VEOLIA INSTITUTE

THE VEOLIA INSTITUTE REVIEW

FACTS REPORTS

2021

INDUSTRY AND WASTE:
TOWARD THE CIRCULAR ECONOMY

In partnership with

Centre de Gestion Scientifique — MINES ParisTech — PSL

THINKING TOGETHER TO ILLUMINATE THE FUTURE

THE VEOLIA INSTITUTE

Designed as a platform for discussion and collective thinking, the Veolia Institute has been exploring the future at the crossroads between society and the environment since it was set up in 2001. Its mission is to think together to illuminate the future.

Working with the global academic community, it facilitates multi-stakeholder analysis to explore emerging trends, particularly the environmental and societal challenges of the coming decades. It focuses on a wide range of issues related to the future of urban living as well as sustainable production and consumption (cities, urban services, environment, energy, health, agriculture, etc.).

Over the years, the Veolia Institute has built up a high-level international network of academic and scientific experts, universities and research bodies, policymakers, NGOs and international organizations. The Institute pursues its mission through publications and conferences, as well as foresight working groups.

Internationally recognized as a legitimate platform for exploring global issues, the Veolia Institute has official NGO observer status under the terms of the United Nations Framework Convention on climate change.

THE FORESIGHT COMMITTEE

Drawing on the expertise and international reputation of its members, the Foresight Committee guides the work of the Veolia Institute and steers its development.

The current members of the Foresight Committee are: **Harvey Fineberg**, President of the Gordon and Betty Moore Foundation and former President of the American Institute of Medicine; **Pierre-Marc Johnson**, international lawyer and former Premier of Quebec; **Philippe Kourilsky**, Honorary Director General of the Pasteur Institute; **Amy Luers,** Global Lead Sustainability Sciences at Microsoft; **Mamphela Ramphele**, former Managing Director of the World Bank and **Amartya Sen**, Nobel Prize-winning economist and Professor at Harvard University.

THE REVIEW

Issue coordinated by Franck Aggeri, Helen Micheaux and Joël Ntsondé, Center for Management Sciences, MINES ParisTech - PSL Research University.

The Veolia Institute Review - FACTS Reports is an international publication compiling diverse perspectives on topics at the crossroads between society and the environment.

The review was launched in 2007 with the aim of sharing best practices from the field, to help find solutions to problems in the economy, development, healthcare, environment, agriculture and education, in both developing and developed countries.

The interdisciplinary review is a vehicle for sharing the experiences and expertise of different stakeholders (researchers, academic experts, policymakers, companies, NGOs, international organizations, etc.), with the aim of taking advantage of a diversity of perspectives on a given topic, by combining feedback on best practices from the field and expert analysis.

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FOREWORD

Amy Luers -
Global Lead on Sustainability Science at Microsoft
Founder of Sustainability in the Digital Age
Member of the Veolia Institute Foresight Committee

Waste is a human invention.

Waste and pollution are human inventions. For many years, I accepted these concepts as essential facts of life, problems that simply had to be managed. As a young environmental engineer, I worked with isolated communities in the mountains of Central America to enable access to potable water, which is essentially freshwater that has not been contaminated by human, animal, or industrial waste. To find an uncontaminated water source, we would search for a spring in the forested hills high above the community. When we found one, we would build an enclosed cistern to protect it from future contamination, and use gravity to pipe water to the community below. This approach provided them with safe drinking water, but it did nothing to clean the natural waterways that the communities used for bathing, fishing, and many other purposes.

This led me to explore inexpensive options for treating wastewater, such as constructed wetlands. As I learned about the ecology of wetlands and lakes, I realized that in nature there is no such thing as waste or pollution. Nature is circular, all outputs eventually become useful inputs to another component of that system: a fallen tree becomes food for termites or a home to other organisms; decomposing branches and leaves add nutrients to the surrounding soil. As I learned more about ecosystem ecology, I had an epiphany about the wastewater problem I was seeking to address: treating wastewater for safe disposal was the wrong design challenge. The correct design challenge should be how to utilize human outputs as inputs to products and services that benefit both human and natural communities.

Circularity is the foundation of nature and humanity's life-support systems. Our linear system of production and consumption, which begins with resource extraction and ends with waste disposal, is disrupting nature's cycles. Consider our energy system. Most of the world's energy is produced by burning fossil fuels and disposing of carbon dioxide and other greenhouse gases as waste into the atmosphere. Most of the world's food is produced by agricultural practices that extract nutrients and water for production, while releasing pollutants in the environment and, according to the United Nations, dispose of over 900 million tonnes of waste each year. These linear processes disrupt the Earth's energy cycle, water cycle, nutrient cycle, and rock cycle, in ways that are creating water, food, health, and financial insecurities.

A circular economy is restorative by design. By using and reusing natural capital with little to no waste, production and consumption are sustained within the Earth's natural cycles. At Microsoft, we are working internally and with partners around the world to support a transition toward a more circular economy. We have committed to becoming carbon negative, zero waste, and water positive, and to protecting more land than we use. Microsoft's largest campus already operates on zero-carbon energy and has been zero-waste certified since 2016. But there is still much work to do. As the demand for our cloud services grows, Microsoft's datacenter footprint will expand. To ensure this expansion is sustainable, Microsoft is innovating to create closed-loop models. We are also working with customers, partners, and suppliers around the world to reduce their waste footprints through our learnings and with the power of data, AI, and digital technology. Today, we still lack consistent, high-quality data about the amount of waste, the type and quality, where it is generated, and where it goes. We are investing to digitize waste data across the company to identify opportunities to improve waste data collection, both for ourselves and for our customers.

The path to a circular economy requires designing waste out of production and consumption systems and designing within nature's cycles. This is an engineering challenge, a socio-economic challenge, and an institutional challenge. This issue of Veolia Institute's FACTS Reports explores each of these, with a focus on the role of industrial players in the process of scaling up the Circular Economy. This multidisciplinary and international collection of papers will enable readers to grapple with one of the most exciting, yet complex, challenges of our century.

INTRODUCTION

Nicolas Renard - Executive Director, Veolia Institute

Waste is a recent invention. It was unknown in the 18th century, when everything was a resource and the economy was circular. It is an invention we must uninvent. This waste, once nonexistent and now omnipresent, has to disappear, be transformed into a resource that can be returned to the economy. The economy of the past was circular, the economy of the future will be too, but in a different way. Returning to circularity is a complex affair because yesterday's world bears no resemblance to the world of today: the extreme variety of materials employed, large number of actors, technological sophistication and globalized trade all combine to make economic reconversion a hugely challenging task. Challenging, but not impossible.

And a reminder to the doubters: the circular economy is not optional, it is critical. Global resource use is forecast to double over the coming four decades. This is unthinkable if we are to preserve our environment. The stark reality is that, in everything that we consume and do, we use an excessive amount of natural resources, whether minerals, energy, biomass, water or space. Remember too that most of what we consume is hidden: for instance, in the digital realm, 90% of overall energy use takes place before a device is purchased, when the metals are extracted, component parts manufactured and assembled, and the finished product transported[1].

Worldwide, only 9 % of exploited natural resources are reinjected into economic channels

Bolstering the productiveness of resources extracted from the natural environment requires that they are recycled. Yet recycling remains marginal. Worldwide, only 9% of exploited natural resources are reinjected into economic channels. The figure for Europe is just 14%[2]. And the fact is that recycling waste is simply one of the initial stages in a circular economy. Even if it were to become widespread, the recycling solution would not be enough to meet all needs, partly owing to losses of material during recycling processes and partly because demand for consumer goods, and thus for mineral raw materials, is growing all the time.

The truth is that there is far more to the circular economy than just recycling. It encompasses all other types of strategies for creating loops and extending the useable lifetimes of materials and products: reuse, repair, hire, share, eco-design and so on. These are all strategies that reduce the materials intensity of economies, create jobs, and strengthen national economic sovereignty. They are also radically different to our current production and consumption habits, our business models, our supplier-client relationships, our logistics chains, and so on.

At the time of writing, the circular economy is more about potential than reality. Ratcheting up from low-level to full-on circularity will require designing products differently, as assemblies of future waste that can be reused or transformed. They must be designed to be traceable, repairable, reusable, recyclable, upgradable and improvable.

Achieving even this is no simple matter, and there are further constraints the circular economy has to overcome, including the possible toxicity of reused materials, technologies that do not always fully deliver, the strict application of hygiene standards, complying with specifications set by manufacturers for quality, price and availability, and the need to upskill actors involved in the new economic ecosystems.

Local and national governments can smooth the way for the circular economy by offering financial support to its constituent sectors until they become viable, nudging consumer behavior (since a circular economy is impossible without consumer demand), and creating indicators that simply and reliably show a product or production sector's degree of circularity.

Linear or circular, clean or dirty, high-carbon or low-carbon, extractive or regenerative: just some of the many terms used to describe an economy, its successes and limitations, and the hopes humanity invests in it. Some people are now calling insistently for an ultimate shift from the circular economy to a sober economy. A form of economy that aims not only to reduce the use of resources but also to scale back needs. It is predicated on using fewer items and services, and therefore deliberately dialing down people's desires and dreams. Is this something consumers will accept?

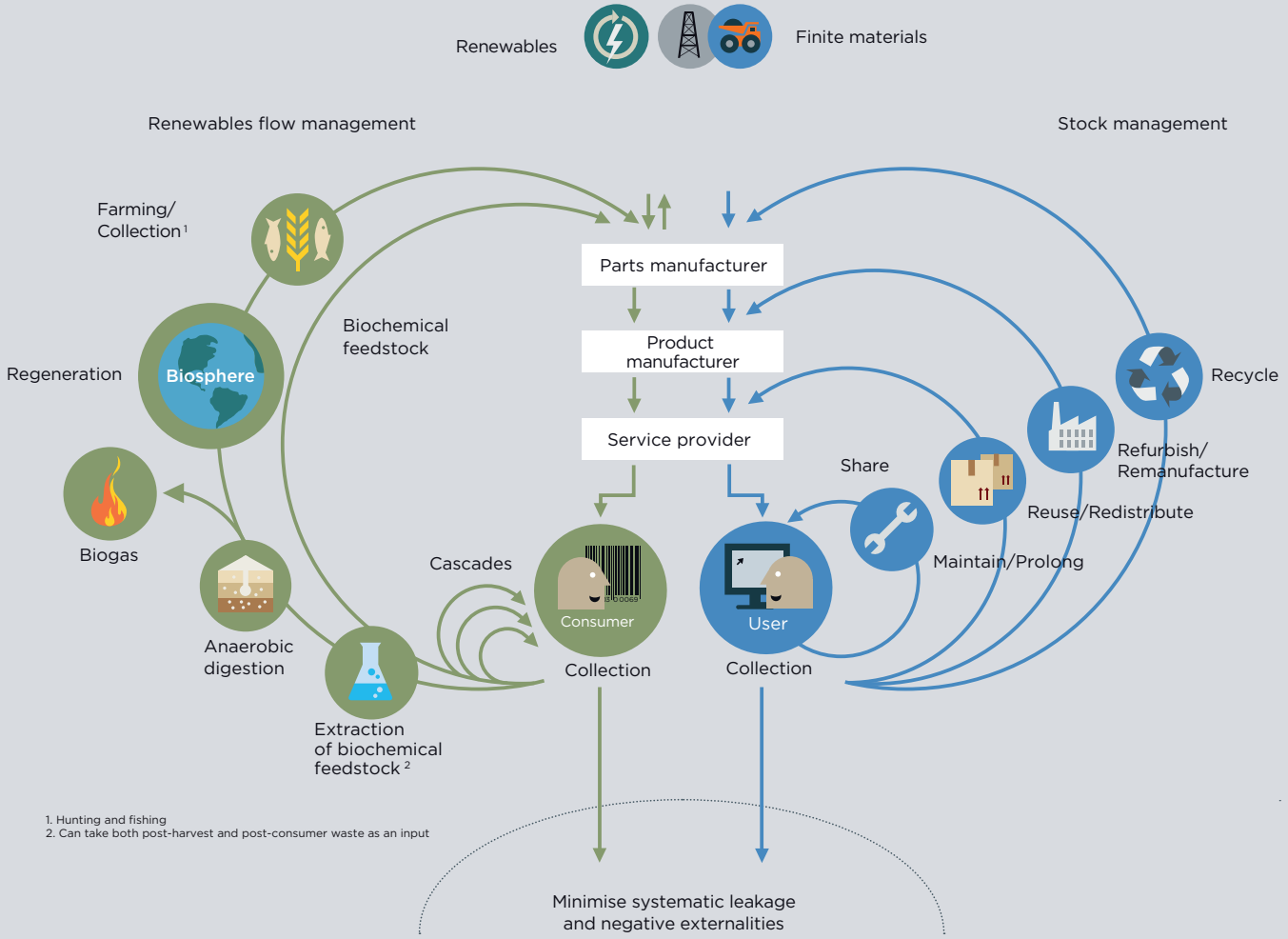
When we consider inherent physical scarcity alongside the scarcity caused by exhausting existing resources, under-investment, overexploitation and waste, we can see that today we live well beyond our ecological means. However, there is a way to redress this: the circular economy. We have an incomparable teacher to help us reach the next level in an economy that is new yet ancient: nature, where everything is a resource and there is no such thing as waste. Nature is an expert in environmentally sensitive, fine chemistry, with extraordinarily efficient transformation processes and billions of years' experience. Seven centuries ago, Leonardo da Vinci was already advising us to "learn from nature, that is where our future lies."

1 GreenIT, 2019. The environmental footprint of the digital world - https://www.greenit.fr/wp-content/uploads/2019/11/GREENIT_EENM_etude_EN_accessible.pdf

2 Circularity Gap Report, january 2018.

Circular economy: strategies and policies

Diagram from the Ellen MacArthur Foundation

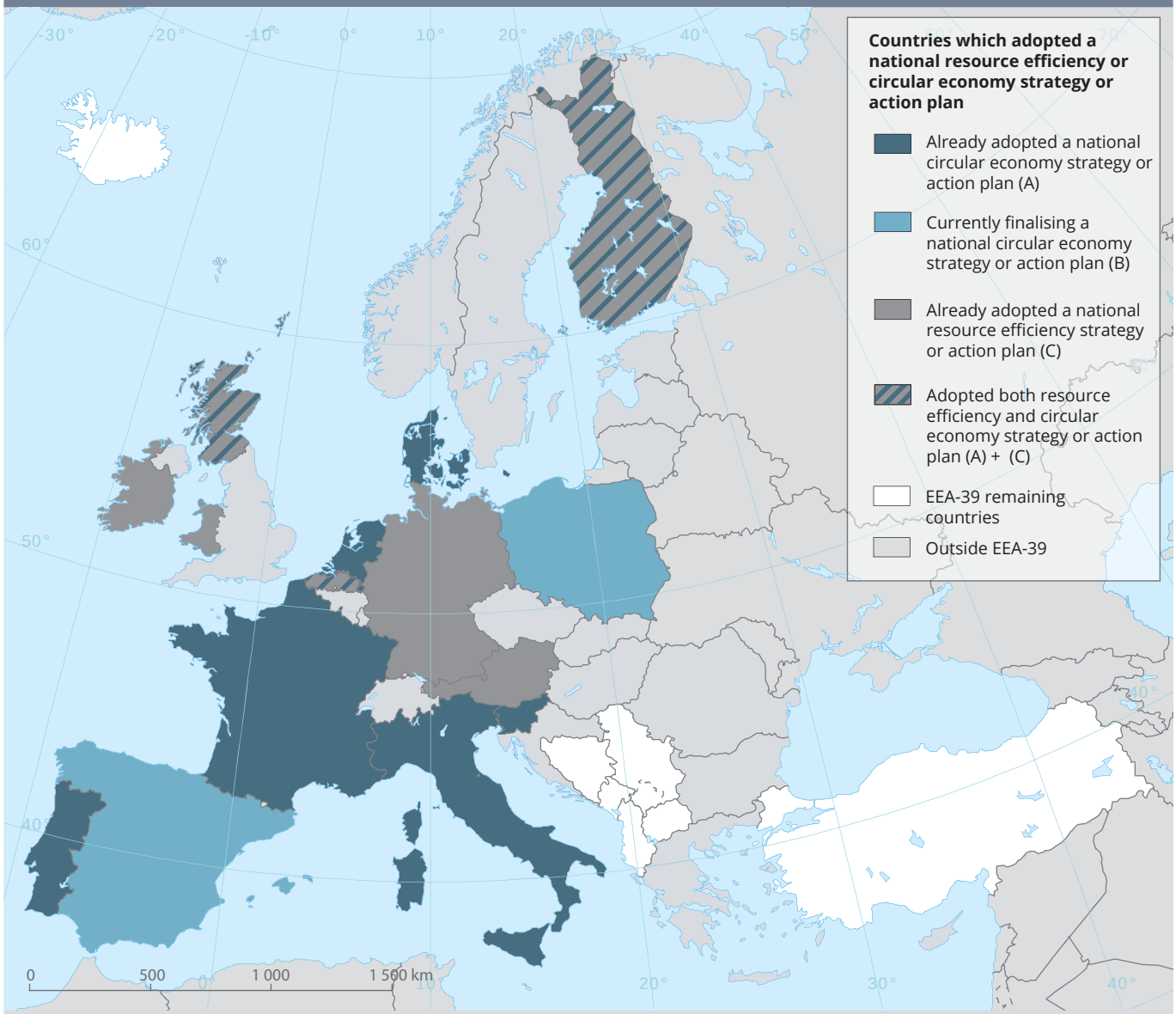


Source: Ellen MacArthur Foundation, *Circular economy systems diagram* (February 2019) www.ellenmacarthurfoundation.org
Drawing based on Braungart & McDonough, Cradle to Cradle (C2C)

The diagram illustrates different strategies for looping material and energy flows to reduce resource extraction (top half) and avoid waste creation (bottom half). Two types of circularity strategies are depicted: for technical inputs from non-renewable resources (right-hand side) and for biochemical inputs from renewable resources (left-hand side).

In principle, the shorter the loop (e.g.: maintenance, reuse), the greater the likelihood of maintaining economic value and minimizing environmental impacts.

European countries with a circular economy strategy



Source: Kazmierczyk, P., & Geerken, T. (2020). Resource efficiency and the circular economy in Europe 2019: even more from less; an overview of the policies, approaches and targets of 32 European countries.

This map, taken from a European Environment Agency study, shows countries which had adopted a national resource efficiency or circular economy strategy or action plan as of 2019. The color legend indicates the state of progress with these measures.

The map does not show countries that have simply indicated an intention to take action in the future. In total, 21 of the 32 countries in the study stated they had begun work on drafting national policies relating to the circular economy.

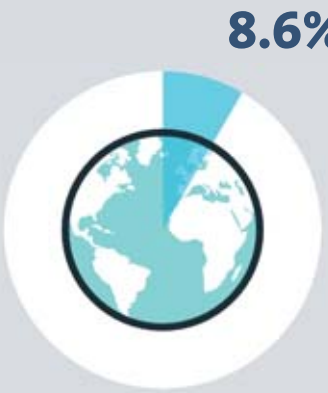
MEASURING CIRCULARITY

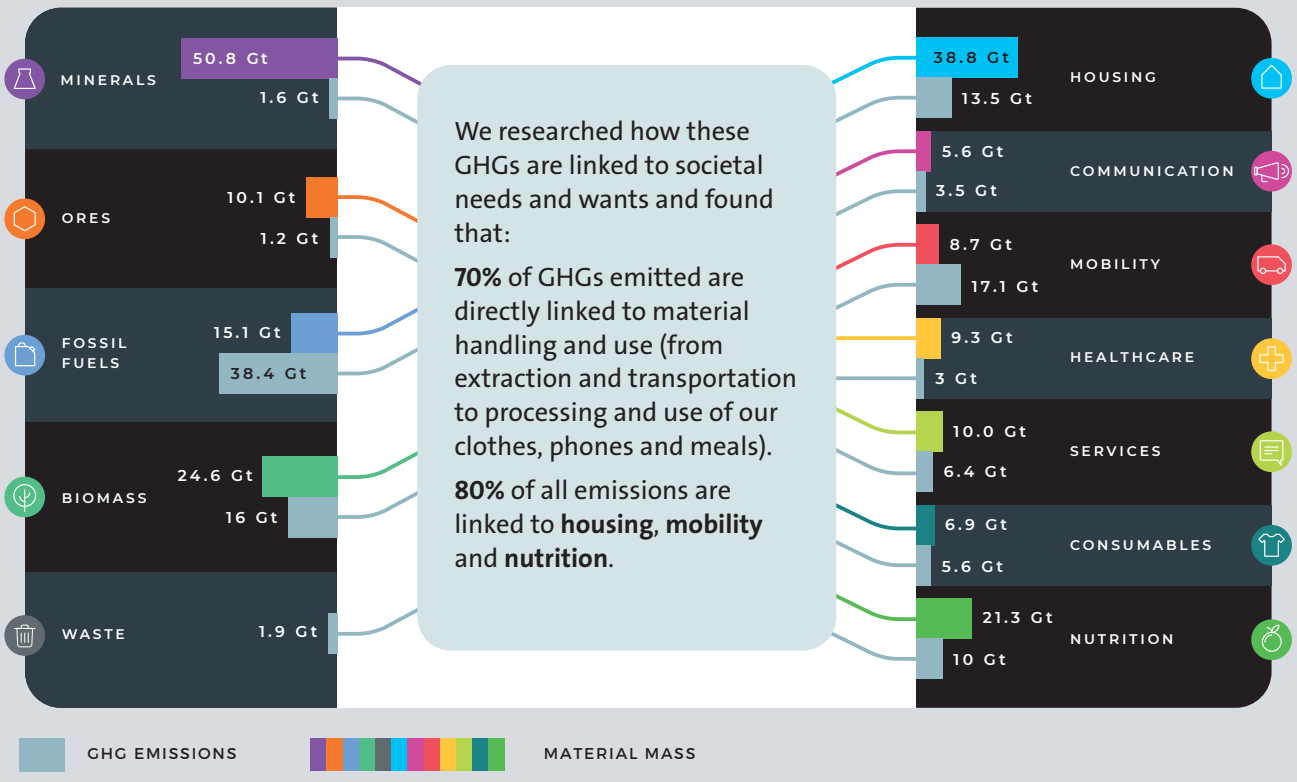
The Circularity Gap

Last year, Circle Economy's Circularity Gap Report revealed that: **our world is only 8.6% circular, leaving a massive Circularity Gap.** The outlook is grim. Just two years ago that number was 9.1%. Humanity has breached two severe milestones:

The world is consuming 100 billion tonnes (Gt) of materials a year

It is 1-degree warmer





Source: https://www.circularity-gap.world/2021

The Circularity Gap is a global indicator measured annually by the Platform for Accelerating the Circular Economy, a collaboration between over 70 private and public sector actors established by the World Economic Forum and currently hosted by the World Resources Institute. This indicator is obtained from the ratio between the quantity of material recycled and the total quantity of material inputs into the global economy each year. In 2020, the Circularity Gap was assessed at 8.6%, down from 9.1% in 2018.

As well as a global indicator, an annual report also assesses the quantities of resources used per category of material (mineral, ores, fossil fuels, biomass and waste), greenhouse gas emissions caused by the extraction of these resources, the quantity of materials used per activity sector (housing, communication, mobility, healthcare, services, consumables and nutrition) and their carbon impacts.

CIRCULAR ECONOMY AND EMPLOYEMENT IN FRANCE

Jobs sustained by various waste management activities:

1 FTE
for each 10,000 metric tons
sent to landfill

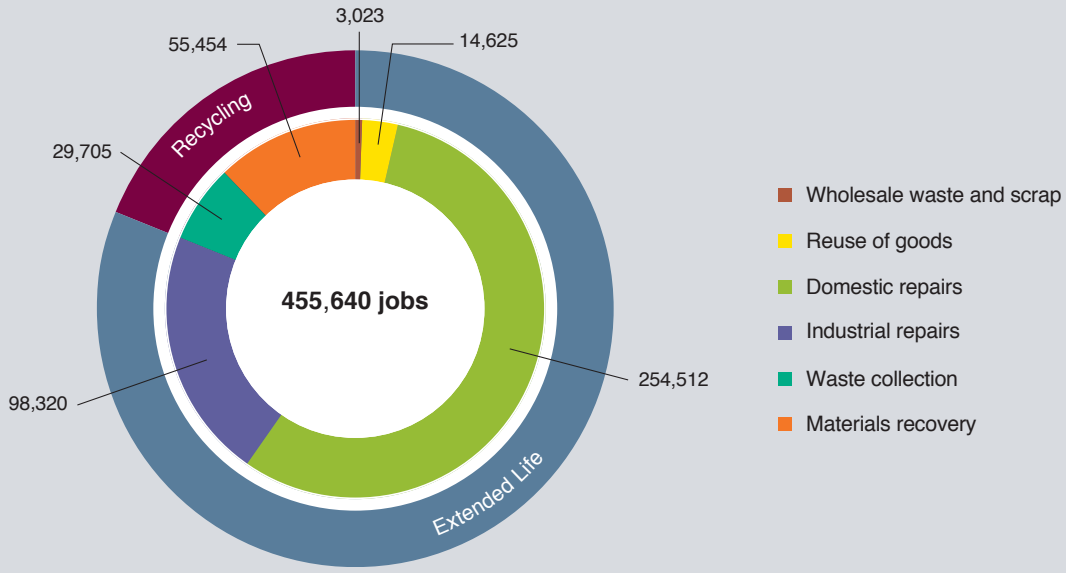
3 to 4 FTE
for each 10,000 metric tons
sent for incineration, composting, sorting-methanization

11 FTE
for each 10,000 metric tons
entering waste sorting centers

50 FTE
for each 10,000 metric tons
of complex end-of-life products sent for dismantling

Sources: ADEME (2014). Fact sheet. Circular Economy: Notions

Job breakdown by pillar and sector in 2017 in terms of number of people employed



NB: vehicle repairs and computer repairs were classified as domestic repairs even though they also involve services to professionals.

Source: Eurostat. Processing: SDES, 2020

This is one of 11 indicators used to track circularity in the French economy. It seeks to quantify the number of jobs associated with economic activities within the circular economy. Only activities relating to "extended life" and "recycling" are studied here, i.e. reuse and repair of goods, waste collection and materials recovery. These activities create more jobs per unit managed than activities relating to waste disposal (landfill and incineration).

1. THE NEED FOR A NEW WASTE MANAGEMENT MODEL

The amount of waste generated has risen ceaselessly since the dawn of the consumer society. This growth is expected to continue with the urbanization of developing countries. In 2018, the world produced two billion metric tons of municipal waste, a figure set to increase by a further 70% by 2050 if there is no change of model. Most of the waste is produced in East Asia and the Pacific, followed by South Asia, neck-and-neck with Europe and Central Asia. The environmental and social impacts are increasingly visible. There is a solution at hand: the circular economy, defined in opposition to the linear take-make-waste model. However, the world's economy in 2020 had a level of circularity of just 8.6%. A number of initiatives exist, but many challenges remain ahead if we are to make the circular transition.

ORIGINS OF THE CIRCULAR ECONOMY

If we step back slightly from all the buzz that surrounds the circular economy, it is reasonable to ask ourselves, particularly the older members of our societies, just what is so innovative. Isn't recycling and reusing material just plain common sense? Reflexes from an age when objects were manufactured essentially using human energy alone, imbuing them with a value that made the idea of mindlessly casting them aside unimaginable. The very concept of waste is a relatively recent one in our societies. What is the history of this waste which didn't use to exist, appeared in modern times, and is now being asked to disappear again in favor of a circular modern world? Franck Aggeri, professor of management at MINES ParisTech, offers an historical perspective that leads us to the idea of urban mines, while Jacques Vernier, former president of ADEME (France's environment and energy agency), writes about the Extended Producer Responsibility (EPR) principle that has underpinned European waste management strategies since the 1990s.

DIFFICULTIES IN THE CIRCULAR ECONOMY

In a circular economy, the challenge is to exploit and recover value from urban mines, i.e. urban waste deposits, under conditions that are economically, environmentally and socially acceptable. But with globalization and far more complex exchanges and technologies making today's world so different from the past, the path back to circularity is strewn with obstacles. As well as value, waste also contains pollutants (heavy metals, refrigerant liquids, etc.) that generate costs for depollution and treatment before any materials or components can be recovered. This embedded value attracts unscrupulous actors that ignore all environmental standards to maximize their profits. Katie Olley, a waste shipment specialist for the Scottish Environment Protection Agency, gives us an illuminating overview of illegal waste trafficking around the world. But there are also difficulties encountered in official treatment and processing sectors. The increasing complexity of products, caused primarily by the ever-growing number of electronic components, makes them difficult and expensive to recycle. Thomas Graedel, professor emeritus of industrial ecology at Yale University, examines the reasons behind low rates of reuse and recycling and suggests ways they could be improved. Then there is the question of waste that has already been buried. Is it possible to recover and reuse this waste to produce secondary materials for reinjection into the economy, as well as to free up brownfield sites for rehabilitation? It certainly makes sense in terms of unimproved former landfills that slowly pollute the soil over the long term. The idea looks attractive on paper, but in practice there are numerous hurdles and limitations. Joakim Krook, professor of industrial ecology at Linköping University in Sweden, describes the most recent work in this field.

OPPORTUNITIES IN THE CIRCULAR ECONOMY

At a time when countries with developed economies are starting to grasp the scale of the commitment to circular transition required after decades of ecological denial, emerging economies are facing two possible paths. They can either follow developed economies' path of excessive growth, which will lead humanity to a point of no return. Or they can immediately start to invent another pathway to low-carbon growth that will deliver far more lasting benefits in terms of innovation, job creation and collaboration. The African Circular Economy Network (ACEN) understands what is at stake and is working to ensure that the circular economy is an opportunity for Africa to boost its resilience in the face of social and climate pressures, pressures that will impact it more heavily and more rapidly than anywhere else on the planet. Alexandre Lemille, co-founder of the ACEN network, offers us an optimistic assessment based on the numerous initiatives emerging across Africa that will build the foundations for the circular models every country in the world needs to move toward.

Helen Micheaux,
issue coordinator

FROM WASTE TO URBAN MINES: a historical perspective on the circular economy

Franck Aggeri
Professor at MINES ParisTech

Ragpicker in the 19th century

Franck Aggeri is a professor of management at MINES ParisTech, PSL University and researcher at CGS-i3, UMR 9217. He is co-director of the Mines Urbaines chair on the circular economy and head of the PhD program in management at MINES ParisTech. His research interests and teaching focus on the circular economy, CSR and the ecological transition in businesses. In May 2021, he co-organized a seminar at Cerisy on the theme of the circular economy. He has published books about the circular economy and several research papers, especially in the Journal of Cleaner Production and the review *Gérer & Comprendre*. He is also a columnist for the French magazine *Alternatives économiques*.

Contrary to a commonly held belief, the circular economy was the dominant economic model for a long period. Nothing was lost or discarded, everything was systematically recovered and reused. At the end of the 19th century, it was superseded by the linear economic model, based on extracting new raw materials and disposing of waste in landfills, that accompanied the industrial revolution and rise of the hygienist movement followed by the growth of the consumer society. The present-day challenge is to develop a new approach to the circular economy that meets expectations in terms of quality and traceability as well as exploring new economic models that are less resource-intensive. But while innovations are certainly needed, in recycling, for example, as a strategy it is not a magic bullet. This is because recycling corresponds to a weak circularity model that fails to challenge how we produce and consume. For a strong and less resource-intensive circularity model to emerge, we need to explore services-based strategies that seek to extend product lives via repair, reuse or rental, all of which require upstream efforts in terms of eco-designing products to improve their repairability and durability.

INTRODUCTION

Over the past decade or so, the circular economy has become a hot topic among policymakers, the media, social and economic actors, and the public in general. The narrative surrounding the circular economy is summed up in this short promotional film released by the European Union.[1] Every European consumes a growing quantity of products that contain raw materials (14 metric tons per person in Europe) and generate a growing amount of waste (5 metric tons per person in Europe). But products, raw materials and waste could equally be repaired, reused or recycled. This is the circular economy principle. The film explains that this ever-expanding material footprint is the result of the linear economic model founded on the idea that we live in a world of infinite resources we can limitlessly exploit to transform into products which we then consume then dispose of in landfill. Conversely, the circular economy model seeks to create looped flows of materials and energy that circulate through the economy. Several strategies are possible within this model: reduce the quantities of energy and materials used to produce goods; share, repair and reuse products to extend their lifespans, and recycle component materials at the end of a product's useful life, forming an endless cycle.

The film emphasizes the dominant messaging surrounding the circular economy: it is presented in utopian terms, promising that a new, less resource-intensive growth model rooted in the circulation of products and materials

1 https://www.europarl.europa.eu/news/en/headlines/priorities/circular-economy/20151201STO05603/circular-economy-definition-importance-and-benefits

is possible and compatible with an ecologically sustainable model of society.

The notion is undeniably meeting with success, as witnessed by the adoption of countless laws and plans for the circular economy in Europe and Asia, and the number of businesses converting to the model. In 2000, Japan became the first country to adopt a framework law based on principles close to the circular economy, the Basic Act for Establishing a Sound Material-Cycle Society. The aim was to reduce the amount of waste generated by products, use the waste generated as a resource in appropriate ways (reuse and recycle), and properly dispose of waste that could not be reused in any form. In 2008, China enacted a framework law to promote the circular economy. The European Union adopted a circular economy action plan in 2016, and France passed its law on the circular economy and combatting waste (AGEC) in 2020.

THE CIRCULAR ECONOMY: A TRULY NEW MODEL?

The circular economy model is presented as being something new, but is this true? Conceptually, there is nothing new about the idea of circularity. It was outlined in 1966 in a book by Kenneth Boulding,[2] who stated that humanity must find its place in a cyclical ecological system which is capable of continuous reproduction of material forms. The concept of the circular economy itself was explicitly cited for the first time in a 1989 book on the environmental economy.[3]

Contemporary problematization of the circular economy borrows heavily from industrial ecology and cradle-to-cradle[4] approaches based on looping flows of materials and energy, with symbioses from the natural world as their model.

In terms of practices, the circular economy model is an ancient one, as shown in the works of many historians. It is reasonable to state that it was the dominant model until the end of the 19th century. The term waste was little employed at the time. Everything was either reused or left to decay naturally. An entire parallel economy, based on rag-pickers and other actors, retrieved all the material available. Rags were reused to make paper, manure and sewage became fertilizer, animal bones had numerous uses, in glues and smelling salts or for whitening beet sugar, fats were used in candle making, and so on. Sabine Barles[5] emphasizes that materials circulated spontaneously between city, industry and agriculture until around 1870.

In terms of practices, the circular economy model is an ancient one, as shown in the works of many historians. It is reasonable to state that it was the dominant model until the end of the 19th century

CIRCULAR ECONOMY MODELS: FROM MODE 1 TO MODE 2

The historical circular economy model, or mode 1,[6] disappeared progressively in response to three major shifts. The first was the emergence of the industrial revolution and coal-fired steam engines, making it possible to generate cheap energy and stimulating the development of new forms of locomotion (trains and boats). The cost of extracting raw materials fell dramatically, while the second industrial revolution, particularly with the development of chemicals and electrification, led to the spread of new synthetic materials, such as chemical fertilizers and cellulose paper pulp, which supplanted previously recovered materials.

A second major shift proved fatal to recovered products and materials: the rise of the hygienist movement in the wake of the pasteurization revolution of the late 19th century. The hygienist movement stigmatized the circulation of waste and organic matter, claiming it to be the primary cause of epidemics. Eugène Poubelle was the Prefect of the Seine region of France in 1884 when, in a famous decree, he ordered landlords to provide tenants with recipients for their household waste, in the process giving French the word poubelle (waste bin). This ushered in an era of waste containment inventions that led to the rise of landfill as the 20th century's dominant waste processing solution.

The third major shift began in the 1930s: the growth of the consumer society, i.e. a lifestyle where modern people began to live their lives in terms of objects consumed or owned, a shift that led to a society of plenty.

REINVENTING THE WASTE MANAGEMENT MODEL

The linear economy model is primarily the one that developed in the 30 years following the Second World War, an era when rapidly expanding economies led to huge increases in the consumption of raw materials and resources and the amount of resultant waste. Landfill was the dominant waste processing solution at the time, followed by the massive development of incineration from the 1970s to recover energy from organic waste. As landfill sites filled up and public opposition to the construction of new sites and incinerators grew, the model faced a crisis caused

2 Boulding, K.E. (1966). *The Economics of the Coming Spaceship Earth*, in: H. Jarrett (ed.) 1966. *Environmental Quality in a Growing Economy*, pp. 3-14.Baltimore, MD: Resources for the Future/Johns Hopkins University Press.

3 Pearce, D.W. and Turner, R.K. (1989). *Economics of Natural Resources and the Environment*, John Hopkins University Press.

4 McDonough, W., & Braungart, M. (2005). *Cradle to Cradle*, McGraw-Hill Education; Ayres, R. U., & Ayres, L. (Eds.). (2002). *A Handbook of Industrial Ecology*, Edward Elgar Publishing.

5 Barles, S. (2005). *L'invention des déchets urbains: France, 1790-1870 (The Invention of Urban Waste: France, 1790-1870)*, Champ Vallon.

6 Aggeri, F. (2020). *The Circular Economy: Historical Perspective and Contemporary Issues*, in: Delchet-Cochet, K. (Ed.). (2020). *Circular Economy: From Waste Reduction to Value Creation*. John Wiley & Sons.

by its incompatibility with the precepts of sustainable development.

The popularity of the circular economy concept can be dated to the late 2000s, a time when three simultaneous events combined to create a favorable reception for the new concept: first was the steep rise in commodity prices, which increased fourfold between 2000 and 2010, serving as a reminder to policymakers and businesses of their economic dependency on natural resources; second was China's embargo on the rare earth metals vital to numerous high-tech applications, creating panic among politicians and businesses; third was the constant rise in alarming environmental indicators, underlining the urgency of the ecological catastrophe.

The narrative surrounding the circular economy, outlined in the introduction, was popularized by reports issued by the Ellen MacArthur Foundation and McKinsey.[7] It seemed a plausible response to the three-pronged crisis. The appeal of this narrative is not really about the originality of a concept that, as we have shown, is far from new. It lies more in clever storytelling that recycles various concepts within an integrating framework inspired by the analogy with natural symbioses. This storytelling is also rooted in mechanisms for constructing a utopia that appear to be realistic, rational even.

According to Jean-Louis Metzger, a rational utopia is constructed around three registers: an inspirational narrative that articulates both a critique of the current situation (e.g.: the linear economy) and a description of an ideal (e.g.: the circular economy); a set of powerful images designed to permeate collective beliefs (e.g.: the butterfly diagram with its looped strategies), and tools and models that guide collective action (e.g.: circularity indicators, norms and tools for managing the circular economy). A rational utopia, therefore, corresponds to the problematized narrative of an ideal society based on images that touch the imagination as well as on rational components (reasoning, modeling, calculations) that are meant to embed it in the domain of the deliverable. Rational utopias thus combine the inspirational properties of utopia with the reassuring properties of reason. This being the case, it is a matter of building collective promises that can pull together and mobilize a wide variety of different actors.

The spread of these rational utopias is all the stronger because they are produced in ways that are collective and anonymous, in line with the European Union's narrative. They appear to the public as neutral constructions, depoliticized and open to multiple interpretations, i.e. free of references to ideologies or particular authors, and can be subject to wide variety of possible appropriations.

TOWARD THE MODE 2 CIRCULAR ECONOMY

Modern-day issues with the circular economy clearly do not involve a return to the historical mode 1 model, but entail the invention of a new, less resource-intensive growth model that respects the need for traceability, hygiene and quality with lower environmental impacts.

Health and hygiene issues remain key, as evidenced in regulations like the European REACH directive that aim to trace substances that are potentially harmful to health and are found in chemical and household products. Ensuring that recycling and reuse comply with these regulations is a key challenge. Plastics with brominated flame retardants are a good illustration of the problem. These plastics, used extensively in electrical and electronic devices, perform an important function as they are designed to prevent devices with batteries that can overheat from catching fire. But they come with a major drawback: they contain chromium, a heavy metal that is potentially harmful to health. This means that recovering them is forbidden and they have to be sent to landfill. But automated plastics sorting at modern waste processing centers is not 100% effective and certain brominated plastic residues can end up mixed in with other plastics for recycling.

So, whether for repair, reuse or recycling, the modern circular economy depends on the development of a quality economy where strict respect for specifications and traceability standards must go hand-in-hand with actor upskilling and the structuring of new industrial and business ecosystems

So, whether for repair, reuse or recycling, the modern circular economy depends on the development of a quality economy where strict respect for specifications and traceability standards must go hand-in-hand with actor upskilling and structuring new industrial and business ecosystems.

TRANSFORMING WASTE INTO RESOURCES: NEW APPROACHES FOR A CIRCULAR ECONOMY

There is no reason for the transition to the circular economy to happen naturally. The consumer society is now deeply embedded in our behaviors, and the intensive pace of innovation drives businesses to accelerate their products' renewal rates so that they can retain a temporary advantage over their competitors. The combination of these two forces leads to endless expansion in the amount of materials consumed and waste generated.

7 Ellen MacArthur Foundation. (2012). *Towards the Circular Economy*. Ellen MacArthur Foundation.

WHAT SOLUTIONS ARE LIKELY TO REVERSE THIS TREND?

One of the first solutions lies in developing innovations, especially technological, for exploiting the potential value contained in recovered waste and end-of-life products. This is the challenge of what are known as urban mines, highlighting the fact that our waste contains potential value to exploit. For example, a metric ton of smartphones contains concentrations of gold two or three times greater than occurs naturally in a mine.

At present, the most frequently recovered metals are the most common ones (steel, aluminum, copper), as well as precious metals for which recycling technologies and industries have been developed that make possible recycling rates of 50% or more. However, effective recycling rates rarely exceed 50%. For all materials, the rate of circularity in Europe was just 11.7% in 2017 (source: Eurostat). For plastics, a recent study by the Ellen MacArthur Foundation claims that just 14% of plastics are recycled, 14% used for energy recovery, 40% go to landfill and 32% end up in the environment.[8] The development of closed loop recycling systems, i.e. for the same applications, is important for protecting value and is an innovation pathway of interest to manufacturers. For rare earth metals, used extensively in high-tech applications (electronic boards, wind turbines and batteries), the recycling rate is below 1%. Securing supplies of materials such as these by developing new recycling sectors is critical to reducing dependency on high-risk countries where these materials are extracted. The challenges are not just technological. They also involve structuring new industrial ecosystems and new regional mechanisms for collecting, sorting, processing and recycling waste so that it can be reused.

But recycling is not a magic bullet. It corresponds to a weak form of circularity that fails to significantly reduce environmental impacts. Even if we assume that technological progress will drive an improvement in recycling rates, it remains the case that the volume of new products consumed will continue to grow, meaning that recycling can only be a partial solution for reducing environmental impacts. Good quality recycling is also hampered by trafficking and illegal exports that represent the fourth largest source of income for organized crime, after narcotics, prostitution and gambling. Traffickers have a decisive advantage over legal operators because they do not have to pay the associated overheads, taxes and pollution clean-up costs. Trafficking is also a source of diffuse pollution, because traffickers only recover parts or materials that interest them, discarding other polluted parts in nature. Finally, from a technical standpoint, not all materials can be recycled indefinitely. Certain materials, plastics for instance, lose their properties, meaning that only a limited number of cycles are possible.

CONDITIONS NEEDED FOR A PARADIGM SHIFT

Not all circularity strategies are equally promising from the environmental perspective and in terms of their potential for creating jobs. Apart from recycling, how can we promote a strong circularity model that is less intensive in terms of materials and resources? Circularity strategies focusing on reusing and repairing, or the functional economy, as ways to promote extended product lifespans and durability are promising avenues to explore when seeking to reduce the material footprint of our economic activities, but also for creating locally based jobs. For businesses, these services-based strategies require upstream work on eco-designing products to improve their ease of disassembly and product durability, and a downstream network with new skills able to roll out services-based solutions across an entire region. These are new business models that have to be invented and lastingly embedded, supplanting models centered on selling products. Consumer behavior must change if this is to happen. Consumers need to be happy with repaired, second-life or rented products rather than constantly buying new. Recent changes seem to suggest this shift may happen, particularly among younger generations who seem less attached to the concept of owning things.[9] The rise of digital platforms like Back Market, specializing in selling refurbished products, is further evidence of this change in behavior. In this regard, the introduction of new incentive mechanisms, such as France's law on the circular economy and combatting waste, may help accelerate these transitions both by making it easier to access information on repairability performance and by encouraging people to purchase repaired or second-life products. These new strategies for strong circularity (repair, reuse and the functional economy) herald sweeping changes to business models and lifestyles.

These new strategies for strong circularity (repair, reuse and the functional economy) herald sweeping changes to business models and lifestyles

8 Ellen MacArthur Foundation (2016). *The New Plastics Economy: Rethinking the Future of Plastics & Catalysing Action.*

9 Guillard V. (2019). *Du gaspillage à la sobriété: avoir moins et vivre mieux? (From Waste to Sobriety: Having Less and Living Better?),* De Boeck Superieur.

RESOURCE REUSE AND RECYCLING: LIMITATIONS AND POTENTIAL OPPORTUNITIES

Thomas Graedel
Professor Emeritus of Industrial Ecology at Yale University

A typical display of fireworks. The brilliant colors are produced by compounds of copper, barium, calcium, magnesium, strontium, and others

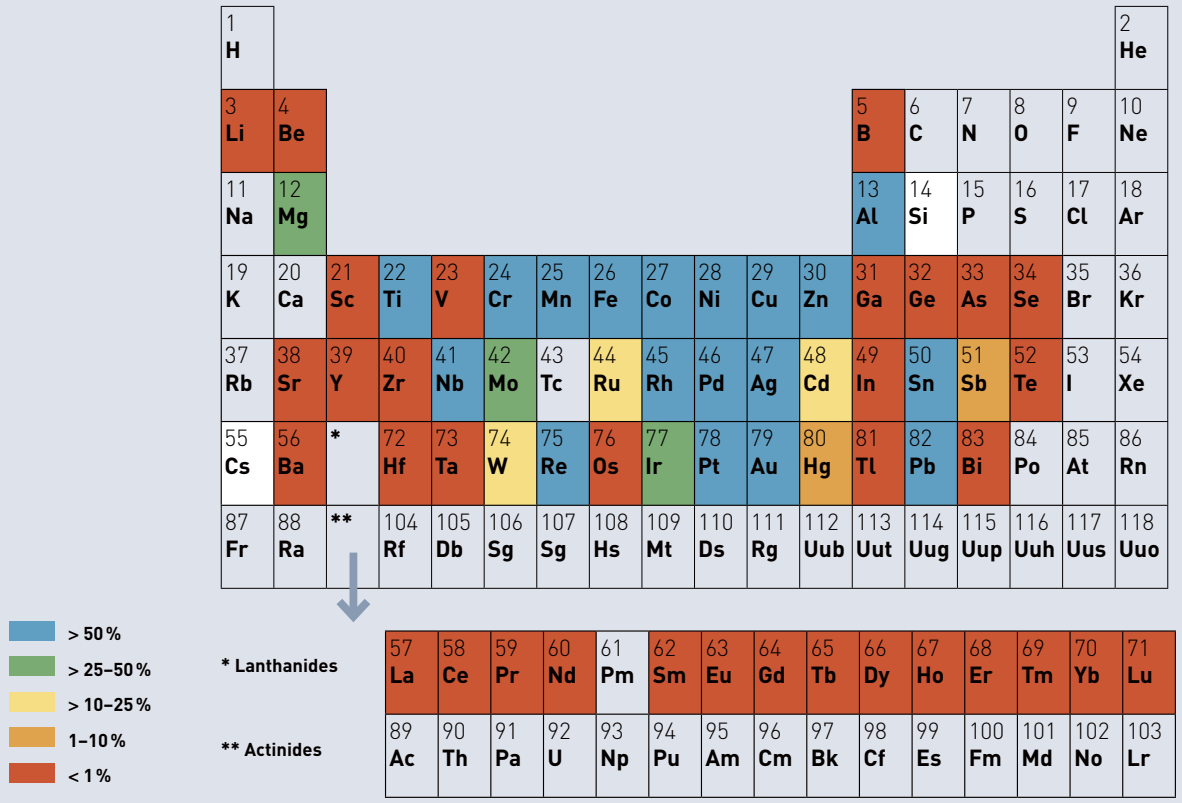
T.E. Graedel joined Yale University in 1997 after 27 years at AT&T Bell Laboratories and is currently Professor Emeritus of Industrial Ecology at Yale. One of the founders of the field of industrial ecology, he co-authored the first textbook in that specialty and has lectured widely on industrial ecology's implementation and implications. His characterizations of the cycles of industrially-used metals have explored aspects of resource availability, potential environmental impacts, opportunities for recycling and reuse, materials criticality, and resources policy. He was the inaugural President of the International Society for Industrial Ecology from 2002-2004 and winner of the 2007 ISIE Society Prize for excellence in industrial ecology research. He served three terms on the United Nations International Resource Panel, and was elected to the U.S. National Academy of Engineering in 2002.

Materials today are often discarded after their first use. This is especially true of those materials in uses that are inherently dissipative, in complex assemblages where elements in low but vital concentrations are often lost in recycling, and for useful but toxic materials. The status of reuse and recycling as well as five opportunities for improvement are presented: (1) eliminate dissipative uses of materials; (2) develop advanced technologies for reuse and recycling; (3) create suitable repositories for materials unsuitable for a circular economy; (4) Design new products for circularity at end of life; (5) create and support international collaborative shipping and recycling chains.

INTRODUCTION

The basic idea of the circular economy is to transform our material society from the traditional material use approach ("dig it up, use it, dispose of it") to one in which materials retained in the inner circles of the "generic" circular economy diagram by the Ellen MacArthur Foundation require less energy and fewer or no new resources to reuse them than would be needed for similar actions in the outer circles. The idea is inherently attractive; the challenge is to determine the degree to which such a transition from the present approach is possible and desirable from technological, economic, social, and political perspectives. Several major issues involving product design, recycling technology, material toxicity, and spatial impediments to effective reuse pose significant challenges to achieving a fully circular economy.

End of life functional recycling rates of sixty elements, with the individual elements categorized into one of five ranges



(International Resource Panel, Recycling Rates of Metals, ISBN 978-92-807-3161-3, United Nations Environment Programme, Nairobi, Kenya, 2011).

Figure 1

RECYCLING STATISTICS

Before deciding where the world is going so far as recycling is concerned, one should assess how the world is doing at present. Unfortunately, the situation, with a few notable exceptions, is not very encouraging. Almost a decade ago a committee of the United Nations International Resource Panel assigned the "best-estimate" end-of-life functional recycling rate of the elements of the periodic table to one of five percentage ranges, as shown in Figure 1. It is easy to see that only fifteen to twenty elements have rates above 50% (and the committee states that few appear to be above 75%). Perhaps more dramatic are the more than thirty elements with essentially no functional recycling at all. Only a few elements were assigned values in between 0% and 50%. Thus, a majority of the elements employed in technology were used once and then lost to technology forever, a sad fate given the energy and effort expended to acquire them in the first place.

Recycling statistics have never been very good, as no regulations require them to be collected. As a consequence, the best current estimates of EOL-RR (end-of-life recycling rates) values remain those of the International Resource Panel of 2011 (see Figure 1). This would seem to call for a more structured data-driven approach to routinely quantifying recycling rates. It would be hoped that such an approach could be put in place in the future; at present all end-of-life recycling rates must be considered "informed estimates based on minimal data".

HOW MATERIALS ARE USED

Why can't materials that are incorporated in products of various kinds be reused when the use of those products is finished? This seemingly obvious inquiry can be addressed, at least to some extent, by realizing that the forms of use of resources can be divided into four categories: "in-use dissipated", "currently unrecyclable", "potentially recyclable", and "unspecified" (generally small-scale uses whose low volumes do not justify tracking them). The "in-use dissipated" category includes uses that may seem beneficial (vehicle brake pads, fireworks, etc.) but offer little or no prospects for material recovery and reuse. Some other applications, such as the use of rare earth elements in polishing powders, could be recyclable if a technological approach had been developed, but often no suitable

The delaying effect of material in product stocks in use

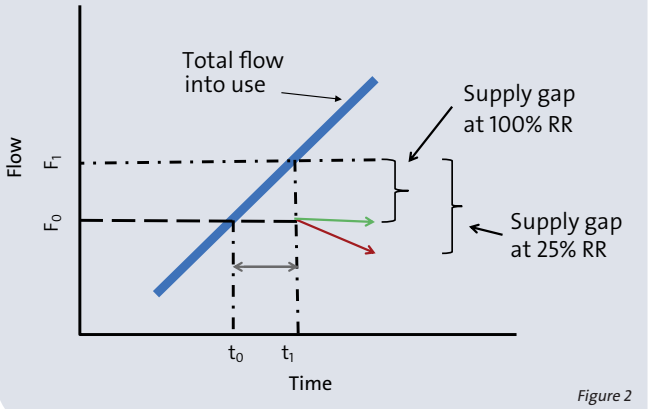


Figure 2

technologies exist at present. In the "potentially recyclable" category, recycling methods are known to exist although they are sometimes not employed for reasons of cost, inconvenience, or lack of sufficient incentives.

In the ideal world, material available through recycling would satisfy the demand for the same material and no new resource extraction would be needed. However, materials enter service and remain there for extended periods, often decades, while all the while demand is increasing. This situation is termed the "delaying effect of stocks", a consequence of which is that in a world of increasing demand even perfect recycling is not enough to meet supply (Figure 2). Even then, some materials may not immediately undergo reprocessing and reuse. Personal electronics are famous for being retained in a bedroom drawer for as long as a decade – these are sometimes termed "hibernating stocks". A related category is "comatose stocks" – material that is stored in such a way that it may never be recovered. For example, power distribution cables that have been disconnected from service but left in place because the benefits of recovery do not offset the effort and expense involved provide an example. Finally, there are stocks that are designed never to be recovered and reused, such as the foundation pilings under tall buildings and harbor structures; these might be termed "abandoned stocks".

In a world of increasing demand even perfect recycling is not enough to meet supply.

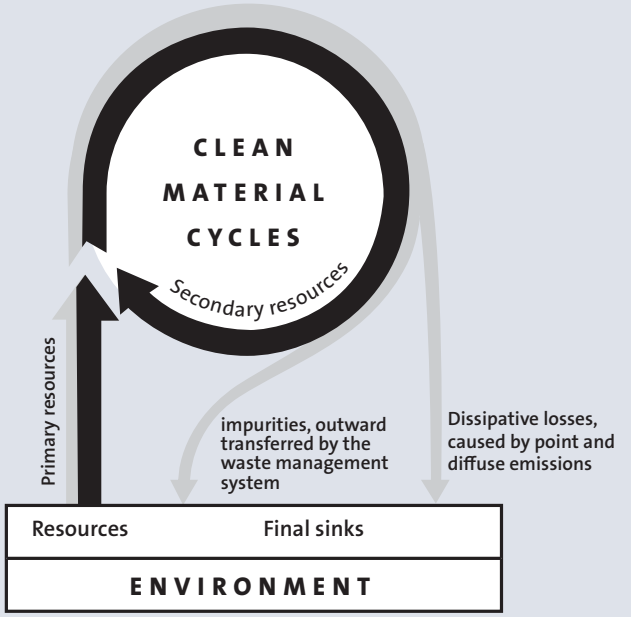
Imagine, however, that a decision has been made to discard a product containing potentially recyclable material. Many steps may be involved in actually carrying out technologically appropriate recycling, as discussed below in some detail.

Reuse and recycling sound as if they are sensible approaches to deal with the accumulation of discarded products, and in general they are. However, there are instances where routine reuse and recycling may not be the ideal approach. One of the most obvious is where a discarded product contains a material that would not now be desired in the economy, particularly materials or assemblages not regarded as hazardous when first employed but now of significant concern: toxic metals such as cadmium in aircraft landing gear, lead in paint, or carcinogenic materials such as polychlorinated biphenyls in transformers. Ulrich Kral and colleagues from the Technical University of Vienna suggest that new product designs need to avoid such constituents, and that older products leaving service or hazardous material dissipated during use should eventually reach a "final sink": a repository that either destroys an unwanted substance completely or retains it for a long time period so that it can be considered in the future. The process is suggested schematically by Figure 3.

In a world of increasing demand even perfect recycling is not enough to meet supply

Examples of the establishment of final sinks are the deep repositories set up by some countries to responsibly contain waste material from nuclear power reactors. Because those materials are potentially hazardous such repositories tend to be controversial, especially to those living nearby.

Material flows based on a clean cycle strategy



(Reprinted with permission from U. Kral, K. Kellner, and P.H. Brunner, Science of the Total Environment, 461-462, 819-822, 2013; Copyright, 2013).

Figure 3

Despite the societal challenges, however, it is clearly inappropriate to utilize materials known or suspected of toxicity and then to provide no way to deal with them when they are no longer desired. If these materials are deemed so beneficial to modern technology that society wishes to use them, the challenges to doing so need to be recognized, and provision made for approaches that do not follow a circular economy approach.

THE CHALLENGES OF PRODUCTS COMPLEXITY

It is worth considering the scope of what a truly circular economy would demand of the medical device industry. As an example, the diversity of elements used by manufacturers of medical devices is thought to include at least seventy different elements for purposes of imaging, robotic surgery, artificial joints, and many more. This incredible elemental diversity is similar to that of modern electronics.

Each element's use in medical devices or for electronics has a purpose, of course: better imaging of body organs, faster storage and retrieval of information, etc. A device maker adhering dogmatically to the circular economy vision would thus have to not only deal with contamination and sterilization issues, but also with the reprocessing of essentially the entire suite of the elements. This would be a major commitment for designers, product manufacturers, and executives, and suggests that dogmatism regarding advanced devices of all kinds so far as the circular economy is concerned is perhaps an unrealistic goal.

Assume, however, that a material (contained in a product) is not subject to any of the constraints to recycling and reuse discussed above and that the material has been discarded. A stepwise sequence is then involved in successful disassembly and recycling of a product, as shown in Figure 4, but incomplete disassembly or the failure to capture components once disassembly is complete occurs all along the recovery and recycling sequence.

Given the estimated current probabilities for successful processing at each stage, the efficiency of the overall total product recycling process turns out to be quite low. Improving this situation requires efforts at all stages of the recycling process, but also in the original product design process. Some of the main points are summarized below:

- If possible, capture a product before discard and seek to use it elsewhere (this is termed 'relocation');
- If relocation is not feasible, seek to remanufacture the product so as to return it to its original condition and capabilities or, better yet, upgrade it to the most recent capabilities of similar products (this is termed 'remanufacture');

A four-node separation sequence for disassembly of a generic product

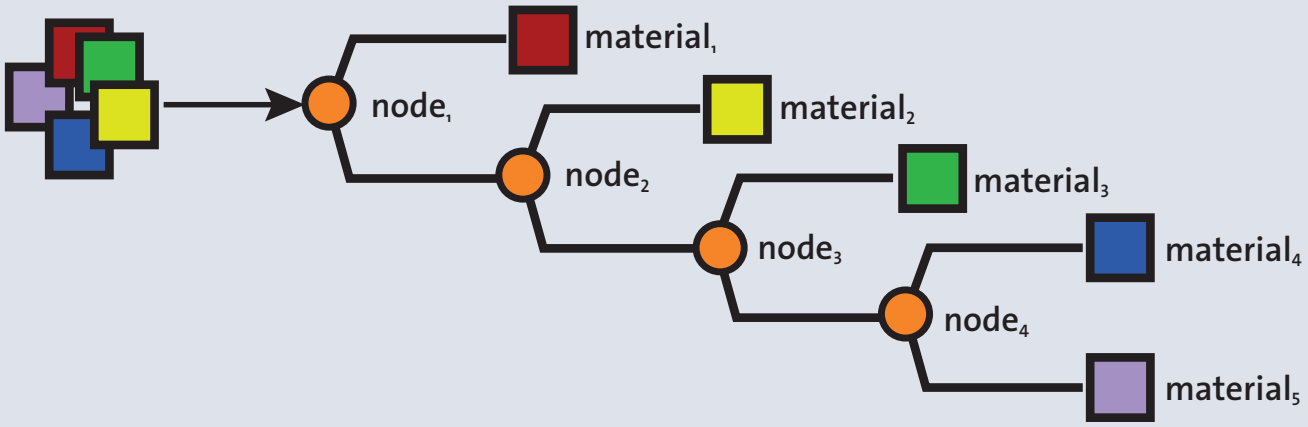


Figure 4

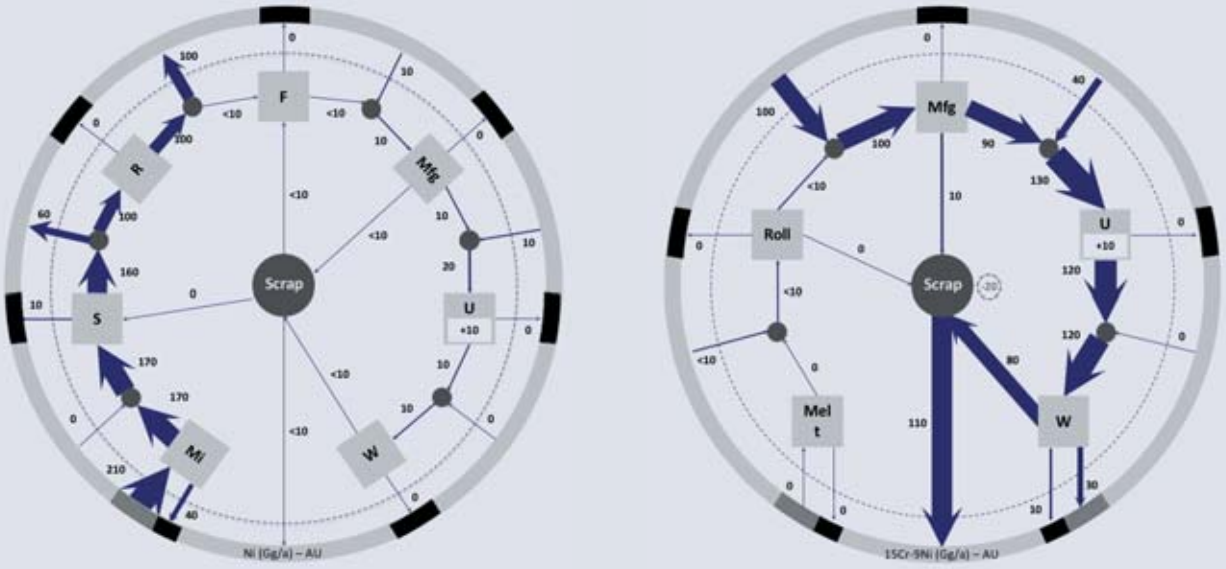
- If remanufacturing is not practical, disassemble the product and reuse the components. This step will be enabled by efficiently identifying the components and researching opportunities for their redeployment. Disassembly is best addressed at the product design stage by minimizing the steps needed for disassembly.
- Components and assemblages that cannot readily be disassembled, or where doing so is not economically or practically feasible, may or may not be shredded, but in any case are sent on to sorting facilities, followed by treatment in chemical or metallurgical reactors.

The efficiency of the overall total product recycling process turns out to be quite low. Improving this situation requires efforts at all stages of the recycling process, but also in the original product design process

SPATIAL LOGISTICS

One issue not commonly discussed by circular economy advocates is where the reuse, remanufacturing, and recycling should or can happen. In a technological world where diverse and complex products are often manufactured in a small number of specialized facilities, sold to users around the world, perhaps later resold or re-leased, and eventually discarded, product complexity and recycling technology cannot be assumed to exist everywhere in order to enable local remanufacturing and reuse. Ideally, one would capture the end-of-life products once they are obsolete but before they become degraded and disassembled and then ensure that

The Australian cycles of (left) nickel and (right) stainless steel in 2010



The units are Gigagrams (thousand metric tons) of metallic equivalent per year (Graedel, T.E., B.K. Reck, L. Ciacci, and F. Passarini, On the spatial dimension of the circular economy, Resources, 8, 32 doi:10.3390/resources8010032, 2019).

Figure 5

they are transported to a facility fully capable of their remanufacture or recycling. For more complex products there will likely be few such facilities in the world, and the challenges of identification, transportation, and economics quickly become daunting.

The locational issues can be illustrated by a simple example, that of nickel in Australia, whose nickel material cycle is shown in Figure 5 (left). Australia has very large metal deposits and a vigorous mining industry. As a result, nickel extraction and ore processing is substantial, but the resulting refined metal is largely exported. Much of this nickel goes to be utilized in stainless steel production elsewhere (Australia does not produce stainless steel, an alloy of nickel with about 74 parts iron, 15 parts chromium, and 9 parts nickel), so does not have the technology in place to reprocess it – that has to happen elsewhere if at all. Thus, stainless steel imports to Australia must themselves be exported if they are to be reused (Figure 5, right). The message here is that in a global economy it is very unlikely that the facilities to enable a circular economy will be available everywhere and for every product, no matter how complex; rather, extensive ocean shipping and international political and scientific coordination would almost certainly be required.

CONCLUSION

The challenges discussed in this article simultaneously suggest five opportunities for improvement. They are as follows:

- Decrease or eliminate dissipative uses of materials;
- Invent and develop reuse and recycling technologies that are currently inadequate or do not now exist for many materials and products;
- Develop national and regional repositories for materials unsuitable for retention in a circular economy because of toxicity, radioactivity, or other undesirable property;
- Design new products for circularity at end of life, not disposal;
- Optimize the collection of components and products that are difficult to remanufacture or recycle and develop an international system to transport such objects to facilities capable of rendering them fit for reuse in one form or another.

None of these improvement opportunities will be easy to accomplish. Indeed, some are likely to be quite challenging. However, the same could have been said about the activities and technological approaches that made them necessary in the first place. Some of the opportunities will require new thinking in product design, materials processing, and recycling. Others will require collaborative actions by governments. Making even modest steps in these directions will generate significant improvement in circularity, however. A moral judgement would seem appropriate: A technological society whose activities have caused these challenges to exist should feel responsible for responding to them.

ENHANCED LANDFILL MINING, CONCEPT AND CHALLENGES

Joakim Krook, Linköping University, Sweden

Joakim Krook is associate professor in Industrial ecology at the division of Environmental Technology and Management, Linköping University, Sweden. He is specialized in multidisciplinary systems analysis research on recycling strategies and landfill and urban mining. Joakim was the principal investigator for Linköping University in the EU MSC-ETN NEW-MINE project.

Enhanced landfill mining (ELFM) is an emerging concept that connects the vision of circular economy with the need to use land more effectively and for purposes that contribute to sustainable development. It bears on the fact that Europe holds more than 500,000 landfills of which the majority is non-sanitary municipal solid waste landfills, lacking modern environmental technology. Beyond that these poorly equipped deposits generate local, regional and global environmental impacts as well as drosscapes of urban land, they contain massive amounts of obsolete materials that could be brought back to use in society.

To prevent unwanted environmental and health effects, many of these old landfills will sooner or later need extensive remediation and aftercare. So far, however, Europe does not have any coherent strategy for their future management. The EU Landfill Directive, for instance, has no bearing on their management as most of them predate its enforcement. In many countries, the available public funding for taking care of such old landfills is also insufficient making any kind of future remediation effort financially challenging and unattractive.

For a share of these landfills, ELFM could offer a more sustainable management option. The potential of this emerging concept lies in its integrated approach, where remediation is combined with the excavation, processing and recovery of the deposited waste. In essence, such a strategy could reduce the cost for remediation of malfunctioning landfills, reclaim valuable urban land and recover significant amounts of dormant materials and energy carriers. To this end, ELFM embraces the use of innovative technologies to transform and upcycle the extracted resources to high-value commodities such as metals, syngas, fuel-grade H2 and low-carbon building materials.

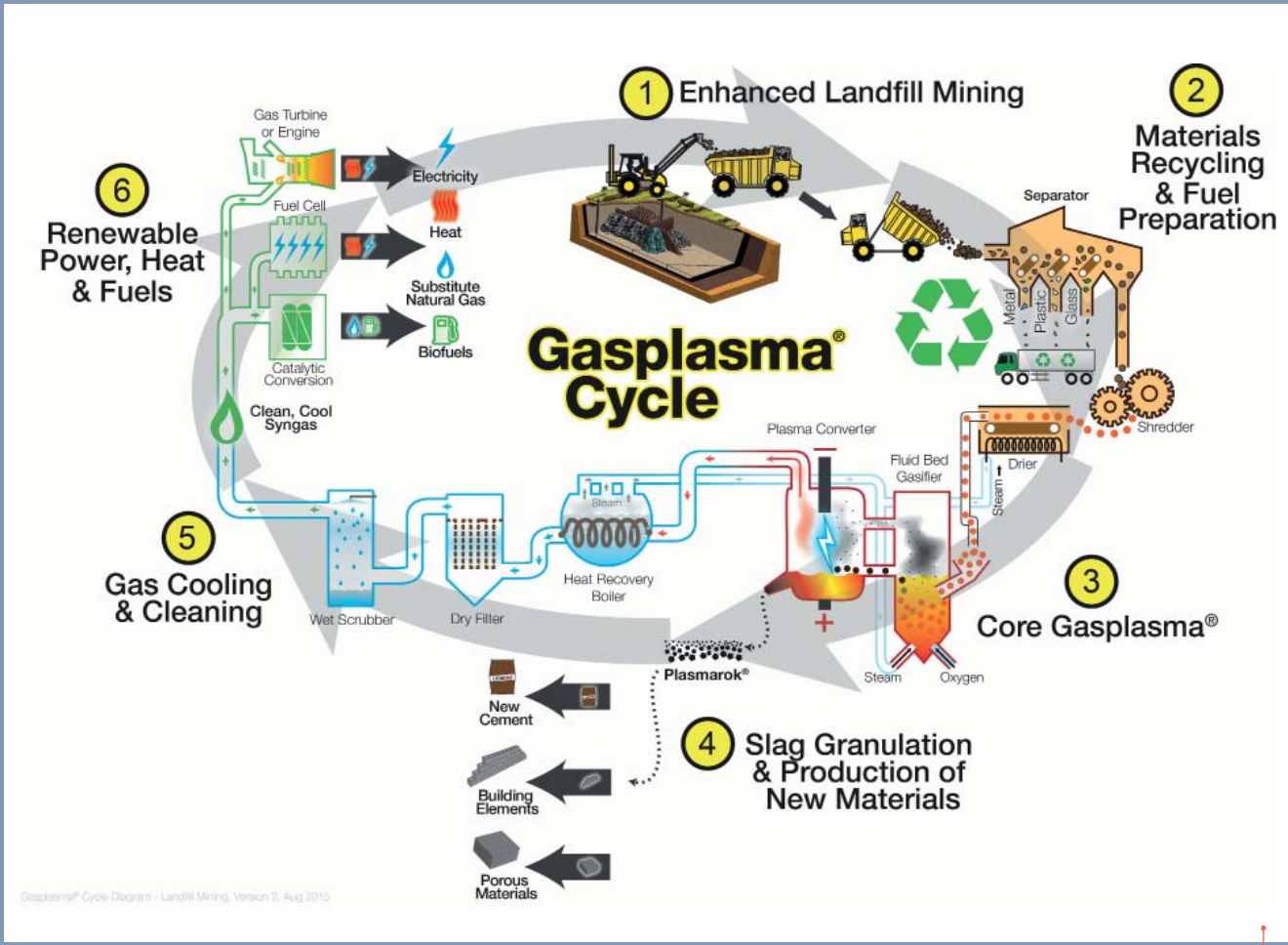
Although ELFM displays a high societal potential, there is a lack of real-life projects validating the sustainability consequences and feasibility of the concept. The so far most concerted efforts are the Closing-the-Circle project in Belgium[1] and the "NEW-MINE" Training Network[2]. NEW-MINE involved 15 early-stage researchers working on technological innovations along the whole value chain of ELFM and multi-criteria assessments for evaluating the sustainability consequences of such yet unconventional projects.

The findings from these early-stage initiatives are promising but also point at several challenges that need to be addressed to facilitate the further development of ELFM. When it comes to the technical feasibility of resource recovery, for instance, it has been demonstrated that it is possible to upcycle and produce high-quality commodities from deposited waste in laboratory scale. However, further investments are needed to improve the technology-readiness-level of these processes before we know what high-value and marketable commodities can be recovered on an industrial scale.

Recent assessments show that developing cost-efficient and sustainable ELFM projects is indeed challenging. It is possible, but it relies on a strategic selection of suitable landfills for mining, carefully tailored project set-ups and in most cases also altered policy and market conditions. Cost-efficiency is particularly difficult to obtain, where most markets involve a low demand and willingness to pay for secondary resources.

1 https://machiels.com/en/division/europe/environmental-services/landfill-mining-solutions/

2 https://new-mine.eu/



A schematic illustration of the ELFM concept

This means that resource recovery alone cannot motivate ELFM financially, but other tangible values also need to be created such as avoided costs for extensive landfill remediation or revenues from reclamation of highly valuable urban land.

As for other sustainability-driven innovations, the further development of ELFM relies on a clear political support as current market conditions are simply not adjusted for such unconventional practices. Several potential policies to decrease investment risks for industrial actors and improve the economic and environmental performance and public acceptance of such projects have also been highlighted in research. However, before political support can be considered, the concept of ELFM needs to be officially recognized, and for this to happen, the level of knowledge in the field needs to progress. Beyond small-scale trials, it is time to demonstrate that there is a real interest in implementing these practices on a large scale.

EXTENDED PRODUCER RESPONSIBILITY (EPR) IN FRANCE

Jacques Vernier
President of the French Extended Producer Responsibility Waste Schemes Commission

Jacques Vernier has spent his entire career defending the environment in France: as head of the Artois-Picardie regional water agency and president of ADEME (French Agency for Ecological Transition) then INERIS (French National Institute for Industrial Environment and Risks). He currently heads both the High Council for Prevention of Technological Risks and the Extended Producer Responsibility Waste Schemes Commission. As a member of the National Assembly, he presented the reports on the "Environmental law" and "Air protection" law in the early 1990s.

Extended Producer Responsibility (EPR) has been voted in France since 1975. The law states that producers, importers and distributors may be required to contribute to the disposal of waste from their products. It was only in 1992 that this law was applied for the first time to household waste and the number of EPR channels has only increased since then in France and in Europe. The efficiency of these channels is indisputable: in 20 years the collection rate of batteries has reached 80%, whereas they were not collected before.

Thanks to the law on the circular economy passed in 2020, this system is developing even further and has modified and strengthened the EPR system with 10 new channels. In addition, there is a stronger incentive for eco-modulation, funds dedicated to repair, reuse, and many other proposals favorable to the evolution of consumption patterns.

As head of the Extended Producer Responsibility Waste Schemes Commission since 2016, you are involved in creating and developing these schemes in France. Can you talk us through the emergence of this waste management model?

Jacques Vernier: On July 15, 1975, a French law and an EU directive formalized the principle of producers being responsible for managing waste generated by their products. The law said almost all there was to say on the subject: "Producers, importers and distributors of these products or the elements and materials used for their manufacture may be obliged to pay for or contribute to the disposal of the waste generated by them." The wording in the current Environmental Code (Article L541-10) has barely changed.

But it was not until almost twenty years later, in 1992, that this principle was first applied to household packaging waste.

For the next 28 years, France's extended producer responsibility schemes expanded considerably, to the extent that there are now 12 mandatory schemes (shortly to rise to 22), whereas until recently there were only three across the European Union. The 12 mandatory schemes concern:

1. batteries*
2. electrical and electronic equipment* (WEEE)
3. end-of-life vehicles*
4. household packaging
5. unused medicines
6. vehicle tires
7. writing paper
8. textiles and footwear
9. household chemicals
10. furniture
11. end-of-life boats
12. sharp self-administration medical devices used by patients

*European scheme

In practical terms, what do the EPR mechanisms consist of, and what results do they deliver in terms of recycling and reducing waste volumes?

JV: The EPR system is designed to ensure that producers pay for or contribute to waste management. Specifically, this means that producers can deal with their waste themselves, running an individual system, but this is extremely rare. Or they can delegate the task to a collective body, called a PRO (Producers Responsibility Organisation) to which they contribute (by paying an eco-contribution). This eco-contribution can be modulated, increased or decreased, according to how difficult it is to manage waste created by the product: in theory, this eco-modulation is intended to foster the eco-design of products. However, this encouragement is limited, as we will see below.

In France, PROs are private companies with a public service purpose. They have to follow terms of reference imposed by the State. Some schemes have only one PRO (packaging, paper, boats, etc.), but there can be more than one (two for WEEE, batteries, furniture, etc.) if producers have decided not to "put all their eggs in the same basket".

PROs can contract with operators for collection, transport, sorting and processing.

In these cases, we designate the schemes as "operational".

But for certain types of waste that are already collected, possibly also sorted and processed by local authorities, rather than dealing with their own waste in collaboration with operators, producers and PROs may choose to use (and therefore finance) all or part of the municipal system:

- municipal waste collection services (because they already collect waste packaging and paper);
- municipal garbage dumps (because they already handle WEEE, furniture, household chemicals, etc.);
- municipal waste sorting centers.

In these cases, we designate the schemes as "financial", the most important factor being that producers finance the local authorities that already do the work.

There can be no arguing with the impressive efficiency of the EPR approach. The figures speak for themselves:

- in the past 28 years, the recycling rate* for household packaging waste has risen from 18% to 70%;
- in the past 13 years, the collection rate* for household WEEE has risen from almost nothing to 53%, and 74% of waste collected is recycled into new materials or reused;
- in the past 20 years, the collection rate for batteries has risen from almost nothing to 49%, and 80% of waste collected is recycled into new materials.

***Caution!** The rates claimed by the various schemes can be misleading. As we have shown above, recycling or recovery[1] rates for material collected can be very impressive (WEEE, batteries, end-of-life vehicles, textiles, etc.). However, collection rates (relative to the quantity of a product sold in any given year) can be low: under 40% for furniture, around 50% (see above) for WEEE and batteries. We can only make a vague estimate for end-of-life vehicles as it is thought that between one-in-two and one-in-three cars never enter the compulsory collection scheme! In summary:

- R (effective recycling rate) = R^1 (collection rate) x R^2 (recycling rate for the material collected).
- When the vehicle scheme claims a recycling rate of 87%, this is merely an R^2.
- When the packaging scheme claims a recycling rate of 70%, this is the effective rate, R.

1 As a reminder, "recovery" includes "recycling" material and recovering energy.

The EPR scheme for cigarette butts means that, from 2021, producers will have to contribute to paying for city streets to be cleaned.

A new law on the circular economy was adopted on February 10, 2020. What progress has been made in terms of EPR?

JV: The law introduces sweeping changes to the EPR regime, including:

1. 10 new EPR schemes (Article L541-10-1 of the Environmental Code)
   From 2021 to 2025, 10 new EPR schemes will be added to the 12 existing ones:
   1. building construction products and materials
   2. commercial packaging*
   3. toys
   4. sports and leisure items
   5. DIY and gardening items
   6. motor oils
   7. plastic-tipped tobacco products*
   8. synthetic chewing gum
   9. single-use sanitary textiles, including pre-soaked wipes*
   10. fishing gear that contains plastics*

*European schemes

   And the scope of certain existing ERP sectors will be extended: for example, the EPR scheme for vehicles will now include two-wheelers.
   The cigarette butt EPR will be the first of the new EPR schemes to be set up, as of mid-2021.

2 Much bigger eco-modulations (Article L541-10-3)
   The following table shows that eco-contributions sometimes account for a tiny amount of the overall price of the product. Previously, even where the eco-contribution was modulated to double in value, It would still represent an infinitesimally small amount, doing nothing to encourage eco-design.

Items	Eco-contribution	Average product price	Percentage contribution/ price
Textiles	€0.007	€18	0.04%
Smartphones	€0.02 to €0.04	€280	0.007%
1.5-liter bottle of water	€0.01	€0.62	1.6%
Car tires	€1.25	€70	1.8%
Refrigerators	€20	€440	4.5%
Washing machines	€10	€370	3.2%

Amount of the eco-contribution compared to the price of the product (by the author, 2018)

The new law introduces two major modifications to correct this failure. No longer will eco-modulations be calculated solely according to the difficulty of processing the waste (the end-of-life approach), but according to a wide range of criteria based on the product's environmental performance (the lifecycle approach): "quantity of material used, incorporation of recycled material, use of renewable resources, durability, repairability, possibility of being reused, etc."

Modulations, whether up or down, can now exceed the eco-contribution paid by producers, amounting for as much as 20% of retail price.

► These two modifications will be applied for the first time in 2021, to the household packaging scheme. Eco-modulation now makes it possible to reward manufacturers of plastic packaging that incorporate recycled raw materials, and the bonus applied can exceed the amount of the eco-contribution paid by the producer.

3. **Repair funds** (Article L541-10-4)
   The new law places great emphasis on the repairability of certain products and it states that in a number of EPR schemes (such as WEEE, furniture, textiles, toys, sports and leisure items, DIY and gardening items), PROs will have to finance a repair fund. However, the law fails to set an exact amount.

4. **Reuse and reemploy funds** (Article L541-10-5)
   Reemploying or reusing a product is far better than creating waste, even when materials are recycled. This is why the new law stipulates that in some EPR schemes (those cited in point 3, above) 5% of PROs' budgets must be used to finance a reuse and reemploy fund.
   The State was already able to set minimum reuse thresholds in the PROs' terms of reference. This mechanism was little used in the past but will likely be more widespread in future. The law also specifically requires that 5% of packaging must be reused by 2023, 10% by 2027 (Article L541-1).

5. **Retailers required to take back certain products** (Article L541-10-8)
   Retailers of electrical equipment, household appliances, electronics and bottled gas were already required to take back used products at no cost. The new law will extend this obligation to other schemes: household chemicals, furniture, toys, sports and leisure items, DIY and gardening items.

6. **Distance-selling electronic marketplaces are now subject to EPR** (Article L541-10-9)

   The law now states that if an organisation acts as intermediary in the sale of goods to a third party, it is the organisation that is subject to EPR, unless the organisation can show that the third party has already fulfilled its EPR obligations.

7. **Sanctions, specifically in the event of failure to meet targets** (Article L541-9-6)
   One of the key criticisms levelled at existing EPR schemes is that there are barely any sanctions if PROs fail to hit the targets set out in their terms of reference, such as for minimum collection or recycling rates. In future, the new law states that if a PRO fails to meet one of its targets, it may be required to put forward an adjustment plan, funded according to budget minimums set out by law. Finally, if it fails to deliver its plan, or in the event of other breaches of its terms of reference, it can be fined a significant amount (10% of its budget, which could amount to several million euros) or have to pay a daily fine (€20,000 per day).
   However, there are two impending challenges:
   - in financial schemes,[1] PROs do not intervene directly; rather, they subsidise local authorities that do the actual work. Some PROs have already stated that under these conditions they cannot accept responsibility;
   - the sanctions described above apply to PROs. But what happens if producers (perhaps in one of the new schemes) have not created a PRO? The sanctions regime for infringing producers created by the former law (unmodified by the new law) has been shown to have limited effect.

8. **Producers required to present five-year waste prevention plans** (Article L541-10-12)
   Following the Belgian example, every five years producers will be required to present a plan for the eco-design of their products, reducing and improving the recyclability of their waste, increasing the use of recycled raw materials, etc. Producers can do this by themselves or collectively, for example, by asking a PRO to do it on their behalf.

9. **Waste management contracts agreed by ecobodies** (Article L541-10-6)
   One of the main criticisms of the EPR system is that in operational schemes[2] it grants a monopoly (sometimes an oligopoly) to a PRO that is responsible for managing waste for the entire scheme. This means that it, and it alone, agrees all the contracts with operators that collect, transport, sort and recycle the waste. This creates a situation of dominance that operators sometimes complain of.
   The new law establishes a number of safeguards: non-discrimination clauses for tenders, more separate lots to encourage greater competition and to allow SME to bid, processing to take place locally, employment opportunities for people on job integration schemes, etc. Specifically, under the new law it will be the PROs (and by extension the producers) that will have to absorb fluctuations in raw material prices, not the waste processing operators.

10. **Substituting a PRO in the case of failure by another PRO** (Article L541-10-7)
    As described above, EPR schemes contribute to financing a portion of local authorities' waste management costs.[3] In the past, failures on the part of a PRO have deprived local authorities of the corresponding revenue. In the future, the new law stipulates that in such situations the state can nominate an existing PRO to take over from the failing PRO.

11. **Mediation**
    In the event of a dispute between a PRO and a stakeholder, the parties can turn to the Business Mediator.[4] This system will be trialed for three years.

1 See above for an explanation of the difference between financial and operational schemes.

2 Ibid

3 Ibid

4 France's Business Mediator was established a dozen years ago to provide mediation between private bodies, or between private and public bodies.

ILLEGAL WASTE SHIPMENT: AN OVERVIEW

Katie Olley
Waste Shipment Specialist, Scottish Environment Protection Agency

Example of a shipbreaking beach taken in 2014 in Bangladesh ©NGO Shipbreaking Platform 2014.

Katie Olley is a specialist in waste shipments for the Scottish Environment Protection Agency, working in the field as a policy maker and operational lead for over 20 years. She is the Project Leader for IMPEL's (Network for the Implementation and Enforcement of European Environmental Law) flagship Shipments of Waste Enforcement Actions Project, and is currently the Chair of the Basel Convention's ENFORCE Network.

There have been fundamental shifts in the shipment of waste around the world over the last two decades. This article describes these, their causes, and the recent acceleration in the shift in illegal shipments to countries least able to deal with them. It also discusses enforcement gaps and how they might be addressed.

INTRODUCTION

The extent of illegal waste exports is difficult to assess. Since 2011 until 2020 approximately 19-22% of shipments inspected within Europe violated the Waste Shipment Regulation (according to IMPEL's Enforcement Action Project series[1]). The violation rates do not just reflect the level of illegal activity but also the ability of competent authorities, who police this trade, to identify problematic waste shipments and intervene accordingly. Waste electrical and electronic goods, metals and plastic and paper from household sources made up 34% of all violations. The main destination regions of European waste, outside Europe, are Africa and Asia.

1 SWEAP inspection results 2018 – 2020. https://www.sweap.eu/wp-content/uploads/2020/07/SWEAP-inspection-results-2018-2020-updated.pdf

BACKGROUND

Waste shipments are a double-edged sword. If properly carried out – in an environmentally sound manner – they can deliver resources to industries that need them. However, inadequate treatment of waste can cause severe damage to the environment and human health. This has been well-documented over several decades. The World Health Organization has stated that "available scientific evidence on the waste-related health effects is not conclusive, but suggests the possible occurrence of serious adverse effects, including mortality, cancer, reproductive health, and milder effects affecting well-being."[2] Health risks from the improper processing of waste can also be indirect, if harmful toxins accumulate in ecosystems, agricultural crops, livestock and eventually humans.[3] The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (1992) was established following a number of the high-profile cases, which had devastating impact on the populations and environments that received hazardous wastes.

THE RISE OF WASTE SHIPMENTS TO DEVELOPING COUNTRIES

Increasingly demanding governmental waste recycling targets, landfill bans, rising landfill taxes in developed countries, and containerisation have led to the rapid rise of global waste shipments, mostly to developing countries. This is mostly due to the lower labour costs and environmental standards in receiving countries. Nowhere is this more visible than on the shipbreaking beaches of the Indian subcontinent.

The informal waste management sector in developing countries can be vast. In 2015, there were approximately 857 recycling companies authorised by Chinese authorities to carry out recycling of imported plastic waste. In comparison, there were literally thousands of informal and therefore unregulated recycling sites.[4] These are labour-intensive operations using basic equipment and often operating under poor safety standards. Recycling residues are usually dumped or openly burned, thereby releasing harmful compounds such as furans, dioxins and carbon monoxide into the atmosphere, and contaminating wastewater.

When looking at plastic waste for instance, its low value, the lack of industries in most developed countries that produce plastic goods and the avoidance costs of adequate treatment, mean that it is appealing to the less conscientious waste broker to exported it illegally. Highly contaminated waste is often shipped fraudulently through falsification of customs forms, or fraud through over- or under invoicing costs and mis-declaring income. The waste itself may even be concealed behind good quality material when being loaded into containers, and it is also common that the ultimate final destination is not revealed to authorities.

China has been implementing increasingly rigid waste import policies since 2010 in an effort to increase its national collection and recycling infrastructure, but also to push back on the poor wastes it was receiving from many European countries and the US. In 2017, China announced a new import policy that would permanently ban the import of many recyclates.[5] Since 2017, the number of illegal shipments of European waste destined directly for China has been decreasing. Household wastes were the most common problem wastes at that point, whereas metals and plastics have now become the waste streams most frequently stopped by European competent authorities heading for China.[2] Since the introduction of China's new import restrictions in 2018, neighbouring countries have inevitably been targeted by waste criminals. This is a familiar pattern with waste crime.

ENFORCEMENT ISSUES

All countries have competing pressures for executive and parliamentary time. The legislation to implement the provisions of the Basel Convention and provide powers to their national regulators can slip down the priority list. Where implementation has been relatively swift, for instance in the European Union, regulatory agencies may still lack the powers they need to prevent illegal shipments. Even where there is adequate enforcing legislation, most authorities lack the resources they need to control waste shipments. European Regulation (EC) No 1013/2006 on shipments of waste requires Member States to establish appropriate penalties and fines. Trying to convince a Prosecutor to take an environmental case can be very difficult though. There are very few countries with dedicated Prosecutors for environmental crime; England, The Netherlands, Sweden and soon France, are rare exceptions. Therefore, the number of infringements relating to waste shipment legislation brought before courts is low.[6] The levels of the actual penalties can also vary greatly.[7]

Since 2011 until 2020 approximately 19-22% of shipments inspected within Europe violated the Waste Shipment Regulation

2 2016, World Health Organization, Waste and human health: Evidence and needs. WHO Meeting Report 5–6 November 2015, Bonn, Germany

3 2012, ILO. The global impact of e-waste : Addressing the challenge. International Labour Office. Accessed 11 December 2020. http://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/publication/wcms_196105.pdf

4 2017, GRID-Adrenal. The Trade in Plastic Waste. Accessed 18 December 2020: https://www.grida.no/publications/333

5 2017, Chinese Ministry of Environmental Protection, "Announcement of releasing the Catalogues of Imported Wastes Management," (Announcement no. 39, 2017); www.mep.gov.cn/gkml/hbb/bgg/201708/t20170817_419811.htm?COLLCC=3069001657&.

6 2018, Gillan, L & Olley, K. IMPEL-TFS Enforcement Actions, Project Report 2016 –2017 Enforcement of the European Waste Shipment Regulation

7 2015, Geeraerts, K., Illes, A. and Schweizer. Illegal shipment of e-waste from the EU: A case study on illegal e-waste export from the EU to China. A study compiled as part of the EFFACE project. London: IEEP

Shipments of Waste Enforcement Actions Project (SWEAP) inspection data from 2018 to 2020.

Regulation of waste activities can be split across various national bodies, with one regulating waste shipments and another waste management licensing. These silos make it difficult to monitor waste shipments from cradle-to-grave, especially when the responsible parties may be 'waste tourists', locating themselves in an exporting country for sometimes only a few months, or a 'few shipments worth' at a time, shipping waste to their home country. This is typical for the waste electrical and electronic equipment trade, with west African countries being a major destination for over fifteen years.

Waste shipment inspectors may also be responsible for regulating other regimes, such as chemicals and producer responsibility legislation. It may seem easy to tell what is legal and what is illegal, but this is not always the case with legislative loopholes and 'grey areas', i.e. when officers have incomplete documentation in front of them, for example when inspecting a container with used electronic equipment, which seems to be too old to realistically be put back on the market. Organisations' priorities change depending on resources, political will and undeniably media pressure. The latter brought about the massive change to the controls surrounding shipments of plastics that will come into force on 1 January 2021.

The global trade in household recyclates involves many different players, such as recycling companies, waste traders, dealers and hauliers, making traceability and control of the waste difficult for investigating officers.

Violation data from 2018 to 2020 (SWEAP)

Curtain-siders move easily from western to eastern Europe, using a network of transport operators. Co-operation with other authorities regulating at national frontiers can also be lacking. Within the EU, co-operation with Customs authorities is relatively high, with 81% of environmental competent authorities having formal or informal working arrangements with Customs.[5] However, this still leaves a significant proportion of European authorities lacking the support of their national Customs. Anecdotally, the situation is much worse outside Europe. This makes the illegal waste trade a low risk business for criminals, enticing them to move high volumes to maximise profit.

Despite, 'intelligence-led' operations being the flavour of the day, and rightly vaunted by Police networks, many environmental authorities lack intelligence capacity. In a survey conducted by IMPEL (Network for the Implementation and Enforcement of European Environmental Law), only 44% of European agencies had access to intelligence systems.[5]

The nature of waste shipments crime is of course that they are transnational. Environmental regulators tend to be a collaborative and enthusiastic group. However, they work across different time zones, meaning it can be difficult to communicate easily. Coupled with this, authorities in developing countries may use personal email addresses because their own organisations cannot provide them with accounts. Although a seemingly minor issue, this can mean the exchange of information is immensely difficult or forbidden.

And then there is the issue of 'port hopping'; the practice whereby illegal waste shippers avoid frequently inspected transport hubs and move their waste through less well-regulated ports or roads. Like water, waste crime always finds the lowest level.

THE FUTURE OF ENFORCEMENT

So how is this situation to be improved? In the EU, the 2014 amendments to the Waste Shipment Regulation (WSR) addressed some fundamental issues for European regulators; namely, reversing the burden of proof on to shippers of waste and requiring each country to have an inspection plan. Enforcement can only be as strong as the weakest points in the regulatory chain however. The WSR is undergoing its next five-year review, with issues on reporting against inspection plans being addressed.

Further work is needed to improve the consistency of reporting inspection results. The Basel Convention Secretariat struggles annually to compile reliable statistics. Ways to streamline reporting have been invented but countries with numerous regulators involved in waste shipment controls will always find this difficult. The IMPEL Shipments of Waste Enforcement Actions Project[8], which runs from 2018 until 2023, will enable officers to report the same detailed data during inspections as their counterparts in other European countries. It will also 'flag' illegal shipments and vulnerable routes to authorities using real-time data. It's to be hoped that this initiative makes a crucial difference to the effectiveness of officers' time. The data will also be more robust and the high-level data (non-nominal) readily available to policy makers. Europol will have access to the nominal data and be able to assist authorities in joint operations, and possibly fill the gaps for environmental regulators without access to their own intelligence systems.

There are plenty of regulatory tools being developed by other European and UN-funded projects. For example, the WasteForce Project seeks to provide Prosecutors with training and guidance. The problem is embedding these ways of working and maintaining co-operation. It is recommended that environmental regulators co-operate more with customs, police and other regulatory authorities, and that formal service-level agreements be considered. Awareness-raising that waste crime is an important threat to security, people and the environment amongst enforcement communities needs to continue apace. Sharing cases on the involvement of other types of crimes, such as major tax fraud and tax avoidance may assist.

The involvement of existing international bodies such as the United Nations Office on Drugs and Crime (UNODC) and the World Customs Organization (WCO) is very welcomed and should continue. The WCO is ramping up its efforts to assist in enforcing the provisions of the Basel Convention, having recently joined the Basel Convention's ENFORCE network and running its Operation Demeters which have a joint focus on transboundary movement of hazardous waste.

Collaboration between different regions of the world tends to work well whilst key and enthusiastic officers are in place. Verification of sites of destination is a 'must' for exporting countries, and the channels of communication need to be as effective as possible. It is often the case that receiving countries are either unaware or unsure about invoking the 'repatriation requirement' whereby an illegal shipment should be taken back to the country of origin. If this was to become regular practice, it would surely act as a deterrent to parties involved in illegal exports and ensure those responsible for waste meet their 'duty of care' by checking downstream treatment operations. Strengthening regional and sub-regional enforcement approaches needs to be considered by reinstating networks such as the successful Regional Enforcement Network for Chemicals and Waste in the Asia and Pacific region, which share best practice.

Mapping of the scale, routes and hazardous nature of the waste involved can only help mount political pressure. This in particular has led to the recent focus on the illegal trade in waste plastics. Perhaps this can address the main issue at the base of all this illegal activity: the need to strengthen national legislative frameworks and regulatory agencies. All in all, there is a long way to go on the enforcement of waste shipments.

8 https://sweap.eu The Shipments of Waste Enforcement Actions Project (SWEAP) is co-funded by the European Commission LIFE fund and co-ordinated by the IMPEL Network. The overall purpose of the project is to support the circular economy by disrupting the illegal waste trade at the EU level.

CIRCULAR AFRICA: A MODEL FOR US ALL?

Alexandre Lemille
Co-founder of ACEN, the African Circular Economy Network

©Wayne Visser- Barloworld Caterpillar.

Alexandre Lemille co-founded the African Circular Economy Network (ACEN www.acen.africa) in 2016 with a group of experts from South Africa. ACEN now operates in 33 countries in Africa, with over 100 experts helping to build a vision for the circular economy in Africa.

Alexandre also uses his Circular Human sphere concept (#CircHumansphere) to trigger debate on the importance of never uncoupling circularity and social justice, and is an active proponent of the vital link between the circular economy and human development (publication: Elsevier Academic Journal). He lectures on the fair and circular economy at several international educational establishments.

He has a Master of Business Administration (MBA) degree from Hult International Business School, Boston (2011).

Today, the African continent faces a pivotal choice: to take advantage of the window of opportunity now open to it for committing to a model centered on the circular economy— better still, the fair and circular economy — or replicate the growth models that proved successful in the past for the Americas, Europe and Asia. This is a choice that only Africa can make and benefit from.

The African Development Bank (ABD), African Circular Economy Alliance (ACEA) and African Circular Economy Network (ACEN) are fully aware of the importance of this choice. They are working together to forge an ecosystem that will boost the emergence of a model as yet little-known in Africa. The task now is to set in place the foundations of a professional framework for extreme resilience in order to adapt the economy to the social and climate challenges that will impact the continent first of all.

Africa needs to show the way at a time of increasing resource scarcity worldwide and a climate emergency that will make living conditions harder than ever.

INTRODUCTION

Africa, like every other part of the world, is closely examining the new circular economy model. This is a collaborative economy that seeks to adapt to social, economic and environmental constraints. But is this really such a new thing for Africa, a continent that has always battled with all manner of constraints and has innovated throughout its history in order to improve the life of its peoples?

Africa today is at a turning point that nobody can deny. Just like India in the 1990s, even China in the 1980s, the race for economic growth is now underway. From Ethiopia to Ghana, growth rates are the envy of long-established economies. But is the rush for all-out growth really the path that Africa should take? In other words, should it move toward an economic model that has unsettled global markets, a growth model with rapacious energy demands that is the cause of vanishing fossil fuel reserves? These are big questions for a continent where over half the population is very young.

At a moment when the continent is seeing an economic slowdown caused by Covid, it is the only place on earth currently able to create a model for human progress based on an economy that acknowledges systemic challenges, in other words, an economy rooted in resilience from the very start of its industrialization phase.

REMANUFACTURING AND REPAIRABILITY: MODELS WITH A FUTURE FOR AFRICAN INDUSTRY

Although often equated with an economy of survival — which has caused such suffering to so many Africans and continues to do so today in the informal recycling and improvisation economy — the circular economy aims to take us beyond recycling and toward a model that seeks to limits it as much as possible.

The circular economy perceives the resource-trading market through the prism of two dimensions: technical nutriments (or resources), our equipment based on metals and non-metals, and biological nutriments, which are material resources derived from our natural ecosystems. Innovative business models can ensure that these resources circulate for as long as possible in our exchange systems, while also rendering them economically viable. The ultimate objective is to generate no waste or pollution with minimal energy input. The continent's leaders must draw inspiration from this approach to apply the fundamentals of circularity principles to economies where the environmental footprint — despite strong growth — remains the smallest in the world.

This might, for example, involve building infrastructure whose modularity is designed-in from the outset, making it simpler to adapt to suit other needs during future lifecycles. But this requires strong political will to change our current practices. Instead of creating a network of factories manufacturing goods that will flood the world with products made in Africa, the idea would be to create interlocking webs of remanufacturers meeting the needs of regional markets in Africa and beyond. Whereas today's factories operate on the basis of unlimited access to virgin materials, remanufacturing, or refabrication, consists of making new objects from non-virgin materials, i.e. that have already been extracted from underground. Flows of previously extracted materials are redirected toward factories, with the aim of reducing the impact of mining and avoiding materials that are still useable piling up in Africa's refuse tips. Remanufacturing offers a threefold advantage: reusing large volumes of durable materials prior to their end of life, avoiding the creation of waste and pollution, and creating jobs that aim to extend the life, or lives, of the products. According to Walter Stahel, one of the pioneers of the modern circular economy, this approach uses far less energy and creates a far higher need for labor than when a product is produced in the conventional manner. He introduced a metric for the labor/weight relationship, man-hours per kilogram (mh/kg), which is used to measure job creation compared to resource use. This enabled him to show that the ratio of man-hours per kilogram of resources used for a remanufactured vehicle engine, compared to manufacturing the same engine from virgin materials, is 270:1.

Remanufacturing offers a threefold advantage: reusing large volumes of durable materials prior to their end of life, avoiding the creation of waste and pollution, and creating jobs that aim to extend the life, or lives, of the products

The impact on employment is enormous and offers Africa an exciting opportunity for the future: to become the remanufacturing hub, not necessarily for the whole world, but for a region that would include Europe and the Middle East, certainly for so long as transport remains a source of pollution (avoiding risks relating to future carbon taxes).

In any strategy for maintenance, repair, reconditioning or remanufacturing, employment, particularly in economies with young populations, becomes essential to the resilience of this type of model. Furthermore, one of the world's benchmark refabrication specialists is located in Africa: the Barloworld Caterpillar factory, where a third of activity centers on remanufacturing heavy equipment, as detailed in the documentary Closing the Loop presented by Wayne Visser, professor at the Antwerp Management School.

The other massive opportunity for Africa is using repairability and durability to extend the lives of products and their components. Repairability offers two economic opportunities: return functional objects to the trading cycle as rapidly as possible, and create jobs at the same time. When it comes to durability, the challenge is to design modular products with components that are accessible, ideally open source, and upgradeable. Africa needs to focus on this approach to professionalizing repairability. By way of illustration, the Fairphone smartphone is an example of a particularly virtuous product, one that every country, not just in Africa, should seek to have on its market. The Fairphone is not just circular but is also type II, meaning open source. The Fairphone is a good-looking 4G smartphone offering a comparable performance to other similar devices. The real innovation lies in its accessibility and upgradeability, thanks to unlimited access to every one of its components. Each component can be unscrewed and reintegrated into the economy. Accessibility of components makes access and repair easier. This could have two instant impacts: the creation of skilled local services that can repair, maintain or even upgrade objects, as well as securing access to certain metals that have become scarce to governments without reserves of their own. The impact on employment and stocks of materials would be considerable if all objects and their components were to become accessible in the markets where they were used.

THE CIRCULAR ECONOMY AS A LEVER FOR INNOVATION IN AFRICA

The circular economy is about perceptions of abundance. The challenge is to shift from the current paradigm of a quantitative abundance of reserves on a planet without limits to a qualitative abundance created by flows of materials. Recycling must be limited in a circular economy, even though we need it for the benefit of the generations to come. This is because recycling is an essentially linear

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concept based on creating waste that is then recovered. From a circularity standpoint, waste must be limited by setting up holistic strategies that promote the durability of objects, and therefore their various uses in their future lifecycles. During an object's design phase, it needs to be thought of as a service provided for a demand, for a function, shared, constantly evolving, perhaps by continually adding new functions. This is very far removed from the notion of recycling, where a pre-made glass bottle, embodying an investment of time, energy and human labor, is usually destroyed so it can be remade exactly the same. This amounts to an excessive and futile use of energy, investment (which could have benefited other solutions), and labor. Circularity is based on natural cycles where energy and material flows are constantly exchanged, continuously changing as they adapt to new contexts. Within this paradigm, the option using the least energy is often chosen. Recycling is therefore not the best solution.

This reasoning has seen the emergence of African businesses such as Agriprotein in South Africa. Influenced by permaculture principles that students at the Songhai Centre in Benin have been learning for several decades, Agriprotein realized that replicating natural cycles and applying them to human environments represents a major opportunity. By laying their larvae on food waste, solider flies ensure larvae can feed themselves. By growing as much as two hundred times their initial size, they serve, once dried, as staple food for a wide range of animals and their oil is used for biofuel or feed oil. The entire process lessens the impact of human food waste. By recreating the natural animal protein cycle, Agriprotein provides a sustainable solution in a market whose economic potential is estimated at a trillion dollars and, most importantly, a natural method for feeding animals while solving the issue of human food waste. Agriprotein is now part of the Insect Technology Group (ITG), a holding company comprising leading global companies such as Circular Organics, MultiCycle Technologies and ITG Bio-polymers. Time Magazine included AgriProtein on its Genius 50 list of businesses that are building the future.

However, setting up a circular business in Africa does not require a holding company. Throughout the continent, a host of soil restoration startups are thriving, protecting soil fertility through better understanding of biological cycles and how to adapt to them. This approach has been embraced by the head of Ecofertil in Morocco and the co-founders of Lono CI in Ivory Coast, where compost and biological products have become the green gold of tomorrow's Africa. As they pave the way in soil conservation and respect for biological cycles, these new-generation businesses are focusing on the authenticity of their approach to guarantee greater resilience for future farming systems.

Africa is currently home to over two hundred innovation and business incubation hubs identified by the African Circular Economy Network. These hubs have resulted in the emergence of numerous circular startups, with plenty of examples to cite. Hello Tractor in Nigeria provides access to shared agricultural equipment to hundreds of farmers. Also in Nigeria, the international Platform to Accelerate Circular Economy (PACE) has invested in various areas: retrieving precious materials contained in electronics once they are no longer in use so that they can be reused in local production processes; safe handling of dangerous components in electronic waste, and strengthening the conditions conducive to legislation on a self-sustaining system for extended producer responsibility in the electronics sector. In Ghana, Agbogbloshie Marketspace

©AgroBootCamp

(AMP) is a platform that creates value from electronic waste by giving it a second life. Rwanda is proving to be a pioneering force, investing five billion dollars in a zero-waste urban project: the city of Wakanda will spread across 620 hectares without generating any waste. In Ivory Coast and Ghana, Coliba has developed a mobile application that municipalities can use to identify and monetize the locked-in value in waste. In Zambia, ICLEI Africa, an ACEN partner, is implementing a composting program in Lilongwe. Further north in Morocco, Fertidev is working on the development of fully Moroccan biotechnological solutions, optimized and adapted to Moroccan ecosystems and biodiversity to provide added value for agricultural products while protecting farmers, consumers and the environment. And Ethiopia has launched a national program to regenerate its agriculture. More broadly, Djouman is a social enterprise that organizes permaculture AgroBootCamps for the whole of west Africa. Biomimetics are being used to great effect to regenerate the Berg River in South Africa, irrigating the region's vineyards. It is also at the heart of a Nigerian project to create a new district, Abuja Centenary, where technical and biological flows are overlaid in perfect symbiosis.

Africa is truly brimming with inspiring innovations!

NEW FRAMEWORKS FOR A CIRCULAR REVOLUTION

But these initiatives are just the tip of the iceberg.

The continent has started on its path to circular conversion. It is ensuring it has the players, international bodies, incubation programs and, above all, legal frameworks needed to get circularity up and running. In May 2017, in collaboration with the European Union and ACEN, the governments of Nigeria, Rwanda and South Africa signed a cooperation agreement on the circular economy. Known as the African Circular Economy Alliance (ACEA), it now includes a significant number of countries in west, north and southern Africa, all of which have committed to passing laws to create a framework favoring an economic model that protects resources while reducing carbon emissions. The ACEA has an office at the African Development Bank in Abidjan and is in permanent discussions with stakeholders implementing relevant laws and regulations. In parallel, the African Development Bank (ADB) has created a program, the African Circular Economy Facility (ACEF), in partnership with the Finnish government, aimed at helping governments who have made less progress to implement regulatory instruments and tools for encouraging circularity. With the ACEF program, the ADB also intends to help the business world, small and large companies alike, by providing them with support in the form of incubation programs and initiatives promoting the circular economy with the overarching goal of speeding up transition.

In addition, ACEN provides them with technical support on the ground by identifying economic actors and businesses innovating in the circular economy, while sharing knowledge with as many businesses as possible.

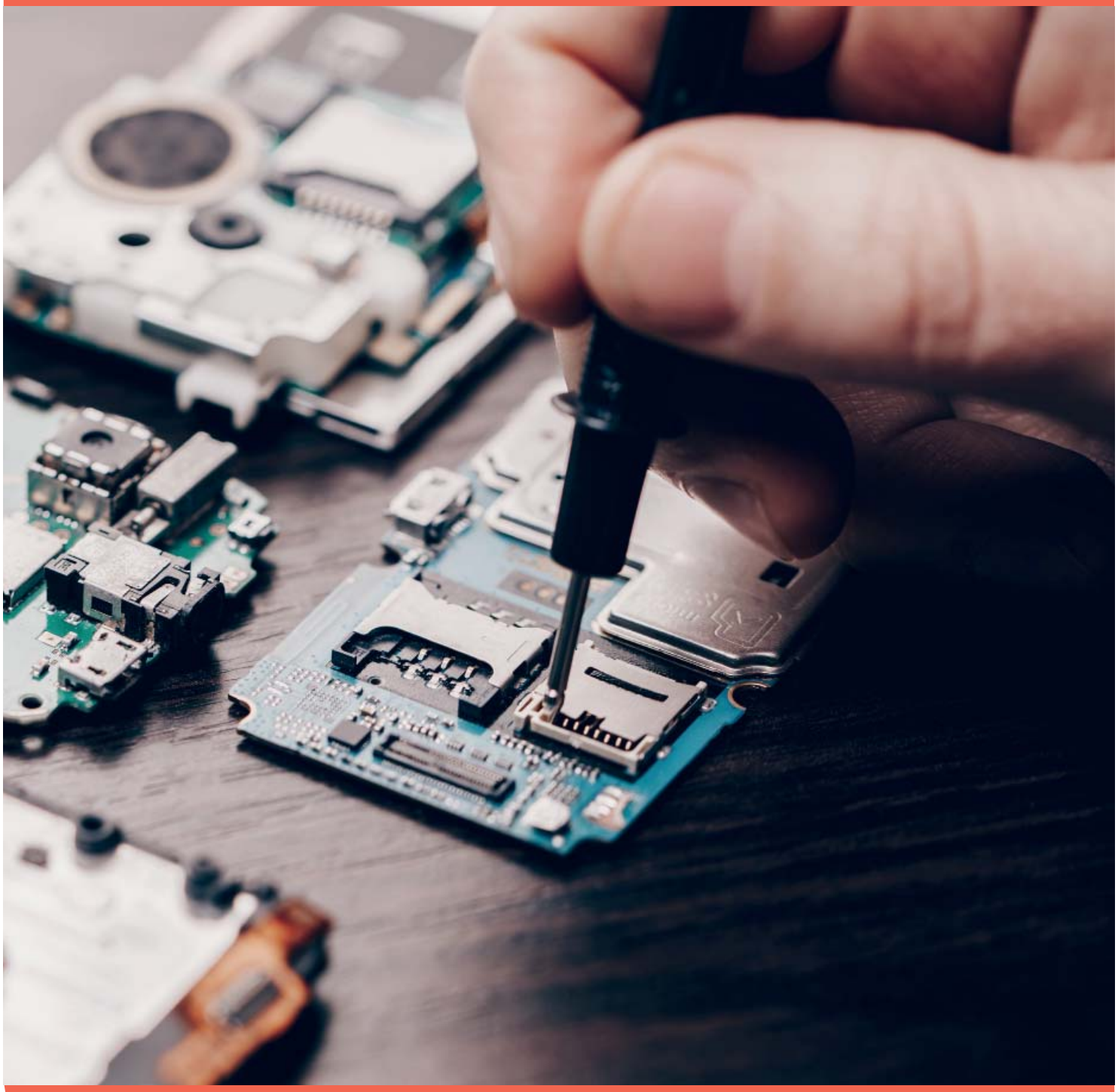
CONCLUSION

What if we were bolder still? What if Africa showed the way to an economy that is both circular and fair?

The continent's population is young and forward-looking. The lack of infrastructure translates into limited effects on the biosphere. It boasts the world's lowest ecological footprint per capita and collaborative societies. African societies are marked by a culture of sharing and survival in the face of multiple challenges, making the continent one of the most innovative parts of the world. One of the only telecommunications companies to have succeeded in adapting to citizens' social needs, Celtel International founded by Mo Ibrahim, initiated the social innovations that have helped Africa to communicate and reinvent itself. One example is the Street Payphone — a pre-paid or post-paid cellphone distributed via street vendors and managed by women who can feed their families thanks to the wages the system provides — using free roaming zones shared across over ten countries. These innovations have been adapted to citizens' needs and their collaborative lifestyles. Seen in Europe as an enviable model, Africa could specialize in collaborative innovative services and develop business models that are still little-known in Europe.

Africa is at a crossroads, a place where the linear economy and the regeneration economy meet. The choice of path to take is Africa's alone. And it can make the choice without having to take drastic action to strip carbon out of its economy. The emergence of this virtuous model with its huge job-creation potential is a wonderful opportunity for the continent as a whole.

2. SHIFTING HOW THE VARIOUS ACTORS BEHAVE



Helping our models transition toward a circular economy requires efforts by the private sector actors involved in producing goods and services, public sector actors regulating the economic and social spheres, and consumers, whose purchasing choices influence businesses' current and future strategies. So, how can we nurture the emergence of new ways of consuming and producing? To answer this question, we need to examine the levers at our disposal for shifting the behavior of individuals, authorities and businesses. From new lifestyles and public policies to management indicators and industrial strategies, countless mechanisms exist for influencing the behavior of socio-economic actors and fostering the rollout of circular practices.

ALTER CONSUMER BEHAVIOR

The transition to a circular economy depends on the participation of consumers, who drive companies' demand for new products manufactured at low cost in emerging economies. The challenge here is to switch from mass consumption within a paradigm of limitless resources to lifestyles that are more environmentally friendly. Moving beyond reuse, recycling and eco-design, Professor Valérie Guillard from Paris-Dauphine University invites us to change our relationship with the world, rooted in our knowledge, skills and attitudes, encouraging us to shift to less resource-intensive lifestyles where quality is valued above quantity.

RETHINK LEGAL FRAMEWORKS

While consumers appear increasingly receptive to environmental considerations, their buying habits still need directing and guiding so they can identify the products that are the most sustainable. This is the idea behind France's law on the circular economy and combatting waste (AGEC), passed on February 17, 2020, and outlined for us by HOP, an NGO actively involved in drafting the new law alongside manufacturers and retailers of electronic devices, repairers and public bodies. This collective process led to the creation of an incentive-based scheme that will provide consumers with more information about the reparability and durability of electronic products while also promoting access to repair services at lower cost. At the local level, the example set by the town council in Aalborg, Denmark, shows how public and private sector actors can cooperate to transform municipalities' procurement practices and encourage businesses to change their habits in a wide range of spheres, from IT equipment to children's play areas.

THE AMBIVALENCE OF DIGITAL TECHNOLOGY

In addition, Xavier Verne, from the Shift Project, stresses the importance of taking into account the material footprint of digital technology, given that only 17% of electronic waste is recycled worldwide, and that it is difficult for companies to take into account, in their environmental assessments, the carbon impact of materials extraction and electronic equipment manufacturing. If digital technology can contribute to the emergence of more virtuous uses and behaviors in terms of consumption and mobility, it can also generate side effects if its impact is not analyzed throughout the value chain

DEVELOP INDUSTRIAL SYMBIOSES INSPIRED BY NATURE

Shifting to a circular economy also means looking to the natural world for inspiration, primarily by developing industrial symbioses that center on flows of materials and energy that are exchanged between regional businesses. Zhao Kai, Vice-President and Secretary General of the China Circular Economy Association, explains how Chinese policy aims to foster ecological transformation at industrial parks and describes a series of projects for green industrial parks developed in China to encourage synergies between actors from different sectors, including metallurgy, energy and agri-food.

DEFINE CIRCULARITY INDICATORS

It is critical that new management tools are created to drive the rollout of circular practices within businesses. Specifically, businesses need new indicators for defining targets and measuring their performance in this area. However, circularity indicators represent a complex issue that requires establishing a delicate balance between effectively addressing the systemic nature of exchanges of flows and materials and ensuring the clarity of information provided to pilot corporate strategies as accurately as possible. This painstaking work has been undertaken by the Ellen MacArthur Foundation and the World Business Council for Sustainable Development. In this issue they present two tools for measuring circularity: Circulytics and the Circular Transition Indicators.

PROMOTE INDUSTRIAL PARTNERSHIPS AND COOPERATION

Aside from the question of how collective actions can be piloted, many technical obstacles face industrial companies seeking to transform their production processes so they can reduce their environmental impact, whether in terms of materials used or waste generated. SEB and Veolia describe how they set about creating an industrial cooperation project based on the introduction of recycled materials into the plastics production process. The initiative enabled them to solve an array of technical obstacles and lay the structural groundwork for a new-look production sector.

Joël Ntsondé,
issue coordinator

TOWARDS A SOCIETY OF SOBRIETY: conditions for a change in consumer behavior

Valérie Guillard
Professor at Paris-Dauphine University

The negative impact our lifestyles have on the environment means we have to think beyond the circular economy (reuse, recycle, eco-design) and imagine lifestyles marked by greater sobriety. Sobriety is a lifestyle that involves not just consuming better but also, and critically, consuming less. It can be expressed in consumption of energy and digital technologies as well as via material objects. Making the commitment and embracing sobriety to live a more sober life are ways of living that are conditioned by changes in practices on the part of consumers, the units analyzed in this article, at every stage of the consumption process (perception and sensation of need, products purchases and places of purchase, use and non-use of objects, dispossession).

Changing your habits as a consumer entails seeking meaning through other ways of doing and being, which requires revisiting, or even initiating, relationships with objects, the self and others. Sobriety places notions of conscience at the center of relationships with the world, alongside the effort and determination involved in challenging personal and social norms.

Organizations, both public (local authorities, for example) and private (non-profits and businesses), could offer a range of mechanisms, products and services to restore to consumers the skills needed for this lifestyle (the knowledge, know-how and attitudes) as well as the opportunity to pursue it. Sobriety should be a space within which consumers and organizations alike can find fulfilment.

Valérie Guillard is a professor at Paris Dauphine University - PSL. Her work examines peoples' relationships to objects. She seeks to understand practices relating to possession, dispossession, non-possession and consumer sobriety with the aim of reducing wastage and waste. She has coordinated and/or participated in research studies financed by ADEME, including most recently CONSCI-GASPI (understanding wastage through its conscientization) and SOBRADEME (conceptualizing sobriety). She won a prize for her thesis on "hoarding behavior" of consumers (FNEGE publication prize), leading to publication of a book *Garder à tout prix, une tendance très tendance [Keeping absolutely everything, a very on-trend trend]* (Éditions Vuibert, 2013). She has also edited several collective works on the accumulation of objects: Boulimie d'objets, l'Etre et l'Avoir dans nos sociétés [A lust for objects, the being and having of our societies] (Éditions de Boeck, 2014) and *Du Gaspillage à la Sobriété, Avoir moins et vivre mieux? [From wastage to sobriety, having less and living better?]* (Éditions de Boeck, 2019). *Comment Consommer avec sobriété, Vers une vie mieux remplie [How to Consume with Sobriety, Towards a more fulfilled life]* (Éditions de Boeck, 2021) is a collection of reflections on the relationship of consumers to sobriety.

INTRODUCTION: FROM A CIRCULAR SOCIETY TO A SOCIETY OF SOBRIETY

Surely the society of tomorrow should shift from the circular economy to the sobriety economy? After the linear economy concept (produce, consume, dispose) and its limits in terms of waste, societies have evolved toward a circular economy, one that places a value on that materials that have become useless by reintegrating them into the production (eco-design[1]) and/or consumption process. Although virtuous, this vision of society focuses on the downstream (recycle and reuse), in other words on managing what exists, with little thought to the upstream, in other words, on ways to avoid depleting reserves of resources. It would appear that, mindful of the state of planet, recycling or reusing the useless is not sufficient to cap carbon emissions. Consuming less would make a bigger impact. "Less and better" is a good way to sum up sobriety, which in academic terms centers on voluntary simplicity. This is a lifestyle rooted in reducing consumption of material objects, digital technologies and energy. Are consumers prepared to shift toward this lifestyle? What are the conditions needed for consumers to switch to sobriety?

1 Franck Aggeri. *Vers l'innovation responsable. [Toward Responsible Innovation]* Esprit (Paris, France: 1932), Editions Esprit, 2020, pp.40-51.

ADOPTING SOBER BEHAVIORS: WHAT ARE THE IMPLICATIONS FOR CONSUMERS?

Committing to a process leading toward sobriety requires rethinking every practice at every stage of the consumption cycle: the purchase, use and dispossession of objects (A), which leads consumers to rethink their relationships to materiality, the self and the other (B).

(A) WHEN CONSUMING LESS AND BETTER ENTAILS A CHANGE IN PRACTICES

Consuming in a sober fashion starts with the expression of a need, or at least, what the consumers thinks is a need but is in fact often a desire or perhaps a whim. Consumers often purchase through habit, acting impulsively because they think they're getting "a good deal", or "just in case" they fail to find that same good deal. But purchases, especially of non-food items, rarely respond to a need. The function of objects is generally to heighten an experience and, by extension, the stimulating emotions that activate pleasure. The products purchased thus become emotional merchandise.[2]

A sobriety-led approach requires consumers to change their practices at every stage of the consumption cycle (defining need-purchase-use-non-use of objects and their dispossession)

To buy only in response to a need is something that can be learned. It implies that consumers ask themselves what their need is truly expressing. This is something that people who joined the Nothing New challenge run by non-profit Zero Waste discovered.[3] Through trying to limit their purchases of new objects, these consumers (95% of them women) realized that the consumer society creates frustration that is experienced through the ceaseless quest for the new (spectacle, object, wellness experience, etc.). The challenge also enabled the women to transform their relationships to consumption through questioning the ways in which items are acquired.

A sober acquisition entails rethinking the types of objects to acquire, how and where they are acquired.

First of all, the idea is to swap from purchasing resource-intensive new products to acquiring pre-existing used products. Consumers are increasingly opting for secondhand thanks to the boom in the number of secondhand stores and platforms that bring private buyers and sellers together as part of the collaborative economy. However, it would seem that the portion of secondhand purchases varies according to the product category. Consumer electronics, for example, are less frequently purchased secondhand than other categories of objects: consumers prefer to buy new when it comes to computers, telephones and tablets, as new products come with better warranties (returnable if they break down or don't work properly, etc.) than secondhand goods.

Sober purchasing also involves buying quality products that will last, and paying attention to the materials used. This entails not merely thinking of the object but feeling it too, no longer deploying only representations and beliefs but also knowledge and senses (touch, hold, experience through the body). In other words, methods of relating to products and acquiring them that are little explored by consumers.

Consumers then turn to alternative non-market mechanisms to acquire what they need. Donations between individuals or between anonymous people via dedicated drop-off boxes (Givebox), swaps, picking up items from the sidewalk[4] or, for the more militant, food from the trash, are all practices that save materials from being thrown away. People's motivations to adopting such practices might be economic:[5] they take remnants and objects no longer wanted by other households, restore or repair then and sometimes resell then via one of the platforms. Most people tend to be driven to act by the idea of "limiting the wastage that revolts them," a motivation that combines with the pleasure of rummaging through a pile of objects, seeking the hidden treasure and restoring it to use. Renting, lending, borrowing, making available, restoring, tinkering, repairing are also practices that extend the life of objects without purchasing them.

In addition, sober consumption entails selecting purchase places that align with this approach. Local outlets are favored where possible, such as small shops or producers, via local producer-consumer networks for example, where it is possible to ask for advice, create a relationship rooted in trust and avoid the packaging that comes with delivered goods.

In essence, being a sober consumer requires the quest for a type of consumption that takes full account of the consequences of consuming on the environment, doing "all that's possible" to avoid triggering production of a new object (and potentially its destruction at an unknown date in the future). This is an approach that requires time (research, collating information, comparing alternatives), during which the consumer may come to realize that they in fact have no need of the product. However, if a secondhand or free acquisition can be a way to "consume better" that fully aligns with the circular economy, such practices do not always help to "consume less." The lower cost of a secondhand object, or having almost unlimited access to something via a fixed-price rental (clothes for example) often leads consumers to "give in to temptation", failing completely to challenge their dependency on consumption. Sobriety demands breaking this dependency, as much for the acquisition of a product as for its use.

2 Eva Illouz (2019), *Les marchandises émotionnelles [Emotional Merchandise]*, Premier Parallèle.

3 Laurence Auzary, Sophie Dubly, Lucie Guillory, Justine Loizeau, Capucine Olivier, Juliette Ricq, Cindy Tieu, Cécile Wajsblat, Philippine Weingarten (2019), Etre et/ou devenir sobre en participant au(x) défi(s) « Rien de neuf » de Zero Waste France: analyse des profils, motivations, vécu et de la communauté Facebook [Adopting sober consumption by taking part In the Nothing New challenge(s) run by Zero Waste France: analysis of profiles, motivations, experience and the Facebook community], in Guillard V. (2019) (dir.) Du gaspillage à la Sobriety [From wastage to sobriety], pub. De boeck.

4 Roux, D., & Guillard, V. (2016). *Circulations of objets entre étrangers dans l'espace public: une analyse des formes de socialité entre déposeurs et glaneurs [Objects circulating between strangers in the public space: analysis of forms of sociality between people who drop off and people who pick up].* Recherche et Applications en Marketing (French Edition), 31(4), 30-49.

5 Naturally, people living in poverty also search for items they can gather to have no-cost access to food and other objects. The choice of a sober lifestyle does not include people living in poverty or on society's margins.

Another condition for consumers to move to sober consumption concerns the use of products. Sober use equates to using fewer things for a longer time. Digital sobriety, for example, involves not having several devices that provide a similar function (such as computer, tablet, e-book reader and smartphone[6]) but just one, preferably a reconditioned purchase that is used to meet a need rather than to stave off boredom. 90% of total energy use occurs prior to the purchase of a digital device (metal extraction, production, assembly and transport).[7] Manufacturing a two-kilo laptop computer emits 124 of the 169 kilos of CO_2 emitted over its entire lifecycle, and requires 836 kilos of raw materials.[8] But consumers do not often wait for a device to break down before changing it. In France, cellphones are replaced approximately every 20 months,[9] sometimes because they are slowing down but often simply so that people can swap to the latest version, the object representing its owner in the social sphere. Product obsolescence is partly due to aesthetics,[10] technological aspects or, paradoxically, to the energy-saving promises of new objects.

And as for the non-use of objects, their accumulation in the home even when they are no longer used, is this also a practice that aligns with sobriety? There is no easy answer. It depends on the true use made of the object. Let's look at an example: a gardener will store bags, old crockery, old windows "just in case" he/she needs them to cover her seedlings, to make mini-glasshouses during a cold spring. On the other hand, some people tend to "keep everything"[11] without realizing these objects have lost their utility, and hence are wasted. Is keeping an object a waste if it serves no purpose? Again, it depends. A gift, personal souvenir or inherited item is rarely wasted in terms of the owner's representation, even when these objects are not used. They embody ties that go above and beyond their mere usefulness.

Lastly, adopting a sobriety-centric approach leads to the dispossession of objects by opting to transform them (for example, turning a pair of jeans no longer worn into a bag), reuse them by giving, handing on or swapping them in place of discarding them, or perhaps recycling them at a dedicated location.

All of these practices needed for a sober consumption approach are challenges to the ways of relating to materiality, the self and others.

(B) WHEN SOBRIETY ENTAILS CHANGING WAYS OF RELATING TO THE WORLD

Consumers who commit to an approach guided by sobriety do so for reasons that are economic or environmental, but also because they feel a need to give (back) meaning to their consumption or modify it. Consumption, and the objects, are a means of self-definition in the eyes of the other, but they also give meaning to daily life or work. We may accept a job that is not much fun but well-paid for the "quality of life" it offers, if quality of life simply involves the possession of objects that can be useless or very little-used, or having experiences supposed to be exciting but where the excitements last no longer than the moment they occur.

Finding a meaning to assign to sobriety in consumption can be conditioned by the quality of ties that bind us to the self and the immediate environment. As Françoise le Hénand explains,[12] "the question of the meaning of life for each human being seems to me to be closely linked to the ability to establish relationships. This is as much about creating links between different aspects of the conscious and sub-conscious subjective experience — sensation, affection, thought, dream, fantasy — as it is about situating components of a person's history within their spatial inscription and chronological ordering (past, present and the future to come) [...] This relationship to the self conditions the possibility and quality of relationships we are capable of maintaining with others and the world, our capacity to love." (p.20).

To question the meaning of consumption is to reflect on relationships to objects. This entails being able to tell the difference, when experiencing consumption and use, between the needs, desires and urges that these objects are supposed to nourish. Being conscious of experiences of consumption that do not nourish a person's individuality is something that has to be worked on, an approach that demands sufficient time be taken to gain consciousness as well as to make the required effort. According to Julia Faure, the founder of a company called Loom, sobriety, the approach she uses when designing her products, demands effort. She explains that one of the problems with our consumption model is the marginal comfort it supplies. A portion of our economy (and source of environmental and ecological problems) is predicated on our greatest weakness: laziness. The concept of effort lies at the interface between the physiology of action and the philosophy of taking action.[13] Making an effort implies "deploying all the capabilities a living thing is capable of for the purpose of conquering resistance or overcoming difficulty."[14] Effort becomes a category that can be used in the analysis of sobriety because it is so closely tied to the phenomenon that conditions it, an expression of will. Effort — that of doing something as much as of not doing something, of resisting — results from the assessment made to determine the quantity of energy to deploy to attain an objective. This means that to embrace sobriety requires making the effort to

6 82% of households owned a computer in 2017 compared to 45% in 2004; 76% have an internet connection compared to 45% in 2004. In 2018, almost 100% of 16-44-year-olds had a smartphone (INSEE, 2019).

7 GreenIT, 2019. The environmental footprint of the digital world: https://www.greenit.fr/wp-content/uploads/2019/11/GREENIT_EENM_etude_EN_accessible.pdf.

8 *La face cachée du numérique. Réduire les impacts du numérique sur l'environnement [The hidden face of digital. Reducing the impact of digital on the environment].* ADEME. November 2019.

9 http://www.journaldunet.com/diaporama/0610-mobile/4.shtml (Source: Observatoire sociétal du téléphone mobile AFOM / TNS SOFRES), in the USA, the smartphone replacement cycle for individuals was 3.17 years in 2020 (https://www.statista.com/statistics/619788/average-smartphone-life/).

10 Guillard, V., & Le Nagard-Assayag, E. (2014). *Mieux comprendre l'obsolescence perçue des produits durables par les consommateurs [A better understanding of consumers' perceived obsolescence of products that last].* International congress of the French Marketing Association.

11 Guillard V., Pinson C. (2012), *Comprendre et identifier les consommateurs qui ont tendance à "tout" garder [Understanding and identifying consumers who tend to keep everything],* Recherche et Applications en Marketing, 27, 3, 57-79.

12 Françoise Le Hénand, *La quête du sens [The quest for meaning],* Cahiers Jungiens de Psychanalyse, 125, pp19-28.

13 Seignan, G. (2013). *Psychologie de « l'effort volontaire »: les déclinaisons de l'énergie psychique entre le XIX^e^ et le XX^e^ [Psychology of the "voluntary effort": manifestations of psychological energy between the 19^th^ and 20^th^ centuries].* Bulletin de psychologie, (5), 407-416.

14 CNRTL, CNRS dictionary.

challenge one's personal norms and habits: downloading films rather than watching them live, reducing temperatures in the home to cut energy consumption, keeping an eye on water use to detect leaks, fitting low-energy lightbulbs, traveling by bicycle not car whenever practical, not spending five minutes under the shower,[15] and so on.

Committing to a sobriety-driven mindset also requires taking a position vis-a-vis the social sphere. Is it acceptable to you, but especially to the other, to receive a secondhand object as a gift? To offer an object that is new is one of the conventions that surrounds gifting (unless the secondhand object is a collector's item).[16] The care, friendship and love that the receiver perceives in the gift depends on the effort made to find the right gift, which corresponds to what they feel the other person thinks of them, but also of the effort involved in having paid a certain price. It is very likely that to be given a designer pullover in perfect condition but that has already been worn and comes without the packaging that gives it all its value will risk damaging the relationship between the two protagonists in an exchange. Aside from gifts, people may encounter difficulties in staking a place in an interaction with others through a refusal, based on belief in their values of sobriety, to travel by plane for a holiday, purchase new trainers for a teenager, order a book from Amazon, or perhaps subscribe to Netflix.[17]

To sum up, the ability to move beyond personal and social norms is a necessary condition for the adoption of the sobriety-led approach. How can organizations help consumers with this approach?

HOW CAN SOBER CONSUMPTION BE MADE ACCESSIBLE?

Sobriety is an approach, and like any mindset it is based on willpower, knowledge and action, three characteristics that fall within the concept of skill sets, but also the ability to act, examined here through the prism of the territory.

In terms of knowledge, setting up workshops, conferences, and practical guides are all tools that help people to learn what can be done to consume less and better. The idea is to reduce consumers' ecological mental workload,[18] particularly among women who are the group that feels the most concerned. Consumers need information that is simple, available when they need it, and sufficiently well-presented so that little effort is required to process it.

In terms of know-how, it seems that consumers need (and want) to learn by doing. How can they learn sober practices? How to find help putting them into practice? Knowing how to sew, drill a hole, plant lettuce, prune fruit trees or repair a bicycle are all skills that have been abandoned to the market for many years. Which does not mean that they could not be reintroduced as part of the curriculum at schools or even universities. Some habits require a real learning process, even though consumers fail to appreciate this. Home organizers, for example, teach consumers how to reconnect with objects, space and others through sorting and tidying their homes. But this as yet little-known profession, despite the popularity of Marie Kondo, is completely in tune with the idea of implementing a sobriety-led approach.[19] Yet home organizers provide a know-how-to-be service, in the sense that they teach consumers to retain only that which truly corresponds to them by purifying their relationship to consumption.

The ability to act, in other words, the existence of suitable mechanisms, remains essential. People living in rural areas feel "penalized" by the lack of such mechanisms, which paradoxically leads them to increase their ties to the town in order to put their sobriety approach into action (buy in bulk, secondhand, attend workshops, etc.).[20]

IN CONCLUSION: IS SOBRIETY REALISTIC IN THE CONTEXT OF THE HEALTH CRISIS?

The Covid pandemic leads us to question our lifestyles, which have suddenly become more sober. Consumers are focusing on buying only essentials, and have also become aware of the dangers that delivery workers are exposed to when delivering non-essential products. A social life that is absent, or limited, also leads to a fall in consumption. In September 2020, 54% of people interviewed, up from 49% in April, stated that they "want to enjoy life differently, by consuming less and renouncing purchases now seen as useless in the light of lockdown."[21] The health crisis has strengthened ties between consumers and local producers, mainly but not only in the countryside,[22] which has helped to initiate new practices.

Nevertheless, the road to hell being paved with good intentions, will these new habits continue over the long term? On the one hand, the negative consequences on national economies of reduced consumption are all too clear. On the other, sobriety can be an approach that offers potential in the economic (responsible production of good quality products or services that transform business models), social (reduce the inequalities caused by the purchase of social markers) and ecological spheres. Realizing this potential will take a great deal of will, especially political will.

15 https://www.ademe.fr/sites/default/files/assets/documents/guide-pratique-economiser-eau-energie.pdf.

16 Montant, S. (1998). *L'invention d'un code: du malaise à la justification [Invention of a code: from uneasiness to justification].* Ethnologie française, 445-456.
Monjaret A. (1998), *L'argent des cadeaux [The money behind gifts]*, in Chevalier S. and Monjaret A., Ethnologie Française: Les cadeaux à quel prix?, XXVIII (4): 493-505.

17 Guillard V. (2020), *Etre ou ne pas être soi face aux autres dans un contexte d'anti-consommation, Une explication par le concept de congruence [Staying or not staying true to yourself in relation to other In an anti-consumption context)*, French Marketing Association symposium, May.

18 Mental workload is the cognitive load represented by all the domestic and professional tasks a person is required to think about (not just those that the person has to do themselves), leading to mental and physical fatigue. For example, thinking about having to pick up bread for dinner while you're in a meeting. Aurélia Schneider, La charge mentale des Femmes et celle des hommes: mieux la détecter pour prévenir le burn-out [Women and men's mental workload: Improving detection to prevent burn-out], Editions Larousse, 2018.

19 https://theconversation.com/comment-expliquer-le-succes-du-home-organising-147768.

20 Ben Kemoun N., Caitucoli PM and Guillard V. (2021), *La déconsommation en ruralité comme axe de développement territorial, L'analyse du lien au territoire dans le cadre du défi « Rien de Neuf » de l'association Zero Waste France [Deconsumerism in the rural environment as a strategy for territorial development, analysis of the ties with territory as part of the Nothing New challenge run by Zero Waste France]*, Revue d'Economie Régionale et Urbaine (awaiting publication). OR FORTHCOMING ?

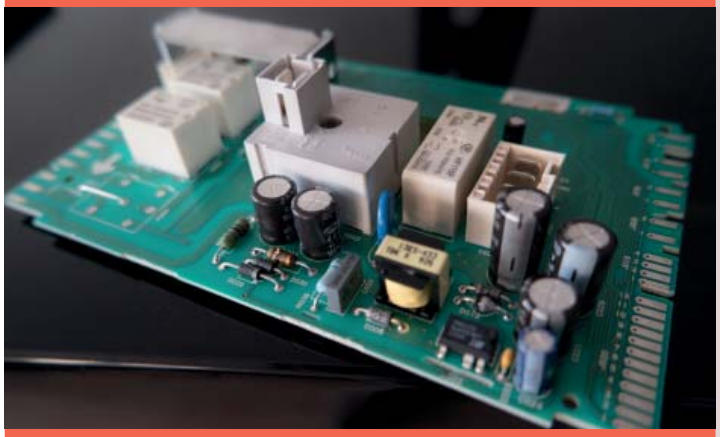
21 Crédoc, Lifestyle and aspirations surveys, April 2020 and September 2020.

22 Salomé Berlioux (2020), Nos Campagne Suspendues [Our countryside suspended], La France périphérique face à la crise, Editions de l'Observatoire.

ACCELERATING THE TRANSITION TO CIRCULAR CONSUMPTION MODELS: the example of the AGEC law in France

Adèle Chasson
Public affairs manager at HOP - Halte à l'Obsolescence Programmée (Stop Planned Obsolescence) from 2019 to 2020

Laetitia Vasseur
Co-founder and executive officer at HOP - Halte à l'Obsolescence Programmée (Stop Planned Obsolescence)



Laetitia Vasseur is co-founder and general delegate of the association HOP / *Halte à l'obsolescence programmée* and Adèle Chasson, formerly in charge of public affairs. HOP aims to bring citizens together to influence laws and manufacturers towards more sustainable and repairable products.

The NGO HOP contributed to drafting the AGEC act (Anti-Gaspillage et Economie Circulaire) [Anti-Waste and Circular Economy] adopted by the French parliament in early 2020. HOP was an active member of the working groups that prepared sections of the new law dealing with repairability and extending the working life of electrical and electronic products. Working with government, manufacturers, retailers and repair specialists, organizations like HOP worked to represent consumers' interests, helping to ensure the adoption of a repairability index that will help consumers understand the extent to which certain categories of products can be repaired.

The process that ultimately led to the AGEC law also led to the establishment of a repair fund intended to lower the ultimate repair cost paid by consumers. These mechanisms should help to shift people's thinking. It is hoped they will also encourage manufacturers and retailers to improve their practices so that they offer products that are easier to repair and last longer. They may also encourage consumers to choose products that are more respectful of the environment.

What are HOP's main missions and activities?

Laetitia Vasseur and Adèle Chasson: HOP was founded in 2015 to unify citizens, influence policymaking and encourage manufacturers to make products that are easier to repair and last longer. It represents a community of 40,000 people and its day-to-day activities are run by a 20-strong team of volunteers.

Our work covers three primary areas.

- Raising awareness in the general public through activities such as conferences and studies designed to allow people to learn more about planned obsolescence (defined in article L.213-4-1 of the French consumer code as "any technique by which a provider seeks deliberately to reduce the lifetime of a product in order to increase the rate of replacement") and the solutions that exist for extending the life of products. We also run an internet platform, at www.produitsdurables.fr, that offers French consumers advice about keeping their products working for longer and ranks products according to their longevity.
- Our lobbying activities seek to guide and influence policy-makers in the drafting of new laws. Specifically, we contributed to implementation of the Anti-Waste and Circular Economy law (AGEC).
- The final pillar of our activities focuses on the Business Durability Club we have set up to encourage member companies to share best practices so they can offer products that are more durable.

Before the AGEC law was finally enacted in January 2020, working groups were established, made up of members from a wide variety of horizons, including retailers, manufacturers, repair specialists, NGOs and public bodies. How did the consultation process function?

LV and AC: In reality it began prior to 2018, with one of the main early achievements being the government's publication, in April 2018, of its roadmap for the circular economy. This law is the fruit of an extensive process of prior consultation between the various interested parties. Working groups with a special focus on the repairability index were set up following the measures announced in the roadmap, with sub-groups for each product category (washing machine, TV, laptop computer and electric lawnmower). The consultation process gave us a chance to think about the repairability criteria to include in the index, which we hope to extend to include other families of products. Specifically, we want to see it extended to include printers and small household appliances.

This was a true collective effort that involved lots of hearings with stakeholders at the national assembly and the ministry for ecological transition, including NGOs like us, even though we do not have the same resources as some industrial lobbyists. However, we certainly made an impact because our work inspired over 50 amendments that were lodged by members of parliament.

HOP HALTE À L'OBSOLESCENCE PROGRAMMÉE

Logo of the HOP NGO

More specifically, what position did HOP adopt during the process of drafting the new law?

LV and AC: Our number one aim was to ensure that consumers were informed and protected. From the outset, we actually argued for a durability index to be introduced as of 2021/2022. However, the government's preference was to start with a repairability index in 2021 before moving, in 2024, to a durability index that would also take account of products' robustness. This means it will be more of a gradual process. And although we are happy with the overall result, we will keep a very close eye on how it is implemented.

For instance, consumers will be informed about the availability of technical documents (instructions, user advice needed to make repairs, product updates, etc.) and will benefit from a six-month warranty extension if their product is repaired.

But you must never lose sight of the fact that product durability depends essentially on manufacturers and not consumers. This is why we feel that there needs to be a requirement to make spare parts available during the entire life of the product, and that there should be a ban on products that cannot be repaired. For example, in 2016 HOP denounced Apple for one of its practices that meant that an error code was generated if a device was repaired by a repairer not certified by Apple. It is important to make sure that manufacturers do not force people to use their network for repairs.

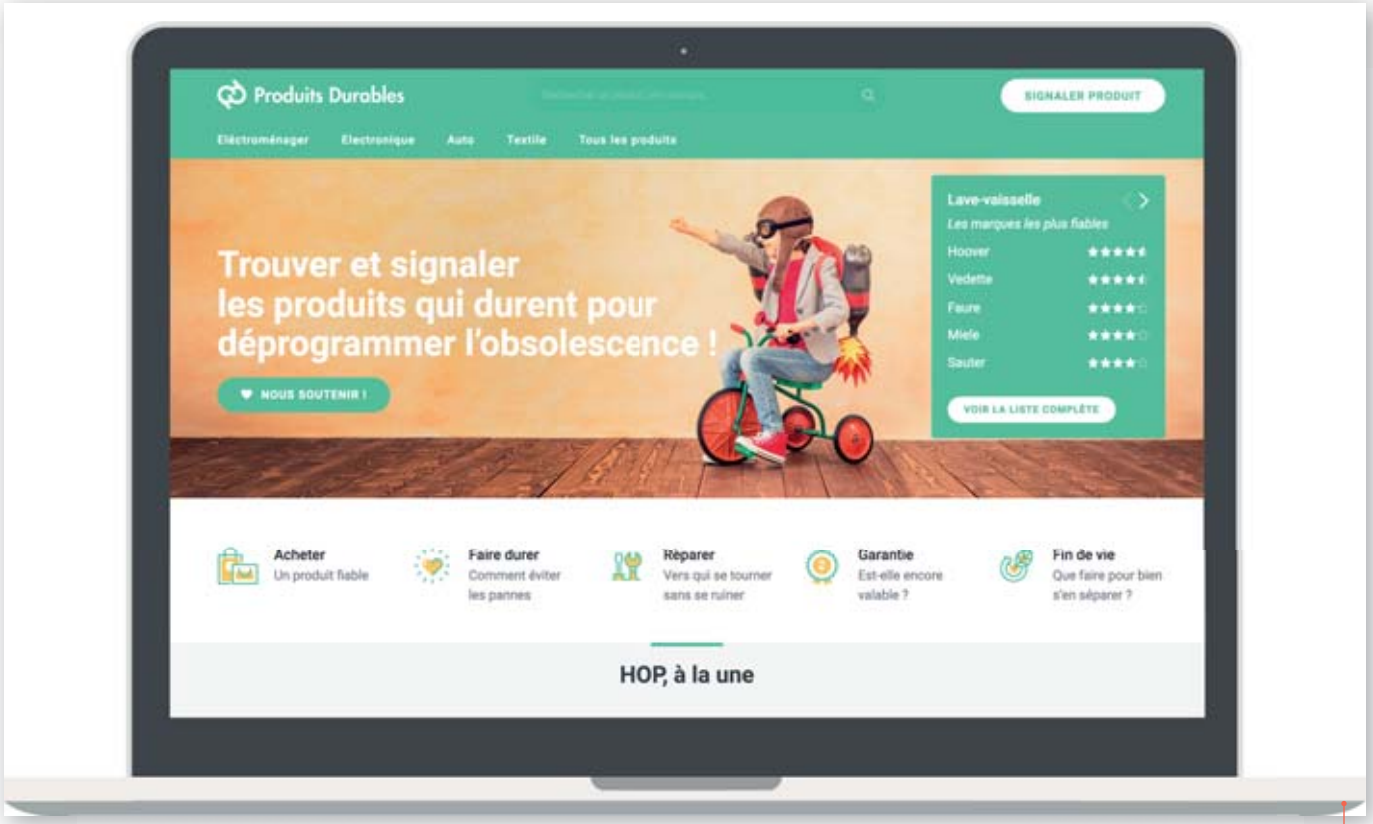
How have manufacturers received this new law? What are the risks and/or opportunities for them?

LV and AC: Some of them consider the new law to be a risk, because they worry that they will face greater restrictions in France than elsewhere. There is certainly a need to harmonize national regulations in this regard. But more and more businesses see this law as an opportunity.

In fact, the members of the Business Durability Club recently published an opinion piece in *Le Monde* newspaper in defense of the law at a time when it was under attack from various manufacturers' lobbies.[1]

These businesses are doing their best to advise their customers about how best to use their products,

1 Column published on June 2, 2020, *La crise que nous traversons nous oblige à repenser notre modèle économique et sociétal à l'aune de la durabilité* [*The crisis we are living through obliges us to rethink our social and economic model in the light of durability*]: https://www.lemonde.fr/idees/article/2020/06/02/covid-19-la-crise-que-nous-traversons-nous-oblige-a-repenser-notre-modele-economique-et-societal-a-l-aune-de-la-durabilite_6041448_3232.html



Internet platform launched by HOP on sustainable products

facilitate access to repairers and draw attention to their environmentally responsible practices. One example is Kippit, which has launched a durable and reparable kettle.

In your view, what are the main advances with the new AGEC law?

LV and AC: The two biggest advances are the establishment of a repairability/durability index to inform consumers about the repairability of certain product families (washing machine, TV, laptop computer, smartphone, electric lawnmower, etc.), as well as the requirement to provide spare parts for laptop computers and smartphones for at least five years.

What effects might these advances have on the economic and civil society actors concerned?

LV and AC: We think that it will become standard practice for companies to keep stocks of spare parts and to facilitate repairs to their products. Manufacturers and retailers might also choose to make a stand, reacting to pressure from the authorities and citizens.

Overall, this law will make it simpler for people to choose products on the basis of durability and respect for the environment.

In your opinion, what role should consumers play in the transition to a circular economy?

LV and AC: Consumers must make sure their demands for new types of offerings are heard, and they must also make full use of new tools such as the repairability/durability index so they can choose longer-lasting products. They also need to learn how to maintain their products so that they last longer.

People need to completely rethink their attitudes to consumption, avoid consuming things that have no purpose, and think about repairing before replacing.

What are the main risks and points to watch out for once the AGEC law is applied?

LV and AC: It is important that the repairability index is operational as of 2021.

We must also be vigilant in terms of controls and transparency and ensure we have access to the methods manufacturers use for their classifications. And the exceptions permitted by the law must not lead to lower standards when the law is implemented, as is sometimes the case. It is important to respect the spirit behind the law.

Building on the progress made with this law, what actions can policymakers take to promote the emergence of new circular practices such as eco-design, longer product lives, repairability and reuse?

LV and AC: Advertising is a question that emerged after the law, as reports have been published highlighting the links between advertising and the ecological transition. However, the advertising industry is not engaging with the issue. Advertising encourages excessive consumption which runs counter to laws like AGEC that are trying to give people the keys to change their behavior. The advertising sector also needs to transition to an ecologically led approach.

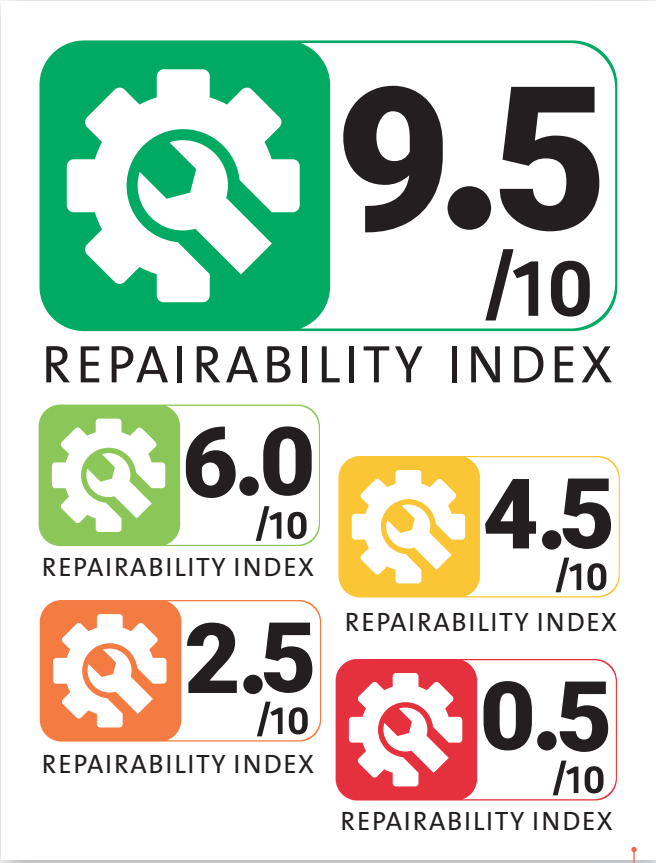
In France, the citizens' climate convention made several recommendations about advertising, but policymakers have not as yet shown any enthusiasm for the subject. Advertising agencies are, however, starting to make voluntary commitments.

There is also the issue of software obsolescence, defined in law as a "set of techniques that lead to degraded device performance caused by updates to content or digital services, or the absence thereof" (senate report number 242, 2020-2021). The law needs to require software publishers to provide long-term maintenance for their products in order to ensure their long-term compatibility with older computers, smartphones, or any other piece of electronic equipment that uses an application layer. The law does not have much to say about this aspect. We feel that a two-year software warranty is too short, and our organization is lobbying for an increase to eight years, which a number of software publishers confirm is feasible. We also want consumers to be able to accept or reject any software updates offered.

Would you say that the new law makes France a pioneer for the circular economy in Europe?

LV and AC: In terms of the messaging, yes, it is setting the pace. But, in practice, we are very far from where we need to be. We will have to wait a few years to see what is actually put in place. And the measures passed on repairs and spare parts should provide more detailed information than anything available right now elsewhere in Europe or around the world.

At the national level we can take things further, with the aim of inspiring future European measures. And being inspired by them since some measures will be more effective when taken at the European level.



Repairability index of the AGEC French law

Which countries in Europe and around the world do you think are particularly advanced in terms of implementing circular consumption models?

LV and AC: Some Scandinavian countries, such as Sweden, have taken concrete steps to encourage equipment repairs, with tax credits and extended warranties. The Netherlands and Belgium have also encouraged the development of repair cafes. There is a very active repair cafe association in Argentina. The RighToRepair movement is also developing in the USA. Canada is currently considering whether to introduce a law banning planned obsolescence. And while in places like Colombia the repairing culture is far less formalized, it is also second nature to its citizens. Each country has its own particular set of circumstances, and initiatives are emerging on every continent.

THE POWER OF PUBLIC PROCUREMENT IN THE TRANSITION TO A CIRCULAR ECONOMY

Ashleigh McLennan
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Birgitte Krebs Schleemann
Marketing manager for green transition at DGE and former project manager in the City of Aalborg

View of Allborg City, Denmark

Ashleigh McLennan is a Sustainable Procurement and Economy Officer at ICLEI - Local Governments for Sustainability, a global network of more than 1,750 local and regional governments committed to sustainable urban development. Ashleigh works across a range of European circular economy projects with a particular focus on sustainable, circular and innovation procurement.

Birgitte Krebs Schleemann Birgitte Krebs Schleemann is a Marketing manager for green transition at DGE (sustainability consulting). For the past five years, Birgitte has worked as a project manager in the City of Aalborg to establish circular public procurement practices within the Municipality, including being part of the pilot projects described in this article.

The City of Aalborg in Denmark is home to around 207,000 inhabitants, making it the fourth largest city in Denmark. Aalborg has been committed to improving the sustainability of their municipality for over two decades, and for the past three years, Aalborg has been developing its use of procurement as a tool for developing innovative circular solutions which meet the city's needs. This article presents an overview of two pilot public procurements conducted by the City of Aalborg which have each challenged current working practices, and led to new understandings of how to meet workers' and citizens' needs, in ways which are both cost effective and sustainable in the long-term.

INTRODUCTION

The City of Aalborg in Denmark has been committed to improving the sustainability of their municipality for over two decades, even giving its name to the Aalborg Charter, which since 1994 has been used as the basis of the commitment of over 3,000 local authorities for local environmental action. Despite this long history, it is still challenged with very high levels of consumption and waste, even in a European context. In fact, the average Danish person consumes 24.1 tonnes of material annually, compared to the EU average of 13.3 tonnes[1].

It's within this context that circular economy solutions have become increasingly attractive to the municipality. The experiences of the City in two recent pilot procurements for the buy-back of ICT products and sustainable "learning environments" provide valuable lessons other public authorities looking to support circular transition.

1 Metabolic (2020) Exploring Circular Solutions in the Waste System

From public procurement to circular public procurement: a change journey - ©City of Aalborg

WHY CIRCULAR ECONOMY?

In the year 2020, there is no longer any question of the scale of the environmental challenges we face – and their associated economic and social challenges. Despite this, current trajectories predict further decline. Global consumption of resources is expected to double in the next forty years, while annual waste generation is projected to increase 70% by 2050[2]. The ability of our natural ecosystems to continue to function in the face of such degradation is in doubt, which is to say, business as usual is not an option. Any attempt to halt and reverse environmental destruction will need to address resource use and consumption, as it is estimated around half of global greenhouse gas emissions and more than 90% of biodiversity loss and water loss occur at the resource extraction and processing phase[3].

It is therefore clear that a more radical change in the socio-economic structure of society is needed, one which goes beyond incremental efficiency improvements and instead reworks our relationship with materials. It is in this context that the concept of a 'circular economy' has emerged, providing fresh impetus in the search for a more sustainable socio-economic system, and signalling in an obvious way a break from the current 'linear' take-make-dispose industrial pattern in favour of material flow loops in which resources are retained in a closed industrial system.

One of the most direct ways that government can incentivize the transition to a circular economy is supporting circular businesses and business models through its own spending

PUBLIC PROCUREMENT IN THE CIRCULAR ECONOMY

A range of policy mechanisms are available for governments looking to support circular transition. For instance, governments can seek to influence the market, whether through soft approaches like encouraging voluntary agreements among industry, or harder measures such as waste and design regulations. They can also try to influence the market from above or below, running consumer-education initiatives or financing research & development programmes. But one of the most direct ways that government can incentivize the transition to a circular economy is supporting circular businesses and business models through its own spending.

Public procurement refers to the acquisition of goods and services by government or public sector organisations and it provides a direct means for government to engage in the economy (estimated to account for between 8 and 25% of the gross domestic product (GDP) of OECD countries). Many public bodies in Europe have already recognised the potential to use procurement to support wider policy goals,

2 European Commission (2020) Circular Economy Action Plan
3 *ibid*

Workshop on sustainable development and the circular economy - ©City of Aalborg

such as promote sustainability. This is based on the premise that environmental innovation is risky, and often requires the complete rearrangement of product chains, or the creation of new sectors from scratch. By using government buying power to support sustainable activities, government is able to incentivise and support businesses to take on environmentally beneficial risks.

An increasing number of projects, policy networks, and individual public procurement agencies are now turning specific focus to the concept of 'circular procurement' i.e. "the process by which public authorities purchase works, goods or services that seek to contribute to closed energy and material loops within supply chains, whilst minimising, and in the best case avoiding, negative environmental impacts and waste creation across their whole life-cycle"[4].

However, while sustainable procurement policy and practice has already adopted principles related to the lower rungs of the waste hierarchy, those strategies which focus on front-end solutions or more holistic change in economic patterns remain new and unexplored. For example, aiming to reduce packaging materials and asking suppliers to commit to waste reduction goals are more widespread than holistic practices, such as service models which challenge how we acquire, use and retire products within a whole life-cycle circularity model.

The potential of public procurement as a tool for achieving a circular transition is already acknowledged at a European level, with both the new Circular Economy Action Plan (2020) and the Green Deal Investment Plan outlining the Commission's intention to set minimum mandatory green public procurement (GPP) criteria and targets in sectoral legislation in the coming years. In practice however, the implementation of circular procurement is still in a nascent phase.

In Denmark, circular procurement has become a hot topic in the past year. In November 2019, Denmark enacted a new Climate Law, which obliges national government to implement measures to achieve a 70% reduction in CO_2 emissions by the year 2030. Circular procurement is recognised as a key tool for achieving this ambition. As well as national government, others are also aligning to

4 European Commission (2017) Public Procurement for a Circular Economy

this goal, including the Danish Assembly of Municipalities (KL) and the Confederation of Danish Industry (DI) both of which are developing strategies for the circular economy and circular procurement.

THE CIRCULAR PUBLIC PROCUREMENT (PP) PROJECT

For the past three years, the City of Aalborg has been working with a group of cities, government agencies, researchers and business representatives from across the Baltic Sea region to explore the potential of public procurement as a tool for advancing the circular economy, with the support of Interreg Baltic Sea Region. By building capacity among key stakeholders, and conducting pilot procurements to buy circular goods and services, Circular PP has developed new knowledge on public procurement for a circular economy, and has enhanced demand for innovative products and services.

In addition to internal stakeholder consultation, communication with suppliers has also been essential

As part of Circular PP, Aalborg has conducted two pilot procurements. The first explored options to create a service for buying back used ICT equipment from the Municipality (including, for example, mobiles, tablets, computers, laptops, wires, storage and servers). The ultimate goal is to prolong the lifetime of ICT equipment[5].

The second pilot tender conducted in Circular PP was for a playground / outdoor learning area, which places emphasis on greater use of landscaping to achieve both circular and creative play goals. It builds on experienced gained in Aalborg's first circular procurement pilot in 2017 for an 'indoor learning environment'. Both of these indoor and outdoor learning environment tenders share a common ambition to challenge our understanding of what schools and playgrounds should look like, calling attention to the needs of children and teachers, and using procurement as an intervention point for encouraging strategic connections between education and environmental policy and developing holistic solutions which better meet current and future needs.

FROM WASTE TO VALUE: ESTABLISHING A BUY-BACK SERVICE FOR USED ICT EQUIPMENT

Electrical and electronic equipment is one of the fastest growing waste streams in the EU (with an annual growth rate of around 2%)[6]. Aalborg like all large organisations, is a massive consumer of electronics, spending an estimated 2.5% of their annual budget on ICT equipment and software.

The average lifespan of a laptop in the City of Aalborg is 3-4 years. After this, they are usually replaced rather than repaired, because this is cheaper than the labour costs of maintaining old equipment. At this point, old laptops were considered as nothing more than waste which had to be disposed of – for a cost. This approach, however, overlooked the inherent value still contained within the laptops, including their material value.

When Aalborg began investigating opportunities to make their ICT consumption more circular, only three out of seven ICT departments in the municipality had agreements for the collection of old ICT equipment, and the financial value recaptured from these agreements was very low. In addition, it was discovered that a municipality policy of engraving laptops with the City's logo was creating a large obstacle to laptop reuse. This requirement dated to a time when laptops and computers were still very expensive, and discussions about circularity, reuse and resale were non-existent. This policy is now being changed, and will result in a relatively simple improvement in reuse opportunities.

In addition to improving the collection of old ICT equipment, Aalborg also wants to extend the length of time it is used for. The Environmental Department calculated that by simply keeping laptops for six years instead of three, the city could cut the same amount of CO_2 emissions created by heating and powering all municipality buildings in the city for a whole year. It would also reduce the waste by the same amount as produced by 3,000 households in one year.

Finally, Aalborg is also now considering other options to improve the use and collection of ICT equipment, including more effective systems for ensuring laptops stay within City's ownership (for example, ensuring that all old equipment is recollected from staff when it needs to be replaced with a new one), and better protection of laptops, smartphone, tablets, etc. to increase their lifetime (such as screen protection and protective covers). In the future, it would also like to ensure high durability and long lifetimes are a feature of new equipment it buys, which can be assisted through the purchase of equipment verified by ecolabels, such as the TCO label. Replaceable batteries for example, are one important circular feature the City would like to see more of.

As a result of her work exploring opportunities to extend the lifetime of ICT, Birgitte Krebs Schleemann, Project Leader at City of Aalborg recommends: "*When selling used ICT equipment, make an agreement with sustainable and circular requirements, such as a requirement to do an annual evaluation of circularity, including data on how many laptops, mobile phones, tablets and storage devices have been resold, how many have been repaired and re-sold, and how much is being reused as spare parts and*

5 https://www.sustaineurope.com/a-journey-to-circular-procurement-%E2%80%93-the-unexpected-outcomes-of-aalborgs-circular-ict-pilot-20200428.html

6 https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf

being recycling. This gives both the supplier and the City the information they need to improve their processes in future".

FROM PLAYGROUND PROCUREMENT, TO PROCURING CREATIVE SPACES FOR PLAY AND LEARNING: AALBORG'S CIRCULAR PLAYGROUND TENDER

Building on their experience in the indoor learning environment tender, in 2018, Aalborg embarked on a similar journey to reimagine playgrounds and find opportunities to increase their circularity.

Play is an important part of a child's development, and playgrounds can support this by providing creative spaces to play and learn. Aalborg's Vision for Municipal Schools sets a target that at least 25% of all learning processes should take place outside of school, either physically or digitally. The goal is to encourage experimental learning and problem solving. Following the COVID-19 pandemic, the importance of outdoor spaces for teaching and learning has only increased.

This process required a shift in the procurement stakeholders understanding of playgrounds as a set of equipment, to playgrounds as a space for learning and play. Starting in 2018, the Environmental Department began speaking with colleagues across all the relevant departments. First, Aalborg set a baseline by interviewing colleagues from a school and a kindergarten, the playground inspector, a landscape architect from the Department of Parks and Nature, and the Procurement Department.

Through speaking with the above, a set of core needs for playgrounds was identified. Procurers need playgrounds to be cost effective. Park officers need equipment to be durable and easy to maintain. The municipality's playground safety consultant needs to ensure that materials and equipment are safe for play. Education officers need space which can be used for teaching. Last but not least, the environmental officers need the park to be sustainable. In addition, several workshops were held with staff from schools, kindergartens and other relevant stakeholders to discuss their wishes for future outdoor play areas. Nature and the use of natural materials was a common theme.

In order to ensure that all these needs were represented in the process to acquire innovative new outdoor play spaces, a steering committee was formed, with a representative from the decision-making level in the Schools department, the Family and Employability department, the City and

Landscape department, the Procurement department, and the Building department. Together, under the leadership of the Environmental department, the steering committee helped to strategically connect the city's priorities in sustainability, health, and education, finding common solutions to issues which are often tackled in silos.

The result of this collaboration was the creation of a bold vision for a playground which avoids the use of materials altogether, by making the most of natural solutions, such as landscaping and vegetation. The lifetime of a landscape is longer than the lifetime of equipment, and when hills, terrain, and vegetation are established property, the ongoing maintenance of a playground can be kept to an absolute minimum. This nature-based solution for playgrounds can also have a positive environmental impact, such as encouraging biodiversity and capturing carbon. What's more, hills and plants can also create a landscape of possibilities for creative play.

Innovation needs collaboration and creative thinking, both of which take time. But through proper preparation, the hope is that time and money can be saved in the longer-term

This vision of a circular playground is now being put into practice as part of a large urban redevelopment project in Stigsborg, a former industrial docklands which is being converted into a residential area with education and leisure services for 8,000 people. The neighborhood's school will accommodate 1,000 pupils plus 160 pre-school places, and is being designed as a 'Universe of Children and Youth' – meaning that young people's needs are placed in the center of the design[7].

In addition to internal stakeholder consultation, communication with suppliers has also been essential. Aalborg first announced their intention to procure a circular playground at the Aalborg Sustainability Festival 2018, giving the market several years notice of their future intentions. In February 2020 they visited a local fair on playgrounds organised by the building department in collaboration with several schools which were planning new playgrounds, where they discussed what was now more concrete ideas for a circular tender, and received feedback from suppliers on their ideas of how to buy sustainably, in particular, avoidance of harmful chemicals, and availability of spare parts and maintenance services. In April 2020, they hosted a further online "Meet the Buyers" event, where they presented their circular and pedagogical vision of the project, in order to prepare potential suppliers for the bidding process. Through market engagement activities, Aalborg developed a better understanding of the current capabilities of the market.

Traditional suppliers of playgrounds are primarily focused on equipment, and do not necessarily have in-house landscape architecture knowledge needed to create features using terrain and vegetation. As such, in their tender, Aalborg asked bidders to provide a first draft of landscape modeling for the area, indicating their use of terrain, surface material, plants, and play and learning equipment. This should include a description of how the model supports learning and circular economy.

The process of developing a new vision for circular playgrounds has taken time, and it will still be several years before the results are seen as part of the Stigsborg Universe of Children and Youth. Circular solutions are still new and innovative, meaning they are not yet deeply embedded in the market. Innovation needs collaboration and creative thinking, both of which take time. But through proper preparation, the hope is that time and money can be saved in the longer-term.

CONCLUSION

Public procurement can be a powerful tool in the transition to a sustainable and just circular economy. There is no standard procedure for implementing circularity however, as much depends on an organisation's structure, current contracts, and local market, to name just a few factors.

Transitioning to a circular economy will require collaboration and concerted effort between new constellations of stakeholders, including internally within public administrations, and externally with market actors. Through implementing the two pilot procurements described above, Aalborg learned that these processes take time, and can sometimes be difficult. This is not a sign of opposition or resistance, but the result of uncertainty. But by focusing on the expected benefits, and ensuring these benefits are in line with organisational policies and goals, progress is always possible.

Based on her experience in each of the above change processes, project manager Birgitte Krebs Schleemann advises: "*The best way to start circular procurement is to just start doing it! No matter what stage your organisation is at, there will always be opportunities to improve circularity, from getting started with criteria which are easy to insert into your current tender specifications – like criteria for lifetime guarantees, spare part availability, or use of recycled materials – to more ambitious approaches which bring stakeholders together for wider change.*" Finally, not all the answers lie in what we buy. Sometimes the biggest impact will be not buying at all: "*Always ask yourself: is it possible to extend the life of the products already in use? Reducing our overall consumption is a quick win solution to avoid environmental impacts including use of virgin material and generation of CO_2 emissions.*"

7 https://www.s2c-eu.com/stigsborg-boerne-og-ungeunivers/

QUESTIONING THE DIGITAL REFLEX

Xavier Verne
IT expert, Lean ICT project, The Shift Project

Wires and optical fibers in a datacenter

The Shift Project is a think tank dedicated to exploring ways to strip carbon out of the economy as part of efforts to combat the climate emergency. It publishes recommendations, modelling, and research applicable to all sectors (energy, construction, transport and digital,...) and addressing the institutional, corporate and government decision-makers that control the levers of the real-world economy, seeking to steer it toward a post-carbon model.

Xavier Verne trained as an engineer at Télécom Paris, is head of digital projects at French national railway operator SNCF, and an active contributor to The Shift Project since 2016, focusing on digital and the Lean ICT project whose publications he co-authors. A qualified teacher of mathematics, he is passionate about the sciences in general and digital sobriety in particular and is introducing digitally lean best practices at SNCF.

Digital plays a double-edged role in humanity's quest for the ecological transition that will ensure its continued existence. As a standalone industry, digital uses massive amounts of hard-to-recycle resources and energy. As an industry that services other sectors of the economy, digital can be a driver of massive savings in resource use and CO_2 emissions, providing enough thought goes into ensuring it is used in the most appropriate and effective ways. Otherwise the rebound effect is inevitable, leading to huge increases in direct and indirect CO_2 emissions. Questions and best practices are now emerging that help make sure digital is part of the solution not the problem, and that it contributes to a more sustainable future.

INTRODUCTION

Bringing people together, providing ways to reuse and share objects, setting up car pools and swapping repair hints and tips all contribute to the circular economy and are facilitated by digital. But digital itself is also a source of pollution, so what is the best way for us to reap the environmental benefits and adhere to the Paris Climate Agreement commitments?

DIGITAL GENERATES HIDDEN WASTE BEHIND THE PAPERLESS CLOUD

Let's start by deconstructing two pieces of received wisdom about digital. The first is linguistic: digital doesn't cause information to vanish into an ethereal and harmless-seeming cloud. In reality, this cloud comprises millions of servers packed into datacenters, processing data that is routed via cables, antennae and network equipment all the way to users' devices. All this hardware generates waste: 2019 was a record-beating year, with 53.6 million metric tons of electronic waste,[1] a 21% increase over a five-year period. Electronics that are part of our daily lives — such as monitors, PCs and residential broadband terminals — account for 21% of the total.

The second concerns recyclability. E-waste recycling is very poor, with a rate of just 17% worldwide. The fault lies essentially in three phenomena. First comes the technical difficulty of extracting rare resources from an end-of-life telephone, with some metals present in trace quantities that are almost impossible to separate and recombine. A second difficulty lies in the availability of recycling plants with the technologies needed to do this work. Their viability is reliant on the long-term price of the recycled commodity, relative to the cost of acquiring the same commodity from direct extraction. A third difficulty relates to the existence of parallel circuits that prevent recovery via official WEEE handling channels that, in Europe, capture around 50% of potentially recoverable waste: the remainder is processed via channels that are less scrupulous about respecting applicable health and environmental standards.

In digital, there are sources of potential environmental savings and performance just waiting to be discovered and exploited

Moreover, digital is seen in two distinct ways, as an economic sector in its own right, with its own value chain, clients and suppliers, but also as a tool that is used to fundamentally alter all other sectors of the economy, via the ubiquitous digitalization of processes. Let's look at these issues one at a time.

A SECTOR WITH A GROWING AWARENESS OF ITS ENVIRONMENTAL IMPACTS

As an industry, the sector's benefits are double-edged. It is resource- and energy-hungry and growing constantly year-on-year by 8 to 10%,[2] with little clear prospect of a disruptive technology that will dramatically lower levels of complexity, delivering the move to Low Tech,[3] without abandoning most, if not all, of this growth. But several strong signals give grounds for hope. First, the digital industry's awareness of environmental factors is very recent. Other industries, such as construction, via successive sets of thermal and environmental standards, and road transport, via the Euro 4, 5 and 6 emissions standards, confronted the issue some time ago and are subject to increasingly well-thought-out rules that take it into account. Recent reports by the French senate[4] and the country's national digital council[5] will sooner or later lead legislators to vote for regulations governing the digital sector, over and above the requirements to display CO_2 and environmental data that have already been passed and are in the process of being implemented. Companies that are prepared for this will have a clear and long-term competitive advantage. Turning to the circular economy, we are seeing the emergence of business models that are more ethically driven: in green design, Fairphone embodies the ideal of modular digital sobriety,[6] showing that it is possible to double the useable life of telephones, complete with all necessary updates. In terms of extending useable lives, the Ifixit[7] website takes this approach further and ranks high-tech items as a function of their repairability, thus creating a real purchasing criterion that is starting to gain traction. We are also seeing the emergence of the functional economy, with websites like Commown[8] offering electronic equipment for hire rather than sale. Lastly, I should also mention the increasingly regular campaigns, in both the B2B WEEE sector and to promote recycling of consumer electronics in the B2C sector, that are having beneficial effects by reducing — slightly — negative externalities.

At the commercial and industrial levels, awareness of the impacts of digital is rising strongly, with (1) regular announcements from Big Tech on their measures to implement low-carbon or zero-emission strategies — which, however, currently overlook the manufacture of their gadgets when calculating carbon footprints — and (2) the adoption of responsible IT, an increasing feature of IT strategies over the past two years at a number of companies quoted on the Paris stock market, and higher standards demanded of the entire value chain as analyzed in the latest Shift Project report. The wastage is overwhelming, in both data storage and the ways that IT systems are built: these are all sources of potential environmental savings and performance just waiting to be discovered and exploited!

1 The Global E-Waste Monitor 2020 report, Global E-waste Statistics Partnership (GESP)

2 Towards Digital Sobriety, October 2018, The Shift Project: https://theshiftproject.org/en/article/lean-ict-our-new-report/

3 L'âge des Low Tech, Philippe Bihouix, pub. Seuil

4 https://www.senat.fr/notice-rapport/2019/r19-555-notice.html Pour une transition numérique écologique [For an ecological digital transition]

5 https://cnnumerique.fr/environnement_numerique Travaux Numérique et environnement [Digital and environmental studies]

6 https://medium.com/@sophiejeanwilson/how-fair-is-fairphone-f3f0e046e40d

7 https:ifixit.com

8 https://commown.coop/

Digital value chain to consider in a responsible digital strategy

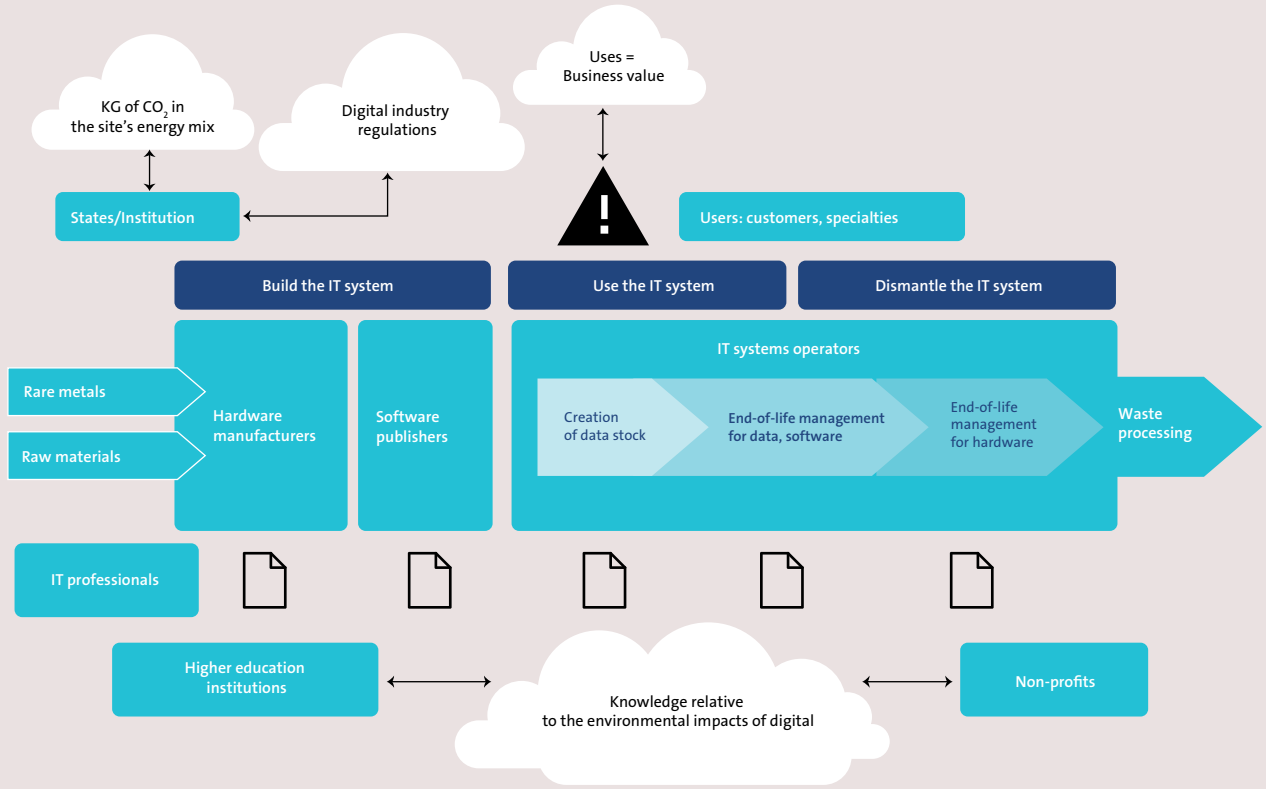


Figure 1

DIGITAL TOOLS: FROM PROMISES TO REBOUND EFFECT

Digital is also an industry at the service of other sectors of the economy, offering the promise of greater sobriety in industrial processes, lower CO_2 emissions and circular uses.

Digital is about the ability to bring things together, so that offer meets demand at a lower cost. In B2C, the website leboncoin.fr — well known for playing fast and loose with personal privacy[1] — has made reuse universally available, putting people from all over France in touch with each other in ways that were impossible in the past. In B2B, we are seeing the emergence of virtual marketplaces, such as Upply[2] for road freight. Unthinkable twenty years ago! The list is endless if we include car-share platforms, mailing lists and social media for lending equipment and swapping services.

Digital is also about the ability to be better informed, which we use today to make our exchanges easier, as Asimov predicted in the 1980s when he anticipated videoconferencing.[3] It is used to promote responsible policies, inform people about recycling options, and compile and disseminate best practices in business, management and environmental responsibility. It would not be hard to imagine the businesses of tomorrow using dedicated platforms to help their customers cut direct and indirect carbon footprints via the services they offer. Using this ability to deliver information, digital is nurturing the emergence of completely new business models, such as repairs and websites like Spareka.com.[4] France's Anti-Waste and Circular Economy Act introduced the requirement that electronic goods display a repairability rating, which should give further impetus to this business model.

Lastly, digital is about the ability to save resources: for example, a simple temperature sensor cuts off the heating when a room is up to the required temperature or switches it on before frost and freezing can cause any damage. When connected to an overall system monitoring buildings or installations, it delivers substantial gains in terms of energy and resources. The latest report from The Shift Project[5] sets out a simple methodology for clarifying under what circumstances the introduction of a connected or digital

1 https://www.pixeldetracking.com/fr/le-bon-coin-donnees-personnelles-rgpd

2 https://www.upply.com/fr-fr

3 https://www.franceculture.fr/emissions/la-methode-scientifique/la-methode-scientifique-emission-du-vendredi-18-septembre-2020

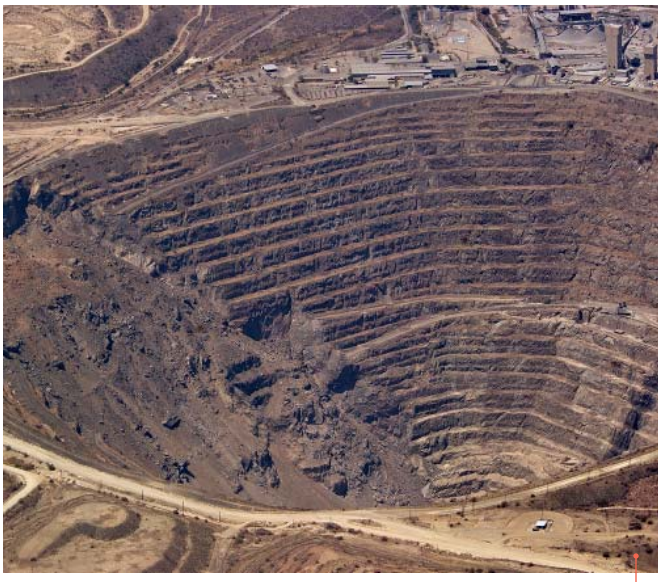
4 https://www.spareka.fr/

5 Towards Digital Sobriety, The Shift Project: https://theshiftproject.org/article/deployer-la-sobriete-numerique-rapport-shift/

layer is or is not relevant, using examples based on smart lighting and the introduction of a Smart Technologies Energy Relevance Model (STERM).

But the moment you roll out a technology that delivers efficiency gains — in terms of energy, performance or working time — the risk of using greater net amounts is all too real! This is the rebound effect which, whether direct or indirect, comes into full effect and prevents us from achieving net carbon gains. Take the example of the Internet of things, whose rapid development is accelerating digital transformation in industry and agriculture: industry 4.0. The idea behind applications for optimizing processes and procedures, or for predictive maintenance, is to fit sensors to production lines. The goal is (1) to predict breakdowns, boost the productivity and reliability of machinery to drive down costs, but also (2) to optimize use of resources such as water, energy, and raw materials, thereby reducing the environmental impacts of industrial processes. European projects such as CE-IoT exist to promote a circular economy model improved by the Internet of things.[6] This trend for what is known as Tech for Good is interesting, certainly from the climate standpoint. However, the greenhouse gas emissions involved in manufacturing, transporting, installing, operating, maintaining, removing, recycling and eliminating all these connected systems and sensors are only of any worth if they genuinely deliver net CO_2 emission savings once everything is taken into account. And the fact is that these calculations are not always made, even at the most superficial level. Why are our hard drives always almost full when their capacity has doubled every year over the past 35 years, faster even than predicted by Moore's Law?[7] Because this increase has been accompanied by ever larger photo and video files thanks to their higher resolutions, along with the ability of our smartphones to produce ever greater numbers of images! Similarly, European telecoms operators continue to lay transoceanic cables on behalf of Big Tech companies even though there has never been more capacity between Europe and North America.

Looking at other sectors shows that the rebound effect is not restricted to digital: in road transport, for example, great efforts are made to optimize flows of goods, trans-shipments, journeys, return legs loaded rather than empty, and so on. And yet never have there been more trucks on the road! Similarly, it has been demonstrated that Uber increases CO_2 emissions in cities where it operates.[8] And then there is the boom in home delivery services over the past decade, which continue to grow as a consequence of the coronavirus crisis. Global virtual storefronts, originally expected to cut the number of journeys made by private individuals and thus, ultimately, greenhouse gas emissions, have had exactly the opposite effect by making it easier than ever to purchase everyday goods and household



Aerial view of copper mine at Palabora, South Africa

appliances. And that's before we even start to think about the soil sealing that results from the construction of new warehouses, which is a further issue of real concern.[9]

In the car industry, two current phenomena are also worthy of mention. The constant increase in the weight and technology content of vehicles,[10] up 60% in 50 years, is directly caused by the fact that technologies for in-vehicle comfort and safety are available and ever more affordable. This is felt in the net impact per vehicle manufactured which, when added to increasing vehicle use over the same period, is in no way offset by efficiency gains in manufacturing and vehicles' improved immediate fuel consumption.

CONCLUSION

These numerous examples show us that it is important to question the digital reflex and that digital, like any technology, should be looked at on a case-by-case basis, with objective examination of CO_2 versus resources, benefits and possible rebound effects. Each and every negative externality impacts the future of all of us and of society.

All companies need to think in terms that reach beyond their product, collaborating with other actors across the entire value chain and asking their IT suppliers to take an objective approach to their social and environmental responsibilities; in other words, an end-to-end approach that includes scopes 2 and 3.[11] Then, and only then, will they become part of the solution not the problem.

6 https://cordis.europa.eu/article/id/413173-where-the-circular-economy-and-the-internet-of-things-meet/en

7 https://en.wikipedia.org/wiki/Moore's_law

8 https://www.forbes.com/sites/davekeating/2019/11/20/uber-adding-to-air-pollution-in-europereport/

9 https://www.banquedesterritoires.fr/centres-commerciaux-les-prefets-appeles-renforcer-la-lutte-contre-lartificialisation-des-sols

10 https://fr.motor1.com/news/266197/poids-moyen-voiture-augmentation-etude/

11 Scope 2: indirect energy emissions
Scope 3: other indirect emissions. Other emissions indirectly generated by the organization's activities that are not accounted for under Scope 2 but that relate to the total value chain. In digital, this may include manufacture of employees' computers, servers used in outsourced datacenters, and public network equipment. They represent a very significant portion of a company's carbon footprint, typically 15 to 20% for a services business.

INDUSTRIAL SYMBIOSIS: PRACTICES IN CHINA'S INDUSTRIAL PARKS

Zhao Kai
Vice Chairman and Secretary General
China Association of Circular Economy

Panoramic view of Suzhou Industrial Park

A senior engineer and Certified Energy Manager with an MBA from Guanghua School of Management, Peking University, Zhao Kai is the current Vice President and Secretary General of the China Circular Economy Association. He has long been engaged in researching and promoting energy conservation and the circular economy and has experience in international project cooperation. He is also a member of various national technical committees, regarding standardization, environmental protection, recycling and energy. He has won the second and third prizes in the China Standard Innovation Contribution awards.

Administered by the State-owned Assets Supervision and Administration Commission of the State Council, the China Association of Circular Economy (CACE) is a nationwide organization, whose role is to formulate both strategic planning for government on the development of the circular economy and development and implementation programs for industries, as well as promoting the development of the circular economy in accordance with the relevant laws and regulations.

As an important driver for regional economic development, industrial parks are not only a zoned area consuming resources and energy while generating pollution, but also an excellent tool to improve the ecological environment and achieve high-quality development. Industrial symbiosis refers to the cooperation between different companies to achieve resource sharing or complementarity, and directly or indirectly enhance resource allocation efficiency within or outside them. It helps foster synergistic developments among industries, efficient use of resources, continuous extension of the industrial chain, and further develop the industrial cycle, symbiosis or coupling.

INTRODUCTION

Around 2000, China began to actively explore industrial symbiosis within industrial parks and adopted various policy measures promoting park circular transformation and demonstration eco-industrial park and green industrial park construction, aiming at symbiotic and sustainable development in industrial parks.

This article summarizes the policy measures taken, main focus and practical experiences in three areas – park circular transformation, demonstration eco-industrial park construction, and green industrial park construction – to explore the pathway to industrial symbiosis within industrial parks in China.

POLICY MEASURES TAKEN TO PROMOTE INDUSTRIAL SYMBIOSIS IN INDUSTRIAL PARKS

PARK CIRCULAR TRANSFORMATION

Issued in September 2005, «Several Opinions of the State Council on Speeding up the Development of the Circular Economy» proposed to carry out trial demonstration work on the circular economy in industrial parks, and to explore its effective development. Park circular transformation has been explicitly listed as a key project of the circular economy in the Outline of the 12th Five-Year Plan for the National Economic and Social Development of the People's Republic of China.

In 2011, Baiyin High-tech Industrial Development Zone in Gansu Province and other eight parks were approved to carry out the pioneering demonstration of park circular transformation; in 2012, the National Development and Reform Commission (NDRC) and the Ministry of Finance (MOF) issued the «Opinions on Promoting the Circular Transformation of Industrial Parks», proposing to develop 100 national demonstration parks and thus provide model for all kinds of industrial parks to achieve transformation by developing the circular economy.

In order to give full play to the leading role of the pioneering demonstration, NDRC, MOF and other relevant departments released "Administrative Measures for Mid-term Evaluation and End-of-term Acceptance Test of the Circular Transformation of Demonstration Industrial Parks", strengthening mid- and late-stage supervision and gradually form a long-term mechanism of park circular transformation.

Policy measures regarding park circular transformation mainly focused on:

Improving the efficiency of resource utilization.

- By-products and waste could be fully utilized by extending the industry chain;
- Energy and resource efficiency could be ameliorated by conducting energy-saving transformation;
- Overall resource efficiency and output could be substantially improved by promoting utilization of waste heat and pressure, adopting graded, quality-based and cascaded use of water, and material exchange.

Leading industrial transformation and upgrading.

In accordance with the comprehensive requirements of «industrial clustering and integration, quantity control and quality improvement, energy conservation and emission reduction», industrial parks will optimize their industrial layout, complete the supporting facilities such as sewage

Hengqin Free Trade Zone, Zhuhai City, Guangdong Province, China

and solid waste treatment, eliminate backward production capacity and promote advanced technology. Traditional industries will be thus optimized and upgraded.

Encouraging the green transformation of industrial parks. By building centralized energy supply centers to replace small coal-fired boilers, parks could optimize their energy structure with a shift towards green energy; by outsourcing waste management services and developing recycling systems, parks could reduce emissions and promote green development.

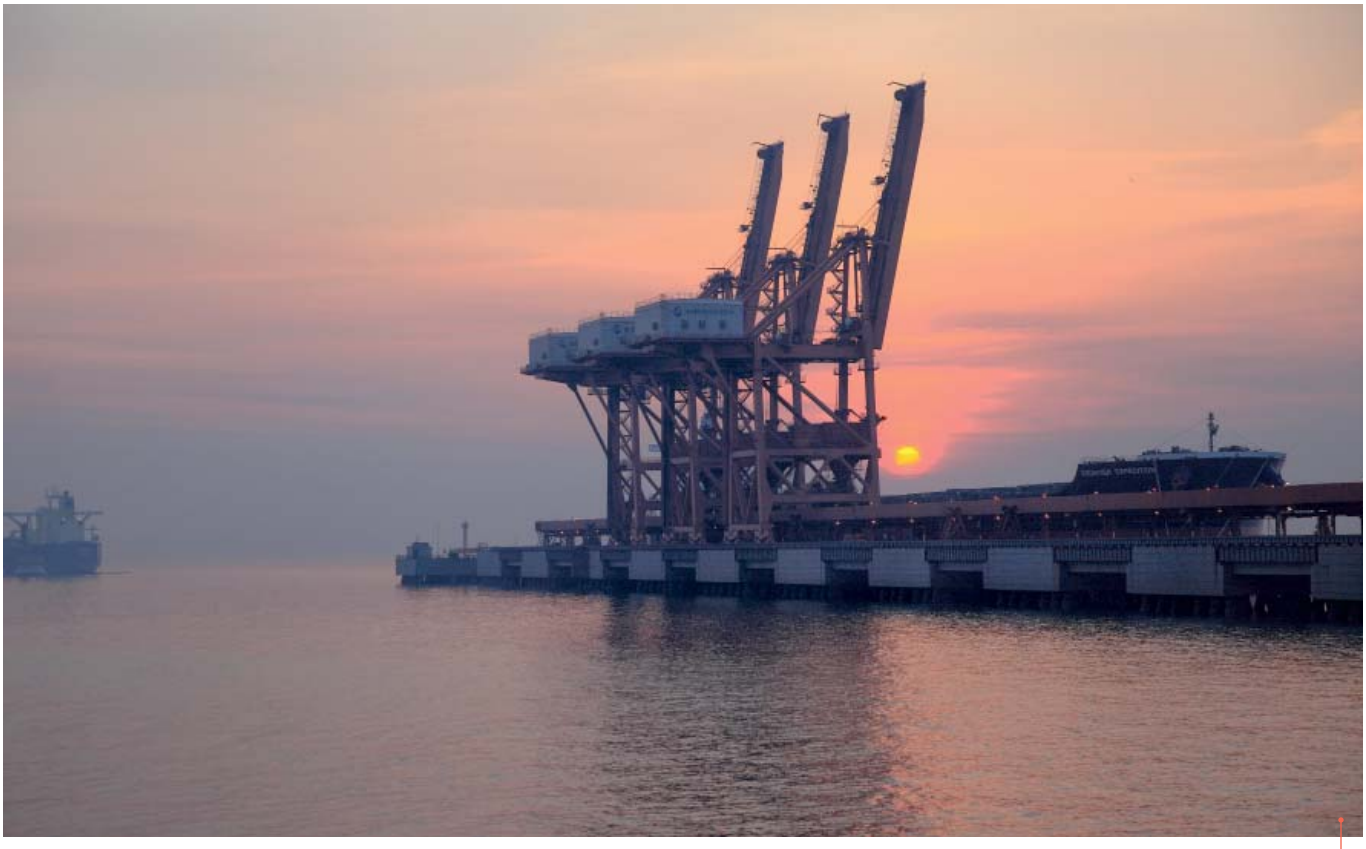
Industrial parks will adopt ecological transformation and reduce pollutant emissions to build an eco-industrial system with resource conservation, clean production and waste recycling

CONSTRUCTION OF DEMONSTRATION ECO-INDUSTRIAL PARKS (EIPS)

In 2000, the State Environmental Protection Administration (SEPA, restructured and renamed the Ministry of Environmental Protection in 2008, then the Ministry of Ecology and Environment in 2018), started to implement EIPs in different regions for different industries, including sugar, aluminum, chemical and high-tech, for local authorities and companies.

In December 2003, SEPA issued the "Notice on the Issuance of the 'Regulations on the Declaration, Naming and Management of National Demonstration EIPs (Trial)' and other documents", which clarified the main characteristics of demonstration EIPs, standardized procedures of declaration, naming and supervision, and formed the basic process of declaration, planning preparation, feasibility analysis, approval, naming, supervision and implementation. The Notice also established a supervision mechanism based on regular reporting, an annual summary and regular assessments.

To comprehensively boost EIP construction, relevant departments have issued several policies including «Guidance on Strengthening the Construction of National Demonstration EIPs», "Management Measures for National Demonstration EIPs", "Standards of National Demonstration EIPs", "Notice on Strengthening the Development of the Low-Carbon Economy in National Demonstration EIPs", "Notice on Review and Evaluation of National Demonstration EIPs", etc. The policy documents encouraged the formation of a long-term mechanism for the construction and development of EIPs.



Sunrise at Caofeidian Industrial Dock

Policy measures regarding construction of demonstration eco-industrial parks mainly focused on:

Promoting the construction of an ecological civilization within parks.
Industrial parks will adopt ecological transformation and reduce pollutant emissions to build an eco-industrial system with resource conservation, clean production and waste recycling. Contributing to a resource-saving and environmentally friendly society, and to sustainable social and economic development in parks, these are essential requirements for the construction of ecological civilization.

Optimizing economic development by complying with environmental requirements.

Industrial parks will transform their concept of environmental management through scientific planning, reasonable industrial layout, raising the environmental access threshold, completing the environmental risk prevention mechanism, and strengthening environmental infrastructure. Environmental management could gradually extend from traditional end-of-pipe treatment to the whole process control, from production, circulation, consumption and trade to investment, etc. This will also help the integration of the environment and economy in industrial production in the region.

CONSTRUCTION OF GREEN INDUSTRIAL PARKS

In September 2016, the Ministry of Industry and Information Technology (MIIT) issued the "Notice on the Construction of a Green Manufacturing System", proposing the construction of one hundred green parks with industrial clustering, green structure and ecological links by 2020, and specifying a green park evaluation system including green indicators covering six aspects: energy utilization, resource utilization, infrastructure, industry, ecological environment, and operation and management. MIIT has taken the lead in organizing the declaration and review of green parks and has established a long-term mechanism for the construction of green parks, which is a post-evaluation based on construction results.

Policy measures regarding construction of green industrial parks mainly focused on:

Improving the level of green development of the park. In accordance with the concept of green development, the park will continuously improve by completing infrastructure construction, creating a green industry chain, enhancing energy structure, increasing energy efficiency, optimizing industrial structure and boosting the technological progress of green industries.

Encouraging the development of industrial clustering. By centralizing promising industries, developing clusters, playing a driving role for promising industries and companies, helping companies in the park to carry out collaborative support, and improving the industrial collaboration level, parks will develop a circular economy with a closed-loop industry chain. Relevant policy measures help effectively protect the environment, achieve economical, comprehensive and circular use of resources, and promote the transformation of industrial development. They also strengthen intensive and economical land use and strive to improve the comprehensive utilization efficiency of industrial land.

PRACTICAL EXPERIENCE OF INDUSTRIAL SYMBIOSIS IN CHINA'S INDUSTRIAL PARKS

China has explored and practiced synergistic development among different industries by promoting park circular transformation, and eco-industrial park and green industrial park construction.

CAOFEIDIAN INDUSTRIAL ZONE: INDUSTRIAL SYMBIOSIS BETWEEN STEEL AND SEAWATER DESALINATION

Located in Tangshan City, Hebei Province, Caofeidian Industrial Zone was approved for trial demonstration work on industrial park circular transformation in 2013. Caofeidian has gradually established a circular economy system covering the whole region and spreading to the surrounding areas by forming a circular economy industry chain, promoting the construction of key projects, improving the efficiency of resource and energy utilization, and cultivating strategic emerging industries. Thanks to circular transformation, the resource output rate of the park has increased by 162.2%, the comprehensive utilization rate of industrial solid waste has reached 97.5%, and the reuse rate of industrial water has reached 94.1%.

The Caofeidian Industrial Zone achieved material recycling and graded use of energy within the steel industry and between related industries, creating a symbiosis between the steel industry and seawater desalination

In accordance with the reduce-reuse-recycle principle, Caofeidian Industrial Zone introduced chain-supplementing and chain-extending projects and formed a relatively complete material and energy circular network in the steel industry. The iron slag in steelmaking slag and steel scrap from steelmaking and rolling are recycled as feedstock to achieve the recycling of iron elements. The zinc slag is returned to the smelter for remelting, and tar slag and biochemical treatment sludge are mixed into coking coal for reuse to achieve waste recycling. The reuse of high temperature exhaust gas in sintering circular cooler and dry quenching flue gas, the recycling of sensible heat during coke dry quenching, residual pressure at the top of blast furnace and extra blast furnace coal gas, marked the recycling of waste heat, waste pressure and waste gas resources. Waste heat steam,

exhaust steam of power generating units, and blast furnace slag water can be used as low-temperature heat sources to power low-temperature multi-effect seawater desalination devices, creating synergy between steel industry and seawater desalination projects.

The Caofeidian Industrial Zone achieved material recycling and graded use of energy within the steel industry and between related industries, creating a symbiosis between the steel industry and seawater desalination.

YEJI ECONOMIC DEVELOPMENT ZONE: INDUSTRIAL SYMBIOSIS BETWEEN BAMBOO PROCESSING AND BIOMASS POWER GENERATION

Located in Lu'an City, Anhui Province, Yeji Economic Development Zone was approved for trial demonstration work on industrial park circular transformation in 2015. Aiming at becoming an industrial cluster, centralized market and future urban area, Yeji implemented circular transformation while focusing on investment attraction, infrastructure construction, project promotion and service improvement, which brought revitalized development to the Zone. Thanks to circular transformation, the park's resource output rate increased by 2.8% in 2017 compared to 2014, the comprehensive utilization rate of industrial solid waste increased by 60%, and the reuse rate of industrial water increased by 100%.

The Zone was closely tied into regional socio-economic factors. With limited resources and restricted environmental conditions, it actively promoted the adjustment of enterprise organization. Based on the basic development strategy of differentiation, cost reduction and recycling, the Zone formed a development mode mainly focused on differentiation and recycling. It has gradually established a sound operation mechanism with furniture and artificial board as flagship products, bamboo and rattan products and crafts, biomass fuel, activated carbon, bamboo charcoal, high value utilization of low-quality wood and targeted cultivation of forest resources as the new growth point. Yeji Economic Development Zone has gradually built several circular economy industry chains, such as the deep processing of raw bamboo and logs, the reuse of forest harvesting residues, the reuse of bamboo and wood processing residues and the recycling of waste wood and bamboo products. This not only extends the deep processing industry chain for the wood and bamboo industry, but also achieves 100% utilization of processing residues, harvesting residues and other waste generated from furniture and panel processing, forming a circular economy model of "make the best use of everything" for wood and bamboo processing and use.

GUIGANG NATIONAL ECO-INDUSTRIAL (SUGAR) DEMONSTRATION PARK: INDUSTRIAL SYMBIOSIS BETWEEN THE SUGAR, ALCOHOL AND PAPER INDUSTRIES

Located in Guigang City, Guangxi Zhuang Autonomous Region, Guigang National Eco-Industrial (Sugar) Demonstration Park is the first national demonstration EIP in China, approved by SEPA in 2001, representing a milestone in the history of China's eco-industrial development.

Guigang National Eco-Industrial (Sugar) Demonstration Park actively carried out environmental management innovation, explored third-party pollution management, built an industrial chain for graded use of resources in the park, offered specialized services for applying clean production policies, norms and standards in the park, provided ongoing consultation and training on environmental protection and clean production, and improved comprehensive environmental management services and management in the park. Taking cane sugar production as its core activity, the Park formed an ecological industry chain to produce alcohol from waste molasses, produce paper from bagasse, and generate power from bagasse pith. The ecological industry chain covered six segments: cane field, sugar production, alcohol production, papermaking, cogeneration and comprehensive environmental treatment. The interdependence and symbiosis between segments positioned them mutually upstream and downstream in the ecological industry chain, and the «resources-products-re-resources» production process presented a cyclical material cycle.

SUZHOU INDUSTRIAL PARK: DIVERSIFIED INTEGRATION OF GREEN INDUSTRIES

Located in Suzhou City, Jiangsu Province, Suzhou Industrial Park was approved for the first batch of trial demonstration work on a green park in 2017. The park insisted on implementing the national strategy of green development and ecological civilization construction, focused on the top-level design of green development, transformed the institutional mechanism for green development, built an ecological green development system, and strived to be a representative project of China's green development. In 2017, the park achieved a 7.2% year-on-year growth in gross regional product, a 2.1% year-on-year reduction in energy consumption per unit of GDP, a 91% industrial water reuse rate, and a comprehensive regional environmental quality index of 97.4. The park also realized a 2.47% year-on-year decrease in the comprehensive energy consumption of six high-energy-consuming industries, and a centralized sewage collection and treatment rate of about 98%.

Guided by ecological civilization construction, the Park focused on the transformation of economic development, acting in various fields including spatial layout, energy utilization, resource utilization, infrastructure, green industry, ecological environment and operation management, etc., and making use of the capacity-building

and management innovation system offered by green development. It also promoted the completion of high-level green parks with the delineation of an ecological red line, improvement of public transportation efficiency, rational layout of public service facilities, underground space utilization, ecological landscape and green space coverage, steady progress in construction of an Energy Internet Demonstration Park, resource recycling, centralized treatment of pollutants, green operation and management in various aspects such as guiding ideology, industrial structure, performance assessment and lifestyle.

ROADMAP ANALYSIS ON HOW CHINA FOSTERS INDUSTRIAL SYMBIOSIS IN INDUSTRIAL PARKS

By reviewing the measures and practices implemented by China to foster industrial symbiosis in industrial parks, we may find that symbiosis is only achieved through space optimization, symbiosis planning, resource reutilization, integrated pollution treatment and shared infrastructure.

SPACE OPTIMIZATION

Based on material and industrial connections in industrial parks, space design and planning are optimized to achieve industrial symbiosis and effective land use. For example, during the planning stage, industrial park A fully considered the industrial system in the park and adopted an integrated development model. Driven by the leading industry, industrial park A divided the park into areas based on different functions of the circular economy, including the harbor area, Lingang industrial area and Liaobin City Area. The regional circular economy is thus enhanced and supported by space planning.

EFFECTIVE RESOURCE UTILIZATION

By promoting clean production in industrial parks, waste is reduced from the source. Industrial parks adopt clean and high-efficiency technology to replace old-fashioned energy and promote renewable energy consumption. Industrial parks promote the use of waste heat and pressure and encourage utilization of local-generated waste and wastewater in a bid to promote efficiency of the circular economy and boost industrial symbiosis. For example, industrial and municipal energy-saving are fast to develop in industrial parks. Resource utilization efficiency is promoted by enhancing recycling of water, by-products and waste gas.

SYMBIOSIS PLANNING

Material loops can be achieved among projects, companies and industries. Along the industrial chain, by-products and waste can be traded as resources. For example, desulfured plaster, coal ashes and slag which is produced by power plants can be used by cement producers as raw materials. The steam and heat generated by cement producers can be used by brewers. Waste diatomite produced by brewers can be put into coals which are burned by power plants and cement producers. Some of it can even be used as raw materials for cement plants. Wastewater generated by brewers can also be used as cooling water for power plants after treatment. Condensate water can be used as boiler water in power plants.

INTEGRATED POLLUTION TREATMENT

Industrial parks boost the construction and upgrading of pollution treatment facilities. Professional waste treatment companies are built to treat pollution with an integrated approach. Environment management is enhanced and certified. An environment management system is adopted at the industrial park level, corporate level and product levels. Emissions are reduced to the maximum level. For example, industrial parks are equipped with wastewater and waste gas treatment facilities to achieve standard emissions. Building treatment facilities which are more connected reduces the operating cost.

GRADED USE OF ENERGY

Water can be used by grades. For example, wastewater can be treated and reused as reclaimed water to save water resources and level up water use efficiency. Energy can also be used in the same way to promote energy efficiency. For example, an energy land can be built in an industrial park to distribute high, medium and low-pressure steam. It can ensure the graded use of energy. Waste heat can also be reused at the company level to promote energy efficiency. Waste heat boilers and supply networks can be built to provide heat for other users. Public heat and pressure pipeline construction are a preferred option to boost energy recycling.

INFRASTRUCTURE SHARING

Infrastructure in industrial parks can be shared and optimized to promote efficiency and reduce costs, including environmental facilities - such as WWTPs, solid waste recycling centers, transportation, water/power supply, lighting, construction, warehouse and public networks. Integrated underground networks can enhance the use of underground space and overall city capacity. An integrated heat and water supply is also necessary.

INDUSTRIAL ECO-PARKS AS DRIVERS OF THE CIRCULAR ECONOMY

Franck Aggeri, Professor at MINES ParisTech

Industrial eco-parks are one of the oldest forms of circular economy. A recent report for the World Bank[1] summarizes the position and puts forward recommendations for ways to promote them as drivers of the circular economy. Eco-parks are industrial zones that promote collaborations between businesses and with local communities, generating environmental, social and economic benefits. Eco-parks that foster exchanges of materials, water, energy and information between interdependent businesses operating complementary activities—along the lines of natural symbioses—are described as examples of industrial symbiosis.

Worldwide, the number of industrial eco-parks is growing rapidly: up from 245 in 2001 to 438 in 2020. They are found particularly in Asia (China, Japan and South Korea) and Europe. Some of them, such as Kalundborg in Denmark, are very well known and have been studied extensively. Every empirical study highlights the potential these forms of symbiosis have to drastically reduce the environmental impacts of industrial activities by promoting synergies, as well as the economic benefits associated with shared resource management. The report stresses that creating industrial symbiosis, including the choice of technologies, depends on the types and quantities of materials and resources available in and around the parks, as well as the number of possible local uses for them. Every situation is different and must be studied in detail beforehand to identify the potential that can be exploited.

The report looks at technologies, infrastructure, governance systems and business models in three types of activity found at industrial eco-parks: energy, water, and materials and waste. 35% of eco-parks have installed renewable energy sources; almost 50% have adopted efficient water practices to optimize water use and recuperation; and 52% have set up an industrial symbiosis program to recover waste and material flows within the park, particularly to generate heat.

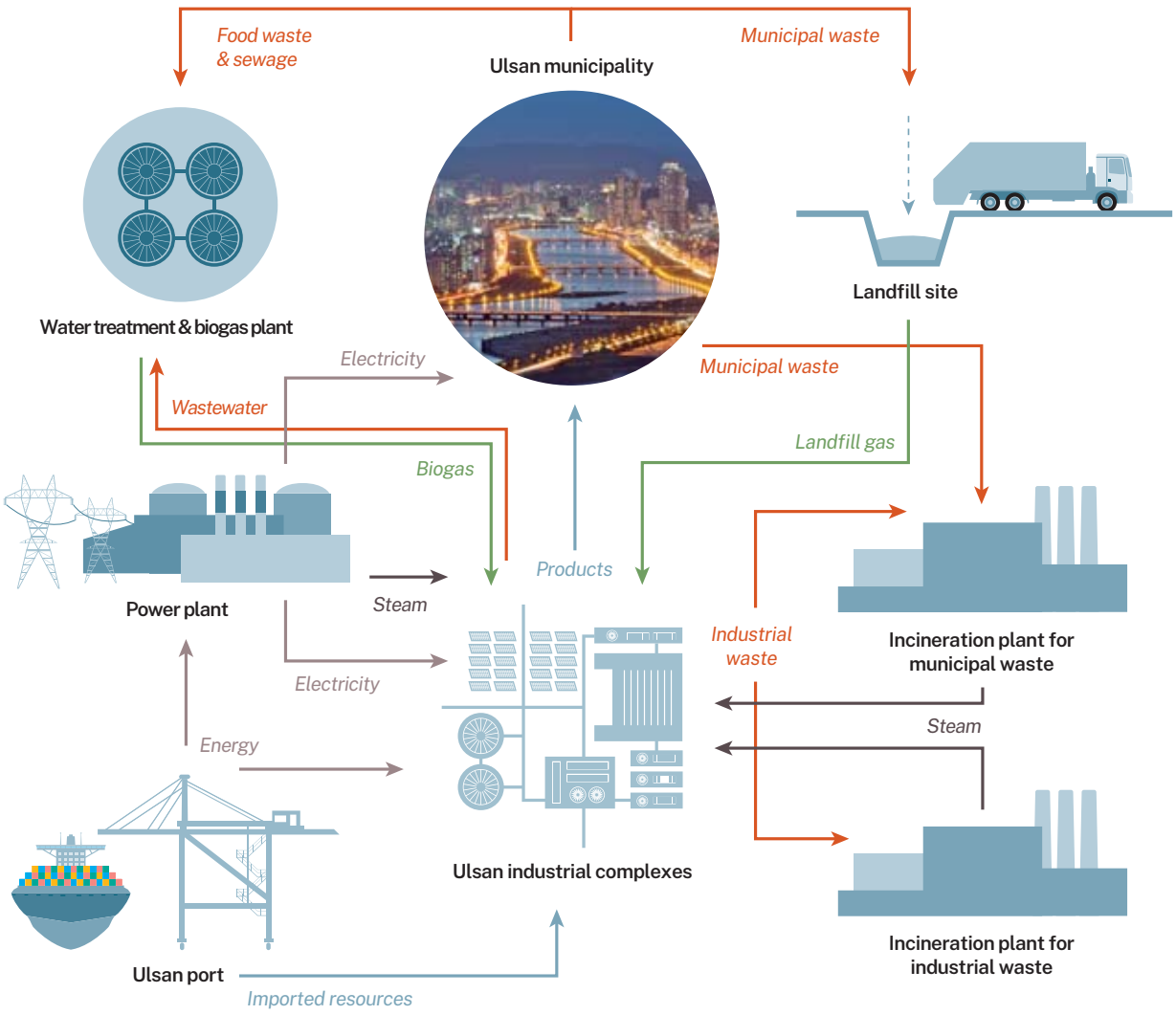
Aside from the adoption of technologies that favor circular economy approaches (water treatment, cogeneration, waste processing, pyrolysis, CO2 recovery units, etc.), the report focuses on business models and collective governance, two key factors for success. Promoting circularity necessarily entails designing business models that demonstrate the tangible benefits of resource pooling for all participants. And adopting collective governance is crucial to this. The report highlights the fact that designing symbiotic networks requires a park operator that can organize exchanges of flows of materials, water, energy and waste between companies; establish legally binding contracts between the parties; invest in and manage pooled infrastructure; take charge of R&D and trials on behalf of industrial companies; monitor the technical and scientific horizon, and set up dashboards and performance indicators. In other words, park operators play an essential role in promoting and incorporating the principles of the circular economy. Their actions can overcome the two main impediments to ramping up exchanges between industrial companies: lack of information about resources and materials available for recovery, and lack of trust between actors when it comes to sharing confidential data and committing to joint investments.

The report lists three recommendations for leveraging circular economy strategies. First, it recommends setting up digital platforms to identify reserves of materials and waste and their sources, as at the Norrkoping industrial park in Sweden. Second, it encourages local and national authorities to establish tax incentives, create financing mechanisms and make it easier for parks to share the lessons learned. Third, it recommends that park operators adopt the World Bank and UNIDO industrial eco-park toolbox, which provides detailed guidance on rolling out circular economy principles for projects of this type.

Among the examples examined in the report, the Ulsan industrial eco-park in South Korea illustrates the symbiotic relationships that have emerged between an industrial eco-park and its surrounding metropolitan area (see diagram). Part of the municipal waste is incinerated to produce energy that is used to power the park. Another part of the municipal waste is used to produce gas by methanization, and sewage is used to generate biogas through aerobic digestion. The gas produced is then used as fuel by industrial companies in the park. Integrating urban and industrial ecosystems in and around an eco-park makes it possible to increase and scale up circular economy practices.

1 World Bank. 2021. Circular Economy in Industrial Parks: Technologies for Competitiveness. World Bank, Washington, DC. ©World Bank. https://openknowledge.worldbank.org/handle/10986/35419 License: CC BY 3.0 IGO.

Urban-industrial symbiosis in Ulsan EIP, Republic of Korea



Source: Park 2016 in "World Bank. 2021. Circular Economy in Industrial Parks: Technologies for Competitiveness. World Bank, Washington, DC. ©World Bank. https://openknowledge.worldbank.org/handle/10986/35419 License: CC BY 3.0 IGO.

MEASURING CIRCULARITY AT THE CORPORATE LEVEL

Irene Martinetti
Manager Circular Metrics project
World Business Council for Sustainable Development

Jarkko Havas
Insights and Analysis Lead
Ellen MacArthur Foundation

Indicators are essential for steering companies' circular economy strategies. Over the last ten years, many tools have been developed in this sense, which were mainly designed to assess circularity at the level of material flows and products. Without questioning the usefulness of these early tools, a need has emerged for more holistic tools that assess circularity at the level of the company as a whole. What are the appropriate tools capable of integrating the complexity inherent in circular economy practice?

The Ellen MacArthur Foundation and the World Business Council for Sustainable Development (WBCSD) have worked closely and coherently to develop tools to support companies in their transition towards more circularity. This cross interview outlines the design of two tools: Circulytics by the Ellen MacArthur Foundation and Circular Transition Indicators (CTI) by the WBCSD.

Irene Martinetti is the Manager for the Circular Metrics project at the World Business Council for Sustainable Development. Irene joined WBCSD in 2017, she supports the development and global adoption of the Circular Transition Indicators with the objective to accelerate the transition to a circular economy. She has an MIA from the School of International and Public Affairs at Columbia University in New York, USA and extensive experience in stakeholder and project management in both the public and the private sector.

The WBCSD is a global, CEO-led organisation of over 200 leading businesses working together to accelerate the transition to a sustainable world.

Jarkko Havas leads the EMF's Insights & Analysis work (I&A). I&A consists of the Data & Metrics Initiative with a focus on measuring company level circular economy performance (Circulytics), and teams working on upcoming focus topics for the Foundation, as well as the case study programme. Prior to joining the Foundation, Jarkko was an Engagement Manager at McKinsey & Company, based first in Tokyo and then in Brussels. His consulting work focused on agriculture and chemicals industries in both private and public sectors. Jarkko's academic background is in environmental engineering and sustainability science.

The Ellen MacArthur Foundation is a UK-based charity, committed to the creation of a circular economy that tackles some of the biggest challenges of our time, such as waste, pollution, and climate change.

INTRODUCTION

As a new objective, the circular economy needs indicators to enable each stakeholder to understand where it stands in this transition, to measure the effectiveness of the actions implemented and to assess the progress that remains to be made.

The Ellen MacArthur Foundation and the World Business Council for Sustainable Development have made a major contribution to the development and dissemination of these new tools. These first tools were mainly designed to assess circularity at the level of material flows and products. A need has emerged for more holistic tools that assess circularity at the level of the enterprise across its operations. But what are the appropriate tools to apply at company level? What is the right data to look at?

This is a challenge as holistic tools need to aggregate complex material flow data, take into account the many interdependencies of the value chain and incorporate the complexity inherent in circular economy practice, while remaining easy to use for practitioners.

CIRCULYTICS: A HOLISTIC MEASUREMENT OF CIRCULAR TRANSFORMATION

The Ellen MacArthur Foundation has developed many tools in the past such as Material Circularity Indicator or the ResCom Project, why initiate a new tool?

Jarkko Havas: The Material Circularity Indicator tool (MCI) is primarily a product level circularity assessment tool, designed for internal decision making on product design aspects, and to think about tradeoffs that different design decisions bring.

At another level, the ResCom project developed a suite of tools to support organisations in identifying opportunities to shift to a circular economy. These tools ranged from high-level decision making about the type of business model that might be most beneficial for a product, to detailed life cycle analysis (LCAs), and analytical modelling of the business case. They were designed for use by organisations to inform specific aspects of their circular economy strategy and product development, rather than present a holistic measurement of progress against circular economy indicators.

Besides these tools, Circulytics was developed based on the demand from our network of companies to have a holistic, independently developed and free to access method to measure circular economy performance on a company level. We also used the wealth of knowledge gathered from developing MCI, ResCoM and other Ellen MacArthur Foundation initiatives, such as product design, innovation, the New Plastics Economy, and our Food initiative. Circulytics has been received well by companies with over 600 sign-ups in the first nine months since launch and over 1,000 sign-ups to date, which is a testament to the timeliness to answering companies need to measure circular economy performance. Particularly since the Covid-19 crisis, many companies are looking to create strategies for better growth — to create economic opportunities that also address global challenges such as climate change and biodiversity loss. In order to create the right strategies, companies need the right data, and that is what Circulytics provides.

Circulytics was developed to have a holistic method to measure circular economy performance on a company level

How does Circulytics work and what was the methodology to build this tool?

JH: It is an independent assessment of a company's circular economy performance, based on information that a company reports using a secure online platform.

The methodology mirrors the way in which many ESG methods have been built (e.g., using weighted averages to aggregate indicator scores into themes) to make it familiar and easy to understand.

It is framed carefully around circular economy to avoid overlaps with other non-financial indicators, but so that it covers all aspects of what circular economy means on a company level. Of course, as it is a company level tool, it has its limits in assessing on a more granular level like products and projects.

All these three aspects of Circulytics are unique: It is the only independent analysis of circular economy performance on company level, done free of charge by a leading organisation fully focused on circular economy. The indicators make the tool one of the most comprehensive out there – it considers the enabling factors companies need for the transition to a circular way of doing business, it has service-specific outcome indicators, and it measures the circularity of water flows for water intensive industries.

What were the challenges in the development of Circulytics and in its implementation by companies?

JH: We encountered two main challenges in building Circulytics. First, finding a balance between being holistic while keeping the number of indicators low in order to make it meaningful but easy to use. Second, finding ways to develop a general set of indicators that apply to as many industries as possible, while being specific enough to be actionable.

We have managed to solve both of these challenges together with the 30 companies and other organisations that have been part of developing Circulytics, and the development will continue in order to keep Circulytics as the most comprehensive, cutting edge method to measure circular economy performance for companies.

When it comes to using the tool, material flow data collection and aggregation into the right format on company level has been the most common difficulty. Most of the time, companies have all the data needed to use Circulytics, but because circular economy is a relatively new concept for accounting, procurement and other key functions, there is work needed to split material flow data in the right way (e.g., non-virgin vs virgin input).

What are the feedback from companies using the tool?

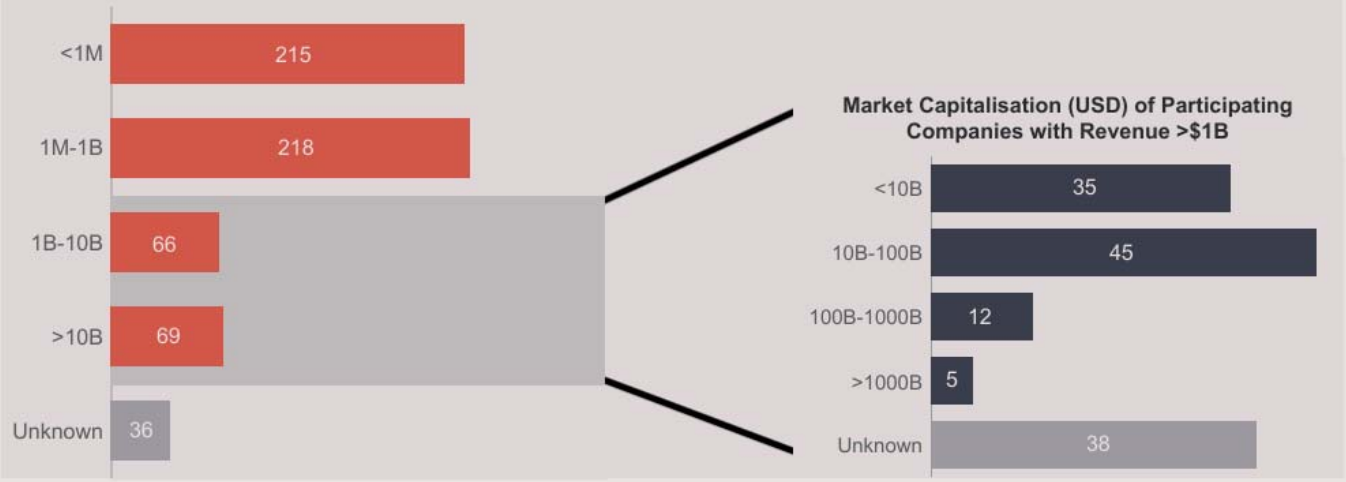
JH: Almost 1,000 companies have signed up to use Circulytics since it was launched in January 2020 and we have gotten positive feedback on how it has helped companies in finding blind spots in their circular economy

HQ Region of Participating Companies

Location of company headquarters for the 604 companies that signed up Circulytics 1.0 in the first nine months (today over 950 companies have signed up). The majority (63%) have their headquarters in Europe.

Figure 1

Annual Revenue (USD) of Participating Companies



On the left, the annual revenue in USD of the 604 companies that signed up to Circulytics in the first nine months (over 950 today). On the right, the market capitalisation in USD of the 135 companies (22%) with an annual revenue greater than USD 1B. The « unknown » bar in the market capitalisation chart includes all privately held companies as well as subsidiaries of publicly held companies.

Figure 2

strategies and informed their internal KPI setting. It has also been used as a tool to get CEO level buy-in to the importance of circular economy, amongst other things.

Of course, we also received constructive feedback from early adopters, which has been incorporated into a second V2.0 released in October 2020. V2.0 features an improved user experience, a new theme on the circular water economy, and has been translated into Chinese, Portuguese and Spanish to better suit audiences in different regions.

Although companies can (and do) disclose their results, as a way to talk about their circular economy journey with customers and stakeholders, we do not disclose company level results. However, we published anonymised data from Circulytics 1.0 company assessments in December 2020 to describe themes in aggregated company results (see Figures 1 and 2).

What are the next steps?

JH: In 2021, we will focus on further developing the digital product, to make it even easier to use and access results. We will also be working on linking Circulytics results to Sustainable Development Goals, to indicate how companies are working towards those. Additionally, we will work with financial institutions and non-financial accounting standards projects to bring Circulytics, or parts of it, to the use of financial decision making and broader non-financial accounting standards.

THE CIRCULAR TRANSITION INDICATORS FRAMEWORK: ASSESSING CIRCULARITY AT ALL LEVELS

The Circular Transition Indicators (CTI) framework was shaped by 30 WBCSD member companies representing 16 countries, 16 different industries and over 1.7 trillion in annual revenue to answer companies' needs to measure circularity and support them in their transition towards a circular economy.

How was this project developed with companies? What were the challenges of buiding a common framework?

Irene Martinetti: This work started in 2018 with the Circular Metrics Landscape Analysis[1] which concluded that there was an existing need for an inward facing, quantitative approach and guidance to measure circularity for the whole company, business unit or product (group) with a framework that complements assessments and tools already used by companies today.

With that in mind, WBCSD member companies joined forces to design a framework that could provide quantitative, data-based insights into circular performance, associated risks and opportunities. We designed the Circular Transition Indicators (CTI) to be an inward facing tool, easy to implement and versatile in scope with an aim to empower companies in their circular transition by allowing them to better understand their circular economy potential. CTI is simple, applicable across industries and value chains, complementary to a company's existing sustainability efforts and agnostic as to material, sector or technology. CTI is an iterative framework, and it is regularly updated to respond to evolving challenges in circular economy.

The three modules of the Circular Transition Indicators methodology : Close the Loop, Optimize the Loop and Value the Loop

To develop the framework, we worked in collaboration with an advisory group consisted of some of the most prominent organizations with expertise in the field of circular economy.

In January 2020, CTI v1.0, a first version of the report, was launched with a set of fundamental indicators for the three modules of the methodology (Close the Loop, Optimize the Loop and Value the Loop). Throughout 2020, WBCSD's water group developed additional metrics to measure water circularity while WBCSD members focused on developing an additional indicator to make the link between circular and financial performance and provide extensive guidance on how to apply CTI consistently for the bioeconomy.

The main challenges during the development of the framework revolved around finding commonality across industries and value chain positions. We wanted to develop a set of metrics that each user could benefit from, regardless of where they are in the value chain or which industry they belong to. We found common ground by maintaining a balance of pragmatism and focusing on metrics that can provide information that would be valuable for more effective decision-making recognizing that CTI v1.0 would not be perfect and that further iterations would be needed.

How does the CTI framework work and what are its limits?

IM: The CTI framework is based on a self-assessment of material flows within company boundaries (see Figure 3), combined with additional indicators on resource efficiency and efficacy, as well as the value added by circular business. In addition to the ability to close the loop, CTI provides insights into overall resource use optimization and the link between the company's circular material flows and its business performance.

1 WBCSD (2018). Circular Metrics – Landscape Analysis. World Business Council for Sustainable Development (WBCSD). Retrieved from: https://www.wbcsd.org/Programs/Circular-Economy/Factor-10/Metrics-Measurement/Resources/Landscape-analysis

The Circular Transition Indicators (CTI) methodology logic

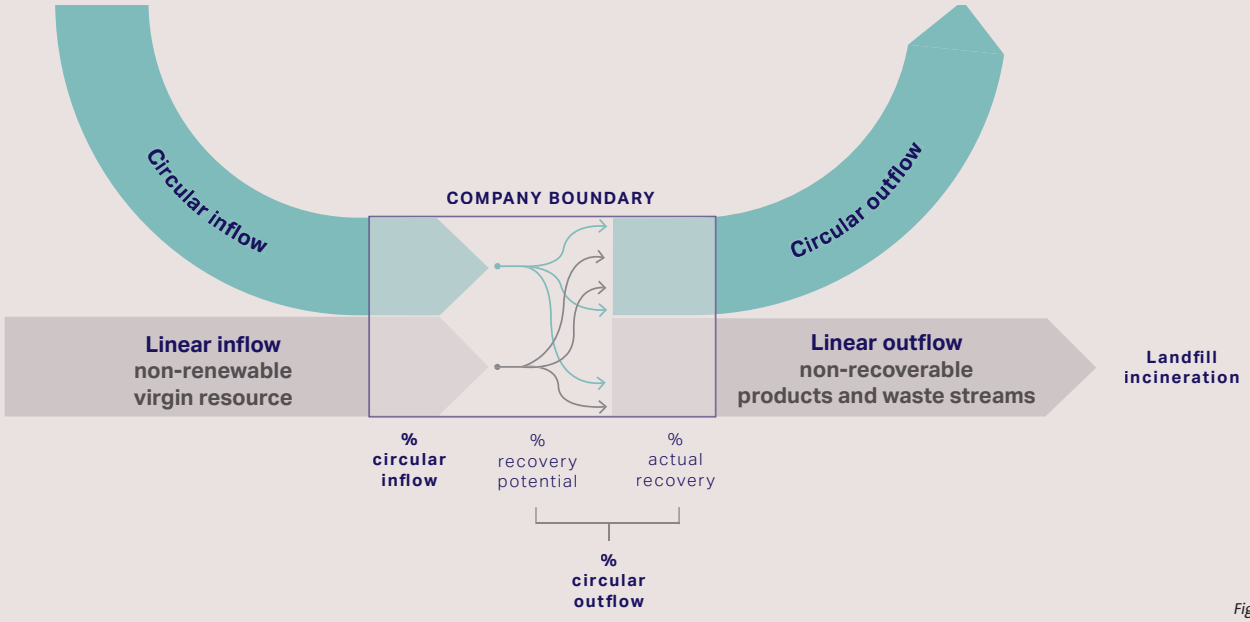


Figure 3

The framework does not evaluate the environmental and social impacts of the company's circular activities. However, understanding mass flows is a major step in knowing their impacts. Moreover, in its current set-up, this is not a methodology designed to share or celebrate achievements but rather to measure progress regularly as circular solutions are identified and tested across products and facilities.

The framework has been developed around 5 core principles: to be as simple as possible within the context of the circular economy (Simplicity), to use one common, cross-industry language that provides consistent insights into circular opportunities and linear risks regardless of organization size, sector or value chain position (Consistency), to offer a complete set of metrics with the flexibility of accommodating diverse business needs (Completeness), to complement other existing sustainability and business metrics (Complementarity) and to refrain from prioritizing specific materials insofar as they all contribute to the circular economy (Neutrality).

How was the CTI methodology received by companies?

IM: The CTI methodology has been very well received by companies globally. With CTI, business now has a clear and common language for circularity with a set of quantitative metrics. Companies find the methodology straightforward and intuitive, user-friendly and comprehensive, complementing companies' existing sustainability efforts.

The CTI online tool counts over 1,000 organisational accounts since its launch in January 2020. User groups from diverse sectors and positions in the value chain are piloting the methodology, enriching it with sector specific application and providing feedback for further upgrades to the indicators.

CTI's Value the Loop module has been particularly welcome by the investors community at it is the only methodology to provide a solid grasp of value created through circular investments allowing to recognize and reward companies that make progress on circularity.

What are the challenges in the implementation of the CTI and its use by companies?

IM: Probably the most significant challenge for companies relates to data collection. This may be because it is the first time that it is gathered or because the range of products assessed is very broad and with a complex supply chain. It is key to set the correct scope at the onset and begin by products or product groups for which data may be already widely available. In many cases, data along the supply chain resides with suppliers who may be reticent to share confidential data externally. To address these challenges, WBCSD developed the CTI Tool which supports companies in structuring data and allows them to invite suppliers to provide their data for relevant products in a confidential manner. Expert guidance is available to support companies to set up their first assessment in the form of advice from

experts or coordination of user groups by WBCSD and its partners. User groups are especially helpful as companies can share challenges, solutions and best practices.

What are the first results?

IM: Based on feedback, companies find that it allows them to analyze their circular performance through a structured process. Applying CTI helps them translate their vision into a strategic roadmap and monitor progress as they embark on their journey towards circularity.

CTI supports innovation. When used in the early stage of products development, CTI helps evaluate possibilities to improve its circularity before it goes to market. Additionally, companies found that using CTI not only helped them characterize how circular their product, product lines, facilities or entire company is but also to identify more efficiently risks and opportunities. By using it at corporate level, CTI can help companies identify opportunities for improvement and highlight areas that can have highest impact on closing company's loops.

No company can drive the transition to a circular economy on its own. The circular economy requires a larger industry, value chain and cross-sector effort

Finally, beyond internal communication, companies find that CTI helps them communicate more responsibly and more transparently with suppliers and clients, building close relationships and developing a common understanding of priorities. The process of data collection to calculate the indicators fosters collaboration across the value chain.

Find feedback from companies that have applied CTI on our CTI case studies page.[2]

What are the next steps to improve the CTI methodology?

IM: In February 2021 WBCSD published an updated version of the CTI methodology. CTI v2.0 features three main additions to the existing methodology, including:

- **Water Circularity**: New calculations for Circular Water Inflow/Outflow and Onsite Water Circulation.
- **CTI Revenue**: Acknowledging growing investor interest for metrics that link circular and financial performance, the new CTI Revenue indicator provides a consistent way to credibly respond to investor inquiries.
- **Bioeconomy Guidance**: CTI now includes extensive instruction and interpretation on the bioeconomy across all indicators and process steps.

The new content builds on CTI's existing data and makes it easier and more valuable to companies that apply the methodology.

What are the differences between Circulytics and CTI and how are the tools complementary?

IM: CTI is a self-assessment framework that provides insights into overall resource use optimization and the link between the company's circular material flows and its business performance.

CTI is a fully quantitative methodology based on demonstrable data. Its objective is to empower companies in identifying linear risks and circular opportunities and which effectiveness can be measured and monitored in reoccurring (annual) cycles.

Circulytics is based on the combination of quantitative data and qualitative insights on a company's readiness to do business in a more circular way, for example in terms of strategy and business functions. Circulytics helps companies explore their circular potential through the scoring of "outcomes" (i.e., how circular you are today) and "enablers" (i.e., how ready you are to be more circular in the future).

No company can drive the transition to a circular economy on its own. The circular economy requires a larger industry, value chain and cross-sector effort. To transform, companies must speak the same language, regardless of size, industry or value chain position.

Having a common approach to measuring and monitoring circular performance is essential. This will allow value chains to become value cycles, progressing towards a shared vision. Collaboration and coordination in the context of circular metrics is essential for accelerated and higher impact results. WBCSD and the Ellen MacArthur Foundation methodologies and definitions are aligned so that companies can use similar data sets in their calculation for material flows and benefit from both approaches in their journey towards circularity if they so choose.

2 https://www.wbcsd.org/Programs/Circular-Economy/Factor-10/Metrics-Measurement/Circular-transition-indicators/Case-studies

CO-DEVELOPMENT OF INDUSTRIAL-QUALITY POST-CONSUMER RECYCLED PLASTIC: the example of Groupe SEB and Veolia

Ingrid Tams,
Environmental Manager, Groupe SEB
Jacques Tanquerel,
Plastics Procurement Category Leader, Groupe SEB
Françoise Weber,
Head of Extended Producer Responsibility Schemes, Veolia Environmental Services
François Guéneron,
Head of Industrial Plastics Recycling, Veolia France

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The introduction of quality recycled plastics from closed loop post-consumer waste is an important issue for manufacturers in their efforts to roll out circular economy strategies. But the lack of pre-existing recycling capabilities means that tackling it requires a co-development approach that presents unexpected difficulties and potential. The project discussed in this interview centers on a pioneering partnership between Groupe SEB and Veolia to develop post-consumer recycled polypropylene for use in electrical and electronic appliances. The project proved highly beneficial for both partners. For Groupe SEB, it was a way of highlighting the potential for incorporating post-consumer recycled plastics, which now encompass various product families, types of plastics and geographical regions. For Veolia, it was the first stage in the development of a recycling process that is now applied worldwide across a range of different sectors.

With a degree in mechanics and production from TI2I Caen, Jacques Tanquerel is Plastics Procurement Category Leader at Groupe SEB. He co-ran a pilot project looking into using recycled plastics as part of the sustainability and procurement strategy.

Ingrid Tams is a materials engineer who studied at INSA in Lyon. From 2012 to 2015, she jointly ran the first project to introduce closed loop recycled plastic into household appliances. Since then, her activities have broadened to cover all aspects of eco-design.

François Gueneron studied engineering at ISPA and has worked in the recycling industry for the past 10 years, joining Veolia in 2016.

Françoise Weber is an engineer with an MBA from Darden University in Virginia, USA. She is currently Head of Extended Producer Responsibility Schemes at Veolia.

Can you tell us about the initial issues surrounding this co-development project?

Ingrid Tams and Jacques Tanquerel (Groupe SEB): We've been looking at product recyclability since 2000 as part of our eco-design efforts. In 2010 senior management at Groupe SEB asked us to switch focus onto recycled plastic, which emits up to three times less CO_2 than virgin plastic. In concrete terms, as early as 2011 laundry care marketing teams were telling us they saw real advantages in incorporating recycled plastic into our products. We initially decided to work on recycled polypropylene since it is the most commonly found material in our products. In 2012, the project to develop use of recycled materials was identified as one of the four key issues facing Groupe SEB in its sustainability approach. This approach was part of a long-term strategic vision that we strongly felt was fully aligned with client and consumer demand, but that also had the potential to reduce supply costs by using recycled materials.

For the first three years, we didn't know if we'd succeed. There were new skills that both sides needed to acquire

Françoise Weber and François Guéneron (Veolia): Working at our waste electrical and electronic equipment (WEEE) processing site at Angers, we set up a plastics waste sorting unit to eliminate brominated flame retardants. As soon as we succeeded in obtaining decent quality resin, we wanted to produce a plastic mixture and develop high-added-value applications in a closed loop. At the time, Veolia was keen to expand its plastics recycling activity but we needed to scale up. We knew how to sort, but we didn't have the capacity to produce recycled plastic from post-consumer plastics.

Why did you choose to work together?

IT and JT (Groupe SEB): Precisely because Groupe SEB has the manufacturing know-how needed to co-develop and then use this recycled plastic. We are founding members of an eco-body called Ecosystem, and at the time it was running a tender for recycling plastics from WEEE. Veolia offered advanced skills in sorting plastics using infrared sorting techniques. We did sound out other recyclers, but our discussions with Veolia were the most productive. They were actively engaged and listened closely to us, but were also prepared to sign up for a process that would inevitably be long and difficult. And we knew that working with Veolia meant we would be able to use post-consumer plastic from WEEE. This aligned with our determination to use material recycled from our own products, in a closed loop. With over 360 million of our products sold each year around the world, it's a responsibility we have to assume.

FW and FG (Veolia): We have a longstanding relationship with Groupe SEB via Ecosystem, which is our primary partner in France for WEEE collection and processing. SEB had a proactive attitude to the issue and Ecosystem pointed them in our direction. From the start of the project we already knew a lot about the process of sorting plastics to separate out brominated flame retardants using our infrared sorting technology and we could sort resin by type (polypropylene, ABS, etc.). Veolia is well known as a serious player and that worked in our favor. But we were missing the final stages of the value chain we needed to meet their requirements. At the time, we didn't have all the stages in the plastics recycling value chain in place. So we reached out to a French specialist in compounding recycled materials. Today, Veolia has in-house recycling capacity thanks to its acquisition of four recycling plants in France. We teamed up with PMG, which specializes in preparing recycled plastics.

What commitments did the two parties make to each other?

IT and JT (Groupe SEB): We undertook to develop recycled material for our laundry care products, where the constraints were pretty reasonable. We wanted a black material that met our exact specifications and was available in the volumes we required. For the first three years, we didn't know if we'd succeed. There were new skills that both sides needed to acquire.

FW and FG (Veolia): It was a long learning curve for us. We had to acquire new skills: setting up a quality control process, applying REACH classifications, and building a process for characterizing the material. We also had to guarantee the stability of the material supplied. In the beginning this was not a commercial project. The management team gave us the freedom to explore. We really wanted to successfully develop a commercial activity in a closed loop in collaboration with Ecosystem, and to show that we could embed a project of this type into our long-term operational processes.

What were project's key stages?

IT and JT (Groupe SEB): It began with a visit to the WEEE sorting site at Angers to assess Veolia's ability to develop a product that would meet our requirements. We then set up a project team at Groupe SEB comprising experts from various departments: marketing, environment, procurement, the plastics design office, site procurement and materials innovation. The second stage was to develop the first samples that matched the specifications and carry out testing to look at mechanical and thermal resistance and regulatory compliance (RoHS and REACH). We hit various unexpected problems during the project. Tests using presses, for example, showed up problems with offensive odors that troubled the operators. It took

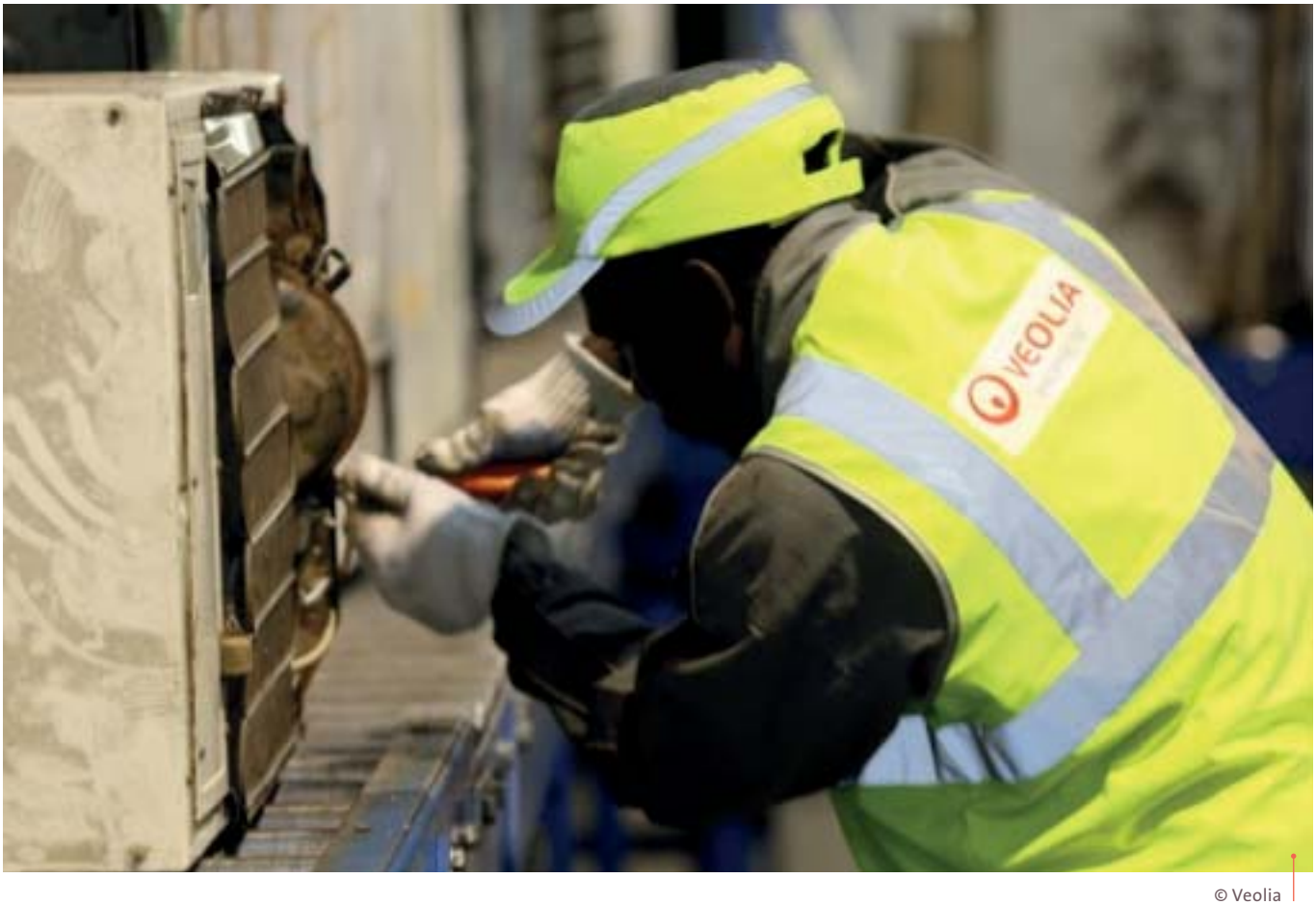
a year to sort it out. The solution included investing in smoke extraction systems for the presses. Once that obstacle was dealt with, the third stage was very much like a conventional development process: prototyping, mold tests, laboratory tests, quality tests, etc. Only then did we settle on prices and shipment frequencies. Overall the project took three years, from initial discussions to characterizing the final material. Production was officially launched in July 2015 and the first products to include recycled material were on the market in September the same year.

FW and FG (Veolia): At one point we thought the project would fail, particularly because of problems centering on the recycled material's smell. ADEME (France's environment and energy management agency) helped Groupe SEB with the design of an odor extraction system for the extrusion phase. Once feasibility was established, we opted to acquire the compounder so that we would have end-to-end in-house recycling capabilities. Our goal was to ensure the project would be a success. We were able to move a lot faster after that. For us, the project was a crucial component in developing a comprehensive recycling capacity, from sorting to grading, washing, grinding, formulating and extruding resin polymers and manufacturing compounds.

We were able to show our clients and management that we had the skills to run a closed loop post-consumer recycling process for industrial quality applications

What have you learned from this co-development project?

IT and JT (Groupe SEB): There were three key takeaways for us: above all it showed us that it is possible to recycle material from our products to make new ones. It was tricky at the beginning, and some experts didn't think we would manage it. Then there was the fact that projects of this type require patience. It takes six to 18 months to develop a new product, but this project took three years. Lastly, there are the spin-offs from new learning about the latest developments in recycled materials. It now takes us much less time to run the pre-qualification phase, although still longer than when using a virgin material as adjustments are inevitably required. Recycled materials take three or four months longer.



© Veolia

FW and FG (Veolia): We were able to show our clients and management that we had the skills to run a closed loop post-consumer recycling process for industrial quality applications. The project also gave us an insight into the difficulties of co-development with clients that manufacture technically demanding products.

What are the outcomes you have noticed?

IT and JT (Groupe SEB): The savings achievable from using recycled materials depend on the price of oil, as the price of virgin material is indexed to it. If oil is expensive, recycled material is attractive. This is less true when the price of oil is low. But the most important point is the impact the project had inside the company as well as among our clients and with the general public. We are starting to see consumer surveys that indicate the public is very receptive to recycled plastic. There is also strong impetus from policymakers – which we saw in France, for example, with the draft climate law – encouraging manufacturers to make voluntary commitments in this field. Within the company, recycled plastic is now seen as being a major plus in terms of customer value. The senior management team are very committed to it. They have set a target of 50% recycled materials for our products and packaging. The increasing importance of recycled materials is reflected in the ever-growing number of requests we're receiving from our brand management teams and manufacturing division, asking us to develop new materials and new colors.

FW and FG (Veolia): Our plastics recycling business has grown very quickly, extending way beyond the market for electronic and electrical equipment, which is small from our standpoint. We currently sell 60,000 metric tons of recycled plastic a year (post-consumer, post-industrial and post-use). We hope to bring this up to 100,000 metric tons a year in France. Worldwide, we currently operate 32 plants for a capacity of 500,000 metric tons. Creating a fully structured sector requires the investment of very large sums. Our plastic recycling subsidiary currently employs 1,000 people worldwide and generates €500 million in earnings. The difficulty facing us now lies in finding an economic balance when oil prices are low. There are fixed costs involved in developing and producing recycled materials. Not only is material qualification testing required, but production molds designed for virgin material also have to be modified. Demand needs to be kick-started to drive these costs down. Mentalities are clearly changing. But action on several fronts is needed if recycling is to be viable over the long term, such as eco-modulation with a bonus for recycled materials, eco-design, and consumer acceptance.

Within the company, recycled plastic is now seen as being a major plus in terms of customer value

© SEB

What are the latest developments and the outlook for recycled plastic?

IT and JT (Groupe SEB): We've extended the process to other, more sophisticated, product families (vacuum cleaners, coffee machines, etc.), which has led us to alter the material to meet impact resistance standards for vacuum cleaners, for example. We are also working on the development of new materials (ABS, ABS-PC) with other suppliers, aside from Veolia. One of the current issues we face in trying to take things to the next stage is how to change the product designs. Recycled material is a dark color, either black or grey. But a lot of our products are white. At the moment, our design teams are working on this to make sure that consumers will accept black as a color. Working closely with all our specialties, we are innovating to help consumers transition to more responsible and sustainable consumption habits. To boost the quantity of recycled plastic we use, we are working on co-development projects with local partners (in Brazil and Vietnam) in other parts of the world, as well as on the development of food-grade recycled colored plastics. We are looking into new techniques for removing color from plastics as well as examining chemical recycling processes. There's still a lot to do!

FW and FG (Veolia): We're working to develop additional materials (PET, ABS, polystyrene, polyethylene, etc.) in addition to polypropylene, and looking into different outlets, particularly packaging and vehicle manufacturing. Other post-consumer flows will emerge with the expansion of EPR recycling schemes, such as for garden furniture and in the construction industry. One of our aims for the future is also to be able to work on other continents, because the ability to supply local products is the crux of the circular economy. We are currently working with the vehicle manufacturing industry.

3. PATHWAYS TO AN INNOVATIVE CIRCULAR ECONOMY

Innovation has a crucial role to play in turning the circular economy's promises into reality. The concept is currently generating countless innovative projects, but assessing their potential and long-term durability is not easy. What do circular innovations look like? What potential do they have to go beyond local experiments to create economic and ecological value as well as jobs? What partnerships and actors are emerging in relation to this topic? How are these innovative processes put in place and what are the obstacles to their success? These are the questions we ask in Part 3 of this issue as we explore circular economy pathways. To answer them, we have chosen to give a platform to actors that have implemented proven projects providing a good indication of the variety of topics that circular innovations tackle: closed-loop recycling of electric vehicle batteries; creating a reuse and repair economy; online platforms specializing in reuse and second-life products, and the functional economy and circular transition within companies.

THE IMPORTANCE OF CLOSED-LOOP ELECTRIC VEHICLE BATTERIES RECYCLING

Recycling electric vehicle batteries is a major ecological, health and economic issue with the anticipated expansion of this market worldwide. These batteries are composed of toxic substances that must be cleaned up under appropriate conditions, but also of metals - particularly strategic metals - that have a high economic value and could be recovered. Recycling these metals in a closed loop means avoiding the polluting extraction of virgin materials, reducing greenhouse gas emissions and avoiding dependence on a small number of producing countries for supplies. Veolia has launched this new activity in Europe and China through the development of advanced recycling technologies. After describing the challenges associated with the development of this activity, the article presents the main technical stages of the recycling process and the business models to be built. It concludes with a discussion of the strategic potential associated with the development of this activity.

THE POTENTIAL FOR CREATING JOBS AND VALUE THROUGH REPAIR AND REUSE

In terms of strong circularity, reuse and repair are seen as priority strategies for extending product lifespans and reducing the material footprint linked to consumption. Envie, a fast-growing network of businesses working in the social and solidarity economy with a 40-year track record in France, illustrates the potential for creating jobs and economic value these strategies have in the field of waste electrical and electronic equipment. Working in partnership with extended producer responsibility schemes and retailers, Envie has emerged as a go-to industrial, economic and social actor, complementing the solutions offered by private sector actors.

THE ROLE OF ONLINE PLATFORMS IN BOOSTING THE GROWTH OF REUSE AND SECOND-LIFE PRODUCTS

Two major obstacles hamper growth in the market for reused and second-life products: the dispersed nature of the actors and doubts about the quality of the products on offer. Online platforms are now emerging as a way to overcome these hurdles. The best known is Back Market, which offers refurbished and secondhand products in 15 countries around the world. But Back Market is more than simply a marketplace. It plays a far broader role, assigning a quality rating to each product on sale in the form of a 12- or 24-month warranty designed to create trust between buyers and sellers. This approach is key to overcoming consumer reticence and scaling up markets of this type.

THE IMPORTANCE OF CREATING ACTOR ECOSYSTEMS

It is often difficult to measure the potential offered by recycling and reuse due to a lack of detailed information about regional sources and outlets. The construction industry is a case in point. In Europe, hundreds of millions of metric tons of construction materials and equipment are sent to landfill every year, even though a large proportion could undoubtedly be used at other work sites. Matériaupôle provides an example of the rollout of a shared strategy for work site management that is used to recover these resources. We are now seeing the emergence of new reuse actors and physical platforms at the local level to meet the demand from urban projects and work sites keen to use recycled materials and second-life equipment.

FROM PRODUCT TO PRODUCT-AS-SERVICE

One of the pathways to strong circularity is to intensify the total use made of a product. This is the functional economy strategy, which aims to transition from selling a product to selling a product-as-service paired with a performance commitment. Signify, formerly Philips Lighting, has taken this route, opting to sell its professional clients lighting services rather than lightbulbs. The challenge of this type of strategy is both economic and technical: it entails pivoting to an entirely new business model and a complete shake-up of the company's specialties and structures.

CIRCULAR TRANSITION WITHIN A COMPANY

Beyond trialing changes in specific areas of business activities, what does implementing a company-wide circular transition entail? Interface Inc., the global leader in carpet tiles, has had just such a strategy in place for the past 25 years in order to limit its environmental footprint as much as possible while simultaneously transforming the company's business model. This systemic strategy, covering every facet of the business, from production to design, sales, maintenance and skilling, is presented here.

Franck Aggeri,
issue coordinator

RECYCLING ELECTRIC VEHICLE BATTERIES:

ecological transformation and preserving resources

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The market for electric vehicles is currently experiencing unparalleled growth in many parts of the world. This expansion is supported by a range of policies designed to boost electric mobility. As a result, vehicle and battery manufacturers are significantly ramping up their production, which is now growing exponentially and incorporates materials that are often crucial and can pose risks to human health and the environment.

This in turn makes recycling electric vehicle batteries essential from both an ecological and strategic standpoint. Veolia offers solutions in this field that leverage its experience in hazardous waste processing, recycling expertise, and network of partners, specifically vehicle manufacturers and chemicals specialists. The aim is to protect the resources needed for ecological transformation.

Dismantling a battery - ©Veolia

Veolia develops innovative models for materials circularity on behalf of customers from a wide range of sectors, including agriculture, with soil fertilization and bioconversion to convert farm waste into animal feed, renewable energies, with recycling solutions for photovoltaic panels and wind turbine blades, and the textile industry. Recycling electric vehicle batteries is a major component of Veolia's innovation drive.

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Romain Duboc helps Veolia business units develop hazardous waste activities, with a particular focus on recycling electric vehicle batteries.

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INTRODUCTION

Electric vehicle batteries will become a major problem in the near future if they are not managed correctly. This is because they contain highly toxic chemicals that represent a threat to ecosystems as well as to the people who handle them. In addition to plastics, solvents and electronic components, the active parts of battery cells also contain strategic metals such as copper, nickel, lithium and cobalt. This means that recycling these components is an environmental and strategic imperative.

The market for recycling electric vehicle batteries is growing exponentially: from 200,000 metric tons of EV batteries eligible for recycling in 2021 to 7 million metric tons in 2035, representing metals with a value in excess of €15 billion. The market is particularly buoyant in China while it is expanding in Europe and should follow suit in the USA in a few years' time. The phenomenon is underpinned by rapidly changing regulations that increasingly require recycled metals to be used in the production of new batteries. Veolia plays an active part in this ecological transformation which boosts the mobility of tomorrow.

"Black mass" extracted from the grinding of battery cells, containing mainly a mixture of carbon, nickel, lithium and cobalt - ©Veolia

RECYCLING ELECTRIC VEHICLE BATTERIES: AT THE CROSSROADS OF ENVIRONMENTAL, HEALTH AND STRATEGIC CHALLENGES

ELECTRIC VEHICLES: A BOOMING MARKET

The market for electric cars is booming. In 2018, the global fleet accounted for over 5.1 million vehicles and is projected to exceed 130 million by 2030 according to Global EV Outlook 2019. This trend is rooted in the desire to reduce the numbers of cars that use internal combustion engines (ICE) in favor of electric vehicles, which are more environmentally friendly. China and Europe have set targets for electric vehicle rollouts paired with stringent emission regulations for ICE vehicles. For example, China now requires vehicle manufacturers operating on its domestic market to offer a complete range of electric vehicles. In November 2020, the United Kingdom announced a ban on the sale of new ICE vehicles on its market by 2030. A similar ban is likely to be in place across the European Union by 2035. These ambitious policies aim to:

- provide local answers to a pressing health problem caused by transport-related pollution, particularly in built-up areas. Tailpipe emissions from ICE vehicles contain particulates and gases from the nitrogen oxide (NOx) family that are particularly damaging to health;
- combat greenhouse gas emissions during the time vehicles are in use, and reduce dependency on fossil fuels. According to a lifecycle analysis by France's ADEME agency in 2016, full-life CO_2 emissions from an EV are three to four times lower than for a comparable ICE vehicle, and atmospheric pollution is very largely reduce.

EXAMPLES OF COUNTRIES THAT HAVE SET TARGETS FOR BANNING ICE VEHICLES

Country	Target date	Goal
USA *California*	2030 *2025*	50% of vehicles sold are electric or hybrid *Ban on ICE cars*
Canada *Quebec*	2040 *2035*	Ban on ICE cars
Norway	2025	All vehicles sold will be carbon neutral
UK	2030	Ban on sale of ICE cars
Singapore	2030	Ban on ICE cars
Israel	2030	Ban on ICE cars
Europe *Sweden, Ireland, Netherland*	2030 *2035* 2050	Ban on sale of ICE and hybrid cars Reach carbon neutrality
China	2025 2035	20 % vehicles are electric or hybrid >50 % vehicles are electric or hybrid
Japan	2035	Ban on sale of ICE cars
India	2035	30% of vehicles are electric

TAKING ACCOUNT OF THE ENVIRONMENTAL IMPACTS OF ELECTRIC VEHICLES

Electric vehicles are clearly not impact-free in terms of the environment: manufacturing, extracting materials to make batteries, and emissions generated by electricity production all need to be taken into account when assessing environmental footprints. This means that rising EV uptake must go hand in hand with greater production of electricity from renewable sources. But it also requires limiting resource use with solutions such as eco-design and recycling. Any massive shift to EV also entails planning end-of-life management for these new vehicles. They contain different components to ICE vehicles and include pollutants, particularly in the batteries. Recycling ensures that these hazardous materials cause no major ecological damage owing to a lack of processing capabilities.

Recycling activities make it possible to reduce carbon emissions by one metric ton of CO_2 equivalent per metric ton of recycled batteries, and they avoid the extraction of virgin metals, with mining activities having critical impacts on biodiversity and water resources

The extended producer responsibility approach has already generated a considerable volume of regulation governing end-of-life vehicles of all types. EU directive 2000/53/EC, dated September 18, 2000, sets environmental performance targets for end-of-life vehicles, including a requirement to reuse and recycle at least 85% of the weight of end-of-life vehicles, and reuse or recover at least 95% of weight per vehicle, as required by the extended producer responsibility policy. Japan, South Korea and China have adopted similar regulations. It is worth noting that batteries represent 30% to 50% of vehicle weight and that, since 2006, European regulations have required that 50% of total battery weight is recycled (directive 2006/66/EC). The European Commission plans to increase this recycling requirement to 70% in 2030. A minimum of 90% of components classed as crucial owing to their toxic or strategic nature will have to be recovered.

Recycling activities deliver significant environmental advantages: they make it possible to reduce carbon emissions by one metric ton of CO_2 equivalent per metric ton of recycled batteries, and they avoid the extraction of virgin metals, with mining activities having critical impacts on biodiversity and water resources.

COMPOSITION OF BATTERIES: STRATEGIC RESOURCES

Another key issue to add to these environmental and regulatory considerations is the availability of raw materials. A battery is an assembly of ten or so modules, each made up of 10 to 15 cells. A new battery weighs an average 500 kg for a capacity of 50 kWh and costs around €7,500. Three distinct categories of materials are used in the composition of batteries, classified by value:

- low-value components (30%), plastic used to make the outer casing, electronics, volatile components and steel;
- intermediate-value components (40%), primarily aluminum used to make casings for modules;
- high-value components (30%), used in the composition of battery cells, such as lithium, cobalt, nickel and copper.

Prices for these metals on the open market can reach several thousand euros per ton and, for some of them, speculation constantly drives prices higher.

The supply of a number of these metals poses significant risks to importing countries. Since 2011, the European Union has regularly published a list of critical raw materials. Lithium was added to the list in 2020 and the European Commission says it is keeping a close watch on nickel, bearing in mind the growing demand for raw materials used to manufacture batteries, even though it is not yet judged "critical". Some metals are extracted in chronically unstable countries; for example, over 60% of cobalt is sourced from the Democratic Republic of the Congo. Recycling makes it possible to lock in a portion of the raw material supplies needed for electric vehicle batteries and countless other industrial applications. It is a real lever for achieving strategic independence.

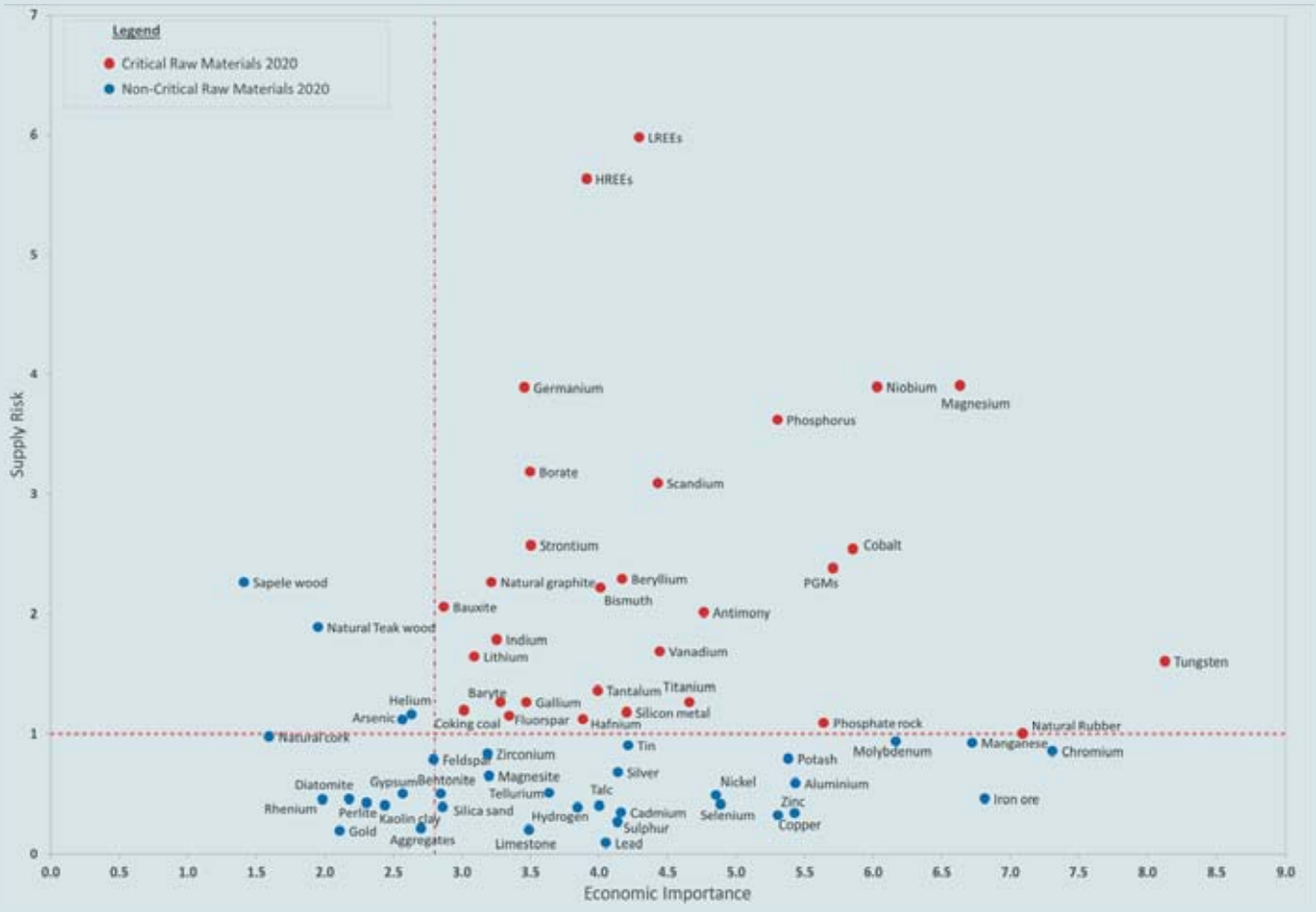
CLOSING THE LOOP: PRODUCING BATTERIES FROM RECYCLED MATERIALS

The medium-term aim is to arrive at a circular economy for batteries by developing closed loop recycling. The European Commission is currently working on drafting a regulation that will incrementally impose the use of recycled materials in the composition of electric vehicle batteries. Threshold levels for recycled materials will concern all batteries sold into the European market, irrespective of their place of manufacture. Starting in 2025, it will be mandatory to declare levels of recycled materials. In 2030, the levels demanded will be 12% for cobalt, 4% for lithium and 4% for nickel. These will rise to 20%, 10% and 12% respectively in 2035. Although these levels may at first glance appear fairly unambitious, in reality they will require a considerable increase in the amount of recycled material produced, and a major shift so that recycled by-products are re-routed back into new battery production processes. The overall efficiency of recycling rates will also be controlled via mandatory thresholds (2025: 90% for cobalt, copper and nickel, and 35% for lithium; rising to 95% and 70% respectively in 2030).

Veolia intends to play a major role in the emergence of this new sector of the circular economy.

List of critical raw materials established by the EU according to their economic importance and supply risk

2020 list of critical raw materials (in bold: newly added since 2017)		
Antimony	Hafnium	Phosphorus
Barite	Heavy rare earth elements	Scandium
Beryllium	Light rare earth elements	Silicon metal
Bismuth	Indium	Tantalum
Borate	Magnesium	Tungsten
Cobalt	Natural graphite	Vanadium
Coking coal	Natural rubber	**Bauxite**
Fluorspar	Niobium	**Lithium**
Gallium	Platinum group metals	**Titanium**
Germanium	Phosphate rock	**Strontium**



Source : European Commission, Study on the EU's list of Critical Raw Materials - Final Report (2020)

Figure 1

VEOLIA: SUPPORTING ECOLOGICAL TRANSFORMATION IN THE MOBILITY SECTOR

SOLUTIONS FOR RECYCLING THIS HAZARDOUS FORM OF WASTE

Recycling electric vehicle batteries is a major challenge that Veolia is ready to meet. In Europe, Veolia works via SARP Industries and its subsidiaries Euro Dieuze Industrie (EDI), specialists in the management, making safe, electric discharge and mechanical processing (grinding) of batteries and capacitors, and CEDILOR, a center for chemical processing (purifying) and recovery. In China, Veolia has recently started production at a new high-capacity plant (25,000 metric tons), a joint venture with local actors from the battery ecosystem. Work to develop additional projects is under way, including in the United States and Europe.

Stages in recycling electric vehicle batteries

Figure 2

Composition of an electric vehicle battery - ©Veolia

Since 2013, Veolia has been leveraging its expertise in processing hazardous waste to develop recycling processes for EV batteries. The main stages are described below.

- **Collection and making safe.**

  Before any recycling can take place, batteries have to be removed from the vehicle where they were installed. They then have to be fully electrically discharged and made safe so that they can be handled securely at every step of the process. These stages are of great importance as it is possible to damage the batteries. They contain highly inflammable materials and chemicals that are harmful to humans and the environment.

- **Dismantling.**

  The protective plastic or aluminum casing, electronic components, wires, connectors and the cooling system are all removed to locate the separate modules that comprise the battery. This part of the process is accomplished manually by trained operators. Next, the aluminum protection around the modules is removed to uncover the battery cells.

- **Mechanical recycling.**

  The battery cells are then ground up to separate the elements with less value from those that are more valuable. Cell grinding takes place under high humidity to avoid all risk of fire or explosion. The ground materials are then mechanically separated to obtain three primary materials: paper and plastics; aluminum, copper and steel; and “black mass”, a powder containing mostly a mixture of carbon, nickel, lithium and cobalt.

- **Chemical recycling.**

  The black mass is then processed chemically to separate and purify the materials it contains. Two main technologies are used to achieve purification: hydrometallurgy and pyrometallurgy. Although pyrometallurgy is simpler to use, it requires large amounts of energy and does not deliver high levels of purification. This means that it often needs to be followed by a hydrometallurgical process that allows materials to be extracted selectively. Veolia applies a hydrometallurgy process directly to purify lithium, nickel and cobalt and separate them from the black mass.

- **Production of precursors.**

  If the by-products produced by hydrometallurgy units are sufficiently pure, they can be used in the production of precursors and materials for anodes and cathodes. This closes the recycling loop as it means recycled lithium, nickel and cobalt can be used in the production of new batteries.

Dismantling a battery - ©Veolia

SARP INDUSTRIES: VEOLIA'S OPERATIONAL EXPERIENCE IN EUROPE

Euro Dieuze Industrie (EDI), a subsidiary of SARP Industries located near Metz in north-east France, processes over 6,000 metric tons of batteries annually, recycling up to 80% of them. Carbon can be used in the metallurgy industry for de-rusting metals. Recovered metals are sold for use in the manufacture of alloys and chemical salts. EDI carries out the initial stages of recycling, from collecting batteries to producing black mass. The plant currently processes 1,000 metric tons of EV batteries a year and will double its capacity to 2,000 metric tons in 2022 then to 5,000 metric tons in 2023.

Also located close to Metz, CEDILOR uses hydrometallurgy to chemically purify black mass from EDI into nickel and cobalt salts. The process is currently being upgraded to allow the use of recycled cobalt and nickel salts in the manufacture of new batteries. By 2023, the plant should be able to process 4,000 metric tons of black mass a year, equivalent to almost 15,000 metric tons of electric vehicle batteries.

VEOLIA CHINA: TWO BOOMING JOINT VENTURES

Veolia's battery recycling activities in China center on two joint ventures with Fang Yuan (a local producer of battery precursors), Pand (a specialist in reusing batteries), BTR (a leading global supplier of anode materials) and Dele (a local supplier of environmental services).

The first joint venture is operated by Veolia and carries out the initial stages of recycling, from collecting batteries to producing black mass. The plant has an annual capacity of up to 20,000 metric tons of batteries. It entered service during Q4 2021.

The second joint venture will purchase black mass produced by the first joint venture, as well as by other recyclers. The technology used will be developed and operated by Fang Yuan. The process will first use hydrometallurgy to purify the metals, then produce battery precursors that can be used for the production of new electric vehicle batteries. Work on building this second plant is not yet under way.

SUPPORTING AN EXPANDING NEW MARKET

The estimated volume of equivalent batteries available for recycling was 180,000 metric tons in 2020. This figure will rise to 7 million metric tons by 2035. These volumes will initially come from China, which is leading the way in electric vehicle adoption. More generally, the majority of battery (LG, Samsung) and EV manufacturers (BYD, Toyota) are historically also Asian. A second wave of material for recycling will come from Europe, which is currently significantly ramping up battery production. Lastly, the market in North America should develop along the same lines around 2030. All this means that the electric vehicle battery recycling industry needs to scale up as of today in order to keep pace with exponential growth in the market.

Battery waste requiring processing can be divided into two types

- **Production waste from battery manufacturing** currently accounts for over half the volume of material to recycle. Waste from the battery production process includes high value materials containing lithium, nickel and cobalt lost at various stages during the process (production of cells, assembling the modules, assembling the batteries, testing, etc.). The overall volume of waste generated by the battery production process is currently estimated to be equivalent to 5 to 10% of the total capacity of a standard factory. Despite the fact that the relative size of this waste stream will probably diminish as manufacturing processes are improved, the exponential increase in production means it will remain the primary source of material for recycling over the coming years.
- **End-of-life batteries** correspondent correspond to the overall volume of batteries available for recycling after a service life of 10 years (end of first life) and up to 15 years (for second-life batteries). This means there is a direct correlation between available volumes and the volume of batteries manufactured 10 years ago. This stream of waste batteries is therefore very limited at present since very few EVs were sold in 2010. It will progressively account for most of the material available for recycling in the years after 2030.

Veolia works non-exclusively with manufacturers of vehicles and batteries (gigafactories) alike. For example, Veolia has signed a deal with Renault that covers construction of a battery recycling plant in France, using streams of materials sourced from Renault vehicles. Discussions have also taken place with gigafactory operators with a view to establishing partnerships for recycling their production waste.

THE JOB-CREATION POTENTIAL OF BATTERY RECYCLING ACTIVITIES

Developing battery recycling activities is also about promoting new skills and encouraging an ecological shift that creates employment. There are several estimates of the job-creation potential of battery recycling. According to a recent study into how to achieve a well-balanced transition in the French automobile industry, conducted by the Fondation Nicolas Hulot (June 2021), battery recycling will create 9,000 jobs in 2030-2035. An earlier study by the Centre for European Policy Studies (Prospects for Electric Vehicle Batteries in a Circular Economy, Eleanor Drabik and Vasileios Rizos, July 2018) estimates that collecting, dismantling and recycling batteries creates 15 jobs for every 1,000 metric tons of lithium-ion battery waste. For example, the Euro Dieuze Industries site acquired by Veolia employed five people in 2000; 40 people work there today recycling batteries of all types, including from EVs. Veolia's teams closely monitor this aspect as part of the group's multi-faceted performance, which measures social impacts in the territories where it operates.

Recycling makes it possible to lock in a portion of the raw material supplies needed for electric vehicle batteries

LOOKING AHEAD: MOVING TO ENHANCED CIRCULARITY

Veolia is already working to deliver the constant improvements to processing procedures needed to obtain secondary raw materials of the highest possible purity. Significant advances in hydrometallurgical technologies will make it possible to meet the closed loop recycling requirements set out in forthcoming European regulations. The goal is to produce batteries from materials recycled from other batteries. In late 2020, Veolia unveiled a partnership with chemicals specialist Solvay for assessing alternatives to the processes for purifying metal salts currently used by Veolia.

Veolia is also examining ways to reuse electric vehicle batteries in other applications, such as energy storage for renewable energy, fast chargers for EVs and smart grid services, activities that offer synergies with Veolia's current operations. Projects are under study in the UK and France. This approach aims to offer solutions that leverage enhanced circularity to cut the carbon footprints of Veolia's customers.

CONCLUSION

Recycling electric vehicle batteries is a strategically important growth area for Veolia. It is a concrete response to the urgent need for ecological transformation among all actors in the electric vehicle value chain. Through its activities, Veolia contributes directly to exploiting urban mines and to increasing the mineral self-sufficiency and independence of its partner territories and businesses. Growth in recycling electric vehicle batteries also creates long-term employment opportunities for technicians: green jobs for the 21st century!

REPAIR, REUSE AND JOB CREATION

Jean-Paul Raillard
Chairman of Fédération Envie

Envie Orleans - ©Alain Goulard

Jean-Paul Raillard is a trained economist who began his career as a teacher of economic management techniques. He joined the Syndex consultancy in 1983, becoming managing director in 2008 and helping to turn it into a productive cooperative (SCOP) in 2011.

He has been chair of the board of Envie 44 since February 2016 and was appointed chair of Fédération Envie in June 2019. He also chairs the supervisory board of Envie Autonomie, a public interest cooperative. He is the administrator of *Alternatives Économiques* magazine and member of the French national CSR platform as well as the National Council for Inclusiveness.

Fédération Envie comprises some fifty organizations employing 2,860 people, 2,011 of them on employment integration schemes, and generating approximately €81 million in turnover across France. Envie's mission is threefold: social (socio-professional inclusion and integration of people excluded from the workforce), environmental (encouraging repair and reuse), and economic (giving regions an economic boost).

Envie's development since the 1980s demonstrates the remarkable source of employment the circular economy can represent at the local level, initially focused on electronics and household appliances then, more recently, expanding to include medical devices. In addition, the shift in public policies and the perceptions of the general public, elected politicians and industry players opens the door to new forms of collaboration with the potential to help make the circular, local economy a dominant model in the years to come. Following France's 2020 law on the circular economy, the role of local authorities and eco-bodies will be decisive in building a circular economy that recreates economic and social value at the local level while protecting natural resources.

INTRODUCTION

Fédération Envie currently comprises 52 local employment integration businesses operating throughout France and active in various areas of the circular economy: collecting household appliance waste, sorting, logistics and processing in the value chain, refurbishing and resale to the public.

The Envie network was built on four main activities. First is refurbishing household appliances, covering everything from repairs, to sales and after-sales services. Second is transport and logistics, an activity that began in the 1990s as part of the waste electrical and electronic equipment (WEEE) system. Envie then developed ultimate waste processing activities for items that cannot be refurbished: they are sorted before being crushed and recycled for recovery. In 2015, Envie Autonomie created a fourth activity in Angers, centering on renovating medical devices, particularly wheelchairs for people living with disabilities.

FROM EMPLOYMENT-LED INTEGRATION TO THE CIRCULAR ECONOMY

Envie's core mission is rooted in a project focused on finding smart opportunities for creating employment integration posts. It all started in 1984 in Strasbourg with a meeting between a social worker from Emmaüs and a senior manager at electrical retailer Darty. They set out a plan to employ young people from disadvantaged districts to repair electrical and electronic products. This was our initial mission, and we set up our first company in Strasbourg in 1984, the first in France to develop activities centering on refurbishing and selling large household appliances like washing machines. At that time, Emmaüs used to check if appliances worked but did not refurbish or sell them. The other major innovation Envie introduced was a one-year guarantee for its refurbished products, proof of our capacity to repair equipment on a lasting basis.

The switch to a circular economy began when we industrialized collection and refurbishing processes by forging key partnerships with Darty and Emmaüs, which really helped us to get going. This phase involved regular meetings and discussions between the various actors to establish a development path in line with Envie's mission. New branches set up in Marseilles and other major French cities meant the network really began to take shape. This phase saw Envie gradually beginning to gain independence from Darty and Emmaüs, its historical partners.

This was when the nonprofit Envie Développement was created to support the new organizations Envie was setting up in different regions and to build what are now Fédération Envie and its network. We operate under market conditions and 80% to 90% of our resources come from selling the goods and services we produce. Our management staff have technical and educational skills. And our business, with its constant focus on increasing product quality and staff skills, can deservedly be called a learning organization. We aim for excellence in everything we do, from providing socio-professional support to our management choices and how we sell our products, including online.

The Envie network makes use of various legal forms:

- household appliance renovations are usually subject to regulations governing nonprofits;
- transport, processing and storage are generally handled by simplified joint stock companies (SAS) owned by the nonprofits to enable them to respond to calls for tenders;
- a public interest cooperative (SCIC) provides the cooperative framework for implementing the national project for renovating medical devices.

All Envie businesses are approved social benefit enterprises (ESUS), i.e. have to serve the public interest, be governed democratically and reinvest the majority of their profits in their own development. Local organizations retain their autonomy and run their repair, reuse and logistics activities in their specific catchment area, while Fédération Envie provides network support for communication, management tools and advocacy. It can also help set up systems in areas with no geographical coverage and provide support for existing installations with specific needs. For example, in the Paris region the unit in Trappes runs a store selling refurbished household appliances in central Paris, while the unit in Gennevilliers has successfully built up a waste processing collection business.

To become a dominant model, the circular economy cannot simply impact the environment; it also needs to impact the local economy and to have a social impact

Since the late 1990s, several Envie organizations have developed waste logistics and transport activities to supplement the revenue they generate from refurbishing, as well as improving control over collection flows. This trend was boosted with the introduction of extended producer responsibility (EPR) schemes following the creation of ecobodies in the 2000s. As the waste electrical and electronic equipment schemes were being put in place, an eco-body called Ecosystem issued various invitations to tender for waste collection and transport services, which the Envie organizations began to bid for. Certain organizations even specialized in the entire chain of logistics and processing activities. Today, we want to scale up quantity and quality in terms of the number of refurbished and repaired products, production of spare parts, and securing our supply sources. Achieving this goal involves adopting a collective approach to our processes and business models at the national level.

But we should not forget that, historically, at the heart of Envie is a social mission rooted in integration through

Envie - Nord

Envie - Rhone-Alpes ©Bernard Langenstein

employment, aiming to help people excluded from the workforce to find possible points of entry. After staff have worked at the company on an integration contract that can last up to two years (in 2020, the average time spent at the company was 11.5 months), we always do everything we can to help them find long-term employment. Last year, 74% of people who left Envie found either a permanent job, a fixed-term contract of at least six months, or skills training to build on their work experience. The environmental dimension offered by the circular economy, pioneered by Envie back when it started repairing and refurbishing household appliances and electronic products to give them a second life, is deeply embedded in our social mission and permeates all our new activities. In other words, Envie aims to create jobs that help improve the environment. The economic, social and environmental dimensions have been successfully incorporated and are also important issues for regions.

To become a dominant model, the circular economy cannot simply impact the environment; it also needs to impact the local economy and to have a social impact. With this in mind, in 2015 we set up a workshop in Angers to refurbish and sell medical devices, focusing mainly on the social aspects: providing low-wage earners with medical devices restored to full working order and complying with all standards, since brand-new equipment can be a heavy financial burden for people who cannot afford the copayment. For example, we sold a refurbished wheelchair to a young man suffering from a degenerative disease at a price fully covered by the national health insurance scheme, whereas a new wheelchair would have cost him far more. This is the sort of case that led us to launch our project nationally.

Creating the organization from scratch has been a real adventure, including lots of work to gradually convince health insurance administrators and CNSA (French national funding agency for the elderly and handicapped) to support the project. Following these discussions, the social security authorities agreed to reimburse medical devices “restored to good working order” and included the provision in the 2020 social security funding law. While the creation of our activities shakes up the existing market, which essentially revolves round selling new products, we are convinced is it a win-win situation for everyone involved, primarily the people who need these specialist devices.

THE CIRCULAR ECONOMY, A SIGNIFICANT SOURCE OF EMPLOYMENT

Even though we lost the battle for industrial jobs in the household appliance sector several years ago, when production was almost entirely relocated to Eastern Europe, Turkey, Asia and North Africa, the development of the circular economy now represents a valuable source of employment, particularly on the booming market for second-life products. These are jobs that cannot be relocated, and being geographically closer to day-to-day uses makes it an economic activity with deeper local roots. A new virtuous circle is possible based on eco-design, durability, reuse and repair. The challenge facing us now is to find new solutions and create new conditions that encourage the sector to develop.

Cities and regions too have a major role to play in building local ecosystems centered on waste reuse and management

The sources of employment that have disappeared from the repair sector need to be restored. In the 1990s, a large number of household appliance and television repairers were working in France. The gradual drop in the purchase price of these products over recent years seriously weakened these businesses. This phenomenon is linked in particular to lower production costs after production plants were relocated, damaging the repair sector's competitivity. This economic difficulty makes it hard to recruit the necessary labor in France, represents an obstacle to repairs, and fosters a form of obsolescence encouraged by manufacturers of low-cost products. It is time to change this.

The demand is already there: currently, 45% of consumers would like to be able to repair their products.[1] Costly spare parts that are hard to obtain also represent a major obstacle to the growth of repair activities. To tackle this problem, we want to become a key actor in the sale of spare parts for reuse, which would also bring down repair costs, as is the case in the automotive sector where manufacturers are legally obliged to offer their customers second-hand spare parts. The same legal provision should also be applied to electronic products and household appliances in the years to come.

Usability and eco-design must be included in the production of television sets, washing machines and care beds so that they last longer and are easier to repair and recycle. These new fields are very attractive to young engineers, who are actively looking for activities of these types.

The benefits in terms of employment are vital, because a metric ton of buried waste only creates the equivalent of one local full-time job, or three jobs if incinerated.[2] In contrast, it can generate 30 jobs when materials are sorted and recycled, and with reuse can provide full-time work for 85 to 130 people. We can therefore see that all the ingredients are in place for creating a real local ecosystem. A host of actors from the social and solidarity economy and for-profit sectors are getting onboard. For example, Darty has just announced its decision to recruit 500 repairers, and all the retailers are looking at business models for the secondhand market. The Envie network has defined an action plan aiming to create over 1,000 jobs in three years, with a view to going much further to avoid waste building up.

The goal is to revise our production processes and move away from non-selective massive waste collection and processing, toward selective upstream collection so that everything repairable is separated from everything that is not. While this type of selective waste sorting can be more costly than throwing everything into garbage trucks, we know that it has far greater potential to create jobs and protect the environment. Ecosystem supports our efforts to achieve this goal.

Envie - Toulouse ©PH Jacob

1 ADEME (2020). *Les Français et la réparation - Perception et pratiques (French people and repairs - perception and practices)*: https://librairie.ademe.fr/cadic/249/rapport-francais-reparation-perception-pratique-2020.pdf

2 Rémy Le Moigne (2018). *L'économie circulaire (The circular economy)*, DUNOD

Envie - Gennevilliers ©Benoit Haesen

KEY ROLE FOR LOCAL AUTHORITIES

Cities and regions too have a major role to play in building local ecosystems centered on waste reuse and management. We need new methods to structure these emerging sectors and ecosystems, including a focus on partnerships with districts and cities, as already happens in Nantes and Lyon, for example. Nantes and Lyon helped fund reuse and repair projects with social and solidarity economy organizations like Envie as well as conventional actors. The projects are designed to manage initial sorting points at waste collection centers and transport recoverable goods to reuse points where they are sorted more methodically and then dispatched to the different schemes. Public actors play a vital role in this type of project, a role that helps to build a new economic model. A public interest cooperative, Iloé, was set up two years ago in Lyon to coordinate the project. Envie has a 25% share in the cooperative with the remaining shares held by industry actors and public bodies.

We also team up with traditional waste recovery businesses like Veolia, Suez and Derichebourg Environnement to manage collection, sorting and reuse activities. For example, in Rennes we have been involved in waste sorting from construction sites in cooperation with Legendre and Veolia since 2019. Even though these activities struggle to make money, we are establishing worthwhile partnerships for creating work insertion jobs that often result in staff being employed directly by our partner companies.

We sometimes have to resolve contradictions. For instance, incinerating waste to supply district heating networks is highly beneficial in terms of limiting CO_2 emissions. However, it is sometimes detrimental to reuse, which reduces the overall volume of waste. We feel that the development of local reuse schemes and ecosystems devised in consultation with all stakeholders represents a truly virtuous path, both socially and environmentally. In the big cities, local politicians very often share this vision, but we also have to convince cities' technical departments. They have a big say in how policies are implemented operationally and do not always see the value of developing reuse as it makes the chain more complicated. As a general rule, we work primarily with cities that have a global vision of how to prevent waste and how it moves across their territories, then the movement spreads to smaller cities and towns as the actors become aware of the importance of the issues at stake.

PROMISING PROSPECTS FOR RETAIL CHAINS

Electrical goods and electronics chain retailers have spotted the potential of the market for second-life goods, which is growing rapidly every year. The trend is driven by consumers who are increasingly green-aware and convinced by the idea of buying secondhand. Their purchasing practices express a quest for economic value as well as, increasingly, the desire to reduce their environmental impact. Major chain retailers in France, like Darty and Boulanger, are already thinking about the stores of tomorrow. They have taken action and entered the second-life market by installing departments specifically

for these products in their stores, going far beyond the refurbished smartphones that are found everywhere these days. But they are not alone. Other chains, such as But and Conforama, are also interested in launching services to repair and sell refurbished products.

The market that most interests chain retailers is for customer returns, where customers return practically new products that do not live up to their requirements or failed the first time they were used. This market is also very attractive to Envie, with good quality products retrieved from Cdiscount or Rue du Commerce before being repaired then resold through Envie stores. Products of this type can expand the ranges available in our stores, but refurbishing them creates less work, and thus fewer jobs, than waste sorting.

Electrical goods and electronics chain retailers have spotted the potential of the market for second-life goods, which is growing rapidly every year

However, some chain retailers are looking for ways to lean into the secondhand market to increase sales of new products, for example, by offering discount coupons to customers who bring in products for repair but where the repair cost is not economically viable. One of the risks posed by approaches of this type is that they restrict extensions to product lives, and actually tend to accelerate the product renewal phenomenon encouraged by marketing campaigns and trends.

In terms of negative side-effects, the market for smartphones is an interesting case. Numerous new actors have entered the refurbishment market, attracted by fast growth and high profits. But this fast growth is not necessarily positive from the environmental or social perspective. A good illustration is the emergence of major players in refurbishment, capable of bulk buying batches of secondhand smartphones, less than six months old, in the USA and Japan where renewal rates are very high, sending them to Asia or to low-cost economies nearer to Europe for repair before selling them in France. This system primarily props up the market for new products and creates very few jobs regionally. What is the true benefit in terms of resource exhaustion and CO_2, and in raising consumer awareness that more sustainable lifestyles are possible? Certain observers have underlined the risk that the market for second-life products will be co-opted by manufacturers that have forecast a fall in sales of their new products and will therefore seek to offset it by capturing a larger share of the growing market for secondhand products.

This one-dimensional perception of the circular economy as simply a new market to conquer is not the vision we believe in. We aspire to the creation of a new economic model in its own right, one that combines inclusiveness, fewer inequalities, environmental sensitivity and local development, ushering in new ways to produce and consume. This is why actors from the social and solidarity economy proposed that French parliamentarians include a financing fund for reuse in the February 2020 law on the circular economy and combatting waste. The idea was very well received by the Senate and approved by the Assembly before being included in the law. The new legislation will also make it possible to set up a repair fund to be managed by eco-bodies to finance activities that will create local jobs by lowering repair costs.

Preparations for setting up these two funds are currently the subject of intensive lobbying by some of the new actors in the market that are attempting to convince the authorities they are legitimate recipients for the millions of euros that will be distributed by these reuse and repair funds. While the debates on the new law showed that parliamentarians were generally in favor of providing significant support to local economic initiatives rooted in the social and solidarity economy, the government is very anxious to ensure free competition. The issue of employment will be partly settled by the final decisions taken in this regard.

CONCLUSION

The circular economy can become a major source of job creation in the future, provided it can develop local reuse activities supported by public policies and regional networks committed to genuine efforts to extending the working life of products. The experience built up by Fédération Envie over the past 40 years in the field of work integration centering on repairs, reuse and recycling is helping to create this new and more virtuous economic model. We have never stopped innovating and proving that this path forward is possible.

Eco-bodies and local authorities will be pivotal in determining how the circular and local economy will develop, particularly when it comes to electrical and electronic equipment. Envie plans to build lasting partnerships. There are plenty of partners ready and willing to join us in this adventure, even though the economic limitations remain unclear—an approach that typifies social and solidarity entrepreneurship. So we need to be ambitious!

The second-life market will continue to grow and we want to play our part by pursuing our goal to ramp up our business fivefold over the next ten years. The market is opening up to competition, which should stimulate it. But we are absolutely determined to tie the circular economy to the creation of inclusive, local jobs. This is the only possible sustainable path forward.

INTRODUCING MATERIALS FROM THE CIRCULAR ECONOMY INTO THE CONSTRUCTION INDUSTRY

Arnaud Bousquet, Director of Matériaupôle

With 40 million metric tons of waste (75% inert, 23% non-hazardous and 2% hazardous), the construction industry is one of France's largescale producers of waste[1] and has been identified by policymakers as one of the major challenges for the circular economy. It is an issue being addressed at the national level via the February 10, 2020 law on the circular economy and combatting waste, which created an Extended Producer Responsibility system for the construction industry, and at the local level with, for example, the Paris region making construction one of the priorities for its 2020-2030 circular economy strategy.[2] At the same time, work on the 2024 Paris Olympics and the Grand Paris project has greatly increased the number of construction sites and quantity of construction waste in the Paris region. It is thought that work on the Grand Paris Express will generate around 43 million metric tons of spoil (50% from tunneling, 50% from creating stations and ancillary structures) at 267 separate sites.[3]

In an effort to address this issue, and with encouragement from national policymakers, new actors are trying to develop practices centering on eco-design, reuse and recycling in the construction industry. However, although certainly on the increase, the place of materials from the circular economy in the construction industry remains peripheral. The industry started by focusing its efforts on recycling concrete from demolitions as a source of subgrade backfill for roads or as aggregate for making more concrete. However, faced with the limitations of recycled concrete that loses some of its physical-chemical properties, such as its compression strength, the industry is increasingly looking into new solutions such as biomaterials (timber constructions, hempcrete and bio-sourced insulation), and recovering and reusing second-life materials, including concrete, plaster, glass, wood and metal. Although at the time of writing these solutions remain marginal in terms of the overall construction industry, they do offer hope for the future.

Business models in the construction industry have changed in recent years, leading to new construction and demolition practices. The Paris region has a profusion of initiatives, projects and experiments designed to set in place new regional ecosystems that will create loops for materials to circulate between various work sites across the region. One of the best examples is Plaine Commune, an authority comprising several municipalities from Seine-Saint-Denis, north-east of Paris.

In 2014, Plaine Commune launched an "urban metabolism" project designed to kick-start mechanisms for reusing construction materials across its territory, based on five pillars: developing synergies between work sites; providing locations where materials reuse platforms could be set up; structuring local recovery and reuse schemes (identification, listing and supporting actors involved in reuse); developing an IT tool to raise the profile of sources of materials and put them in contact with construction and renovation sites, and, finally, supporting businesses to learn more about the problems associated with reuse (types of materials, legal framework, etc.) via individual and collective training sessions.

Taking account of factors such as the volume of available sources and their potential outlets, Plaine Commune opted to focus on several types of materials: bricks and terracotta tiles; concrete; doors and windows in PVC, aluminum or wood; wooden construction components, and metals and metal elements. The local authority has also begun to develop a platform to aid reuse of terracotta, metal components, metalwork, PVC, aluminum and wood, and plans to recover demolition concrete to be transformed into recycled aggregate for subsequent use in the production of structural concrete components.

It is also worth mentioning the Cycle Terre project,[4] which has led to the creation of a plant at Sevran, east of Paris, that makes unfired clay bricks on a 6,000-square-meter site adjacent to a source of excavated earth. The plant has circularity designed in and can be moved to wherever the sources are. The idea behind the project is to use unpolluted earth excavated from city construction sites to manufacture unfired clay bricks that can then be used in the construction of new districts for the Grand Paris project. At present, the project aims to process

1 Ademe (2018) - *Déchets du Bâtiment, Optimiser les matières premières, renforcer le tri, le réemploi et la valorisation des déchets du bâtiment (Construction waste, optimizing raw materials, strengthening reuse and recovering building waste)*: https://www.ademe.fr/dechets-batiment-0

2 Région Ile de France (2020) – *Stratégie Régionale en Faveur de l'Economie Circulaire (Regional Strategy to Promote the Circular Economy)*: https://www.iledefrance.fr/sites/default/files/medias/2020/11/strategie_economie_circulaire_2030.pdf

3 ORDIF (2016) – Paris region waste figures: https://www.ordif.com/publication/tableau-de-bord-des-dechets-franciliens-2016

4 Projet Cycle Terre: https://www.cycle-terre.eu/

Timber-framed house with solar power, Bouray-sur-Juine, 91 - ©AREC

25,000 metric tons of earth a year, a modest goal when you remember the 43 million metric tons that will be produced by work on the Grand Paris Express, and the 400 million metric tons that work on the entire Grand Paris project will produce by 2030.

In reality, companies that want to use recycled or reused materials face numerous difficulties. To start with, processes for designing and transforming materials are usually cross-functional within organizations and also impact the countless contractors that construction professionals rely on to deliver their site works. This means that a change in materials involves changes to an entire ecosystem, which can be very complex to put in place. The widespread adoption of building information modeling (BIM), which makes it possible to fully digitalize the building design process, may offer the beginnings of a response to this problem.

Companies also face issues surrounding the quality, quantity and durability of sources of reused materials. The logistical arrangements between the removal, reconditioning (where needed) and reinstallation of components or materials have to be totally fluid, and operator training is needed. The companies also need access to storage depots in the event that an operation or site is delayed, and remain hampered by legal restrictions and uncertainties relating to the status of the waste, approval from insurers and obtaining environmental impact records.

Countless local synergies are possible to overcome these hurdles, but this also involves setting up new industrial ecosystems where some companies can use local waste or resources generated by other companies as inputs for their production process. Inter-organization cooperation of this type requires building relationships of interdependency between companies, in turn requiring the collective establishment of a system of rules and conditions for cooperation in order to access shared infrastructure and resources. A whole host of clusters already exist in France, like Matériaupôle, with the capacity to bring actors together from across a region (businesses, researchers, authorities, etc.) to organize the pooling and sharing of the tools, technical installations and infrastructure that can support the setting up of these new ecosystems. Matériaupôle is a multi-actor cluster operating as a registered nonprofit and located in Vitry-Sur-Seine. It was co-founded by the Val-de-Marne department and the Grand Orly Seine Bièvre inter-municipal authority. Its goal is to bring together companies (small businesses, startups and large corporates), research and teaching centers (laboratories, universities and schools), local authorities and creatives (designers, artists and makers). Since it was established in 2009, Matériaupôle has helped breathe new life into the materials and processes sectors in the Paris region.

USING DIGITAL TO DEVELOP THE MARKET FOR REFURBISHED PRODUCTS

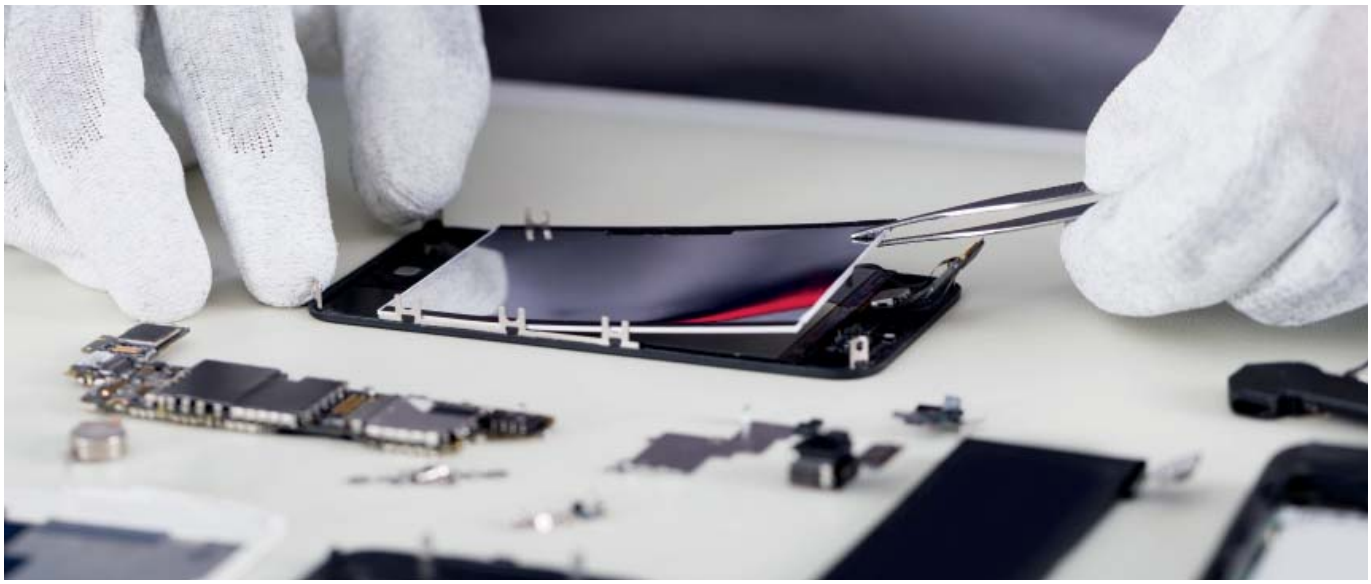
Camille Richard
Head of CSR at Back Market

Back Market's advertising campaign in Paris underground

Camille Richard has been Head of CSR at Back Market since 2020. After several years spent with the sustainable development department at Suez, she joined Back Market to pilot the rollout of its sustainability strategy. She is a graduate of Sciences Po Bordeaux.

Back Market is a pioneering online marketplace for refurbished electronic devices and household appliances. Operating in the USA and several European countries, Back Market has designed a digital platform that helps put buyers, refurbishers and sellers of refurbished devices in touch with each other. The Back Market platform fosters the creation of new sectors of the circular economy, which in turn help promote the emergence of more responsible consumer habits.

Aside from its commercial activities, Back Market is also committed to being a socially and environmentally responsible actor, evaluating the social and environmental impact of selling refurbished products, whether in terms of job creation or the reduction of greenhouse gas emissions.



Can you give us a quick overview of Back Market and its main activities?

Camille Richard: Back Market is an online marketplace that puts consumers in touch with refurbishers of electronic products and household appliances. We have no bricks and mortar infrastructure; instead, we provide our clients and partners with a digital platform for organizing the sale and refurbishment of second-life products. Consumers can buy or sell warranted secondhand products (smartphones, computers, washing machines, etc.) via our online site.

The company was founded in 2014 and has a 500-strong workforce, based mostly in Paris, Bordeaux, Berlin and New York. We have a commercial presence in 15 countries, including France, Germany, Italy, Spain, Belgium and the USA.

Who are your main suppliers and partners?

CR: They are a very varied bunch. We work with specialists that can handle high volumes of products for repair, refurbishment and sale, as well as intermediaries such as high street pawnbrokers with access to large numbers of second-life products. These are stores that let individuals sell their used products (household appliances, clothes, books, and so on) and purchase secondhand products too, if that's what they want.

Our business model is based on a 10% commission on sales made via our platform, home to 1,500 suppliers in 184 product categories, mostly phones and computers as well as games consoles and televisions.

To ensure that our customers enjoy the best possible service, we have set up a carefully calibrated procedure for selecting our suppliers. Before gaining full access to our platform, suppliers have to go through a screening process that allows us to assess them for the first month or so. During this probationary stage we limit them to no more than 10 sales a day and keep a close watch on a range of indicators, such as their product breakdown rates, delivery times and the levels of service they offer customers.

With uncertainty about product quality being one of the main factors holding back consumers from acquiring a second-life product, how do you set about reassuring your clients?

CR: In France, we offer customers a 12- or 24-month warranty. We have also created a quality charter that our suppliers have to follow if they want to use our platform. On top of that, we place lots of anonymous orders to test the quality of our refurbishers and check that the services they offer comply with our requirements and quality charter.

What is your strategy for persuading consumers to change their buying habits?

CR: Back Market was born of the realization that there was a supply of and demand for refurbished products, but that bringing the two together was tricky, particularly because of issues linked to warranties and after-sales service.

So we decided to tackle the problem by putting in place detailed monitoring of a range of indicators. We pay special attention to the breakdown rate of products sold on Back Market and do our utmost to ensure that they are as close as possible to equivalent new products.

But consumer behaviors are changing too. Price remains the most important consideration when making a purchase, but we reckon that around a quarter of our buyers use the platform for environmental reasons, tribute to the growing importance consumers place on these issues.

The work we have put in to boost trust in refurbished products has also helped win over consumers. We have spent heavily on advertising, with posters in the metro and advertisements on TV to give refurbished products a more attractive image. Then there is the high price of new goods, which increasingly leads buyers to turn to the secondhand market.

What we need now is for manufacturers to supply spares at affordable prices, bearing in mind we don't accept spares that fall below our quality threshold. This is one reason why we paid such close attention to the details of France's law on the circular economy and combatting waste (AGEC), which proposes to use a repairability index to make access to spare parts easier.

We are seeing demand outstripping the supply of refurbished products in certain categories, such as smartphones and laptops, providing that the purchase price is not too steep. An ADEME study has shown that if the cost of a repair exceeds 35% of the new product price, consumers prefer to buy the new product.[1] But at the moment it is not necessarily in most manufacturers' best interests to make accessing spare parts and repairs any easier.

We reckon that around a quarter of our buyers use the platform for environmental reasons, tribute to the growing importance consumers place on these issues

What role does digital play in your strategy?

CR: We are a fast-growing company, but all we do is provide refurbished products to as many people as we can, something made possible by digital technologies. Since it was founded, five million consumers have purchased at least one product via the Back Market platform.

Our warranty system is made possible thanks to digital, which offers us an accurate overview of the quality of service provided by repairers and refurbishers.

Digital also helped us design an algorithm to improve the way sellers and buyers are put in touch with each other, with the aim of making sure that buyers obtain the best possible product that meets their needs and offers the best value for money.

1 ADEME (2016), Marie Hervier. Etude relative à la perception des réparateurs sur leur activité et les possibles évolutions de cette activité (*Study of repairers' perceptions of their activity and possible changes to it)*

In addition, the platform has been designed to make it possible and easy for private sellers to sell their secondhand products. It lets them provide a small amount of information about the product (purchase date, brand, etc.) that any interested refurbishers then use to make an offer to buy it.

Our platform plays an important role because we feel that refurbished products contribute to reducing the ecological impact of our consumer habits. it is important to bear in mind that half the impact of digital occurs when devices are manufactured.[2]

In a more general sense, what role do you think digital can play in the circular economy?

CR: Digital can help cut the environmental impacts of consumer goods by promoting the emergence of new buying habits that focus on second-life products. This is an important issue because not all ecological problems are solvable by developing eco-designed products.

We are hearing more and more about digital's energy impact due to the massive increase in data usage, but the ecological impact of manufacturing devices is a problem that is not taken seriously enough. And there is often a discrepancy between the data on repairability and use of recycled materials claimed by certain manufacturers and their actual practices.

To gain a better understanding of the issues, we rely heavily on research into extending device lifetimes published by ADEME. For example, one of its reports examines the environmental impact reduction obtained depending on when repairs occur during the product's lifetime.[3]

What are the biggest difficulties holding back the development of Back Market?

CR: The main difficulty we face is in the supply of second-life products. We have trouble sourcing sufficient quantities. To solve this problem, we are trying to improve the collection of electronic devices, offering solutions via our website as well as exploring the possibility of working with eco-bodies.

We also try to incite people to sell their old devices and appliances rather than leave them lying in the back of a drawer. A report from the French senate estimated that only 15% of smartphones sold are actually collected once they're no longer in use and that around "100 million telephones are 'sleeping' in our fellow citizens' drawers" (Senate report 850, 2015-2016). It is vital that people are encouraged to alter their behavior and change their habits when it comes to these issues. We also think that the tax system could be a good way to encourage consumers to choose refurbished products.

And then there is the fact that businesses are not incentivized to look into second-life products when renewing their computers.

Access to spare parts remains difficult. This issue is addressed by the AGEC law and is an area where our interests coincide with those of refurbishers.

As the Head of CSR, can you talk to us about the sustainable development challenges facing Back Market?

CR: Back Market is keen to formalize its sustainability strategy and assess the environmental impacts of refurbished products versus new products.

For example, we have set up a carbon footprint assessment to track our greenhouse gas emissions, and we are taking part in an ADEME study on the lifecycle analysis of refurbished products, the first of its kind to be carried out nationally. The study will be released in the fall of 2021.

We have also run a study of our socio-economic footprint to assess Back Market's impact in terms of job creation, whether directly within the company or indirectly, at our partner companies in the countries where we operate. We used a methodology developed by the Utopies consultancy to run the study, which is aimed at policymakers and consumers. Initial results show that refurbishers on the Back Market platform represent around 5,000 jobs.

What is your strategy for growing your international activities?

CR: We are trying to reflect the differences between each country, because buying habits and behaviors do vary slightly. For example, we offer longer warranties in Germany because German consumers are more used to them than in other countries.

In the USA, Goldman Sachs' acquisition of a minority stake in our company has given us access to a powerful network that is consolidating our strong growth in a country where more and more customers are looking for ways to buy electronic goods that are cheaper, more respectful of the environment, and offer a better warranty, particularly for secondhand products.

2 ADEME (2021). La Face cachée du numérique. Réduire les impacts du numérique sur l'environnement (*The hidden face of digital. Reducing the impact of digital on the environment*) https://www.ademe.fr/sites/default/files/assets/documents/guide-pratique-face-cachee-numerique.pdf

3 ADEME (2018). Quantification de l'impact environnemental d'une action de réparation, réemploi, réutilisation (*Quantification of the environmental impact of repairs or reuse*) https://www.ademe.fr/quantification-limpact-environnemental-dune-action-reparation-reemploi-reutilisation

CIRCULAR LIGHTING TO PROTECT VALUE

Francois Darsy
Head of Office & Industry Marketing, Signify France

Lighting renovation - ©Signify

Francois Darsy is a trained engineer and expert in smart lighting. He is head of office and industry marketing at Signify France, formerly known as Philips Lighting. He is also president of the indoor lighting commission at the French Lighting Syndicate and of the joint commission put in place by the French Lighting Association and the Smart Building Alliance.

He is at the forefront of changes in the French lighting market as it moves to roll out new business models, particularly light-as-a-service, selling the function not the product.

He is a fervent advocate of an ambitious and planned policy for rapidly renovating existing installations in buildings.

Light has impacts that are environmental, economic, social and cultural. Our aim is develop solutions that align with actions worldwide to protect the climate and promote the circular economy, health, well-being, safety and security.

Lighting currently accounts for 14% of electricity use around the world, making it an issue of major concern. Designed with and for users, our products, systems and services contribute to boosting the environmental performance of buildings. LED lighting, which uses less electricity, can deliver energy savings of 50% to 90% compared to conventional lighting technologies.

To guarantee long-term performance in use, we now offer a circular lighting service where clients purchase lighting services for their premises rather than lamps and fittings. This focus on use over ownership delivers warranted performance in terms of lux output, electricity use, and availability. At the end of a contract, Signify is responsible for recovering products for reuse, reconditioning and recycling.

INTRODUCTION

Philips Lighting is now called Signify. This new name evokes the fact that lighting has become an intelligent language, providing connections and meaning.

Sustainability is key to everything we do. Our clients and employees expect us to work toward delivering positive impacts. Operational sustainability is what we aim for as we build our competitive advantage and our future.

This new identity is also closely tied in to the step-change in technology in the lighting market that is redefining how we will light the spaces where we live and work.

LED technology coupled with the Internet of things is delivering massive savings in terms of energy use, as much as 90%, as well as lifespans that far exceed those offered by conventional solutions.

These developments led Signify to pivot to a new of way of thinking about its offering: the company now offers a circular lighting service where clients buy a lighting service rather than lights.

Transitioning toward a new business model inevitably has far-reaching implications, requiring a change in our perspective on how we create value for our clients, on our offering of products and services, and on our relationships with our partners.

THE CIRCULAR ECONOMY: DO MORE WITH LESS

Humanity currently uses 1.6 times more resources than our planet can support. Every day sees 1,440 truckloads of plastic waste swept into our oceans. Today's linear model, extract-manufacture-use-discard, is broken and needs to change.

This is more than just a question of ethics. As a responsible company, doing more with less is a wholly rational attitude. While the world continues to overexploit its precious and finite resources, ever scarcer materials will become ever costlier and ever harder to find. We owe it to our clients, and to the wider world, to do better.

START BY REDUCING OUR WASTE

In the circular economy, the first thing that often comes to mind is improving how waste is managed. In 2016, we committed to zero waste to landfill or incineration at our production sites, a target we met at the end of 2020 as planned.

We have committed to doubling our earnings from circular products, systems and services by 2025 so that they account for 32 % of sales

The next phase of our roadmap is now underway. Signify is committed to stripping out plastics from all its packaging by the end of 2021. This amounts to a saving of 2,500 metric tons of plastic every year. Using packaging that is recyclable and, crucially, more compact has another major advantage: it weighs less and is cheaper to ship, which cuts our transport and materials carbon footprint.

REVOLUTIONIZING OUR PRODUCTS AND SERVICES OFFER

Switching from a linear model to a circular model implies a commitment to far-reaching change. The switch cannot be undertaken lightly, requiring a new way of thinking about our products, business models, and relationships with our ecosystem of partners and supply chain.

This transition is underway and we have committed to doubling our revenues from circular products, systems and services so that they account for 32% of sales by 2025.

PROTECT VALUE AND MINIMIZE WASTE

In the conventional linear model, customer-supplier relationships focus on one transaction: the product purchase. Value for money becomes central to this relationship. Structurally, pressure on product prices forces companies to optimize their product, which can lead to lower performance and — often — downgraded durability, in the case when it is not directly perceived and valued by the market. Customers essentially invest on the basis of the value they perceive, but suppliers have trouble leveraging value from the durability of a product or service. Additionally, this durability is often simply a promise, the transaction and the transfer of product ownership imposing little or no obligation on the supplier in terms of long-term real-life performance and costs. While repairability, reliability and even recycling are all aspects that are rarely valued.

In every sector, we see products that are less and less durable and only diminish trust in the brands that sell them. Turning the market dynamic around and moving away from this race to the bottom is an end in itself. For a business like Signify, which sells the world's finest lighting brands such as Philips, this is a major challenge in its quest to protect the value of its market.

A major disruptive technology in the lighting market is revolutionizing the structure of the market and the way that we will consume light. The transition to LED can deliver in-use energy savings of up to 90% along with far longer lifespans. The energy savings are massive. Lighting's share of global electricity use fell from 19% in 2006, prior to the market's transition, to 14% in 2018, and should continue to decline to 8% by 2030. All of this is despite a forecast 35% increase in the number of lighting points in use between 2006 and 2030, as a result of the growing global population, rise in middle classes and ongoing urban expansion. Gains in lifespans are also promising, signifying a shift from a market for consumables, where lamps have to be changed regularly, to a market for investment goods where LED fittings have operational lifespans of up to 20 years, or longer if designed properly.

In this new paradigm, creation of value is inextricably linked to the phase when the product is in use. A product that lasts longer and uses less will be an excellent investment.

The circularity of our offering is essential for a transition toward a circular economy model. There are two areas where major change has to occur:

- **Product design:** the aim is no longer to make a product that is "not too costly" and therefore easier to sell, but one optimized to minimize the amount of value destroyed. In practice, this means products with sustainability designed in, making them traceable, repairable, reconditionable, recyclable or upgradeable so that their energy efficiency can be enhanced or they can be adapted to enable associated uses and services such as connectivity.
- **Business model:** moving from a transactional relationship to a contractual relationship with a performance commitment. The product is no longer central to the relationship; the quality of the service provided is what defines client satisfaction. In practice, a client purchases a light level (in lux), a rate of availability for the fittings and a guarantee covering energy use. This is a model for the long-term, currently 10 years, and it requires an ecosystem of financial partners, installers, maintainers, recyclers, etc.

SUSTAINABLE PRODUCT DESIGN

Over the past few years, we have developed a sustainable product design program intended to protect value and avoid waste. Environemental lifcycle analysis, as per the ISO 14040 standard, shows that the impact of a lighting product occurs predominantly during use, meaning that the most efficient strategy for protecting resources is to:

- minimize impact during periods the product is in use via lower energy consumption;
- increase time in use by maximizing the product's lifespan, repairability and upgradeability.

Our circular portfolio is divided into three categories: lighting fixtures, circular components and smart systems.

- **Circular light** fittings are lights that consume significant less energy than market average, are easy to repair, maintain and update. They are also connectable, offering total traceability throughout their lifecycle. Their specifications include end-of-life planning via reuse, reconditioning or recycling.
- **Circular components** are interchangeable and include parts that can be recycled, particularly electronic drivers and LEDs. Their specifications stipulate lifespans and failure rates that meet the most rigorous standards on the market.
- **Smart systems** constantly monitor light fittings and allow preventive maintenance by predicting when and where maintenance is needed. This helps to cut costs, outages and labor time. These systems make it possible to understand how lighting is used in practice and to adapt uses during the life of the product. For example, by adapting lighting levels and management modes to constantly optimize comfort and energy savings.

Repairable & upgradable product: Philips PacificLED - ©Signify

It is essential to design products that generate a minimum of waste and that can be improved, maintained, reused, restored or recycled.

Interact Industry - ©Signify- Pilkington

3D PRINTING, AN INNOVATION ACCELERATING TRANSITION

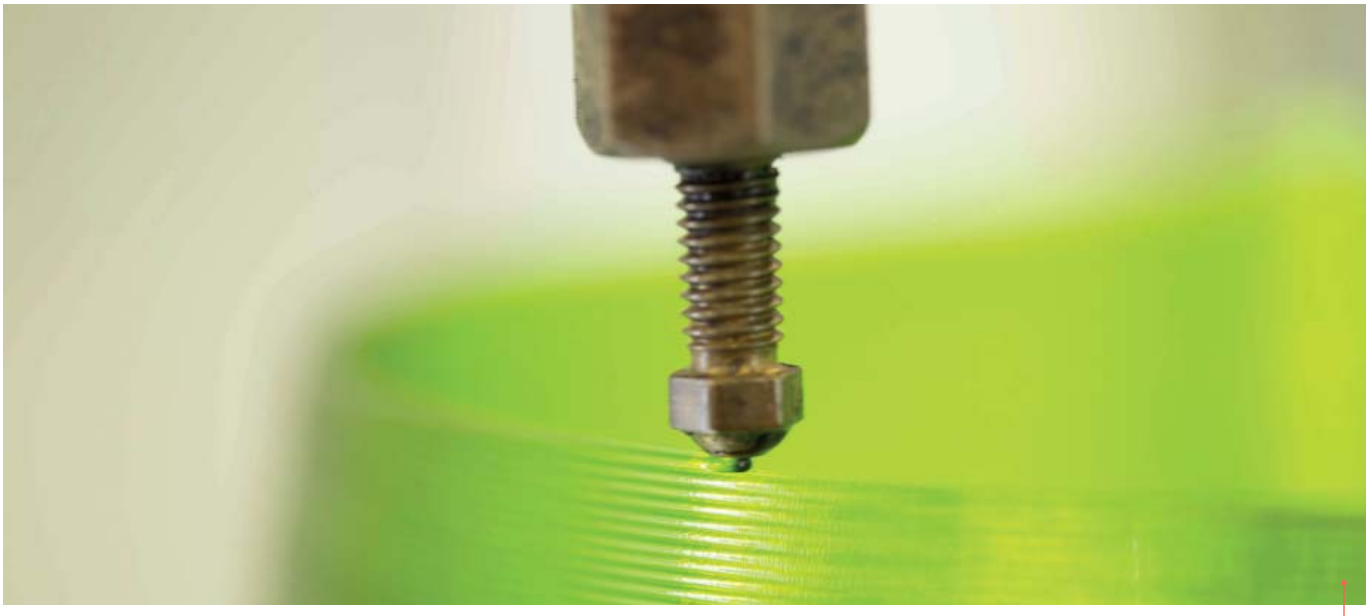
One example of this commitment is the launch of new generations of light fittings designed for a circular economy. Our 3D-printed fittings are an excellent illustration.

3D printing is a powerful tool that helps us to design and manufacture custom products for every client. The fittings are designed to be modular and parts for 3D-printed light fittings are less numerous, less complex, single material, and lighter in weight. By varying materials, shapes, appearance, transparency and texture, our designers offer a virtually unlimited variety of models. Modularity makes it possible to change the apparent design of a product during its lifecycle in response to new needs expressed by clients. Instead of replacing the entire fitting, modules can be swapped or added, helping to protect value and avoid waste. Close examination of lifecycles shows that a 3D-printed light fitting has an environmental footprint up to 70% lower in terms of materials, manufacture and logistics than its conventional equivalent.

This additive manufacturing method is flexible and sustainable, allowing us to manufacture on demand and close to where our clients are located, further reducing the carbon footprint of our transport operations. We also use a fully recyclable polycarbonate to minimize resource wastage. Almost every part of 3D-printed light fittings that we recover at the end of their lives are then recycled. It is even possible to print from materials such as discarded CDs that all too often end up in landfill.

3D light fittings can be made on demand to suit the tastes and preferences of each client, and delivered very rapidly, without in any way compromising performance or durability. We now have five 3D production facilities in operation around the world and an ever-larger portion of our ranges are 3D printed.

Lifecycle analysis using the ReCiPe method based on the ISO 14040-44 standard - ©Signify



3D printing of a light fitting - ©Signify

3D-printed light fitting made from recycled CDs - ©Signify

SERVICE IS CENTRAL TO VALUE IN USE

Having products that last longer and use less electricity is the first step, but to go all the way requires a commitment over the long term and the ability to provide warranted performance in use at all stages of the product lifecycle.

In-use performance and durability are more important than the actual fittings. Ultimately, our product is light itself. As the Dutch architect Thomas Rau said, "I'm interested in buying light not lamps." Specifically, switching from supplying a product to performing a contracted service means this change of paradigm also shifts where the risks lie. The designer and manufacturer of a system are best-placed to anticipate how it will work, minimizing failures and optimizing long-term performance. It is natural that they assume risks relating to the use of their product and those relating to potential impacts on their client's operations.

This has led Signify to pivot to a new of way of thinking about its offering: we now offer a circular lighting service where clients no longer buy lights but a lighting service for their premises, delivering warranted long-term performance in terms of lux output, electricity use, availability, etc. Rather than becoming the owner of a lighting system, clients simply pay for the amount of light that they use.

Our innovations thus extend to include the business model. Our Light-as-a-Service (LaaS) offer covers the design, financing, installation and maintenance of lighting in a single contract. We deal with the lighting, leaving our clients completely free to concentrate on running their business.

At the end of a LaaS contract, the equipment can be returned to Signify. In this case, we are responsible for recovering value from end-of-contract products, primarily via reuse or recycling. Having originally designed the product and monitored its actual use throughout its in-service life, we have all the data we need to choose the best scenario for each product.

THE COVID-19 AND FINANCIAL CRISIS: DRIVING THE PACE OF TRANSITION

The transition toward this service-led model is occurring fairly rapidly as it has been shown to create value for all parties. In the case of renovation of an existing & conventional lighting system, the energy savings are always massive and often cover the entire cost of the lighting service. This delivers instant cost reductions with no upfront investment.

In order to deal with the current situation brought about by Covid-19, our clients need to optimize their expenses and ringfence their investment capacities. Lighting for buildings is a major cost to control, with significant potential for optimization if existing installations are out of date. In practice, around 80% of lighting needs renovation.

By offering a financing mechanism, LaaS makes it possible to renovate lighting without any investment and often leads to immediate reductions in running costs. This makes it a solution of particular interest in the current financial situation.

We estimate that for services contracts like LaaS in 2020, over 40 % of industrial lighting projects were financed via energy savings without any need for clients to make a front-end investment. And this is just the beginning.

WORKING WITH THE SUPPORT OF AN ECOSYSTEM OF PARTNERS

Maximizing value involves minimizing risk. It is important to master all the skills involved in a turnkey lighting service designed for the long term, requiring specific know-how for:

- plan lighting design that meet the client's needs;
- installing the lighting system;
- creating a financing plan tailored to each client's profile;
- supervising the lighting system;
- operational maintenance;
- coordinating these functions.

Every client has a different environment, meaning that to be effective it is important to work with complementary partners and foster long-lasting synergies. This allows each partner to focus on their own added value, thereby minimizing costs and risks over time.

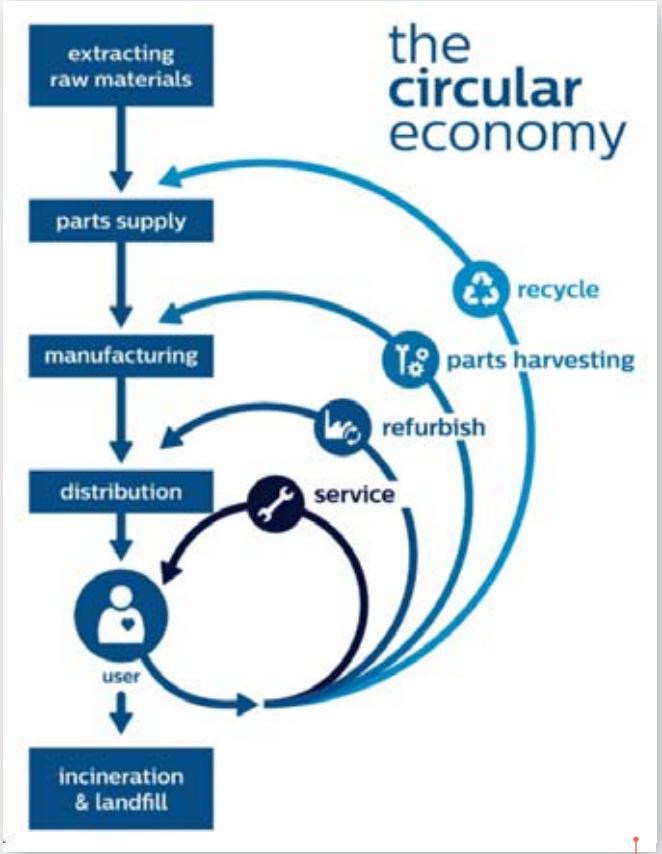
LESSONS & CONCLUSIONS

The transition to a circular economy must create value for our clients, partners and ourselves if it is to be genuinely sustainable in the long term. Our circular transition focus on a simple principle: minimizing the destruction of value at every stage.

Looking carefully at the butterfly diagram produced by the Ellen MacArthur Foundation, we note that the shorter the loop the greater the value retained. Keeping a light fitting operational for longer consumes less resources and energy than dismantling and reconditioning, and even less than partial recycling of the raw materials. In fact, recycling a light fitting destroys most of the value. The value of the raw material recovered via recycling represents just a few percent of the total value. Circular services are designed to extend lifespans, which means that it is in all parties' interests to use efficient products whose quality optimizes the efficiency and lifespan of a lighting installation.

This is a total change of paradigm from the linear transactional model. Cost and in-service performance become keystones of the client relationship. Uses may alter over the service life of the system, performance requirements too, but the service simply adapts.

The key to the sustainability of this business model is a commitment to the long term.



Circular economy (graphic from the Ellen McArthur Foundation) - ©Signify

This is why circular products, modular and upgradeable, make perfect sense. Items such as occupancy sensors can be used for other functions besides turning lights on and off to save energy: when connected, they provide a real-time record of how each space is used. This in turn identifies spaces that are under-used and are, as such, major sources of potential operational optimization. Transitioning to a service-led model opens the doors to new value streams that were undreamed of at the start. They are identified through client insights resulting from long-term service-led relationships.

This transition to a service-led model is similarly beneficial for the stability and long-term prospects of the provider, as it is able to better anticipate changing needs in its market.

Innovation is part of who we are. Our teams love to express their creativity and to experiment, to iterate and improve, and this is the approach that has allowed Signify to lead the lighting industry for over a century. The key to this transition lies in our capacity to innovate, not just in terms of products but also in relation to what our clients need and in the development of new circular business models.

LEADING A CORPORATE ECOLOGICAL TRANSITION

Eric Rampelberg
Vice-President of Interface, Inc. for Southern Europe, India and South-East Asia

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Eric Rampelberg studied economics and management and holds an MBA from EM Lyon Business School. He has over 20 years of experience in business development, international trade and sustainable industry.

Eric Rampelberg joined Interface in 2018. He is in charge of defining and rolling out the company's growth strategy in France, Southern Europe, India and South-East Asia. His role includes creating development plans for legacy products such as carpet tiles while launching new flexible floorings like LVT (Luxury Vinyl Tile), rubber floorings, and other products currently in the pipeline. He also leads the Mission Zero corporate project, shares Interface's experience and results as part of the previous Interface's mission to achieve carbon neutrality by 2020 and promotes Climate Take Back, Interface's new mission to help reverse global warming.

Interface was founded by Ray Anderson in 1973 and specializes in manufacturing carpet tiles for commercial clients, a sector where it is world leader with 2019 revenue of 1.2 billion dollars. The company became aware of the scale of its environmental impacts, and of the fact that it is part of the problem, as early as 1994. At the time, Ray Anderson instigated a top-to-bottom review with the company's various stakeholders to transform the company mission and focus on transitioning to a more sustainable approach. In 1996, the company adopted Mission Zero, a new corporate project targeting the year 2020: the goal was to move to zero environmental impact by 2020. A new and even more ambitious roadmap, called Climate Take Back, has been put in place for the period up to 2040.

In terms of circularity, a range of targets and actions have progressively emerged: incorporation of recycled and bio-sourced materials when designing products, and development of products with designed-in sustainability that are longer-lasting and easier to reuse. In addition to actions in the product design sphere, the company's circular strategy also covers its business models, with the development of service-led solutions such as reuse and a function-led model based on usage rather than product-led solutions based on volumes.

Interface has the reputation of being one of the pioneers of the ecological and circular transition. Can you talk us through the key stages of this transition?

Eric Rampelberg: In 1996, when the company adopted its new Mission Zero strategy, the question we asked ourselves was "where do we start when trying to tackle this?" We began by analyzing the life cycles of our carpet tiles to identify where our environmental impacts were.

This process led us to rethink how our products were designed (Does carpet really have to be glued down? Can we change materials to reduce the impacts?), but also the manufacturing, logistics chain and end-of-life processes (How can we give our products a second life? How can they be recycled?). When you have an eco-design mindset, you have to consider the total lifecycle all the way to the end: you must be able to dismantle the product, sort it and recover the material. For example, we created self-grip pads to replace the use of adhesives, so that carpet tiles could be easily removed for reuse or recycling.

We then included a series of quantified commitments as part of the Mission Zero roadmap, designed to combine innovation with our mission (to reduce environmental impacts). We painstakingly worked to reduce our environmental footprint at every stage in the lifecycle, not just within the company but also with our suppliers and those responsible for end-of-life management. Over 25 years,

this has allowed us to cut the amount of waste we produce, our water use and CO_2 emissions by 90% or more.

Our business model centers on occupying a premium position selling high quality products. The products we sell are long-lasting, good to look at and innovative, backed by quality services and respect for the environment. Everything is linked. The environment is not our customers' number one criterion when making their choice, but it is becoming an increasingly important factor, especially in France, as people become more and more aware of the climate emergency.

What is your strategy for the circular economy?

ER: Many of our stakeholders think the circular economy is simply a question of recycling. This is far from the truth. We've established a ranking of the most environmentally friendly circular solutions. If you mean what you say about environmental impact then you have to make certain that your products will last. Our carpet tiles are designed to last at least 15 years, and they can last twice as long. But customers change their carpets on average every seven years. Our carpets can be repaired and reused. From a circular standpoint, the best strategy is to reuse them locally. Other local customers may want to reuse them. We are trying to develop this strategy because the modular and removable design of our carpet tiles makes it a deliverable solution. The trickiest aspect of reuse is to get the entire industry in alignment so that flows can be managed. We will be able to recover our products now that an extended producer responsibility system operates in France's construction sector.

We are also training our customers to make sure they look after their carpet correctly, as this is one of the factors that ensure their durability. If a product is damaged, we will take it back and recycle it. It is returned to our factory. This is one of our commitments. We try to do everything possible to prevent any of our products going to a landfill site.

What do you hope to do to take this circularity approach to another level?

ER: You need to think about product and process innovations as a whole if you are interested in the circular economy. In terms of product innovation, our top priority is randomized design inspired by biomimetics. This is not simply a matter of aesthetics; it is also designed to minimize environmental impacts, since the patterns can be laid in any direction. Which is a tremendous advantage in terms of reuse because a damaged tile can be replaced by any other tile without having to swap out the entire carpet, as happens in hotels, for example, where most of the carpet used comes in rolls. In this case, as soon as a fault appears, a stain for example, then the entire carpet is changed.

Synthetic fibers account for 69% of our carbon footprint. We are working to introduce bio-sourced materials, as they have a far lower impact and also help to capture carbon. They will be coming on sale next year. The challenge this

© Interface

innovation poses lies in improving our sourcing to reduce the environmental impacts. The idea is to increase the possibilities for them to be reused. We are also working on adding recycled material sourced from shredding our carpets to the backing layer, with the aim of closing the loop.

These product innovations make the production process more complex as they are far more difficult to master. For our new-generation products, we will be moving from using weaving machine technologies to fusion-extrusion production lines. This is a radical change.

We are also on the point of shifting from a transaction-based approach, where we sell products in terms of square meterage, to a use-based approach where we sell a service, a function-led model. Reuse really comes into its own with a function-led model in B2B. This involves a totally different business model because we have to pivot to a new position where we operate lease or management systems for our products. We need to train our staff, particularly our sales people, so they can adapt to the change of model. And we need to change our management and incentive systems as well as the entire value chain (logistics, maintenance and site work). You have to prepare at least three years in advance to be able to put all these changes in place and adjust to the shift from a transactional model to a model based on recurring revenue.

What are your projects and goals for the future?

ER: We have set out a new roadmap for 2040, called Climate Take Back. Its goal is to play a regenerative role and help improve the state of the planet. Doing this requires a networked approach to developing innovations. An example of this is carpets that capture carbon, part of a new approach we're calling Love Carbon. For example, we pinpointed the fact that the nylon 6 we use to make our carpets is the same material used to make fishing nets. And fishing nets drifting in the oceans are a major source of pollution. We have set up a partnership with local nonprofits in Africa and the Philippines to recover old fishing nets that we then reuse completely. We have recovered 250 metric tons so far, but we hope this is just the start.

Our goal is very much to take our regenerative strategy, recently honored with a 2020 UN Global Climate Action Award, to new levels.

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"We have an incomparable teacher to help us reach the next level in the circular economy: nature, where everything is a resource and there is no such thing as waste. Seven centuries ago, Leonardo da Vinci was already advising us to "learn from nature, that is where our future lies"."

Nicolas Renard
Executive Director of the Veolia Institute

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