Improving Plastics Management: Trends, policy responses, and the role of international co-operation and trade

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This Policy Paper comprises the Background Report prepared by the OECD for the G7 Environment, Energy and Oceans Ministers. It provides an overview of current plastics production and use, the environmental impacts that this is generating and identifies the reasons for currently low plastics recycling rates, as well as what can be done about it.

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Authorised for publication by Rodolfo Lacy, Director, Environment Directorate

Improving Plastics Management: Trends, policy responses, and the role of international co-operation and trade

Background Report

Prepared by the OECD for the G7 Environment, Energy and Oceans Ministers

September 2018

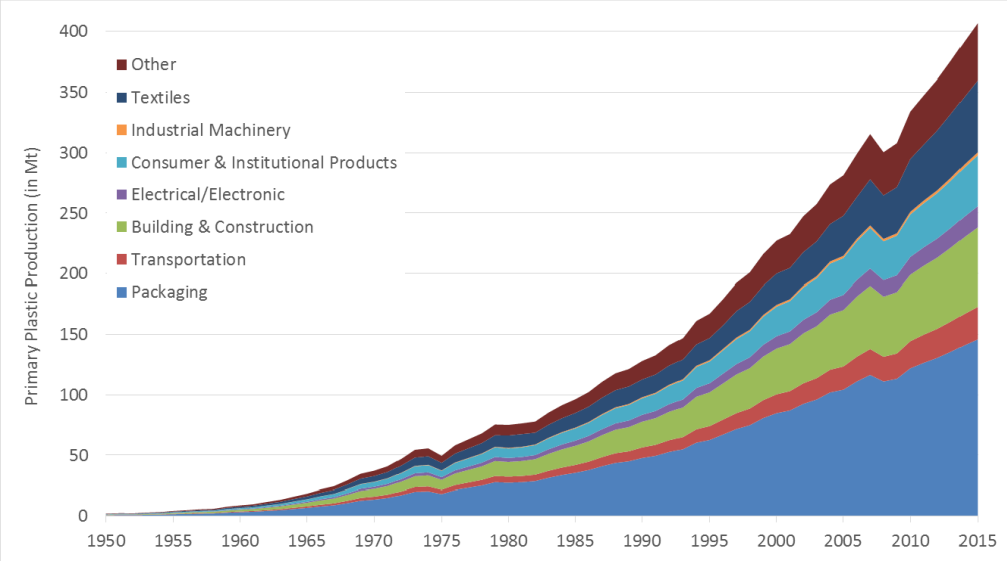
1. Plastics: Production, uses, and benefits to society

1. Plastics are a remarkable family of materials that have gathered attention recently due to their ubiquity in the global economy, the low material recovery rates that they currently achieve, and the environmental impacts associated with current disposal methods.

2. Although early forms of plastics were already in existence during the mid-19th century, plastics other than Bakelite were largely unknown prior to 1950. Since then, plastics have rapidly become one of the most commonplace materials on the planet. In 2015, global plastics production reached 407 million tonnes per annum (Mtpa) (Figure 1), making it more than the production of paper (400 Mtpa), fish (200 Mtpa), and aluminium (57 Mtpa)[1,2,3]. If production continues to grow at similar rates, plastics production will reach 1 600 Mtpa in 2050[4].

3. The rapid growth of plastics production and use is largely due to the unique properties of the material. Plastics have a high strength-to-weight ratio, can be easily shaped into a wide variety of forms, are impermeable to liquids, and are highly resistant to physical and chemical degradation. Plastics can also be produced at relatively low cost. It is these properties that have led to the substitution of traditional materials (e.g. concrete, glass, metals, wood, natural fibres, and paper) by plastics in many applications.

Figure 1. Global plastics production: 1950 to 2015



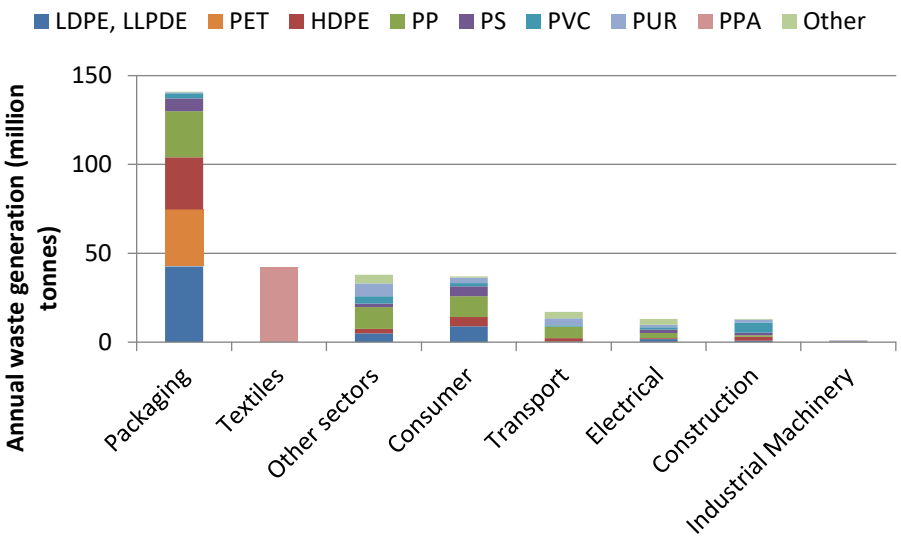
Source: Geyer, R., J. Jambeck and K. Law (2017), "Production, use, and fate of all plastics ever made", *Science Advances*, Vol. 3/7, p. e1700782, http://dx.doi.org/10.1126/sciadv.1700782.

4. Plastics are a diverse set of materials with specific chemical and physical properties. At least eight major polymer types are widely used[5], and a range of chemical additives are introduced at the manufacturing stage in order to improve polymer performance. The diversity of plastics has important implications for their end of life management. In

particular, it means that the issues that hinder material collection, sorting, and recovery can differ substantially across polymers.

5. The versatility of plastics has led to their use in almost all major product categories (Figure 2). Plastics packaging is the largest application by weight, but plastics are also used widely in the textile, consumer goods, transport, and construction sectors. Some polymers of plastic are used primarily in a single application (e.g. polyethylene in packaging) while others are used more widely (e.g. polypropylene). This distinction also has implications for end-of-life plastics management: developing effective sorting and recycling technologies is likely to be simpler for polymers used in a narrower range of applications.

Figure 2. Global plastics use by polymer and sector



Note: The polymer breakdown for each product category has been translated on a proportional basis from 2015 production data. Polyester, polyamide, and acrylic (PPA) fibres are assigned exclusively to the textiles sector following Geyer, Jambeck, and Law (2017[1]).
Source: Geyer, R., J. Jambeck and K. Law (2017), "Production, use, and fate of all plastics ever made", *Science Advances*, Vol. 3/7, p. e1700782, http://dx.doi.org/10.1126/sciadv.1700782.

6. The widespread use of plastics has generated a number of benefits for society and for the environment. Plastics are often used to protect or preserve foodstuffs and, in doing so, help to reduce food waste. Plastics are also an important input in vehicles, where their relatively light weight results in lower fuel use and greenhouse gas emissions. Plastics are widely used in infrastructure applications, where their impermeability and durability can lead to water savings in urban areas. Finally, the use of plastics rather than materials derived from biomass (e.g. wood and paper) in a range of applications could slow land-cover change and biodiversity loss[6].

2. The environmental side effects of plastics production and use

7. The increasing pervasiveness of plastics has not been without drawbacks. The production and disposal of plastics is responsible for significant greenhouse gas emissions and, when poorly managed, generates plastics pollution in the natural environment. In

addition, the loss of natural resources resulting from current systems of waste management represents a missed economic opportunity. For example, it is estimated that 95% of the material value of used plastic packaging, or USD 80 - 120 billion, is lost annually.[7]

Greenhouse gas emissions

8. Traditional plastics production involves the transformation of petroleum or natural gas into their constituent monomers. This process is highly energy-intensive, and was estimated to account for 400 million tonnes of greenhouse gas emissions (around 1% of the global total) in 2012[8].

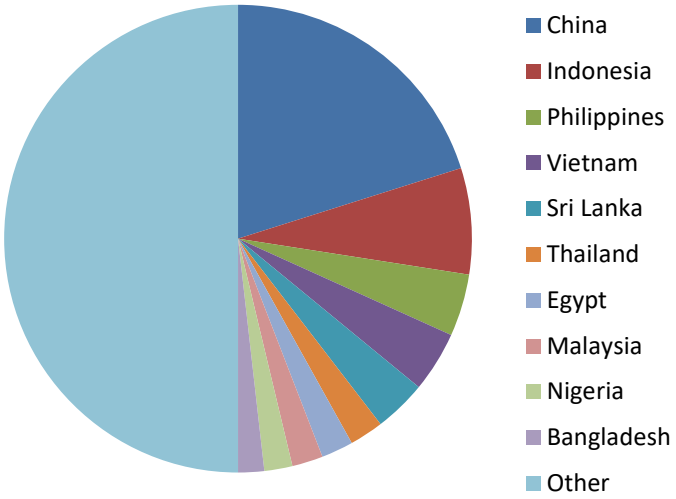
9. The fossil fuel feedstock used in plastics production also accounts for 4 - 8% of global oil and gas production[9,10] and this share could increase further in the future[11]. The hydrocarbon molecules that are bound into the structure of plastics are initially inert, but release carbon dioxide as well as other greenhouse gases when incinerated.

Plastics pollution

10. The proliferation of plastics use, in combination with poor end-of-life waste management, has resulted in widespread, persistent plastics pollution. Around 6 300 million tonnes of plastics waste are thought to have been generated between 1950 and 2015, of which only 9% were recycled, and 12% incinerated, leaving nearly 80% to accumulate in landfills or the natural environment[12]. Plastic pollution is present in all the world's major ocean basins, including remote islands, the poles and the deep seas, and an additional 5 to 13 million tonnes are introduced every year[13,14].

11. Modelling suggests that around 10% of global plastics waste generation (or 30 Mt) was mismanaged in 2010[15,16]. G7 countries are thought to account for less than 2% of this material: around half originates in ten large emerging economies (Figure 3). This highlights the importance of improving waste collection services in middle- and low-income countries.

Figure 3. Mismanaged plastics waste by country in 2010



Source: Jambeck, J. et al. (2015), "Marine pollution. Plastic waste inputs from land into the ocean.", *Science (New York, N.Y.)*, Vol. 347/6223, pp. 768-71, http://dx.doi.org/10.1126/science.1260352.

12. Once in the ocean, plastics have a number of significant economic impacts. Marine wildlife is harmed through ingestion of plastics or entanglement, with negative implications for ecosystem health and the overall sustainability of fisheries[17]. Coastal tourism is also affected as tourists seek to avoid beaches known to have high concentrations of plastics litter. Taken together, the economic cost of these impacts has been estimated at USD 13 billion per year[18].

13. Plastics pollution also poses risks for human health. The presence of plastic in seafood, including fish and shellfish, and their subsequent consumption by the public has led to concerns about chemical bio-accumulation in the food chain, although empirical evidence for this is currently limited[19,20,21]. Plastics are also entering the food chain more directly. Research has found microplastic contamination in tap water and bottled water across a number of countries[22,23], and plastic contamination has also been found in sea salts[24].

14. Plastics pollution warrants considerable attention for two additional reasons. The first relates to the longevity of plastics: those that accumulate in the natural environment will only decompose over hundreds, or even thousands of years, during which time they fragment into smaller microplastics and nanoplastics. The second relates to uncertainty about the magnitude of the damages. Significant quantities of plastic have only been introduced into the natural environment relatively recently. While the full impact on marine and terrestrial ecosystems will only emerge in the longer term, some environmental effects of plastics pollution are already clearly visible.

3. The environmental side effects of plastics can be addressed in several ways

15. Several approaches are available to address the environmental side effects of rapidly growing plastics production, use, and disposal.

- **Changes in product design**, such as through the use of alternative materials in the place of plastics, could reduce the production, use, and disposal of plastics in the first instance. Changes in design practices, such as through product light-weighting, could also help to prevent the generation of plastics waste[25]. Shifting towards bio-based or biodegradable plastics could reduce the adverse environmental impacts of plastics more directly by reducing their environmental footprint.
- **Better waste management systems**, by facilitating higher waste collection and recycling rates, would allow waste plastics to be captured before they begin creating problems in the natural environment.
- **Clean up and remediation activities**, such as beach clean-ups and technology to collect plastics from oceans, would allow the removal of plastics already in the natural environment.

16. Each of these approaches has considerable potential, as well as a set of associated risks and costs. The use of alternative materials in the place of plastics can reduce the use of plastics, but may magnify environmental burdens elsewhere. Substituting away from plastics may also negate the use-phase energy savings (in transport for example) that plastics can bring in the first place. Shifting to bio-based or biodegradable plastics may also have unintended consequences. In particular, enhanced biodegradability can increase the dispersion of microplastic fragments in the environment if degradation is incomplete[26]. Finally, clean up and remediation activities can come at a significant cost and are unlikely to be effective at addressing microplastic pollution.

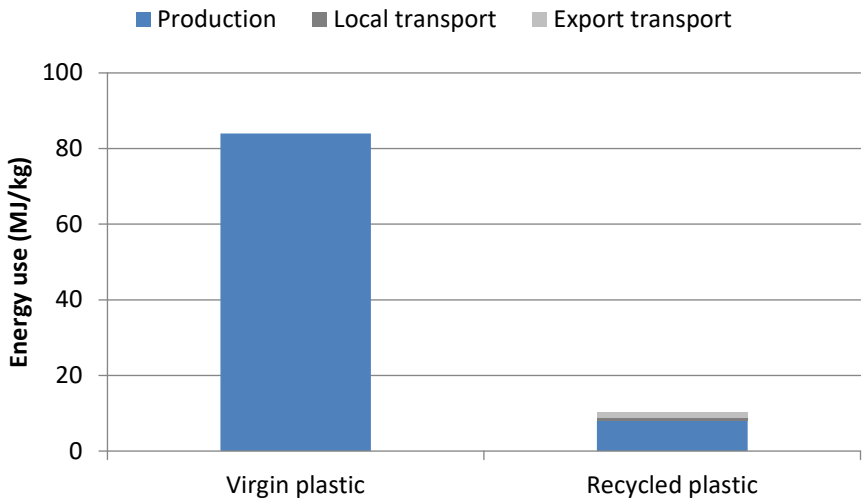
17. Higher waste collection and recycling rates are not without problems, but have the twin advantages of allowing the continued realisation of the beneficial aspects of plastics use, while also addressing the associated adverse environmental side effects. Higher recycling rates, to the extent that they are driven by the emergence of an economically sustainable recycled plastics industry, could also become a source of long-term job creation[27].

18. The greenhouse gas footprint of recycled plastics is a fraction of that of virgin plastics (Figure 4), and high quality waste management systems reduce the risk of plastics leaking into the environment. The development of better waste management systems can also be seen as a form of "future-proofing". Plastics production and use is projected to increase significantly in coming decades, and some proportion of this material will inevitably make its way into the environment unless waste management systems improve.

19. A large number of life-cycle assessments (LCAs) have been carried out on the relative environmental impacts of various options for end-of-life plastics management. Several recent meta-analyses of this body of work unambiguously conclude that plastics recycling has a significantly smaller greenhouse gas footprint than plastics incineration or landfilling[28,29,30]. Around three quarters of the individual LCA studies assessed in WRAP[31] found that the global warming potential associated with plastics recycling was, at a

minimum, half of that associated with incineration or landfilling[32]. The displacement of virgin plastics by their recycled equivalents is one important reason for the relative desirability of plastics recycling. Figure 4 shows the energy intensity of virgin and recycled plastics production.

Figure 4. Relative energy intensity of virgin and recycled plastics production



Note: Data is for plastic resins only.
Source: Wong, C. (2009), "A Study of Plastic Recycling Supply Chain 2010 A Study of Plastic Recycling Supply Chain", https://www.ciltuk.org.uk/portals/0/documents/pd/seedcornwong.pdf (accessed on 28 March 2018).

20. The LCA literature for plastics focuses mostly on environmental indicators such as global warming potential, energy use, and water use. Less attention has been directed towards other environmental impact categories such as those associated with marine plastic pollution. Despite the lack of empirical evidence, recycling is likely to be just as effective as alternative waste treatment options – landfilling or incineration – in reducing the flow of plastics waste into the environment: in each case, initial waste collection is a prerequisite for further treatment[33].

4. Low recycling rates and limited market share highlight the poor functioning of markets for recycled plastics

21. The dysfunctional character of markets for recycled plastics manifests itself in several ways. Market volumes and liquidity are limited, trade flows are small as a proportion of total plastics waste generation, and market prices are highly volatile. Global plastics recycling rates, and the share of recycled production in total plastics output, also remain low.

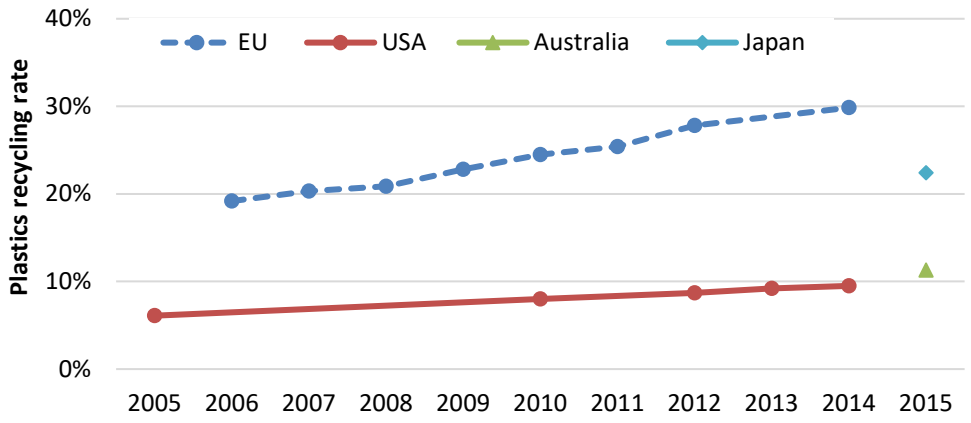
Recycling rates

22. Despite recent efforts, plastic recycling continues to be an economically marginal activity. Current recycling rates are thought to be 14 - 18% at the global level. The

remainder of plastic waste is either incinerated (24%), or disposed of in landfill or the natural environment (58 - 62%)[34]. Plastics recycling rates are substantially lower than those for other widely used materials. Recycling rates for major industrial metals – steel, aluminium, copper, etc. – and paper are thought to exceed 50%[35,36].

23. Plastic recycling rates vary significantly across different countries[37], waste streams[38], and polymer types. Some polymers are more widely recycled than others. Recycling rates for polyethylene terephthalate (PET) and high-density polyethylene (HDPE) commonly exceed 10%, while those for polystyrene (PS) and polypropylene (PP) are closer to zero[39]. Recycling rates in the European Union average 30%, and are thought to be considerably higher in some EU Member States[40]. Recycling rates in other high-income countries are typically in the order of 10% (Figure 5). Recycling rates in low- to middle-income countries are largely unknown, but may be significant in situations where there is a well-established and effective informal sector. Data indicates that plastics recycling rates may be approaching 20 - 40% in some developing-country cities[41].

Figure 5. Recycling rates in selected high income countries

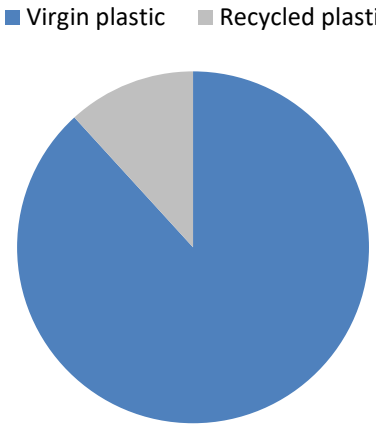


Source: OECD (2018), *Improving Markets for Recycled Plastics: Trends, Prospects and Policy Responses*, OECD Publishing, Paris, https://doi.org/10.1787/9789264301016-en.

Recycled plastics market share

24. Production statistics for recycled plastics are largely unknown. However, data provided in Geyer, Jambeck and Law[42] allow some rough approximations to be made. A global plastics recycling rate of 18%, and plastics waste generation of 258 Mtpa[43] (both resins only) translate into approximately 46 million tonnes of recycled plastics production per year. This represents 12% of total global plastics production (Figure 6), but is likely to be an upper estimate because, in some cases, the material that is reported as "recycled" may refer only to the material diverted towards recycling: some proportion of this is likely to become recycling residues that require disposal.

Figure 6. Estimated global market share of virgin and recycled plastics



Note: Data are for resins only.
Source: Geyer, R., J. Jambeck and K. Law (2017), "Production, use, and fate of all plastics ever made", *Science Advances*, Vol. 3/7, p. e1700782, http://dx.doi.org/10.1126/sciadv.1700782

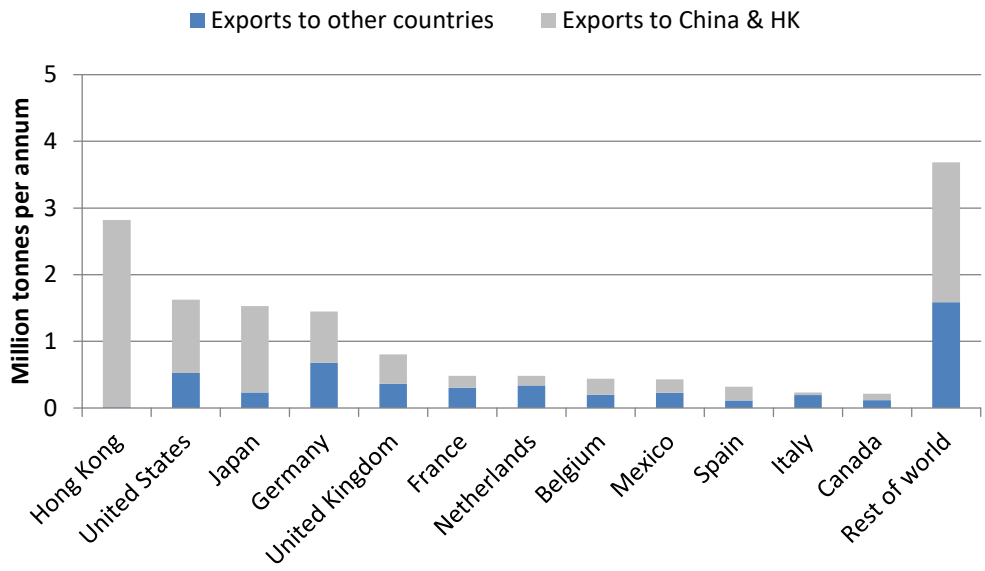
5. Trade in plastics waste is limited and increasingly hindered by trade restrictions

25. Allowing waste plastics (and other materials) to flow towards jurisdictions with a comparative cost advantage in sorting or recycling can help to boost global recycling rates, while also generating increased shared economic benefits and improving environmental outcomes[44]. Despite that, global trade in plastics waste remains small relative to overall plastics waste generation. Of the 300 million tonnes of plastics waste generated in 2015[45], only around 14 million tonnes (or 4%) was exported outside the country of origin[46,47].

26. Imports of plastics waste are concentrated in a small number of countries. People's Republic of China was the largest market for plastics waste in 2016, accounting for around 8 million tonnes (or 60%) of global imports[48]. The next largest importers were Hong Kong (2 million tonnes)[49], Germany (0.5 million tonnes), and the United States (0.4 million tonnes).

27. The largest exporters of plastics waste to China in 2016 were Hong Kong[50], the United States, Japan, Germany, and the United Kingdom (Figure 7), with each shipping between 0.5 million tonnes and 1.3 million tonnes of material. France, Canada, and Italy shipped 0.2, 0.1, and 0.05 million tonnes respectively. Taken together, G7 countries accounted for around half of all the exports of plastics waste to China in 2016. The monetary value of this trade amounted to USD 0.9 billion[51].

Figure 7. Major exporters of plastics waste to China in 2016



Source: UN COMTRADE (2018), *United Nations Statistics Division - Commodity Trade Statistics Database (COMTRADE)*, HS codes 391510, 391520, 391530, 391590. https://comtrade.un.org/db/default.aspx (accessed on 21 March 2018).

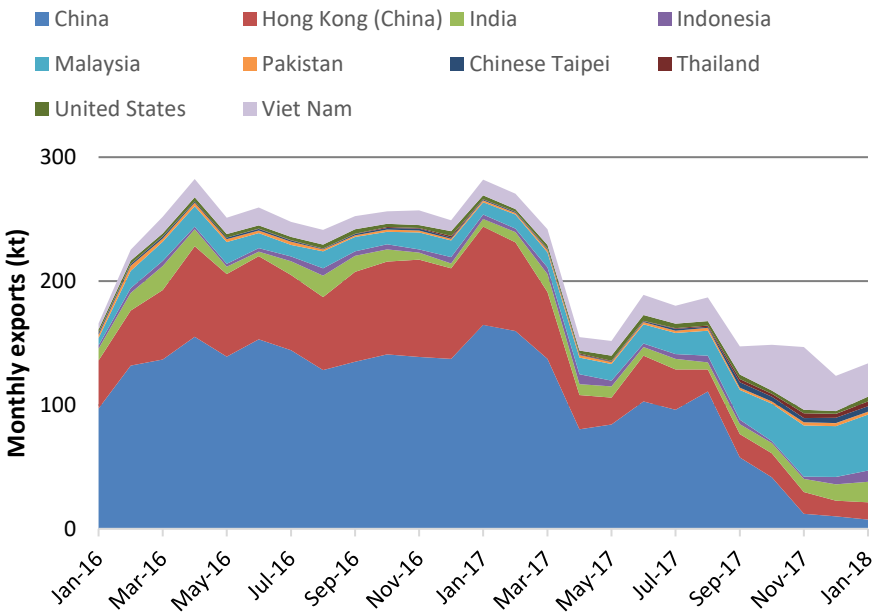
Recent trade restrictions imposed by the People's Republic of China

28. In 2017 the People's Republic of China made notifications to the WTO and the Basel Convention on the Transboundary Movement of Hazardous Wastes and Their Disposal relating to imports of solid waste that have significantly affected trade. The first notification lists 24 kinds of solid waste that are prohibited from import as of 1 January 2018, including some plastics. The second notification is an import restriction that sets out maximum acceptable levels of contamination for 11 types of imported materials, including plastic waste and scrap, and came into force on 1 March 2018[52]. The stated rationale for both regulations was the protection of the environment or of human health[53], which is consistent with China's rights and obligations as a Party of the Basel Convention (Basel 2017)[54].

Impacts of trade restrictions

29. Although they have only been in place for four months, the effects of China's import restrictions on global trade and on domestic markets are already emerging. Trade volumes have fallen dramatically: China's imports of plastics waste from the European Union fell from around 100 000 tonnes in June 2017 to less than 10 000 tonnes in January 2018 (Figure 8). China's imports of plastics waste from the United States fell by a similar amount, from 75 000 tonnes in January 2017 to 6 000 tonnes in December 2018[55]. More recently, data reported by Reuters suggests that China's imports of plastics waste from all countries was less than 10 000 tonnes in February 2018[56,57].

Figure 8. Monthly exports of plastics waste from the EU by destination: 2016 to 2018



Source: Eurostat (2018), *Eurostat - Data Explorer - Generation of Waste*, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgen&lang=en (accessed on 28 March 2018). HS code 3915

30. For exporters of plastics waste, China's import restrictions are leading to growing domestic waste stockpiles and diversion of material into other export markets. Domestic prices for waste plastics have fallen as a result. Developing additional domestic recycling capacity could help to increase prices, but this will take time. Waste management firms in most countries are generally responding through a mix of increased disposal and a search for alternative export markets, mostly in Asia.

31. Increased incineration and landfilling of plastics waste has implications for meeting pre-existing disposal and recycling targets. Many G7 countries have regulatory requirements, at the national or sub-national level, in the form of constraints on material that can be incinerated or landfilled, as well as recycling targets for plastics. In many cases, the waste plastics that were formerly shipped to China were included in the recycling targets. Lower export volumes could therefore result in significant falls in recycling rates in countries that were previously shipping a significant proportion of their domestic waste generation to China.

32. The growth of waste stockpiles in exporting countries has also led to a search for new market outlets where waste plastics can be recycled. This has resulted in significantly higher trade inflows for countries like Thailand, Malaysia, Vietnam, Turkey, and India during the second half of 2017. It has also triggered concerns about the health and environmental impacts that could result in these countries, given their poorly developed plastics recycling facilities and relatively weak environmental and treatment standards.

33. The effects of the import restrictions can also be observed in China itself. The rapid fall in imported waste plastics has led to feedstock shortfalls for China's recycling industry, and a surge in prices for domestic waste plastics[58]. The textiles sector, heavily reliant on the import of recovered polyethylene (PET) from bottles, is reportedly suffering from a shortage of material. Increased black market trading is one immediate consequence[59,60]: Chinese authorities reportedly seized over 100 000 tonnes of smuggled plastic waste material during the first quarter of 2018[61]. In the longer term, it may be that higher prices will improve the incentives for improved waste collection and sorting in China, which may result in less plastics dispersion in the environment overall.

6. Key challenges in markets for recycled plastics and possible policy responses

34. The disruptions resulting from recent restrictions on the import of plastic waste to China highlights the poor functioning of domestic markets for recycled plastics. There is a basic co-ordination failure lying at the heart of this issue. Potential suppliers of recycled plastics do not invest sufficiently in sorting and recycling capacity because the profitability of these operations is limited. Potential buyers (i.e. manufacturing firms) have limited incentives to use recycled plastics as inputs because of uncertainty about their availability and quality. Market outcomes could improve significantly if these issues were addressed.

The consequences of import restrictions need to addressed, but in a way that minimises longer-term risks and exploits economic opportunities

35. In the short term, there are two main options for addressing growing waste stockpiles resulting from recent import restrictions, neither of which are satisfactory in the long term:

- Divert existing trade flows to alternative export destinations, and
- Increase domestic disposal and incineration.

36. Diverting exports of waste plastics towards other destinations could be problematic, especially for mixed plastic waste collected from households, which is very difficult to recycle. If recycling capacity and treatment standards are less stringent in the recipient country than in China, this could lead to an increase in regional and global environmental impacts. It will also hinder investment in domestic facilities capable of producing higher quality recycled materials. Increased domestic disposal through landfilling and incineration should only be considered a temporary solution as it leads to a loss of valuable material and has negative environmental impacts if not appropriately managed. Both options run the risk of undermining trust in municipal waste management systems, with a longer-term loss of household sorting effort.

Stronger domestic policy frameworks are required to seize economic opportunities linked to investment in higher quality waste plastic processing

37. In the longer run, there is a need for G7 and other exporting countries to rethink the use that is being made of plastics more generally, as well as an opportunity to restructure the way waste material is handled.

38. In the first instance, efforts to prevent plastic waste from arising need to be considered. In particular, opportunities to reduce unnecessary use could be seized where this is feasible. technically feasible. Where plastic cannot be eliminated, plastic products can be designed to allow for reuse (i.e. multiple uses instead of single use, possibly in the context of deposit-refund systems) and recycling, in order to minimise the amount of waste that is generated. Finally, opportunities to substitute alternative materials could be used where this is technically feasible and does not lead to an increase in the overall environmental footprint.

39. Effective management of remaining plastic waste requires the relocation of some plastic waste processing domestically and the strengthening of domestic secondary waste markets. Suppliers and buyers of recycled plastics would both benefit from larger and more liquid markets for recycled plastics, but neither party has strong incentives to act alone. In turn, improved market outcomes could, to some extent, become self-fulfilling as scale efficiencies are captured and a more widespread consumer acceptance develops. These factors provide a clear rationale for policy intervention, as well as potential insights into how to do it effectively. In particular, policies are likely to be more effective if they jointly address the challenges – market failures, policy misalignments, and status quo biases – on both the supply and demand sides of recycled plastics markets. Put differently, an effective policy framework would address challenges across the entire plastics life cycle, from plastics and product design through to end-of-life management and recycled plastic production.

Supporting the market for recycled plastics

40. Manufacturers of recycled plastics operate in the same market as traditional (virgin) plastics producers, and are price takers in that market. At present, recycled plastic production is, for the most part, not economically competitive. Certain polymers (e.g., PET and HDPE), when used in in particular product categories (e.g., plastic bottles) are widely recycled, but this remains the exception rather than the rule. This is partly a consequence of the cost structure of recycled production (see below), but also reflects virgin plastics prices that are highly volatile[62] and perhaps too low to reflect all external costs. Un-addressed market failures and existing policy misalignments (e.g. government support for hydrocarbon inputs to plastics production) both contribute to the low prices for virgin plastics.

41. Governments of G7 countries could address these challenges through policy interventions that aim to level the playing field between virgin and recycled plastics or support the market for recycled plastics. They include:

- Taxes on the use of virgin plastics or differentiated value added taxes for recycled plastics or plastic products;
- Reform of support for fossil fuel production and consumption;
- Introduction of recycled content standards, targeted public procurement requirements, or recycled content labelling; and
- Creation of consumer education and awareness campaigns (concerning the environmental benefits of recycled plastics) in order to stimulate demand for products containing recycled plastics.

Addressing uncertainty about the availability and quality of recycled plastics

42. Manufacturing firms have incentives to use recycled plastics in their production processes. Doing so can create reputational benefits[63], and may also allow a small price premium to be charged if the final product can be marketed as "green". That said, many manufacturers continue to rely solely on virgin plastic inputs, both because of their lower cost, but also due to inertia and uncertainty about the properties of recycled plastics. While the quality, performance characteristics, and near-term availability of virgin plastics are largely assured, there may be uncertainty about the same characteristics of recycled plastics. Status quo biases also hinder switching, even in situations where recycled plastics are cost competitive and of comparable quality to their virgin equivalents[64].

43. There are also increasing concerns over additives (e.g. colours, plasticizers, flame retardants) used in the manufacture of some virgin plastics that complicate recycling or pose risks to human or ecological health[65]. For manufacturers of recycled plastics, uncertainty about the presence of these additives in plastic waste can hinder recycling altogether (because the resulting output may be of low quality or pose significant health risks in certain food related applications such as food packaging and children's toys). The lack of information and transparency regarding the use of additives in some plastic waste streams (e.g. electronics and other durables) is thus a major barrier to increased recycling of those products.

44. Governments of G7 countries could address these challenges through the following policy interventions:

- Creation of certification standards for recycled plastics;
- Creation of requirements to collect and recycle all types of plastic products;
- Facilitation of better coordination and communication across the plastics value chain, including through the promotion of chemical information systems; and
- Restrictions on the use of hazardous additives in plastics manufacturing.

Reducing the cost of recycled plastic production

45. The cost structure of recycled plastics production is different from that of virgin production and is, at current oil prices, often higher. There are a number of reasons for this.

46. Plastics waste generation is geographically dispersed, and aggregating waste materials into economically viable quantities incurs considerable collection and transport costs. In many cases, this waste is comingled with food residues, paper, and other materials. The separation of the plastics fraction (and the individual polymers of plastic) into clean feedstock for reprocessing can be technically challenging and involves considerable capital or labour costs. In addition, a significant proportion of the plastics in the waste stream are built into more complex end-of-life products that, in many cases, are difficult and costly to disassemble.

47. On top of these factors, the alternative waste management options to recycling – landfill or incineration – are relatively cheap in many countries. The per-tonne charge levied for waste disposal may not necessarily reflect the full social cost of these alternatives.

48. Governments of G7 countries could address these challenges through the following policy interventions:

- Introduction of multiple stream collection systems allowing separated collection of recyclables;
- Creation of incentives for better product and plastics design (e.g. design for reuse and recycling), such as through better designed extended producer responsibility, product stewardship and deposit-refund systems;
- Support for R&D for improved plastics management systems and the sustainable design of plastics (more easily recyclable or more easily biodegradable for example), working in close partnership with industry;
- Introduction of more ambitious recycling rate targets and harmonisation of the methods used to calculate these rates; and
- Increased stringency of landfill and incineration fees to better reflect the full social cost of these activities.

Increased international co-operation is needed to boost innovation and support improved environmental standards in fast growing markets

49. Governments of G7 countries can also address the barriers that hinder markets for secondary plastics through various forms of international cooperation.

50. First, by showcasing the public policy developments and private sector initiatives taking place in their respective countries, the G7 could help to promote the spread of best practices elsewhere. As touched upon in the Charlevoix Ocean Plastics Charter, this type of knowledge exchange could be enabled through the establishment of an international platform dedicated to plastics management.

51. Second, G7 countries can go beyond sharing of best practices by promoting increased international cooperation in the area of plastics management.

- G7 countries could use official development assistance to support the development of effective and environmentally sound waste collection, sorting, and recycling infrastructure, including incentives or requirements for plastics source separation. A lack of collection capacity in emerging market economies leads to a significant loss of potentially recyclable material each year and limits the scale of the market for recyclable plastics. Globally, about 2 billion people do not have access to basic waste collection services. This is a key driver of marine plastics pollution and deprives the recycled plastics industry of scale, and the cost efficiencies that potentially come with scale.
- G7 countries could promote stronger environmental standards in plastic sorting and recycling in emerging and developing countries. Convergence of environmental standards relating to material recovery would allow waste plastics to flow towards countries with a comparative cost advantage in sorting and recycling activities,

thereby helping to boost global recycling rates while also generating shared economic benefits and improved environmental outcomes.

- G7 countries can co-operate to boost innovation that supports product design for reuse and recycling. This would facilitate recycling, reduce contamination in the waste stream, reduce costs, and provide better quality recycled plastic, as laid out by G7 leaders at their recent meeting in Charlevoix[66]. Coordinated efforts on the provision of public R&D support and incentives for the development of more efficient processing technologies could also help to lower the overall cost of material recovery activities and improve material quality.

OECD can support the G7 in addressing these challenges

52. The OECD can support its members to address these challenges by continuing to develop analysis of the economics of plastics recycling and of the policy approaches that can help strengthen plastics recycling. Specific attention could be given to issues that sit at the interface of chemicals and waste management policies, building on current efforts on the sustainable design of plastics being pursued jointly by the Chemicals Committee and the Environmental Policy Committee.

References and notes

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[11] Ibid.

[12] Geyer, R., J. Jambeck and K. Law (2017), "Production, use, and fate of all plastics ever made", *Science Advances*, Vol. 3/7, p. e1700782, http://dx.doi.org/10.1126/sciadv.1700782.

[13] Jambeck, J. et al. (2015), "Marine pollution. Plastic waste inputs from land into the ocean.", *Science (New York, N.Y.)*, Vol. 347/6223, pp. 768-71, http://dx.doi.org/10.1126/science.1260352.

[14] Modelling undertaken by the same authors suggests that G7 countries are responsible for a small proportion (< 5%) of marine plastics pollution. Instead, around 70% of these inputs originate in ten countries, most of which are located in South Asia or East Asia. This highlights the importance of improving waste collection services in middle- and low-income countries.

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[16] The authors define mismanaged plastics waste as those that arise through littering or dumping in low quality landfill or open dump sites.

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[34] Geyer, R., J. Jambeck and K. Law (2017), "Production, use, and fate of all plastics ever made", *Science Advances*, Vol. 3/7, p. e1700782, http://dx.doi.org/10.1126/sciadv.1700782.

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[38] Recycling of post-industrial plastics is well-established and has been relatively stable over recent decades. Recycling of post-consumer plastics is less common, but has increased steadily since the 1980s as municipal waste management systems have developed.

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[44] Provided that environmental standards in importing countries are sufficiently stringent

[45] Geyer, R., J. Jambeck and K. Law (2017), "Production, use, and fate of all plastics ever made", *Science Advances*, Vol. 3/7, p. e1700782, http://dx.doi.org/10.1126/sciadv.1700782.

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[63] Witness Coca-Cola's 19 January 2018 commitment to incorporate 50% recycled content in their packaging by 2030.

[64] Manufacturers have considerable experience with virgin plastics inputs, and well established supply chains for sourcing them.

[65] Exposure to chemicals from plastics is widespread with biomonitoring studies detecting bisphenol A and phthalates in over 90% of participants (see Calafat et al. (2008), "*Exposure of the U.S. population to bisphenol A and 4-tertiary-octylphenol: 2003-2004*"). Exposure to bisphenol A and phthalates has been associated with a range of adverse human health impacts (see Katsikantami et al. (2008), "*A global assessment of phthalates burden and related links to health effects*" and Rochester, 2013, "*Bisphenol A and human health: A review of the literature"* for example) . The effects of exposure to bisphenol A are, however, a matter of controversy. A recent assessment by the US Food and Drug Administration concluded that the substance is essentially safe in the food contact applications where it is authorised.

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Improving Plastics Management: Trends, policy responses, and the role of international co-operation and trade

This Policy Paper comprises a Background Report prepared by the OECD for the G7 Environment, Energy and Oceans Ministers. It provides an overview of current plastics production and use, the environmental impacts that this is generating and identifies the reasons for currently low plastics recycling rates, as well as what can be done about it.

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