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Pathways towards circular plastics

Point of view

Deloitte Belgium, April 2021

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1. Purpose of the article

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The devastating effects of widespread plastic litter, microplastic pollution and global climate change are omnipresent. Nobody can contest that we have been stuck at the stage of making pledges for too long. Although acknowledged as an extraordinary human invention with a vast set of exceptional features and applications, plastics have to transition from a linear to a circular lifecycle in order to preserve our planet's environment.

On top of causing an unprecedented health and socio-economic crisis, COVID-19 is driving mass production of single-use, plastic-based face masks. Since the start of the pandemic, an estimated 129 million units are being used and discarded every month, leading to an increase of litter in the environment. In parallel, social distancing measures are boosting home deliveries for consumer goods, sustaining the growth of single-use plastic packaging. [1]

This article provides an update on the environmental impact of plastics[1] and presents essential pathways towards circularity. It is based on Deloitte's professional experience in the plastics ecosystem, previous publications and additional secondary research. We hope you will enjoy the read and we are looking forward to joining forces to make plastics circular.

[1] The effects of microplastics and toxic additives on human health will not be elaborated in this article

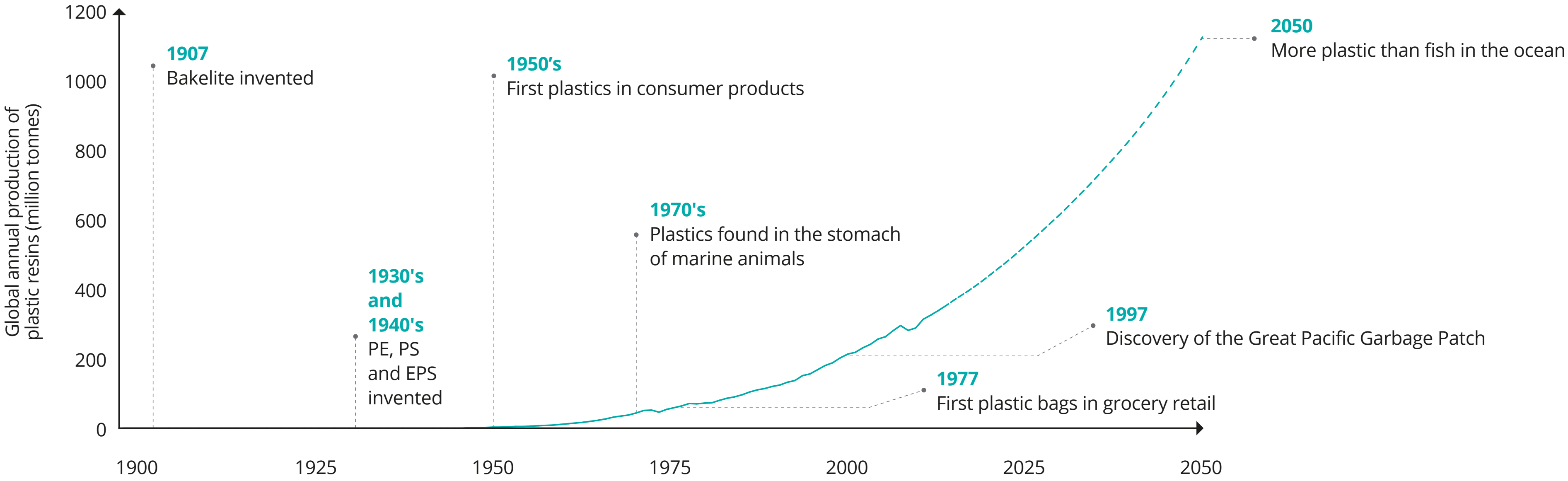
2. Environmental impact

The rise of plastics and the environmental consequences

Often considered as the Father of the Plastics Industry, Belgian chemist Leo Baekeland created bakelite in 1907, the first fully synthetic plastic, brought to market as electrical insulator. Three decades later, during World War II, plastics were used in military applications such as parachute nylon and airplane plexiglas, replacing metals and other scarce materials. [2]

As of the fifties, plastics boomed together with the rise of consumer goods. Given their low cost and versatility, they started to replace steel in cars, paper in packaging and wood in furniture. Their environmental impact was only discovered in the sixties, when plastic debris were found in oceans. The high consumption of disposable plastics and their inability to be easily degraded in nature started to affect their reputation, but consumption continued to grow. Collection and recycling started in the eighties, yet today we are still a landslide away from full circularity. If we do not make radical changes, plastic debris will outweigh fish in the ocean by 2050. [2,2 bis]

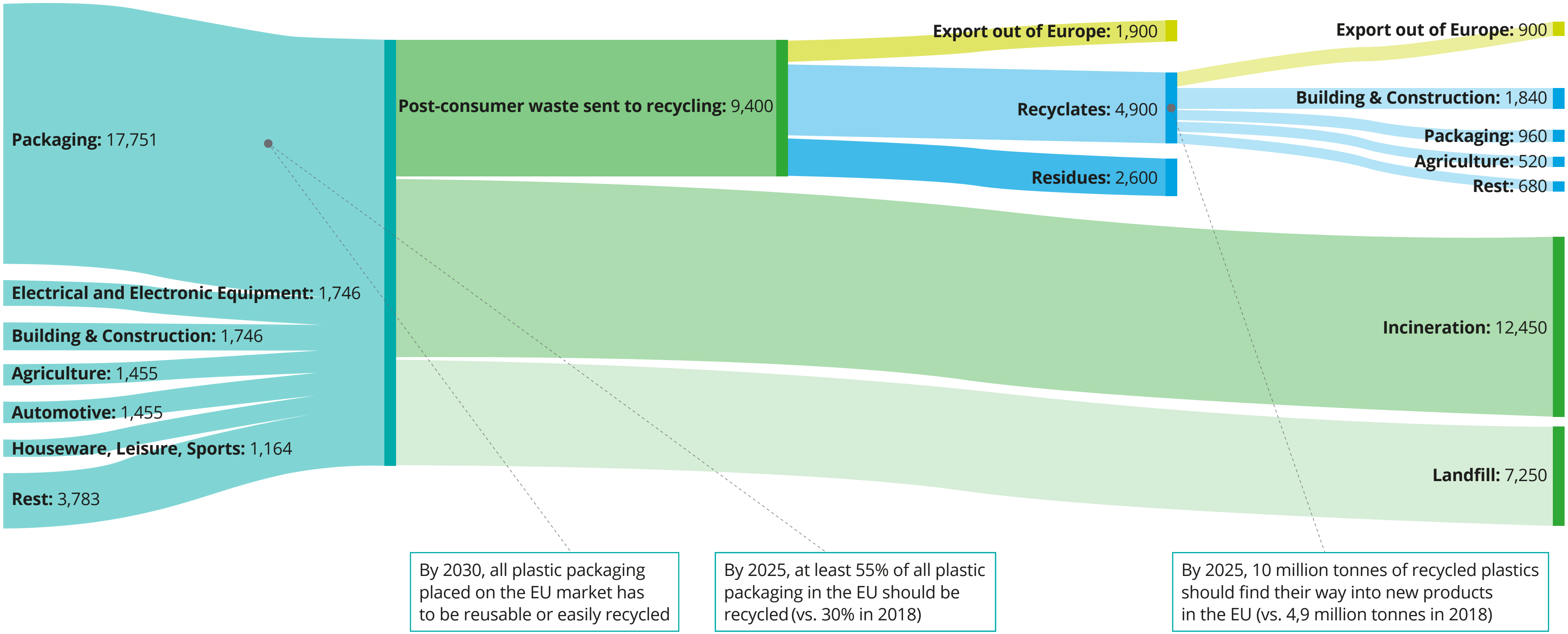
Evolution of global plastic production



Plastic waste volumes and targets in the EU

The most recent figures show that the total post-consumer plastic waste collected in the EU[1] accounts for a yearly 29.1 million tonnes, of which 43% is incinerated for energy production and 25% still ends up in landfills. The remaining 32% (9.4 million tonnes) is destined for recycling, out of which 4.9 million tonnes actually find their way into recyclates. The top three sectors using recyclates are today building & construction, packaging and agriculture. [3,4]

2018 plastic waste volumes (kilo tonnes) in the EU compared to the targets

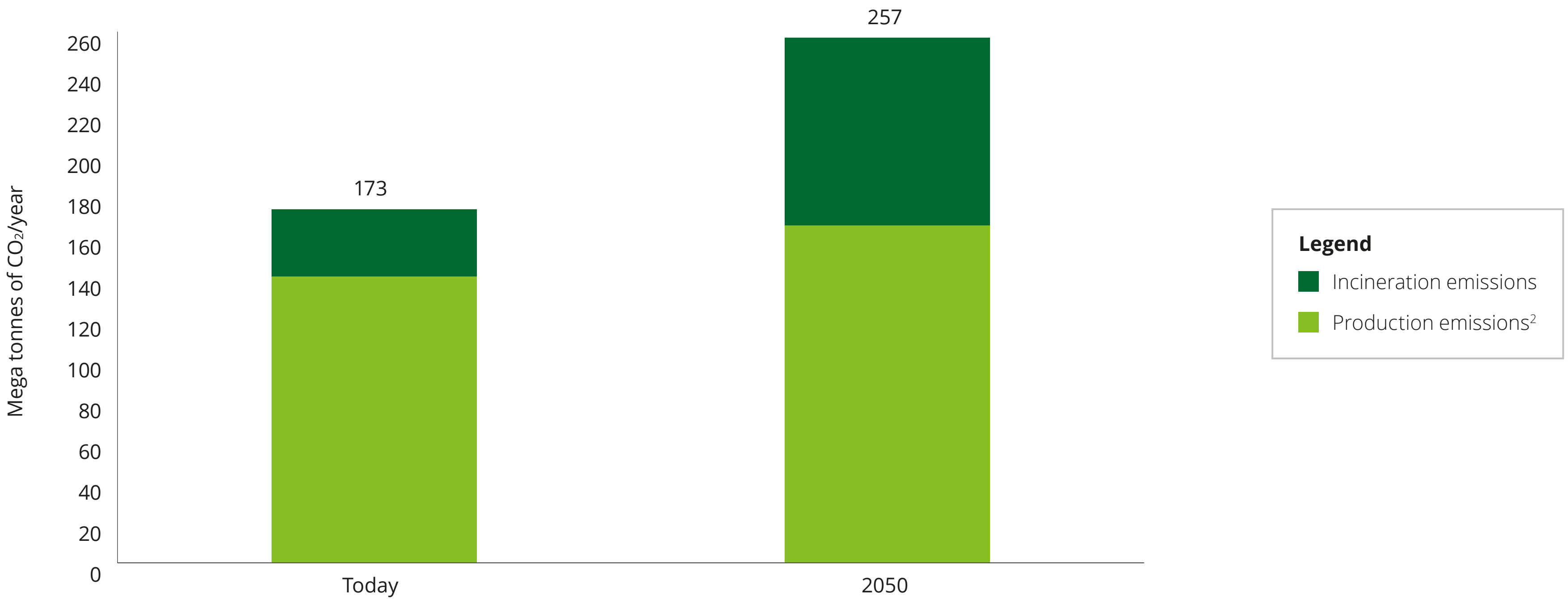


[1] Including the UK

The carbon footprint of plastics

Plastic is today the second material after steel in terms of CO_2 emissions related to production. The combination of plastics production and end-of-life treatment is generating 173 M tonnes of CO_2 in the EU on a yearly basis. Without any bold circular moves, waste incineration would remain the best alternative to landfilling. The overall CO_2 footprint would grow by another 50% by 2050, if we assume continued increase of plastics usage. [5]

Plastics CO_2 footprint in the EU[1]



[1] Including the UK
[2] Excluding savings from potential process efficiencies

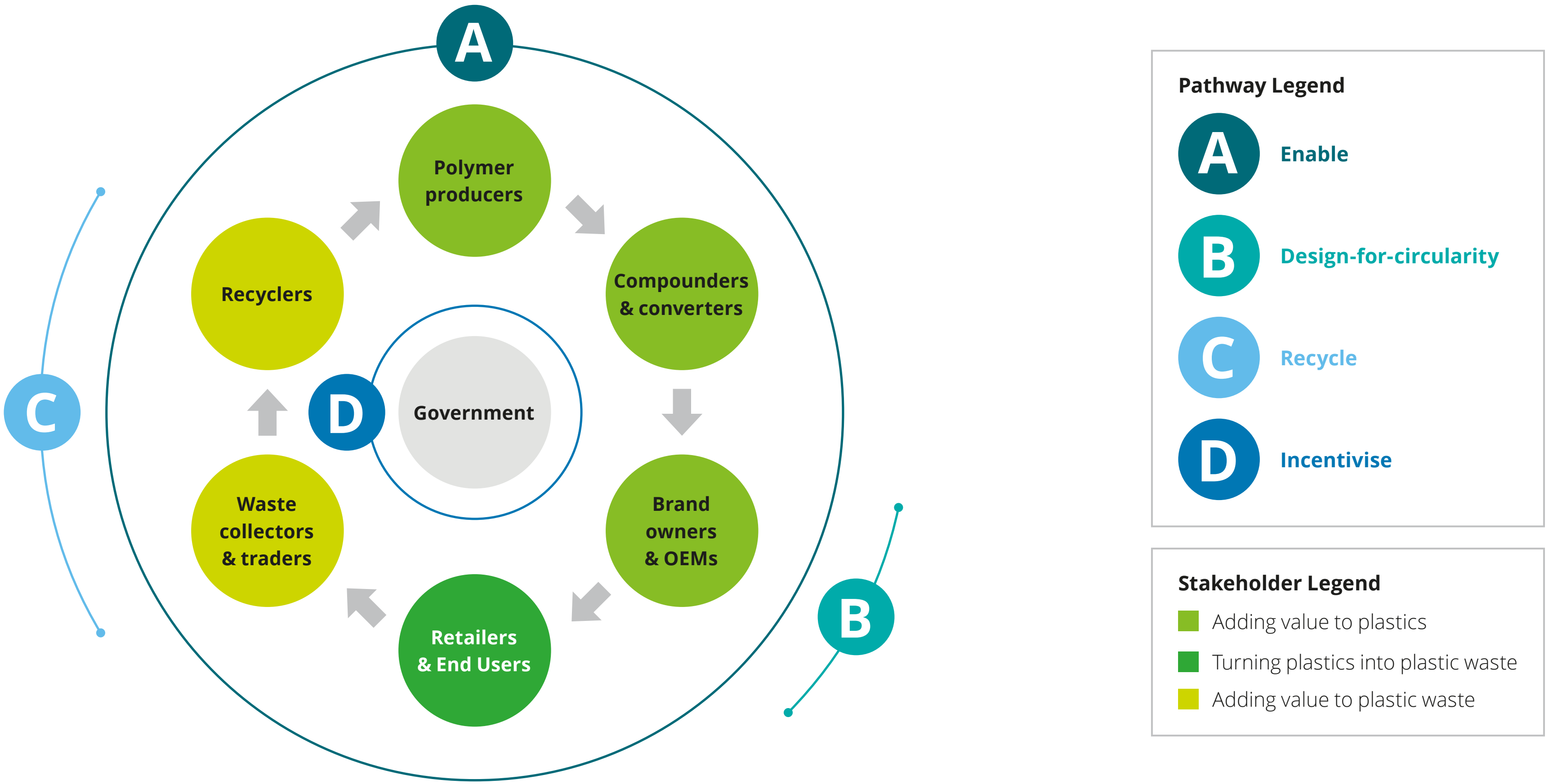
3. Pathways towards circular plastics

Four compatible pathways

Circular plastics is a hot topic today, with high public attention and with governments, industry associations and other organisations driving various initiatives. In this section, we provide more insight in four essential pathways. Bio-based and biodegradable plastics are not addressed here as more taxonomy and scientific evidence is needed.

Below is a schematic overview of the international plastics ecosystem, with a representation of the main stakeholders that add value to plastics and plastic waste. We have plotted the four pathways to this scheme, showing that a stakeholder can have more impact on certain pathways than on others. Nonetheless, for each pathway, concertation across the ecosystem is a key success factor and that is why running initiatives such as the Circular Plastics Alliance have to be further intensified and expanded.

Stakeholder ecosystem and four pathways towards circularity



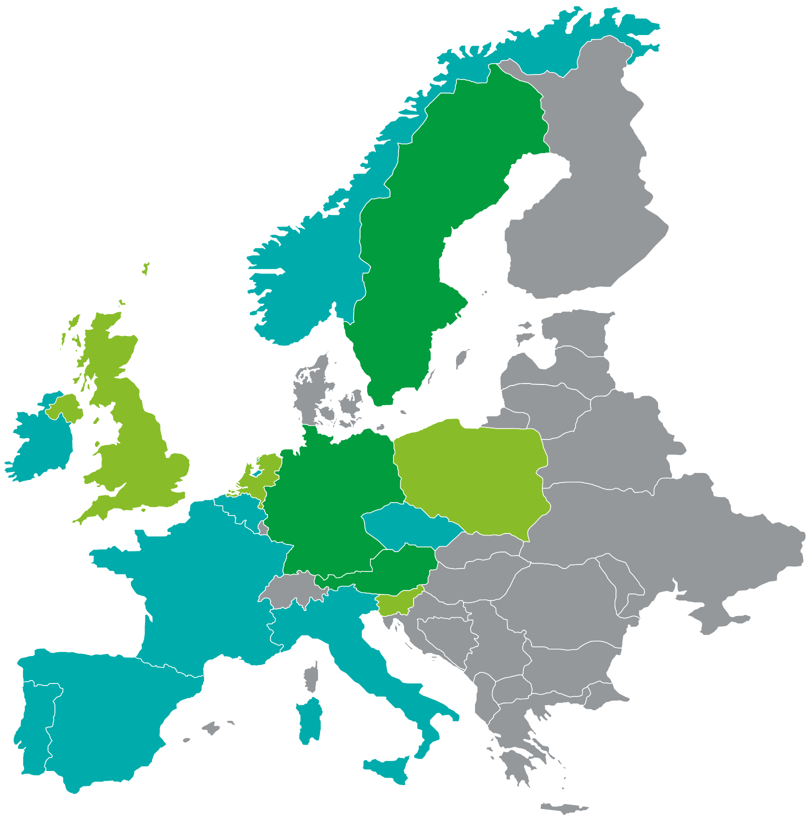
A Enable: Harmonise and enhance the regulatory framework

1. 2008 – The Waste Framework Directive

This directive has introduced the foundational polluter-pays principle through "Extended Producer Responsibility" (EPR) schemes for different materials including plastics. [6,7]

Each EU member state[1] has introduced its own EPR schemes and within each national scheme, a Producer Responsibility Organisation (PRO) is mandated to collect fees from brand owners and OEMs in order to cover waste collection and treatment costs downstream. Three main categories of EPR models can be laid out based on the role the PRO is playing.

Overview of EPR models applied across EU member states[1]



Country Legend

- PRO (co-) finances waste collection and treatment
- PRO (co-) finances and (co-) organises waste collection and treatment
- PRO is fully responsible for financing and organising waste collection and treatment
- Other EPR model

[1] Including the UK

A Enable: Harmonise and enhance the regulatory framework

2. 2018 – The Single-Use Plastics (SUP) Directive

The directive aims at tackling the SUP waste issues by setting concrete and binding, targets for the coming years [8]:

- Plastic ban on products[1] for which suitable alternatives are readily available
- Labelling requirements for appropriate disposal
- Consumption reduction targets for plastic food containers and beverage cups
- Min. 25% recycled plastic content in PET bottles
- 75% collection target for plastic bottles <3 litres
- Caps to remain attached to beverage containers <3 litres

3. 2021 – EU Plastics Levy

To fund part of the EU COVID-19 recovery package, member states will be charged an effective rate of €0.80 per kilogram of non-recycled plastic packaging produced and/or imported, as of 2021. This will likely end up in different national schemes discouraging producers and importers to work with virgin plastics (see pathway D for the UK example). It is today still unclear which measurement standards will be rolled out (e.g. definition of non-recycled volume) and how the single market concept across the member states will be ensured. [8bis]

4. Path forward

With the recent Circular Economy Action Plan as part of the 2019 Green Deal, the EU has committed to further intensify the efforts towards circular plastics. This will include EPR harmonisation through standardised definitions of plastics, plastic waste, fair cost allocation, product marking and labelling as well as enforced minimal levels of recycled content usage in packaging, construction materials and vehicles. [9]

The ambitious EU policies will undeniably be a game changer for the plastics ecosystem. The coming months and years will show to which extent they will impact each individual stakeholder group. The challenge will be to guarantee an equal-level playing field in the international plastic value chain. If there is too much variety of national implementation models, there is a risk of triggering production relocation moves instead of circular moves. In parallel, significant material streams to and from non-EU countries will either have to stop or become part of the policies to guarantee full effect (e.g. the current waste flows to Turkey for landfilling). [9bis]

Finally, embedding the principle of eco-modulation can enhance the EU policies and EPRs. It has the potential to incentivise brand owners to design-for-circularity beyond recyclability and it can be applied to non-SUP products, for instance through a levy on micro-waves or vacuum cleaners not reaching minimal useful life, or through a bonus for produced laptops that assure easy disassembly and spare part replacement.

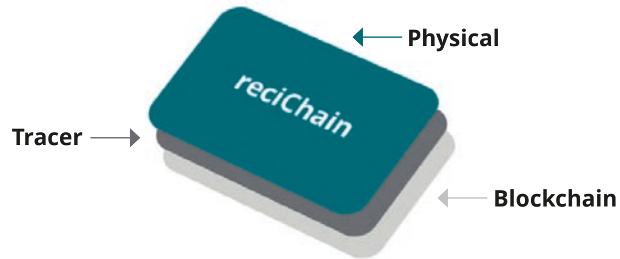
[1] SUP cotton buds, straws, plates, cutlery, beverage stirrers, balloon sticks, oxo-degradable plastics (plastics with specific additives facilitating fragmentation in nature), and expanded polystyrene food containers, beverage containers and beverage cups

A Enable: Increase the availability of reliable data

An enhanced and harmonized regulatory framework will only have the right impact if it can lean on reliable performance measurement across the ecosystem . Even though concrete targets have been set up in the Single-Use Plastics Directive, the pervasiveness of plastic products and the complex international supply chain make it hard to quantify plastic flows and to monitor the actual progress. Blockchain technology can enable decentralised, verified, multi-stakeholder data generation which is required to ensure plastic traceability and accurate performance monitoring.

Industry Case | BASF ReciChain

BASF and its partners, including Deloitte as strategic advisor, have made a circular breakthrough with the ReciChain project, which consists in marking plastics with a barcode resistant to manipulations and mechanical recycling. This barcode generates a digital twin in the blockchain that captures the right information to enable different circularity pathways, for instance tracking of closed-loop recycling, administration of EPR schemes and quality assurance on recycled content.



BASF is currently conducting a pilot in Canada and in Brazil with the aim of further expanding.
See here for further details.

B Design-for-circularity

There is no such thing as "the" circular economy. There are different ways of closing the loop and the principle is that the smallest loops (reuse, repair, endure) are the most cost-effective and environmental-friendly ones. If brand owners and OEMs do not take into consideration circularity in the design of products and packaging, the downstream cost of circularity will increase. Here are examples of how brand owners & OEMs can apply the four circular design principles. [10,11]

Reusability	Repairability	Durability	Recyclability
Product ability to get multiple consecutive useful lives. Needless to say, this is the most cost-effective solution to make plastics circular.	Product ability to be easily repaired, for instance through modularity, ease-to-disassemble and spare part availability.	Product ability to extend useful life without excessive damage or unexpected maintenance. Regulation around minimum durability of plastic products and parts can play a major role in extending the useful product lifetime.	Product ability to be efficiently collected, sorted and reprocessed for new usage (e.g. mono-polymer materials, avoidance of colour usage, etc.).

Examples

Reusability	Repairability	Durability	Recyclability
CupClub is a returnable drink packaging service in the UK, enabled by cup traceability through radio-frequency ID and internet of things (IoT). This allows brand owners to track products and intensify customer loyalty schemes.	Krups, a German kitchen appliance manufacturer, has pledged to be able to repair its products up to 10 years after purchase. To ensure a lifetime supply of the right plastic spare parts, Krups has set up a 3D-printing capability.	The Ecodesign regulation for vacuum cleaner hoses is today the only minimum durability policy, e.g. the hose must be able to resist 40 000 oscillations, as an expression of minimal product lifetime.	Borealis and Borouge generated a series of new and fully recyclable mono-material pouch solutions for various applications such as food packaging.

C Recycle

When neither reuse, repair nor endure are feasible, there are still two ways to avoid incineration. Mechanical recycling is currently the only operational technology, whereas chemical recycling is still in development stage and expected to become a valuable complement.

Mechanical recycling is a sequence of physical process steps such as grinding, washing, separating, drying and re-granulating. With 600 active companies and 20,000 employees across Europe, the sector accounts for a yearly capacity of 8.5 million tonnes of recyclates. To meet the target of 10 million tonnes of recyclates in new products by 2025, the recycling capacity has to increase by at least 18%. [12,13]

Effective mechanical recycling is strongly conditioned by the waste characteristics. It can only digest mono-polymer plastics, as each polymer has its own production parameters and melting temperature. It also becomes less effective in case of contamination (e.g. food, metals, paper). Nonetheless, there are two noteworthy innovations that will further increase the volume of plastic waste suitable for mechanical recycling:

Near-infrared sensors in waste collection

The miniaturisation of optical identification technology to enable automated recognition of waste fragments in smart collection bins, leading to higher waste purity and increased collection efficiency.

Machine-learning in waste separation

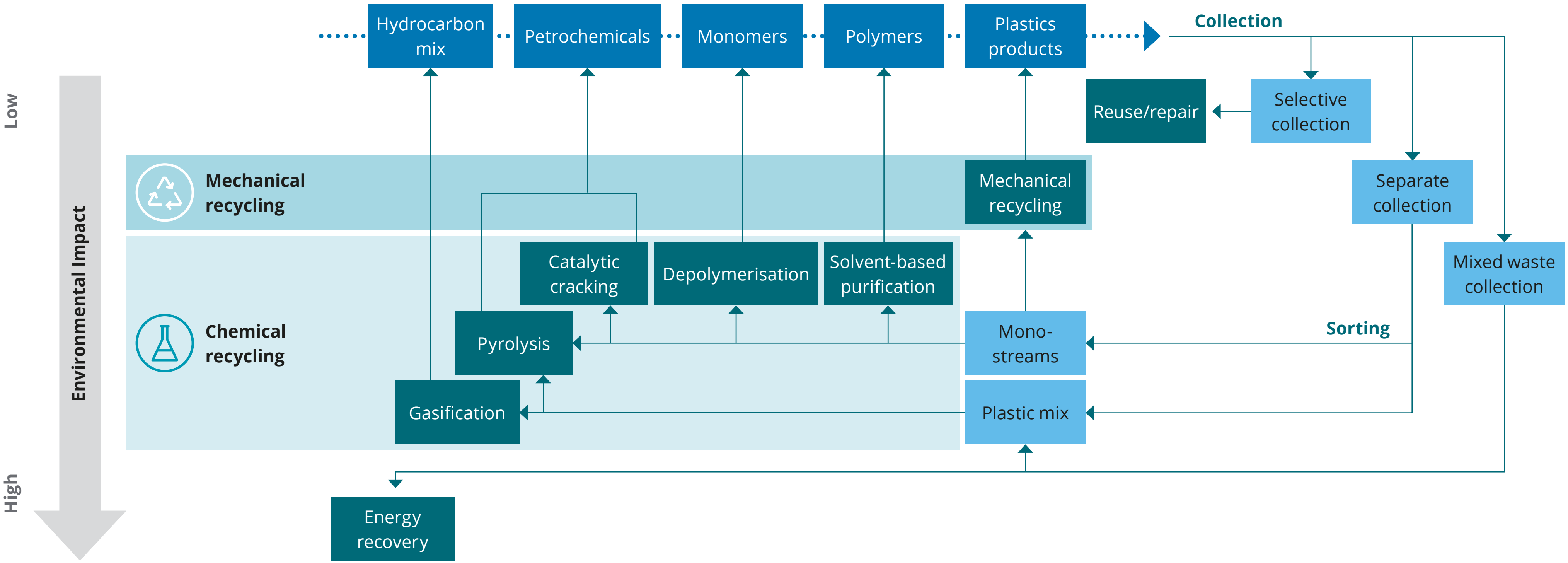
Machine-learning systems to enhance the sorting and picking process during waste separation, whilst decreasing the amount of required manual interventions.

Despite these improvements, there will still be a large fraction of plastic waste left that is too impure to be mechanically recycled. A second limitation is the polymer degradation inherent to mechanical recycling. Polymers suffer from thermo-mechanical degradation due to the combination of heat and shear. This leads to lower quality recyclates after a certain number of loops and to not meeting required product specifications.

C Recycle

Chemical recycling is the process of chemically degrading plastic waste into its monomers or other basic chemicals, which can become alternative fuel or be re-polymerised into new plastics. This addresses the main challenges of mechanical recycling, as it can cope with mixed, contaminated waste and has the flexibility to be up- or downcycled to other plastic applications. Nonetheless, there is the drawback of being more energy intensive and requiring large volumes of input waste to ensure economic attractiveness. [14,15]

Recycling technologies and their environmental impact



Legend

Plastic production stage | Intermediate / final waste form | Waste conversion method

C Recycle

Below is a comparison of chemical recycling technologies under development [16,17]:

Technology	Description	Pros	Cons
Gasification	Partial oxidation of plastic waste into gaseous mixture. Can be converted into various chemicals used for plastics production, fuels and fertilisers	• Technology proven • Suitable for highly heterogeneous mixtures of plastics	• Complexity of reactions leading to less controllable product output • Production of noxious NOx and other impurities • High temperature needed
Pyrolysis	Thermal degradation of plastic waste in the absence of oxygen into basic hydrocarbons. Can be converted into waxes, oils, gas, etc.	• Relatively simple technology • Suitable for highly heterogeneous mixtures of plastics	• Complexity of reactions leading to less controllable product output • Extensive pre-recycling treatment required for PVC
Catalytic cracking	Decomposition of polymers with a catalyst. Can be converted into fuels and fine chemicals	• Controllable product output through process conditions and catalyst selectivity • Lower temperature needed compared to pyrolysis	• Risk of catalyst deactivation due to waste contamination
Depolymerisation	Solvent-based decomposition of polymers into smaller polymer fragments or into monomers	• High process efficiency • Operational for PET waste	• Mainly limited to polycondensate polymers (PET, PA, PUR, PLA, etc.) • Extensive pre-recycling treatment required to get homogenous waste input
Solvent-based purification	Solvent-based separation of polymers from their additives and contaminants, followed by filtration or phase-extraction	• Polymers as direct output • Promising for contaminated EPS	• Risk of residual contaminants in the output

D Incentivise

The transition to circular plastics requires significant investments of different stakeholders. This seems especially relevant in COVID-19 times, which show that the dependency of virgin plastic price on petrol is jeopardising the chances of recycled plastics on the market. The unfavorable price difference has grown to the extent that investments in recycling capacity are slowing down. Governments can roll out different incentive types to increase the attractiveness for stakeholders to invest in closing the smaller loops or to replace virgin plastics by recyclates:

Incentive type	Inspirational examples
Technology	The Dutch government has budgeted €22.5 M in 2019 for its Plastic Pact NL, amongst others, to run tests and pilots on full PET tray-to-tray recycling technology. [18]
Education	The EIT (European Institute of Innovation & Technology) has set up a RawMaterials Academy to emphasise the relevance of raw materials to the society as a whole, to train on current technical standards of raw materials and to foster the right entrepreneurial and innovation skills to transition from linear to circular material usage. [19]
Social Economy	The Flemish regional government in Belgium has set up a network of certified reuse centres, boosting the social economy (5000 employees) and achieving 5kg reused material per capita. The reuse centres collect around 64,000 tonnes of material annually, of which half is reused. [20]
Market conditions	With a 92% return rate for PET bottles, Finland is demonstrating the potential of deposit and refund schemes for plastics. [21]
Finance	The UK government has introduced a tax of £200 per tonne produced or imported packaging with less than 30% recycled plastic, showing how taxation can be used to give more chances to circular products. [22]

4. Conclusion

Conclusion

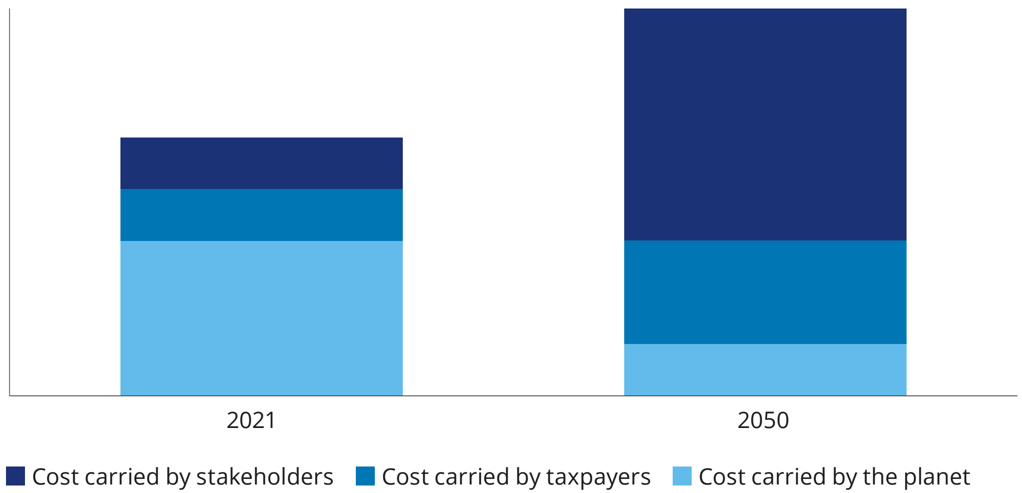
Since World War II, many natural products have been replaced by plastics because they are cheaper, lighter, safer and stronger. Today, we can hardly spend a day without being in contact with plastics. This generates a major environmental impact in terms of litter and CO_2 emissions and it brings significant health risks associated to microplastics and toxic substances. Only 17% of the European post-consumer plastic waste is currently turned into recycled products.

There are four essential, complementary pathways to turn the situation around. The first one entails an equal-level playing field through harmonised regulation across the EU and traceable plastics generating reliable monitoring. The second pathway focuses on the product design principles that brand owners have to adopt to maximise the plastic volume running through small-loop circularity and minimise the volume left for recycling. The third pathway aims to scale up mechanical recycling and mature the chemical recycling technologies, allowing Europe to cope with its own end-of-life plastics. Finally, the fourth pathway demonstrates the opportunity for governments to incentivise stakeholders.

No matter how the pathways will be activated, stakeholders and taxpayers have to expect and accept a significant rise in total cost of plastics for two reasons. Firstly, the price of plastics will incorporate the temporary and enduring costs associated to the pathways. Secondly, the so-called externalities (cost carried by the planet) will have to shift to stakeholders and taxpayers.

Circularity relies on the collaboration of the entire ecosystem, which means that the pathways will only have the desired impact if they are set up in concertation and if they have the buy-in of all stakeholders. At Deloitte, we are committed to making an impact that matters in our contribution as strategist, catalyst and orchestrator.

Illustration of expected cost increase and cost allocation



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