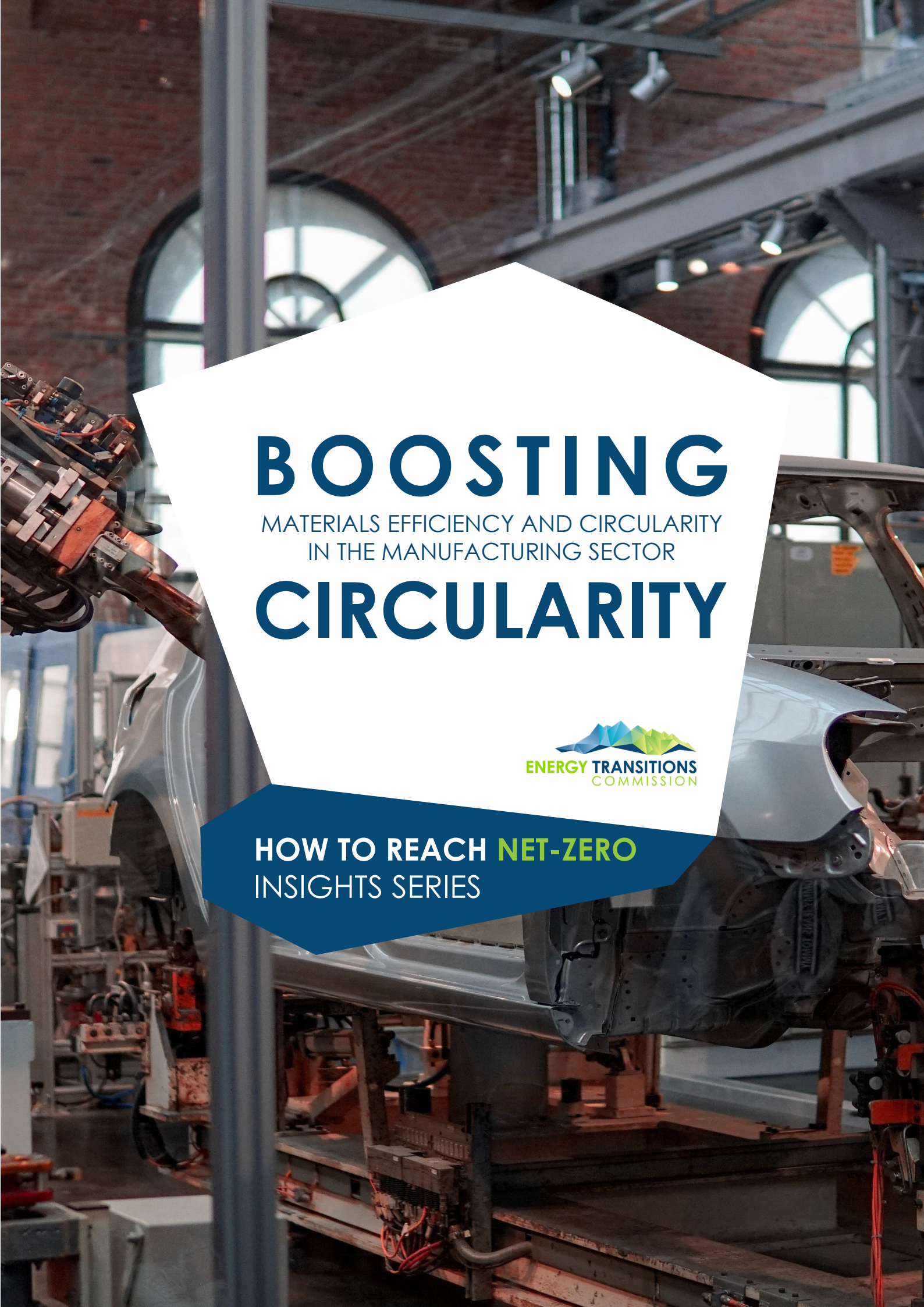


BOOSTING CIRCULARITY

MATERIALS EFFICIENCY AND CIRCULARITY IN THE MANUFACTURING SECTOR

ENERGY TRANSITIONS COMMISSION

HOW TO REACH NET-ZERO
INSIGHTS SERIES

OVERVIEW

In its 2050 long-term strategy[i], the **European Commission called for a climate-neutral Europe** and laid out several scenarios on how to achieve this objective. In parallel, analyses from the Energy Transitions Commission[ii], Industrial Transformation 2050[iii] and others have demonstrated the technical and macroeconomic feasibility of achieving net-zero carbon emissions from the energy and industry system by mid-century, including in the harder-to-abate sectors of the economy.

These analyses have revealed that **materials efficiency and circularity can drastically reduce carbon emissions from heavy industry sectors** by reducing the volume of carbon-intensive virgin materials produced. By 2050, annual carbon emissions from four sectors (plastics, steel, aluminium, cement) could be reduced **by 40% globally**[iv] and **up to 56% in Europe** versus a business-as-usual scenario[v].

- The **biggest opportunity lies in the plastics value chain**, as less than 10% of plastics consumed in Europe are currently recycled[vi]. By contrast, **metals (steel, aluminium) are already commonly recycled,** although recycling rates can be pushed further up. **Cement is technically difficult to recycle** once transformed into concrete, but concrete can be reused as aggregates.
- In parallel, greater materials efficiency (i.e. lower materials input to a given product), reuse of components, longer product lifetimes and shared use models can significantly **reduce the total materials input to the buildings and automotive value chains**, triggering potential CO2 emissions reduction of up to 50% in the buildings and 70% in the automotive value chains.

Developing materials efficiency and circularity demands to **profoundly alter current practices at multiple stages across value chains**, from product design to recycling. But responsibilities are split between materials producers, product manufacturers, retailers, service providers, consumers, waste collection authorities, recyclers, etc. The core of the challenge lies in this fragmentation:

- Greater materials efficiency and circularity **can only be achieved through coordinated action along key value chains**. Isolated action could at best be ineffective and even be counter-productive, as stakeholders fail to anticipate externalities at other stages of the value chain.
- **The stakeholders who would most benefit** from greater materials efficiency and circularity **are rarely the ones who would have to evolve their practices and face related upfront costs**. In particular, the shift to a more circular economy implies a shift from a model where value is mostly captured upstream – by materials producers, manufacturers and retailers – to a model where value would be mostly captured downstream.

To drive progress, **policymakers face a trade-off between multiplying regulations** and standards at different stages of key value chains **and establishing broader financial incentives** which could alter practices of multiple players. Beyond legislation already in place at EU level and in member countries, **five additional areas of intervention** could be further explored:

- **Broadening the scope of materials-related policies**, by also incentivising or regulating materials efficiency, quality of recycled materials, and longer product lifetimes;
- **Applying extended producer responsibility in a broader range of sectors**, including a larger number of household appliances as well as the automotive, construction or energy sectors…;
- **Getting materials prices right** by using carbon pricing and/or taxation to enhance the competitiveness of recycled materials versus primary materials;
- **Taxing – or even banning – landfilling and incineration** of recyclable end-of-life materials;
- **Using public procurement** to drive adoption of new circular products and services.

SETTING THE SCENE
The importance of materials efficiency and circularity for climate

Significant reductions in carbon emissions can potentially be achieved by **reducing the volume of carbon-intensive virgin materials produced** in the economy while continuing to provide the same level of end services to consumers. This would come with additional benefits: (i) the scale of the investment required to decarbonise the remaining virgin production would be lower and (ii) it could also reduce consumption of other constrained resources, like water or rare metals.

What materials efficiency and circularity entails

Various dynamics at play in the materials value chains could lead to such an outcome:

- **Materials recirculation**: A greater share of materials demand can be met by recycled materials rather than virgin materials by driving up both recycling volumes and the quality of recycled materials. Components can also be re-used and re-manufactured.
- **Product-material efficiency**: The material input required for a given product can be reduced thanks to lower production waste as well as better design (substitution of carbon-intensive materials by lower-carbon ones, use of high-strength materials enabling light-weighting…).
- **Circular business models**: It is often possible to deliver the same benefits or service to consumers with a lower stock of products by increasing the lifetime of these products as well as by increasing utilisation rates through sharing practices or product-as-a-service offers.

Carbon mitigation potential in Europe

We estimate that adopting a more circular economy can **cut annual CO2 emissions from heavy industry by 40% by 2050 globally**[vii]. On a European scale, the emissions reduction potential could be even greater, given that materials demand is flatter and potentially recyclable materials stocks higher in developed economies than in developing economies: **annual emissions from the European heavy industry could be reduced by up to 56% by 2050**[viii].

A large share of this carbon mitigation potential arises from **reuse and recycling**:

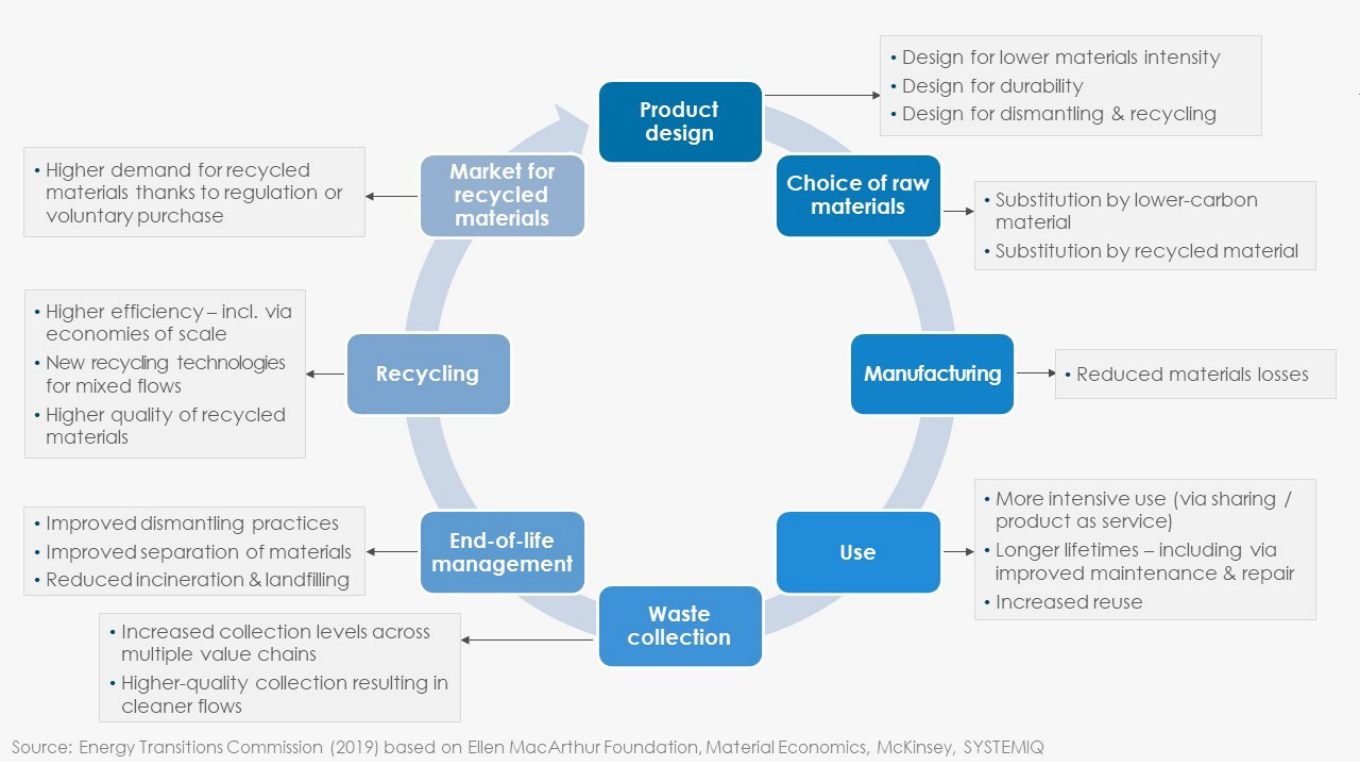
- **The greatest opportunity lies in the plastics value chain**. 58Mt of plastics are produced in Europe every year, of which about 50Mt are consumed in Europe while the rest is exported. Only 20% of the European consumption is collected for recycling at end-of-life, and only half of that is actually recycled. In a circular scenario, **reuse and recycling could go from 10% to 50% of European consumption by 2050**, by focusing on three major plastics-using value chains (packaging, construction, automotive) and five major types of plastics. This could reduce carbon emissions from plastics by 57% by mid-century, if accounting for both emissions from plastics production and emissions from end-of-life plastics incineration.
- **Metals are already highly recycled materials**: around 80% of end-of-life steel aluminium are recycled in Europe. However, recycled materials are often lower-quality due to contamination with other materials, in particular copper, which limits the number of applications of recycled metals. Recycling rates could be driven further up through improved collection and higher-quality dismantling. **In Europe, steel demand could in principle be met almost entirely by recycled steel and about half of aluminium demand could be met with scrap-based production**. This would lead to a reduction by respectively 67% and 56% of carbon emissions from these sectors.
- Finally, **cement is almost impossible to recycle** once transformed into concrete. However, progress can still be achieved in the cement-concrete value chain by (i) **recycling the share of unused cement still found in the concrete**, which is now possible thanks to breakthrough technologies and (ii) **recycling concrete as aggregates**. These practices could reduce carbon emissions from cement production by 44% in Europe by 2050.

Beyond reuse and recycling, **greater materials efficiency** in key value chains can unlock further carbon emissions reduction:

- In Europe, **carbon emissions from materials used in buildings could be reduced by more than 50% overall**. Beyond materials recycling, the most important levers to achieve this target are to prolong the lifetime of buildings, improve the materials efficiency in buildings design, reuse building components (instead of demolishing) and develop space sharing (in particular shared working spaces) to reduce the total number of square metres required in the economy.
- The potential is even greater in the automotive value chain. In Europe, **carbon emissions from materials used in the automotive industry could be reduced by up to 70%**, in particular through longer vehicle lifetimes and vehicle sharing practices – reducing the number of vehicles required – and light-weighting – reducing the amount of materials per vehicle.

The need for value chain coordination

Developing materials efficiency and circularity demands to **profoundly alter current practices at multiple stages across key value chains**, from product design to secondary materials markets. Some of these are **technical changes** – e.g. product design, dismantling practices – while some imply **behavioural changes** at consumer level – e.g. new consumption patterns, recycling practices. The below exhibit describes some of the main developments required.



Source: Energy Transitions Commission (2019) based on Ellen MacArthur Foundation, Material Economics, McKinsey, SYSTEMIQ

Achieving those changes **demands greater coordination across the value chain**, since:

- Improvements at different stages are highly **interdependent** – for instance, improved product design is a prerequisite of improved dismantling, which is itself a prerequisite of higher-quality recycling;
- **Failing to anticipate externalities** at other stages of the value chain could drive counterproductive results – for instance, light-weighting should not come at the expense of product lifetime, and materials-efficient design should not require higher maintenance and be higher-carbon in use.

FRAMING THE DEBATE
What hinders improvements in materials efficiency and circularity?

Most of the carbon mitigation opportunities arising from greater materials efficiency and circularity would in principle come at a negative carbon abatement cost, that is **they would generate a net economic benefit to the economy**[ix]. **New business models** are being deployed to capture that value, often by new entrants and sometimes also by incumbents. These players usually seize opportunities that least depend on changes at other stages of the value chain (e.g. product sharing based on digital platforms) or tend to integrate vertically to control key change levers across the value chain (e.g. manufacturers developing product-as-a-service offers as well as end-of-life management). However, progress is still limited due to the fragmentation of those value chains.

Split incentives across value chains

Responsibilities are indeed split between a large number of stakeholders: materials producers, product manufacturers, retailers, service providers, consumers, waste collection authorities, recyclers, etc. The core of the challenge lies in this fragmentation: **the stakeholders who would most benefit from greater materials efficiency and circularity are rarely the ones who would have to evolve their practices and face related costs**, for instance:

- **Product manufacturers** have no incentive to improve the design of their products for recyclability as they generally do not face the cost of their end-of-life management, nor for durability as their revenues usually depend on rapid stock turnover.
- **Providers of products "as a service"** – which rely on lending or sharing business models – are not usually manufacturers and have limited power to influence the characteristics (e.g. durability) of products put on the market by upstream producers.
- **Waste collection services** are generally rewarded for the quantity of materials they collect, rathe than the quality of these materials.
- **The recycling industry** has limited-to-no ability to influence waste collection schemes, and even less so product design.

The shift to a more circular economy implies **a shift from a model where value is mostly captured upstream** – by materials producers, manufacturers and retailers – **to a model where value would mostly be captured downstream** – by consumers, service providers as well as secondary materials producers and traders.

The conundrum of regulation vs. pricing

In that context, policy interventions are essential to shape new incentives at every step of the value chain. However, to drive progress, policymakers face a trade-off between:

- **Multiplying regulations and standards at different stages of key value chains** – e.g. on the materials efficiency, recyclability, recycled content of a broad range of consumer products, on the quality of waste flows collected, on the quality of recycled materials…;
- **Establishing broader financial incentives by pricing key externalities** – e.g. pricing raw materials based on lifecycle carbon-intensity or recycled content, increasing pricing of end-of-life collection and management...

The multiplication of standards is made more difficult by the fragmented, diverse and constantly evolving nature of the value chains in question, while pricing could potentially drive more efficient practices across broader and longer value chains and leave more space for innovation. But **both routes face political acceptability issues**: the multiplication of regulations is rarely well perceived by businesses, while pricing can be unpopular with consumers and tax-payers.

MOVING FORWARD
How to accelerate the growth of a circular economy

In the last five years, the European Union and Member States have developed **a growing body of legislation to encourage the growth of a circular economy**. The EU Circular Economy Package was adopted in 2018 and national roadmaps have been developed in many Member States. These texts focus in particular on increasing recycling rates and reducing landfilling rates, improving separate collection of materials to improve the quality of end-of-life flows, reducing waste flows (in particular by reducing packaging, single-life plastics products and food waste), and strengthening extended producer responsibility schemes (in particular for packaging). We have identified **five areas of policymaking** that could be explored further to accelerate progress:

Broadening the scope of materials-related policies

At this stage, most policy levers focus on improving product design for recyclability, on the one hand, and end-of-life collection and treatment, on the other hand. **There has been less policy focus to date on other key steps of circular value chains**, in particular on incentivising:

- Use of recycled materials instead of virgin materials;
- Greater materials efficiency in product design;
- Conception of products with longer lifetimes;
- Behavioural changes at consumer level, in particular to encourage sharing, maintenance and reuse of products;
- Development of business models which enable more intensive use of materials and products;
- Scale-up of recycling activities so as to achieve economies of scale.

Applying extended producer responsibility in new sectors

EPR schemes have already been used effectively in several sectors, like packaging and electronics. They could be extended to a broader range of sectors, including

- **A larger number of household appliances** – in particular furniture, white goods, electronic materials;
- **The automotive industry** – especially as growing electrification of transport will lead to increased use of batteries and establishing a circular batteries model is essential to limit impact on resources like rare metals[x];
- **The construction industry** – where constructors are currently rarely exposed to the costs of buildings in use and at end-of-life, given very long asset lifetime;
- **The energy sector** – in particular at the dawn of a new wave of investments in the power sector, driven by increased electrification of the economy.

Getting materials prices right

Virgin materials currently often outcompete recycled materials, hence limiting the size of the market for the recycling industry. This difficulty is twofold: on the one hand, the **quality** of recycled materials is often lower than that of virgin materials – with the implications and solutions outlined earlier in this note –; on the other hand, the **price** of recycled materials can also sometimes be higher than that of virgin materials. This second issue arises from the fact that materials pricing does not reflect externalities related to carbon emissions and other forms of environmental pollutions.

Getting materials prices right is essential to scale-up the secondary materials market.

- An obvious route to do so would be **carbon pricing**. However, this option is made more difficult (i) by concerns over the international competitiveness of local industries if carbon pricing was to be imposed regionally and (ii) by the difficulty to track and measure lifecycle carbon emissions along extended value chains.
- An alternative route would be to enhance the competitiveness of recycled materials through **preferential taxation**. This route offers a broader set of options, as governments could modulate value-added tax rates, corporate tax rates, labour taxes (which could be particularly powerful given that waste collection, sorting and recycling are usually labour-intensive activities).

Taxing – or even banning – landfilling and incineration

The underlying reason of relatively low recycling rates in some value chains is that landfilling and incineration are often lower-cost end-of-life solutions than recycling. **Taxation can help bridge this gap, but banning could also be pursued where taxation does not prove to be sufficiently dissuasive**.

- **Policies to reduce landfilling** are already being deployed in Europe and should continue to be pursued. Increasing taxes on landfill is a key tool to make recycling a comparatively more economic option, but banning could also be considered for key products like metals.
- **Incineration should be treated in the same way as landfilling**. Although it is sometimes considered as a better solution than landfilling as it limits risks of waste leakages in the environment (lands, rivers, oceans) and appears to be a circular option as it allows for a second use of the materials (to produce heat for industry or the residential sector), **incineration remains a carbon-emitting pathway**, which at best replaces carbon emissions from fossil fuels, but still contributes to climate change, unless it is combined with carbon capture. By contrast, **plastics or paper recycling offer a closed carbon cycle** – as the carbon remains embedded in the recycled product – and even secured landfilling could be considered as a form of carbon storage in material form.

Using public procurement to drive adoption of new circular products and services;

Alongside regulation and pricing, **demand for more circular products and services** is essential to drive the deployment of new product designs, reused/recycled products and new business models. This demand pull can sometimes come from consumers and consumer-facing companies – as is currently happening in packaging –, but this pull is unlikely to be sufficient, especially in sectors like construction or energy which are less consumer-facing.

In Europe, public procurement represents a significant share of demand in multiple sectors of the economy – including but not limited to construction, buildings equipment, municipal services, office supplies, light-duty, medium-duty and heavy-duty vehicles, etc. **Integrating criteria related to materials efficiency and materials circularity in public procurement practices** would not be a small endeavour, given the multidimensionality of the topic, but progressive steps could help create initial niche markets for circular products and services, incentivising additional investment in the circular economy.

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[viii] All European numbers in this section are from Material Economics (2019), *Industrial Transformation 2050 – Pathways to Net-Zero Emissions from EU Heavy Industry*

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The E**nergy Transitions Commission (ETC)** is a diverse coalition of global leaders from across the energy landscape: energy producers, energy-intensive industries, equipment suppliers, investors, non-profit organizations and academics from the developed and developing world. We aim at accelerating the transition to low-carbon energy systems providing prosperity to all, by using our unique voice and our original research to inform policymakers and private sector decision-makers.

In 2018, the ETC published the report "**Mission Possible**: Reaching net-zero carbon emissions from harder-to-abate sectors by mid-century", which demonstrated that it is technically and economically feasible to bring carbon emissions from heavy industry and heavy-duty transport down to zero globally by mid-century, without relying significantly on offsets from the land use sector. This report was followed, at European level, by the report "**Industrial Transformation 2050**", focusing on the decarbonisation of heavy industry, with the support of a consortium of organisations, including the ETC.

Building on these visions of a future that is both desirable and possible, the ETC is now exploring **what policies and business initiatives could accelerate the transition** to net-zero carbon emissions in Europe. We are convening a series of high-level discussions, under Chatham House rule, to explore specific areas of intervention with selected policymakers, experts, industry and finance executives. This insights series summarises the **key takeaways** of these discussions. The ETC Commissioners have not been asked to formally endorse these conclusions.

STAY IN TOUCH