of foodstuffs) the objective is for them to not end up in the bin.

### The online food waste wholesaler of the future?

The Swiss startup RethinkResource has created an online marketplace for manufacturers to sell their manufacturing byproducts. They use an intelligent system that also helps to pair up buyers and sellers. In addition to this, the organisation is constantly seeking industry-spanning opportunities to assist companies: a company that processes pomegranates, for example, was hooked up with a cosmetics company for whom pomegranate seeds are an important raw material.

**Tool:** utilisation of byproducts

### Printing ink from coffee? Of course!

CaffeInk gives coffee a second chance: it extracts the pigments from it, and uses them to make sustainable printing ink. They were inspired by the fact that coffee waste weighing as much as three Eiffel Towers is generated every day, while the market for printing ink, which is exceptionally polluting, continues to grow. CoffeeInk not only links up the two sectors as a service provider, but also provides the technology necessary for using coffee waste as printing ink. For the time being their focus is on the Netherlands and France.

**Tool:** utilisation of byproducts

### Far from perfect

According to a survey by Mintel, only 51% of Americans are prepared to buy vegetables that do not have a perfect appearance

(in other words, those that are damaged or a less attractive shape). Because the bulk of food waste consists of fruit and vegetables, it is important to investigate where in the supply chain it is advisable to intervene.

Several initiatives – including the EU-supported FLAW4LIFE – have recognised that masses of fruit and vegetables don't even make it into the shops, simply because their shape is not "perfect". The aim of the initiative is for local producers, consumers and coordinators in Portugal to establish a network in which less-than-perfect fruit and vegetables can change hands, at collection points set up for this purpose. The pilot projects in Lisbon and Porto have "rescued" 8.7 tonnes of food waste a week at seven collection points.

The Australian supermarket Woolworths, which sells foodstuffs online, has launched its Odd Bunch campaign, in which aesthetically flawed fruit and vegetables – which previously wouldn't have made it into the shop – can be bought for a lower price. According to Woolworths, at least a quarter of fruit and vegetables have a less-than-perfect shape or are damaged. Their aim to demonstrate to shoppers that these products taste just as good, and there is no difference in their nutritional value.

**Tool:** consumer education

### Packaged freshness

Bakery products – including bread – are high on the list of types of food waste. According to Mintel's analysis, in the United Kingdom 56% of the population would be happy to buy bread with packaging that keeps it fresh. Manufacturers have already come up with several responses to this phenomenon.

One, known as MAP (modified atmosphere packaging), is a type of air-permeable packaging filled with natural gases of a composition that suits the requirements of the product inside. MAP technology can be used in many different ways, adapted to the requirements of the product – for example, the packaging of Buitoni pasta prevents oxygen from coming into contact with the pasta inside. Although MAP technology is used by certain companies, the use of the technology has not yet been extended to a wide range of perishable products. The process is being slowed down by factors related both to food manufacturers and to consumers: for manufacturers, replacing existing packaging would entail costs, and they have doubts regarding the safety of the gas used to fill the packaging, while consumers still find it hard to believe that a packaged product can also be fresh.

**Tool:** sustainable design

### A second chance

**Wefood:** The Danish Wefood opened in Copenhagen in 2016. It is the first Danish supermarket to sell products that cannot be sold in other shops for some reason. The products might have damaged packaging, or be past their "best before" date (which is not the same as the sell-by date, but the period during which the product is guaranteed to be of the highest quality). The shop sells its products at 30-50% below regular store prices. Wefood receives the products as donations, and the proceeds from their sale are used for charitable purposes, primarily reducing hunger and food waste.

**The Real Junk Food Project:** a chain of coffee shops that started out in the United Kingdom but now has a presence in several European and Australian cities, offering food made by acclaimed chefs from out of date products. They claim that the quality of their food is excellent, and they break no laws, but are simply challenging the legislative grey areas. Interestingly, the food available in the cafés have no fixed price. Guests pay as much as they would like.

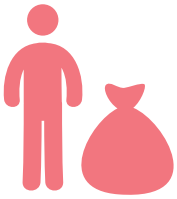
**Tool:** sustainable design

### Back to the production line

Some 60% of Europe's citrus farming takes place in Spain, 30% in Italy and 10% in Cyprus, Portugal and Greece. Masses of waste are generated in the farming process, including products that cannot be sold due to aesthetic flaws or other properties. In the past, at best, this was used for manufacturing animal feed. The aim of the LIFECITRUS project is to develop a manufacturing solution that enables nutrients and constituents (essential oils, sugar, hesperidin, etc.) to be extracted from non-saleable products (oranges, lemons, grapefruits and tangerines), and made into a gel with minimal use of water and solvents or other chemical substances, which can then be sold on as a raw material to the food industry. The project could reduce the quantity of waste generated by 80%.

**Tool:** recycling of byproducts

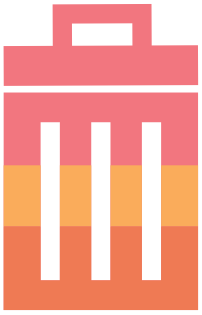
Per capita food waste per annum



146-200 kg

*EU 2012*

Contribution to food waste



Households 53%

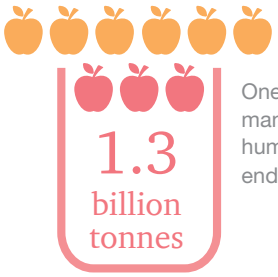
Manufacturing 11%

Processing 19%

*EU 2012*

In the past 20 years shopping trolleys have grown 20% in size.

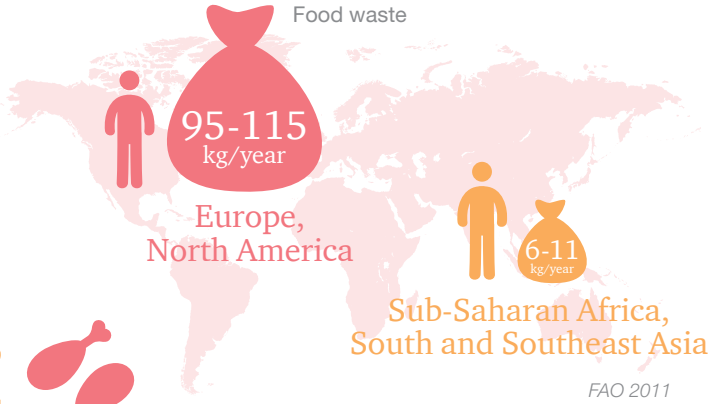
*Huff Post*



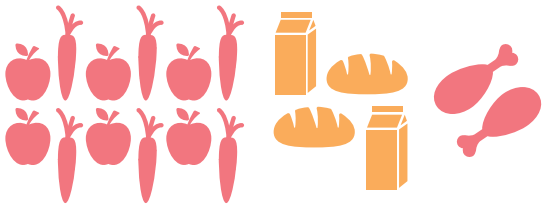
1.3 billion tonnes

One third of foodstuffs manufactured for human consumption ends up in the garbage.

*FAO 2011*

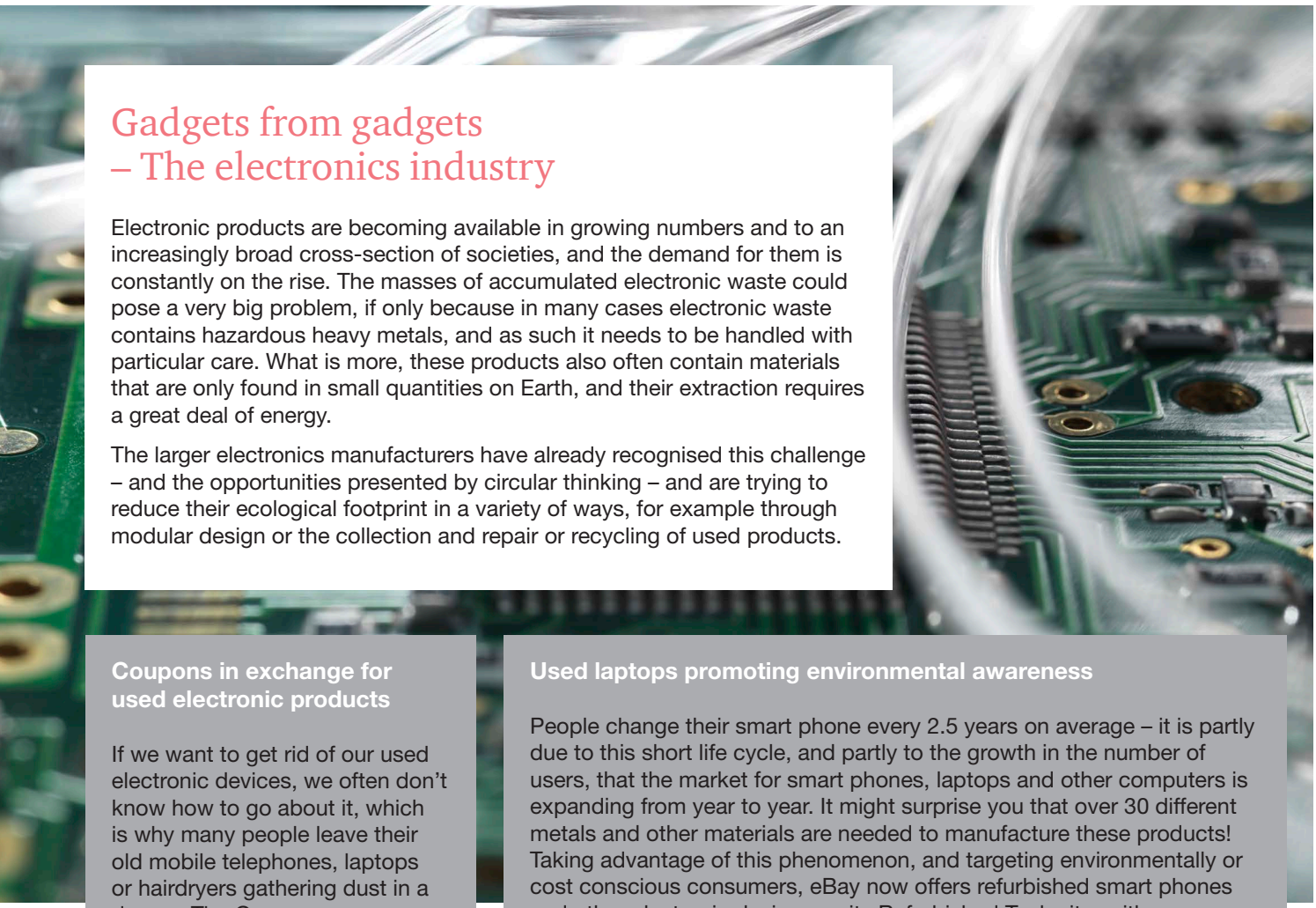



*FAO 2011*



Most food waste consists of fruit and vegetables, followed by dairy and bakery products, and meat.

*Realsimple*



# Gadgets from gadgets – The electronics industry

Electronic products are becoming available in growing numbers and to an increasingly broad cross-section of societies, and the demand for them is constantly on the rise. The masses of accumulated electronic waste could pose a very big problem, if only because in many cases electronic waste contains hazardous heavy metals, and as such it needs to be handled with particular care. What is more, these products also often contain materials that are only found in small quantities on Earth, and their extraction requires a great deal of energy.

The larger electronics manufacturers have already recognised this challenge – and the opportunities presented by circular thinking – and are trying to reduce their ecological footprint in a variety of ways, for example through modular design or the collection and repair or recycling of used products.

### Coupons in exchange for used electronic products

If we want to get rid of our used electronic devices, we often don't know how to go about it, which is why many people leave their old mobile telephones, laptops or hairdryers gathering dust in a drawer. The German company binee offers a solution for this. Based on contracts made with shops selling electronic goods, they set up collection points in the retail outlets, where owners of electronic products can drop them off in exchange for discount coupons.

In this way, the company motivates consumers to recycle products. The collected items might include anything from laptops, mobile phones and headphones to epilators, hair tongs or even alarm clocks.

The company later delivers these to its recycling or re-manufacturing partners.

**Tool:** Sustainable design

### Used laptops promoting environmental awareness

People change their smart phone every 2.5 years on average – it is partly due to this short life cycle, and partly to the growth in the number of users, that the market for smart phones, laptops and other computers is expanding from year to year. It might surprise you that over 30 different metals and other materials are needed to manufacture these products! Taking advantage of this phenomenon, and targeting environmentally or cost conscious consumers, eBay now offers refurbished smart phones and other electronic devices on its Refurbished Tech site, with a one-year guarantee, at significantly below the original price. Local companies in Hungary also sell reconditioned electronic products, one of the largest being PC Aréna, which has a turnover running into the billions of forints, mainly from the sale of refurbished laptops.

**Tool:** Sustainable design

### Washing efficiently

Bundles is a company that rents out high-quality, environmentally-friendly washing machines, while consumers pay a monthly fee that is proportional to the amount they use the machine. This gives more people access to higher-quality, but more expensive machines, which are far more energy-efficient and water-saving. The company uses smart meters to help optimise the necessary quantities of water and detergent, as another way of cutting down on consumption. When the rental contract expires, the company can rent the machine out again, refurbish it or use its components to make new washing machines, which substantially reduces the materials costs of new machines.

**Tool:** Customer education

### It won't work if consumers aren't on board

**In many cases the main barrier to recycling electronic goods is that collecting the products is inconvenient for consumers, and they are not well-informed about the available opportunities. Recognising this, many companies – including the three companies introduced below – have ensured that they have appropriate processes in place for the collection of used products.**

#### Modular design – Just change the screen, don't throw the laptop away!

Dell believes that the most effective method of waste reduction is modular design. Product design engineers make an effort to assemble the products from stand-alone modules. Consequently, if individual modules malfunction, there's no need to replace the whole product, and at the end of the product's life the individual components are easier to use again by building them into other products. As a part of the Dell Reconnect programme, which also operates in Hungary, the used electronic products of various brands are collected, at more than 2000 locations in the United States, for example, to be re-used later as spare parts. On its website the company gives detailed information about how to drop off the products, and also arranges for them to be picked up.

**Tool:** Sustainable design

#### Clothes irons from recycled materials

Philips takes special care to ensure that as many of its products' components as possible are manufactured from recycled materials.

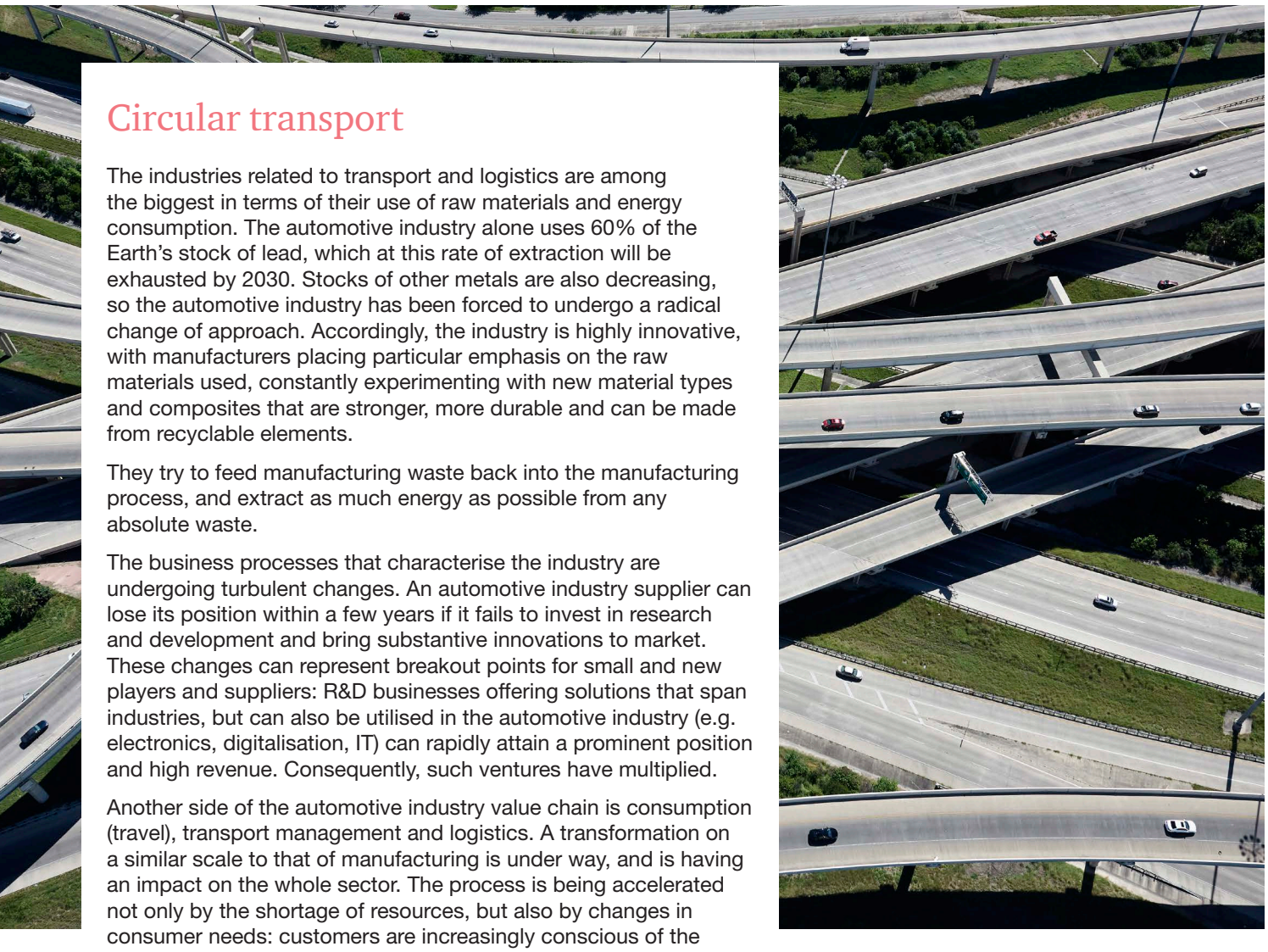
Their sustainability programme was launched ten years ago, with the aim of continuously increasing the proportion of recycled components. To this end, numerous collection points have been set up in the United States, where consumers can drop off their used electronic devices. The programme is a success – in one of their clothes irons, for example, 11 components were changed so that 30% of the product now consists of recycled materials, but with another model of iron they have managed to reach 50%.

**Tool:** recycling

#### Printers reborn

Canon is one of the photographic industry's pioneers of the circular economy. The products they manufacture are collected at the end of their useful life, and used to make new ones, subject to the same quality assurance. This may be done by simply re-using the components, or by converting certain materials – especially plastics – and manufacturing new components from these. At least 80% of a pre-owned product is used for re-manufacturing, which considerably reduces the harmful environmental effects of producing raw materials and components. The company's greenhouse gas emissions, for example, have decreased by 80% due to this initiative. In the printer market, the company also has several product lines where all products are made of reused components.

**Tool:** re-manufacturing



# Circular transport

The industries related to transport and logistics are among the biggest in terms of their use of raw materials and energy consumption. The automotive industry alone uses 60% of the Earth's stock of lead, which at this rate of extraction will be exhausted by 2030. Stocks of other metals are also decreasing, so the automotive industry has been forced to undergo a radical change of approach. Accordingly, the industry is highly innovative, with manufacturers placing particular emphasis on the raw materials used, constantly experimenting with new material types and composites that are stronger, more durable and can be made from recyclable elements.

They try to feed manufacturing waste back into the manufacturing process, and extract as much energy as possible from any absolute waste.

The business processes that characterise the industry are undergoing turbulent changes. An automotive industry supplier can lose its position within a few years if it fails to invest in research and development and bring substantive innovations to market. These changes can represent breakout points for small and new players and suppliers: R&D businesses offering solutions that span industries, but can also be utilised in the automotive industry (e.g. electronics, digitalisation, IT) can rapidly attain a prominent position and high revenue. Consequently, such ventures have multiplied.

Another side of the automotive industry value chain is consumption (travel), transport management and logistics. A transformation on a similar scale to that of manufacturing is under way, and is having an impact on the whole sector. The process is being accelerated not only by the shortage of resources, but also by changes in consumer needs: customers are increasingly conscious of the need for a smaller ecological footprint and sustainability. On the back of the new trends and technologies, electric and digitally supported solutions, and forms of transport that are based on communication and networking, are flourishing. Three aspects are especially important for consumers: the experience, performance and sustainability. Accordingly, consumers are increasingly conscious of their behavior, which is being aided by the fact that cities themselves are placing greater emphasis on the latest trends. This has led to the spread of sharing-based transport (car/bike/ride sharing) in recent years, which favours the highest possible rate of utilisation of a given means of transport, rather than private ownership.

A long useful life and minimal environmental burden, as well as technologies that ensure safety, therefore, will become important for both manufacturers and users.

### Fresh city centres

Urban transport is increasingly intolerable in a growing number of locations, thanks to the rise in the number of vehicles. To ensure clean air, reduce noise and eliminate the continuous congestion, cities need to rethink their own road networks and community transport systems.

Since 2012, Volvo and Siemens have been working to find solutions for the environmental burden resulting from inner-city transport: the aim is to build new, electric bus networks in larger cities. Volvo is manufacturing electric and hybrid buses, while Siemens is developing their charging stations. A number of these innovative services are already running in Gothenburg and Hamburg, and the objective is to electrify the entire bus network. How does the concept of an electric bus network fit into the circular economy? The primary objective is to reduce environmental pollution, and to optimise the energy use associated with operation. The initiatives have led to a 75% reduction in CO2 emissions, and a 60% cut in energy consumptions.

**Tool:** Sustainable design

### Technology for raw materials

Under its TREC (Tyre Recycling) project, the Michelin Group feeds used tyres back into the manufacturing process, recycling 17 million tonnes of tyres globally every year as a part of this project. A major factor in TREC's success is the know-how, professional expertise and R&D that is shared between companies. The Michelin Group collaborates with several ventures that provide support for the project (Protéus, SDTech, CEA–Liten), to ensure that the best quality raw materials are produced from the used tyres.

The project is driven by two approaches:

1. **TREC Recycling**
   The used tyres are made into granules, which are then transformed into micro-powder, which can form the raw material for new, high-performance tyres, thus reducing the generation of waste.
2. **TREC Alcohol**
   Used tyres are made into a synthesis gas, which is then transformed into alcohol, to be used for the manufacturing of new tyres.

**Tool:** recycling

### Used parts in new cars!

Renault's factory located in Choisy-de-Roi has focused on the refurbishment and reuse of components since 1949. The reconditioned components undergo strict quality checks to ensure their flawless functioning, so they can be resold as spare parts. Returning the still usable, old components to the factory requires complicated reverse logistics.

The parts are collected from the sales network, and delivered to a sorting centre. Here, the components that can be reused in vehicles after reconditioning or even relatively major modifications are selected. The usable parts are sent from the sorting centre to manufacturing plants, where the modifications are performed, then they are returned to the central warehouse. As the recycling takes place in a closed loop, the raw materials are not permitted to leave the covered area.

Circularised manufacturing not only has environmental implications, but also ensures a considerable competitive advantage in spare parts manufacturing. Consumers are given the same guarantees when purchasing used components, but still pay 30-50% lower prices than they would for new parts. The Choisy-de-Roi factory achieves substantial savings through recycling. It uses 80% less energy, 88% less water and 92% less chemical substances in the course of its operation. Owing to recycling, it is able to cut down on waste generation by a substantial 70% in total. The factory also follows an internal rule that no raw material whatsoever can be placed into waste disposal bins; everything is used for production.

**Tool:** re-manufacturing, recycling

The automotive industry uses

**60%**

of the Earth's stock of lead, so it is calculated that this stock will run out by

**2030**

The use of hybrid and electric buses in cities leads to a

**60%**

reduction in total energy consumption, and a

**75%**

reduction in $CO_2$ emissions.

Feeding back modified and reconditioned components into the manufacturing process uses

**80%**

less energy

**88%**

less water, and

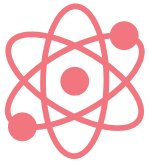
**90%**

less chemicals than manufacturing an entirely new part.

This approach can produce a

**70%**

reduction in waste generated by manufacturing.



Every year, European automotive industry players spend

**EUR 50.1 billion**

on research and development.

### Share your car in exchange for free parking

The Hungarian venture BeeRides has developed a car sharing solution that solves the problem of travelling to and from the airport. There are two distinctive parts of the service:

1. Car owners travel to the airport in their own cars, which can be left in the nearby BeeRides car park free of charge.
2. Anyone who wants to hire a car in and around Budapest at favourable terms can go to the BeeRides car park and rent a vehicle that suits them, for up to several days.

The basis for this sharing solution is that the cars available for hire are those left in the car park by the travellers. BeeRides has no rental fleet of its own, but simply provides a platform for those who would like to rent out their car, and those who wish to make use of the rental service. In this way, the renter can hire a car for less than it would cost from a mainstream hire company, while in addition to the free "parking", the owners also receive a share of the rental income, which can be up to several hundred thousand forints a month.

**Tool:** sharing

### Community transport from anywhere in Budapest

GreenGo is a Hungarian application that enables registered users to quickly locate the GreenGo car parked nearest to them, which they can then use on a pay-by-the-minute basis. The venture is based on community sharing, which has the aim of maximising the use of a given asset – in this case, the car.

The service offers a solution to environmental pollution and the shortage of parking spaces.

The cars are electric. GreenGo takes care of maintenance, and customers don't even have to charge them up. The company has come up with a very simple solution to the question of quality assurance: the users inspect the interior and exterior state of the cars. The vehicle can only be started once the driver has rated its condition. If a driver rates the car as satisfactory without checking properly, and the next driver finds the damage, then the first driver is liable for the unnoticed damage.

This form of community transport is not only aimed at individuals, but also presents opportunities for companies. A top priority for the company is to conclude contracts with a few larger corporations, thus increasing their existing customer base. They started operation with 45 electric cars, but the objective is to cover the existing service area (the inner districts of Budapest) three times, with 300-500 available cars.

**Tool:** sharing

# Not destroyed, but conserved? Energy and utilities

When it comes to more efficient energy use and waste reduction, the energy industry is a special sector. In other sectors, unused or discarded products take the form of visible, physical waste, while unused/wasted energy does not (with the exception of sewage). Although wasted energy – for example, a light left on unnecessarily – does not pollute the environment directly, the resources used to generate it are used up just the same. Our circular-economy approach for the energy industry focuses on how to avoid wasting energy.

The energy industry serves every single part of the economy, encompassing whole sectors, individual processes and households like a sort of net. In coming decades the energy sector, which is already in a state of flux due to the availability of ever cheaper renewable sources, will be affected by trends such as the growth in IoT devices, big data analysis or even developments in the batteries powering electric vehicles, all of which are opening new doors for the sector. In the following sections, we will introduce technology-driven solutions that make the operation of energy suppliers more efficient, facilitate the optimisation of consumption, and leverage the input-output connections offered by the circular economy.

## Household energy generation and storage

Advances in solar panels and their increasingly widespread adoption is enabling households to generate electricity increasingly cheaply and efficiently, but there are still several obstacles preventing a household from independently supplying itself with purely green energy.

The greatest barrier to going off-grid is that generation is not aligned with consumption.

While solar panels generate the most energy in the hours around midday, electricity consumption peaks in the early morning and in the evening, while certain appliances also use electricity at night. The situation is made even more difficult by the extreme seasonal variations of our climate, which can cause output to fall to one sixth of its normal level during the winter months.

The security of supply for households, therefore, is highly dependent on the central grid even if solar panels are used, but the development of household energy storage units could offer a solution to the problem.

These are high-capacity, integrated lithium-ion batteries, which mainly serve to store locally the energy generated by the solar panels. These batteries make it possible to smooth out the daily fluctuations: the surplus electricity produced in the trough periods can later be used to cover the much higher consumption of the peak period.

Several manufacturers currently offer batteries for household use in the market. Tesla recently launched the Powerwall 2, a 13.5 kWh lithium-ion battery, with 5kW constant and 7kW peak output, which is capable of serving the daily electricity needs of an average Hungarian family.

Besides Tesla, proprietary batteries have been launched in the market by LG, Mercedes and BMW.

**Tool:** Sustainable design

## Capacity balancing and dynamic tariffs with smart devices

The smart meter is a device for measuring the consumption of various utilities, which enables both the consumer and the service provider to track consumption in real time.

This allows the service provider to prepare more accurate analyses of the data thus gathered, in order to examine consumption patterns. On the one hand this encourages energy-awareness, and on the other it creates an opportunity for demand regulation on the consumer side. The purpose of the latter is to smooth out the uneven consumption caused by peak periods. The most effective means of achieving this is fee-setting, that is: offering different fees at different times.

Smart meters promise substantial savings for consumers, and also make it easier to detect theft and outages, while helping to balance out generation capacities, while the shelving of new investments leads to an overall reduction in greenhouse gas emissions.

As part of a project implemented in Arkansas, in the United States, the local electricity supplier Woodruff Electric Cooperative provided 14,450 smart meters and the necessary infrastructure in a region with high unemployment and poverty indicators. As well as the dynamic fees, household savings were helped along by automated solutions that resulted in further substantial fee reductions (off-peak fees decreased by 55% overall), as for Woodruff the cloud-based monitoring performed by the smart devices removed the need to carry out field measurements, which were costly due to the large distances involved.

**Tool:** sustainable design, consumer education

### Water utility networks

Energy awareness and circularity are about more than just electricity grids, however. They also hold numerous opportunities with respect to water utilities. The purification of water, delivering it to consumers, and the removal and treatment of sewage, are costly and also take a heavy toll on the environment.

Grey water is mildly polluted water containing no human effluent, mainly resulting from the washing of clothes and dishes.

This grey water, which is mostly generated by households and is no longer suitable for human consumption could be used for other purposes (for example cleaning, toilet flushing or irrigation), but the sewer system drains it away as wastewater. However, its use by households could considerably reduce demand for pure drinking water, as well as the quantity of water that needs to be drained away and treated: the water flowing into households can be used for up to three cycles, first for human consumption, then as washing water, and finally for flushing toilets. Besides the utilisation of grey water for these purposes, 60% of the heat energy stored in it can also be extracted.

Rainwater, which like grey water is not suitable for human consumption but excellent for other purposes, is also not utilised in the unified sewage drainage systems that are currently widespread. This system handles rainwater and sewage together, whereas in half of the areas of application drinking water could be substituted with rainwater. An additional advantage is that rainwater is soft water, so it protects household appliances from calcium deposits, and permits the use of less washing powder than the harder tap water.

The water drainage system in Potsdamer Platz, Berlin, has been designed to fit in with the circular economy. In this new district, environmental awareness is reflected in all aspects from the building materials and the passive cooling systems of the buildings, to the central rainwater management system. This has reduced the energy consumption of property in the square by 50%.

The rainwater collected from the roofs is used for flushing toilets and watering green spaces, which saves on the water purification and drainage costs of the central network. The accumulated water is stored in underground cisterns and the 1.2-hectare system of lakes surrounding the square, and is treated as appropriate given its usage, through sedimentation and biological cleansing, without the use of chemicals. In this way, the water that would otherwise leave the system can be reused, thus achieving circularity with regard to water utilisation.

**Tool:** sustainable design, re-use

### Using Denmark's excess wind power

The circular economy principle can also be implemented between two public utility networks. Over the last decade, wind-rich northern countries have invested heavily in installing wind farms. In Denmark, this program has been so successful that they could achieve a target of 50% renewables in the country's energy mix before 2020. Today, wind power can cover up to 116% of Denmark's energy needs on windy days, and up to 140% in periods when power demand is low and weather conditions are favourable. However, excess power is not necessarily a good thing, because, together with the surplus generated by wind farms in northern Germany, it puts a considerable burden on neighbouring Polish and French grids. In certain countries, such as Ireland, which cannot transfer excess power to the grids of neighbouring countries, some power plants are shut down in the case of oversupply.

In Denmark, however, they have come up with a much better solution. District heating units, established in a decentralized layout in the 1980s, were replaced by CHP (Combined Heat and Power) plants by the end of the 1990s. However, as the Danish energy mix shifted towards wind power (already at 39% in 2014), the need for CHP plants to meet the country's power needs has gradually decreased. Today CHP plants are primarily used to convert power generated by wind farms into thermal energy for district heating systems. Thus, rather than reducing power generation capacities in the case of oversupply, excess power can be used to contribute to the operation of heating systems.

**Tool:** energy recovery

Eco-design can result in annual savings of

332 EUR

for consumers.

# Sustainable construction

The unbelievable quantity of raw materials used, and the impact of the built environment on nature mean that the construction industry cannot be left out of the conversation when it comes to sustainability.

Our most common building material, Portland cement, is one of the most important ingredients of concrete, the production of which involves considerable harmful emissions: for every 1 kg of cement manufactured, approximately the same quantity of carbon dioxide is generated. What is more, the quantity of concrete used in the world is growing rapidly every year in line with population growth, so it is important to exploit opportunities for circularity in the construction industry, to achieve economic and sustainable development.

And the completion of a project is by no means the end of the construction industry's impact on the environment. During the 50-100-year planned life of a built structure, it continues to burden the environment through its running and maintenance costs: our buildings are responsible for over 40% of primary energy consumption, and in parallel with this, the harmful emissions associated with buildings are also substantial. And at the end of the life cycle comes the time for demolition, which releases similarly high quantities of harmful substances into the atmosphere.

It's not enough, therefore, to build something "well", it's also important to build something "good". The circular economy should not only be present in the manufacturing and the use of construction materials, but also in the maintenance of the buildings. Improving the present low utilisation rate and energy efficiency of existing building stock, and rehabilitating aging buildings represents a major challenge, to which modern technologies can provide numerous responses. When analysing the construction industry, we looked for projects and case studies where innovative solutions are offered in terms of planning and implementation, and maintenance and operation, leveraging the principles of circular economy.

### Re-using demolition rubble – integrating the construction industry into the circular economy

Re-using demolition rubble – integrating the construction industry into the circular economy

The rubble created when buildings are demolished is one of the most “visible” type of waste, because – although you may not encounter it every day – the quantity of airborne dust and waste is a considerable burden on the environment. By modernising construction industry technologies and keeping sight of sustainable development, however, the sector’s environmental load can be significantly reduced.

A potential means of doing this is to make the demolition waste “circular”, and use it as a building product. After the rubble has been ground down and sorted, following numerous inspections and quality checks, it can be used for the manufacturing of concrete, among other purposes. In many cases, demolished construction materials can be reused without processing: bricks, tiles, doors and windows can often be reclaimed "intact" and used again. In Hungary, the rating of such materials is performed by the quality inspection body ÉMI Non-profit Llc., and the legislative environment also supports the recycling of demolition waste. The responsibility of building material manufacturers also has to be addressed, because apart from the issues relating to legal compliance, the sale of recycled construction waste is also financially rewarding, and reduces dependence on raw materials. The world’s largest building material manufacturer, the LafargeHolcim group, for example, uses 54 million tonnes of construction waste every year, and makes 6.5 tonnes of aggregate from construction and demolition waste.

**Tool:** re-use

### Building certifications

The World Green Building Council’ global project, Net Zero, has set the objective of making every building’s carbon dioxide emissions close to zero by 2050. The most important milestone in the project is that after 2030 all new projects and properties undergoing major renovations should conform to the Net Zero requirements, and that 75,000 specialists undergo the training and education necessary for this by 2030, with this number rising to 300,000 by 2050.

The Green Building Council in Hungary, established in 2009, has also joined these efforts. They aim to provide support and guidance for the implementation of highly energy-efficient buildings that generate the quantity of energy necessary for their operation from renewable sources, and which may even supply additional energy. Besides electricity, the concept can be extended to water and waste management as well.

Apart from the Net Zero project, there are currently numerous rating systems that promote the sustainability of buildings, and thus their integration into the circular economy, such as BREEAM, DGNB and LEED.

**Tool:** Sustainable design

### Smart design

IoT (Internet of Things) technologies have become a part of our everyday lives in many respects, and brought innovation to several industries. Today, the biggest users of IoT technologies are smart buildings, and it is forecast that by 2020 the IoT market will triple relative to its size of USD 46 billion in 2014. In spite of the higher construction costs, green buildings fitted with IoT technology are increasingly popular among investors, thanks to the lower running costs and the increase in the value of such properties. It is estimated that a building equipped with smart technology brings a 6.6% extra return.

A smart office creates management and building maintenance opportunities that can greatly contribute to reducing the ecological footprint of offices. Unused space is as costly for investors as it is harmful to the environment. Smart beacon technologies provide real-time data on the position of workers, and thus on unused spaces, available meeting rooms, and even the length of the queues for the canteen. Improving the usage of space is of key importance in large metropolises such as London, where the annual cost of office space for one employee is approximately USD 30 000. Besides the more efficient use of space, the data retrieved from the Beacons can also be used to boost worker efficiency. The optimal layout of an office can significantly improve work discipline, and have an inspirational effect on white collar and creative workers.

**Tool:** sustainable design, maintenance, repair

For more on the relationship between the IoT and the circular economy, see our separate Outlook.

## Reconstruction

The vast majority of buildings that lose their function are demolished, and while some of the rubble can be utilised, reusing the building entails less loss of materials and environmental harm, and represents a higher level of the circular economy. Taking a building that was originally built with outdated standards and technology, to fulfil a different function, and reconstructing it to meet today's requirements is a major engineering and architectural challenge, and is usually not even cost-effective. But nevertheless, we can find numerous excellent examples of how the buildings of bygone eras can be preserved and converted to suit today's needs.

An outstanding urban rehabilitation programme has been implemented in the formerly industrial German town of Essen, where industrial buildings left behind by the coal mining and steel manufacturing plants, shut down in the 1980s, were rehabilitated. The former Krupp steel works, now known as Krupp Park, has become a symbol of environmentally friendly urban rehabilitation, while the famous Zollverein coal mine and factory have been converted into a museum park. Through additional infrastructure developments supporting community transport, sewer construction and tree planting programmes, Essen was the first former industrial town to be awarded the title of "Green Capital of Europe" in 2017. Essen's example could show the way forward for many European large cities struggling with legacy buildings that have lost their original function.

**Tool:** refurbishment


production leads to almost the same amount of $CO_2$ production

The yearly steel production of the Earth comes to

**1.030 million**

tons, from which the construction industry accounts for

**50%**

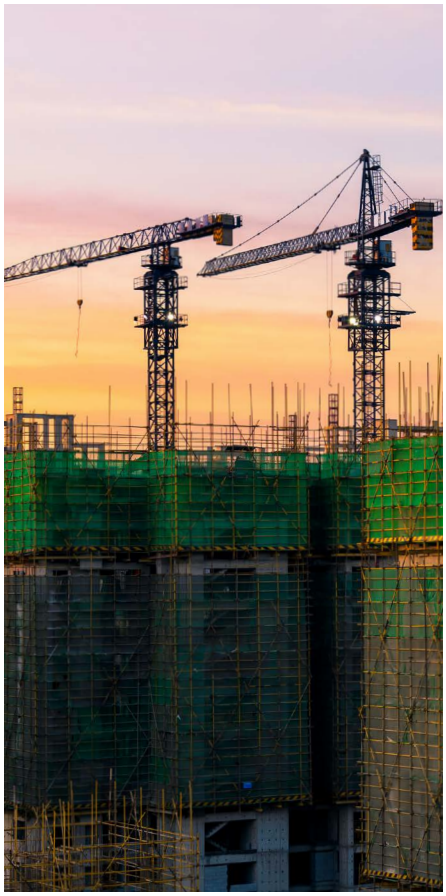
## Concrete manufacturing

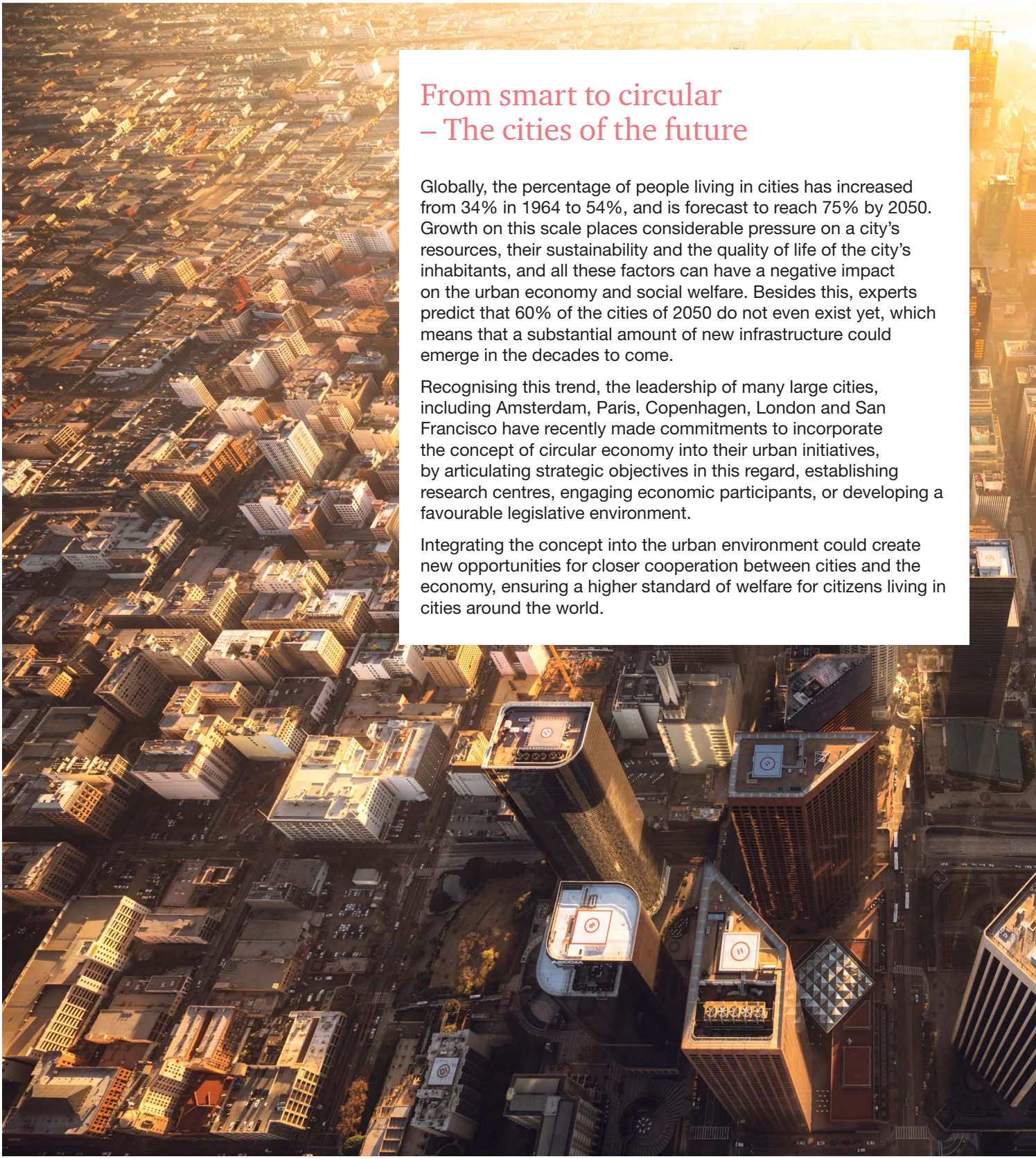
The construction industry produces an incredible 5.2 billion tonnes of concrete every year, which has a substantial impact on the environment, accounting for more than 5% of annual CO2 emissions. Numerous research studies and projects focus on reducing the quantity of concrete needed for construction, and cutting down on the harmful substances generated by its manufacturing.

One of the most promising of these from the perspective of the circular economy is Earth Friendly Concrete (EFC), developed by the Australian construction firm Wagner. One of the most polluting ingredients of concrete, Portland cement, has been successfully substituted with a byproduct of steel manufacturing, blast furnace slag, and a byproduct from coal-fired power generation, fly ash. The substitution of Portland cement reduces greenhouse gas emissions by 90%, and the EFC concrete costs about as much to produce as the conventional type.

Green concrete, which incidentally does have a greenish hue, was used in the construction of Wellcamp airport in Brisbane, which has been awarded the title of "greenest airport". Many other research projects aim to replace Portland cement, but the material will not be squeezed out of the construction industry for a long time yet, as international standards demand the use of a certain quantity for general compliance reasons.

**Tool:** sustainable design, recycle



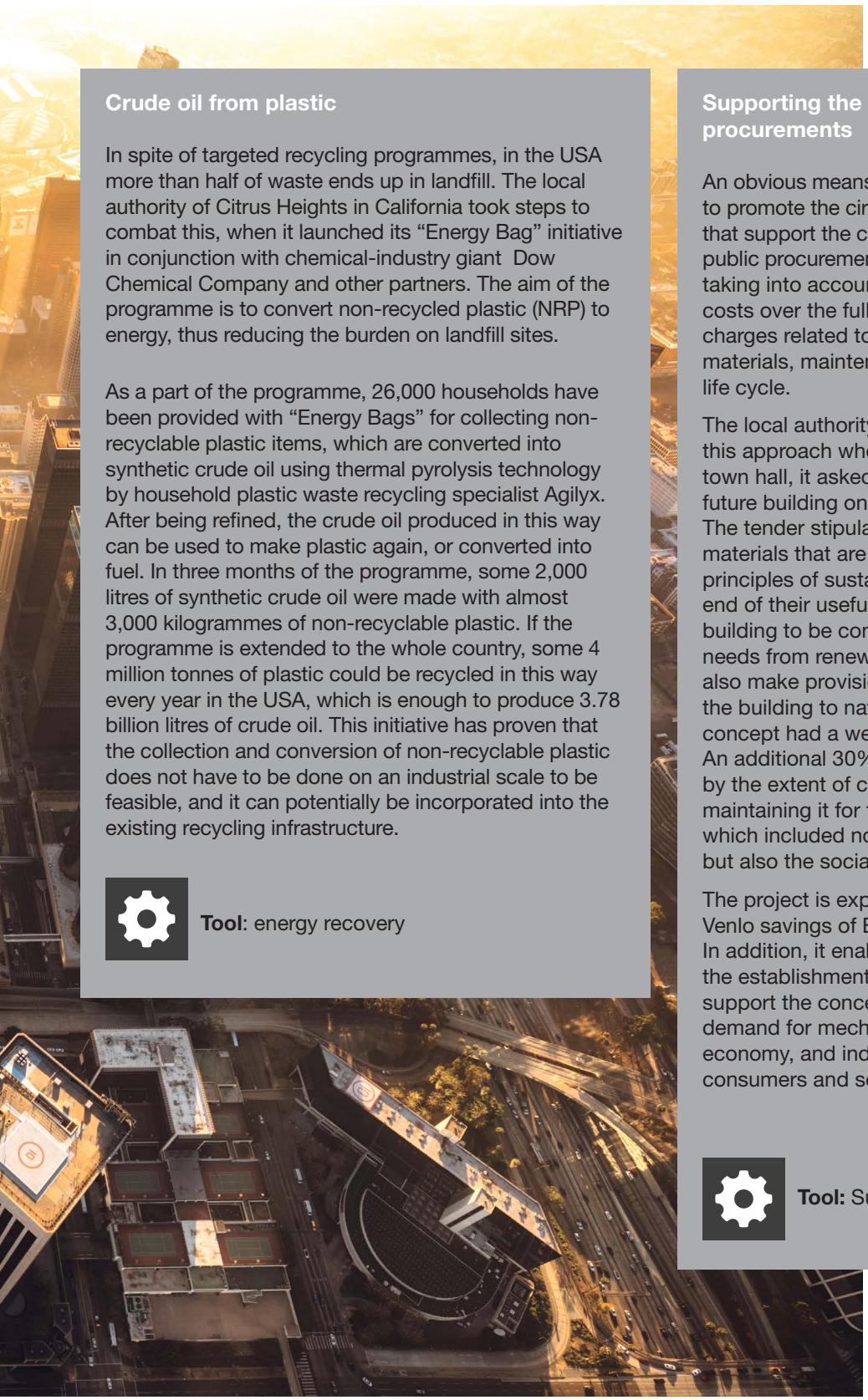


# From smart to circular – The cities of the future

Globally, the percentage of people living in cities has increased from 34% in 1964 to 54%, and is forecast to reach 75% by 2050. Growth on this scale places considerable pressure on a city's resources, their sustainability and the quality of life of the city's inhabitants, and all these factors can have a negative impact on the urban economy and social welfare. Besides this, experts predict that 60% of the cities of 2050 do not even exist yet, which means that a substantial amount of new infrastructure could emerge in the decades to come.

Recognising this trend, the leadership of many large cities, including Amsterdam, Paris, Copenhagen, London and San Francisco have recently made commitments to incorporate the concept of circular economy into their urban initiatives, by articulating strategic objectives in this regard, establishing research centres, engaging economic participants, or developing a favourable legislative environment.

Integrating the concept into the urban environment could create new opportunities for closer cooperation between cities and the economy, ensuring a higher standard of welfare for citizens living in cities around the world.



## Crude oil from plastic

In spite of targeted recycling programmes, in the USA more than half of waste ends up in landfill. The local authority of Citrus Heights in California took steps to combat this, when it launched its “Energy Bag” initiative in conjunction with chemical-industry giant Dow Chemical Company and other partners. The aim of the programme is to convert non-recycled plastic (NRP) to energy, thus reducing the burden on landfill sites.

As a part of the programme, 26,000 households have been provided with “Energy Bags” for collecting non-recyclable plastic items, which are converted into synthetic crude oil using thermal pyrolysis technology by household plastic waste recycling specialist Agilyx. After being refined, the crude oil produced in this way can be used to make plastic again, or converted into fuel. In three months of the programme, some 2,000 litres of synthetic crude oil were made with almost 3,000 kilogrammes of non-recyclable plastic. If the programme is extended to the whole country, some 4 million tonnes of plastic could be recycled in this way every year in the USA, which is enough to produce 3.78 billion litres of crude oil. This initiative has proven that the collection and conversion of non-recyclable plastic does not have to be done on an industrial scale to be feasible, and it can potentially be incorporated into the existing recycling infrastructure.

**Tool**: energy recovery

## Supporting the circular economy with public procurements

An obvious means for local and regional authorities to promote the circular economy is to apply criteria that support the circular economy when making their public procurement decisions. In practice, this involves taking into account such factors as the examination of costs over the full life cycle of a product, including the charges related to the sustainable procurement of raw materials, maintenance, and recycling at the end of the life cycle.

The local authority of Venlo in the Netherlands took this approach when in a tender for construction of the town hall, it asked bidders to plan the life cycle of the future building on a “cradle-to-cradle” (C2C) basis. The tender stipulated the use of healthy and safe raw materials that are produced in accordance with the principles of sustainability, and can be recycled at the end of their useful life. A further condition was that the building to be constructed should meet all its energy needs from renewable sources, and bidders should also make provision for returning the water used in the building to nature. The plan submitted for the C2C concept had a weight of 30% in the judging of bids. An additional 30% of the total score was represented by the extent of costs of constructing the building and maintaining it for ten years (total cost of ownership), which included not only the directly incurred expenses, but also the social and ecological costs.

The project is expected to bring the municipality of Venlo savings of EUR 17 million over a 40-year period. In addition, it enables the town’s leadership to promote the establishment and development of systems that support the concept of the circular economy, stimulate demand for mechanisms that support the circular economy, and indirectly expand the knowledge of both consumers and service providers.

**Tool:** Sustainable design

**Budapest – smart city**

January 2017 saw publication of a document entitled *Smart Budapest – A Vision of Budapest as a Smart City*, which sets out a framework for the objectives of the city's leadership in this regard.

**The key objectives of the document with respect to the circular economy**

- Supporting environmentally friendly energy use in the consumer, business and public sectors alike, through raising of awareness, the promotion of best practices, and regulation. The aim is to reduce both per-capita and overall energy consumption and carbon dioxide emissions by 30%, relative to their 2005 figures, by the year 2030.
- Another objective in terms of energy consumption is for the city to increase the proportion of renewable energy sources to 20% by 2020, and to 27% by 2030.
- Regarding waste management, the targets include cutting the proportion of waste dumped in landfills to 10% by 2030, and increasing the recycling rate of municipal solid waste to 65%, also by 2030.
- The city's leadership aims to support the use of vacant business premises on a sharing basis, and the sharing-based use of other assets.

**Tool:** sharing, sustainable design

By 2050 75% of the world's population will live in cities. Cities are the motor of economic growth, with

85%

of the world's GDP now generated in cities.

In spite of targeted recycling programmes, in the USA more than

50%

of waste continues to end up in landfill.

## Recycling park

The Alelyckan recycling park established and operated by the city of Gothenburg provides residents with a platform where they can sell their unwanted items, and pick up some bargains among things that are judged to be useless or unnecessary by others.

The waste received by the centre is sorted and classified by specialist employees, and then, depending on their nature, are taken to various sales outlets located in the park, where visitors can buy them, either in their original state or after being repaired.

The accepted waste items cover a broad spectrum: used furniture, electronic devices, and even reclaimed building materials are welcome. Since it was established, the park has handled an average of 500 tonnes of waste a year, 75% of which found a new owner at the sales outlets in the park. It is estimated that owing to the centre, 5.5% of items slated for disposal are successfully reused in some form or another. Besides this, the park also functions as a traditional recycling centre, where the selectively collected types of waste are expertly managed

**Tool**: reuse, recycling

## Sharing city projekt

In September 2012, the city leadership of Seoul launched the

"Sharing City Seoul" initiative for the implementation of projects that support the sharing economy and tie in closely with the lives of the city's residents, and for establishing and broadening the foundations of the sharing economy.

The city's leadership set out to implement social innovation initiatives that give rise to new economic opportunities, and simultaneously cut down on the wasting of resources in urban areas.

The project mitigates the various socioeconomic challenges that arise in the city, by promoting the shared use of both public and private resources, while increasing the participation of citizens and supporting local businesses.

In the five years since its launch, the programme has achieved many significant results:

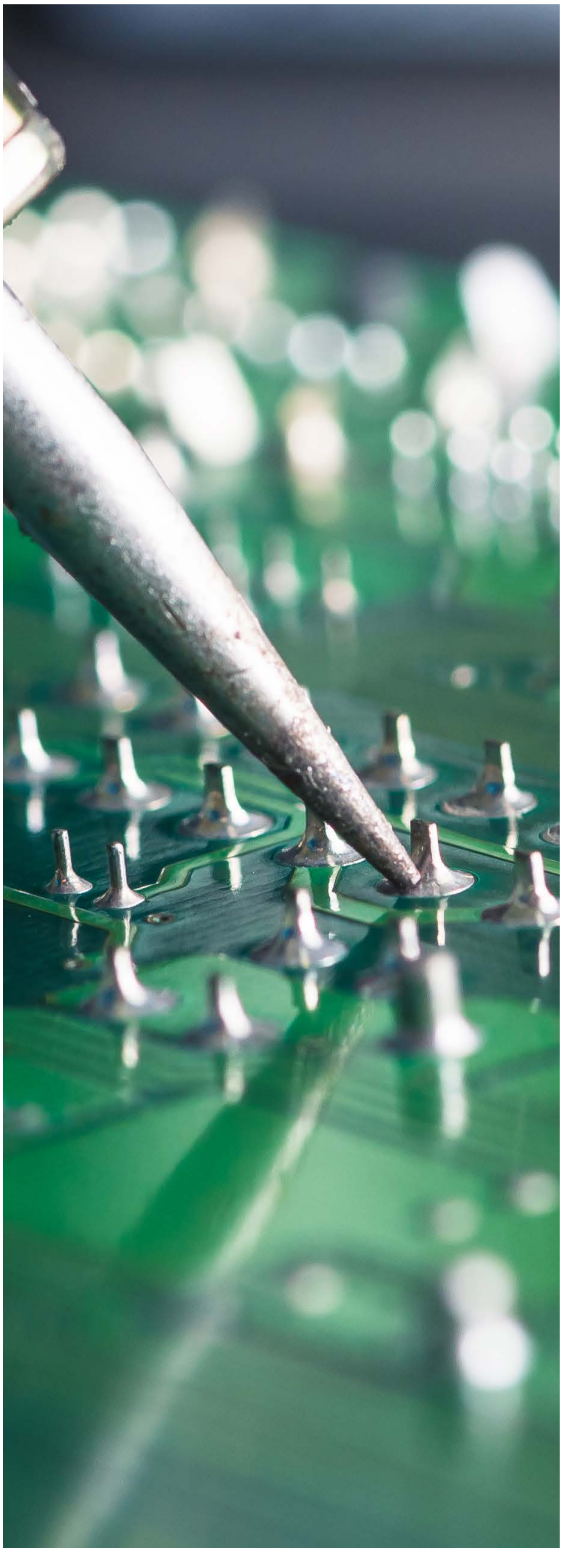
- Since 2013, the number of companies participating in the programme has more than doubled. The number of sharing service providers participating in the programme, and their revenue, has doubled on average between 2014 and 2015.
- The number of city-dwellers affected by the sharing economy has risen five-fold since 2014, to over one and a half million.
- Car sharing services are used by an average of 6,000 city-dwellers every day.
- The services of businesses specialising in the rental of durable goods are used by an average of 1,400 users a month.
- The idle capacity of 1,200 public institutions is being put to good use.
- 180,000 items of children's clothing have been re-used.
- Users shared 9,140 parking spaces in 363 parking garages.

**Tool:** sharing, sustainable design

OUTLOOK

# Will technology close the loop?

## Industry 4.0 in the service of the circular economy



### Industry 4.0 – the steam engines of the circular economy

While the main drivers of the circular economy are the shortage of resources, population growth and changes in consumer behavior, the main prerequisite for its emergence is technological development and the latest technological advances.

The fourth industrial revolution (Industry 4.0) and the development of the circular economy are mutually reinforcing: tools that support the emergence of Industry 4.0 can accelerate and ease the transition to circularity. At the same time, these tools also continue to evolve, taking the Fourth Industrial Revolution to a new level, with the creation of solutions that prevent the waste of valuable resources and pave the way for achieving a waste-free economy.

In the following section, we give a – by no means exhaustive – roundup of innovative technological solutions that are supportive of Industry 4.0, and which have the potential to promote more efficient resource management.

# New business models enabled by the Internet of Things and data analysis

**Industry 4.0 tool:**
Internet of Things and data analysis

**Supported circular-economy-tools:**
sharing economy, maintenance, repair, recycling

**The Internet of Things (IoT):**

The Internet of Things, the system of devices that are connected to the internet (and capable of communicating with each other), gives manufacturers or operators the ability to constantly receive data from the devices, control their operation remotely, determine their position and status, and gather and analyse data relating to their usage. This capability could form the basis for countless business solutions that have the added advantage of circularity. Let's look at a few examples.

## Sharing 4.0

**Cars:** one of the best known sharing-based platforms is probably car sharing, and a number of initiatives of this type have also been launched in Hungary, for the sharing of both conventional cars (Avalon CareSharing) and electric cars (GreenGo). With GreenGo, a telephone app can be used to locate cars in the local area, and check their charging level and estimated range. The app is also used to open the cars. Obviously, this would not be possible without a network of smart devices that can communicate with each other.

**Tools:** almost every household possesses valuable technical equipment that their owners probably only use very rarely (drills, chainsaws, etc.). Recognising this, several companies have been established that specialise in the rental of such tools, which clearly points in the direction of the circular economy. Certain Industry 4.0 tools can also boost the efficiency of these companies, for example if the tools are fitted with sensors, then the operation of the equipment pool becomes much simpler for the rental firm.

## A new age of maintenance

IoT technology permits the use of operating and follow-up procedures that can reduce the amount of waste resulting from failings in maintenance procedures or inadequate quality assurance. Through the use of sensors, maintenance that would otherwise be performed at set intervals can be replaced with targeted maintenance, scheduled on the basis of operating data collected from each individual component if needs be. It is also possible to effectively screen out the errors occurring at the very beginning of the manufacturing process, so they can be corrected in good time to prevent further waste.

**The "Product as a Service" model:** In Product as a Service (Paas) business models, the manufacturers retain ownership of the goods that they make, so it is the product's problem-free operation that they sell to consumers. They can only do this if they are capable of monitoring and analysing the activity of their products. In the PaaS model, a smart device monitors its own status, and sends an alert if it needs to be repaired or replaced. At the end of its useful life, it can even provide information about how it could be recycled.

## Smart waste collection solutions

A factor driving the development of smart waste collection solutions is that the frequency with which waste is collected in cities is often less than efficient, due to the difficulty of predicting consumer habits – but analysing past consumer conduct and the quantities of waste can assist with the forecasting.

Finland-based **Enevo** and the US companies **Compology** and **BigBelly** support waste disposal companies through the creation of targeted IoT and data analysis-based software and platforms, helping them to prepare their forecasts, monitor their assets and optimise their logistics decisions, picking up a raft of innovation and environmental awards and accolades along the way.

After collection, the sorting of the waste and its preparation for recycling takes place with the help of robot technology. We will deal with this in more detail in a later section of this publication.

# Robotics and artificial intelligence

**Industry 4.0 tool:**
robotics and artificial intelligence

**Supported circular-economy-tools:**
reuse, remanufacturing, recycling

The most tangible impact of Industry 4.0 in terms of the transition from a linear to a circular economy model is that the development of automation (machine learning, robotics) and smart logistics (data analysis, IoT, sensor networks) makes it possible to significantly reduce the quantity of waste generated, or to effectively feed the waste that is generated back into the manufacturing process.

The limits of robotics as we used to know them are being pushed back, and new rules are being laid down, by control systems that are based on artificial intelligence and learning algorithms, which are opening a storehouse of new opportunities for developers and programmers.

This level of advancement of robotics is enabling manufactures to apply mechanical work to more and more activities, thus increasing yields, reducing waste and extending the useful lives of products. In what follows we describe some case studies and examples that demonstrate the impact that robotics and artificial intelligence can have on the economy through the reduction and recycling of waste.

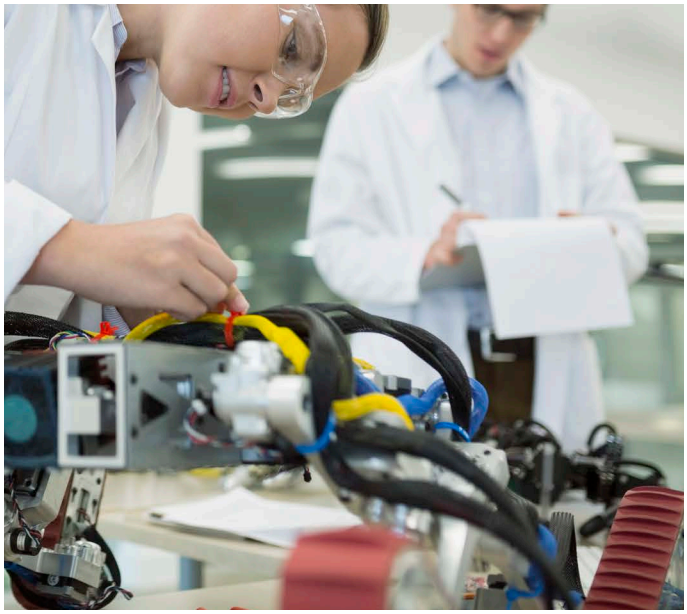
## Robots can be waste experts!

The use of technological innovations resulting from the latest industrial revolution far exceeds the limitations of conventional waste sorting processes. The Finnish **ZenRobotics**, which is currently market leader in the sector, has rethought the inflexible, mechanical method of sorting by shape, colour, material, density or size. The ZenRobotics Recycler has revolutionised the sector by combining three technologies made available by the fourth industrial revolution. Sensors identify the various materials, automated robot arms perform the sorting, and learning software, which gives the system its artificial intelligence, controls the process and makes it possible to teach the system new types of waste, greatly improving the flexibility and efficiency of the sorting lines.

## Robots that could rescue us from the sea of electronic waste

The Swedish company **Refind**, which specialises in electronic waste, not only makes the management of today's increasingly pressing electronic waste problem more efficient, but also demonstrates the complexity of decisions that can be made by an automated system. The selecting robot identifies the scrapped electronic devices, analyses their usable components and selects the appropriate means of processing them. At present the factory sorts 70% of batteries in the United Kingdom, including built-in units.

**Liam**, a robot developed by Apple, has developed further specialised skills for the management of electronic waste. Every year the robot sorts 1.2 million telephones, identifying them and picking out the usable components and materials, thus reducing Apple's need for new resources.



# Additive manufacturing, 3D printing

**Industry 4.0 tool:**
Internet of Things and data analysis

**Supported circular-economy-tools:**
sharing economy, maintenance, repair, recycling

The 3D printing of replacement and spare parts on demand can improve the maintainability of devices, extend the life cycles of products and appliances, and simplify the manufacturing process. Thus, through the manufacture of sustainable and long-lasting products, it is aligned with the principles of the circular economy. It can also substantially reduce manufacturing time and costs of low-volume and complex products.

3D printing makes it possible to cheaply manufacture small quantities of complex structures, removing the need to acquire and maintain special production lines. In this way, it can offer a rapid, potentially on-site solution to the problems associated with keeping stocks of spare parts that are in short supply, or perhaps no longer in production. This plays an important role in extending the useful life of products and, through the fabrication of individual components, in the re-use of old products.

## 3D printing = fewer byproducts

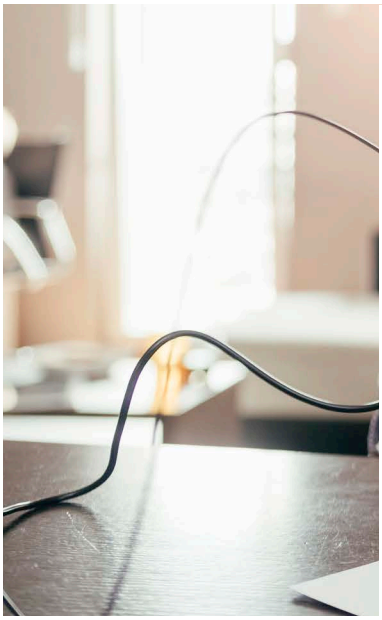
Manufacturers all around the world have switched from milling or similar technologies to 3D printing.

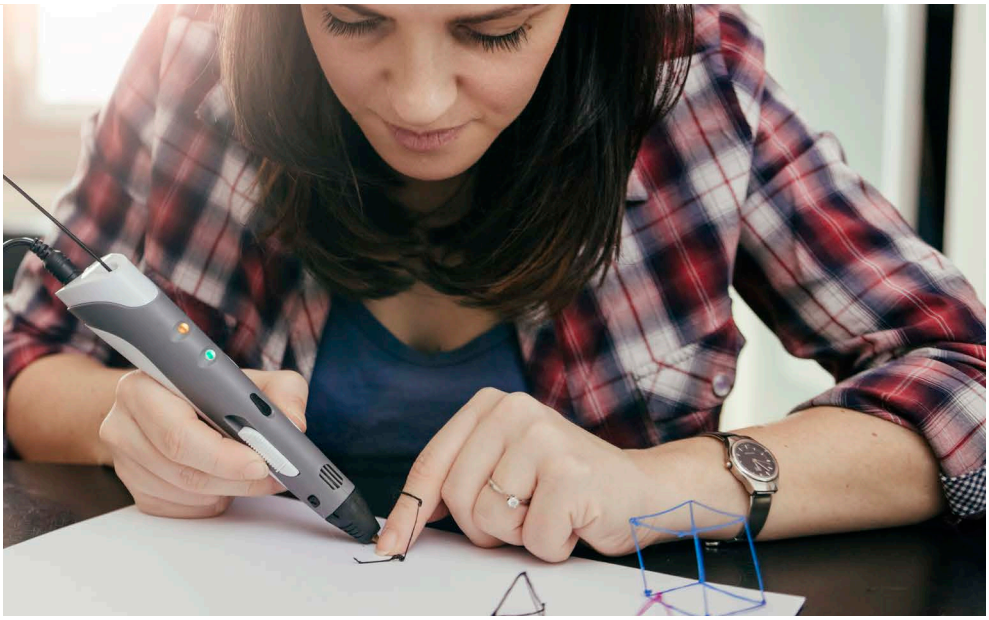
An excellent example of how the opportunities offered by the new technology can be leveraged is the China-based **Haier Molds Co.** The company has incorporated 3D printing, which is significantly faster than milling, into its R&D activity, making it possible to manufacture prototypes ready for testing within a few hours. This permits an iterative design method that allows them to launch better quality products onto the market in a shorter space of time.

The Oakland-based company **FATHOM** has been in the 3D printing business since 2008, and their objective is to serve customers with customised and complex components with minimal stock levels. According to the head of the company, Rich Stump, it is already economical to manufacture fewer than 200-400 units using 3D printing, and they are working to push this figure higher in the future.

## No more empty loads

Inventory management and logistics place a considerable burden on the environment, but 3D printing can relieve both companies and the environment of these costs. **Philips Lighting** has completely overturned the model of central design, manufacturing and distribution, by moving the manufacturing of spare parts to local business units equipped with 3D printers, situated in close proximity to consumers. As a result, in this business line, Philips has seen a reduction of 20% in inventory management costs and 30% in operating costs, while harmful emissions have decreased and the efficiency of materials use has improved.





# Materials technology

**Industry 4.0 tool:**
materials technology

**Supported circular-economy-tools:**
recycling, sustainable design

By developing the raw materials of products it's possible to significantly reduce the quantity of waste that's produced, so materials technology has an important role in the circular economy.

On the one hand, the new raw materials are designed to fit in with the biological or technical circular processes; in other words, they should be biodegradable and suitable for reintroduction into the natural environment, or it should be possible to dismantle and recycle them. Raw materials designed for the biological cycle are compostable, while raw materials designed for the technical cycle – such as polymers, various alloys and other artificial materials – are designed to be recyclable with minimum energy investment and the lowest possible rate of deterioration in quality.

On the other hand, if the development of the materials makes us capable of manufacturing, for example, a milk carton from 30% less raw materials due to the improved mechanical properties of the material, this means we use less plastic and therefore less crude oil. In other words, there's less material that we need to recycle, and we get a lighter product that requires less fuel for transportation, so lower quantities of harmful substances are released into the atmosphere.

## New opportunities for recycling

When it comes to food packaging, it is very common for manufacturers to combine types of materials in order to extend shelf life; but this often makes it impossible or far more expensive to recycle the packaging.

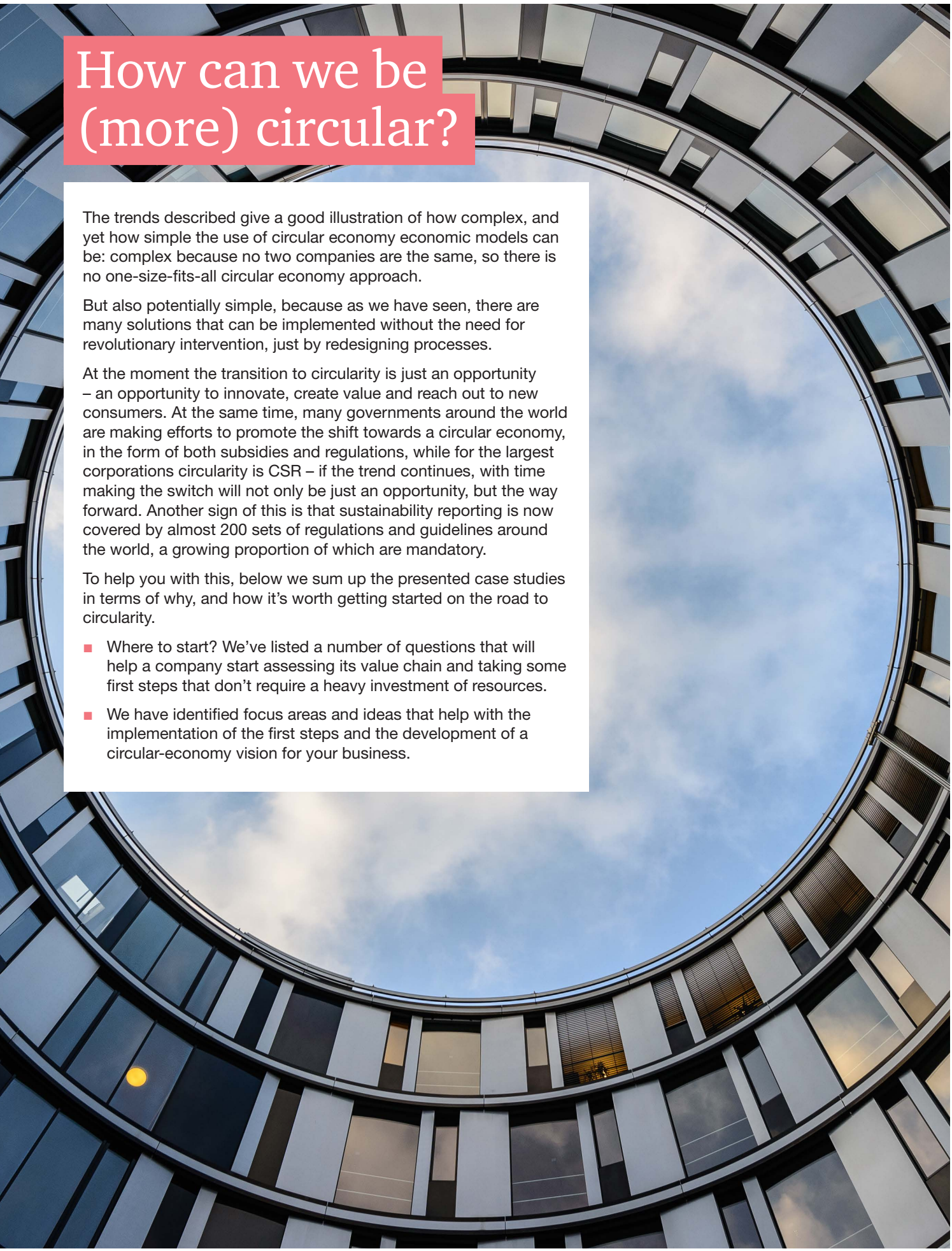
In the solution developed by the German company Separtec, the mixed packaging materials are shredded and then separated in a special bath. This technology makes it possible to extract and recycle the LDPE plastic, polyester and aluminium from the packaging. The technology is currently in the experimental phase, with large-scale use expected from 2018. After this, the company plans to process 18,000 cubic metres of waste a year.

## Plastic from rice husks

Taiwan-based **Miniwiz** has spent many years creating a technology that makes it possible to manufacture new plastic by combining municipal plastic waste and the byproducts of agricultural production (rice husks). The manufacturing process uses two thirds less energy and emits 40% less carbon dioxide than the conventional process for manufacturing plastic. The new material is used in all traditional processes for the use of plastic, and it is also recyclable.

Photo by JJ Ying on Unsplash

# How can we be (more) circular?



The trends described give a good illustration of how complex, and yet how simple the use of circular economy economic models can be: complex because no two companies are the same, so there is no one-size-fits-all circular economy approach.

But also potentially simple, because as we have seen, there are many solutions that can be implemented without the need for revolutionary intervention, just by redesigning processes.

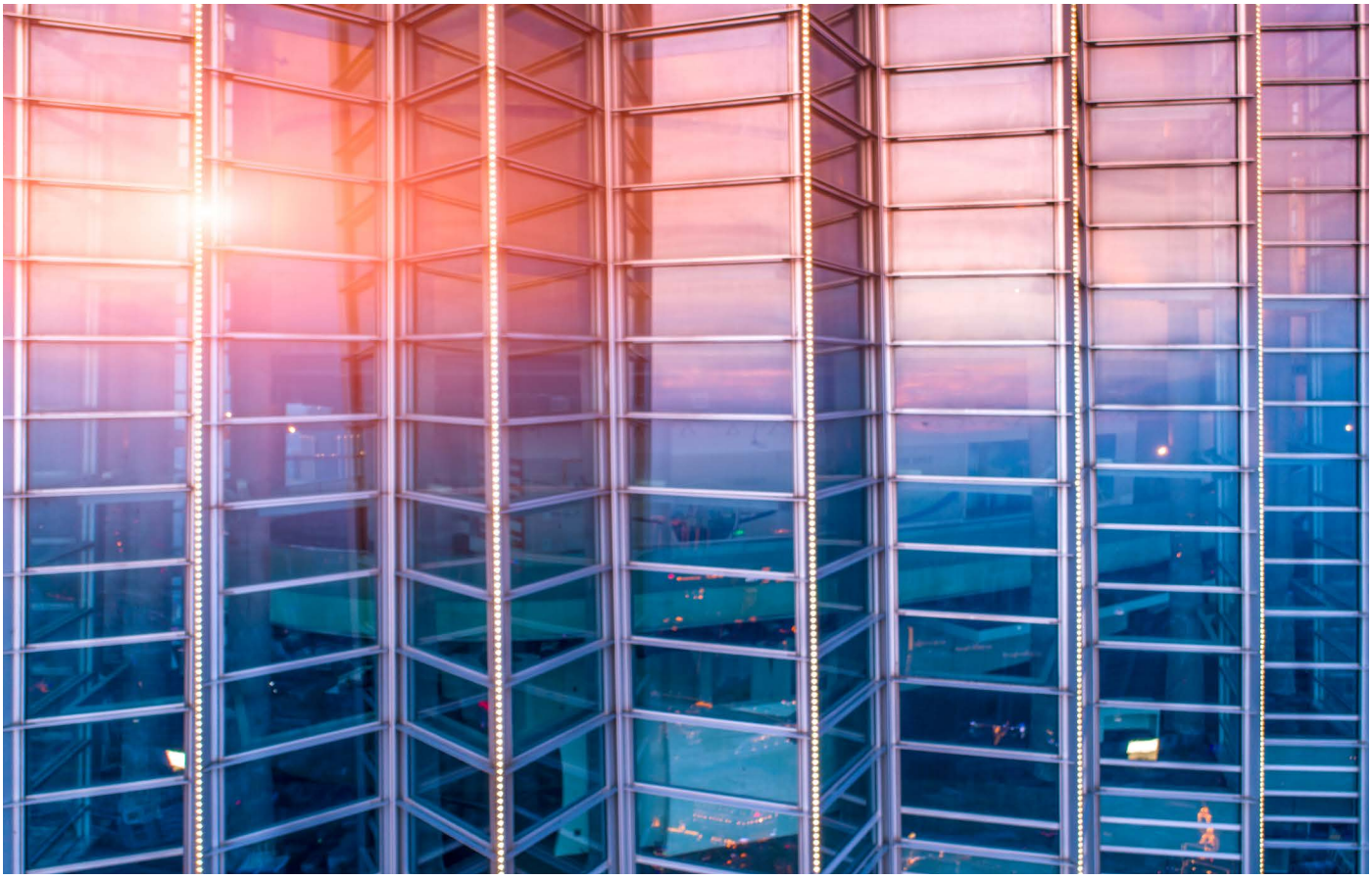
At the moment the transition to circularity is just an opportunity – an opportunity to innovate, create value and reach out to new consumers. At the same time, many governments around the world are making efforts to promote the shift towards a circular economy, in the form of both subsidies and regulations, while for the largest corporations circularity is CSR – if the trend continues, with time making the switch will not only be just an opportunity, but the way forward. Another sign of this is that sustainability reporting is now covered by almost 200 sets of regulations and guidelines around the world, a growing proportion of which are mandatory.

To help you with this, below we sum up the presented case studies in terms of why, and how it's worth getting started on the road to circularity.

- Where to start? We've listed a number of questions that will help a company start assessing its value chain and taking some first steps that don't require a heavy investment of resources.
- We have identified focus areas and ideas that help with the implementation of the first steps and the development of a circular-economy vision for your business.

# Where to start?


*PwC Global Sustainability Team, 2017*



# Focus areas for getting started

### Question what your products are!

Think carefully about what the true value and function of your product is for consumers. Can raw materials be removed from it without any significant loss of value?

*The Twenty project in Denmark points out that vast quantities of packaging material could be saved if we bought liquid cosmetic and household products (shampoo, shower cream, washing powder, etc.) in dessicated, powder form, which takes up a fraction of the original volume of these products.*

### Innovate (together)!

Could your product be made from sustainable raw materials? If you can't find a sustainable alternative, produce one yourself or collaborate with research institutes.

*The Adidas Parley collection is made of 95% plastic waste from the ocean. After a successful pilot project, they plan to sell 1 million units.*

*Ohoo wants to redefine how we drink: instead of plastic bottles, they package the water in (edible) bubbles made from plants and seaweed.*

### Talk to consumers!

Without consumers, there is no circularity. Campaigns are needed to raise consumers' awareness of product (re)use and encourage them to return the products that they have grown tired of.

*Levi's wants to achieve full circularity by 2020, and they know that without the consumers on board it won't happen.*

*The quality of their jeans allows them – if properly looked after – to be worn for a lifetime. Levi's offers tips to consumers, via several forums, on how to wear and wash their denims. No-longer-needed items can be returned, and Levi's will recycle them.*

### Repair it!

Create infrastructure for repairing the products. In the circular economy, companies assist – either themselves or through contracted partners – with the maintenance and repair of their products.

*At IKEA in Belgium, as well as buying new products, customers also have the opportunity to repair their old IKEA furniture, as the company also sells spare parts. Besides this, they hold workshops where shoppers are given new ideas about how to refurbish, modify or repurpose products that they have become tired of.*

### Turn it around!

Make logistics a two-way street! You need to establish a system for enabling consumers to return used products to you (or the secondary market) after use.

*I:CO specialises in working together with large retail clothing chains, managing the complete logistics of used products from the moment that they are returned by shoppers, including sorting, processing and resale.*

### Look for a secondary market! /Create a secondary market!

You might have more customers than you think. Beyond the first buyers of your products, there may also be a market for their used products or your manufacturing byproducts. Search for markets outside your own sector!

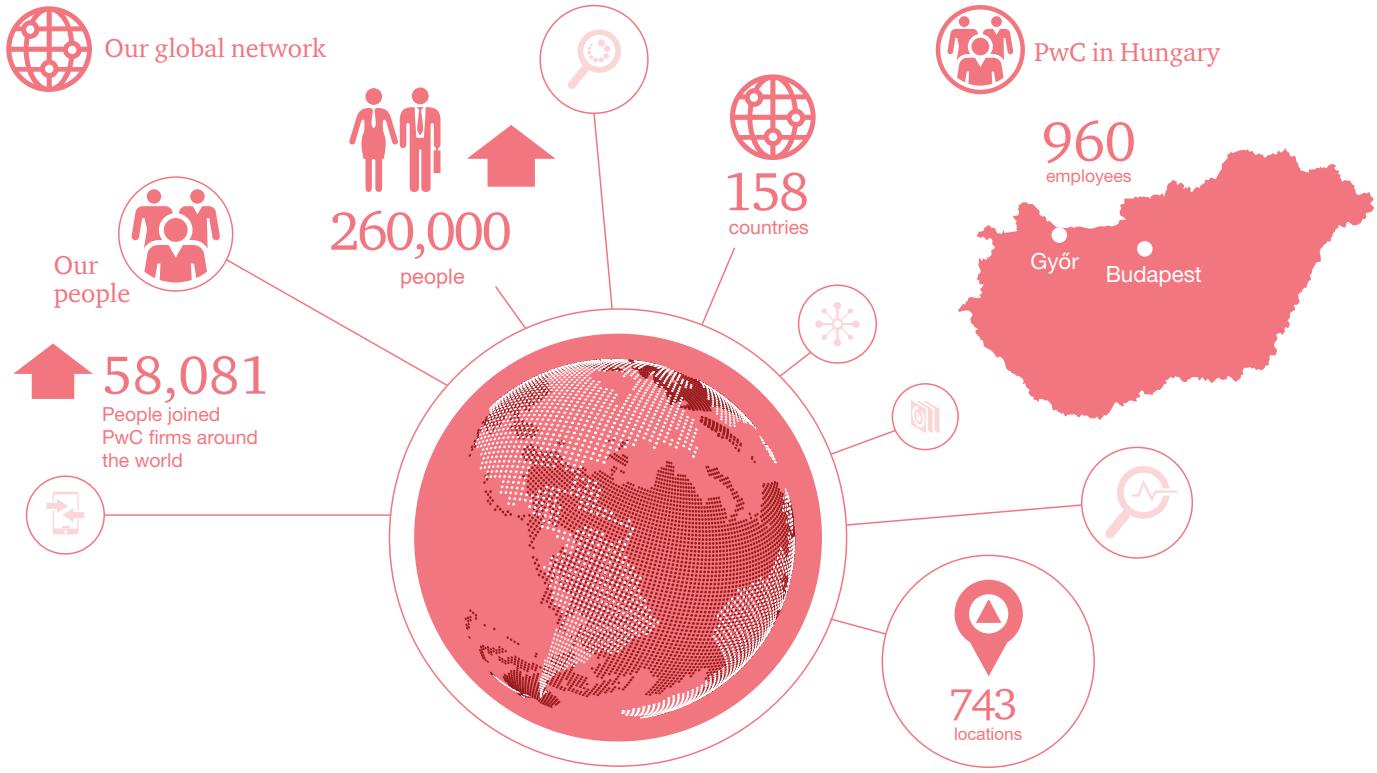
*The possibilities are endless: running tracks from sports shoes, carpets from clothes, animal feed from food byproducts, furniture from sports equipment, cosmetics from pomegranate seeds.*

### Follow the trends!

Keep track of initiatives that are committed to the transition to a circular economy.

- The European Commission's initiatives and recommendations supporting the circular economy
- Initiatives of the European Institute of Innovation and Technology (EIT)
- Initiatives of the Ellen MacArthur Foundation
- Humusz Szövetség – Humusz Community
- Körforgásos Gazdaságért Alapítvány – Foundation for Circular Economy
- Business Council for Sustainable Development in Hungary (BCSDH)

# About PwC




## How can PwC help?

We believe that in business, there's nothing more important than trust-based relationships. We've been working for more than 25 years in Hungary to ensure that for our clients – be they multinational groups of companies or local, privately owned businesses – we are not merely consultants, but dependable long-term partners in the making of their day-to-day decisions.

Thanks to our extensive international network, we can provide our clients with professional services that draw on the combined expertise of almost 236,000 specialists in 158 countries around the world, from auditing and tax or legal consulting through the provision of business or financial advice.

In our sustainability projects, building on our international and local experience combined with our expertise in transparent operation and sustainability, we provide our clients with comprehensive services from elaboration of the initial concept through the detailed planning and implementation stages.

We can support the introduction of various sustainable, circular economy solutions from the time that the needs arise, through implementation and the back-testing of the results achieved, and we can also assist our clients in finding and securing the sources of funding necessary for this, working closely with our tax consulting and legal consulting divisions.

## PwC Hungary's sustainability services:

**General**

- Sustainability strategy development
- Sustainability reporting and monitoring (SDG reporting guidance, TIMM, etc.)
- Sustainability-related training

**Business processes**

- Sharing economy
- Reuse planning
- Life-cycle assessment and optimisation
- Sustainable procurement

**Society and environment**

- CSR strategy development
- Social impact assessment
- Sustainability Stakeholder Management Program design and implementation
- Smart city solutions

**Industry 4.0**

- Pre-planned maintenance

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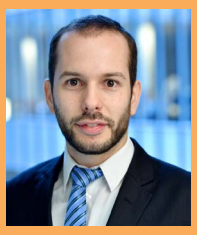

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