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## Plastics in the circular economy (CE)

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### Abstract

Plastics are used in a great number of applications; therefore, the production of the sector intensively increases. It is estimated that in future, the production of plastics can double by 2035 and almost quadruple by 2050. Still globally, most of the plastic waste is landfilled. Only 9% of plastic waste generated between 1950 and 2015 was recycled. New strategy of European Commission proposes actions designed to make the vision for a more circular plastics economy a reality. The circular economy represents an alternative, more sustainable model to the traditional linear economy. EC has approved new recycling targets for plastics to a minimum of 50% by the end of 2025 and to a minimum of 55% by the end of 2030. Changes that will be introduced in design and production of plastics will contribute to increasing their recycling rates for all key applications. The new strategy will help achieve the priority set by the UE for an energy union with a modern, low-carbon and energy-efficient economy and will make a tangible contribution to reaching the 2030 sustainable development goals.

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## 1. INTRODUCTION

Plastics have become key materials in many sectors of economy and daily life. They are used in a great number of applications such as building and construction materials, transportation, renewable energy, packaging, medical devices, clothing, household and personal goods or even sports. Moreover, plastics have enabled innovation in many sectors allowing the development of products and solutions that could not exist today without these materials. Production and distribution of plastics continue to increase both in developed and developing countries. World and EU plastics production were respectively 322 and 58 million tons in 2015 and 335 and 60 million tons in 2016 (Plastics the facts, 2017). Future plastics production is projected to double by 2035 (EC, 2018a) and almost quadruple by 2050 (Barra and Leonard, 2018). It is assessed that about 4900 million tons of the estimated 6300 million tons total of plastics ever produced have been discarded either in landfills or elsewhere in the environment. This is expected to increase to 12,000 million tons by 2050 unless action is taken (Barra and Leonard, 2018). Pollution of the seas from plastics and microplastics (in principle items smaller than 5 mm) is one of the most important problems. Microplastics are a threat to ecosystem health,

as small organisms and those in early life-stage can more easily uptake these materials. Therefore, microplastics may become entrained in benthic and pelagic food webs (Conkle et al. 2018). It has been estimated that between 4.8 to 12.7 million tons of marine litter enter the seas from land and coastal sources around the globe each year (Brink et al. 2018, Conkle et al. 2018). The oceans contain over 150 million tons of plastics or more than 5 trillion micro and macroplastic particles. The amount of plastic in the oceans could triple by 2025 without further intervention (Barra and Leonard, 2018). Great accumulation zones occurring in oceanic gyres are sometimes also referred to as a 'plastic soup' of waste. More recent research reveals that most of the plastic litter there is actually microplastics and not large piles of material forming 'islands', whereas, it is assumed, most of the plastic released in the ocean finds its way to the sea floor. Concentration of litter is also high on the beaches (EC, DG Environment).

Globally, it is estimated that only 9% of plastic waste generated between 1950 and 2015 was recycled. India has the highest plastic recycling rate ranging from 47 to 60%. In the EU, only approximately 30% of 25 million tons of post-consumer plastic waste was recycled in 2014; China

had a recycling rate of 22% in 2013; while only 9.5% of plastics entering the US municipal solid waste stream were recycled in 2014 (Barra and Leonard, 2018). Nevertheless, slowly but steadily, the recycling of plastic waste has been increasing. The data for 2016 on the management of plastic waste in Europe indicate that the first time recycling has exceeded landfilling. In 2016, 27 million tons of plastic waste was collected, of which 41.6% was used for energy recovery, 31.1% was recovered in recycling processes, and 27.3% of waste was landfilled. The levels of recycling, energy recovery and landfilling of plastic waste vary between the EU countries. In 10 countries, the recycling and energy recovery as a sum exceeds 90%, in some the value is below 30%. This means that more than 9 million tonnes of plastic waste are still landfilled in Europe (Plastics the facts, 2017).

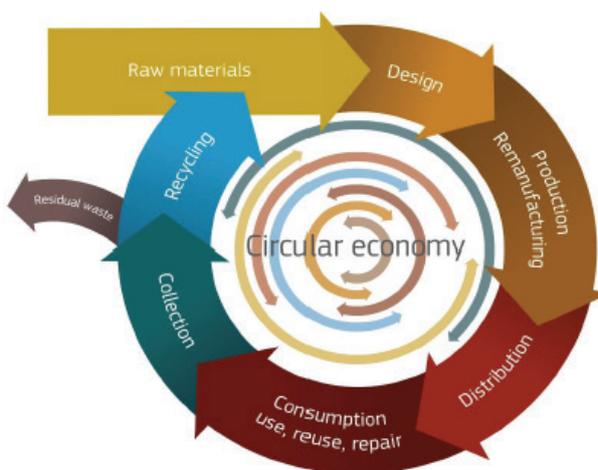
Nowadays, a fairly common solution to the problem of getting rid of plastic waste is exporting them to other countries, especially to poor and developing countries. As estimated, 15 million tonnes of plastic is traded per year as waste destined for recycling. Plastic waste should not be exported for disposal or treatment in locations with significantly lower treatment standards than the country of origin. Therefore, the countries that export waste for recycling should have responsibility to assess and take into account the impacts of that trade (Brink et al. 2018).

It should also be emphasized that the plastics industry is very important to the European economy and increasing its sustainability can bring new opportunities for innovation, competitiveness and job creation. New strategy of the European Commission proposes concrete actions designed to make the vision for a more circular plastics economy a reality. The circular economy represents an alternative, more sustainable model to the traditional linear economy. A linear model follows the path of make, use and then dispose. In contrast, in a circular economy, it keeps resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of their service life. As a result, a circular economy also offers a way to improve Europe's competitiveness and resource efficiency.

The aim of the short communications paper is explaining the basic assumptions and action plans of the circular economy with respect to plastic waste.

## 2. CIRCULAR ECONOMY (CE)

On 2 December 2015, the European Commission (EC) adopted a Circular Economy (CE) package consisting of a Communication and an action plan and proposals for revised legislation on waste. It indicated that 'the transition to a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised, is an essential contribution to the European



**Figure 1.** Diagram of the Circular Economy (EC, 2018b)

Union's (EU) efforts to develop a sustainable, low carbon, resource efficient and competitive economy'. The actions support the circular economy in each step of the value chain – from production to consumption, reparation and remanufacturing, waste management, and secondary raw materials that are fed back into the economy (EC, 2018b). This circular economy concept, which foresees a production and consumption system where materials are circulated as waters are re-used, recycled and recovered, has been increasingly promoted by many governments and international organizations (Van Eygen et al. 2018).

Recent strategies in the EU are the 'Zero waste programme for Europe' and 'Closing the loop action plan for the Circular Economy'. An important material that can still be improved within the circular economy is plastic because most plastics end up as waste (Huysman et al. 2017). The first-ever European Strategy for Plastics in a Circular Economy adopted on January 2018 will transform the way plastic products are designed, used, produced and recycled in the EU. Better design of plastic products, higher plastic waste recycling rates, more and better quality recyclates will help boosting the market for recycled plastics. It will deliver greater added value for a more competitive, resilient plastics industry.

The EC has classified plastics amongst the five priority areas, where progress needs to be made towards a circular reality, recently launching a relative strategy (EC, 2018b). To monitor the progress towards a circular economy, many different indicators have been proposed to quantify the calculation of this performance. Huysman et al. (2017) have suggested the circular economy performance indicator (CPI). The CPI was defined as the ratio of actual environmental benefit over the ideal environmental benefit according to quality. These benefits are expressed in terms of resource footprints, calculated through Life Cycle Assessment (LCA). Van Eygen et al. (2018), in their analyses, used three indicators. First – Recycling Rate (RR), which is frequently used in policy documents to quantify

the amount of waste materials that is fed back into the economy. RR is defined as the amount of re-granulate produced at the mechanical recycling plant divided by total waste amount. Second indicator – the Collection Rate (CR) is the amount collected divided by the total waste amount. And third indicator – the Sorting Rate (SR) is the amount sorted and sent to the mechanical recycling processes divided by the total waste amount. However, as the authors have emphasized the general consensus for the EU targets is to calculate the recycling rate at the gate of the recycling plant, that is, the input to the recycling process, although this has not been clearly defined. This causes confusion, especially with regard to comparing the performance of different regions or countries. However, monitoring and assessing the waste management system is indispensable. Therefore, the best or most favourable mass-based indicators should be used. These considerations are a subject of now and further researches. Composition and application of appropriate tools – optimal indicators are necessary to assess the principal goal of circular economy, which is to protect the natural environment whilst at the same time lay foundations to a new plastic economy, where the design and production fully respect reuse and recycling needs and more sustainable materials are developed.

### 3. CIRCULAR ECONOMY AND EU TARGETS FOR PLASTICS

The new approach in the field of plastics management is promoted by Ellen MacArthur as the initiative 'The New Plastics Economy'. The overarching vision of the New Plastics Economy is that plastics never become waste, rather, they re-enter the economy as valuable technical or biological nutrients. In this field, Ellen MacArthur promotes cooperation with a broad group of leading companies, cities, philanthropists, policymakers, academics, students and citizens. The New Plastics Economy is underpinned by and aligns with circular economy principles. It has three main ambitions:

1. Create an effective after-use plastics economy by improving the economics and uptake of recycling, reuse and controlled biodegradation for targeted applications. This is the cornerstone of the New Plastics Economy and its first priority, and helps realise the two following ambitions.
2. Drastically reduce leakage of plastics into natural systems (in particular the ocean) and other negative externalities.
3. Decouple plastics from fossil feedstocks by – in addition to reducing cycle losses and dematerialising – exploring and adopting renewably sourced feedstocks (The New Plastics Economy, 2016).

In 2018, the EU Member States approved new recycling targets for plastics to a minimum of 50% by the end of 2025 and to a minimum of 55% by the end of 2030. Presented by the European Commission vision and the rules of the new plastic economy represent the most

modern plastic waste legislation. Changes in production and design enable higher plastics recycling rates for all key applications. Actually, many plastic products cannot be reused or recycled. Redesign includes exploring alternative materials or products where they exist (for example, using natural alternatives to plastic microbeads in personal care products). Simultaneously, attention needs to be given to designing plastics without toxic chemical additives, as this undermines their potential for secondary uses as well as creating health and ecological risks (Brink et al. 2018). For plastics, the EU needs to meet targets for waste packaging (EC, 2018b). By 2030, all plastics packaging placed on the EU market is either reusable or can be recycled in a cost-effective manner. Recycling of plastics packaging waste achieves levels comparable with those of other packing material. Sorting and recycling capacity has increased fourfold since 2015, leading to the creation of 200,000 new jobs in Europe. Recycled plastics have become an increasingly valuable feedstock for industries, both at home and abroad. More plastic recycling helps reduce Europe's dependence on imported fossil fuel and cut CO<sub>2</sub> emissions. Innovative materials and alternative feedstocks for plastic production are developed and used where evidence clearly shows that they are more sustainable compared to the non-renewable alternatives. Exports rise in lockstep with global demand for more sustainable ways of processing end-of-life plastics. Innovative solutions are developed to prevent microplastics from reaching the seas (EC, 2018c).

Best practices are disseminated widely, scientific knowledge improves, citizens mobilise and innovators and scientists develop solutions that can be applied worldwide.

### 4. SUMMARY

To achieve the assumptions of circular economy for plastics the improve of plastic products designation and high efficiency of plastic waste management in many countries are needed. Currently still, the majority of the initiatives are in infancy, and plastic re-use and recycling rates remain low. Therefore, investments in waste infrastructure are a key-way to increase the rate of recovery and reduce the leakage of plastics. Plastic waste should not be exported for disposal or treatment in locations with significantly lower treatment standards than the country of origin. Systematic investment in the research and evaluation of policy experiments is needed in order to identify and communicate good practice cases to catalyse action.

It was founded that by pursuing the aims of adopted strategy for plastics in a circular economy, the strategy will help achieve the priority set by UE for an energy-efficient economy, and will make a tangible contribution to reaching the 2030 sustainable development goals.

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