ELLEN MACARTHUR FOUNDATION

The circular economy: a transformative Covid-19 recovery strategy

How policymakers can pave the way to a low carbon, prosperous future

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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. A circular economy designs out waste and pollution, keeps products and materials in use, and regenerates natural systems, creating benefits for society, the environment, and the economy. The Foundation collaborates with businesses; governments, institutions, and cities; designers; universities; and emerging innovators to drive collaboration, explore opportunities, and develop circular business initiatives.

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About this paper

In the unparalleled response to the Covid-19 pandemic, trillions of dollars in economic stimulus have been made available around the world while the calls for a recovery that is in alignment with other global challenges, have never been louder. Many see beyond the pandemic a rare opportunity to build a resilient and low-carbon economic recovery. Achieving this goal requires governments to take critical actions that not only focus on safeguarding national economies during crises, but that also pave the way toward a wider economic transformation that is more resilient against future global risks.

The circular economy, as an instrument to decouple economic growth from resource use and environmental impact, opens up the way for a resilient recovery. It not only addresses the negative impacts of the linear economy, but more importantly it represents a systemic shift that builds long-term resilience, generates business and economic opportunities, and provides environmental and societal benefits.

Building on the past ten years of research carried out on the circular economy, the Ellen MacArthur Foundation highlights in this paper how policymakers can help pave the way towards a resilient recovery. As part of this, ten attractive circular investment opportunities across five key sectors of the built environment, mobility, plastic packaging, fashion, and food have been identified. Together, they optimise the use and circulation of assets, materials, and nutrients while offering economic, environmental, and societal benefits that can help address both short- and long-term goals of the public and private sectors.

In embracing these opportunities, policymakers can enable the transition to the future economy we need; one that is more prosperous and inclusive, achieving the multiple public policy objectives of the 21st century while mitigating the risk of future crises.

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Introduction

The world is facing an unparalleled global crisis, highlighting the shortcomings of our current system.

In the space of just a few months, the Covid-19 pandemic swept across the world restricting the movement of millions of people, impacting lives and jobs, disrupting international supply chains, and bringing global economies to a halt. In doing so, the pandemic and the lockdown measures have revealed our system's exposure to a variety of risks, and triggered the most severe economic recession in nearly a century.[i,1] The current situation has also revealed our limited ability to contain and adapt to the systemic risks posed by the pandemic within a highly interconnected world relying on rapid and frictionless global flows of people, goods, and information.[2] More importantly, the current crisis has highlighted the shortcomings of our linear system. This is a system in which resource extraction and waste production—which are inherient to the way we make and produce goods—cause untenable environmental degradation, climate change, biodiversity loss, and pollution.

How governments act today will shape the post-Covid-19 world for generations to come.

With the Covid-19 pandemic revealing the vulnerability of global systems to protect the environment, health, and economy,[3] many voices from governments, businesses, and civil society have been calling for a response to the devastating impacts of the pandemic that is inclusive and does not turn attention away from other global challenges.[4] An alliance of 180 European politicians, business leaders, MEPs, and environmental activists have, for example, urged that investments are directed towards the shaping of a "new European economic model: more resilient, more protective, more sovereign, and more inclusive".[5] Over 100 investors, representing EUR 11.9 trillion in assets either managed or advised, have also called on European business and finance leaders to ensure a green recovery be delivered.[6] These calls are taking place at a pivotal time, since investments and policy actions will determine the direction of economic recovery both in the short-term and the long-term. The pandemic may also be reconfiguring the roles of state and market actors for years to come.[7]

i Covid-19 triggered the most severe economic recession since the Great Depression in the 1930s, with GDP declines of more than 20% and a surge in unemployment in many countries.

A circular economy offers a tangible pathway towards a low-carbon and prosperous recovery.

With around USD 10 trillion in economic stimulus being unveiled by governments all around the world, there is an unprecedented opportunity to "move away from unmitigated growth at all costs and the old fossil fuel economy, towards a lasting balance between people, prosperity, and planetary boundaries."[8] European Commission President Ursula Von der Leyen presented such a vision for Europe by saying, "We will need to 'bounce forward' and not 'bounce back'. And we will need to build a resilient, green and digital Europe. At the heart of this will be our growth strategy, the European Green Deal, and the twin transition and opportunity of digitalisation and decarbonisation."[9] As an integral part of this European strategy, the circular economy is a framework for resilience and regeneration that delivers on multiple policy objectives. Policymakers, CEOs, and other influential individuals are mobilising businesses and governments around the world to join the journey towards achieving a resilient recovery with the circular economy in response to the economic impact of the coronavirus pandemic.[10] [11] The circular economy therefore remains highly relevant to keep in the sights as new sources of growth and economic renewal are considered. Achieving such a recovery will require the rethinking, resetting, and redesigning of the economy from one that is merely reactive in a time of crisis to one that is prosperous, inclusive, low-carbon, and mitigates the risk of future crises.

The Ellen MacArthur Foundation highlights how policymakers can help pave the way towards a low-carbon and prosperous future, while drawing on ten attractive circular investment opportunities.

For policymakers, embracing the roles of setting a common direction of travel, making the economics work, unlocking circular investment opportunities, and fostering collaboration will be essential in creating the enabling conditions for the recovery. As part of this, directing investment into ten circular opportunities across five key sectors of built environment, mobility, plastic packaging, fashion, and food, can help jump-start the transition in these industries while ensuring their improved future resilience. Together, these policy actions and investments can help achieve both the short- and long-term goals of the public and private sectors, while contributing to the creation of a more resilient economy and reducing the risk of future shocks.

How policymakers can help pave the way

Towards a low-carbon and prosperous future

Policies that are aligned with circular economy principles can play a vital role in recovery packages by stimulating value creation and economic resilience. Prior to the pandemic, a number of governments were taking steps to promote a circular economy approach, recognising that a new economic model is required that is less wasteful and environmentally damaging, as well as not so critically dependent on globalised linear supply chains and cheap virgin raw materials. In the aftermath of the Covid-19 crisis, it is crucial for policymakers to address the global systemic risks of our current linear economies as they aim to deliver more jobs and equitable growth in the short-term, and reduce long-term risks linked to climate change and biodiversity loss.

To meet these short- and long-term ambitions through a circular economy, policymakers have a key role to play in:

- **Setting a common direction of travel:** a resilient recovery with the circular economy
- **Shaping incentives** to enable a circular, low-carbon economy
- **Fostering collaboration** to obtain system-level solutions
- **Unlocking circular investment opportunities** to meet key public priorities

Setting a common direction of travel: a resilient recovery with the circular economy

There are still many uncertainties about how the economic landscape will evolve. The many uncertainties that remain around the Covid-19 virus and its potential cure—through a vaccine or a widely available treatment—are still weighing on the economy and people's lives and livelihoods. There are also uncertainties around the economic impact of the pandemic, the policy responses, the speed of recovery, and the extent to which pandemic-induced shifts will persist in society e.g. shifting consumer patterns, business travel, working from home.[12] As a result, macroeconomic projections are showing massive divergences,[13] and while policymakers are providing unprecedented support to households, firms, and financial markets, a McKinsey study highlights that the uncertainty is still present which is "toxic for an economic recovery".[14] It is therefore important to establish clear visions and to align strategies towards a new economic model for long-term prosperity and resilience.

Ambitious policies will be needed that not only focus on short-term 'rescue', but also on long-term 'recovery' efforts.[15] At a global level, it is estimated that 30% of all economic stimulus funding is being directed to areas with highly relevant impacts on the environment, yet most of this is being mobilised without any clear environmental conditions.[16] In fact, studies have shown that the vast majority of the policies for economic stimulus—that have already been implemented in G20 countries since the onset of the pandemic—are more 'rescue' than 'recovery' policies, paying limited attention to climate, sustainability, and resilience.[17] Many countries around the world are still prioritising 'brown' stimulus packages over 'green' ones, relaxing, for example, laws around controlling pollution and standards for vehicle energy-efficiency.[18] Only a few of the member states of the European Union,[ii,19] the United Kingdom, and Canada are attaching some conditions to ensure stimulus packages dedicate attention towards shaping a more sustainable transition.[20] As an example, Spain has prominently featured green investments in their draft national recovery plans. Over the next 3 years, 37% of the EUR 72 billion in funds will be spent on the green and ecological transition which include schemes aimed at: expanding renewable power, promoting e-mobility, and making buildings energy efficient.[21] However, the large majority of countries are prioritising 'brown' sitmulus packages. This therefore presents a missed opportunity for many, since recent analysis by the European Central Bank (ECB), World Bank, and OECD, shows that 'greener' economies with less carbon-intensive activities are better placed to ensure faster recoveries.[22] In particular, countries with higher environmental protection measures in place, are expected to experience higher GDP and sectoral growth compared to countries that do not prioritise these measures.[iii,23] Therefore to ensure a long-term recovery, it is critical that government ambitions and actions not only focus on safeguarding national economies during crises, but also pave a way forward towards a wider economic reform that is more resilient against future global risks.

ii In addition to stimulating a green recovery, the EU has set a union-wide greenhouse gas emissions reduction goal of 55% including emissions and removals by 2030 compared to 1990.

iii "Recovery" has been defined as the two year period after a recession; "Environmental protection" is measured by an index of environmental protection stringency (EPS), for the countries with below-median and the countries with above-median EPS; "Sectoral growth" is the growth difference between the least and the most carbon-intensive sector during recovery.

It is encouraging to see many governments seizing this once-in-a-lifetime opportunity to ensure a truly sustainable recovery, but countries should go much further in greening their support packages. Climate change and biodiversity loss are the next crises around the corner and we are running out of time to tackle them. Green recovery measures are a win-win option as they can improve environmental outcomes while boosting economic activity and enhancing well-being for all.

Angel Gurría, Secretary-General, OECD [24]

Circular economy policy strategies provide a pathway towards a resilient and low-carbon economic recovery. The circular economy—as a solutions framework to decouple economic growth from resource use and environmental impact—can help shape a pathway towards a more resilient and low-carbon economic recovery. It is a pathway that must, however, be supported by complementary policies to enable a more inclusive and 'just transition' that reduces inequalities within and between countries, leaving no one behind.[25] The circular economy also acts as a delivery mechanism for achieving mutually reinforcing economic, societal, and environmental objectives; addressing challenges and policy objectives that are interlinked. It does so by fostering innovation and competitiveness, increasing productivity, reducing resource dependency and environmental impact, increasing resilience, and creating new jobs. As an example, the *Breaking the Plastic Wave* report by the Pew Charitable Trusts and SYSTEMIQ has shown that a comprehensive circular economy approach for the plastics sector has the potential to reduce the annual global volume of plastics entering our oceans by over 80%, generate savings of USD 200 billion per year, reduce greenhouse gas (GHG) emissions by 25%, and create 700,000 net additional jobs by 2040.[26] As this shows, the circular economy, in taking a systemic approach to tackling global challenges, can help ensure a stronger recovery that is not only more resilient and prosperous, but also meets multiple policy objectives, both in the short- and long-term. The EU has, for example, since before the pandemic paved the way by establishing the European Green Deal—of which the Circular Economy Action Plan is a key pillar—and in light of the current context, it is now being placed at the core of the Covid-19 recovery package offering a roadmap to reinvigorating the economy and ensuring climate-neutrality.[27]

Fostering collaboration to obtain system-level solutions

A global crisis requires international and well-coordinated recovery efforts. The Covid-19 pandemic has affected us all to varying degrees and an international coordinated response will be of vital importance.[28] Strong public–private collaboration will be essential in the shaping of a post-pandemic future that and ushers in redefined growth towards a next wave of prosperity, while also improving society's resilience to future shocks. Such a transition, enabled through a circular economy, will, for example, require collaboration between governments, the investment community, industries, companies, academia, and civic organisations. The value of such international coordination was demonstrated before the pandemic by the Fourth United Nations Environment Assembly (UNEA-4),[iv] which in 2019 focused a session on 'Innovative solutions for environmental challenges and sustainable consumption and production'.[29] The conference brought together five heads of state and government, 157 ministers and deputy ministers, and almost 5,000 participants from 179 countries, which led to a Ministerial Declaration and 26 thematic resolutions on topics such as: sustainable consumption and production (SCP); resource efficiency, chemicals, and waste; biodiversity and ecosystems; environmental governance.[30]

An integrated and collaborative approach is needed for tackling global systemic challenges. As expressed by the Institute of Advanced Sustainability Studies, "the governance of systemic risks, and of pandemics in particular, is a genuinely interdisciplinary undertaking".[31] However, the siloed way of working is quite ingrained within many political systems and in the way in which societal challenges are being tackled. As an example, a study has emphasised how policies—that were pursued during the 2007–2009 financial crisis and the subsequent European debt crises that peaked in 2011–2012—failed to achieve the integrated objectives that were set, due to policymakers addressing priorities, like employment and growth, in isolation.[32] With regards to overcoming the impacts of the Covid-19 pandemic with the circular economy, similar concerns exist. Namely, the risk remains high that circular economy strategies are being narrowed down to waste management policies, while sitting in isolation from the rest of economic policymaking. Instead, an integrative and collaborative approach is needed to help manage system-level challenges that are transboundary by nature. This will require working with cross-cutting thematic teams or departments, bringing a new lens, and helping unearth new solutions that meet multiple policy objectives. The circular economy should, for example, be mainstreamed into interconnected policy areas (such as construction, transport, and urban planning policies) and thematic strategies (such as industrial renewal, climate change, resilience, and nature-based solutions[33]), helping reinforce synergies that can address key priorities such as employment, growth, and decarbonisation. This can support the emergence of a common vision, and enable the transition benefitting from the expertise and leadership of different actors.

As economies recover from the pandemic, inevitably reshaping global trade and value chains,[34] integrating circular economy practices into trade policies will be a key area for future engagement. Transitioning to a more circular economy will inevitably have implications on a global scale. However, to ensure circular economy practices are integrated into trade policies, improved policy coherence will be needed.[35] According to the Institute for European Environmental Policy, this could include: the better harmonisation of recovery programmes; standardising definitions and standards; reviewing regulatory systems; improving the integration of the circular economy into EU trade policy and free trade agreements; championing trade incentives for circular economy goods; and increasing cooperation between countries.[36]

The circular economy offers a 'systems approach' to economic development that is critical for stimulating collaboration, enabling innovation, and building resilience for a post-Covid-19 future. It often involves stakeholders from across the entire value chain and collaboration to help rethink the way in which products are made and used. As discussed in the paragraphs above, global challenges are too complex to be approached with isolated efforts. When it comes to complex challenges around materials streams like plastics, textiles, or food, high levels of commitment, and incentives and actions at pre-competitive level are needed from those with a stake in the way materials cycle in the economy. For example, the Jeans Redesign—

iv The UNEA is the highest level global decision-making body on issues related to the environment and has been held every two years since 2013.

created by the Ellen MacArthur Foundation's Make Fashion Circular initiative[37]—brought together more than 40 experts from academia, brands, retailers, manufacturers, collectors, sorters, and NGOs to co-develop guidelines[v] for circular jeans.

Such opportunities do not only exist for specific product supply chains but also for industries as a whole, which encompass an even wider system of actors. In this respect, ambitious strategies and collaboration platforms play key roles in setting the direction of travel and enabling co-creation, innovation, knowledge exchange, and alignment. As an example, in its proposal for A New Industrial Strategy for Europe,[38] the European Commission has acknowledged that policymakers need to look closely at the opportunities and challenges facing industrial ecosystems. These ecosystems encompass all players operating in a value chain, each having their own specific expertise, and bringing different research and innovation skills. In light of this, the Commission has expressed being ready to co-design and co-create solutions with the industry itself, as well as with societal partners and all other stakeholders in order to ensure the industry can successfully lead the ecological and digital transitions and drive competitiveness.[39] The European Battery Alliance is another good example of system-level collaboration, bringing together more than 120 European and non-European stakeholders representing the entire battery value chain. It has made the EU an industrial frontrunner in this key technology. Moreover, alliances can also help steer work and aid the financing of large-scale projects with positive spill-over effects across Europe, using the knowledge of SMEs, big companies, researchers, and regional actors to help remove barriers to innovation and improve policy coherence.

Building circular economy knowledge and capacity will be essential to help to accelerate the transition for a lasting recovery. As a part of this, sharing learnings and best practices from the implementation of recovery programmes among key actors and regions will be critical to ensure the goals of the recovery are effectively reached across the globe.[40] For example, the United Nations Economic Commission for Europe (UNECE) is mobilising experts—from their network of eight International Public–Private Partnership (PPP) Specialist Centres—to develop knowledge and guidance on PPPs to help build back stronger from the Covid-19 pandemic.[41] Together there is an opportunity to rebuild confidence, demonstrate a clear and unambiguous way ahead, and pave the way for a better and more resilient future.[42] As seen in the built environment where disruptive technologies—that enable circular practices, such as durable and flexible design, and industrialised processes of construction—could be applied to a greater degree if the capabilities and skills necessary to do so were made available throughout the industry.[43]

v The Jeans Redesign Guidelines set out minimum requirements on garment durability, material health, recyclability, and traceability. Based on the principles of the circular economy, the guidelines will work to ensure jeans last longer, can easily be recycled, and are made in a way that is better for the environment and the health of garment workers.

Shaping incentives to enable a circular, low-carbon economy

As economies restart, there is an opportunity to restructure SME and wider business support schemes towards long-term resilience. The dramatic and sudden loss of demand and revenue that followed the pandemic has caused many businesses, especially SMEs,[vi,44] to face severe liquidity shortages.[45] Public financial support will therefore be essential to help SMEs bounce back or even survive the impacts of the pandemic. While policymakers in the EU, in response to this challenge, have increased budgets for direct public support mechanisms and SME subsidies,[46] many of these tend to only focus on short-term liquidity needs.[47] However, to shape a stronger and more resilient long-term recovery, there is an opportunity to restructure SME schemes. For example, schemes could be provided that help businesses implement circular economy principles to improve their competitiveness and environmental performance, leverage digital technologies, achieve inclusivity, and strengthen their resilience against future shocks.[48] The pandemic has also shown the importance of local value chains, while reliance on stretched international supply chains is now being perceived as riskier. Governments therefore also have a role to play in supporting businesses that offer more localised, diversified, and distributed production—through repair, refurbishment, remanufacturing, and local production—as they can help pave the way towards a more resilient future that enhances the economic development of communities.[vii] In achieving these cross-cutting objectives, the circular economy acts as a key delivery framework.

When it comes to larger businesses, governments can also help guide the transition to a cleaner and more resilient recovery by attaching conditions within, for example, stimulus packages, state aid, and bailout funds. This can help increase the uptake of certain practices or technologies that contribute to a better recovery. In Austria, for example, the government has asked airlines to commit to reducing carbon emissions as a condition for its support,[49] and in France, a EUR 7 billion package of state-guaranteed loans for Air France, in which the government is a shareholder, comes with the requirement that the airline reduces domestic CO_2 emissions by 50% by 2024.[50]
The tax system is a powerful tool to shape economic activity and combat systemic issues that long predated the Covid-19 pandemic, providing a conducive environment for a circular economy. Since the onset of the pandemic, fiscal packages have been aimed at cushioning the immediate impact of the sudden drop in economic activity.[51] The current crisis also presents governments with an opportunity to shape, for the long-term, a more prosperous economic recovery that also meets environmental objectives. In particular, the OECD stresses that lowering taxes on labour and capital, in favour of taxing environmentally harmful consumption and production, can play an important role in stimulating job creation and investment.[52]
It is this shift of taxes that could play an instrumental role not only in the valorisation of resources, but also in the stimulation of labour intensive circular business models such as R&D, repair, maintenance, and recycling.[53] To give an indication of the benefit, a study on Finland showed that over the course of seven years (2019–2025), reducing labour taxes, increasing environmentally related taxes, and phasing out environmentally harmful subsidies could reduce carbon emissions by 8.4 million tonnes, save EUR 924 million on energy import bills, as well as add 115,600 person years of employment and EUR 12.9 billion in GDP.[54] Another study has also shown that cuts in taxes on labour income may even outperform other stimulus plans in promoting job creation for those who lost their jobs in the Covid-19 downturn, i.e. jobs that are care-orientated (such as retail trade, hospitality, social work) and involve manual labour (such as construction, manufacturing, maintenance).[55] With these benefits in mind, The Ex'tax Project—a think tank striving for a fundamental tax shift from labour to natural resource use and consumption—has now started a new research project on fiscal innovation and reform, with the ultimate aim of offering a perspective on putting the Netherlands, and ultimately the European Union, on a pathway towards a green and inclusive recovery.[56]

In addition, specific fiscal support can also play a vital role in stimulating innovation and incentivising circular economy practices. Reducing taxes such as value added taxes on reuse, repair, and remanufacturing activities can incentivise circular designs and business models and support the circulation of valuable goods, materials, and nutrients. Other fiscal measures can increase the use of secondary materials and encourage the adoption of regenerative food production. While these

vi SMEs provide 70% of jobs in countries around the world and about half of economic activity.

vii However, the environmental implications of such a shift are far from clear.

instruments are increasingly being put in place, more will be needed to help accelerate the transition.

To pave the way towards a low-carbon Covid-19 recovery, the OECD has emphasised that both the removal of fuel subsidies and the introduction of long-term carbon pricing will be needed to help align price signals with green stimulus packages.[57] While the pandemic may have derailed carbon reduction plans, the need to decarbonise the economy remains as urgent as ever.[58] The prevailing economic and financial frameworks are hardwired for and by the linear economy, and the cost of inaction on tackling emissions could amount to USD 600 trillion by the end of the century.[59] A circular economy can help meet global climate targets by transforming the way we produce and use goods.[60] Relying solely on energy-efficiency and switching to renewable energy will only address 55% of global GHG emissions. By adopting circular practices, the remaining 45% can be tackled.[61] However, companies seeking out circular economy opportunities that help shape a low-carbon economic recovery,[62] can face multiple market failures including unpriced negative externalities, transaction costs, split incentives, imperfect information, insufficient public goods or infrastructure, and insufficient competition.[63] Unpriced negative externalities often take place across virgin material extraction, product use, and disposal which do not reflect their full associated environmental and societal costs. This is particularly apparent with fossil fuels with, for example, the fuel used in international aviation and maritime transport being generally exempt from carbon pricing initiatives.[64] However, pricing negative externalities can help level the playing field[65] and scale the circular economy.

In addition, policymakers can also use subsidies, especially in times of crisis, to promote future areas of growth and employment, and incentivise producers to minimise their resource dependency by exploring circular opportunities. As an example, subsidies that are environmentally harmful should be phased out as these could hinder a swift transition to a circular economy and the tackling of challenges such as climate change. Actions to this effect are already being taken in some places, as evidenced by Nigeria's decision to end subsidies for fossil fuel consumption.[66] Unfortunately, these measures are not yet commonplace as today, much of the subsidies still go towards unsustainable production systems. When it comes to energy, for example, more than twice the amount of subsidies are going to fossil fuels (USD 478 billion in 2019) compared to renewables.[67]

However, the OECD, after reflecting on the lessons learned from past green stimulus packages, has observed that it is only by combining the removal of environmentally harmful subsidies with the pricing of negative externalities, that such measures can help accelerate a carbon-neutral recovery, and improve resilience to future shocks from climate change.[68]

> **The key point is not that climate change will be disastrous. The key point is that, if we learn the lessons of Covid-19, we can approach climate change more informed about the consequences of inaction, and more prepared to save lives and prevent the worst possible outcome. The current global crisis can inform our response to the next one.**
>
> Bill Gates, Co-founder, Microsoft Corporation[69]

Unlocking circular investment opportunities to meet key public priorities

All aspects of finance will play an important role, not only in the immediate response to the Covid-19 crisis, but also in the recovery phase, supporting the transition to a more resilient economy. Investors, banks, and other financial services firms have the scale, reach, and expertise to support businesses to make the shift towards a circular economy. This is not just about investing in perfectly circular companies or divesting from extractive ones, but about engaging and stimulating all companies, across industries, in their transition. Governments, central banks, and financial regulators will complement and enable the private sector shift. As highlighted in a recent study published by the Ellen MacArthur Foundation, *Financing the circular economy: capturing the opportunity*,[70] the market for financing the circular economy is rapidly taking off with early examples showing how investors, banks, and insurers are already capturing these opportunities across asset classes and economic sectors. For example, while no such fund existed in 2017, in the past three years ten public equity funds focusing partially or entirely on the circular economy have been launched by leading providers including BlackRock, Credit Suisse, and Goldman Sachs.[71]

Governments and financial institutions can offer direct financial support for circular economy activities and breakthrough innovations that contribute to shaping a more resilient post-Covid-19 future. Governments can align taxes and subsidies to promote growth and employment in ways that favour a circular economy approach as discussed in the section above on 'Shaping incentives to enable a low-carbon economic recovery'. However, public institutions can also invest directly in certain economic activities and sectors, including by issuing loans and guarantees at favourable rates, setting price controls, and providing resources like land and water at below-market rates. Some countries, like the UK, are considering setting up a state-backed Green Investment Bank 2.0 to ensure the government-led recovery from the Covid-19 lockdown keeps the country on track with its climate goals, while also generating thousands of jobs.[72] Another example is the European Investment Bank (EIB), which has highlighted the important role that the circular economy plays in the Covid-19 economic recovery.[73] The support around a more circular economy was already set in motion prior to the pandemic, with the EIB launching a Joint Initiative on the Circular Economy making EUR 10 billion in investments available from 2019 to 2023. The initiative will provide "loans, equity investment, or guarantees to eligible projects, and develop innovative financing structures for public and private infrastructure, municipalities, private enterprises of different size, as well as for research and innovation projects".[74] Recently, the EIB has also launched a new guidance for supporting the transition, which—in addition to setting eligibility criteria for financing—includes a revised section on circular economy categories and project types, a new section for cities, and additional case studies.[75]

> **We need to be bold, and invest in a green and circular recovery. Taken together, the Green Deal and the circular economy action plan show us exactly what needs to be done. They are like a powerful vaccine that can help us become more resilient and protect us when other crises will appear or existing ones may worsen. The transformation is already under way, and businesses, consumers and public bodies are endorsing and supporting the sustainable model. It will be vital to draw on that momentum, and use the circular economy to define a new structure for rebuilding the economy.**
>
> Virginijus Sinkevičius, European Commissioner[76]

In response to the crisis, central banks can explore the possibility of adjusting their bond-buying activities and financial modelling practices to support the transition to a circular economy. While the less conventional method of quantitative easing (QE) has its limits in the current low-interest situation—and its effectiveness to stimulate the economy is still debated,[77]—central banks could potentially explore green quantitative easing. It could act as a tool to help lower the cost of borrowing for circular economy projects, as well as stimulate central banks to buy more green bonds with positive environmental impacts.[78] For example, the circular economy could be considered as a key delivery mechanism in the European Central Bank's examination of using its trillion-euro asset purchase scheme to pursue green objectives, or the European Banking Authority's work on a green supporting factor. More broadly, central banks and financial regulators could also benefit from integrating not only climate change into their risk assessments and financial modelling, but also the potential of the circular economy to address these risks. In fact, the circular economy could inform scenario analyses on fundamental solutions, such as the redesign of products and services, that complement the current focus on supply-side changes, with demand-side measures (e.g. car electrification versus car-sharing models).

Investments through public procurement[viii,79] will be vital tools for the rebuilding of societies and economies during the recovery phase. As governments look to rebuild their societies and economies, after having addressed the immediate emergency response, there is an opportunity to leverage public procurement—that makes use of circular economy criteria—to help shape a recovery that is more prosperous, low-carbon, and resilient. The circular economy acts in this respect as a key delivery mechanism by keeping materials in use which reduce resource dependency, lower emissions, and increase resilience (through diversified supply chains). Given governments' large purchasing powers, making it mandatory in tenders for public procurement to use, for example, recycled materials that are compatible with a circular economy, can create demand and accelerate the transition.

More broadly, such measures can make circular designs and business models the default options in public procurement, strengthening the demand for circular economy products and services, as well as for more flexible buildings and infrastructure designs. As an example, Amsterdam has developed its Roadmap for Circular Land Tendering that includes 32 performance-based indicators for circular economy building developments.[80] The city developed such a circular land tender process in the Zuidas area[81] where a multifunctional mixed-use building will be designed to include a material passport, reclaimed resources, and design for disassembly, alongside the highest BREEAM[ix] sustainability standard. At a European level, the European Commission is setting out several actions in the Circular Economy Action Plan to help facilitate the integration of circular economy principles in public procurement.[82]

viii Public procurement represents an average 12% of GDP in OECD countries and 30% of GDP in developing countries.

ix BREEAM is the world's leading sustainability assessment method for master planning projects, infrastructure, and buildings. It recognises and reflects the value in higher performing assets across the built environment life cycle, from new construction to in-use and refurbishment.

In addition, governments and financial regulators can enhance transparency by providing standardised definitions and metrics for circular economy investments that contribute to a low-carbon economic recovery. A good example is the common classification system or 'taxonomy' under development in the EU which is being created to encourage private investment in sustainable growth and a climate neutral economy.[83] Providing policymakers, businesses, and investors with a common language on circular economic activities that substantially contribute to a low-carbon and resilient recovery, can help scale the efforts of all stakeholders involved, track progress, and eventually evaluate the impacts achieved. As such, the EU's recovery plan will now be guided by a green finance taxonomy, where the circular economy features.[84] Moreover, such a system could also be of particular use in blended finance solutions where public and private capital come together to help fund circular economy infrastructure and innovation.

In the recovery phase, investment in specific sectors and areas will critically be needed to help shape a more prosperous and resilient economy. Yet, even in the EU, where its Green Deal is seen as the "motor of the recovery", there are to date few concrete investment plans in place despite the wealth of opportunities. In light of this, the European Commission has stressed that "clearer and stronger investment signals are urgently needed for today's investment planning and decisions to be coherent with the transition to climate neutrality".[85] To help ensure investments can be directed towards areas that can help achieve a resilient economic recovery that also tackles environmental challenges, the Ellen MacArthur Foundation presents ten attractive circular economy investment opportunities that spread across five key sectors.[x]

x Each sector has been independently explored in a series of 'Insight' papers which can be found at the Ellen MacArthur Foundation page: Policy & investment opportunities shaping a resilient and low-carbon economic recovery.

10 circular investment opportunities

Towards a low-carbon and prosperous future

> **The concept of the circular economy is so important, it's a foundational blueprint. If we could get more and more of the money owners to agree that this is a good way to invest, not just for social reasons, not just for environmental reasons, but for investment reasons, performance reasons**
>
> Larry Fink, CEO, BlackRock

Following the onset of the pandemic, governments all around the world have made trillions of dollars available to stimulate the economy. The question now being raised is where these funds should be best allocated. Stimulating a system shift that builds long-term resilience—working to keep economies from collapsing, preserve jobs and income, while at the same time supporting a transition to a dynamic, prosperous and low-carbon economy—is the key challenge of the moment. Some of the decisions that governments are taking now have the potential to shape a new era of development. Thus, the circular economy, as a tangible way of achieving this vision, emerges as more relevant than ever.

Building on research carried out over the past ten years on circular economy across various sectors and regions, the Ellen MacArthur Foundation has identified ten attractive circular investment opportunities which address both the short- and long-term goals of the public and private sectors. Two circular investment opportunities are highlighted for each sector; the first outlining a way of optimising the use of assets, materials, and nutrients (i.e. during the use phase), and the second presenting a way for ensuring that the materials and nutrients can be circulated to maintain their value (i.e. in the after-use phase). Together, the two opportunities foster system effectiveness by providing added value for business, reducing exposure to resource price volatility and supply shocks, and improving societal access to high-quality, affordable, and healthy products and services. For the environment, they offer a pathway towards optimising resource use, while also designing-out waste and pollution. In addition, the role of design—as an essential prerequisite to achieving a circular economy—in combination with trends such as digitisation and decarbonisation, run as cross-cutting themes through each sector and opportunity.

Though numerous investment opportunities for enabling the creation of a circular economy across these sectors exist, the opportunities presented were selected due to their ability to offer solutions to key challenges created by the pandemic (by e.g. increasing resilience, and enabling access to vital goods); meet governmental priorities for economic recovery (e.g. stimulate innovation, create jobs, meet Sustainable Development Goals (SDGs) and climate targets); offer circular economy growth potential (driven by e.g. innovation, policies, and evolving customer preferences); and help reduce the risk of future shocks (e.g. those relating to climate change and biodiversity loss).

The following chapters explore, per sector, how each circular investment opportunity plays a key role in helping achieve a more prosperous and low-carbon economic recovery.

These opportunities spread across five key sectors:

The built environment

1. Renovation and upgrade of buildings
2. Building materials reuse and recycling infrastructure

Mobility

3. Multimodal mobility infrastructure
4. Automotive refurbishment, remanufacturing, and repair infrastructure

Plastic packaging

5. Innovative reuse business models for plastic packaging
6. Plastic collection, sorting, and recycling infrastructure

Fashion

7. Rental and resale business models for clothing
8. Clothing collection, sorting, and recycling infrastructure

Food

9. Tools enabling farmers to shift to regenerative agricultural production
10. Food surplus and by-product collection, redistribution, and valorisation infrastructure

10 circular investment opportunities for a resilient recovery

Built environment

Shaping a liveable, cost-effective, and low-carbon built environment

1. Renovation and upgrade of buildings
2. Building materials reuse and recycling infrastructure

Every **EUR 1** invested in energy-efficiency renovations can yield **EUR 5** in public finance returns.[86]

2 million energy-efficient homes = **2 million** new jobs

Retrofitting **2 million homes** for energy-efficiency could create nearly **2 million new jobs**.[88]

25%

Utilising recycled or reused steel for building construction could generate up to **25%** in material cost savings per tonne of steel.[87]

40%

The processing of recycled aggregates compared to virgin ones could reduce GHG emissions by **40%** or more.[89]

Mobility

Shaping an interconnected, low-carbon, and resilient mobility system

3. Multimodal mobility infrastructure
4. Automotive refurbishment, remanufacturing, and repair infrastructure

USD 1.6 trillion

Multimodal mobility systems could bring **USD 1.6 trillion** in benefits in **2030** for **China**, assuming 42% of all car kilometres were made by shared vehicles.[90]

70%

Multimodal mobility systems reduce **global** CO_2 emissions by **70%** or 0.4 billion tonnes of CO_2 in **2040.**[92]

120%

The remanufacturing of vehicle parts can increase skilled labour requirements by up to **120%**.[91]

10 million

The number of EVs on the road is expected to reach almost **10 million this year**, as sales grow despite the Covid-19 pandemic.[93]

Plastic packaging

Shaping a more competitive and less polluting plastic packaging industry where plastics are kept in circulation

5 Innovative reuse business models for plastic packaging

6 Plastic collection, sorting, and recycling infrastructure

Replacing just **20%** of single-use plastic packaging with reusable alternatives **globally** offers an economic opportunity worth at least **USD 10 billion**, while saving about **6 million tonnes** of material.[94]

The processing of recyclables can sustain about **20 times more** jobs than landfill, and plastic manufacturers making use of recycled materials, about **100 times more**.[95]

Returnable packaging market projected to grow from **USD 37 billion** in **2018** to **USD 59 billion** by **2026** (across industries).[96]

Reducing growth in plastic production and consumption can avoid **one-third** of **global** projected plastic waste generation by **2040**.[97]

Fashion

Shaping a competitive and low-carbon fashion industry that promotes increased utilisation

7 Rental and resale business models for clothing

8 Clothing collection, sorting, and recycling infrastructure

Compared to buying new, one pre-owned purchase is said to save on average **1kg** of waste, **3,040 litres** of water, and **22kg** of CO_2.[98]

The lost value of textile waste amounting to more than **USD 100 billion** annually could be retained, by capturing and recirculating materials.[99]

2x
by 2029

The secondhand market is projected to reach nearly **twice the size** of fast fashion by **2029**, with resale models expected to drive the increase (growth projected at **414%** in the next five years)[100]

71% of customers are expressing a greater interest in circular business models, such as rental, resale, and refurbishment, as well as investing in higher quality apparel **following the pandemic**.[101]

Food

Shaping a resilient, healthy, and food-secure food system

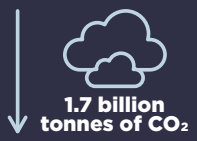
9 Tools enabling farmers to shift to regenerative agricultural production

10 Food surplus and by-product collection, redistribution, and valorisation infrastructure

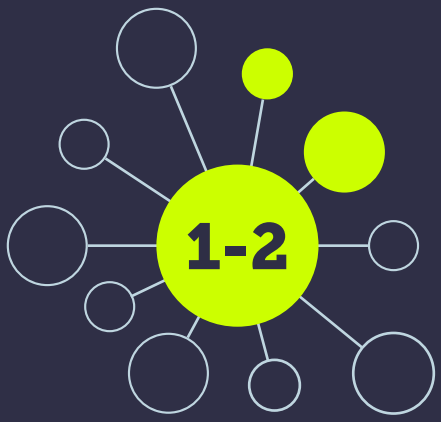
Spending **USD 78–116 billion** (on accelerating the adoption of regenerative annual cropping) could save **USD 2.3-3.5 trillion** in lifetime operational costs.[102]

USD 700 billion in environmental costs caused by the food waste created in the current system could be avoided.[103]

72% of Europeans have reported a greater willingness to put effort into healthier eating in the future.[104]



Reducing edible food surplus and increasing the composting of inedible by-products and green waste could save **1.7 billion tonnes** of CO_2 annually.[105]



The built environment

The pandemic has laid bare the entrenched shortcomings of the built environment sector; underscoring the prevalence of low-quality buildings, issues around the affordability of decent housing, and the lack of adaptability of our current building stock. These issues, coupled with the growing concern around the industry's highly wasteful and resource-intensive nature, present a strong impetus for the sector's transformation. Renovating and upgrading buildings along circular principles to become more adaptable, comfortable and positive impact (low-carbon), can provide solutions to some of these issues. Additionally, increasing the availability of building materials reuse and recycling infrastructure would allow greater value circulation and effective use of resources that, in turn, can lower the industry's burden on virgin resource consumption. These circular strategies represent key investments that can help shape better and more resilient future built environments that are safe, comfortable, cost-effective, and aligned with environmental targets.

30 intensive care units built and **1,000 beds** added in just ten days

The pandemic has impacted the built environment sector abruptly and in profound ways. Global lockdowns instituted in over 100 countries by the end of March confined people to their homes and severely restricted the ability of construction supply chains to function.[106] Shortages and delays in retrieving necessary virgin materials, and the shutdown of many building sites, have left the industry cash-strapped.[107]

Existing problems surrounding constructions have also been laid bare, with those living in low-quality housing in the cities of high-income countries being confined to small, rigidly designed, and energy-inefficient buildings.[108] At the same time, inadequate access to sanitation facilities has impeded the ability of many people in low-income countries to follow guidance to help stop the spread of the virus.[109]

Meanwhile, there has been an accelerated adoption of certain established circular design strategies, especially building modularity and adaptability, as these have demonstrated convincing solutions to some of the newly emerged issues. In some areas, modular building strategies have enabled rapid construction of vital structures to respond to the pandemic. For example, in Wuhan, China, an emergency hospital of 30 intensive care units was built and 1,000 beds added in just ten days using prefabricated units for its construction which, due to their modularity, could easily be deconstructed and reused in another structure later on.[110] This enhanced speed that modular building affords construction projects, may well increase the attractiveness of adopting such circular solutions in the future as the continued effects of the pandemic and social distancing are expected to reduce construction

productivity, slowing projects down considerably.[111] Elsewhere, greater building adaptability has suddenly been required, as the shutdown of spaces like schools, offices, and entertainment venues has forced the home to absorb their varied functions. With some geographies gradually re-opening public areas, contingent on their ability to adjust in order to enable social distancing, the needs for space adaptability are only growing.[112]

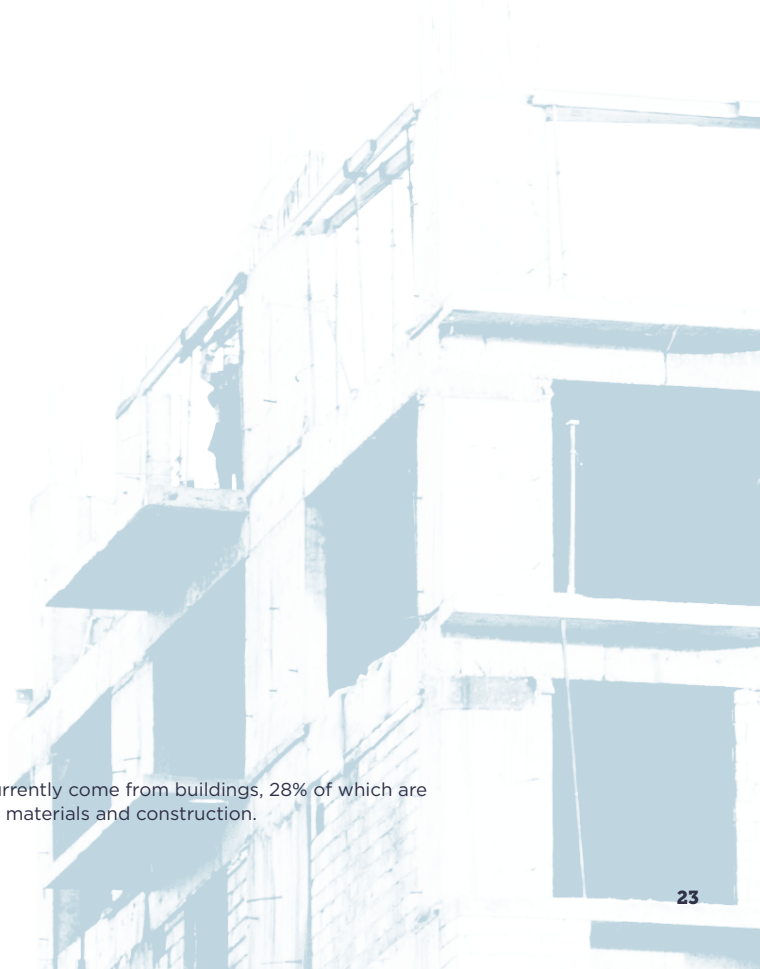
Though lockdown measures have, at the time of writing, eased in many places, a number of pre-existing trends are predicted to continue putting pressure on the built environment. Rapid urbanisation, with population growth and shifting demographics, will lead to an increasingly urgent demand for buildings. This will have especially strong impacts in Africa and Asia, with China's urban population expected to double by 2040 and 70% of the buildings to be used in India in 2030 yet to be built.[113] This will lead to an estimated USD 8 trillion growth of the global construction market by 2030.[114] At the same time, the current building stock continues to be in need of renovation, with improved energy-efficiency a key concern to lift people out of energy poverty, while helping reduce greenhouse gas emissions.[115] All of these needs come at a time when even before the pandemic, the gap between the global demand for infrastructure and the amount estimated to be spent on infrastructure, had been predicted to surge to USD 15 trillion by 2040.[116]

Changes in behaviour and attitude are also likely to create challenges for the built environment sector. With people projected to continue spending more time at home than in the pre-pandemic world, the amount of underutilised space in urban environments is expected to increase, while public and shared spaces like offices will have to adapt to enable greater social distancing, at least for the near-term.[117] In addition, with citizens becoming more environmentally conscious, and with the increased awareness of the construction sector accounting for about 40% of global resource demand and being a major contributor to climate change, greater pressure may well be put on organisations to address these issues.[xi,118] More stringent rules and regulations around the industry's environmental impacts are also to be expected.[119]

The circular economy presents robust solutions to address these issues and seize these opportunities in alignment with the future trends, by creating built environments that are safe, liveable, cost-effective, and contribute to achieving climate targets. In a circular built environment this vision is realised through designing out waste, keeping materials in use at their highest value for as long as possible, and integrating natural systems to buildings while also regenerating natural systems. A number of attractive circular investment areas could help attain this vision, including: renovation and upgrade of buildings for adaptable use, durability and positive impact (low-carbon); building material reuse and recycling infrastructure to enable value circulation for a more competitive recovery aligned with global challenges; online platforms to list existing underutilised building spaces for short-term use;[xii] and product-as-a-service models to provide access to, rather than sell ownership of, building services (e.g. lighting-as-a-service). Though all of these investment areas can help contribute to the creation of a better and more resilient future built environment, two especially attractive circular investment opportunities in the current scenario emerge:

1. Renovation and upgrade of buildings
2. Building materials reuse and recycling infrastructure

These selected opportunities highlight especially attractive areas that can help address both the short- and long-term goals of the public and private sectors. Together they provide solutions to key challenges created by the pandemic; meet governmental priorities for economic recovery; offer economic growth potential; and help reduce the risk of future shocks.



xi In total, 39% of the world's energy related carbon emissions currently come from buildings, 28% of which are generated through their use, and 11% of which come from their materials and construction.

xii Providing the right regulatory framework is in place.

Renovation and upgrade of buildings

for adaptable use, durability, and positive impact (low-carbon)

The need for renovating has long been seen by public authorities as a priority—especially in Europe. Yet, even in the EU, less than half of member countries have concrete strategies for improving their building stock, at the time of writing.[120] With the pandemic having highlighted the varied shortcomings of the built environment, renovation has now become a measure that cannot be delayed any further if we are to achieve a resilient, low-carbon economic recovery.[121]

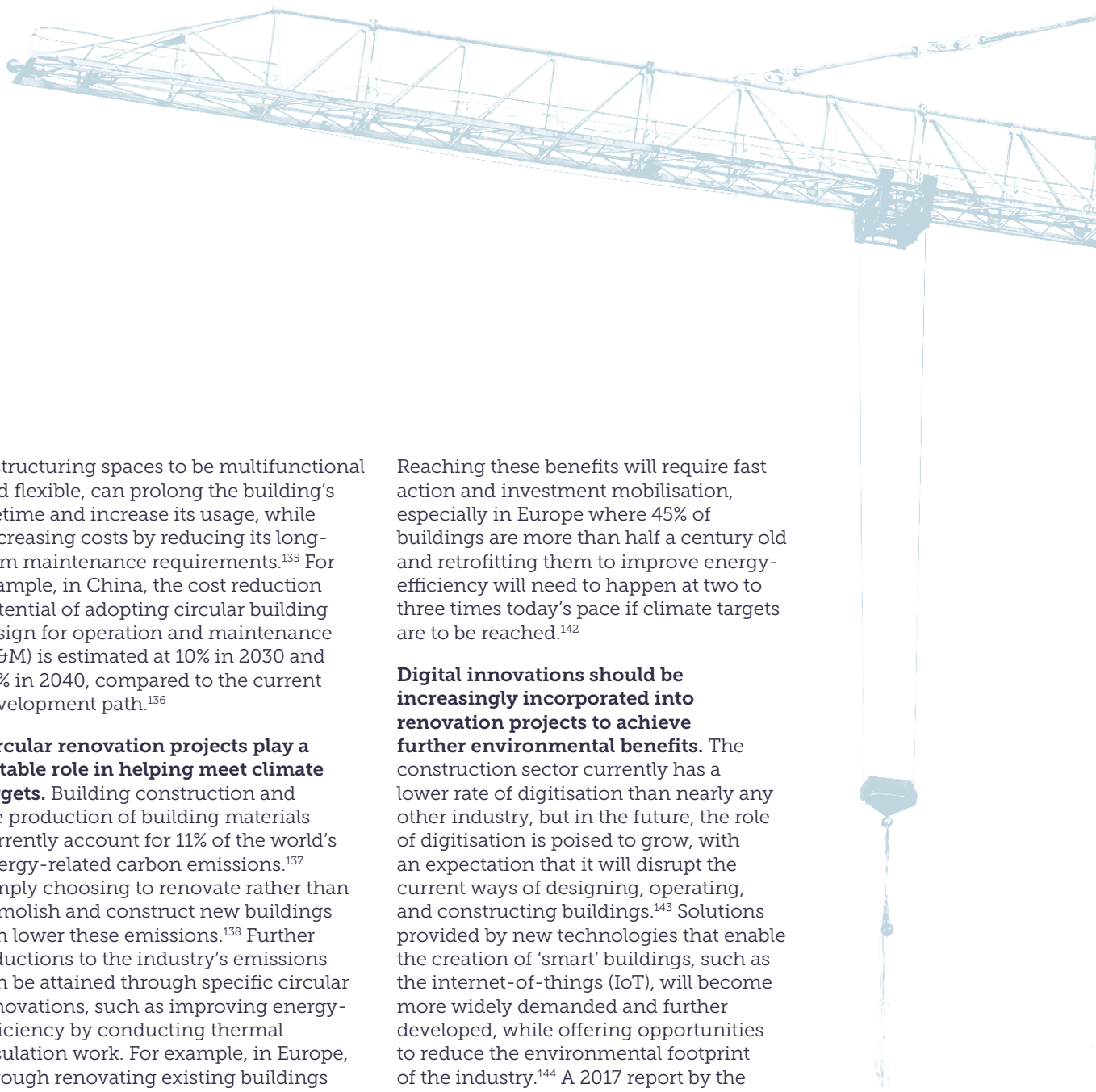
Every **EUR 1** invested in energy-efficiency renovations can yield **EUR 5** in public finance returns

Renovation is seen as a robust instrument to rapidly stimulate the economy while helping to achieve climate targets.[122] The renovation wave announced in the European Green Deal, for example, is being lauded as a vital instrument to deliver a climate-neutral economic recovery following the pandemic.[123] Compared to demolition and new construction, by simply repairing, refurbishing and retrofitting existing structures, renovations can offer more cost-effective, less resource-intensive and lower emissions-creating solutions to improving the building stock.[124] This is particularly interesting for OECD countries to note, where 65% of the projected building stock required by 2060 already exists, and is in need of 50% to 70% energy intensity improvements.[125]

However, to ensure that renovation projects lead to all the desired economic and environmental benefits, investments should be directed towards renovating and upgrading existing buildings in alignment with circular design thinking. Such circular renovation projects will ensure that building upgrades are made to increase their durability (e.g., by selecting longer-lasting materials), adaptability (e.g., by applying modular design), and energy-efficiency (e.g., by better insulating them), while using low-impact, reused, and recycled materials to do so.[126] As such, circular renovations will create built environments that are more liveable, less polluting, and easier to adapt to changing space needs, thus increasing buildings' lifespans while keeping materials in use for longer and designing out waste.

Circular renovation projects offer an attractive opportunity for boosting employment at a local level.[127] Following the pandemic, unemployment numbers around the world have soared. In Europe alone, 59 million jobs have been reported to be at risk,[128] while the International Labour Organization (ILO) found that almost half of the global workforce was in danger of losing their livelihoods in late April.[129] Investments in circular renovation projects can offer attractive solutions to curbing these unemployment issues, as these projects are by their very nature highly labour-intensive and localised, and the construction sector is relatively easily able to absorb workers from other industries.[130] In France alone, it is estimated that up to 93,000 new jobs over a period of ten years could be created through focused efforts to improve energy-efficiency in poorly insulated homes.[131] Meanwhile, a McKinsey study estimated that investing into retrofitting 2 million homes for energy-efficiency could create nearly 2 million new jobs in a European country of 50–70 million people.[132]

Renovating using circular strategies can yield an array of economic benefits. For every EUR 1 invested by a government or local authority in renovations improving energy-efficiency, up to EUR 5 can be retrieved as returns back to public finances within one year.[133] A 2016 report by Dodge Data and Analytics also found that "green buildings—whether new or renovated—command a 7% increase in asset value over traditional buildings."[134] Additionally, increasing building durability by selecting longer-lasting materials, and enhancing adaptability by



restructuring spaces to be multifunctional and flexible, can prolong the building's lifetime and increase its usage, while decreasing costs by reducing its long-term maintenance requirements.[135] For example, in China, the cost reduction potential of adopting circular building design for operation and maintenance (O&M) is estimated at 10% in 2030 and 28% in 2040, compared to the current development path.[136]

Circular renovation projects play a notable role in helping meet climate targets. Building construction and the production of building materials currently account for 11% of the world's energy-related carbon emissions.[137] Simply choosing to renovate rather than demolish and construct new buildings can lower these emissions.[138] Further reductions to the industry's emissions can be attained through specific circular renovations, such as improving energy-efficiency by conducting thermal insulation work. For example, in Europe, through renovating existing buildings to lower their energy usage by 40% by 2030, the building sector's overall GHG emissions would be reduced by 63% in the residential sector and by 73% in the non-residential sector.[139]

On the one hand, this enhanced energy-efficiency can improve the comfort and liveability of a building while lowering running costs for residents—an important factor given that globally one-third of urban dwellers struggle to financially secure decent housing.[140] On the other hand, since 30% of global energy consumption and 28% of the world's energy-related CO_2 emissions are linked to the use of buildings, the emission reductions can also play a pivotal role in helping meet climate goals, in line with political agendas and the demands of a growing proportion of the population.[141]

Reaching these benefits will require fast action and investment mobilisation, especially in Europe where 45% of buildings are more than half a century old and retrofitting them to improve energy-efficiency will need to happen at two to three times today's pace if climate targets are to be reached.[142]

Digital innovations should be increasingly incorporated into renovation projects to achieve further environmental benefits. The construction sector currently has a lower rate of digitisation than nearly any other industry, but in the future, the role of digitisation is poised to grow, with an expectation that it will disrupt the current ways of designing, operating, and constructing buildings.[143] Solutions provided by new technologies that enable the creation of 'smart' buildings, such as the internet-of-things (IoT), will become more widely demanded and further developed, while offering opportunities to reduce the environmental footprint of the industry.[144] A 2017 report by the International Energy Agency found that innovative digital solutions, such as smart lighting and smart thermostats, could lower a building's total energy use by 10% between 2017 and 2040.[145] This reduction could lead to a cumulative 65 PWh energy saving by 2040—the same amount of energy consumed in total by all non-OECD countries in 2015.[146]

Other technological innovations – such as digital material passports (discussed further later), laser scanning technologies that quickly create accurate 1:1 base models of existing buildings, and infrared surveys that can reveal any areas of a building from which heat or cooling is escaping – can also be employed to ease the work of design teams and enable more targeted and effective renovations.[147]

Renovations lowering energy use by **40%** can reduce GHG emissions by **63%** in the residential sector

Furthermore, by increasing investment in these digital innovations, the businesses producing them can grow and increase their supply, thus allowing the technologies to become more widely adopted, which in turn can accelerate the dissemination of their varied benefits across the built environment. As such, the role of digital innovations ought to be carefully considered in future renovation projects, to better enable their contribution to the creation of a more adaptable, durable and positive impact building sector.

Design is a key enabler in attaining the vision of a more adaptable and durable built environment. This is true not only for new builds, but for existing buildings in need of upgrades too, with careful consideration required for how renovation projects are conducted from the outset. For example, by selecting locally sourced and reused secondary building materials for renovations, the GHG emissions and amount of finite resources used in a project can be notably reduced.[148] These materials should also be non-toxic, regeneratively sourced, and designed for circulation for maximum benefits to be attained. Similarly, by deliberately upgrading spaces to make them more adaptable to changing needs, such as by including movable walls, they can become more intensively used, or can change use overtime, therefore reducing the amount of dead space and increasing the building's lifespan.[149] Therefore, design decisions—such as material selection and space adaptability—should be carefully considered to ensure the greatest benefits of a renovation project may be realised. Moreover, it should be noted that if a building is initially designed in alignment with circular strategies to be, for instance, more adaptable, energy efficient and easily deconstructed, then the future renovation needs of that building could be reduced and the ease of carrying out upgrades increased.[150] Beyond renovation, this is particularly relevant for newer economies, such as in Asia and Africa, where large additions to the overall building stock are still needed in the coming years.[151]

Building materials reuse and recycling infrastructure

to enable value circulation and effective use of resources

Building material reuse and recycling infrastructure offer another attractive circular investment opportunity that could contribute to ensuring a more competitive and clean post-pandemic recovery, while creating jobs.

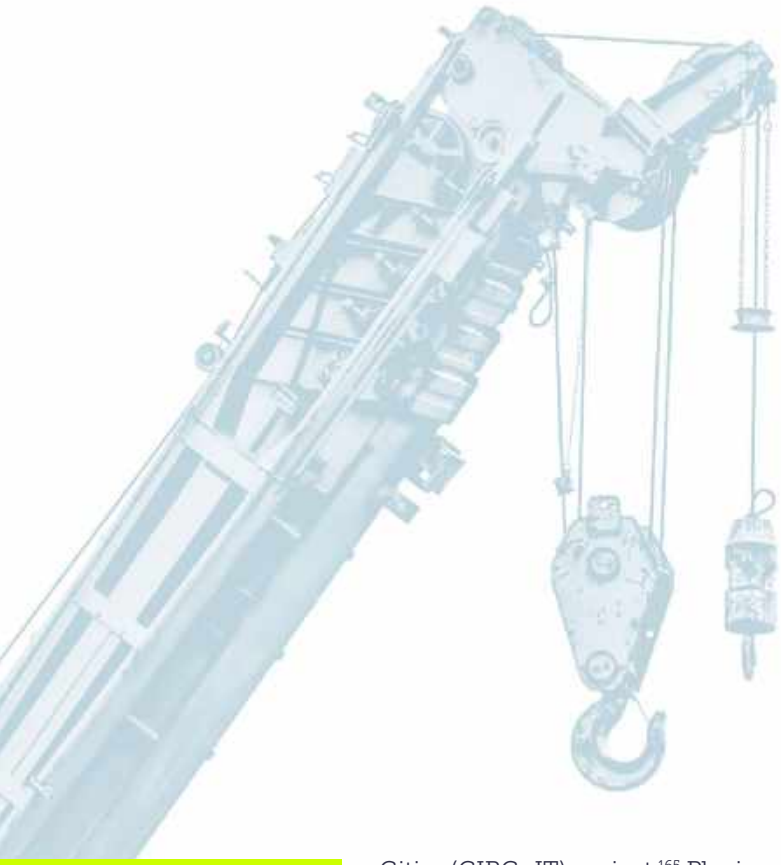
Investments in developing building materials reuse and recycling infrastructure can create substantial cost savings. The construction industry is currently the single largest global consumer of resources and raw materials, and it is also extremely wasteful.[152] By 2025 it is expected that 2.2 billion tonnes of construction waste will be generated around the world, and in places like India, construction and demolition waste already account for about one-third of the country's total solid waste.[153] If these materials were not considered as waste but instead retrieved and kept in use, their value could be captured and overall construction costs reduced. For example, an ARUP study estimated that designing steel for reuse could generate environmental impact- and resource-use savings of 6–27% for a warehouse, 9–43% for an office, and 2–10% for a whole building, as well as up to 25% savings on material costs per tonne of steel.[154]

By increasing the looping of building materials, disposal fees could be reduced, and new revenue streams obtained from developing a market for secondary materials.[155] At the same time, the fluctuation of building material prices could be addressed.[156] Developing a secondary material market may also increase resilience in the face of future shocks by reducing supply chain disruptions through the diversification of material supply. Given the shortages of virgin building materials, and low cash flows among construction businesses following the pandemic, cost-effective and readily available recycled or remanufactured materials may offer attractive opportunities.[157] Design will play a critical role in enabling this greater material looping, as without ensuring that building materials are from the outset designed to be fit for circulation, i.e. more easily retrievable from buildings after their first use and able to retain their value, they cannot be effectively circulated.[158]

Greater material circulation can significantly lower GHG emissions in the construction industry.[159] The processing of recycled aggregates compared to virgin ones, for example, can reduce GHG emissions by 40% or more, with a 2018 report by Material Economics having found that recycled steel can cut emissions by 90%, if also using largely decarbonised electricity.[160] In fact, research has shown that GHG emissions in the G7 countries could be reduced by 14–18% in 2050 by improved recycling of construction material.[161] This reduction could have a significant impact on lowering the risk of a future climate crisis, given that today the carbon emissions from construction materials and processes alone account for 11% of all carbon emissions in the world.[162]

Investments into physical infrastructure, especially in the form of recycling premises and deconstruction facilities, is crucial in enabling building material circulation and creating additional jobs.[163] There are many existing examples of such premises already. In Canada, the city of Vancouver gained funding for the creation of its 'Deconstruction Hub' where salvaged materials from disassembled buildings can either be restored, repurposed, or resold for use.[164] Meanwhile in Europe, Copenhagen, Hamburg, the Vantaa region of Helsinki, and Greater London have received funding for creating Circularity Hubs, where materials from dismantled buildings can be sent for reuse or transformation and refurbishment, through the Horizon 2020 Circular Construction In Regenerative

Designing steel elements for reuse could generate savings of **2–10%** for a whole building and up to **25%** savings in material costs



The European Commission is launching a new strategy to promote **building lifecycle circularity**

Cities (CIRCuIT) project.[165] Placing these facilities in cities, close to their inputs, makes them more accessible and thus helps facilitate greater reuse and exchange of building materials.[166] In addition, for these facilities to have their desired impact, technology supporting the creation of online markets where the reused building materials obtained can be bought and sold, must also be developed. Globechain and Oxara are examples of existing innovators in this space.[167]

Digital infrastructure, especially in the forms of tracking technology and digital modelling, accelerates the transition to a circular built environment. Digital material passports that enable end-to-end tracking of building materials, can help identify materials for reuse as they come to the end of their (first) life, thereby retaining material value over time and encouraging tighter looping.[168] Through increasing transparency and aggregation of material data, digital material passports can also heighten knowledge about material and component composition. The increased and eased access to material information can in turn enable constructors and building designers to create healthier indoor environments by allowing these professionals to more easily select building materials which are, for example, non-toxic.[169] These digital passports are also mentioned in the EU's new Circular Economy Action Plan as important factors for mobilising the potential of product information digitisation.[170]

The use of other digital innovations—such as building information modelling (BIM) which create virtual models of buildings, or digital 3-D 'twins', that precisely depict every component used—will also grow in prominence.[171] These digital twins can help track and trace materials across the supply chain, predict material performance, and enable preventive maintenance, thereby increasing reuse and recycling efficiency while reducing maintenance costs.[172] By using these digital doubles, renovators can easily and quickly experiment with different upgrade and refurbishment options for a building, selecting the ones which provide the best value in terms of cost-effectiveness and carbon footprint, for example.[173] In addition, as these solutions are digital, they can be utilised even remotely. As such, BIM became more widely adopted within the industry during the pandemic lockdown, when designers would not have been able to meet in person.[174]

Material circulation is increasingly supported by policy and may in future become a legal requirement. In some areas, this support is given in the form of direct financial means, like for the CIRCuIT project funded by the EU's Horizon 2020 programme.[175] In other cases, this support may take on the form of strategy and vision setting, or even the creation of legislation. For example, the EU's new Circular Economy Action Plan mentions a new 'Strategy for a Sustainable Built Environment' with the aim of reducing climate impacts and increasing material efficiency, which is said to possibly include the "introduction of recycled content requirements for certain construction products, taking into account their safety and functionality".[176]

Mobility

While the onset of the pandemic may have brought mobility to a near standstill, it has offered an opportunity to reignite a journey towards interconnectedness, value creation, and healthier environments. Multimodal transport systems—supported by vehicles designed for durability—contribute to this journey by enhancing connectivity and accessibility between different forms of transport, while also ensuring a cleaner, safer, and seamless experience. Supported by physical and digital infrastructure, citizens can be better connected to travel options, while vehicle parts and materials are kept in circulation, shaping a more competitive and resilient future.

The transport sector[xiii] has been one of the hardest hit by the pandemic and finds itself in a critical economic situation. The introduction of lockdown measures, travel restrictions, the closure of schools and non-essential businesses, and social distancing, have collectively had a significant impact.[177] From local transport to global supply chains, nothing has been spared, hampering not only the flow of people, but also that of goods.

In fact, global trade demand (in volume terms) is now forecasted to drop by as much as 13–32% in 2020; a striking amount when compared to the 9% decline experienced in 2009 after the financial crisis.[178] It is impacting freight logistics, as well as related industries, markets, and supply chains with consequences on the economic activity of cities and regions. This is putting millions of people out of work.

Lockdown measures, coupled with travel restrictions, have forced many to stay at home, and, up until May, caused public transport ridership to fall 70–90% in major cities across the world.[179] These measures have also caused the demand for cars to drop sharply with original equipment manufacturer (OEM) and supplier factories expected to produce 7.5 million fewer vehicles in 2020.[180] While lockdown measures have, at the time of writing, eased in many places, social distancing measures are still impacting mass transit significantly.

Active forms of mobility, such as walking and cycling, have since become more widely adopted, being seen as healthier and safer than taking public transport. These radical shifts have been one of the key contributors to the observed 17% drop in global carbon emissions seen around the world (by early April).[181] People living in cities are seeing clearer skies and are benefitting from breathing in cleaner air and being more physically active. This has made investing in air pollution reduction measures, active mobility infrastructure and electric vehicles (EVs) to have earned support.[182]

As we look into the future, a number of trends are expected to persist and further shape the world of mobility. Physical distancing requirements, in particular, will change the mobility mix, consumer behaviour, and transportation demands, perhaps permanently.[183] Remote working

17% drop in global carbon emissions seen around the world (by early April)

xiii The transportation sector, as addressed in this section, focuses specifically on land transport (such as passenger cars, logistics, public transport, cycling, and walking), and not aviation and shipping.

and online retail is predicted to stay with us, decreasing the need for commuting, increasing the demand for home delivery, and stimulating rural relocation for some.[184] This is expected to come with an increased reliance on e-commerce, a megatrend that already pre-dated the Covid-19 crisis. Other megatrends that pre-existed the crisis—such as the growth in car-sharing services, electric and alternative forms of transport, innovative lightweight materials, and autonomous vehicles—will stay relevant. Moreover, megatrends such as e-commerce, direct sales, and electric vehicles are currently disrupting conventional pricing, and the accelerated transformation is expected to bring massive changes to both price models and price setting for cars.[185] The future state of such trends, however, will depend on how the pandemic evolves, how society responds, and how the recovery plans are shaped.[186]

A circular economy approach to the recovery offers the opportunity to leverage these trends to tackle key challenges and shape a more resilient mobility system that is clean, adaptable, and interconnected, and that also meets climate targets. In a circular mobility system, this vision is realised through designing out waste, keeping materials in use at their highest value for as long as possible, while also regenerating natural systems.

A number of attractive circular investment areas could help attain this vision, including: multimodal mobility infrastructure to ensure seamless interconnectivity, lower congestion, and zero-emission transport systems; product-as-a-service models to provide access to, rather than sell ownership of, vehicles; designing and producing more circular cars to increase durability and make them fit for shared multimodal systems; refurbishment, remanufacturing, and recycling infrastructure to deliver a more competitive and resilient recovery; zero-emission forms of transport to decouple the reliance on fossil fuels and ensure climate targets are met.

Though all of these investment areas can help contribute to the creation of a better and more resilient mobility system, two especially attractive circular investment opportunities in the current scenario emerge in:

3. Multimodal mobility infrastructure
4. Automotive refurbishment, remanufacturing, and repair infrastructure

These selected opportunities highlight especially attractive areas that can help address both the short- and long-term goals of the public and private sectors. Together they provide solutions to key challenges created by the pandemic; meet governmental priorities for economic recovery; offer economic growth potential; and help reduce the risk of future shocks.

Multimodal mobility infrastructure

for a more interconnected, less congested, and cleaner transport system

The past couple of years have seen a rapid growth and integration of shared multimodal mobility solutions—a trend set to disrupt the transport industry. The pandemic has now severely impacted this sector, but some changes are believed to be temporary. Multimodal integration of active, shared, electric, and autonomous (micro)mobility could rebound post-Covid-19, as the crisis fades and sanitation practices are implemented.

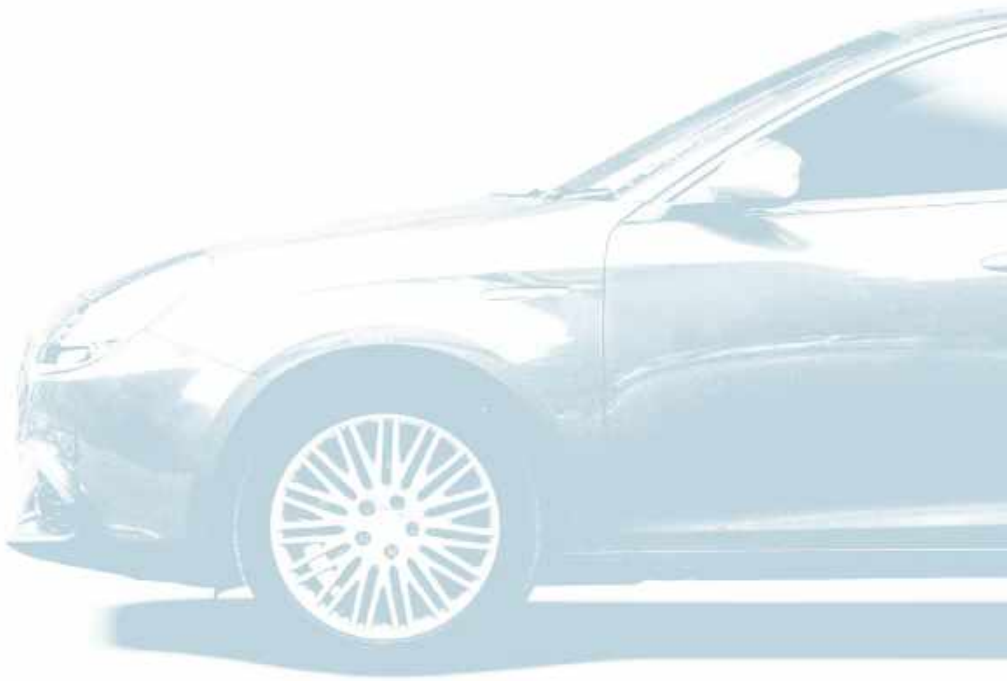
Multimodal mobility systems bring attractive economic benefits through the increased use of assets and the optimisation of transport systems. Investments directed towards multimodal mobility infrastructure offer the opportunity for the system-level integration of different modes of transport—such as cycling, public transport, ride-sharing, and car-sharing—that would let people seamlessly shift between personal, shared, and public transportation. The benefits of such systems were discussed in the Ellen MacArthur Foundation's 2015 study, *Growth Within: a circular economy vision for a competitive Europe*. The impact of shared multimodal systems within Europe that made use of autonomous cars and vehicles—designed to be silent, durable, non-polluting, and renewable energy-powered—was explored. The findings showed that such systems could reduce household costs by 70% within Europe by 2050, while offering cost-effective solutions to low-income groups. When applied in a country such as China, as much as USD 1.6 trillion in benefits in 2030 was estimated, i.e. assuming 42% of all car kilometres were made by shared vehicles.[187]

From an environmental perspective, multimodal systems can also play a pivotal role in lowering GHG emissions and meeting climate targets. With tailpipe emissions contributing 65–80% of emissions in passenger cars, much of the attention has understandably been focused on zero-carbon energy, e.g. electrification. This can play a central role in helping meet climate targets by integrating zero carbon (micro) mobility within multimodal transport systems. However, to reach the full decarbonisation potential of, for example, automotive vehicles, not only tailpipe emissions should be tackled, but also material emissions that arise during production. If left unaddressed, material production may reach 60% of life-cycle emissions by 2040.[188] Integrating circular economy principles in the design and use of passenger cars has the potential to address these emissions. A shared multimodal system in particular—where passenger cars are increasingly shared, while designed for durability and reuse—offers the opportunity to reduce global CO_2 emissions from materials by 70% or 0.4 billion tonnes of CO_2 in 2040.[xiv,189] For citizens, this means cities would also become healthier places in which to live.[190]

When active mobility is integrated within multimodal systems, it has the potential to stimulate the economy, boost physical activity, and limit air pollution. Since the start of the pandemic, active mobility—such as cycling and walking—has increased. Investments in shared multimodal infrastructure can help reap the benefits of people being more active by ensuring the integration of cycle lanes and other infrastructure to support the use of bikes (e.g. more parking spots, and electric bike charging

Multimodal mobility systems could reduce household costs by **70%** within Europe by **2050**, and reduce global CO_2 emissions by **70%** in **2040**

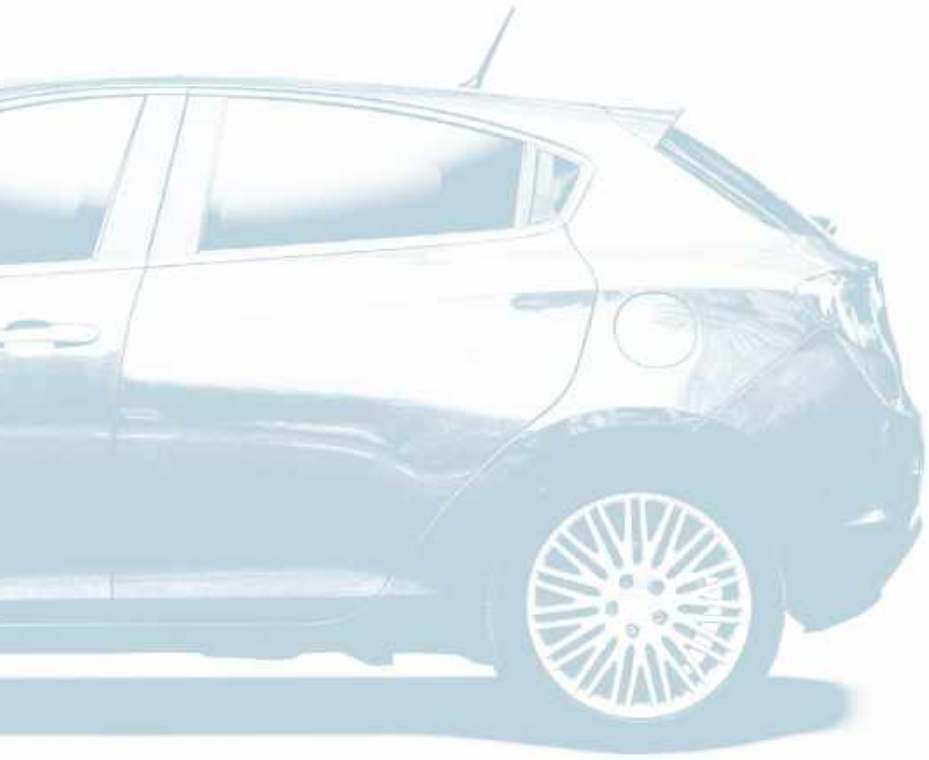
xiv Data includes the impact of employing vehicles in multimodal systems that are designed for durability and reuse.



stations). Active mobility has seen an increase in bike sharing in China—the country first hit by Covid-19—rising by 150% immediately post lockdown.[191] Governments are acknowledging the need for increasing funding for active mobility infrastructure. Europe is already seeing a rise in schemes and investments to support cycling and walking, as governments look to protect their transport systems, boost public health, and capitalise on clean- air gains. [192] Cycling, in fact, offers the best return on investment of all transport, e.g. GBP 5.50 per GBP 1 spent within the UK.[193] As such, a golden age of cycling may be upon us.

Despite the effect of Covid-19 on the sale of cars, the popularity of EVs continues to grow. According to the International Energy Agency, the global number of EVs on the road is expected to reach almost 10 million this year, as sales of electric cars continue to increase, counteracting the declining trend in sales of combustion engine cars.[194] When zooming in on Europe, as registrations of petrol and diesel cars fell one-third year-on-year in June 2020, EV sales were up almost two-thirds over the same period.[195] According to Forbes, these trends are expected to stay post-pandemic since the need to tackle climate change and local air quality will keep the EV market on course for growth.[196] As such, maintaining long-term low-carbon policies would help ensure that by 2040, over half of passenger cars sold worldwide will be electric (representing 31% of cars on the road).[197] China has in fact already started strengthening their EV market during the pandemic, while many European countries are launching stimulus packages that offer incentives and subsidies for the purchase of EVs[198] i.e. with regulations and incentives likely to propel EV market share in China to roughly 35% to 50% and in Europe to 35% to 45% by 2030, according to a McKinsey study.[199] To support the wider adoption of EV, others are pushing for a coordinated private–public partnership: the Green-Car New Deal.[200] This investment fund would aim to accelerate the shift towards large-scale EV use by, for example, investing in the rollout of EV charging infrastructure (alongside other infrastructure), while saving existing jobs and creating new ones. Such trends would ensure that electric mobility emerges from the Covid-19 crisis in an even stronger position than pre-crisis estimates had predicted.[201]

It is expected that the pre-Covid-19 increase in car sharing will pick up again after the crisis, shaping a mobility future that is cost-effective and accessible. In a circular economy, multimodal mobility systems embrace car sharing to enable maximum vehicle usage and occupancy rates. They leverage circular design to help keep materials in use by ensuring cars are designed for durability, modularity, and reuse. These opportunities pre-existed the pandemic and were on track to disrupt and transform the automotive industry. As customer preferences started shifting towards service-based solutions, a global car sharing market size exceeding USD 2.5 billion was established in 2019.[202] It was estimated to grow at 24% annually between 2020 and 2026. In countries such as China, the central government and local municipalities have issued multiple policies to encourage the growth of car sharing[203]



However, the car sharing sector has been severely hit by the pandemic with some businesses possibly not surviving the upheaval. Nevertheless, studies and surveys have pointed out that "many of the changes in the modal mix experienced today are temporary and that shared-mobility solutions, including public transit, will rebound and continue to capture increased market share".[204] In fact, in the short-term, a survey by the Boston Consulting Group has shown that between 67% and 76% of heavy users[xv] of shared mobility pre-Covid plan to continue using (or to increase their use of) those modes after the pandemic—which include solo or pooled ride hailing, taxis, car sharing, and bike and e-scooter sharing.[205]

In the meantime, car sharing businesses such as Zipcar are finding creative solutions by, for example, offering exclusive vehicle use for several days at a time, which has since the summer experienced a sharp increase in demand.[206] In Japan, the largest 'used' car dealer, Idom, launched a USD 280 monthly subscription service from February this year, and orders have doubled in just two months.[207] This is a relatively new trend in Japan that has been gaining traction since the start of the pandemic, possibly indicating a shift within society increasingly opting for access-over-ownership. Similarly, German start-up Cluno, termed the 'Netflix of car subscriptions' has seen a 53% rise to its service, despite massive economic uncertainty.[208] Subscription services have therefore been said to be currently filling the needs that fall between car ownership and car rental or sharing. In addition, it is also being seen by many customers as a transparent and reliable alternative to riskier and negotiation-intensive cash buying or leasing.[209] Momentum also continues to be generated through different means as the forthcoming Comprehensive European Strategy on Sustainable and Smart Mobility looks into enhancing synergies with the circular economy transition—with a key focus on stimulating the use of product-as-a-service solutions within transport systems.[210]

Multimodal shared transport will also require investment within digital infrastructure to help integrate all modes of transport, as well as help citizens navigate the options. Digital user apps—when fully integrated—could, for example, help citizens to better connect seamlessly to multimodal transport, to better plan and optimise their journeys, and to avoid congestion. As remote working, e-commerce, and home delivery have become trends that may stay with us post pandemic, digital solutions could further help reduce physical touchpoints, accelerate the digitisation of service offerings (e.g.ticket payment), improve operational resilience (e.g. allowing for flexible planning), optimise logistics and support the consolidation of freight services and reverse logistics.[211]

Japan's largest 'used' car dealer, Idom, launched a subscription service this February and orders have **doubled** in just **two months**

xv Boston Consulting Group conducted a survey of 5,000 residents of major cities in the US, China, and Western Europe (France, Germany, Italy, Spain, and the UK).

4 Automotive refurbishment, remanufacturing, and recycling infrastructure

for material circulation and effective use of resources

By enabling the circulation of high-value components and materials, investments in refurbishment, remanufacturing, and recycling infrastructure offer attractive economic opportunities that not only help deliver a competitive and resilient economic recovery from the Covid-19 crisis, but also help tackle global environmental challenges.

The remanufacturing of vehicle parts could increase skilled labour requirements by up to **120%**

An attractive, yet still under-valued, investment opportunity exists in facilities that refurbish, remanufacture, and recycle car parts. Investing in such facilities plays a critical role in ensuring that cars—designed for durability and reuse and often used within service-business models—can be disassembled and repaired e.g. multimodal shared mobility systems employing cars that are easy to maintain and reuse to maximise their returns. Such investments have to be done in parallel with the creation of markets for end-of-life parts (based on standardised quality measures for parts). This is an essential step in ensuring that demand is created for high-quality refurbished, remanufactured, and repaired car parts.

Refurbishment, remanufacturing, and recycling activities offer a strong economic case and job creation potential, when cars are designed for disassembly and reuse. In a post-pandemic world, with a possible rebound in car sharing services, such reuse activities can present a strong economic case for companies working in this space. Remanufactured car parts are, for example, cheaper than newly manufactured parts. The process allows the total value of the materials to be recovered, while reducing the need for virgin, non-renewable resources, and energy. In the United States, such remanufacturing activities have already been passed into law through, for example, the implementation of the *Federal Vehicle Repair Cost Savings Act of 2015*, where all federal vehicles in the United States are encouraged to make use of remanufactured parts during their use phase.[212]

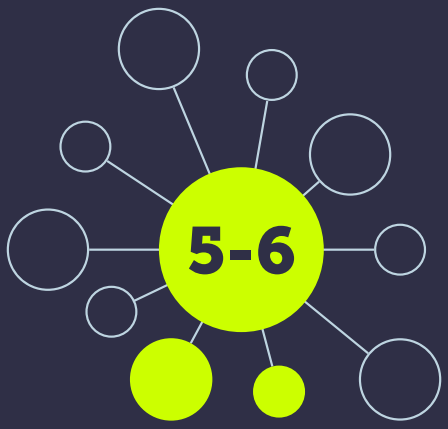
The remanufacturing of vehicle parts can also create high quality jobs. It can, for example, increase skilled labour requirements by up to 120%.[213] For the remanufacturing industry as a whole, conservative estimates show that with reduced input costs and increased labour spend, there can still be up to a 50% increase in gross profit, offering a competitive advantage.[214]

Remanufacturing activities can also bring substantial environmental benefits and opportunities to increase resilience. Renault has, for example, demonstrated that vehicles can be designed to be 85% recyclable and 95% recoverable,[215] while 43% of its engines can be remanufactured.[216] The remanufacturing process has led to savings of at least 80% in energy, water, and chemicals.[217] Customers benefit from all of these advances by being offered a 'good-as-new' warranty for a 30–50% lower price compared to new replacement parts.[218] Furthermore, with increased localised refurbishment and remanufacturing activities, supply chains are shortened. Flexibility is being generated as components and parts can also be obtained from customers and reintroduced in production. This offers the potential to increase the resilience of supply chains to external shocks—a topic that has now become more critical than ever.

Investment opportunities also exist in the setting-up of recycling facilities that keep high-value materials in circulation—a shift that is increasingly being supported by policy. Such infrastructure can help ensure that cars designed for disassembly and recyclability can, in fact, be recycled and treated with minimal material and quality loss. Such investments will be needed, considering the way in which policies in Europe are heading. The European End-of-Life Vehicles Directive, for example, has already set a target of 95% recyclability per vehicle per year.[219] Rules are also being considered around mandatory recycled content and improving recycling efficiency. The aim is to ensure that upstream designs and downstream end-of-life processes are better aligned, strengthening the market for secondary materials and components.

As the shift towards EVs picks up speed, investing in remanufacturing and recycling infrastructure will also play a critical role in ensuring the longevity and reuse of EVs and their respective batteries. As an example, used EV batteries, whose charge capacity has become too low for automotive use, can be given a second life for approximately ten more years in mobile applications or stationary energy battery storage systems.[220] When it comes to battery recycling, the current recycling rates are around 50%, but with a new process by Fortum and Crisolteq they reach up to 80%, and metals are kept in circulation.[221] Advances in repurposing, remanufacturing, and recycling are being made offering clear benefits, with a report showing that when fully implemented these could lead "to a 25% reduction in demand for new batteries".[222] Increasing regulation on this subject can already be seen. The European Circular Economy Action Plan is, for example, aiming to establish a new regulatory framework around batteries that facilitates the increased: reuse (rechargeability) of batteries, recovery of valuable materials, recycling of batteries, and use of recycled content.[223] This builds on the strategic action plan for the European Battery Alliance that was launched in 2017 and which had the ambition to establish a competitive and sustainable battery manufacturing industry in Europe that operates within the context of a circular economy.[224]

The European Circular Economy Action Plan is establishing a **new regulatory framework** around batteries to boost circularity



Plastic Packaging

Plastics have played a critical role during the pandemic, especially in keeping hospitals running by protecting frontline workers. At the same time, the pandemic has further emphasised the wasteful nature of single-use packaging. As we combat the pandemic and shape a resilient economic recovery that also mitigates global risks, a response is needed to ensure that plastics never become waste. With the growth of e-commerce, investments in reuse models offer attractive opportunities that meet public demands, save on material costs, and reduce the need for single-use packaging. Coupled with infrastructure for collection, sorting, and recycling, plastics can be decoupled from the consumption of finite resources while drastically reducing their leakage into natural systems. Such investments will help shape an economic recovery for the plastics packaging industry that is not only competitive and resilient, but that also offers significant climate and environmental benefits.

95% of plastic packaging material value, or **USD 80-120 billion**, is being lost from the global economy **annually**

As the world is fighting the Covid-19 pandemic, plastics have become an even more key staple of our everyday life, with the global medical community requiring protective equipment, customers stockpiling sanitary products, supermarkets increasing their grocery packaging, and retailers relying on e-commerce shipments, etc. The global demand for medical supplies and other essential goods, that are often disposable and not recyclable, has therefore increased since the Covid-19 outbreak.[225]

In fact, at this rate, the global packaging market size is expected to grow from USD 909 billion in 2019 to USD 1,013 billion by 2021—with the plastic segment leading the market.[226] Plastic packaging, the focus of this paper, is and will remain the largest application; in 2017, packaging represented around 30% of the total volume of plastics used.[227]

With hygiene measures being the number one priority during the pandemic, many countries around the world have, at the start of the Covid-19 crisis, either lifted or delayed bans on certain single-use plastic packaging, based on the misperception that they are safer than reusable and compostable alternatives. Concerns over reusable packaging and virus transmission have however now subsided. Scientists from various countries signed a statement on 22 June 2020 declaring reusable packaging is safe to use, by employing basic hygiene.[228] The lockdowns have also forced many recycling centres to shut down or temporarily cease operating during the pandemic. Regular waste management practices have also experienced extra pressure, leading to inappropriate management strategies, including mobile incineration, direct landfills, and local burnings.[229] In addition, the Covid-19 pandemic is happening at a time when already 95%

of plastic packaging material value, or USD 80–120 billion, is being lost from the global economy annually, with only 14% of plastic packaging being collected for recycling.[230] In addition, amidst the pandemic, the plummeting of oil prices globally to around USD 40 per barrel (as of October 2020) is further challenging the market for recyclates.[231]

Looking towards the future, the Covid-19 crisis is likely to alter or amplify certain packaging megatrends.[232] With more people working from home and businesses digitising their services, many will be increasingly inclined to purchase online and opt for home delivery services, leading to a strong acceleration of e-commerce shipments. Customers are also starting to change their behaviour, becoming more price and health conscious than before. The Covid-19 crisis has also forced many businesses to deal with uncertainty and those that have leveraged digital assets to be able to react quickly to unexpected changes, have been found to be more resilient.

The circular economy can play a vital role in tackling the plastic waste issue that predated the pandemic as well as shaping an economic recovery, in which the system for plastic packaging not only delivers cost and material savings, but also keeps waste and pollution out of the environment. In a circular plastic packaging system this vision is realised by: eliminating the plastic items that are not needed; innovating so that all plastics that are needed are designed to be safely reused, recycled, or composted; and keeping materials in circulation to keep them in the economy and out of the environment.

A number of attractive circular investment areas could help attain this vision, including: new delivery models to eliminate problematic or unnecessary plastic packaging; innovative reuse business models to reduce the need for single-use packaging; material innovation in recyclable and compostable alternatives to improve recycling quality, eliminate hazardous chemicals, and decouple plastics from the consumption of finite feedstocks; and collection, sorting, and recycling infrastructure to scale-up the production of high-quality secondary materials and keep plastics out of the environment.

Though all of these investment areas can help contribute to the creation of a more resilient plastic packaging system, two especially attractive opportunities in the current scenario emerge in:

5. Innovative reuse business models for plastic packaging
6. Plastic collection, sorting, and recycling infrastructure

These selected opportunities highlight especially attractive areas that can help address both the short- and long-term goals of the public and private sectors. Together they provide solutions to key challenges created by the pandemic; meet governmental priorities for economic recovery; offer economic growth potential; and help reduce the risk of future shocks.

5 Innovative reuse business models for plastic packaging

to enhance material productivity and reduce leakage

The global awareness around plastic pollution, raised by the bleak prospect of having more plastic than fish in the ocean by 2050, predated the pandemic.[233] Innovative reuse solutions exist that can ensure plastic never becomes waste. These can offer significant user and business benefits, that together can help deliver a more resilient and low-carbon economic recovery.

The European Commission is aiming to make **all plastics packaging** placed on the **EU market** either **reusable or recyclable** in a cost-effective manner **by 2030**

Investing in reuse business models helps reduce the need for single-use packaging, while unlocking significant economic benefits. It enables high-quality materials to be kept in circulation within the economy, unlocking substantial material savings and societal and environmental benefits. Nevertheless, reuse models still represent only a small part of the total packaged goods market. For example, while over a third of the New Plastics Economy Global Commitment signatories in the packaged goods sector are exploring reuse business models, only 3% of signatories' packaging is reusable today.[234] However, replacing just 20% of single-use plastic packaging with reusable alternatives globally offers an economic opportunity worth at least USD 10 billion, while saving about 6 million tonnes of material.[235] Moreover, reusable packaging could help enable the 'Physical Internet'—a logistics system based on standardised, modularised, shared assets—that could unlock significant economic value, estimated at USD 100 billion annually in the United States alone.[236] These opportunities are therefore still largely untapped, with the reusable packaging market predicted to experience continued growth and register USD 145 billion in 2026.[237]

Besides economic benefits, reuse business models can also play a critical role in helping tackle pollution, and deliver user and business benefits. As an example, a report by Material Economics estimated that business models that increase the reuse of plastic products could reduce emissions by around 3 million tonnes per year by 2050.[238] Reusable personal and home-care bottles, coupled with innovative delivery models, could achieve an 80–85% reduction in GHG emissions versus today's traditional single-use bottles.[239] When enabled by digital technology and changing customer preferences, these can also help unlock benefits for both businesses and customers.[240] Reuse models can, for example, enable superior user experiences by enhancing the look, feel, or functionality of reusable packaging, while product customisation options can be offered to help meet the customer's individual needs. With digital technologies such as Radio Frequency Identification (RFID) tags, sensors, and GPS tracking incorporated into reusable packaging systems, information on user preferences and system performance can be gathered and used to improve services. In addition, businesses can help achieve brand loyalty and customer retention through the introduction of deposit and reward schemes. Operations can also be optimised by building economies of scale for distribution and logistics, while packaging and transportation costs can be reduced by supplying compact refills for reusable containers.

The set-up of enabling conditions for stimulating the development of reuse packaging solutions was already underway before the pandemic. Regulations had been put in place around the world—in a wide range of countries including Peru, Australia, and Zimbabwe—to ban single-use plastics in a collective effort to start tackling plastic waste pollution. The European Commission in particular rolled out its Single-Use Plastics Directive banning ten single-use plastic products by 2021,

and has also put regulations in place to help ensure that all packaging on the EU market is reusable or recyclable in an economically viable way by 2030.[241] Other measures that have been taken around the world include: extended producer responsibility (EPR) schemes, deposit return systems, landfill taxes, as well as the set-up of mandatory requirements for packaging, e.g. recycled content and waste reduction measures. Reuse models are therefore here to stay, with the returnable packaging market projected to grow from USD 37 billion in 2018 to USD 59 billion by 2026 (across industries), at a CAGR of 5.9%—with the plastic segment expected to lead the returnable packaging market in terms of both value and volume.[242]

Based on the science and guidance from public health professionals, evidence supports the ability to safely continue using reusable packaging systems, while navigating the Covid-19 pandemic and beyond. This was expressed on 22 June 2020, with 100 scientists from 18 countries stating that, "based on the best available science and guidance from public health professionals, it is clear that reusable systems can be used safely by employing basic hygiene".[243] Concerns over the safety of reusable packaging have since subsided. High standards and protocols to ensure hygiene and safety are an important part of any packaging system, whether single-use or reuse.[244] Safety and hygiene are not determined by an item being disposable or reusable, but by how packaging and containers are managed and handled.

Most reuse systems, some active for decades, have withstood the impacts of the pandemic without needing to make any changes within their cleaning processes. Reuse business models offering home delivery, pick up, and/or return services have continued to operate smoothly, with some even thriving during the pandemic. Companies such as Loop and Vessel, that offer reusable containers to customers, have for example experienced their biggest surge in demand during the pandemic months.[245] Another example is Algramo, a provider of reusable packaging refill systems on-the-go, which has thrived during lockdown thanks to its no-customer-touchpoints tricycle distribution system across Santiago, Chile.[246] Sales increased by 356% between April and June, all the more impressive considering that the city of Santiago has been in a military-enforced lockdown. It seems that only one type of reuse model, 'refill-on-the-go',[247] has been challenged during the pandemic, with a shift towards disposables in some cases. These include the use of reusable shopping bags and bring-your-own cups and containers in the food service sector. However, even with this surge in disposables, these models have been shown to be resilient. Systems have been reconfigured to limit contact between people and clear public guidance has been offered on how to continue the safe use of reusables.[248]

Algramo, a provider of reusable packaging refill systems on-the-go, experienced a sales increase of **356%** between April and June 2020

6 Plastic collection, sorting, and recycling infrastructure

to circulate materials and design out waste and pollution

Collection, sorting, and recycling infrastructure offers an attractive investment opportunity to scale up high-quality materials circulation and enable a secondary market. An economic recovery can be shaped to decouple plastic packaging use from the consumption of fossil-based feedstocks and keep plastics out of oceans and soils, while also meeting climate targets.

High-quality recycling processes within Europe could supply up to **60–70%** of the material input needed for plastics production

Investments in physical infrastructure and technology upgrades are needed to radically improve recycling economics, quality, and uptake. In 2016, the global share of mismanaged plastics was around 41%, and has been projected to increase to 56% in 2040, contributing to almost tripling the annual volume of plastic entering the ocean.[249] Part of this has to do with the fact that a substantial share of global plastic waste today is still left uncollected, while a share of collected waste ends up directly being dumped into the environment. To help increase well-managed collection rates, investments in rural areas will particularly be needed since they represent 45% of uncollected waste and account for a similar share of plastic leakage into the ocean. For middle-/low-income countries, where funding is less available but whose informal sector plays an essential role in the collection of 59% of all plastic recycled globally, investing in the formalisation of the sector could increase the value of after-use plastic packaging and reduce the likelihood for material leakage.[250]

When it comes to sorting and recycling processes, only 35–40% of the virgin material value of plastics collected for recycling is currently retained for a next use cycle, (due to significant losses during processing) indicating the need to complement efforts to increase the collection rates with actions to drastically improve recycling yield, quality, and economics.[251] This will require directing investments towards the scale-up of sorting and recycling processes, while making use of the latest technology upgrades—such as advances in process control, chemical marking technologies, and automation. However, the ability to create high-purity after-use streams at competitive prices will largely depend on packaging and material design; an essential upstream measure that can help unlock the full potential of recycling and reprocessing efforts. The Ellen MacArthur Foundation's 2017 report, *The new plastics economy: catalysing action*, has estimated that by leveraging such measures, together with packaging designed for recirculation, recycling

A comprehensive circular economy approach could reduce the global annual volume of plastics entering our oceans by over **80%**, generate savings of **USD 200 billion** per year, reduce GHG emissions by **25%**, and create **700,000** net additional jobs by **2040**

economics could be improved by around USD 190–290 per tonne collected, or USD 2–3 billion annually across OECD countries.[252] To tap into such benefits, investments of at least USD 150 billion will be required in collection and reprocessing over the next five years alone to ensure that the plastics we do need can be circulated.[253] This has led many, such as the Polyolefin Circular Economy Platform (PCEP), to call for investment decisions—taken as part of recovery packages—to contribute to shaping forward-looking infrastructure that will accelerate the transition to a circular economy.[254] However, without significant action on elimination and redesign these costs would be significantly higher.

Packaging design in particular has a direct and significant impact on the economics of recycling. Without fundamental redesign and innovation, about 30% of plastic packaging will never be reused or recycled, and non-recyclables entering the recycling streams result in additional net costs. As an example, opaque PET bottles, that are difficult to recycle, add an estimated USD 1–2 million a year in avoidable costs to the French recycling system.[255]

Policymakers are increasingly turning their attention towards policies that improve recycling economics and support the creation of markets for recycled plastics. In the EU, for example, a new tax on non-recyclable plastic packaging waste (EUR 0.80 per kilogramme or EUR 800 per tonne) will be introduced as of 1st January 2021, with the ambition to increase recycling rates.[256] However, the effectiveness of the measure in tackling the systemic issue is still being debated.[257] Other actions taken prior the pandemic include the EU Strategy for Plastics in the Circular Economy, with the ambition to increase sorting and recycling capacity fourfold by 2030. The new EU Circular Economy Action Plan contributes to this by mobilising policies that: improve product design towards reuse and recyclability, reduce complexity of packaging materials, boost the recycled content of products, improve separate collection of plastic waste, and reduce single-use plastics where necessary.[258]

Investments in recycling infrastructure can also offer opportunities to address climate change and create additional jobs. A study by Material Economics showed that scaling high-quality recycling processes within Europe could supply up to 60–70% of the material input needed for plastics production, approaching the recycling levels for aluminium today.[259] With recycling saving around 90% of the CO_2 emissions arising from new production, this can have a significant impact.[260] Not only do these technologies help us to meet our climate targets, but they can also create jobs in higher income economies. According to some studies, on a per-tonne basis, the processing of recyclables alone can sustain about 20 times more jobs than landfill, and plastic manufacturers making use of recycled materials, about 100 times more jobs than landfill.[261]

For the world's emerging and lower income cities, investments in after-use infrastructure offer much needed economic and societal opportunities. Around the world, an estimated 15–20 million waste pickers earn a living from the informal collection, sorting, and recycling of discarded items.[262] Worldwide, they may even be responsible for collecting more plastic for recycling than the formal sector, accounting for 15–20% of collection globally.[263] For two-thirds of waste pickers, these earnings are the main source of household income, with more than three-quarters of them having formal businesses as their main buyers.[264] However, the pandemic has made informal communities particularly vulnerable, facing unprecedented threats to their health, safety, and livelihoods. Their health has been jeopardised, due to limited access to healthcare, hygienic necessities, and protective equipment and their jobs threatened, due to temporary shutdown of recycling centres. As such, investing in and formalising this sector could offer huge opportunities to keep materials in circulation, while also improving sanitary conditions and alleviating poverty.

When it comes to tackling plastic pollution, however, focusing on collection, sorting, and recycling alone will not be enough. According to the July 2020 report developed by The Pew Charitable Trusts and SYSTEMIQ called *Breaking the Plastic Wave: A Comprehensive Assessment of Pathways Towards Stopping Ocean Plastic Pollution*, applying a strategy that focuses solely on recycling—including an ambitious design for recycling coupled with a scale-up of collection, sorting, and recycling infrastructure—would still result in "18 million metric tons of plastic flowing into the ocean each year by 2040".[265] The latter would cost governments USD 250 billion more than if an integrated system-level approach was taken (see paragraph below) between 2021 and 2040.[266] Therefore, any solution based solely on waste management and recycling is highly unlikely to succeed in stopping plastic pollution—as it will neither be technically nor financially feasible. A comprehensive circular economy for plastic is needed, in which it never becomes waste or pollution.

An integrated approach is needed that deploys both upstream and downstream solutions to effectively tackle plastic pollution. This includes the global implementation of multiple synergistic system interventions by industry and government such as the elimination of problematic and unnecessary plastic packaging, switching from single-use to reuse models, scaling waste collection, sorting and recycling, and substitution to other materials where relevant. Compared with business-as-usual, such a comprehensive circular economy approach has the potential to reduce the annual volume of plastics entering our oceans by over 80%, generate savings of USD 200 billion per year, reduce greenhouse gas emissions by 25%, and create 700,000 net additional jobs by 2040.[267]

To catalyse change towards such an integrated approach, collaboration across sectors and regions are needed that is driven by a shared sense of direction. It is for this reason that the New Plastics Economy initiative has spent the last four years rallying businesses and governments behind its common vision of a circular economy for plastic. Today, this vision unites more than 850 organisations across the plastics value chain, public and private sectors through the New Plastics Economy Global Commitment and Plastics Pact network.[268] These initiatives drive collective action to eliminate the plastic we don't need, to innovate so that all plastic we do need is reusable, recyclable, or compostable, and to circulate all the plastic we use, keeping it in the economy and out of the environment.

Fashion

The pandemic has upended the fashion industry, creating mass-scale supply chain disruptions while making people re-evaluate their shopping habits. Price-sensitivity and concern over the resource-intensive and wasteful nature of the current linear fashion system are projected to increase among customers following the economic downturn and into the recovery period. To respond, the industry will need to develop new solutions. Business models that move away from making and selling more, towards using more, such as rental and resale enabled by digital technologies, can offer promising opportunities. These models can attract increasingly price- and environmentally conscious customers, while decreasing the pressure on virgin resources and increasing the revenue streams per garment. Combined with developments in clothing collection, sorting, and recycling infrastructure that can enable substantial material value retention, these investments will help shape a fashion industry that is not only more in tune with its customers, but also more resilient and environmentally beneficial.

More than **USD 500 billion** of value is being lost annually due to clothing underutilisation and lack of recycling

The fashion industry and the apparel sector more broadly have been among those consumer good sectors most deeply affected by the pandemic.[269] All in all, a 27–30% reduction on year-on-year revenues for the global fashion industry is predicted for 2020.[270] As with other industries, the sector's heavy reliance on global supply chains has caused difficulties for businesses trying to obtain products from their manufacturers.[271]

With retailers being forced to close their brick and mortar businesses, sales have moved online, encouraging an increase in first-time fashion e-commerce shoppers of 14% in the US and 17% in China.[272] Nonetheless, given people's lack of appetite to spend on discretionary products during these uncertain times, total online sales during the pandemic have also rapidly declined: in Europe by 5–20%, in the US by 30–40%, and in China by 15–25%.[273] The reduced sales led to around USD 2.9 billion worth of exports being cancelled or suspended by April, affecting the livelihood of more than 2 million workers.[274]

Before the pandemic, more than USD 500 billion of value was being lost annually due to clothing underutilisation and lack of recycling.[275] Currently, due to the consequences of 'lockdown' and social distancing measures, many retailers are facing unprecedented challenges in dealing with the deadstock resulting from clothes and accessories they were not able to sell in time for the intended season.[276] This is all happening at a time when the massively environmentally detrimental and wasteful nature of the industry is becoming increasingly more urgent and scrutinised.

Trends that were already identifiable in the fashion industry before the pandemic, are predicted to gain speed and urgency in the coming months and years. E-commerce is poised to continue its growth, with online sales persistently taking more market share from physical retail locations.[277] Moreover, companies with built-in digital and analytics capabilities across the value chain are believed to have been more resilient during the pandemic, and many more are therefore expected to go through a 'digital transformation', i.e. helping adapt cost structures and make each step of the value chain better, faster, and cheaper.[278] Sustainability concerns among customers are also projected to heighten, with individuals shopping less, exchanging more and increasingly favouring purpose-driven brands.[279] Yet, historically this has failed to translate into large-scale uptake, with such items often unable to compete with traditional economies of scale, demanding a price premium that customers are not always willing to pay.[280] Moreover, the economic downturn will increase the price sensitivity of many customers looking to cut costs on discretionary spending.[281] This will drive fashion businesses to re-evaluate their current business models and consider new opportunities, such as the adoption of seasonless design and lower-priced resale.[282]

For the fashion industry to meet these new challenges effectively while leveraging future trends, investments in circular economy opportunities that promote increased utilisation over increased consumption can offer attractive opportunities. The Ellen MacArthur Foundation sets out a vision for fashion, where clothes are used more and made to be made again, from safe, renewable and recycled inputs. In order to more rapidly realise this vision, investments could be directed towards areas including: rental and resale business models; collection, sorting, and recycling infrastructure; material innovations to improve durability, recyclability, and reduce microplastic leakage; and digital technologies to better track and trace resources.

Though all of these investment areas can help pave the way for a more resilient and environmentally beneficial fashion industry of the future, two particularly interesting circular investment opportunities emerge:

7 Rental and resale business models for clothing

8 Clothing collection, sorting, and recycling infrastructure

These selected opportunities highlight especially attractive areas that can help address both the short- and long-term goals of the public and private sectors. Together they provide solutions to key challenges created by the pandemic; meet governmental priorities for economic recovery; offer circular economy growth potential; and help reduce the risk of future shocks.

7 Rental and resale business models for clothing

to move away from making and selling more, towards using more

Investing in circular business models that keep products in use through rental and resale can be an effective way to enable a faster and more future-proof recovery and growth plan for the fashion industry.

Investments into rental and resale business models can generate numerous economic benefits through increasing clothing usage in alignment with evolving customer demands. By enabling the same item to be obtained and utilised by many customers over its lifetime, clothing rental and resale models can increase the revenue stream per garment when compared to traditional linear models, which rely on volumes sold to generate revenue.[283] The increased utilisation rate, combined with the lower costs that may be achieved as raw material needs are reduced, also allows for a lower price point per garment (sale or rental).[284] As such, resale and rental models can be used as effective tools for tapping into new, more price-sensitive customer segments. This may be particularly valuable moving forward as the post-pandemic economic uncertainty is expected to increase the share of customers in this segment significantly.[285] In fact, over 60% of consumers have reported reducing their spending on apparel during the crisis, with about half expecting that trend to continue post-pandemic.[286] Nonetheless, consumers are likely to cut back on accessories, jewellery, and other discretionary categories before reducing their spending on apparel and footwear. There is also evidence that clothing-as-a-service models, such as rentals, may increase customer loyalty to service providers, thereby generating consistent revenue streams. For example, clothing rental technology platform, CaaStle's data revealed that their fashion business clients using the platform to implement their rental offering before the pandemic, experienced a 125–175% increase in spend year-over-year among active customers.[287]

These business models are supported by a change in customer sentiment around apparel consumption and ownership, with a McKinsey study showing that 20% of customers want to reduce their clothing consumption following the pandemic.[288] Moreover, 71% of customers are expressing a greater interest in circular business models, such as rental, resale, and refurbishment, and want to invest in higher quality apparel after the pandemic.[289] This has already been felt by industry actors, as 54% of apparel and textile brand sustainability leaders have noted an increased customer interest in environmentally conscious practices and products since the onset of the pandemic.[290]

Rental and resale models can also offer environmental advantages, increasingly called for by policymakers and consumers alike. For example, a 5–10% reduction in a garment's carbon, water, and waste footprint has been shown to be attainable by extending its lifetime by a mere three months, assuming garment purchasing is subsequently decreased as well.[291] In fact, compared to buying new, one pre-owned purchase is said to save on average 1kg of waste, 3,040 litres of water, and 22kg of CO_2.[292] Furthermore, a 2019 study found that 65% of second-hand clothing purchases in the US and UK, and 41% in China, successfully prevented the purchase of a new item.[293] These savings could be substantial, given the current environmental damage caused by the fashion industry. In 2015, the GHG emissions from textiles production totalled 1.2 billion tonnes of CO_2 equivalent, i.e. more than the amount produced by all international flights and maritime shipping combined.[294] At the current rate, the textile industry is poised to account for over 26% of the global carbon budget by 2050.[295] Meanwhile, according to thredUp's 2020 Resale Report, in the aftermath of the pandemic, 70% of customers are seeing a greater need for fashion to address climate change than ever before.[296] Policymakers are also increasingly drawing their attention to the environmental impacts

Compared to buying new, one pre-owned purchase is said to **save** on average 1kg of **waste**, 3,040 litres of **water**, and 22kg of **CO_2**

of the fashion industry. The French Circular Economy Law already bans the destruction of unsold or customer returned items, while groups like the UN Alliance for Sustainable Fashion and the OECD Due Diligence Guidance for Responsible Supply Chains in the Garment & Footwear Sector have been formed to address the fashion industry's sustainability issues.[297] This mounting pressure, paired with the accelerating customer demand for environmentally responsible clothing, affects the whole fashion industry and further enhances the attractiveness of new business models—such as rental and resale—as investment opportunities.

Substantial growth is currently happening and projected to continue into the future within clothing rental and resale markets. Before the pandemic, strong growth was projected for both rental and resale business models, with revenue from rental models poised to increase by USD 801 million between 2019 and 2023 with a CAGR of almost 11%, while the apparel resale sector was set to grow from USD 5 billion to USD 23 billion between 2018 and 2023.[298] In 2019, one study found that 87% of clothing retailers were eager to trial resale models, and 61% wanted to test rental models.[299]

These trends are only expected to grow following the crisis, with heightened awareness and concern over the fashion industry's substantially negative environmental footprint and increased customer demand for more responsible garments.[300] In fact, a study released since the onset of the pandemic by the resale platform, thredUp, has projected that the total second-hand market will grow from USD 28 billion in 2019 to USD 80 billion by 2029, reaching nearly twice the size of the fast fashion segment in the same period.[301] Resale models are expected to drive this increase, with their growth projected at 414% in the next five years, while the overall retail market is predicted to shrink by 4% over the same period.[302] Even clothing rental models, despite having taken an initial hit due to people's confinement to their homes and some concerns around perceptions of hygiene, are expected to bounce back relatively quickly following the relaxation of global confinement measures and recommencement of social gatherings.[303] This has already been evidenced in China where clothing rental platform, YCloset, began to see a gradual recovery in their business as lockdown measures were eased.[304] Moreover, some new retailers are seen to be adopting the rental model in the midst of the pandemic as well. For example, Selfridges introduced their new clothing rental model during the summer of 2020.[305]

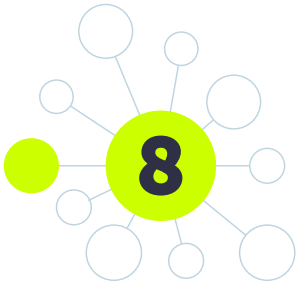
Meanwhile, the strength and resilience of resale business models have been demonstrated by many companies which, after making innovative adaptations to increase operational hygiene (by e.g. enabling contactless home delivery), have thrived during the crisis. Peer-to-peer resale businesses, Depop and Vestiaire Collective, for example, reported sales increases of 150% in the US mid-April compared to the same time last year, and 54% in early May compared to February, respectively.[306] In fact, it bears noting that a number of business models—B2C, C2C, C2B2C—can be adopted to engage

The second-hand market is projected to reach nearly **twice** the size of fast fashion by **2029**, with resale models expected to drive the increase (growth projected at **414%** in the next five years)

in clothing rental and resale. For larger fashion retailers, partnerships with innovative and more agile clothing rental and resale organisations may offer a more attractive, faster, and easier path to adopting these business models compared to building these capabilities in-house, while also creating more jobs in garment repair and refurbishment.[307] These partnerships are already being utilised by various players as exemplified by The Renewal Workshop and Trove, which build and operate resale programmes for clothing brands like Carhartt and Patagonia, offering collection, cleaning, repairing, and even selling of the brands' pre-owned garments.[308]

Increased use of digital technologies will allow a greater uptake of these business models. The rise of fashion e-commerce has accelerated since the onset of the pandemic. One study on German and UK customers conducted in April 2020 found that 43% of respondents had begun purchasing fashion items online for the first time ever since the start of the pandemic, and 28% expected to reduce their purchasing in physical locations in the future.[309] As such, investments into developing e-commerce platforms that facilitate the rental and resale of clothing will be crucial to reach customers, and can also allow smaller brands and creators easier access to markets, thus potentially positively impacting job creation.[310] In fact, many smaller fashion brands, such as Baja East that saw sales rise by 64% in April compared to March by focusing more heavily on direct-to-consumer and digital marketing, have attributed these strategies to their ability to weather the shock of the pandemic.[311] Other digital solutions, such as innovative customer engagement through social media, livestream sessions turning physical stores to virtual shopping stages, and omnichannel inventory capabilities, have also proven themselves to be valuable for businesses during the pandemic by increasing sales and customer engagement.[312] However, to attract and incentivise customers to use these platforms, they will need to be designed and developed with convenient user experience in mind, as customers have become increasingly overwhelmed by the amount of choice[313] and are discerning of platform interfaces and deliveries.[314] For clothing rental and resale businesses to become more resilient and aligned with shifting demand, investments should then also be directed towards increasing the digital capabilities of these companies.

Design will play a key enabling role in the success of clothing rental and resale businesses. To enable the garments' safe and extended circulation, clothing must be designed with durable and non-hazardous materials that can sustain several use cycles.[315] At the same time, design decisions should be made to ensure the emotional durability of the item is also prolonged, i.e. that customers continue to value and want to wear it, or else it will not be circulated to its greatest physical potential.[316] To achieve this, solutions such as 'timeless' designs (i.e. classic, seasonless designs in patterns and silhouettes), or greater garment adaptability can be adopted to avoid premature obsolescence of the items.[317] For example, Petit Pli designs children's clothing that can be expanded to fit as the child grows.[318] To gain the most value out of an investment, investors should then also ensure that the rental and reuse businesses in which they are investing, take these design principles into account as well.



Clothing collection, sorting, and recycling infrastructure

to retain material value for a competitive and clean recovery

With recycled fibres expected to replace virgin sourced materials at an ever increasing pace in the textile sector, investments into clothing collection, sorting, and recycling infrastructure can offer many economic and environmental benefits that can contribute to the creation of a more resilient future fashion industry.[319]

13% of textiles get recycled after clothing use, **12%** are downcycled into lower value uses that are often extremely difficult to recirculate, while only **1%** gets recycled into new clothing

Investing in collection, sorting, and recycling infrastructure can enable significant economic value retention while reducing disposal costs. Of the total fibre input used for clothing today, 87% is landfilled or incinerated—equivalent to burning one rubbish truck full of textiles every second.[320] A meagre 13% of textiles get recycled in some way after clothing use, 12% are downcycled into lower value uses that are often extremely difficult to recirculate, while only 1% gets recycled into new clothing.[321] In addition, wasted garment and fabric leftovers account for a quarter of industry resources.[322] The pandemic has only exacerbated these issues, with decreased sales having led to the cancellation of orders that had already been produced, thereby creating even greater amounts of deadstock.[323] If these inventories are not repurposed or saved for next year, the risk of an increase in the total amount of waste is high as businesses may destroy their products to avoid flooding the market.[324] If instead of incineration or landfill, these materials were captured and recirculated, the lost value of textile waste amounting to more than USD 100 billion annually could be retained, while new jobs in collection, sorting, and recycling facilities could be created.[325] Additionally, increased collection, sorting, and recycling of clothing could also lower costs. On one hand, disposal costs associated with clothing waste management could be avoided by increasing material circulation, while on the other hand the increased amount of recycled textiles available could reduce total material costs for apparel production. These savings could be substantial. In New York City alone, more than USD 20 million a year is spent on landfilling and incineration of textiles—most of which is clothing—and in the UK the estimated cost of landfilling clothing and household textiles each year is approximately GBP 82 million, thus representing a substantial economic opportunity for increased textile recycling.[326]

Increased clothing collection, sorting, and recycling can also create environmental benefits by reducing industry extraction and pollution. Increased clothing recycling can help lower the strain placed on natural resources caused by the cultivation and manufacture of virgin inputs. For example, by reducing the sector's reliance on virgin resources, some of the 93 billion cubic meters of water used annually for textile production could be saved, while the GHG emissions of clothing production could also be lowered.[327] The largely detrimental methane releases, and potential groundwater contamination through leached dyes and chemicals can also be avoided as textiles at the end of their first life get redirected away from landfills.[328] By reducing the environmental burden and lowering emissions, greater clothing recycling can thus also help mitigate against the future risk of climate emergencies. Moreover, with customers becoming more environmentally conscious, and responsible shopping habits predicted to grow at a fast rate, companies involved in collection and recycling programmes may also be better able to acquire and retain customers.[329]

Policy support for increased clothing circulation is growing as evidenced by various fiscal measures and regulations. Businesses can already receive tax benefits from partaking in collection and recycling programmes in some areas. For instance Knickey, an organic cotton underwear startup, receives tax credit for forwarding the undergarments they collect from customers to a non-profit for recycling.[330] Besides offering incentives, tighter regulations around textile waste may also become more commonplace, making increased clothing collection, sorting, and recycling in fact a requirement. For example, based on the revised Waste Framework Directive in the EU, all member states will be required to run collection schemes to separate textile waste by 2025.[331] The expected increase in collection volumes will put pressure on local sorting/reprocessing/recycling in the coming years, thus making timely investments in these areas all the more attractive.

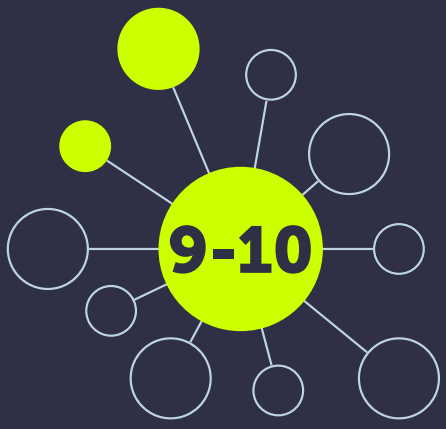
Design has a key role to play in ensuring clothes can be kept in circulation. In a circular economy for fashion, garments are, from the outset, made to be made again. As such, conscious decisions concerning material durability (such that the items and materials can be used more and withstand recycling), garment construction (to potentially ease material and component separation), and item processing (such as dyeing) will have to be made to ensure all of these factors support the ability of a garment to be kept at its highest value, used more, and be recycled at its end of life in alignment with the available infrastructure.[332]

To attain these benefits, critical investments in collection, sorting, and recycling infrastructure are required. Such investments are needed to create an effective, interconnected textile waste revalorisation network that can operate at scale, as the current structures are often characterised by fragmentation and are thus ineffective in collecting, sorting, and recycling products in the volumes required.

Investments are needed for developing formalised, physical clothing collection, sorting, and recycling infrastructure. Currently, there are huge discrepancies between countries around the world, concerning the availability and type of clothing circulation infrastructure. In places like the UK and Germany, many formal choices for clothing disposal are offered, while some other countries, particularly in Asia and Africa, solely rely on informal collection systems.[333] Even where collection rates are high—such as in Germany, where 75% of textiles are collected—much of the collected clothing ends up being exported to countries with no collection infrastructure of their own.[334] The results of this are two-fold. First, though the utilisation of the garments is increased, the end result is that the waste issue only gets off-shored, usually to lower income countries, creating pollution and other issues in the receiving areas.[335] Second, with many receiving countries of used clothing at least momentarily banning these imports in an attempt to curb the spread of the virus, the end markets for the collected clothing in the West were effectively closed-off. With their strong reliance on external end-markets and an underdeveloped recycling infrastructure of their own, many used clothing exporters then struggled with storing their collected garments and attaining some value from them.[336] It is thus of paramount importance to ensure that collection, sorting and recycling infrastructure is developed in all areas where clothing waste is created and ends up—especially where none currently exists—if large-scale transformation is to be achieved.[337]

Technological infrastructure should also be prioritised, especially in order to improve clothing sorting and recycling. Automated optical sorting technologies (such as Fourier Transform Infra-Red spectroscopy (FTIR)) and technical innovations enabling material tracking and product information encoding (such as Radio Frequency Identification (RFID) tags), could substantially increase the speed and accuracy at which items get sorted.[338] This is critical for recyclers to be able to acquire high-quality feedstocks that they can better utilise, and it also greatly optimises the sorting process.[339] Given the reduced operating costs and ability to target higher value markets with the resulting recyclates, investments into these technologies would easily be recouped, while the scale-up of recycling and cost competitiveness of recycled materials against virgin resources would be improved.[340] At the same time, the textile recycling infrastructure and technology itself requires investments. To retain the greatest value possible of the material, innovative technologies and processes enabling clothing-to-clothing recycling should be prioritised over those which downcycle materials. For example, through its chemical recycling process, Aquafil is able to produce recycled nylon at a competitive price compared to virgin nylon.[341]

Based on the **revised Waste Framework Directive** in the EU, all member states will be required to run collection schemes to separate textile waste by **2025**



Food

While the pandemic has exposed the vulnerabilities of the current food system and strained food security in some areas, it has also reignited people's interest in their food. In the midst of the health crisis, the value placed on nutritious food that benefits, rather than degrades nature, has grown, strengthening the case for shifting towards regenerative food production. At the same time, to ensure high levels of value and access are retained, the need for improved food collection, redistribution, and valorisation infrastructure has become glaringly apparent. Investments in these areas will thus be key to building back a more resilient and healthy food system that enables greater food security while allowing both people and nature to thrive.

Taking into account the overall economic impact of the pandemic, a staggering **265 million** people around the world are expected to be at risk of facing acute food insecurity in **2020**

The pandemic has had mixed impacts on the food industry. On the one hand, initial global lockdowns decreased spending on eating out and takeaways, while increasing the popularity of from scratch cooking and, subsequently, the global food expenditure on groceries.[342] To avoid crowds and travelling far, people also switched to buying their food from smaller local retailers, or even ordering food directly from farmers themselves.[343]

In some places, these trends have been supported by the increased adoption of online ordering and home delivery services, resulting in a 11.5% increase of online food purchase compared to the previous year, in the UK alone.[344] A surge in demand for foods perceived to be safer and healthier has also been detectable in the midst of the pandemic.[345]

Meanwhile, the upstream players in the supply chain, such as farmers, have been challenged with oversupply issues due to a number of factors. Mobility restrictions created shortages of seasonal migrant agricultural workers in some regions. This resulted in exceptional admissions and visa extensions being urgently put in place for these 'essential workers' to ensure food security in host nations could be retained.[346] The lockdowns and border closures also constrained producers in their ability to transport their goods to where they were demanded.[347] Infrastructural shortages and the inflexibility caused by extreme efficiency and specialisation of supply chains, have only further exacerbated oversupply issues. Farmers typically delivering to out-of-home eateries have suffered cancelled orders from shut down schools, restaurants and other B2B customers, facing issues in finding alternative markets for their goods and struggling to adjust their production, packaging, and distribution systems to fit the needs of retail consumers.[348] As such, redistribution of these stocks has been difficult, leading to massive post-harvest losses of food.[349]

Many of the trends detected during the pandemic in the food sector are also projected to continue into the future. The health-consciousness of consumers is predicted to rise, increasing the demand for foods that are, for example, local, healthy and certified organic, and that can be traced through the supply chain to their origins to ensure their safety.[350]

Additionally, the increased trend of at-home cooking and eating is likely to continue, as more people are likely to embrace remote working and as a result spend more time at home.[351] At the same time, online food shopping as well as deliveries from grocery stores and restaurants are predicted to remain at higher levels than before the pandemic, and even continue their growth.[352] Regulation around food safety will also become more stringent while consumer concern regarding this heightens.[353] Meanwhile, the expected global population rise to 9.7 billion by 2050 will require food system adaptations to ensure adequate nutrition is provided for everyone.[354] As 80% of the world's food is projected to be destined for cities by 2050, consumption patterns in urban areas will also have a greater influence upstream, thereby potentially redefining the urban-rural dynamic through, for example, increasing demand for local production.[355]

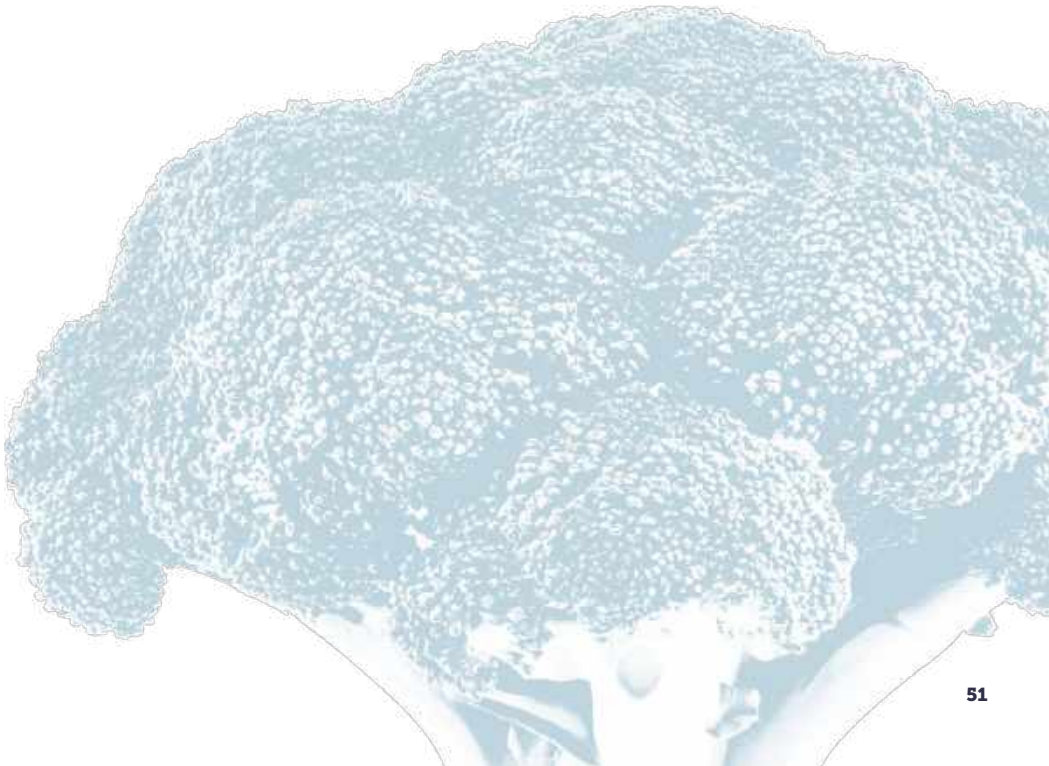
As funds around the world are being made available to aid the recovery of the agricultural sector, there is a growing need to ensure they get directed towards areas that can address all these future trends and challenges effectively. This will require clear direction setting, which is currently lacking. For example, in France, a total of EUR 1 billion has been allocated for the agricultural sector recovery, without specific conditions tying the use of all these funds to areas that also support the ecological transition and help the country reach their climate goals, among other priorities.[356] Without any such conditions, there is a risk that investments are directed towards short-term rescue areas, rather than long-term recovery efforts that could improve the overall resilience of the food system.

The circular economy provides an effective blueprint for achieving a stronger food sector recovery. It offers many solutions that can leverage future trends and address the identified issues faced by the industry, including: shifting to regenerative food production methods; developing surplus edible food prevention and redistribution, and by-product collection and valorisation infrastructure; reconnecting with local food production; scaling the adoption of circular indoor urban farming; and diversifying ingredients including protein sources to offer alternatives to industrially produced animal products. Though all of these could contribute to the creation of a better and more resilient future food system, in the current situation, two especially attractive circular investment opportunities arise:

9 Tools enabling farmers to shift to regenerative agricultural production

10 Food surplus and by-product collection, redistribution, and valorisation infrastructure

These selected opportunities highlight especially attractive areas that can help address both the short- and long-term goals of the public and private sectors. Together they provide solutions to key challenges created by the pandemic; meet governmental priorities for economic recovery; offer circular economy growth potential; and help reduce the risk of future shocks.



Tools enabling farmers to shift to regenerative agricultural production

to create food systems that allow people and nature to thrive

The pandemic has heightened anxieties around food safety, while highlighting the unhealthy state of the current food system.[357] For the food sector to re-emerge from the pandemic stronger than before, increasing system resilience and reducing the sector's environmental impacts will be vital.[358] Investing in a faster and broader shift towards regenerative agriculture could offer attractive opportunities for achieving this vision of a healthier and more resilient food system of the future that benefits natural systems and people alike.

A **USD 78– 116 billion** spend on accelerating the adoption of regenerative production has been estimated to yield **USD 2.3–3.5 trillion** in lifetime operational cost savings

Investing in the acceleration of regenerative agriculture can reduce costs and increase profits in alignment with evolving consumer demand. A recent report by the World Economic Forum indicated that by 2030, 191 million jobs and USD 3.56 trillion in economic opportunities could be created by reforming food, land, and ocean use by, among other things, making greater use of regenerative agricultural practices.[359] In a regenerative system, input costs can also be reduced as enriched soil organic matter and mutually beneficial relationships between different crop and animal species are created, thus reducing agricultural reliance on pesticides and synthetic fertilisers. For example, a USD 78–116 billion spend on accelerating the adoption of regenerative production through promoting practices such as planting diverse cover crops, no tillage, and multiple crop rotations, has been estimated to yield USD 2.3–3.5 trillion in lifetime operational cost savings.[360]

Diversifying the types of food grown can also lead to greater farmer income diversification, subsequently improving both crop-resilience and the resilience of producers' livelihoods in the face of external shocks, such as those created by climate change.[361] Moreover, the profitability of regenerative agriculture has in some cases even been found to be higher than that of conventional food production systems. For example, a 2018 study on corn fields found that those managed regeneratively saw a 78% increase in profits compared with conventionally farmed fields.[362] In addition, the growing demand for healthy food, accelerated since the onset of the global pandemic, is only likely to increase the attractiveness of regenerative agricultural produce, with 72% of Europeans reporting to put more effort into healthier eating in the future.[363]

Regenerative food production systems can also create significant environmental benefits by improving the ecosystems in which they are embedded. The current linear industrial agricultural food production system is extremely extractive and degrading of natural systems. In the linear way of cultivating food, increased agricultural yields are linked to the heightened use of synthetic fertilisers and pesticides that leads to soil, erosion, and depletion of valuable mineral resources, jeopardising their long-term fertility. A 2015 study estimated that one-third of global soils were moderately to highly degraded, threatening food security of the future.[364] To circumvent these issues, a shift to a regenerative food production system is needed. Regenerative food production is aimed at building healthy, biologically active ecosystems: improving, rather than degrading the environment in which the food cultivation or livestock rearing is embedded.[365] These aims can be reached through a variety of practices, such as crop rotations and diversification to promote greater biodiversity, no-till farming, using cover crops, and managed grazing.[366]

With an emphasis on improving the ecosystems in which they are embedded, regenerative food production systems work with nature, rather than against it. A 2017 paper by Farmland LP found that USD 85 million of farmland—which under conventional farming would have generated USD 8.5 million in ecosystem harm—was able to generate USD 12.9 million value in ecosystem services after being regeneratively farmed.[xvi,367]

By encouraging the diversification of the production system and moving away from monocultures, regenerative agriculture can also increase biodiversity while strengthening soil health and the resilience of farmer livelihoods.[368] With biodiversity loss having been identified as a key global challenge of the future, and being included in the UN's Sustainable Development Goals,[369] the ability of regenerative agriculture to increase biodiversity can also make the adoption of this system effective in mitigating the risk of future crises.

In addition, as fewer synthetic herbicides and pesticides are used in regenerative production, lower environmental toxicity can be achieved by circumventing harmful leakage, while avoiding the costs associated with its clean-up.[370] The reduced reliance on synthetic fertilisers manufactured using fossil fuels, combined with the adoption of practices such as no-tillage, also means that switching to regenerative production could – at a conservative estimate – reduce total agricultural GHGs by a minimum of 17% annually.[371] As food production and agriculture are currently responsible for over one-fifth of all GHG emissions, improvements in this area can have significant global impacts.[372] To add to this, regenerative food production has also been found to positively contribute to soil carbon sequestration, thus further increasing its ability to contribute to climate change mitigation. In fact, it has been estimated that in a period of 25 years, soils alone could sequester over 10% of anthropogenic carbon emissions.[373]

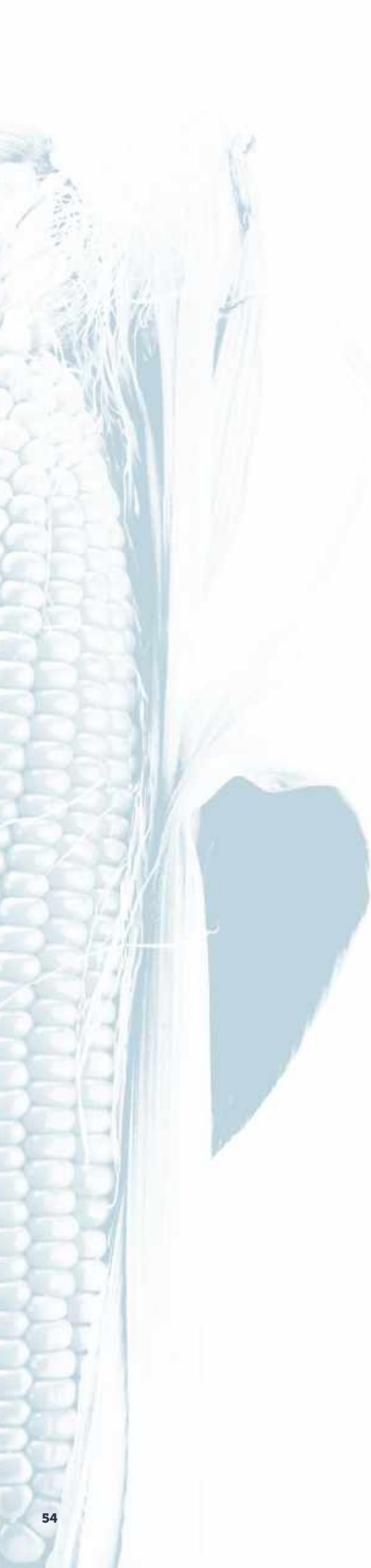
Moreover, by applying regenerative methods to the production of animal products, overall food production emissions can be even further reduced. As the current linear intensive livestock rearing practices are switched out for regenerative ones such as integrated crop and livestock operations, the massive GHG contribution of industrial livestock rearing can be addressed and the farm's carbon sequestration ability improved.[374] These savings may be very impactful given that livestock rearing in the traditional linear model was found to account for approximately two-thirds of the agricultural sector's total production-related emissions in 2009.[375] In addition, to ensure maximum benefits with regards to emissions reductions may be achieved, rethinking our food products and menus to diversify protein sources will be critical.

Investments in technical tools facilitating farmers' adoption of regenerative food production methods will be vital in achieving these benefits. Increasing the availability of specific equipment and non-synthetic inputs—such as biofertilisers, vertical tillage tools that preserve soil structure, and 'finger weeders' that can remove unwanted flora without toxins—will support farmers in making the transition.[376] Additionally, emerging digital and technological capabilities are giving way to new tools that provide valuable insight into soil quality, and crop and animal welfare, for example.[377] Digital farming, i.e. combining data collection, storage, analytics and decision modelling, can also be leveraged by large-scale farms in combination with big data and Internet-of-Things (IoT) solutions, to enable optimal regenerative results.[378] Examples of these solutions are already being tested and used, with the AI mobile app 'Nuru' using machine learning to identify plant disease symptoms from photos,[379] and service-based businesses, such as FarmShots and Vine View measuring hydration, health, and disease of crops through aerial and drone footage.[380]

The successful uptake of these technical solutions and regenerative practices will also require investments in farmer training. To improve training success and accessibility, both online solutions and in-person agricultural teaching will require investments. Local adaptations to training will be critical in ensuring that effective results and greater farmer acceptance can be achieved.[381] Examples of existing organisations helping farmers transition to regenerative practice, can be found in the Horn Farm Center for Agricultural Education[382] in the United States, and Sustainable Harvest International[383] in Central America, which provide in-person training. Other institutions, such as the Savory Institute and Ecological Farming Association (EcoFarm) provide online courses and links to relevant resources.[384] To enable

Regenerative food production can contribute to soil carbon sequestration, with a study estimating that in a period of **25 years**, soils alone could sequester over **10%** of anthropogenic carbon emissions.

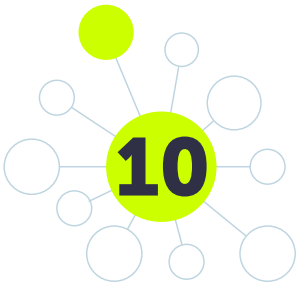
xvi Ecosystem services encompass a variety of the benefits generated by natural ecosystems, such as water purification, and crop pollination and production.



a faster and wider farmer transition to regenerative production, more investments will, however, be needed to improve farmer access to these resources.

Investments in tools to help establish a market for food grown using regenerative methods will also be needed. Digital and technological solutions that can provide timely, cost-effective, and accurate measurement data on the impacts of regenerative food production require investment to help producers and companies clearly communicate the benefits of regenerative food to consumers, creating greater demand-side pull for these products. One example of such a solution is the Soil Condition ANalysis System (SCANS) which reliably estimates soil carbon stocks by combining an automated soil-core sensing system with advanced statistical modelling and analytics.[385] Blockchain and other technologies enabling better traceability can also be harnessed to build consumer awareness of product origin, farming techniques used, nutritional content and environmental impact, thereby enabling the creation of greater demand for regeneratively produced goods.[386] Additionally, digital commerce platforms can provide enhanced channels for farmers to directly reach consumer markets. For example, SiembraViva provides training to farmers in Colombia to adopt more regenerative practices and then, through its e-commerce platform, delivers produce from the farmers directly to urban citizens' doorsteps.[387] The heightened demand created by the adoption of these solutions can, in turn, attract more farmers to adopting these practices, thus increasing the benefits that can be achieved through regenerative production.

The policy environment is increasingly supportive of investments in a regenerative agriculture system. A number of policies, though not directly related to regenerative agriculture, also benefit the movement towards this production method and strengthen its attractiveness in the future. For example, the Australian government formed an Emissions Reduction Fund, whereby farmers can receive credits for producing goods using lower emissions methods, and even sell them to others.[388] Meanwhile, the EU's Farm to Fork Strategy sets out targets to reduce the use of fertilisers by 20% by 2030, and the use of chemical pesticides by 50% by 2050.[389] Although these goals are not yet fixed in any legislation at EU level, the tone set by the strategy is clear and will guide future national implementation measures, notably under the Common Agricultural Policy (CAP), e.g. through supporting more environmentally sound ways of agricultural production.[390] Moreover, given the rising multi-stakeholder advocacy for a more restorative food production system, exemplified by, for example, the formation of the One Planet Business for Biodiversity cross-sectorial coalition in 2019,[391] policies in support of regenerative food production methods will likely only become more commonplace in the future.



Food surplus and by-product collection, redistribution, and valorisation infrastructure

to make the most of food and improve food security

Concern over the massive amount of food waste generated around the globe is ever-growing. In their SDGs, the UN has even set a target of halving global food loss and waste by 2030.[392] Creating a circular food system where surplus edible food gets redistributed and inedible by-products are collected and transformed into valuable products—rather than discarded as in the current linear model—will be necessary for the value of these streams to be retained in the economy. To attain this vision, critical investments in collection, redistribution, and valorisation infrastructure are needed.

Investments in food collection, redistribution, and valorisation infrastructure could enable the retention of substantial economic value and the creation of new revenue streams. Each year around the world the 1.6 billion tonnes of food wasted amounts to USD 1 trillion of economic costs.[393] This lost organic matter consists of edible surplus food and inedible by-products, both of which could be transformed from costly burdens to attractive economic opportunities through enhanced collection, redistribution, and valorisation efforts. In fact, food waste reduction has been found to present an annual economic opportunity between USD 155–405 billion by 2030.[394] The edible surplus food could either be redistributed through, for example, food banks, to help improve food security and fight hunger, or processed to create new food products and revenue streams.[395] The latter option could allow food manufacturers to save costs and attract substantial investments. For example, Renewal Mill, a flour-producing venture using the by-products of tofu and soy milk production as inputs, raised USD 2.5 million for a seed round in 2019.[396]

Inedible food by-products, in turn, could be valorised to create inputs for agriculture as well as new materials and bio-energy, depending on the mixture of by-products present in the stream and technologies available for processing. Innovative solutions for inedible food by-product valorisation can create new revenue streams for farmers and food businesses, while providing them with access to new growing markets. For example, with the global compost market projected to grow with a CAGR of 6.8% from 2019 to 2024, reaching USD 9.2 billion by 2024, investments into valorising inedible food by-products to compost could offer attractive economic returns for food producers and companies.[397] In some cases, food by-products are even well-suited to be transformed for material use in the bioeconomy. For example, Ananas Anam produces a leather-like material called Piñatex®, from the by-product of existing agriculture, i.e. pineapple leaves that would otherwise be discarded.[398]

This infrastructure will also play a critical role in unlocking a variety of environmental benefits for the food system. Currently, every year, one-third of all food produced globally is wasted.[399] Moreover, barely any of this waste is retained and valorised; in Europe only 16% of food waste is captured,[400] while globally less than 2% of all valuable nutrients present in urban food waste and by-products get valorised.[401] As a result, the energy and resources used to grow, harvest, transport, and package these wasted goods is also lost, which, when combined with the methane produced from landfilling some of

In Europe, only **16%** of food waste is captured, while globally less than **2%** of all valuable nutrients present in urban food waste and by-products get valorised

this waste, creates substantial GHG emissions.[402] In fact, food waste has been found to account for approximately 8% of the annual anthropogenic GHG emissions.[403] If, instead, circular solutions were employed to prevent food waste, increase the redistribution of edible food surplus, and increase the valorisation of unavoidable by-products and green waste through composting, 1.7 billion tonnes of CO_2 could be saved annually.[404] Furthermore, some of the USD 700 billion in environmental costs caused by the current linear food production system could be avoided by increasing the collection, redistribution, and valorisation of food surplus and inedible by-products.[405] With food waste volumes surging during the pandemic as a result of farmers' inability to get their produce to the market, the need for circular solutions that capture, redistribute and valorise surplus food and inedible food by-products will become increasingly important for easing the environmental strain of food systems.

USD 700 billion in environmental costs caused by the current system could be avoided by increasing the collection, redistribution, and valorisation of food surplus and inedible by-products

Reaping these benefits will require investment in physical infrastructure in low-income countries, such as cold chains that enable the storage, processing, and distribution of edible food. In low-income countries, most of the food loss occurs immediately after the harvesting stage, due to insufficient infrastructure to store or process excess food.[406] In India, for example, deficiencies in cold chain, distribution, and transport infrastructure are hindering industry growth.[407]

The vast lockdowns and significant disruptions to food flows caused by the pandemic, have only compounded these issues. For example, in Africa, the border closures preventing produce transport resulted in mountains of rotting crops in depots.[408] Increasing the availability of cold chain or specific food processing infrastructure could then extend the shelf life of food while addressing the main cause of food waste in these areas. Using freeze-drying infrastructure to process food, for example, allows it to be kept from spoiling before reaching consumers, while also retaining up to 98% of the food's nutritional value.[409] These solutions are already being trialled on the market as exemplified by, for instance, the Ugandan fruit and vegetable dehydrator Sparky Dryer that runs on garden waste and extends food shelf life from days to months.[410] However, much more investment is still needed for storage and processing infrastructure to effectively tackle the challenges of edible food surplus.

In high-income countries, infrastructure facilitating the redistribution of edible food surplus will be needed. In contrast to the situation in low-income countries, high-income countries generate the majority of their food waste at the post-consumer stage.[411] A 2011 FAO study found that 95–111 kg of food waste per capita was generated annually by European and North American consumers, while the corresponding number for sub-Saharan African and South/Southeast Asian consumers was a mere 6–11 kg.[412] A lot of this wasted food is still edible, but due to factors, such as confusing labelling or aesthetic issues, these items get unduly discarded.[413] In order to prevent this edible food from going to waste, investments in redistribution systems that allow retailers, restaurants, and consumers to redirect their surplus food, will have to be made. Many examples of such systems that could be widely adopted and further developed already exist, such as the FareShare FoodCloud platform connecting large retailers with surplus food to local charities, the Danish WeFood supermarket selling produce past its sell-by date at strong discounts, and the mobile app Karma showcasing the unsold restaurant meals that consumers can buy at half-price nearby.[414]

Processing infrastructure to collect and valorise discarded inedible food by-products will also be critical. Door-to-door collection systems, for example, may offer attractive opportunities for municipal organic waste valorisation. Though initially more costly, these systems have been found to generate purer and higher quality by-product streams at greater volumes, thereby lowering treatment costs and rejection rates further down the value chain.[415] Greater purity, in turn, can allow for these inedible streams to be utilised for higher value applications, thereby increasing the returns on valorised content. Organic fertilisers that can return valuable nutrients back to soils to help grow new food are one example of a product that can be made from purer inedible by-product streams. For example, Safi Organics helps farmers convert agricultural residues such as rice husks into a fertiliser blend that can improve farmer yield by up to 30%.[416] Alternatively, in some instances these valuable by-product streams can be turned into various bio-based materials, as evidenced by Orange Fiber, a fabric creating company, that uses pure streams of citrus juice by-products (i.e. peels) for the production of their material.[417]

However, to enable the valorisation of these collected streams, investments into processing infrastructure and reverse logistics will be needed at the same time as well. Large structures such as anaerobic digesters that produce biogas and biofertiliser; bio-refineries that create protein feed, biofertilisers and biochemicals; composting facilities that generate valuable compost or biogas; and other innovative processing solutions that use, for example, insects to convert organic waste streams to valuable products, such as AgriProtein,[418] will need to be developed and distributed, ensuring their accessibility so that their benefits may be achieved.[419] At the same time, smaller scale distributed systems that can be used on-site, such as the anaerobic digester Waste Transformer, can also offer attractive solutions for valorisation of smaller localised inedible food by-product and waste streams.[420]

Digital infrastructure, particularly food flow mapping technologies, will play a key role in the emergence of thriving food networks. Currently, very little information is available for consumers about where food comes from, and for producers about where their food ends up. Some initial attempts of food flow mapping have been made, such as the regional efforts under the FAO's City Regions Food System (CRFS), which tested rapid food flow mapping in seven cities across the world.[421] Similarly, in the US, the first map of the country's food supply chain was just created in 2019, revealing 9.5 million links between value chain players across the country's counties.[422] However, with the global nature of the food supply chain, more investments are needed to develop global food flow maps that can help create clarity around the highly complex system.

Access to this data will enable much more effective use of resources and can improve system resilience, while the increased transparency around where food comes from (taking into account all the steps of the value chain), will enable consumers to make even more informed decisions about their purchases, as they increasingly wish to.[423] Meanwhile, regenerative food producers can benefit from being more easily recognised as such, thus enabling the streamlining of supply chains to better connect these farmers directly to buyers interested in their produce. Food waste streams can also be more easily identified and potentially even circumvented through mapping,[424] while the ease of redirecting unavoidable waste for redistribution or valorisation can be increased.

Digital technologies will play a major role in enabling this greater traceability, and as such require investments. Blockchain technologies allow for real-time traceability, thereby improving consumer confidence in food safety, a factor of great importance following the pandemic.[425] Internet-of-things solutions, combined with food sensing technologies that automatically capture and report data on the status of food in transport, for example, can also be used to help determine whether unsold food items can be redistributed or ought to be valorised in other ways.[426]

While existing examples of these technologies being applied for the food sector are not yet commonplace, innovation in the space is taking place. For example, in September 2020 Farmers Business Network launched GRO Network™, a platform that combines data provided by grain farmers with artificial intelligence to produce a low-carbon grain score, which can then be used by buyers to better inform them about the impact of their sourced goods.[427]

The policy environment is increasingly supportive of investments in food circulation and valorisation. Policymakers everywhere are becoming more aware of the detrimental economic and environmental impacts of food waste, while also starting to see opportunities in its valorisation. As such, numerous initiatives and regulations are, and have been, sprouting up around the world. Japan introduced the Food Waste Recycling Law in 2001 that improved the recycling rates of food-related businesses.[428] In 2017, the Australian government released its National Food Waste Strategy aimed at halving the country's food waste produced by 2030.[429] Meanwhile, the EU's Farm to Fork Strategy of 2020 set out to create legally binding targets on food waste reduction for each member state, in order for all member states to achieve their goal of halving per capita food waste by 2030.[430] With more innovations for food waste revalorisation popping up, and a growing concern over the issues surrounding food waste, it is likely policies around this matter will also become more commonplace and potentially more welcomed by citizens in the future.

The EU's Farm to Fork Strategy of 2020 set out to create legally binding targets on food waste reduction for each member state, in order for them to achieve their goal of **halving per capita** food waste by **2030**

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