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Plastics waste trade and the environment

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1 Trade and the changing plastic waste game

International trade has been an option for dealing with the growing amount of plastic waste in Europe, given the weakness of domestic economically viable post-collection treatment and recycling and the willingness of China and Asian countries, amongst others, to import waste. This trade prevailed even though it was known that treatment in non-European Union (EU) countries often caused higher environmental pressures than treatment/recycling in the EU.

The domino-like recent sequence of import restrictions on wastes, including on plastics, adopted by China (2018) and then other non-EU countries is pushing European countries to change their plastic waste management. Even though European export flows have found, for the moment, alternative destinations, the export option is bound to become increasingly difficult. The global plastic waste game is changing, creating both an immediate challenge and an opportunity for the EU.

The challenge is the domestic capacity for treatment and, in particular, recycling in EU countries. Although this seems to be slowly increasing, it is currently insufficient, and is now facing the effects of decreasing opportunities for exporting waste beyond the EU. The new and more ambitious recycling targets for plastics included in the 2018 Waste Directives are further exacerbating the challenge.

The opportunity is to trigger a more robust and complete circular economy for plastics in Europe. At present, the industrial recycling and recovery system for plastics in the EU is underperforming relative to other waste sectors. From a circular economy perspective, this is a loss of materials and value. The pressure arising from the weakening of export options could push investment and innovation towards the creation of new business opportunities in the EU. At the same time, keeping waste plastics within the EU could reduce their net global environmental pressures by securing better environmental management, under the EU standards.

These changes, challenges and opportunities are taking place within a rapidly evolving policy setting.

The trade in waste plastics by EU countries is regulated by the Waste Shipment Regulation (WSR) (EU, 2006a), which prohibits the export of:

1) waste plastics for disposal to non-EU countries other than European Free Trade Association (EFTA) countries that are party to the Basel Convention; and
2) hazardous waste plastics for recovery to non-Organisation for Economic Co-operation and Development (OECD) countries – this includes hazardous waste containing plastics, such as end-of-life vehicles.

The shipment of non-hazardous waste plastics for recovery to non-OECD countries is regulated by WSR Article 37, which stipulates that the European Commission has to send a written request to each non-OECD country seeking confirmation in writing that non-hazardous waste may be exported for recovery in that country and under which control procedure, if any. Most non-OECD countries have decided to ban the import of such waste or to allow it under specified control procedures (see Section 4.2).

The WSR transposes the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel Convention) into EU law. The Convention, which prohibits the export of hazardous waste unless the importing state has given its prior consent in writing to the specific import, has recently been amended, based on a proposal from Norway, extending the current regime to include contaminated, mixed or hard-to-recycle plastic waste[1].

Action on plastics has been identified as a key priority by the European Commission and several policies and legislation have recently been adopted which may impact the trade in waste plastics directly and indirectly. In particular, the 2018 EU Plastic Strategy (EC, 2018a) has shaped a systemic approach aimed

[1] See Rethink Plastic website. https://rethinkplasticalliance.eu/

at transforming the way plastic products are designed, produced and recycled in the EU, possibly laying the foundations of a circular plastics economy.

New recycling targets for packaging waste, including a specific target for plastic packaging, and for municipal solid waste (MSW) were set in 2018. A new Directive on the reduction of the impact of certain plastic products on the environment (EU, 2019a) has been adopted, which provides, *inter alia*, for a ban on some single-use plastic items, the introduction of separate collection targets for recycling and targets establishing a mandatory recycled content in plastic beverage bottles. Other pieces of legislation, for example on chemical substances (EU, 2006), can also affect the waste plastics sector.

This report aims to contribute to a better understanding of the recent dynamics of the trade in waste plastics and the two-way relationship between this trade and the EU Plastics Strategy.

In Chapter 2, the EU's rapidly changing international trade in waste plastics is analysed, including the illegal trade in waste plastics. In Chapter 3, the drivers of the waste trade are explored together with the environmental and economic implications of the international trade and 'non-trade' from Europe. In Chapter 4, the evolving policy framework for the trade in waste plastics is addressed by focusing on EU plastics and waste policies, and a set of options to better manage the trade within those policies is suggested.

2 European countries' trade in waste plastics

2.1. Plastics production, consumption, and waste

The annual global production of plastics has increased from 2 million tonnes in 1950 to 380 million tonnes in 2015 and is projected to double by 2035 and almost quadruple by 2050. China is now the leading plastics producer responsible for 28 per cent of global production, the rest of Asia produces 21 per cent, the USA, Canada and Mexico together about 19 per cent and Europe 18 per cent and the rest of the world 14 per cent (Barra et al., 2018).

Plastics are a family of hundreds of different materials, which can be either fossil fuel based or bio-based, with a wide variety of properties and uses. The European plastics industry is made up of about 60,000 companies with a turnover in 2017 close to EUR 355 billion and providing direct employment to more than 1.5 million people.

About 64 million tonnes of plastic were produced in the EU, Norway and Switzerland in 2017 (Plastic Europe, 2018a). In the same year, the total demand for plastics in the EU, Norway and Switzerland amounted to about 51 million tonnes (Table 2.1).

Table 2.1. Plastics demand in the EU, Norway and Switzerland, by sector, 2017, per cent

Sector	Per cent
Packaging	39.7
Building and construction	19.8
Automotive	10.1
Electrical and electronic	6.2
Household, leisure and sports	4.1
Agriculture	3.4
Others	16.7

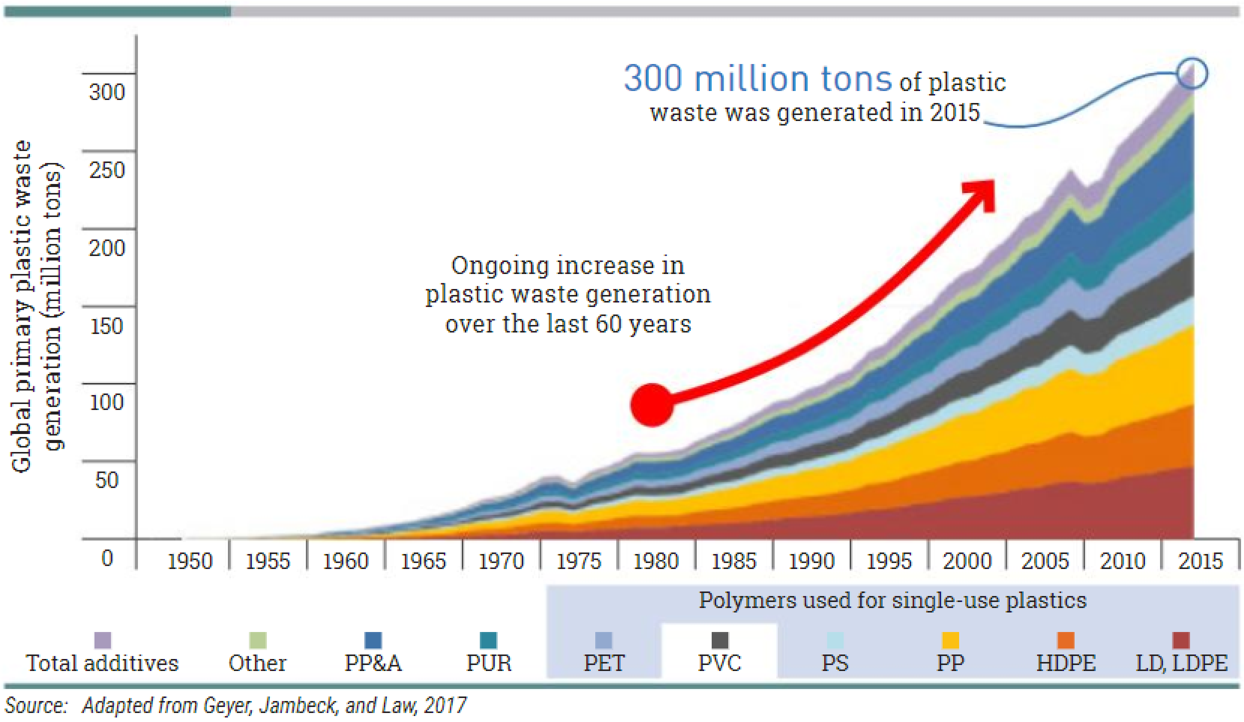
Source: Plastic Europe, 2018a

Single-use plastic food packaging, which is difficult to recycle because it is made of multiple materials, makes up a large part of the plastic used for packaging (Schweitzer et al., 2018).

It is estimated that the total amount of plastic ever produced is around 8,300 million tonnes of which about 70 per cent is now waste (Geyer et al., 2017) and due to mismanagement around a third of that is estimated to have entered the environment as land, freshwater or marine pollution[2]. The World Wilde Fund for Nature (WWF) estimates that, despite increasing efforts to improve the collection and treatment, as much as 37 per cent of global plastic waste is currently managed ineffectively. Most plastics do not biodegrade, which means that if they leak into the environment they remain there for hundreds of years (WWF, 2019).

[2] Mismanaged plastic waste refers to plastic left uncollected, dumped, littered, or managed through uncontrolled landfills, and it is much more likely to become pollution than waste managed through a controlled waste treatment facility.

Figure 2.1. Global primary generation of waste plastics, 1950–2015



Keys: PP&A = polyphthalamide; PUR = polyurethane; PET = polyethylene terephthalate; PVC = Polyvinyl chloride; PS = polystyrene; PP = polypropylene; HDPE = high-density polyethylene; LD/LDPE = low-density polyethylene

Source: WWF, 2019

In 2016, 27.1 million tonnes of plastic waste were collected in the EU and sent for energy recovery, 41.6 per cent; recycling, 31.1 per cent; and landfilling, 27.3 per cent. Between 2006 and 2016, the volume of plastic waste collected increased by 11 per cent and, with regard to waste management operations, recycling and energy recovery increased by 79 and 61 per cent respectively, while landfilling decreased by 43 per cent (Plastic Europe, 2018a).

A significant share of waste plastic is exported to non- EU countries. Indeed, these totalled around 3.1 million tonnes in 2016, almost 39 per cent of the figure for its recycling in the EU – around 8 million tonnes in 2016[3]. This makes plastic waste different, for example, from glass waste, for which traded volumes are small as compared to recycling volumes and trade flows are mostly within the EU[4]. On the other hand, plastic waste is closer to paper and cardboard waste, which also features significant extra-EU exports: in 2016, paper and cardboard waste recycling amounted to around 36.4 million tonnes, while extra-EU exports were around 11.6 million tonnes[5].

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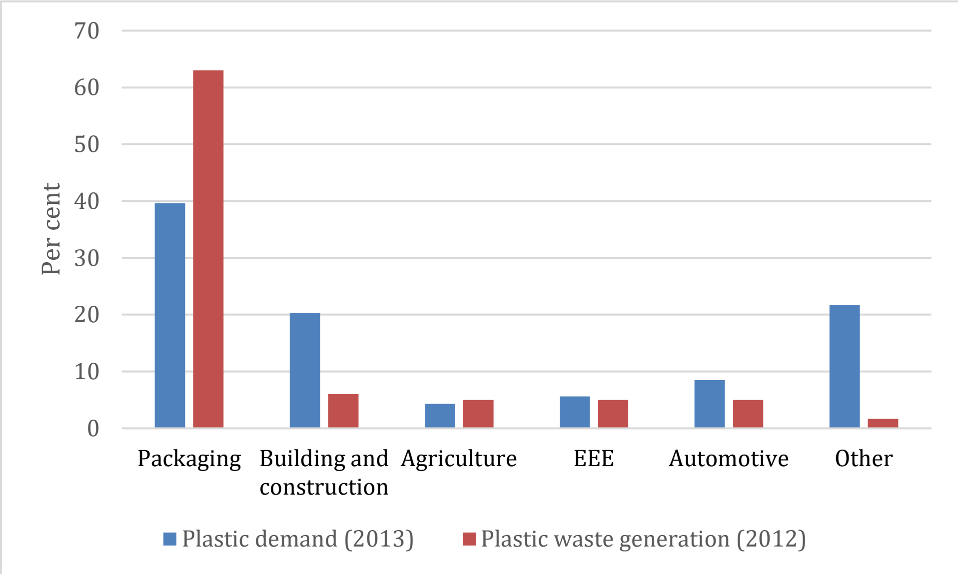
[3] The trade figures are from Eurostat statistics for international trade in goods (https://ec.europa.eu/eurostat/web/international-trade-in-goods/data/database). The amount of extra-EU trade in waste plastics is calculated using HS code 3915 – *Waste, parings and scrap of plastics*. Data for recycling was obtained using data for plastic waste and selecting *Recovery-recycling* from the Eurostat database on *Treatment of waste by waste category, hazardousness and waste management operations* (https://ec.europa.eu/eurostat/web/products-datasets/-/env_wastrt) (accessed 27 May 2019).

[4] See https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Recycling_%E2%80%93_secondary_material_price_indicator#Price_and_trade_volumes.

[5] The trade figures are from Eurostat statistics for international trade in goods (https://ec.europa.eu/eurostat/web/international-trade-in-goods/data/database). The amount of trade in waste paper and paperboard to non-EU countries is calculated using HS code 4707 – *Recovered (waste and scrap) paper or paperboard*. Data for recycling of paper was obtained using data for paper and cardboard wastes and selecting

Figure 2.2 shows the share of different markets in total plastic demand and the share of different waste streams in total plastic waste generation in the EU. The share of packaging in plastic waste generation is considerably higher than in plastic demand. This may be due to the shorter average life time of packaging compared to other applications such as electrical and electronic equipment (EEE) or cars and the fact that separate collection systems and the statistics may be more complete for waste plastic packaging than for other plastic waste types [6].

Figure 2.2. Plastics demand and plastics waste generation in the EU by sector, per cent



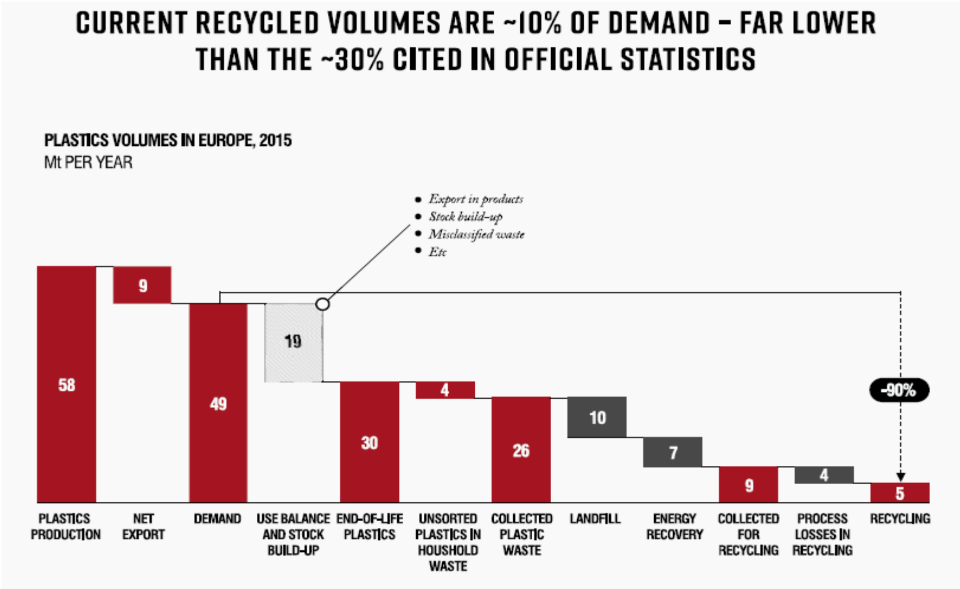
Source: Plastic Recyclers Europe, 2016

According to Material Economics (2018), only about 20 per cent of the plastic waste collected for recycling in Europe actually ends up as recycled plastic, and the market of recycled plastics covers 10 per cent of the demand for plastics (Figure 2.3). Furthermore, the majority of recycled plastic ends up in lower-value applications such as flowerpots and buckets. The combination of high recycling costs, the low quality of recycled material and a lack of quality standards has resulted in a limited demand for secondary plastics. An improvement in the quality of the recycled plastics could considerably increase demand by enabling new application areas (Material Economics, 2018).

Recovery-recycling from Eurostat database on *Treatment of waste by waste category, hazardousness and waste management operations* (https://ec.europa.eu/eurostat/web/products-datasets/-/env_wastrt) (accessed 27 May 2019).

[6] According to Bio Intelligence Service (2011), plastic products in the construction sector are designed to be durable and can last between 30 and 40 years before being disposed of; electrical and electronic devices have on average a service life of 3–12 years, with larger objects having a longer service life. According to the European Automobile Manufacturers Association (ACEA) in 2016 passenger cars in the EU were on average 11 years old (https://www.acea.be/statistics/tag/category/average-vehicle-age),.

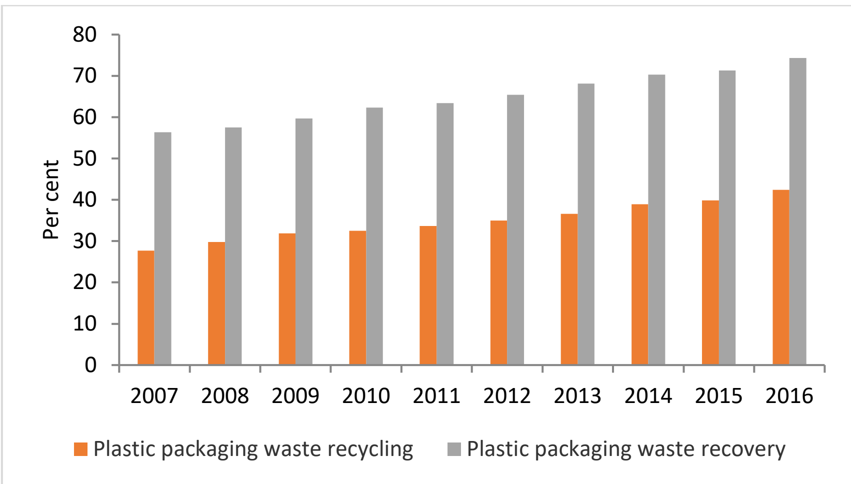
Figure 2.3. From waste plastics collected in Europe to recycled plastics, 2015, million tonnes



Source: Material Economics, 2018

According to Plastic Recyclers Europe (2016), packaging is the biggest source of plastic waste in Europe, 63 per cent; followed by building and construction, 6 per cent; EEE, 5 per cent; end-of-life vehicles (ELVs), 5 per cent; and agriculture, 5 per cent. In 2016, the EU generated 16.3 million tonnes of plastic packaging waste, of which 74.3 per cent were recovered and 42.4 per cent recycled[7].

Figure 2.4 Plastic packaging recycling and recovery in the EU, 2007–2016, per cent [8]



Source: Eurostat website[9]

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[7] Eurostat *Environment*, *Waste*, *Waste streams*, *Packaging waste by waste management operations and waste flow (env_waspac* (http://ec.europa.eu/eurostat/data/database).

[8] According to Eurostat 'The weight of recovered or recycled packaging waste shall be the input of packaging waste to an effective recovery or recycling process. If the output of a sorting plant is sent to effective recycling or recovery processes without significant losses, it is acceptable to consider this output to be the weight of recovered or recycled packaging waste'. Recovery includes recycling.

[9] Eurostat *Environment*, *Waste*, *Waste streams*, *Packaging waste by waste management operations and waste flow (env_waspac)* ((http://ec.europa.eu/eurostat/data/database).

The EU's Packaging and Packaging Waste Directive (PPWD) binding recycling target for plastics packaging waste, 50 per cent by 2025 and 55 per cent by 2030, implies that more than an additional 10 million tonnes of recycled material need to be absorbed by the markets. Compared to 2014, this corresponds to more than twice the amount of the total currently recycled material (Deloitte Sustainability, 2018).

Some European countries already recycle 50 per cent or more of their plastics packaging waste. Currently, in 2019, however, the EU's recycling rates are calculated as the waste collected for recycling *including* waste exported for recycling. It is not always clear what happens to the exported waste and whether the conditions of recycling meet the standards set by the EU. Furthermore, all the collected waste is counted *as recycled*, even though there are always some material losses in the sorting and recycling processes and, in many cases, some of the waste entering the sorting site is incinerated due to the poor quality, or contamination of the waste.

Changes in the calculation methods were introduced by the EU in 2018 (EU, 2018), with the recycling rate calculated on the basis of the amount of waste plastics that enters a recycling facility and not on the amount of waste plastics collected and sent for recycling (Member States shall transpose the Directive by 5 July 2020). This calculation method will necessitate the waste collector being more aware of what happens to the waste after collection. It is also likely to reduce the recycling rates as the collected amount is always higher than the amount that actually enters the recycling facility as it does not include rejects from sorting.

At the global level, according to the Ellen MacArthur Foundation (2017), 95 per cent of the material value of plastic packaging, USD 80–120 billion annually, is lost to the economy after a first use (one cycle). Globally, 40 per cent of plastic packaging waste is landfilled, 32 per cent escapes all waste management and leaks into the wider environment, 14 per cent is incinerated and just 14 per cent is collected for recycling. When additional value losses in sorting and reprocessing are taken into account, only 5 per cent of the original material value is retained for a subsequent use.

All products that contain plastics potentially contribute to the volume of plastic waste. The average content of plastics in European cars has increased from around 9 per cent of a vehicle's weight at the end of the 1990s (Kanari and Shallari, 2003) to 16 per cent in 2016 (CBI Market Intelligence, 2016). In 2016, the EU generated 6.4 million tonnes of ELVs[10], so assuming an average service life of about 10 years and applying a share of plastic content of 10 per cent, it can be roughly estimated that, in 2016, at least 645,000 tonnes of plastic waste were generated from ELVs.

The composition of waste electrical and electronic equipment (WEEE) depends on the type of appliance. Buekens and Yang (2014) have estimated that average plastic concentration in large and small household appliances is 9 and 48 per cent respectively. When applying these shares to the amount of WEEE collected in the EU in 2015, about 180,000 tonnes and 181,000 tonnes of plastic waste was generated, respectively, from discarded large and small household appliances.

2.2. Plastics waste trade of EU countries

Exports of waste plastics, from both the EU and other regions/countries, increased significantly in recent years. In 2016, 4 per cent of global plastic waste was exported, amounting to roughly 13 million tonnes, of which nearly 50 per cent originated in G7 countries[11]. Brooks et al. (2018) report that 89 per cent of historical global plastic waste exports consist of polymer groups often used in single use plastic food packaging (polyethylene, polypropylene and polyethylene terephthalate) and, based on the UN

[10] Eurostat *Environment*, *Waste*, *Waste streams*, *End-of-life vehicles by waste management operations – detailed data (env_waselv)* (http://ec.europa.eu/eurostat/data/database):.

[11] G7 countries: Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States.

Comtrade Database, they estimated that, in 1998–2016, the EU was responsible for 31 per cent of global plastic waste exports.

In spite of growth in domestic recycling and recovery capacity, about half the plastic waste collected in the EU is sent abroad for treatment (EC, 2018a). More than 85 per cent of this was, until recently, shipped to China (EC, 2018a), which, since the 1990s, had been the main importer of plastic waste. Ships carrying the huge volumes of consumer goods imported from Asia facilitated the export of EU waste back to Asia but this suddenly changed when China, and subsequently other destination countries, progressively introduced rigid waste import policies culminating in bans on imports in 2018.

This section presents the analysis of EU countries' trade in waste plastics based on Eurostat data on international trade in goods[12]. The data were extracted from the Eurostat database[13] and specifically the datasets on EU trade since 1988 by HS2-HS4 (DS-016894) and CN8 (DS-016890), depending on the information needed[14].

2.3. Changing trends

Total exports of waste plastic increased steadily from 2000 to 2010, then fell until 2013 and again in 2017–2018 (Figure 2.5). Trade to China changed from almost zero in 2000 to slightly more than 1 million tonnes in 2017, but returned to very low levels in 2018. In recent years China moved towards a ban on the import of waste plastic, which became effective in January 2018 (Section 4.2). The recent decrease in extra-EU exports started even earlier, from 2014, while exports between EU Member States (intra-EU) shows a significant increase between 2000 and 2018, from 0.6 to around 2.5 million tonnes. As a result of these changes, intra-EU exports of waste plastic are now greater than extra-EU exports.

Import of waste plastics is largely an intra-EU flow. This trade increased steadily between 2000 and 2016, since when it has remained more or less constant (Figure 2.6)[15].

The evidence from Figures 2.5 and 2.6 indicates that the Chinese trade ban has contributed to a reduction in total extra-EU exported quantities of plastic waste while the intra-EU trade has remained close to stable. This suggests that at least part of the previously exported waste is now being retained for management within the producing EU countries.

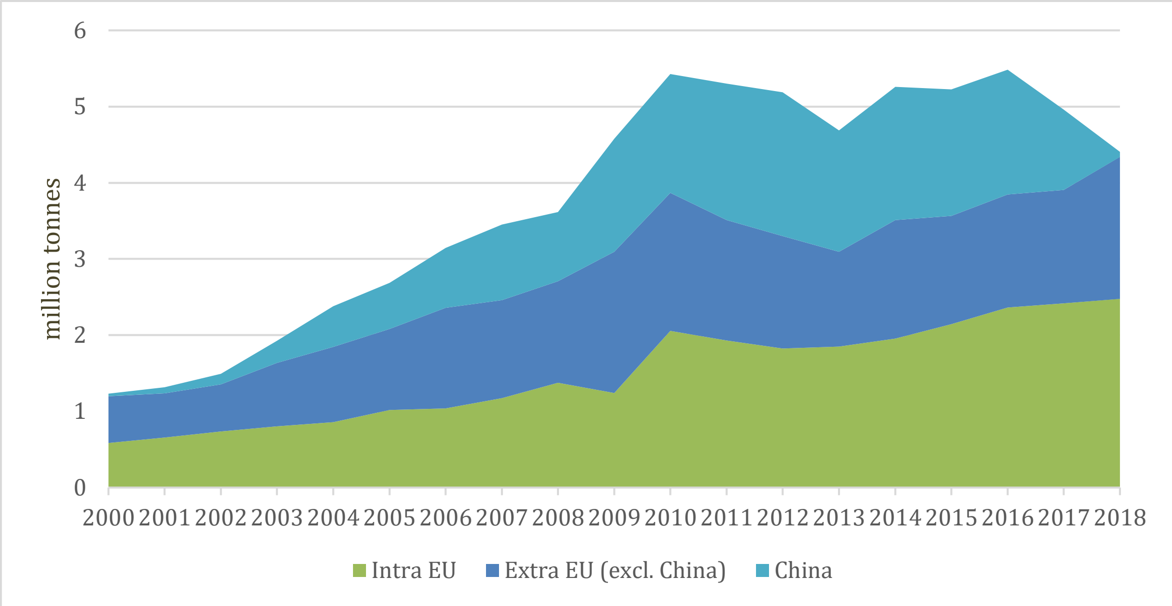
[12] Based on the Waste Shipment Regulation, Eurostat provides data on the transboundary shipment of plastic waste for 2001–2018. These data, however, are not used in this report for the following reasons. First, within this data set, only notified shipments are reported, i.e. mainly shipments of waste destined for disposal and of hazardous waste destined for recovery, excluding most of the trade in plastic waste, which mainly includes non-hazardous waste destined for recovery. Moreover, waste classification codes that are used in notification documents, and which are correspondingly reported by Eurostat, are very generic. The Basel Convention lists 47 Y-codes, 45 of which cover hazardous waste. Non-hazardous waste is addressed only by Y-46 *Waste collected from households* and Y-47 *Residues arising from the incineration of household wastes*. The inclusion of the European Waste Catalogue codes, which could provide for a better identification of shipped types of plastic waste , is optional and the related code field is often unfilled or unknown.

[13] https://ec.europa.eu/eurostat/web/international-trade-in-goods/data/database

[14] In Figures 2.5, 2.6 and 2.9 we refer to HS4 code 3915 - *Waste, parings and scrap of plastics*. More specific codes will be highlighted where needed (Figures 2.7 and 2.8).

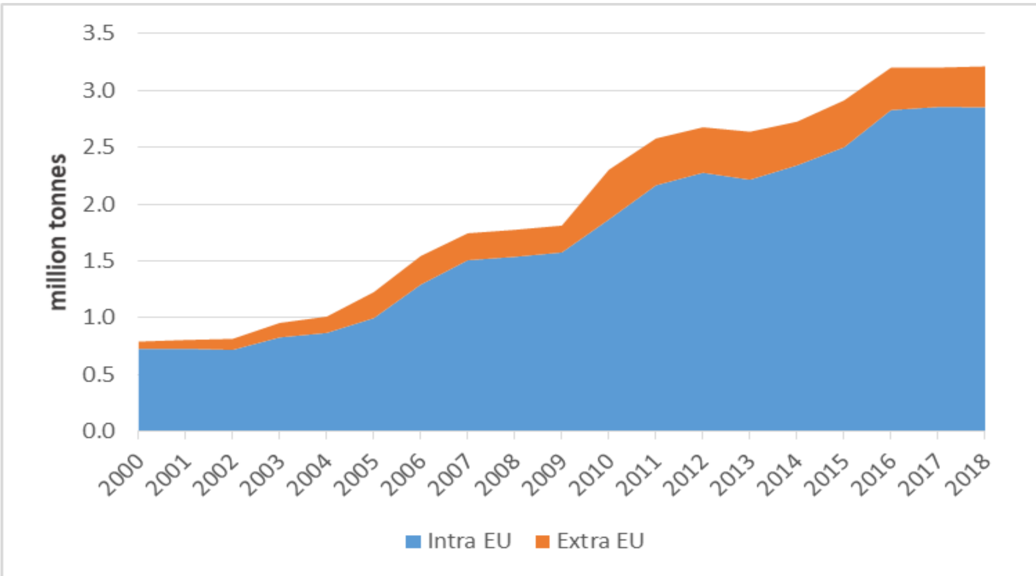
[15] Imports from China are not shown separately as the related share is small.

Figure 2.5. Total exports of plastic waste from EU28, 2000–2018, million tonnes



Source: own elaboration on Eurostat EU trade since 1988 by HS2-HS4 (DS-016894) (accessed 9 July 2019)

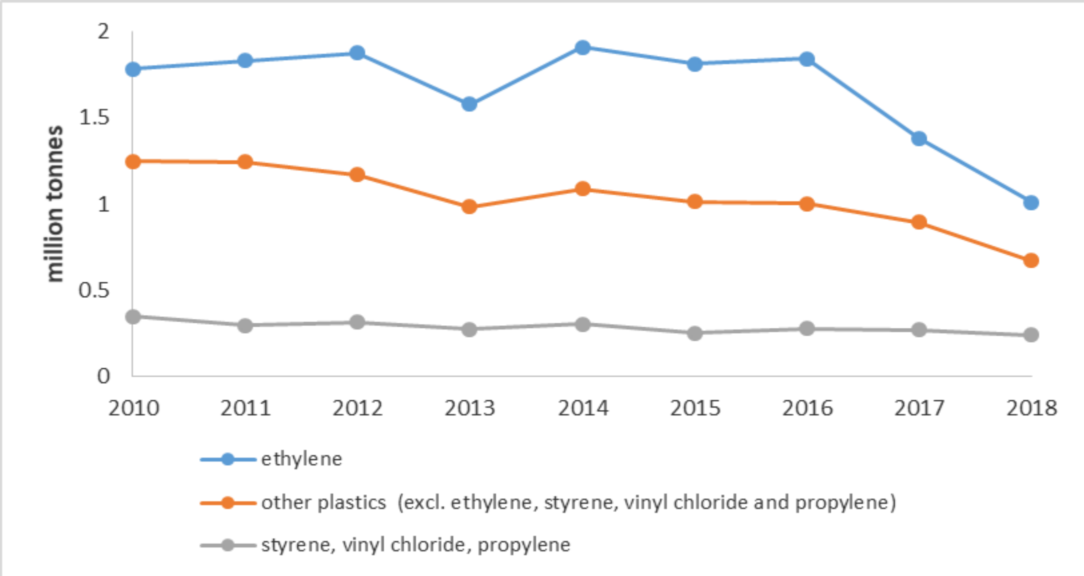
Figure 2.6. Total imports of waste plastic from intra-EU and extra-EU countries, 2000–2018, million tonnes



Source: own elaboration on Eurostat EU trade since 1988 by HS2-HS4 (DS-016894) (accessed 11 July 2019)

More detailed data on extra-EU exports of waste plastics, classified according to the related CN8 codes, are presented in Figure 2.7. Extra-EU exports are dominated by CN code 39151000 (Ethylene polymers) and by CN code 39159080 (other plastics, excluding ethylene, styrene, vinyl chloride and propylene). Figures 2.5 and 2.7 clearly show that extra-EU exports decreased significantly between 2017 and 2018, most significantly for ethylene polymers, and this can, at least partly, be explained by the Chinese ban.

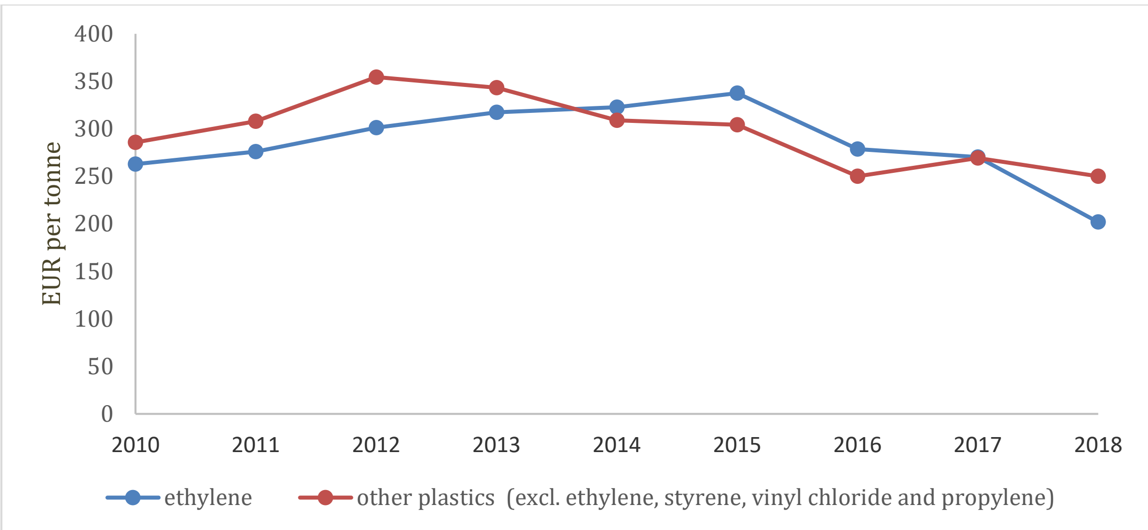
Figure 2.7. Extra-EU exports of waste plastic, by CN 8 Codes, 2010–2018, million tonnes



Source: own elaboration on Eurostat EU trade since 1988 by CN8 (DS-016890) (accessed 12 July 2019)

Figure 2.8 shows the recent trend in the unit value of the two most important traded plastic waste types, based on the yearly quantities shown in Figure 2.7[16]. The unit value of ethylene increased up to 2015 and decreased thereafter; for other plastics, it rose until 2012, then fell until 2016 since when it has recovered slightly.

Figure 2.8. Average unit value of ethylene and other plastic waste exported to extra-EU destinations, 2010–2018, EUR per tonne



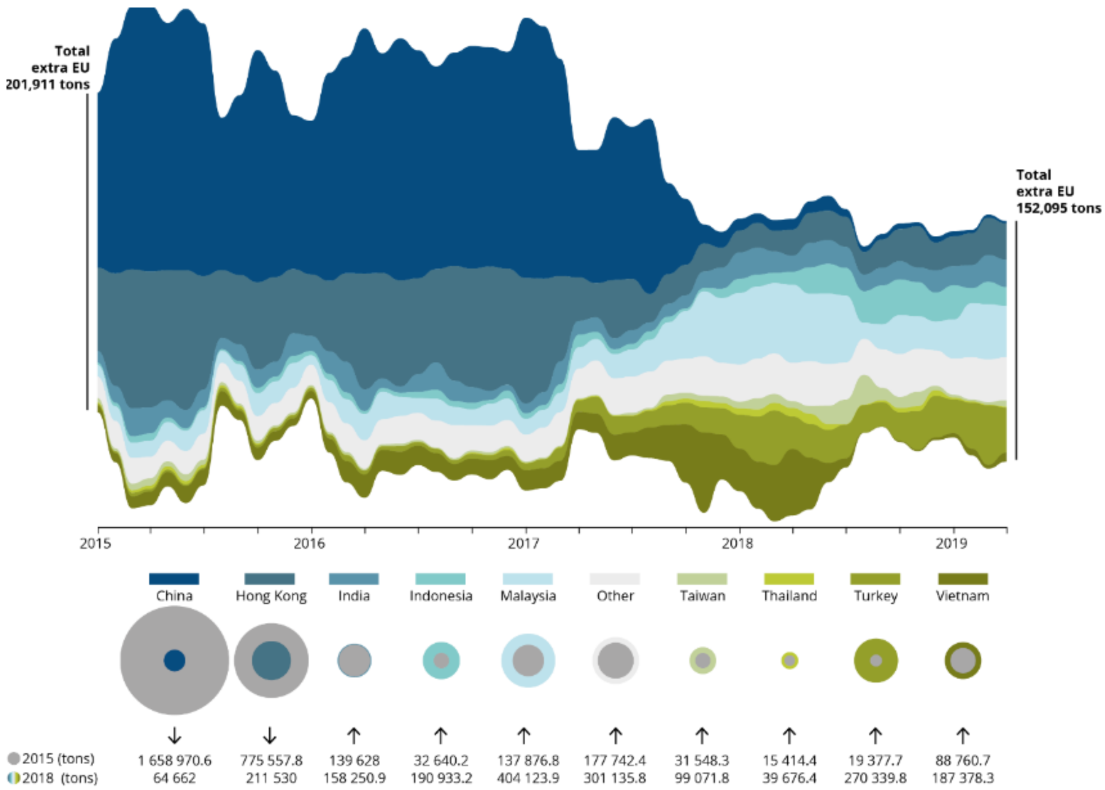
Source: own elaboration on Eurostat EU trade since 1988 by CN8 (DS-016890) (accessed 12 July 2019)

[16] The price indicator measures the unit export price and is calculated as the ratio between yearly value (in EUR) and yearly traded volume (in tonnes) for the relevant foreign trade statistics codes. See, among others, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Recycling_%E2%80%93_secondary_material_price_indicator#Price_and_trade_volumes.

2.4. Changing destinations

Figure 2.9 provides a detailed picture of EU exports to key extra-EU destinations[17]. In line with data reported in Figure 2.5, a significant reduction in extra-EU exports of plastic waste took place between January 2017 and April 2019. Furthermore, extra-EU exports have been redistributed significantly across countries. The volumes of plastic waste exported to China and Hong Kong in 2018, for example, were, respectively, 96 and 73 per cent lower than in 2015, while the opposite occurred in other countries, with Turkey and Indonesia recording the most significant increases, +1,295 and +485 per cent respectively. The January 2018 Chinese ban, together with others or similar policies announced or introduced during 2018 in other countries[18], suggest a possible explanation of these changes, although in some cases it may still be too early to observe an impact.

Figure 2.9. Extra-EU plastic waste exports by receiving country, tonnes, January 2015–April 2019



Source: Eurostat EU trade since 1988 by HS2-HS4 (DS-016894) (accessed 9 July 2019)

Changes took place between 2017 and 2018 also in intra-EU trade but these changes may be the outcome of multiple co-existing factors, and it is not possible to provide an in-depth analysis of the effects of bans in extra-EU destinations on intra-EU trade flows.

[17] Based on Eurostat graph at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Figure_10_Export_of_plastic_waste_for_recycling_from_the_EU_to_receiving_countries,_2015_to_March_2018.png

[18] See Section 4.2 for additional details.

2.5. Illegal plastic waste trade

Illegal shipments of plastic waste are likely to cause severe pressures on the environment. Plastic waste may be exported to non-EU countries for the purpose of disposal and hazardous plastic waste to non-OECD countries for the purpose of recovery both in breach of the WSR. It is worth noting that, since plastics are often mixed with hazardous waste to disguise illegal shipments of the latter, they can be contaminated. Moreover, hazardous waste containing plastic, such as ELVs and some WEEE, may be exported for recovery to non-OECD countries also in violation of the WSR. Finally, plastic waste may be illegally exported for recovery to non-OECD countries that have prohibited its import or in breach of the control procedure applied by the importing country (Section 4.1 and 4.2).

Data on illegal shipments of waste is provided by European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) under the Enforcement Actions (EA) Project. This has been regularly used since 2008 to carry out inspections aimed at enforcing the WSR and analysing the related data.

With regard to EA Project III (2012–2013), EA Project IV (2014–2015), and EA Project V (2016–2017), Figure 2.10 shows the share of transport and company violations[19] related to plastics, WEEE and ELVs/car parts (IMPEL, 2018; 2016; 2013). It has to be underlined that each EA Project is characterised by a different number of administrative and transport inspections and of participating countries[20].

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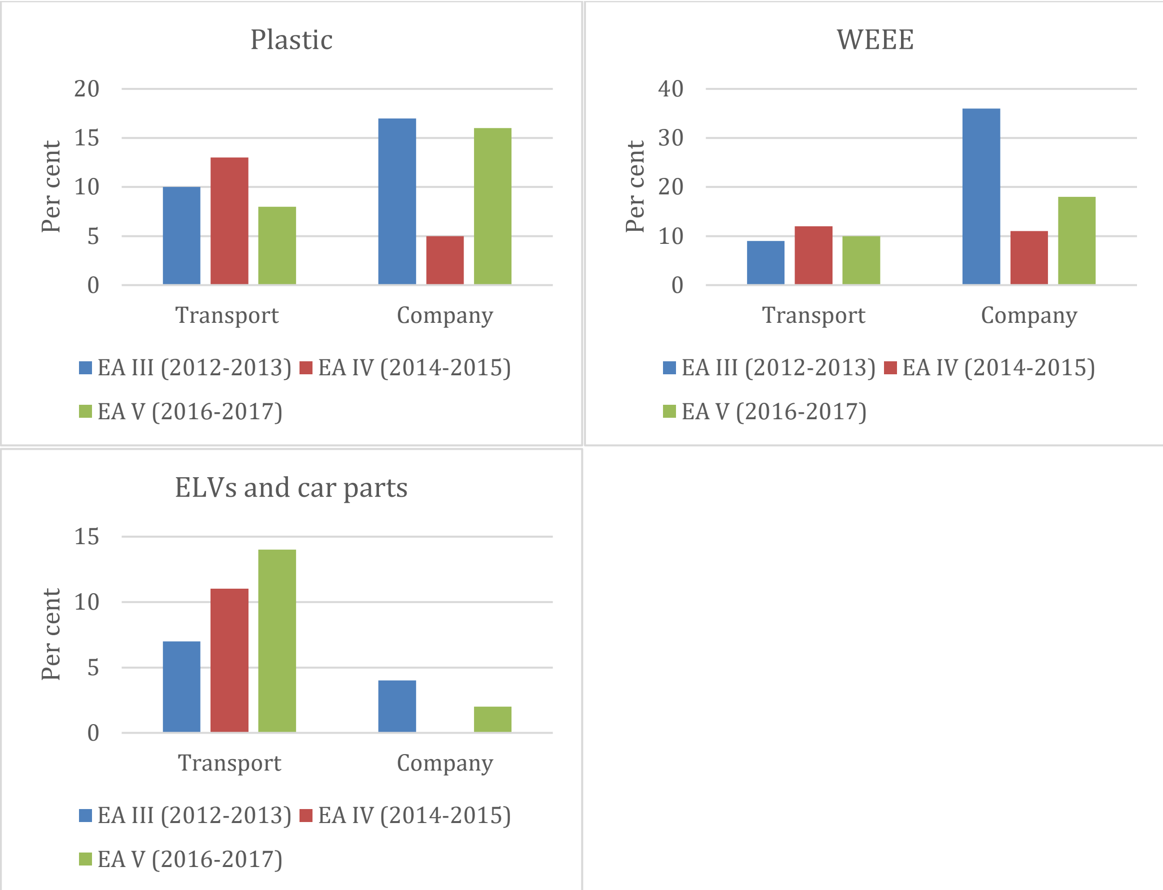
[19] The focus of the EA Projects was on transport inspections. Company inspections were introduced for verification purposes and for authorities that have limited opportunities to carry out transport inspections or where company inspections are a more effective tool for particular waste streams.

[20] EA III (2012-2013): 11,890 administrative and 10,524 physical transport inspections; 30 participating countries, 24 of which have reported inspection activities. EA IV (2014-2015): 4,787 administrative and 12,396 physical transport inspections; 31 participating countries, 26 of which reported inspection activities. EA V (2016-2017): 6,048 administrative and 16,222 physical transport inspections; 34 participating countries, 27 of which reported inspection activities. Please note that administrative inspections consist purely of a review of the paperwork associated with import/export traffic, for example, a review of port manifest documents to highlight shipments for further inspection, while physical inspections included a visual inspection of the consignment usually at a roadside location or a seaport if recorded as a transport inspection. They, however, could also take place at a known waste export site or reprocessing facility.

Figure 2.10. Violations by selected waste stream under IMPEL EA III, EA IV and EA V, per cent of violations



Source: own elaboration on data from IMPEL, 2018, 2016 and 2013

In 2016–2017, the major waste streams involved in transport violations were metals, 20 per cent; ELVs and car parts 14 per cent; paper and cardboard, 10 per cent; WEEE 10 per cent and plastics, 8 per cent. The major waste streams involved in company violations were household and mixed municipal waste, 23 per cent; WEEE, 18 per cent and plastics, 16 per cent.

In June 2017, Interpol conducted Operation 30 Days of Action, the largest law enforcement operation ever mounted against waste crime, targeting illegal landfill activities and illegal shipments of all types of waste and involving 43 countries from every region of the world. According to the operational findings (INTERPOL, 2017), Europe had most cases of illegal waste shipments (77 per cent) originating in the region. In particular, 68 per cent of all criminal cases involving inter-regional shipments consisted of exports from Europe to Africa. Waste types detected were essentially WEEE falsely declared as used electrical goods (43 per cent) and waste from the car industry (32 per cent), which mostly included used tyres (20 per cent), vehicle components and oil or a mixture of both WEEE and tyres.

The two main waste streams illegally exported from Europe to Asia were paper and cardboard, and metals, with plastics, WEEE and ELVs playing a minor role.

Europe was also the region from which most intra-regional and domestic illicit trade took place. These findings, however, should be analysed bearing in mind that more than 50 per cent of countries participating in the operation were European with consolidated waste-crime related legislation and law enforcement capacity (INTERPOL, 2017).

Other information on illegal shipments of WEEE and ELVs comes from literature and reports. With regard to WEEE, according to Huisman et al. (2015), only 35 per cent (3.3 million tonnes) of all WEEE discarded in 2012 in the EU ended up in official collection and recycling systems, while 1.3 million tonnes were shipped as undocumented exports beyond the EU. In general, small scale exports are destined to West Africa, while larger and more structurally organised transport went to Southeast Asia, although China had introduced an import ban on all WEEE in 2000 (Palmeira et al., 2018; EFFACE, 2015).

Furthermore, it has been estimated that, on average, 25 per cent of all ELVs in the EU do not end up in authorised treatment facilities (European Commission, 2014). The 2017 Assessment of the implementation of the ELV Directive (European Commission, 2017) shows a significant increase in the number of unknown whereabouts[21] in the EU, from 3.4 million vehicles in 2009 to 4.66 million vehicles in 2014. Some of these vehicles were illegally exported to non-OECD countries (European Commission 2017).

The effectiveness of the EU WSR depends on several factors, such as inspection capacity, which requires well-trained staff, adequate financial resources and technical equipment; co-operation between enforcement authorities within and beyond national borders – customs, police services, environmental agencies, etc.; the extent to which environmental crimes are prosecuted and infringements penalised in trading countries, etc. The revised WSR (EU, 2014) provides for stronger national inspection of waste shipments, including at the final destination.

Since not all trading countries have the same level of monitoring/enforcement, some illegal waste traders engage in port-hopping, choosing those ports where the import and/or export controls are weakest.

The illegal trade provides substantial profits, while the risk of fines or imprisonment is generally low. The trade is usually outsourced to small organised crime groups, typically of up to 10 people, which operate for a short period, take the profits and then rapidly dissolve to form new groups. Corruption of border guards, customs, officials and port operators is often used (Palmeira et al., 2018). Legal activities/businesses, such as banks, hauliers and lawyers, are also frequently, whether intentionally or not, involved, making the export chain long and complex (EFFACE, 2017).

The main method used to breach customs systems is to mingle illegal and legal waste to obtain a false classification – trade the mixture using the HS code of the legal material. Enforcement is complicated by the broad definitions of waste applied in the EU – for instance, the Waste Framework Directive Article 3 (EU, 2008) often makes the decision of whether a product is second hand or simply waste arbitrary[22] – and by the existence of different code systems – WSR codes/Basel codes and HS codes used by custom authorities.

Based on the above considerations, unless inspections and enforcement are regularly implemented trade bans will probably not succeed in stopping the targeted waste flows.

[21] *Unknown whereabouts* are vehicles that are deregistered without a certificate of destruction being issued or available to the authorities and also with no information available indicating whether the vehicle has been treated in an authorised facility or has been exported.

[22] However, the revised WSR has shifted the burden of proof regarding the distinction between *waste* and *products* as well as the environmentally sound management in third countries to suspected illegal exporters. A similar provision has been introduced in the recast WEEE Directive (2012/19/EU).

3 Drivers and pressures of the trade in waste plastics

3.1. Drivers of trade in waste plastics

Drivers of the waste trade can be described by following the existing empirical literature that addresses the determinants of the trade (Mazzanti and Zoboli 2013; EEA 2012; Kellenberg 2012). These drivers also apply to the trade in waste plastic. A large part of the drivers identified in research and reporting are not regularly documented, however, and the empirical measurement of the role of different drivers, including those for the trade in waste plastic, can be challenging outside specific studies.

In the framework provided by Kellenberg (2012), domestic waste is generated by consumption and production, on the basis, among other things, of countries' economic structures. Waste is then recycled, disposed of domestically or exported. Relevant factors that determine waste exports include domestic and foreign waste policies, infrastructure and traditional trade drivers.

Based on literature and studies, Mazzanti and Zoboli (2013) propose a more detailed set of drivers.

1. *Gate fees and transportation costs.* For a specific waste and a given management option such as energy recovery, if there is enough management/treatment capacity in both the home and destination countries, a driver of the waste trade can be the difference between the domestic and foreign gate fees, excluding environmental taxes, or between domestic and foreign prices, if the price for the waste is positive. The gate fee differential must be weighed against transport costs because, to justify the export, the advantage (cost saving or benefit) in gate fees (or prices) abroad must be higher than the additional transport costs. When considering transport costs, it must be noted that some waste management locations, such as northern Italian regions, can be closer to foreign countries than certain home country destinations, southern Italy, for example. For long-distance transport costs, the working of the freight market must be considered, in particular return-freight costs may be very low as an alternative to return travel without a load. Return-freights costs may favour international shipment of non-hazardous waste or some waste categories such as plastics waste that do not require specialist transport facilities. Another factor is the availability of international harbours, such as in the Netherlands, which may explain the concentration of waste shipments and transits in some countries.

2. *Administrative costs.* Administrative costs must be added to the transport cost and they may reduce the profitability of international shipments. Specific administrative costs, notification fees for compliance to regulations, for example, must be added for some waste flows. For hazardous waste, these costs may be high compared to gate fee/price differential and may discourage legal international shipments.

3. *Tariff and non-tariff barriers.* For extra-EU destinations, there may be trade tariffs on waste in importing countries that may discourage the waste trade. For certain categories of waste there may be non-tariff customs measures or bans that may increase the costs of international shipment or even prevent it. This may explain changes in geography of trade if destination countries impose different tariff rates or non-tariff barriers.

4. *Differences in environmental taxes and policy stringency.* Different countries may apply different environmental taxes, for instance on landfill or incineration, on the same management/treatment of the same waste type. This may stimulate shipments out from high-tax countries. Different implementation of other economic instruments and (voluntary) environmental management systems can also contribute to push trade flows. In transitional phases of the regulatory process,

different maturity in the implementation of rules, even between EU countries, can explain waste being shipped for disposal.

5. *Differences in treatment capacities between countries (excess supply/demand)).* There may be a saturation of capacity for a given technology such as landfill at a reasonable distance within the home country. The consequent excess supply of waste requiring management may drive export flows. In some critical situations, institutional failures and lack of diversification in (technological) options can play a role. In this case, trade can be a necessary but not always the least-cost solution because trade is efficient only if its cost is lower than the least-cost mix of waste management at the local level. The capacity factors can also push demand to import waste. For example, large waste-to-energy capacities in a country in which recycling is increasing may push procurement of waste as an energy feedstock from others. In the capacity-differential discussion, dynamic considerations may be relevant: short-term benefits of trading could delay investment in domestic capacity; as a consequence, trade can be beneficial in the short run but may induce dependence on foreign capacity. The transition from landfill disposal to recycling/recovery starts with domestic policies on separate collection, which may face a short-term lack of recycling/recovery capacity in the home country and then trade can prevail if there is enough capacity (in excess of domestic supply) in other countries. Imbalances between domestic supply and domestic demand capacity, as well as for different technologies, may occur asymmetrically between countries and can change dynamically over time. The gradual creation of domestic capacity can reduce trade flows and/or can change the quality, composition and destination of trade. The increase in transboundary shipments of waste, therefore, is driven partly, but hopefully temporarily, by the introduction of recycling/recovery requirements and targets.

6. *Different incentives for recycling/ energy recovery.* For waste suitable for energy recovery, energy policies may indirectly stimulate waste trade. For example, the incentives on renewable energy sources (RES), which include waste as a feedstock, are still high in some EU Member States compared to others and non-EU countries. This may attract international procurement (import) of waste for energy.

7. *Differences in legislation/classification.* Differences in legislation or administrative practice for waste classification and treatment across countries could create incentives to ship waste internationally. These costs can be compared to others – gate fees, transport, taxes/incentives, administrative and customs costs – to determine whether the trade in waste is profitable.

8. *Need for specific technologies.* For some waste categories, for example some hazardous waste, there may be limited capacity for treatment according to legislation in the home country. This may drive international flows to where the technology is in operation, even over long distances and at high transport and administrative costs.

9. *Geographical characteristics of countries/regions.* Although they may be proxied by some of the drivers discussed above, especially transport costs, the geographical characteristics of countries/regions may be relevant drivers of waste trade. These are also easier to define than transport costs and may be used as proxies for the latter in empirical analyses.

Table 3.1 summarises these drivers and possible empirical indicators. Most of the indicators, and the corresponding drivers, are poorly documented in official statistics, and require information that can be scant or fragmented, or may require direct enquiries.

Nonetheless, the trends and factors described in previous chapters suggest what can be the most important factors behind European countries' international trade in waste plastics. These factors are shown in the last two columns of Table 3.1 for, respectively, intra- and extra-EU trade.

The combination of gate-fee differentials and transport cost can be relevant for extra-EU export of waste plastics, in particular gate fees given the possible low transport costs by sea to Asia, whereas high overland transport costs may discourage intra-EU trade. The existence of bans can be a very relevant factor in discouraging extra-EU trade. Different landfill taxes, when different from gate fees, can be relevant for both intra- and extra-EU trade. Differences in domestic capacity for treatment and recycling/recovery with respect to domestic collection capacity can be a very relevant factor behind both intra- and extra-EU trade in waste plastics, probably the most important one in pushing trade as a result of the rapid development of separate collection in most EU Member States not being matched by an equivalent increase of recycling capacity. While differences in classifications, legislation and, more importantly, different administrative practices across EU Member States cannot be excluded as a factor stimulating plastics waste trade, this can be much more important in pushing the extra-EU trade. Finally, both the need of specific technologies or the availability of different technologies giving economic value to waste plastics, as well as the closeness of countries and lower transport costs can be factors mainly behind intra-EU trade in waste plastics.

Table 3.1. Drivers of bilateral flows of waste and their possible importance for the treate in waste plastics waste

(Note: The sign of the indicator is the relevant one in driving export)

Driver	*Possible indicator (–= difference between …; * = multiplied by …..)*	*Expected sign on trade (+ or -)*	*Likely importance for intra-EU trade*	*Likely importance for extra-EU trade*
Gate fees and transport costs	Gate fees in exporting country – gate fees in importing country (technology of treatment in importing country)	+	*	***
	Distance between exporting and importing countries * average transportation cost	-	**	
Administrative costs	Cost of exporting/importing practices	-		
Tariff and non-tariff barriers	Existence of bans	-/+		***
Differences in environmental taxes and policy stringency	Landfill tax in exporting country – landfill tax in importing country	+	**	***
Difference in treatment capacity (policy-driven excess supply or demand)	Capacity in exporting – capacity in importing (treatment in importing)	-	***	***
	Or: (Collection – capacity in recovery/recycling exporting country) – (Collection – capacity recovery/recycling exporting country)	+	***	***
Different incentives for recycling/energy recovery	Incentive on Renewable energy socurces in exporting country –	-		

	incentive on e-RES in importing country			
Differences in legislation/classification	Stringency of legislation in exporting country – stringency legislation in importing country	+	*	***
Need for specific technologies	Availability of X technology in importing country only	+ if available	**	
Geographical characteristics of countries region	E.g. common borders	e.g. + if the two countries have a border in common	***	

Source: own elaboration starting from Mazzanti and Zoboli (2013)

3.2. Environmental and climate pressure in plastics' lifecycle

a) Source materials

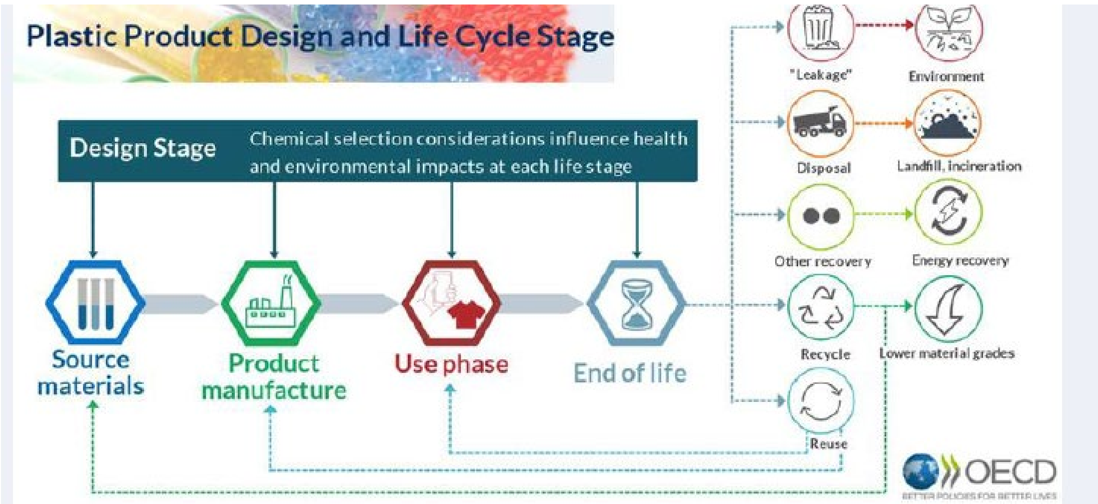
The production of plastic is largely reliant on fossil hydrocarbons. In Europe, 49 million tonnes of oil and gas were used for the production of plastics in 2015, about 6 per cent of the total amount used (Kaiser et al., 2018). This is equivalent to the oil consumption of the global aviation sector.

If the growth in plastic production continues as expected, the plastics sector will account for 20 per cent of total oil consumption and 15 per cent of the global annual carbon budget by 2050[23].

Incineration and energy recovery also result in a direct release of carbon (not taking account of the potential carbon savings of replacing it with another source of energy). If the plastics are landfilled, this feedstock carbon could be considered sequestered. If it is leaked, carbon might be released into the atmosphere. Even though plastics can bring resource efficiency gains during use, these figures show that it is crucial to address the greenhouse gas impact of plastic production and after-use (Ellen MacArthur Foundation, 2017).

[23] The budget that must be adhered to if global warming is to be limited to less than 2° C above pre-industrial levels

Figure 3.1. The different stages of the plastic lifecycle



Source: UNEP, 2018

b) Product manufacture

One of the greatest technological challenges in increasing the recycling of plastics is the complexity of the materials in the market. Multilayer structures, the large selection of resins and the use of a variety of additives in the plastic materials create difficulties in waste sorting and refining. Few plastic packaging materials and products are designed to be easily recyclable. The Ellen MacArthur Foundation has estimated that without fundamental redesign and innovation, about 30 per cent of plastic packaging will never be reused or recycled. It is therefore of crucial importance that more attention is paid to end-of-life options from the initial design stages of materials and products (Ellen MacArthur Foundation, 2017).

The raw materials of plastics are delivered to plastics converters in the form of small plastic pellets. These typically have a diameter of 2–5 millimetres (mm) and are regular in shape. Smaller powders, often referred to as fluff, are also produced and have more irregular shapes and sizes. Pellets are transported from their production site by ship, train and/or truck to the facility where the final products are made. Some material can be lost at each stage of the production and transportation chain. Several studies indicate that, in many cases, pellets leak out of the system – plastic pre-production pellets have been found in environmental samples all over the world (Karlsson et al., 2018).

c) Use phase

About half the plastics produced are used in products and packaging the life cycle of which is less than three years. This, together with the lack of proper waste management in many developing countries, is the main cause of the leaking of plastics into the environment.

Two main issues, which can cause both environmental and health pressures in the use phase, are: i) the release of secondary microplastics[24]; and ii) the release of additives (or monomers/oligomers).

In addition to polymers (resins) almost all plastic materials contain variable amounts of other chemicals added to improve their processability and other properties. Several studies have highlighted

[24] Primary microplastics are plastics originally manufactured to be that size, while secondary microplastics originate from fragmentation.

the likelihood of these additives contaminating air, food, soil and water (Hahladakis et al., 2018). Due to wearing, some break down into micro- (0.1–5 mm in length) and/or nano- (0.001–0.1mm in length) plastic particles, which are difficult to detect and remove from the air, oceans and soils. Microplastics can contain, on average, 4 per cent of additives and can adsorb other contaminants. Both additives and contaminants can be organic as well inorganic; as most plastics do not biodegrade, the microplastic pollution stays in the environment for hundreds of years, and thus starts to accumulate. Microplastics have already been found in, amongst others, common table salt, both tap and bottled water and human manure[25].

The impacts of microplastics in soils, sediments and freshwater are not known in detail. It is suggested that they may have a long-term damaging effect on terrestrial ecosystems globally through adverse effects on organisms, such as soil-dwelling invertebrates and fungi, needed for ecosystem services and functions. Up to 730,000 tonnes of microplastics are transferred to agricultural lands in Europe and North America every year from urban sewage sludge used as farm manure. Furthermore, toxicity and toxicokinetic data are lacking for a human risk assessment of both micro- and nanoplastics (Barra et al, 2018)[26].

Plastics has become a serious challenge for the natural world. Wildlife entanglement has been recorded in more than 270 different animal species, including mammals, reptiles, birds and fish. It is estimated that about a thousand marine turtles die every year from entanglement in plastic waste. Studies have shown that more than 240 different animal species have been ingesting plastic. These animals are often unable to pass the plastic through their digestive systems, resulting in internal abrasions, digestive blockages and death. Toxins from ingested plastic have also been shown to harm breeding and impair immune systems (WWF, 2019).

d) End of life

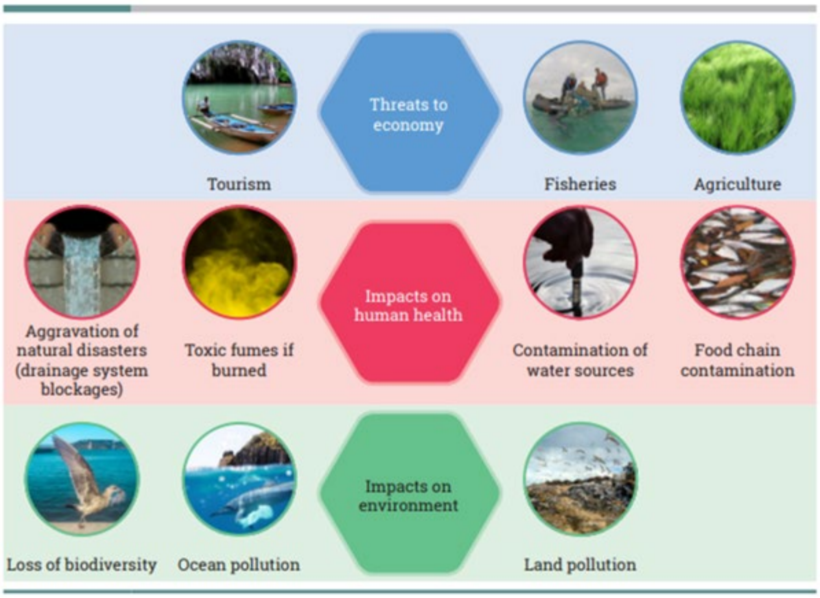
Proper local waste management is a prerequisite for sustainable end of life of plastics. While some mismanagement of waste exists in many regions, it is greatest in low- and middle-income countries as a result of inadequate waste management infrastructure. In 2016, more than 76 per cent of total plastic waste in low-income countries was mismanaged (WWF, 2019).

Mismanaged plastic waste – plastic left uncollected, openly dumped, littered, or managed through uncontrolled landfills –, is much more likely to become pollution than waste managed through a controlled treatment facility. The majority of mismanaged plastic waste is believed to have polluted land-based ecosystems, and 80 per cent of ocean plastics are estimated to come from land-based sources, rather than from such sources as cruise ships or fishing boats. On land, plastic can also leak from collection sites to the ocean, but it is much more likely to reach the ocean if it was never collected formally in the first place. Mismanaged plastic waste has many negative impacts on the environment, human health and economies (Figure 3.2).

[25] See https://www.theguardian.com/environment/2019/mar/07/microplastic-pollution-revealed-absolutely-everywhere-by-new-research; https://www.theguardian.com/environment/2018/apr/27/the-hills-are-alive-with-the-signs-of-plastic-even-swiss-mountains-are-polluted; https://www.theguardian.com/environment/2018/oct/22/microplastics-found-in-human-stools-for-the-first-time; The European Food Safety Authority (EFSA) Panel on Contaminants in the Food Chain (CONTAM), 2016.

[26] https://www.theguardian.com/environment/2018/oct/22/microplastics-found-in-human-stools-for-the-first-time

Figure 3.2. Examples of impacts of mismanaged plastic waste



Source: UNEP, 2018

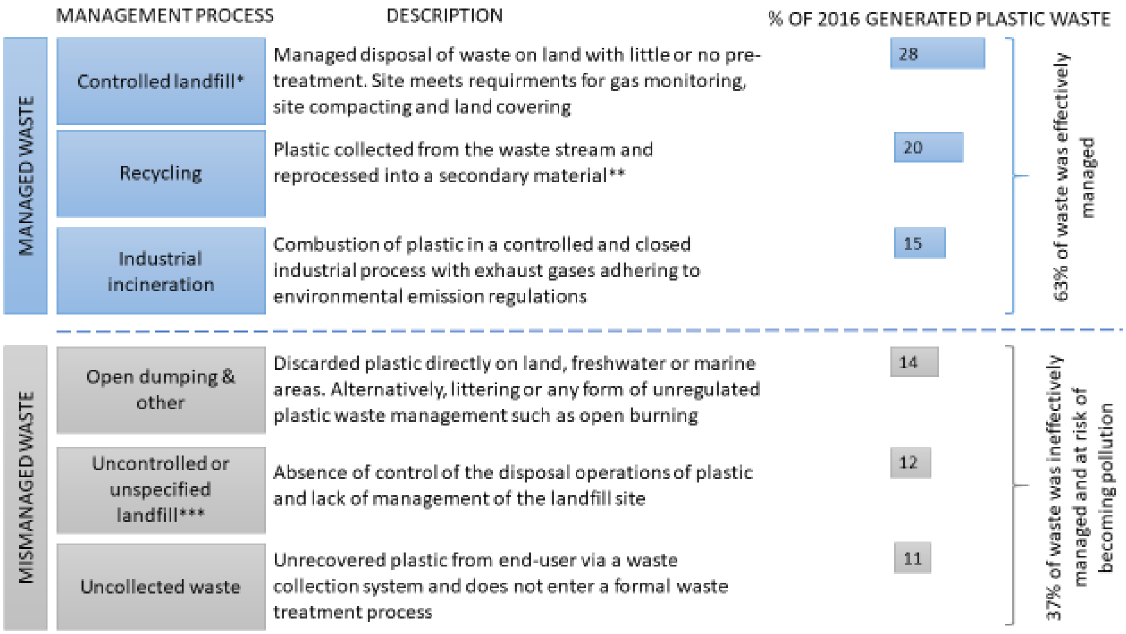
In 2016, McKinsey and the non-profit Ocean Conservancy conducted a study according to which roughly 60 per cent of all the plastic in global waters originates in five countries: China, Indonesia, the Philippines, Thailand and Viet Nam[27]. None of these five countries had a comprehensive formal recycling system in 2016. Instead they had waste pickers, who root through garbage piles to find reusable items to sell for cash. Only about 20 per cent of discarded plastic is valuable enough to be of interest to a waste picker, for example plastic bags are not collected – due to their light weight and balloon-like design, plastic bags are easily blown in the air, eventually ending up on land and/or the sea. Over the past two to three years China has made efforts to curb waste: in 2018, it ended imports of low quality foreign waste and in 2019 it has ordered 46 cities to begin sorting waste in order to achieve a 35 per cent recycling rate by 2020.

According to a study by the Helmholtz Centre for Environmental Research (2018) in Germany[28], 10 rivers in Asia and Africa carry 93 per cent of plastic trash into seas. These rivers are the Yangtze, Yellow, Hai, Peral, Amur, Mekong, Indus and Ganges in Asia, and the Niger and Nile in Africa. The Yangtze alone dumps 1.5 million tonnes of plastic waste into the Yellow Sea each year.

With more than 150 million tonnes of plastic in the ocean, augmented each year by an estimated further 8 million tonnes, plastic pollution is a growing environmental problem worldwide – plastics take longer to degrade in the sea than on land due to the lower temperatures and the presence of salt.

[27] https://qz.com/595673/more-than-half-the-plastic-in-the-ocean-comes-from-these-five-countries/
[28] https://www.weforum.org/agenda/2018/06/90-of-plastic-polluting-our-oceans-comes-from-just-10-rivers/ ; https://www.scientificamerican.com/article/stemming-the-plastic-tide-10-rivers-contribute-most-of-the-plastic-in-the-oceans/.

Figure 3.3. Overview of end-of-life options for plastics



Notes: * We consider that all landfills on high income countries are controlled based World Bank data from the 'What a waste 2.0' Report; ** Not accounting for plastic losses during the recovery process; *** Unless explicitly specified as 'controlled' or 'sanitary' landfills, we consider landfills in upper middle, lower middle and low income countries as uncontrolled or unspecified.

Source: WWF, 2019, based on Dalberg analysis; Jambeck et al. (2015); World Bank (2018); SITRA (2018); European Commisison (2001)

d.i) Collection

Recycling supply chains in most countries are often quite complicated. For example, materials may be collected and sorted by contractors before being sold on to third parties. Collection systems are fragmented and much of the infrastructure is optimised to meet policy targets and not necessarily to the actual production of high-quality secondary materials. Furthermore, the dismantling of end-of-life products, such as the demolition of buildings and ELVs, needs to be improved to obtain better quality waste streams for further refining.

Under-developed waste management infrastructure is a major challenge in low- and middle-income countries and leads to low collection rates. Low-income countries invest three times less in waste management systems than high-income countries (WWF, 2019).

d.ii) Incineration

Plastics have a high caloric value and thus release a considerable amount of energy when incinerated. However, as many plastics are complicated mixtures of resins and additives, toxic emissions often occur during combustion due either to incomplete burning or the inherent behaviour of the constituents. Incineration of plastics should, therefore, be carried out in controlled and professional waste-to-energy plants equipped with suitable filters, etc.

A significant proportion of end-of-use plastics ends up in MSW. In many developing countries inadequate or informal waste management systems result in the waste usually being burned in open dumps or household backyards, often for heating and/or cooking purposes, exposing women and children particularly to significant toxic emissions. The open burning of plastics has several negative effects, for example it releases carbon dioxide and black carbon, often together with such other toxic air pollutants as furans and dioxins. The toxic particles released can also settle on crops or in waterways, degrading water quality and entering the food chain. Furthermore, illegal disposal practices of plastics waste often take the form of open burning, accentuating the release of toxic gases. Poorly regulated incineration or the open burning of plastics waste have been shown to human heighten respiratory ailments, increase the risk of heart disease and damage the nervous system. Communities living close to inadequately controlled waste management facilities are particularly at risk.

The incineration capacity for waste plastics is projected to grow in developing countries, for example, by 7.5 per cent in Asia by 2023. In order to guarantee safe operation, attention has to paid to regional environmental regulations and incineration plant performance. For example, 78 per cent of China's current waste-to-energy facilities fail to meet EU standards for dioxin emissions (WWF, 2019; UNEP, 2018).

d. iii) Recycling

Currently the recycling plastics is almost entirely carried out by a mechanical route that is suitable only for homogenous and contaminant-free waste, which most of the plastic wastes are not. In general, mixed plastics waste will never be more than 60 per cent recyclable by mechanical means. This means that 40 per cent of the waste entering plants has to be treated separately, which creates a risk of mismanagement in countries with poorly developed environmental legislation. Globally it is estimated that only 9 per cent of the 6,300 million tonnes of plastic waste generated between 1950 and 2015 has been recycled (Geyer, R. et al., 2017).

Waste treatment of any kind needs careful risk management and special attention to issues including fire and occupational safety as well as emissions control. Examples exist of poorly managed plastics recycling plants in Asian countries causing environmental and health risks (GAIA, 2019).

Currently operating costs for recycling plastics are often high due to high collection and separation costs and a limited supply of recyclable plastic. Collecting and sorting is a time consuming and labour-intensive process, due to the high levels of mixed and contaminated plastic waste. Together, collecting and sorting constitute approximately 40 per cent of recycling costs. Securing of a supply of suitable plastics waste is one of the key elements of make recycling profitable but due to fragmented collections systems, this can be an important bottleneck for business development.

The focus of mechanical recycling has so far been on polyethylene terephthalate (PET), high density polyethylene (HDPE), and polypropylene (PP) recycling. The price of virgin plastic is linked to the price of oil, which is highly volatile. This fundamentally influences the price that manufacturers are willing to pay for recycled plastics. At the present, plastics recycling is in most cases down-cycling, which means that the quality of the recycled plastic is less than that of the original material (Hundertmark et al., 2018; Material Economics, 2018).

Chemical recycling can also play a role in developing a more circular economy for plastics, as it can offer pathways to achieve higher volumes and higher quality recycled materials. Chemical recycling of plastics, also known as tertiary recycling or feedstock recycling, means converting plastic waste into monomers, other chemical raw materials or fuels with the help of catalysts, heat and/or pressure. Chemical recycling encompasses a family of different technologies, but to fulfil their potential, most chemical recycling technologies still have to be further developed to ensure the reliable production of high-quality secondary raw materials in safe, sustainable and economically-feasible ways. Furthermore, building new infrastructure for waste handling and chemical processing would be needed. New supply-chains also, including actors along the whole value cycle, will have to be developed and new markets created for recyclates. Some of the supply chains are based on concepts in which the thermochemical conversion of plastic waste into pyrolysis oil takes place in plants near the source of waste, thereby supporting local economies and job creation, and the oil then be shipped to centralised petrochemical sites for further refinement (De Smet 2019). Chemical recycling is still an emerging end-of-life option for plastics, and several technological and regulative challenges will have to be overcome before large scale utilisation can take place.

d. iv) Landfill

It is estimated that more than 60 per cent of the plastic made since 1950 is in landfills and the wider environment (Geyer et al., 2017). If current consumption patterns and waste management practices do not improve, by 2050, there will be about 12 billion tonnes of plastic in landfills and the natural environment. Furthermore, if the landfills are not well constructed, plastics will leak, polluting nearby aquifers, water bodies and settlement (Ellen MacArthur Foundation, 2017).

In Europe, waste legislation of some countries introduced bans the landfilling of organic waste, including plastics. This has created pressure on companies and municipalities to find new end-of-life options for plastics.

d. v) Mismanaged plastic waste

If plastics leak into the environment, the stay there for a long time – it can take hundreds of years for them to be broken down. This harms biodiversity and damages the ability of ecosystem to deliver services needed to support life. Plastic can enter the natural environment either in the form of litter, or micro- and nanoplastics. The main impacts of plastics in natural environment can be divided into 10 groups.

i) Release of harmful or toxic chemicals: some plastics contain toxic chemicals, including persistent organic pollutants (POPs), which have been linked to health issues including cancer as well as and mental, reproductive and development diseases. (WWF, 2019; Hahladakis et al., 2018)

ii) Spoilage of international waters: plastics pollution is prevalent in all the world's oceans. At the global level, it is estimated that 15–51 trillion plastic particles are floating on the surface of oceans. In a business-as-usual scenario, the Ellen MacArthur Foundation (2017) estimates that the ocean will contain 1 tonne of plastic for every 3 tonnes of fish by 2025 and more plastic than fish by 2050.

iii) Harming biodiversity: plastics pollution is the second most significant threat to the future of coral reefs after climate change. Wildlife entanglement has been recorded in more than 270 different animal species, including mammals, reptiles, birds and fish, and more than 240 different animal species have been shown to have ingested plastic. High concentrations of plastic materials, particularly plastic bags, have been found blocking the breathing passages and stomachs of hundreds of different species. Plastic bags in the ocean resemble jellyfish and are often ingested by turtles and dolphins who mistake them for food. It is estimated that a minimum of a thousand marine turtles die every year due to entanglement in plastic waste, which includes lost or discarded fishing gear. There is emerging evidence that the toxic chemicals added during the manufacturing processes transfer from the ingested plastic into the animals' tissues and eventually enter the human food chain (WWF, 2019; UNEP, 2018).

iv) Land degradation and contamination of food systems: the emerging threat from microplastics to terrestrial ecosystems, especially agricultural soils, could lead to further land degradation affecting food production and contaminate of food products.

v) Air pollution: much microplastic ends up in ocean, but some travels long distances through the air to remote area including Pyrenees mountains. The maximum distance microplastics can travel is still unclear, but research has found that larger dust particles have travelled 3,500 kilometres across the Atlantic Ocean (Allen et al., 2019). Flying insects (ontogenic transference) are also a possible pathway for the aerial dispersal of microplastics (Al-Jaibachi et al., 2018)[29].

vi) Hotspots for microbial activity: plastics and microplastics can create a micro-environment, within which microbial and chemical conditions differ significantly from surrounding water. Their influence on the transformation and composition of marine organic matter is still largely unknown, but some research results point to the possibility that marine microplastics act as localised hotspots of microbial activity, with the potential of influencing marine carbon dynamics. A research group in the National University of Singapore found more than 400 types of bacteria on 275 pieces of microplastic collected from local beaches. The bacteria include those associated with coral bleaching (*Photobacterium rosenbergii*) and those that cause wound infection (Vibrio) or gastroenteritis in humans (Arcobacter) (Curren and Leong, 2019; Galgani et al., 2018).

vii) Possible health effects to humans from the ingestion of plastics: humans are highly likely to ingest micro- and nanoplastics, but the direct health impacts are still unknown. Humans can ingest plastic by consuming foods contaminated with micro- and nanoplastics. This is most likely to occur through seafood, particularly shellfish, mussels and oysters, but there are many other potential sources of contamination. A recent study of bottled water found microplastic contamination in 93 per cent of bottles, sourced from 11 different brands (EFSA, 2016).

viii) Social and tourism impacts: plastics waste at the seaside creates visual pollution, which is increasingly becoming an issue, especially in countries that rely heavily on tourism, such as Small Island Developing States. For instance, the Asia-Pacific Economic Cooperation (APEC) estimated the economic impact of marine plastics on the tourism, fishing and shipping industry as USD1.3 billion per year (WWF, 2019; UNEP, 2018).

ix) Marine transport: commercial shipping vessels are extremely sensitive to collisions with plastic pollution and damage to vessels could also endanger human lives. The Asia-Pacific Economic Cooperation (APEC) estimated the annual cost of litter damage to commercial shipping as USD297 million (WWF, 2019).

x) Some mismanaged plastic waste such as plastic bags can choke waterways and intensify natural disasters. In 1988, poor drainage resulting from plastic bags clogging drains contributed to floods in Bangladesh, causing several deaths. In developing countries with inadequate solid waste management regulations, plastic bag litter can also raise the risk of the transmission of vector-borne diseases such as malaria by blocking sewage systems and providing breeding grounds for mosquitoes and other pests (WWF, 2019).

The total economic impact of plastic pollution is not yet known. Most research so far has focused on the impact on oceans. The UN Environment (UNEP) estimates the economic impact of ocean plastic pollution at USD8 billion per year. It is also estimated that there is four times more plastic pollution on land than in the oceans, suggesting that the total economic impact of plastic pollution is actually much greater (WWF, 2019).

[29] https://www.theguardian.com/environment/2018/oct/22/microplastics-found-in-human-stools-for-the-first-time

3.3. Pressures from trading plastic waste and potential benefits of 'non-trading'

Given the pressures arising from the life-cycle of plastics, the consequences of traded waste plastics can be seen from two perspectives: the economic and environmental costs and benefits of trading for importing countries, and the possible economic and environmental costs and benefits of 'non-trading' for exporting countries.

In general, importing countries can enjoy economic benefits from the import and industrial processing of waste plastic while suffering environmental pressures, which in general are those described for landfilling, recycling, incineration and waste mismanagement, together with those of domestic logistics and transport. Exporting countries can avoid environmental pressures and economic costs if domestic management options are not economically viable, but can lose potential economic benefits if appropriate costs and market conditions should prevail or could be created (Mazzanti and Zoboli 2013).

While the trade of plastic waste has become widespread and significant, the closure of major export channels will force European countries to consider the possible advantages of 'non-trading' – processing plastic waste domestically – not only from an economic point of view, but also from a general environmental one, given that their technological opportunities are better than those in many destination countries.

Pressures from imports in Asian countries

The EU used to promote plastic recycling from a waste management perspective, preferring recycling to incineration and landfilling. But its success has mainly been in the first stage of the recycling value chain, that is collection, which is then followed by large export flows. China and other countries turned the corresponding trade in plastic waste into an opportunity to boost their industrial growth, possibly at the expense of their social and environmental conditions (OECD, 2018).

The global rise of the export of plastic waste to China went hand-in-hand with increasing plastic production capacity and consumption of plastic products in China (Brooks and Jambeck 2018; ISWA, 2014). Meanwhile, the plastic product manufacturing and reprocessing in China is shifting from a large number of small, unregistered facilities with no rules for operation, quality standards or inspections to investment in larger manufacturing plants, which are subject to increasing quality and environmental controls.

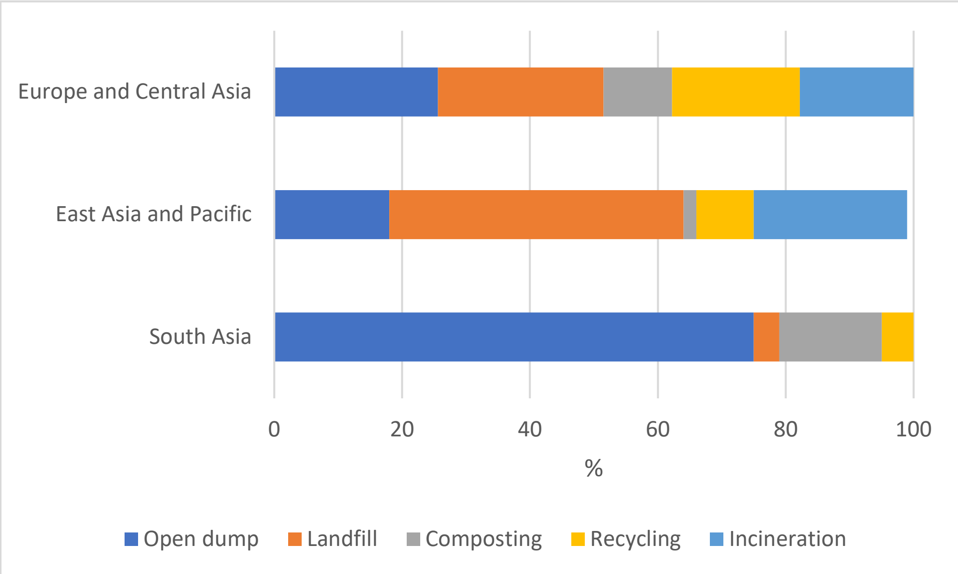
China's intention is to improve its domestic waste collection, in part also for environmental reasons, and, in the longer term, to rely mainly on its own recovered material collection. China's State Council intends to end all solid waste and scrap imports by the end of 2019 and replace them with domestic sources[30].

As a consequence of the Chinese ban, a group of other South-Asian countries including Malaysia and, initially, Viet Nam are currently importing traded waste plastics in the hope to enjoying the economic

[30] Stephen Moore summarized it in *Plastics Today*: *'It is somewhat ironic that a developing economy in China, facing numerous environmental challenges of its own including polluted waterways and air, has provided the impetus for the global plastics industry to reconsider how it handles its waste. For too long, numerous developed economies have been happy to push their plastic waste problems onto emerging economies in Asia without worrying about developing sustainable plastic recycling strategies. The days for such actions would appear to be limited. No longer does any country want to import other countries' problems. It is time for the developed world to step up to the plate.'*

benefits from it that China did[31]. However, many of these countries are still in their infancies with respect to the development of waste management plans to deal with their domestic waste in a controlled, sustainable way and are even struggling with shifting from dumping to landfilling and incineration. As these first steps on the waste hierarchy are an insurmountable condition to continue climbing the hierarchy (Material Economics, 2018), it does not come as a surprise that these countries do not seem to be organised to receive this imported waste to recycle, and its final sustainable disposal is quite uncertain.

Figure 3.4: Average waste treatment in different regions



Source: Kaza et al., 2018

Historical trends of waste management practices show that many low- and middle-income countries often import waste materials for recycling but have weak waste management infrastructure. Therefore, it is not unconceivable that considerable amounts of the waste sent for recycling will ultimately be landfilled or dumped.

The imported waste in some developing countries is often not processed according to EU standards and might even get dumped or burned in unregulated ways, although EU waste legislation lays down that recovery operations of exported waste must take place under 'broadly equivalent conditions' to those within the EU (Eunomia, 2018). Many actors in Southeast Asia profit from the inability of legal operators and the failure of authorities to cope with the increased imports, ignoring the local impact on human health and the environment.

In some countries, after legal import, plastic waste is often sorted into two grades: high-grade for recycling, and low-grade for burning or landfilling. Nevertheless, part of the high-grade plastic still ends up in dumps or being burned while recycling rates can drop as low as 30–40 per cent because of poor sorting (Greenpeace Malaysia, 2018).

For example, a field investigation by the Global Alliance for Incinerator Alternatives (GAIA, 2019) in Asia revealed illegal recycling operations, open burning, water contamination, crop death and a rise in

[31] National Geographic, (2018); China's ban on trash imports shifts waste crisis to Southeast Asia, https://www.nationalgeographic.com/environment/2018/11/china-ban-plastic-trash-imports-shifts-waste-crisis-southeast-asia-malaysia/

illness tied to environmental pollution that has led citizens to protest and governments to rush in restrictions to protect their borders.

In addition to harming the natural ecosystems this also generates significant economic costs by reducing the productivity of vital natural systems and clogging urban infrastructure. According to the Ellen Mac Arthur Foundation (2017), the after-use costs added together with greenhouse gas emissions from plastic packaging production are estimated to be approximately USD40 billion annually, which is more than the plastic-packaging industry profits.

Potential benefits for Europe from 'non-trading' with non-EU countries

The presently traded volumes of European plastic waste could potentially provide substantial amounts of secondary material resources for European manufacturing. Additionally, recycling in the EU could also provide a net benefit for the European economy, through the creation of additional jobs and added value, and for the environment, through the development of extensive knowledge and expertise in Europe in dealing with recycling in relation to human health and environmental standards.

Currently much European waste plastic is traded because of limited or low-quality collected waste streams, corresponding with the proportional cost of recycling them into a valuable secondary material able to meet strict industry specifications (Letsrecycle, 2019) and a lack of domestic recycling capacity.

A first necessary step to promote local recycling to produce high value secondary materials for which there is a local market would be the further separation of plastic waste in line with the requirements of the corresponding sorting and recycling infrastructure, thereby providing higher quality feedstock (Letsrecycle, 2019; ISWA 2014).

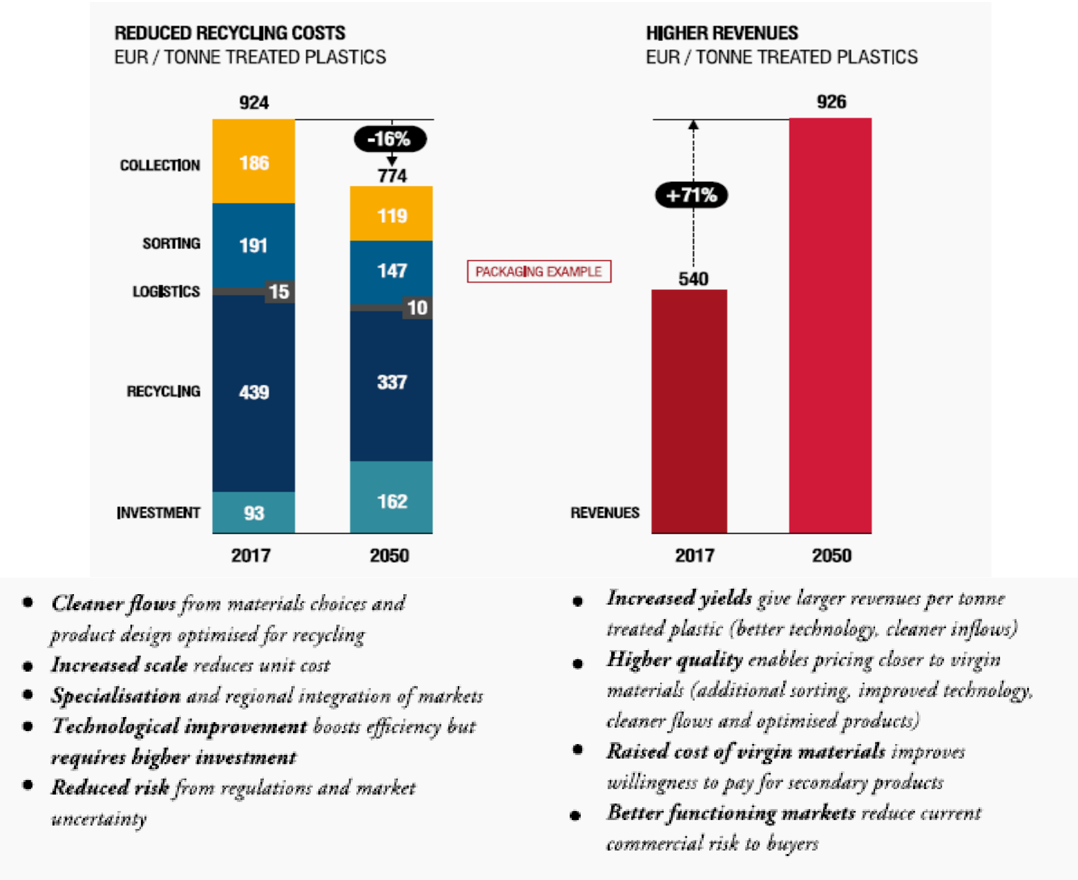
Since the Chinese ban, there is an oversupply of plastic waste in Europe and available European recycling capacities are filling up. On the other hand, investment in new plastic recycling capacity has been held back by the sector's prospects of low profitability. Although some additional capacity is being built or is in the pipeline, the total recycling capacity still only represents a fraction of both the total plastic waste supply and of the demand for plastics. Therefore, there is definitely room for expanding plastic recycling in Europe.

Investments in additional waste incineration capacity in Europe have been announced, but as this focuses on residual waste, it should neither nullify nor diminish efforts to setting up additional plastic recycling capacity in Europe.

It is also of crucial importance that European Member States stop exporting low-quality plastics to countries which lack the infrastructure to safely handle this waste.

Figure 3.5. Measures suggested by Material Economics to transform the economics of the plastics value chain

Impacts of the suggested measures are shown in the column on right



Source: Material Economics, 2018

Increasing advanced plastic recycling can be seen as an important way of decreasing plastics leaking into the environment. In the best scenarios, environmental benefits are coupled with economic ones. It is estimated that a scale-up of high-quality recycling of plastic packaging could generate a benefit of USD30–40 per tonne collected – USD0.3–0.5 billion in OECD (Ellen MacArthur Foundation, 2017).

A recent report released by the American Chemistry Council (2019) suggested that the potential annual economic impact of expanding advanced plastic recycling and recovery technologies in the United States would be nearly USD10 billion.

The economics of plastics recycling is highly dependent on the price of oil. McKinsey has estimated that by 2030 one third of plastics entering the global market could be manufactured from recycled plastics. This would need a considerable increase in mechanical recycling and in the use of thermochemical technologies to convert waste plastics to feedstock for the petrochemical industry (Hundertmark et al., 2018). The estimate is that this could be economically beneficial for both the petrochemical and plastics industries, assuming a USD75-a-barrel oil price and an effective regulatory framework reinforced by supportive behaviour from other industry stakeholders and consumers. Since the beginning of the 21st century, oil prices have been subject to very significant volatility, and the unpredictable cost of fossil feedstock creates a risk for companies. The use of recycled and renewable feedstock in plastics production could help reduce exposure to volatility of the price of (fossil-based) virgin feedstock (Ellen MacArthur Foundation, 2017).

According to WWF estimates, eliminating waste mismanagement and reusing plastic could create more than a million jobs in plastic recycling and remanufacturing. Their no-plastics-in nature scenario calls for developing capacity to recycle 60 per cent of global plastic waste, approximately 113 million tonnes annually (WWF, 2019).

A recent report by Material Economics (2018) suggests that a range of measures to improve the collection and processing of waste plastics is needed to transform the economics of the plastics value chain. Once a system which retains the value of the material is created, recycling plastics would become profitable and take off on a larger scale. Material Economics' analysis shows that this could be feasible for all the large-volume plastics types which dominate the markets.

4 Evolving policies and regulations

4.1. EU legal framework on plastic waste trade

The shipment of waste within and beyond the EU is regulated by the WSR (Regulation EC No 1013/2006; EU, 2006a). This Regulation stipulates, among other things, the following trade bans: 1) exports to non-EU countries of waste for disposal, except to EFTA countries that are party to the Basel Convention; 2) exports for recovery of hazardous waste, except those directed to countries to which the OECD decision applies. The shipment of non-hazardous waste plastics for recovery to non-OECD countries, is regulated by WSR Article 37, which stipulates that the European Commission has to send a written request to each non-OECD country seeking confirmation in writing that non-hazardous waste may be exported for recovery in that country and under which control procedure, if any. Most non-OECD countries have decided to ban the import of such waste or to allow it under specified control procedures (Section 4.2). Moreover, all the parties involved in the shipment shall ensure that waste is managed in an environmentally sound manner, complying with EU and international rules.

EU Member States have developed different approaches for verifying that the recovery of exported waste takes place in the importing country under 'broadly equivalent conditions' to those prescribed by EU legislation. The adequate implementation and enforcement of the Regulation, although challenging, is crucial to avoiding illegal shipments and preventing harmful environmental effects.

The WSR transposes the Basel Convention into EU law. The Convention prohibits the export of hazardous waste unless the state of import has given its prior consent in writing to the specific import. On June 2018, the government of Norway submitted a proposal to amend the Basel Convention, in order to extend the provision on prior consent to the shipment of plastic waste (IMPEL website). The 14^{th} Conference of the Parties to the Convention, in May 2019, decided to extend the prior consent regime to contaminated, mixed or hard-to-recycle plastic waste (Rethink Plastic website). Based on this amendment, which will become effective in January 2021, the WSR will also require prior written notification and consent when mixed/hard to recycle non-hazardous plastic waste is shipped for recovery:

1) within the EU – instead of general information requirements;
2) from a Member State to an OECD country – instead of general information requirements;
3) from a Member State to a non-OECD country when the shipment is not prohibited by the importing country, instead of national or no control procedures eventually applied by the importing country, according to Implementing Regulation (EC) No 1418/2007 (Section 4.2).

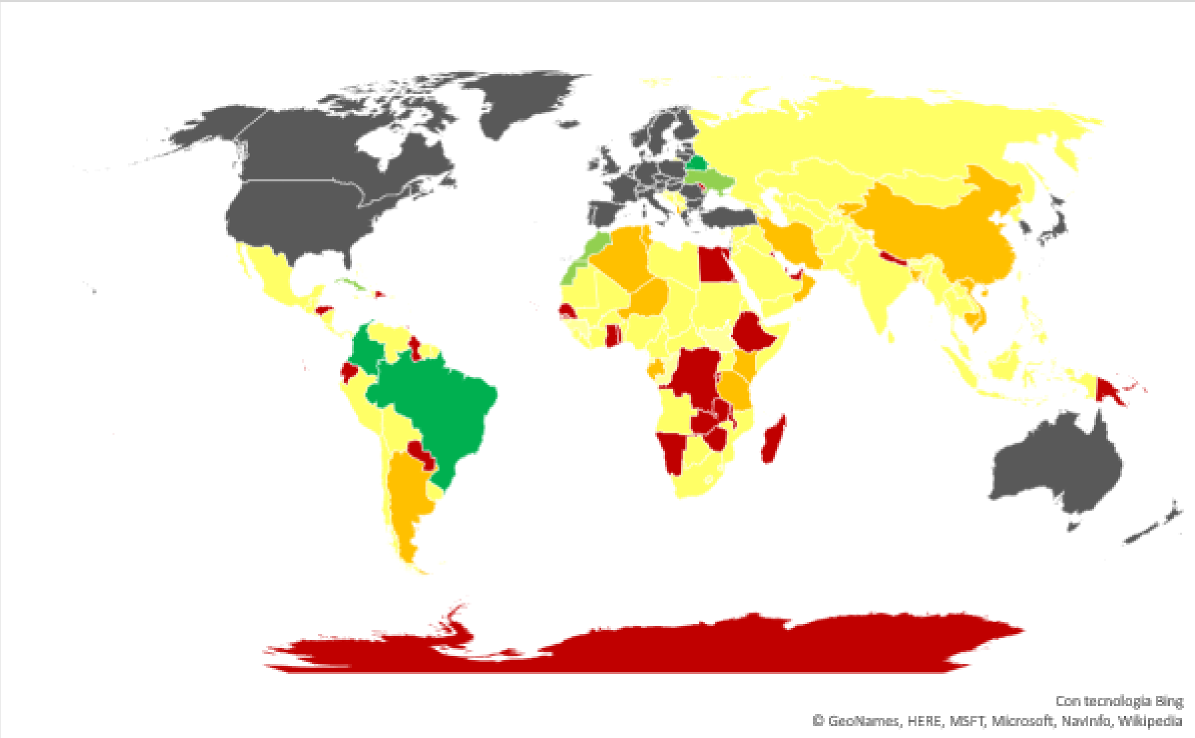
The WSR is currently undergoing a review, initially of its effectiveness, efficiency, relevance and coherence as well as the added value it provides. By 31 December 2020, the EC has to report back on this review to the European Parliament and the Council and if appropriate table a proposal to revise the Regulation. It seems important that this review takes account of current developments in the waste trade and their effects on the EU waste treatment market, and in particular on plastic wastes.

4.2. Legislation/initiatives on trade in plastic waste to/by non-EU countries

Some non-EU countries have prohibited the import of certain plastic waste or have specific control procedures in place. In particular, in accordance with the WSR's Article 37.1, the EC has sent a written request to each non-OECD country seeking confirmation in writing that non-hazardous waste may be exported for recovery in that country and requesting an indication as to which control procedure, if any, would be followed in the country of destination. Non-OECD countries' replies have been published within Commission Implementing Regulation No 1418/2007, which is periodically updated. Countries that have not issued confirmation in writing that waste may be exported to them are to be regarded as having permitted the related shipments under the procedure of prior written notification and consent – the most stringent control procedure under the WSR.

Figure 4.1 maps bans and control procedures applied by non-OECD countries on the import from the EU of non-hazardous solid plastic waste, mixed solid plastic waste and PVC, pursuant to Commission Implementing Regulation (EC) No 1418/2007, as updated in 2014.

Figure 4.1. Bans and control procedures applied by non-OECD countries on the import of non-hazardous solid plastic waste, mixed solid plastic waste and PVC



Note: Grey = OECD countries and EU Member States; Red = Ban on import; Orange = Prohibition to import + shipments permitted under control procedures (national control procedures or prior written notification and consent), depending on the plastic waste considered; Yellow = Shipments permitted under control procedures (national control procedures or prior written notification and consent); Light green = Shipments permitted under control procedures (national control procedures or prior written notification and consent) + no control procedure, depending on the plastic waste considered; Green = Shipments permitted with no control.

Source: based on Commission Implementing Regulation EC 1418/2007, updated on 18.07.2014

More recently other bans on the import of plastic waste and/or restrictive trade policies have been implemented in some Asian countries:

- In 2013, China launched the Green Fence campaign, aimed at improving the quality of imported plastic waste, while decreasing illegal trade. In 2017, a new initiative permanently banned the import of certain types of household plastic waste (WTO, 2017)[32]. The import ban came into force in January 2018, raising issues of other possible export routes for EU plastic waste. According to an

[32] According to the notification, the ban on household plastic wastes applies to imports of waste or scrap polymers of the following resins: ethylene (HS 3915100000); styrene (3915200000); vinyl chloride (3915300000); PET (3915901000); other plastics (3915909000).

announcement by the Chinese Ministry of Ecology and the Environment in April 2018, the catalogue of banned solid waste was extended to include post-industrial PE, PET, PS, PVC and other scrap plastic, with effect from the end of 2018 (Resource Recycling website a). The import of WEEE has been banned since 2000 (EFFACE, 2015).

- Thailand issued a temporary ban on the import of plastic waste and WEEE in June 2018 (No-Burn Org website) and announced the introduction of a permanent ban by 2021 when current import licenses will expire (The Telegraph website).
- In 2018, Malaysia revoked approved permits for plastic waste imports of 114 waste processing factories as a temporary measure (No-Burn Org website) and, at the end of that year, announced an immediate and permanent ban on the import of plastic waste (Recycling International website).
- Taiwan Province of China recently proposed a set of policies to regulate imports of plastic waste including permission for businesses to import plastic waste only originating from their own overseas production processes and prioritising the purchase of domestic over foreign waste. These policies became effective in October 2018 (No-Burn Org, 2018; Resource Recycling website).
- Viet Nam stopped issuing plastic recycling import licenses in June 2018 and it is expected to ban plastic waste imports in the future (No-Burn Org website).
- On March 2019*,* India prohibited the import of solid plastic waste by amending the Hazardous Waste (Management & Trans-boundary Movement) Rules (Recycling Today website).

4.3. Recent EU initiatives on plastic waste

In the last few years, the EU has taken several policy and legislative initiatives to address plastics and plastics waste, with direct and indirect impacts on the trade in waste plastics. In particular, it has to be underlined that all the measures aimed at plastic waste prevention and reusing plastic products decrease plastic waste generation and, indirectly, the potential export of plastic waste.

On the other hand, all the measures that support separate collection, recycling and reduce the landfilling of plastic waste may have a twofold impact on plastic waste shipments. These measures, in theory, may generate an increase in plastic waste exported to non-OECD countries, since more plastic waste would be collected to be recycled and the WSR allows EU countries to ship plastic waste destined for recycling/recovery to non-OECD countries. Moreover, considering waste recycling targets applying to packaging waste, ELVs and WEEE, it has to be noted that recycling rates in Europe are calculated as the waste *collected* for recycling, including waste exported for recycling, provided that there is sound evidence that recycling takes place under conditions that are broadly equivalent to those prescribed by the EU legislation (European Commission, 2005a, 2005b and 2005c).

However, the measures supporting plastic waste collection and recycling, since they are aimed at developing and strengthening the EU plastic recycling market, make Member States' plastic waste management less dependent on the export to non-EU countries. This decrease in the export of plastic waste outside the EU may be supported by plastic waste bans introduced by non-OECD countries, if they are properly implemented and enforced.

In 2015, the Commission adopted the Action Plan for a Circular Economy (European Commission, 2015), identifying plastics as a key priority. In the same year, the Packaging Waste Directive (Directive 94/62/EC; EU, 1994) was amended (by Directive 2015/720/EU; EU, 2015) and Member States were required to introduce measures to cut the consumption of plastic bags – a prevention measure aimed at decreasing plastic waste generation.

In 2017, the Commission Work Programme 2018 (European Commission, 2018b), confirmed that the EU would focus on plastics production and use to ensure that all plastic packaging is recyclable by 2030. The EU Plastic Strategy of 2018 (European Commission, 2018a) reaffirmed that objective and shaped a systemic approach to protect the environment from plastic pollution, while fostering growth and innovation. The Strategy aims to transform the way plastic products are designed, produced, used and recycled in the EU, laying the foundations for a new plastic economy. To this end, the EU will take measures to prevent/minimise the generation of plastic waste and to stop littering at sea. Moreover, it will improve the profitability and quality of plastics recycling by focusing on separate collection and sorting; design for recyclability and the demand for recycled plastics. Support for innovation will be scaled up to finance the development of smarter and more recyclable plastic materials, making recycling processes more efficient, and tracing and removing hazardous substances and contaminants from recycled plastics.

Within the framework of the Circular Economy Package, several measures have been introduced to reduce the amount of plastic waste destined for landfilling, while increasing recycling. The recent amendments to the Packaging and Packaging Waste Directive (pursuant to Directive 2018/852/EU; EU, 2018) have increased the current recycling target for plastic packaging waste from 22.5 per cent to 50 and 55 per cent to be reached, respectively, by 2025 and 2030. Moreover, the amended Waste Framework Directive (EU, 2008) sets reuse/recycling rates of 55, 60 and 65 per cent by 2025, 2030 and 2035 respectively for municipal waste, which includes several waste streams containing plastic, and the amended Landfill Directive (EU, 1999) establishes that the amount of municipal waste landfilled shall be reduced to 10 per cent of the total amount of municipal waste generated by 2035. Member States shall also endeavour to ensure that, as of 2030, all waste suitable for recycling or other recovery, in particular in municipal waste, shall not be accepted in a landfill, with the exception of waste for which landfilling delivers the best environmental outcome.

Apart from packaging waste and MSW, collection, recycling and recovery targets have also been set by EU legislation for other waste streams that contain plastic including ELVs, WEEE and construction and demolition waste (EU, 2000, 2008 and 2012).

A new Directive has been recently adopted by the EU in 2019 to reduce the impact of single-use plastic products on the environment (EU, 2019a), introducing a wide range of different measures for different types of plastic product (Annex I).

Some of these measures, such as prohibition to place on the market and measurable reduction in consumption, are aimed at preventing plastic waste generation, while others, including separate collection targets and extended producer responsibility, mainly support waste collection and recycling, with the potential twofold conflicting impacts on trade, discussed above. The proposal also sets a mandatory minimum recycled content for plastic bottles, with the aim of increasing EU demand for recycled plastic, which currently represents around 6 per cent of EU plastics production (European Commission, 2018a).

This requirement is likely to decrease the export of waste plastic for recycling to non-OECD countries. The International Solid Waste Association (ISWA) (2014) argues that in China, before the introduction of the plastic waste import ban, most of the finished products containing secondary raw materials from imported plastic waste were destined to the national market because of their lower quality and/or cost. This could, in theory, apply to other non-OECD countries, making it unlikely that products containing recycled plastic are re-exported to EU Member States.

In 2018, the EC proposed a new Directive on port reception facilities for the delivery of waste from ships, repealing Directive 2000/59/EC (European Commission, 2018d). According to the new Directive, which was adopted in April 2019 (EU, 2019b), ships, including fishing vessels, will be required to pay a fee, regardless of whether or not they unload any waste, to cover the costs of operating port facilities for the reception and treatment of waste from ships, other than cargo residues. In this way, since ships have already paid to use the port waste management facilities, they are expected to be less likely to dump their waste overboard, thereby contributing to a reduction in marine litter. The fee will be based on the principle of full cost recovery –costs that are not covered by the fee, if any, shall be covered by additional fees levied on the types and quantities of waste actually unloaded. A reduced waste fee will be applied for short-distance sea shipping and for 'green ships'[33].

In the Communication on the Multiannual Financial Framework for 2021-2027, the Commission has proposed, in order to finance the long-term EU budget, a basket of new Own Resources, including a national contribution calculated on the amount of non-recycled plastic packaging waste in each Member State (European Commission, 2018e). This measure is expected to increase plastic waste recycling.

According to the 2018 EU Plastic Strategy (European Commission, 2018a), the EC will work on a revision of the essential requirements for placing packaging on the market, listed by Directive 94/62/EC (EU, 1994), with the objective of ensuring that, by 2030, all plastics packaging placed on the EU market is reusable or easily recycled. The measure, the adoption of which is planned for the end of 2020, is aimed at supporting plastic waste prevention, reuse and recycling.

4.4. EU legislation on chemicals

To minimise the associated risks, EU legislation regulates the manufacture, placing on the market, and use of chemical substances. The more the use of hazardous chemicals in plastic products is prohibited or restricted, the less hazardous plastic waste is generated and the higher is the related recycling potential. In particular, the EU Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) (EU, 2006), through its authorisation procedure, provides for the progressive replacement of the substances of very high concern by less dangerous substances or technologies and for the restriction of the manufacture, placing on the market or use of chemicals posing unacceptable risks to human health and the environment. Moreover, food contact packaging must comply with the requirements of the European Food Safety Authority (European Commission, 2011) and several other plastic products are affected by specific regulations (EU, 2009).

This legislation, as waste legislation, is continuously evolving. In January 2019, for instance, the European Chemical Agency (ECHA) has submitted a restriction proposal for microplastic particles that are intentionally added to mixtures used by consumers or professionals. The Agency believes that, if adopted, the restriction could reduce the amount of microplastics released to the environment in the EU by about 400,000 tonnes over 20 years (ECHA website).

In many cases, if, for example, products are not labelled or information on chemical content is not traceable through the value chain, it is not obvious which chemical substances are contained in plastic products. This has clear potential health, safety and environmental risks, especially if these products are recovered (OECD, 2018) and is likely to operate as a driver of the extra-EU export of waste plastics.

Additionally, requirements applied to specific plastic products lack harmonisation with wider legislation regulating hazardous substances. For instance, according to the OECD (2018), diethylhexyl phthalate (DEHP), a plasticiser contained in flexible PVC, is subject to authorisation and restrictions under REACH but it is often managed as a non-hazardous waste and its use has been authorised as a plastic food-contact material.

[33] Pursuant to Article 8 of the new Directive on port reception facilities for the delivery of waste from ships (EU, 2019b), the fees shall be reduced provided that the ship's design, equipment and operation demonstrate that the ship produces reduced quantities of waste, and manages its waste in a sustainable and environmentally sound manner.

4.5. Voluntary initiatives by industry

Improvement in the collection and recycling of plastic waste is not only supported by several EC legislative and policy initiatives, but also by a wide range of voluntary commitments and measures that are increasingly been taken by the private sector.

Annex III of the European Strategy for Plastics in a Circular Economy (European Commission, 2018a) called on stakeholders to submit voluntary pledges to ensure that overall 10 million tonnes of recycled plastics find their way into new European products by 2025. By end 2018, the Commission received pledges from 70 companies and business organisations, which were assessed by the EC. It concluded that the pledges received from suppliers of recycled plastics, if delivered as expected, are sufficient to meet the target of 10 million tonnes, but that there is still a mismatch between the pledges from the supply and the demand sides (European Commission, 2019a). In order to bridge the gap and stimulate further dialogue between the suppliers of recycled plastics and their customers, in December 2018 the EC launched the Circular Plastics Alliance, a platform of key industry stakeholders covering the full plastics value chain.

Shortly after the Strategy's publication, Plastic Europe, representing European plastics manufacturers, made a voluntary commitment to ensure high rates of reuse, recycling and recovery of plastic packaging waste, with the ambition of reaching 60 per cent of reuse/recycling by 2030 and 100 per cent by 2040 in the EU, Norway and Switzerland (Plastic Europe, 2018b). To this end, action plans and time-based performance indicators will be prepared and progress will be evaluated by an independent committee made up of representatives of the EC, European Parliament, national and local authorities, civil society and academia[34].

The European Committee for Standardisation (CEN) has adopted a set of harmonised standards for packaging, published in the Official Journal of the European Communities, providing a presumption of conformity with the essential requirements set by the Packaging Waste Directive (EU, 1994), with which all packaging placed on the market in the EU have to comply[35]. The definition of biodegradable plastic, provided by the proposed Directive on Single-Use Plastic Products (European Commission, 2018c), is based on the European Committee for Standardization (CEN) standard for compostable and biodegradable packaging (CEN, 2000).

Other relevant initiatives jointly undertaken by various stakeholders at the EU level include the following.

- European PET Bottle Platform: a voluntary industry initiative that provides PET bottle design guidelines for recycling (EPBP website).
- Polyolefin Circular Economy Platform, involving European Plastics Converters (EuPC), PlasticEurope, Plastics Recyclers Europe (PRE), etc.): the platform has two strategic goals, namely innovation with a circular economy focus and enhanced collection and sorting systems (Polyolefin Circular Economy Platform website).

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[34] https://www.plasticseurope.org/application/files/6115/1700/8779/PlasticsEurope_Voluntary_Commitment_16012018.pdf

[35] CEN EN 13427:2004: Requirements for the use of European standards in the field of packaging and packaging waste; CEN EN 13428:2004: Requirements specific to manufacturing and composition – prevention by source reduction; CEN EN 13429:2004: Reuse; CEN EN 13430:2004: Requirements for packaging recoverable by material recycling; CEN EN 13431:2004: Requirements for packaging recoverable in the form of energy recovery, including specification of minimum inferior calorific value; CEN EN 13432:2000: Requirements for packaging recoverable through composting and biodegradation – test scheme and evaluation criteria for the final acceptance of packaging.

- At the international level, the New Plastics Economy Global Commitment was signed in 2018 by more than 350 companies that, together, are responsible for 20 per cent of all plastic packaging produced globally. It sets a 2025 target to make 100 per cent of plastic packaging reusable, recyclable or compostable (New Plastics Economy website).
- At the beginning of 2019, the Alliance to End Plastic Waste was launched as a non-for-profit organisation, made up of about 30 member companies that produce, use, sell, process, collect, and recycle plastics. It has allocated USD1.5 billion over the next five years to finance the implementation of a strategy which identifies infrastructure development, innovation, education and clean-up as priorities (Alliance to End Plastic Waste website).

4.6. Options for 'sustainable plastics waste trade'

Europe is at a crossroads for plastics, plastics waste, and trade in waste plastics. The restrictions to the export option, which has to date been part of the solution for managing the mounting quantities of plastic waste, could strongly promote EU policy efforts to prevent plastic waste and to manage it domestically to the highest environmental standards and the best potential economic benefits.

Trade restrictions on plastic waste are bound to increase as a result of a domino effect amongst importing countries. Without action, the potential consequences could include negative conditions for achieving the ambitious targets for plastics recycling introduced in the revised Packaging and Packaging Waste Directive, the redirection of intra-EU trade flows, and increasing consideration of incineration of plastics waste for energy production as an option. Therefore, trade restrictions on plastic waste provide pressure on EU Member States to find alternative solutions for managing post-consumer plastics.

The current end-of-life management of plastics in the EU is underperforming compared to more homogeneous materials such as glass and metals (Deloitte, 2017). The significant share of plastic waste exported beyond the EU for recycling or recovery can result in a significant loss of valuable resources to the EU economy and in a significant cost to the environment of the importing countries. With the 2018 Plastics Strategy, the EU has adopted 'a material-specific lifecycle approach to integrate circular design, use, reuse and recycling activities into [the] plastics value chain' (European Commission, 2019b).

All the policy options that are available to implement a circular economy for plastics, directly or indirectly, impact on trade in plastic waste.

The following could be options for action.

- While the implementation of the new waste Directives and the Plastics Strategy will push to increase the quantity of plastic waste collected, thus possibly adding pressures on the quantity of plastics traded, it could significantly improve the quality and attributes of plastics waste. This could possibly reduce trade as higher quality could increase domestic demand and also have positive consequences on environmental impacts in importing countries.

- Being at the top of the EU waste hierarchy, prevention and reuse represent an effective way of reducing plastic waste generation and the related environmental impacts. With regard to the prevention of plastic waste, when the related measures result in a shift towards the use of alternative materials, the sustainability of the latter could be assessed, based on a life-cycle assessment perspective. The same could apply to novel plastic materials such as plastics from renewable feedstock or biodegradable and compostable plastics. Reuse provides an economically attractive opportunity for selected plastic packaging items including carrier bags, home-care bottles and pallet wraps. However, it needs to be adequately supported, as it often requires a systemic change, entailing the development of innovative business models and specific infrastructure including reverse logistic systems and cleaning facilities (OECD, 2018; Ellen MacArthur Foundation, 2017).

- Collection is an essential precondition for high quality recycling, but, compared to other waste streams, it poses specific challenges in the case of plastic waste. For instance, amongst plastic packaging waste, small-items, even when collected rather than becoming litter, are removed in automated sorting facilities to avoid damage to equipment in subsequent steps; nutrient-contaminated packaging is often difficult to sort and clean; dark and black plastics cannot be identified in optical sorting processes; etc. (Deloitte, 2017; Ellen MacArthur Foundation, 2017). Collection and sorting systems could be improved, based on best practice and appropriate investment, to become more efficient/effective and offer greater opportunities for recycling and eventually downcycling. This could contribute to reducing plastic waste landfilling and littering. The achievement of both these objectives is also highly dependent on consumers' choices and behaviour, which can be affected by awareness raising and information campaigns. Deposit refund systems generally prove to be an effective instrument to ensure a high/stable supply of reusable/recyclable materials.

- Levels of recycling should be increased, both in terms of quality and quantity. Mechanical recycling technologies, which are currently mainly focused on PET and HDPE, could be also used for recycling other polymers. The potential of chemical recycling, which is still at an early stage of development, could be better explored to strike a balance between regulatory compliance, environmental impacts and economic viability (Deloitte, 2017). Investment in recycling infrastructure/technologies could be stimulated and supported.

- Chemicals matter in the whole lifecycle of plastic products. The use of hazardous chemicals in plastic products is prohibited/restricted by several pieces of EU legislation. A wide range of chemical substances are, however, often added to plastics to deliver specific qualities and material properties. In many cases, the chemical content of plastics is not traceable through the value chain as there is a lack of internationally harmonised databases and information systems, and, if these materials are recycled, chemicals may enter the recycling stream undiscovered. This can hamper the quality of secondary raw materials and make them unsuitable substitutes for virgin materials in some applications. For this reason, in order to support the development of an effective after-use plastic economy, stringent standards could be developed to certify the quality of plastic raw materials (OECD, 2018). The legislator, by adopting a systemic approach, should ensure the coherence of the requirements for chemicals used in plastics in the whole value chain.

- Based on EU legislation, most of the waste streams containing plastics – packaging waste, WEEE and ELVs – are covered by extended producer responsibility (EPR) schemes and new ones will be set up in the future to address selected single-use plastic products. There is empirical evidence that EPR schemes, combined with the use of collection/recycling targets, lead to an increase in separate collection and recycling of waste, reducing both landfilling and littering (OECD, 2016). However, there is still a significant potential for improvement, at least in the respect of the following points.

    - The effectiveness of EPR schemes with regard to design for the environment (DfE) is lower than expected, but DfE is pivotal to improving plastic waste management. For instance, according to the Ellen MacArthur Foundation (2017), without fundamental redesign and innovation, about 30 per cent of plastic packaging could never be reused or recycled. To date, only a few true fee-modulation mechanisms have been applied by EPR schemes (IEEP, 2017). A wider use of eco-modulated fees, fees modulated based on criteria related to products' environmental impacts, could support DfE. Design requirements, taken into account by modulated fees, are more likely to be effective if they are harmonised at the international level, especially when products are globally traded (OECD, 2016).

  - Currently, EPR schemes for packaging waste, WEEE and ELVs can meet their related recycling/recovery targets by exporting the collected waste. This option could be discouraged when plastic waste is traded to non-OECD countries, where it is often difficult to ensure that recycling/recovery takes place under 'broadly equivalent environmental conditions'. This objective could be achieved through regulatory measures – for example, by amending the method for calculating the recycling/recovery targets set by the relevant EU legislation or, at least, by prohibiting, within the WSR, that the plastic waste that can be recycled is exported beyond the EU for the purpose of energy recovery; or through the use of market-based instruments. If, in the latter case, revenues are generated, these could be used to fund the development of collection and recycling infrastructures in the non-OECD importing countries. Further, more transparency is needed in the decisions taken by EPR schemes on the management of the collected waste – particularly on quantities/types of plastic waste that are exported beyond the EU.

- The EU market for plastic raw materials needs to be strengthened/created. Some supporting measures are being introduced, such as, targets related to the minimum recycling content of beverage containers set by the Single-Use Plastics Directive, while others, including standards certifying the quality of secondary raw materials or obligations for public procurement of products with a specified share of recycled material, could be shaped in the future to increase the demand for plastic recyclates.

- Landfills bans: countries with landfill restrictions on recyclable and recoverable waste, including plastic, show higher plastic waste recovery rates and also, on average, higher recycling rates (Plastic Europe, 2018a). These restrictions, as well as the use of market-based instruments penalising the disposal of recyclable/recoverable waste, could be considered best practice.

International technology transfer, that is the transfer to plastic waste importing countries of better equipment and systems for plastics waste management aimed at lowering environmental impacts, could be part of the EU strategy for plastics. The transfer of knowledge and technologies could be supported, for example, by existing channels of international cooperation for development, including the growing green-finance sector, and also by EU financial institutions including the European Investment Bank.

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Annex I: Measures provided by the Single-Use Plastic Directive (EU, 2019a) and related deadlines for implementation

	Single-use plastic products	Prohibition to place on the market	Measurable reduction in consumption	Separate collection target	Marking requirements	EPR	Product requirements (attached caps/lids)	Product requirements (minimum recycled content)	Awareness raising
Beverage packaging and products	Beverage cups and containers made of EP	2021							
	Beverage containers (up to 3 litres)			2025 (77%) 2029 (90%)		End 2024	2024		2021
	- PET bottles							2025 (25%)	
	- Beverage bottles							2030 (30%)	
	Composite beverage packaging					End 2024	2024		2021
	Beverage cups		2026		2021	End 2024			2021
	Beverage stirrers and straws	2021							
Food packaging and products	Containers of food for immediate consumption made of EP	2021							
	Containers of food for immediate consumption		2026			End 2024			2021
	Cutlery and plates	2021							
	Packets/wrappers made from flexible material containing food for immediate consumption					End 2024			2021
Sanitary	Cotton bud sticks	2021							
	Sanitary towels				2021				2021
	Wet wipes				2021	End 2024			2021
Other plastic products	Balloons					End 2024			2021
	Sticks for balloons	2021							
	Oxo-degradable plastic items	2021							
	Lightweight plastic carrier bags					End 2024			2021
	Tobacco products with filters				2021	Beginning 2023			2021
	Fishing gear containing plastic			MS shall set target by 2021		End 2024			2021

EP= expanded polystyrene

Source: EU, 2019a

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