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Global trade in plastics: insights from the first life-cycle trade database

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Abstract

This paper presents the first attempt to quantify and map global trade flows across the entire life cycle of plastics – from raw inputs to final plastic products as well as waste. It draws on a new prototype database created by UNCTAD and the Graduate Institute, which draws on a granular examination of official trade classifications and compiles data on a far broader set of plastics-related inputs and products than those commonly used. This paper finds that trade is immense, with exports of primary, intermediate and final forms of plastics summing up to more than US$1 trillion in 2018 or 5% of the total value of global trade – almost 40% higher than previous estimates. This paper also finds that plastics trade is multifaceted and complex. While some key countries dominate trade across the plastics value chain, a wide diversity of countries are active as both importers of plastic products and exporters, using plastic as a means to participate in global value chains and to add value to exports.

At the same time, while this original database captures a range of neglected trade flows across the plastics life cycle, it is a prototype and still provides an incomplete picture, in part due to the methodological challenges of quantifying the value and volume of plastics 'hidden' in millions of products traded internationally (e.g., plastics embedded in products or used in pre-packaged products). The paper makes an original contribution to understanding of the dynamics of the global plastics economy, through the lens of trade. The findings can help governments and stakeholders to reduce plastics pollution and CO_2 emissions through more effective use of trade policy in addition to other policy levers.

Key words: Plastic, Trade, Development, Green Economy.

Contents

Acknowledgements

The analysis presented in this paper draws on a prototype database that is a work in progress and will be released online as a free and open resource by UNCTAD later in 2021. This paper aims to stimulate debate that will help to refine the database and contribute to wider efforts to reduce plastics pollution.

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Introduction

This paper presents the first attempt to quantify and map global trade flows across the life-cycle of plastics – from raw inputs and subsequent plastic products to its final stage as waste. It draws on a new original prototype database currently under development by UNCTAD and the Graduate Institute. Derived from granular examination of official trade classifications and UN Comtrade statistics to identify the breadth of plastics-related inputs and products traded internationally, this new database reveals trade flows commonly neglected in efforts to capture the scale of plastics trade.[1] By drawing attention to the trade flows partly or completely hidden in conventional estimates of plastics trade, this original approach enables a better estimation of the extraordinary scale, breath and complexity of trade flows across the life-cycle of plastics.

The first finding from this new approach is that the scale of global trade in plastics is immense, with exports of primary, intermediate and final forms of plastics summing to more than US$1 trillion in just one year alone – around 5% of total global trade in 2018.[2] This figure is almost double previous estimates that did not capture the entire plastic life-cycle nor the breadth of plastics products traded internationally (WTO 2020). Even then, this higher valuation still significantly under-estimates the total value of plastics traded internationally due to the challenges of estimating the value and volume of 'hidden' plastics embedded in millions of products traded internationally or used in associated packaging.

Second, the data shows that international trade occurs at every step of the plastics life-cycle – from feedstocks, to primary plastics in resin pellet and fibre forms, through to intermediate plastic goods, final manufactured plastic goods and plastic waste. Trade is also broad in terms of geographic spread – virtually all countries are importers of plastic in one form or another, and many are exporters as well. This trade is multifaceted and complex, with different countries being involved in different points of the life-cycle depending on their endowments of plastics feedstocks (fossil fuels) or infrastructure (refining capacities; position in global manufacturing chains), or the nature of their economies (agricultural or industrial). Developing countries are involved alongside advanced ones; for some, plastics trade has been part of a wider strategy of economic diversification. For example, plastic packaging has been central to efforts of some countries to add value to their agricultural exports. At the same time, some of the countries most heavily impacted by plastic pollution contribute least to plastic production, consumption and trade, especially Small Island Developing States (SIDs).

Third, the data shows that trade is significant across the life-cycle of plastics. For some plastics – such as synthetic textiles and rubber tyres, as much as 60% of the total volume of global production is traded internationally. For other categories of plastics, trade is less significant, with a larger share produced and consumed domestically. However, even where the total volumes of trade as a proportion of production are not significant, their environmental impacts can still be important. For countries that lack capacity to manage plastic waste, import of single use plastic products, empty plastic packaging and pre-packaged imported products can significantly exacerbate their existing environmental burden.

The analysis in this paper aims to contribute to a better understanding of the plastics industry and plastics life-cycle, through the lens of trade, and to inform analysis of the range of policy levers and tools that could potentially help reduce plastics pollution. Recent efforts to regulate environmentally unsustainable trade in plastic waste have already highlighted the trade policy has a vital role to play as part of the solution to plastic pollution (Khan 2019). Our findings widen the focus beyond waste; they suggest that a logical next step will be

[1] The UNCTAD ComTrade database is accessible at https://comtrade.un.org. The UNCTAD dataset on plastics will be published online in early 2021; it will be free and open to all (as all UNCTADstat is published under CC IGO 3.0) with the goal of providing a high value global public good.

[2] The WTO estimated that world merchandise exports totalled US$19.48 trillion in 2018 (WTO 2019).

to explore the potential role of trade policy to support efforts to reduce plastics pollution across the life cycle and to transform national and global production systems toward greater environmental sustainability (Deere Birkbeck & Sugathan 2021). This is important because, in addition to widely publicized challenges of marine plastic pollution, the plastics sector contributes significantly to greenhouse gas emissions and to an array of environmental and health challenges on land and in the air across the life cycle of plastics (Pew and Systemiq 2020), many of which disproportionately impact economically disadvantaged communities (Azoulay et al, 2019). On the international policy front, our analysis of trade flows across the life-cycle of plastics can also support and inform emerging policy dialogue on the relevance of international trade policy to plastics pollution at the WTO (Deere Birkbeck 2020; WTO 2020b) and in the context of calls for a new UN treaty on plastics pollution (Raubenheimer & Urho 2020).

Background to the development of the prototype database

This prototype database emerged from, and is nested within, broader efforts by UNCTAD, the Graduate Institute and others to address the gap in attention to the global political economy of the plastics sector, including the economics and politics of international trade in plastics. Together, a project on Transforming the Global Plastics Economy was launched in early 2019 with the support of the Swiss Network of International Studies (SNIS) (see www.plasticpolitics.solutions). To date, most literature and public attention to plastics pollution has focused 'downstream' on plastic waste – arising mostly from concerns about pollution of waterways and the ocean – including international trade flows in plastic waste (Brook et al 2018; Lavendar Law et al 2020).

However, there has been surprisingly little attention to the production or 'upstream' side of the plastic life cycle, i.e., plastics production and consumption before it becomes waste. In the policy arena, interest in a more circular economy for plastics is shedding some light on the links between upstream production and downstream pollution, but the upstream dynamics of the plastics and petrochemical sectors and their relevance to plastic pollution across the life cycle are only just starting to attract the scholarly analysis it deserves (Nielsen et al 2019). Similarly, although this study of trade flows underscores that the plastics economy is global, there has been surprisingly little systematic academic focus on the global political economy of the global plastics sector – underpinned by international trade and investment – and how this impacts efforts to reduce plastics pollution (Barrowclough & Deere Birkbeck 2020).

Moreover, beyond looking at trade in plastic waste, there has been no systematic scholarly attention to other international trade flows across the life cycle of plastics and the relevance of trade and trade policy to efforts to curb plastic pollution. And yet, a significant portion of key plastic products is traded internationally. Tens of millions of tonnes of plastic packaging are associated with thousands of pre-packaged products traded internationally each year, from electronic goods to bottled water and chocolate bars, and millions of additional tonnes are associated with the international transportation and distribution of products. Plastic is also embodied in countless products traded and consumed across the world – from cars to household appliances, toys, construction equipment, rubber tyres, and paints. Further, one of the most valuable components of plastics trade is in fact plastic its rawest forms – resin pellets and fibres – which are then transformed into a vast array of intermediate and final plastic products within importing countries. Improved understanding of all of these trends in trade will help policymakers to identify strategic entry points for regulations or other measures to reduce excessive use of plastics and plastic pollution.

Plastic trade flows are relevant to plastic pollution for three reasons: 1) trade in plastics products, products containing plastics, and products packaged in plastic adds to the waste management burden that importing countries face and is a conveyer belt for the spread of products responsible for microplastics pollution; 2) trade flows in plastic waste to countries with inadequate waste management capacity can exacerbate leakage of plastics into the environment, and 3) the plastics sector and the fossil fuel and chemical inputs from which it stems contribute significantly to greenhouse gas emissions and environmental and health challenges. Indeed, the plastics issue can be seen as a concrete, sectoral example of how a more sustainable global economy requires structural transformation – an agenda sometimes described as a Green New Deal (UNCTAD 2019).

Shifting the plastics sector toward greater environmental sustainability, including a lower contribution to greenhouse gas emissions, will require a judicious blend of government and industry policies to ensure that weaning the world off excessive use of plastic occurs through a transition process that is just – which in turn is vital to ensuring the transformation is sustained. The information that our prototype database draws together will support this process of transformation and just transition by enabling policymakers and experts to identify key trends, significant actors and pivot points across the life-cycle of plastics where policy levers and support mechanisms are needed, and could potentially be applied.

Structure of the paper

Section 1 sets out the basic issues at stake. It briefly introduces the key phases of the plastics life cycle, focusing upstream on the production end of the cycle and the trade flows to be explored. Section 2 introduces the prototype database and data sources for trade flows at different stages of the plastics value chain, highlighting the new insights revealed. Section 3 introduces the main findings, Section 4 shows findings by industry sectors and Section 5 shows bilateral trade trends and discusses their implications for plastics production and trade. Section 6 concludes with ideas for further research.

1. Plastics pollution and trade: issues at stake

Plastic pollution has fueled the environmental debate since the 1950s. It is only in the last decade, however, that scholarly interest in plastic pollution really start to grow, as reflected by growing numbers of papers and reports into this area. Most of this literature has focused on understanding and measuring the leakage of plastic materials into the oceans and its environmental impacts. Recent papers have focused, for instance, on the public health implications of plastics pollution that disrupts ecosystems and contaminates food chains.

In general, the existing scholarly and policy literature has been oriented toward the downstream side of plastic pollution, leaving largely unexplored the source of pollution in the first place and the potential for policies to curb pollution by focusing attention 'upstream' on production and consumption. In this paper, we aim to contribute to growing efforts to bridge the gap by analyzing trade relations across the global plastics industry and the life cycle of plastics.[3]

Plastics as an industry – the plastics life-cycle

The plastic life cycle begins when oil and gas are extracted and then refined, usually by petrochemical companies. Fossil fuel feedstocks for plastic production are outputs of the oil and gas refining process and are the key inputs for virgin plastic polymers. These polymers are usually produced in the form of resin pellets or fibres and there are about 30 main different types of primary plastic polymers in this first stage of the plastics life cycle. These primary forms of plastics are purchased by producers and suppliers of plastics materials, both nationally and on the international market. The buyers convert the pellets and fibres into value-added plastics products (intermediate or final) that are also tradable internationally.

The list of plastic products traded internationally is enormous, including plastic packaging; synthetic textiles and finished clothes; construction materials and industrial machinery; electrical and electronic goods; beauty and household consumer products; paints, coatings and markings; automobile parts. These are produced and used in myriad ways, including by vertically and horizontally integrated companies with subsidiaries and partners across the world as well as by small and medium enterprises. Plastic packaging, for instance, is both produced and shipped across the world; either traded 'empty', as a product in its own right, to be combined with the products in the purchasing country, or as wrapping of underlying products and as part of packaging used in distribution.[4] The final stage in the plastics life cycle examined in this paper is plastic waste. In the past several years, there has been growing recognition that trade in plastic waste from developed to developing countries has greatly exacerbated problems of marine plastic pollution (GRID-Arendal 2019; Jambeck 2017).

[3] For two recent reviews of the global political economy of the plastics industry, see Barrowclough and Deere Birkbeck (2020), and CIEL (2017).

[4] See for example UN Environment (2018b), Jambeck and Low (2017), and Barrowclough and Deere Birkbeck (2020) among others.

Although purportedly shipped for management through landfill, incineration or recycling, the evidence reveals that most waste shipped to developing countries has been openly discarded on land or leaks into river systems and the sea (UNEP 2018a, b). This reality has spurred a number of countries to restrict or ban imports of certain plastic wastes as well as international agreement on a set of 'plastic amendments' to the Basel Convention on the Transboundary Movement of Hazardous Wastes that aim to better regulate trade in plastic waste (BRS, 2019).

The lifecycle of plastics thus engages a broad set of commercial stakeholders – starting with the fossil fuel feedstocks sold by major global companies (fossil fuel and petrochemical); moving through major global value chains in the construction, clothing and foods industries; to transporters at all points across the value chain; to small domestic enterprises and eventually to waste management companies, plastics waste traders and informal workers in the waste-sorting and scrap industries. In some cases, the cycle starts up again with new products generated from waste that is re-cycled, downcycled or up-cycled or used in waste-to-energy applications.

In contrast to most of the literature, which has focused attention on trade in plastic waste, this paper highlights the fact that international trade plays a central role in global supply chains across the whole plastic life cycle (see Box 1).

Box 1. International trade in plastics – points of trade entry in the plastics life-cycle

Trade flows are key to global markets & supply chains for:

- fossil fuel feedstocks and chemical precursors for plastics
- additives used in plastics
- primary plastics (resin pellets and fibres)
- multiple plastic end-products (including synthetic textiles and plastic packaging)
- products with a high share of embedded plastic
- products wrapped in plastic
- plastic waste,
- recycled plastic
- secondary waste products.

2. Creation of the Plastics Life-Cycle Trade dataset

Limitations of existing classifications and measures

Most data on the production of plastics comes from industry and is compiled by market analysis firms responding to the detailed product specific needs and interests of manufacturers, retailers and other businesses producing or using plastics directly in their business processes or to package final products. This literature offers useful insights on the importance of the plastics market, the key sectors using plastics, key companies, key trading partners, and which countries are driving demand for and producing specific plastic products across the life cycle. For example, according to PlasticsEurope, one of the leading plastics trade associations, the plastics industry employed 1.6 million people in 60,000 companies across Europe in 2018, generating 360 billion euros of sales and ranking seventh in industrial value-added contribution (Plastics Europe 2018, 2019). While usually behind a significant paywall, such data and analysis offer an important insight into the commercial value of the plastics sector in terms of its total sales, employment and value-added, and also provides some information on international prices for specific products and trade flows among leading trade partners.[5]

For a fuller and publicly accessible picture of trade flows, the United Nations International Trade Statistics Database, known as UN Comtrade, is the main source of international trade data based on official national sources. This database provides information on global trade data, reported at the bilateral level, going back to 1962. UN Comtrade's repository of international statistics relies on self-reporting by more than 170 countries of their trade transactions, detailed by trading partner and commodity. Individual goods are classified according to the Harmonized Commodity Description and Coding System (HS), which is administered by the World Customs Organization (WCO). The data are reported and are available monthly or annually in value (US Dollars) and quantity. In the HS, commodities are described in a hierarchy of codes of 2, 4 or 6 digits where longer codes provide more detail.

The most obvious group of plastic products are those listed with the 2-digit code (Chapter) 39 *Plastics and articles thereof*. In the 2017 revision of the HS system, commodities included in Chapter 39 are disaggregated into 26 codes at the 4-digit level and 126 codes at the 6-digit level, covering products ranging from plastics in their primary forms to plastic office and school supplies and tableware. (Some countries even go to 8, 10 or 12 digits to capture a more detailed picture of trade but there is no international standard for these more detailed digit levels used nationally.)[6] Notably, analysts citing statistics on trade in plastics generally refer only to those aspects of plastics trade that are included in Chapter 39 (see, for instance, WTO 2020a: 41-42).

However, while the list of plastic products covered under Chapter 39 is long and seems exhaustive, in fact it captures only a sub-set of the actual trade in plastics and plastic inputs. (In addition, some products included in Chapter 39 as 'plastics' are not entirely plastics but are combined with other materials). The HS system is not primarily designed for the identification of products according to the material composition, meaning that considerable additional effort is needed to extract the full value and volume of all plastic that crosses international borders.

Importantly, a number of other predominantly or entirely plastic products that are readily identifiable in the HS are included under chapters other than Chapter 39. This includes synthetic rubber products and textiles as well as items such as nappies and sanitary towels, which are almost entirely plastic, and fishing nets, which are also plastics. Further, not all plastic in primary forms (polymers) in pellet and fibre form, such as synthetic textile fibres and synthetic rubber polymers, are included in Chapter 39.

In addition, there is also a vast quantity of plastic that is embedded or associated with products and their international transportation that is not readily identifiable using the HS classifications. Even if we know certain highly traded items, such as cars and electronic goods, which are not evidently 'plastics' have a high proportion of plastics embedded in them, official trade statistics give us no way to know the share of the product that is plastic or the total volume of plastic embedded in such products traded internationally.

[5] Key firms providing analysis of the petrochemical and plastics sector are the International Commodity Information Service and Grandview Research, along with industry publications such as Chemistry World and Chemical and Engineering News, as well as periodic and annual publications of industry associations such as PlasticsEurope and the Plastics Industry Associations. Across the life cycle of plastics, an array of industry specific publications exists, targeting business involves in conversion and manufacturing of plastics as well as specific sectors such as the packaging sector.
[6] https://unstats.un.org/unsd/tradekb/Knowledgebase/50018/Harmonized-Commodity-Description-and-Coding-Systems-HS.

Beyond HS categories that cover empty plastic packaging traded as a product in its own right, a vast quantity of additional plastic packaging crosses international borders but is "hidden" in the sense that neither its volume or value can be easily quantified using the HS. Importantly, when working to identify trade flows relevant to plastics, and especially packaging, the WCO's General Rules of Interpretation (GIRs) (a set of legal principles that govern the tariff classification of merchandise under the HS) are relevant.[7] The General Rules underline that various types of packaging, cases and containers are usually classified with the goods they are associated with.[8] In the case of pre-packaged meals and confectionary included in HS Chapters 16-21 focused on food, for instance, neither the official classifications nor statistics are designed to reveal the volume or value of 'hidden' plastics trade associated with the plastic packaging of those food products.

Notably, existing HS classifications for plastics differentiate between some but not all different kinds of primary plastics polymers. A handful of conventional plastics in primary forms are distinctly specified under their own subheading, but others are grouped under the general category "Other". Although there is an HS code for PLA (an alternative type of 'bio-based' primary plastic), there is no separate HS code for other types of non-conventional primary plastics, such as biodegradable and compostable plastics. In addition, there is little differentiation of the diversity of intermediate and manufactured plastics products by polymer type, with some exceptions such as for certain plastic sheets, tubes, pipes and hoses. Beyond primary flows, trade flows of intermediate and final goods plastic goods made of PLA are not distinguishable from other trade flows.

Similarly, although HS codes differentiate some types of plastic waste by polymer type, they do not differentiate kinds of plastic waste (hazardous, contaminated, mixed, recyclable) or secondary materials (e.g., recycled plastic pellets). For instance, Note 7 of the official Section Notes for HS Chapter 39 (which provide guidance on the scope of items covered under the Chapter) states that Heading 39.15 (waste pairings and scrap of plastic) does not apply to waste parings and scrap of a single thermoplastic material, transformed into primary forms. Such transformed plastics (presumably through recycling) are classified under headings 39.01 to 39.14 but are not specifically identified as being recycled primary forms of plastics.[9] The plastic wastes included in Chapter 39 sub-headings do also not include all kinds of plastic waste. Some rubber waste and scrap, for instance, is included in HS 401700.[10]

A further consideration is that, despite the existence of the harmonized system of classifications, importers and exporters may register the same product under different HS codes, as may customs officials who process products at the border. The fact that the HS is not used consistently around the world means that official trade statistics are not necessarily reliable. The United Kingdom's advice to importers and exporters on how to

[7] Kawazoe, T. (2019). What is "General Rules of Interpretation (GRIs). https://www.customslegaloffice.com/global/what-is-general-rules-of-interpretation-gris/.

[8] Principle 5 (a) of the GIRs for HS 2017, for instance, states that " (a) Camera cases, musical instrument cases, gun cases, drawing instrument cases, necklace cases and similar containers, specially shaped or fitted to contain a specific article or set of articles, suitable for long-term use and presented with the articles for which they are intended, shall be classified with such articles when of a kind normally sold therewith. This Rule does not, however, apply to containers which give the whole its essential character". Article 5 (b) further adds that "Subject to the provisions of Rule 5 (a) above, packing materials and packing containers presented with the goods therein shall be classified with the goods if they are of a kind normally used for packing such goods. However, this provision is not binding when such packing materials or packing containers are clearly suitable for repetitive use." For further information see: http://www.wcoomd.org/en/topics/nomenclature/instrument-and-tools/hs-nomenclature-2017-edition/hs-nomenclature-2017-edition.aspx.

[9] See the World Customs Organization. HS Nomenclature 2017 edition. http://www.wcoomd.org/en/topics/nomenclature/instrument-and-tools/hs-nomenclature-2017-edition.aspx.

[10] The description for HS 4018000 is: Rubber; ebonite and other hard rubbers in all forms, including waste and scrap, and articles of hard rubber.

classify their transactions, for instance, explains that the important criterion is whether the "defining characteristic" of the product is its plastic content or something else. Hence, goods with a high plastics content are only classified under the Plastics Chapter if they are not specifically referred to elsewhere in the HS and the UK tariff schedule[11]. As can be imagined, such a complex and somewhat subjective system may not be the best way to fully capture the true, underlying extent of trade in plastics at all diverse levels of the life-cycle. It also reflects the fact that the HS codes are primarily designed to classify goods for customs purposes (such as the administration of tariffs and quotas at the border) rather than for purposes related to tackling the environmental implications of trade.

The new approach

In 2020, UNCTAD has worked to develop a Plastics Trade dataset that captures the breadth of trade across the life cycle of plastics as well as inputs into plastics, and that is based on official sources.

The new approach we propose in this paper combines four kinds of trade flows in the life cycle of plastics:

- Input flows – flows in feedstocks, precursors and additives used in production of primary plastics);
- non-hidden flows -- those included in HS Chapter 39 Plastics and articles thereof, as described above;
- semi-hidden flows -- those plastic products that can be readily identified under other chapters of the HS, such as synthetic textiles and rubber;
- hidden flows — products with embedded or associated plastics where the volume and value of plastics is not readily identifiable or traceable). Such hidden trade flows include packaging associated with specific products (pre-packaged food and beverages) (e.g., not empty packaging); packaging used in the distribution and transportation of products; and the massive volume of plastic embedded in household and consumer goods (as with the spectacles or toys examples above) (Paruta et al forthcoming). Estimates of these hidden flows are not yet included in the prototype database as they require the development of a distinct methodological approach but will be added in the course of 2021.

In order to capture all non-hidden and semi-hidden flows, in addition to the readily visible Chapter 39 plastics, an essential first step involved scientists with expertise in chemical industry, plastics and the HS. With their help, we identified the various categories of feedstocks, precursors and additives that are the 'raw' inputs into the plastics value chain. This granular process involved detailed micro-analysis, HS code by HS code, of all traded products to identify those traded inputs used in plastics production.

One advantage of the UN Comtrade data is that they are 'raw' in the sense that no additional estimation or imputation of any kind is applied to the data reported by countries. However, at the same time, countries who

[11] There is a multitude of goods made from plastics like this, including textiles, textile products (clothes) and toys, all of which are covered in other chapters and hence not recorded the in Chapter 39 on plastics. British importers and exporters are advised that, as a general rule of thumb, if the defining characteristic is that a product is made of plastic, it will be recorded in Chapter 39. For example, a plastic bottle or floorcovering is classified under this chapter. However, spectacle frames which happen to be made of plastic are classified elsewhere, as the fact they are spectacle frames is the defining factor, not their construction from plastic (Gov. UK accessible at https://www.gov.uk/guidance/classifying-plastics).

do not self-report their data do not appear in the database, which has been the case in recent years for a few countries of global economic importance. This study uses data from 2018.[12]

The findings from the UN Comtrade database were also compared with UNCTAD's Merchandise Trade Matrix, which reports trade data at a higher level of product aggregation and uses a different classification – the Standard International Trade Classification (SITC) revision 3.[13] Correspondence tables exist to enable matching between information from both classifications. This database offers a larger country coverage than UN Comtrade, thanks to estimation and correction methodologies used to impute plastics data pertaining to missing countries,[14] but it only reports value estimates (in US Dollars). A third comparison was made with the Base pour l'Analyse du Commerce International, known as BACI database, constructed by the French think tank Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). BACI uses raw data from the UN Comtrade Database and the same HS classifications. Although only updated annually (whereas Comtrade is continuously updated), it goes a step further by providing reconciled information on annual bilateral trade flows disaggregated at product level.[15] All three databases provide broadly consistent information on the plastics data, which is perhaps not surprising given their common roots.

Once all of those HS codes that explicitly cover plastic inputs and products along the life cycle were identified, the codes were sub-divided into six categories that roughly approximate important phases of the plastics life cycle, as shown in Box 1. The full list of HS subheadings included in the database are reproduced in Annex 1, broken down according to their place in the life-cycle, along with explanatory notes. The authors hope publication of this paper will stimulate researchers to help improve the categorizations and dataset). As noted above, in addition to non-hidden and semi-hidden trade in plastics along the life cycle, to present a fuller picture of trade across the whole value chain and life cycle of plastics, we also included input categories that cover trade flows in feedstocks and related chemical precursors that are used in the production of primary plastics, as well as additives used in plastics. The reason for doing this is that they are integral to the production of plastics, and are also associated with many problems of pollution, so could also potentially be important places for attention of trade policymakers.

Data is presented for 2018, the most recent year available, by importer, exporter and country-pairs. Attention is focused on the top-20 exporters and importers and the top-50 trade relations, for each stage of production. In addition, to complement our analysis of plastics trade according to the life cycle categories noted in Box 1, we also zoomed in on several illustrative sub-categories of plastics trade – such as plastic packaging and fishing nets (which are sub-categories of final manufactured plastic goods), as well as trade in synthetic textiles (where we analysed trade across the entire life cycle for synthetic textiles – from primary synthetic fibres through to final manufactured goods). It also did not examine trade in secondary plastic waste products – such as recycled primary plastics or other recycled plastic products – as HS classifications do not currently differentiate trade at this level of detail. Notably, our analysis did not investigate the trade in plastic-related services, such as waste transportation services, plastic distribution services, and waste management services. While some data on trade in waste management services is available, this is not broken down to plastic-specific waste management services.

[12] The availability of data can be checked on https://comtrade.un.org/data/da.
[13] The UNCTAD Merchandise Trade Matrix is available here: https://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx.
[14] Missing data is imputed from partner countries reporting trade with that country.
[15] The BACI database can be consulted here: http://www.cepii.fr/cepii/en/bdd_modele/presentation.asp?id=37.

3. Findings: Trends in Global Plastics Trade

3.1 Plastics trade was at least 40% higher than previous estimations by value, and at least 25% higher by volume in 2018

Once the previously "semi-hidden" plastics are included, the new data shows the massive extent to which plastics inputs and products are traded at every stage of the production chain, from raw material to manufactured goods placed on shelves in retail stores. Table 1a shows that total trade in plastic inputs and products, not including the basis precursors, was worth at least US$1,008 trillion – accounting for around 5% of total world trade in 2018. It was also almost 40% higher than the value of the sub-set of plastics trade accounted for by HS Chapter 39, which in 2018 was US$631 billion (WTO 2020). The new approach therefore appears to have been successful in revealing aspects of plastics trade otherwise neglected in estimates.

One concern for us that a simple addition of volume and value of trade across different stages of the plastic life cycle may over-state plastic quantities because a proportion of the intermediate and final plastic products will already have crossed borders at different stages of the plastics life cycle for value addition. The figures nonetheless provide a useful guide to the volume and value of plastics trade by stage of production and overall.

The new dataset shows that when semi-hidden plastics (i.e., HS codes that include plastics but that are not in Chapter 39) are included, the volume of plastics traded in 2018 rises to around 336 million metric tonnes (MT), as compared to 257 million metric tonnes (MT) when using only Chapter 39 codes – that is almost 25% higher.[16] As noted above, the UNCTAD data suggest that semi-hidden trade is dominated by rubber (57 MT) then synthetic textiles (20 MT). Tables 1b and 1c provide the volume traded by stage of plastics production.

Critically, these findings are still an underestimation of the volume of plastics trade because a vast diversity of products containing 'embedded' plastics are not included (television sets, computers, car components, etc). Further, these findings do not include the vast quantity of plastics packaging associated with products traded internationally. Such 'hidden flows' of plastics trade are still under examination and preliminary results of a first methodology for tracing these will be published in early 2021 (see Paruta et al forthcoming).

The total value of trade related to the plastics sector would also be significantly higher if we included trade flows in inputs to plastics products, namely fossil fuel-based feedstocks and chemical additives. A first estimation of the value and volume of trade flows in feedstocks and chemical additives known to be used in plastics is included in Table 1c. However, as noted in Part 4, the products covered by the HS codes included in each category may not be used entirely for plastics production but may also be used in other industrial sectors (i.e., it was beyond the scope of this paper to determine what proportion of the trade flows for each HS code was for plastic-specific purposes).

Even without these lacking elements and caveats, plastics trade figures dwarf those for other sectors that are somewhat similar in their use or purposes. To give a sense of the relative scale, global cotton fabrics exports were just US$12.9 billion in 2017; paper exports amounted to US$170.5bn in 2019; glass and glassware US$76.5 billion; and pharmaceutical products amounted to US$392.9bn in 2019.

[16] All data reported here is from the prototype UNCTAD Plastics database, as of October 2020.

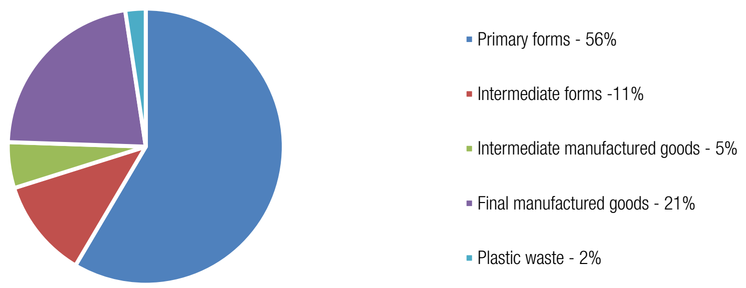
For some countries, the scale of markets for plastics are an encouraging sign of the potential market for plastics substitutes and alternatives (UNCTAD 2020; Barrowclough and Vivas 2020).

Table 1a. Snapshot 2018 - Summary international trade in selected plastics, by phase in the plastics life-cycle (exports, 2018, $US billions).

Plastic Products	$US billions
Primary forms of plastics	348
Intermediate forms of plastics	158
Manufactured plastic goods - intermediate	83
Manufactured plastic goods - final	416
Plastic waste	3
Total	1008

Source: UNCTAD plastics trade database prototype as of October 2020. See Annex for a detailed list of HS codes included in each category and explanatory notes. Note that these figures do not reflect a simple addition of values for each category or a calculation of value-added across the production process.

Figure 1. Proportion of total plastics trade in volume



Source: Authors' compilation, using UNCTAD Plastics prototype database as of October 2020. Note that the data on volumes should not be interpreted as the total volume of plastics traded internationally; instead, they represent a simple addition of volumes traded under different HS codes selected. In reality, the same underlying quantity of primary plastics is traded between countries at different stages of the plastics life cycle for value addition and eventually disposal.

Table 1b. Snapshot 2018 - Summary international trade in selected plastics, by phase in the plastics life-cycle (exports, 2018, million metric tonnes).

Products	Million metric tonnes (MT)
Primary forms of plastics	196
Intermediate forms of plastics	39
Manufactured goods - intermediate	18
Manufactured goods - final	74
Plastic waste	8

Source: UNCTAD plastics trade database prototype as of October 2020. See Annex 1 for a detailed list of HS codes included in each category and explanatory notes.

Table 1c. Snapshot 2018 - Summary international trade in selected plastics-related products, by phase in the plastics life-cycle (exports, 2018, $US billions and million metric tonnes).

Products	$US billions	Million metric tonnes (MT)
Feedstocks and precursors	94	100
Additives	81	55

Source: UNCTAD plastics trade database prototype as of October 2020. See Annex 1 for a detailed list of HS codes included in each category and explanatory notes.

3.2 Trade is a significant part of total production

Trade flows in plastic are not a proxy for production in plastics. A country may, for instance, be a major producer in a certain category but not a major exporter of that product. The product may be used domestically for further manufacturing or processing and then shipped internationally. Alternatively, it may simply be produced directly for domestic consumption. That said, an important new finding from the whole of life database is that trade is significant as a proportion of the total production of many plastic products and at key points along the life cycle of plastics.

Notably, calculating trade as a proportion of production is a difficult exercise due to the inconsistency in coding between trade and production data. One approach to overcoming this difficulty is to match HS codes with codes from International Standard Industrial Classification (ISIC) (UNDESA 2008). In the ISIC codes, the only production statistics available are for what is referred as 'plastics and rubber'. According to ISIC data, global production in this category in 2018 was 359 MT (Statista 2020).[17] Measured against our figure of 196 MT of primary plastics and rubber traded in the same year, trade represented an estimated equivalent of 54% of the volume of production for this stage of production in 2018. An alternative commonly-cited estimate is that global annual plastic production, including plastic pellets, synthetic rubber and textile synthetic fibres, reached 415 million tonnes in 2016. Using this estimate as a proxy, trade as a share of global primary plastic production reaches a smaller but still significant 36%. (A 2018 production estimate using this methodology is not yet available but we note that overall production is widely recognized to have further increased by the 2018 reference year for our trade data. (Billard & Boucher 2019).

Using a similar methodology, the data suggests that total exports of synthetic textiles reached 60% of the total volume of global production. Even exports of 'empty' plastic packaging (i.e., shipping containers full of plastic packaging) alone account for around 5% of plastic packaging produced annually.[18] A critical finding from our study is that official statistics on plastics packaging trade fail to capture a vast proportion of plastic packaging

[17] For further research, a primary source for more detailed data on plastics production is the UN Industrial Development Organization (UNIDO).

[18] As shown in Annex 1, HS codes used to derive these figures for plastic packaging were HS Codes: 392310 (plastics; boxes, cases, crates and similar articles for the conveyance or packing of goods 392321 (ethylene polymers; sacks and bags (including cones), for the conveyance or packing of goods; 392329 (plastics; sacks and bags (including cones for the conveyance or packing of goods, of plastics other than ethylene polymers); 39330 (plastics; carboys, bottles, flasks and similar articles, for the conveyance or packing of goods; 392340 (plastics; spools, cops, bobbins and similar supports, for the conveyance or packing of goods; 392350 (plastics; stoppers, lids, caps and other closures, for the conveyance or packing of goods; and 392390 (plastics; articles for the conveyance or packing of goods n.e.c. in heading no. 3923.

known to be traded internationally and thus prevent a very partial view. It is well recognized that millions of tonnes of plastics packaging cross borders through consumer and household products that are pre-packaged, through business-to-business packaging (B2B), and through additional packaging used for transportation and distribution. All of this 'hidden' packaging is not, however, identified in official trade statistics and is thus not easily traced. These findings suggest that trade policy could be a significant tool, among the other policy instruments used to reduce plastics and promote substitutes.

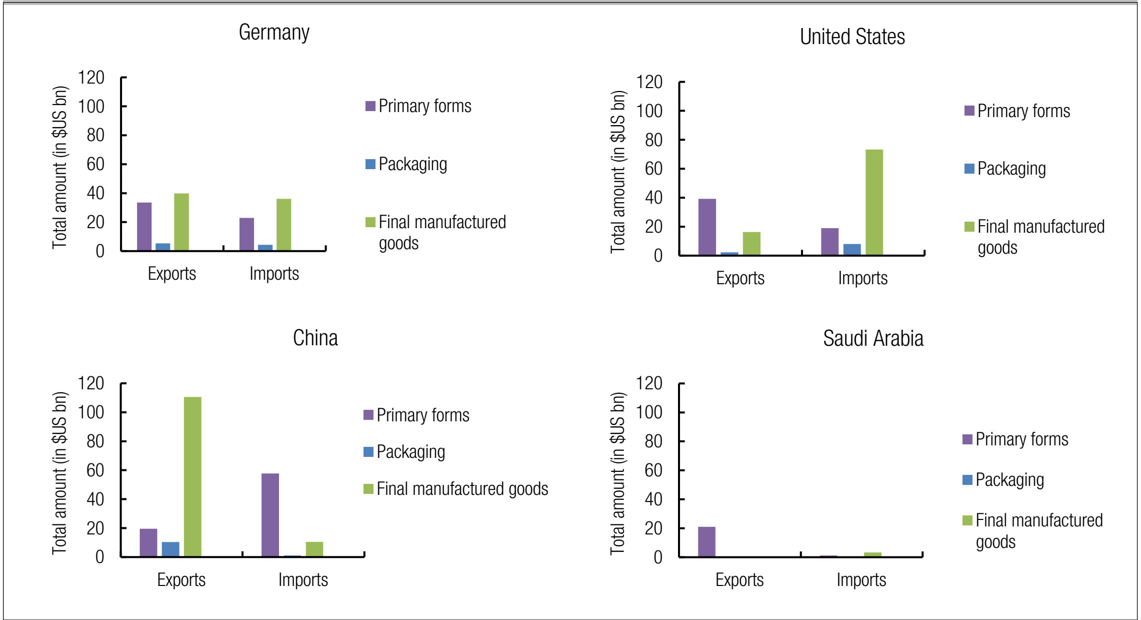
Tables 1 a-c and Figure 1 show the respective contribution of each category to total plastics trade. As noted above, our analysis suggests that respective size of trade in primary plastics (resin pellets and fibres), is large – accounting for at least 36% by value of total world plastics trade. For advocates wishing to reduce plastics trade, this could potentially be one place to look for regulatory levers, especially in consideration of the fact that these are direct by-products of the fossil-fuel industry, which is in many countries the recipient of large-scale government subsidies. While plastics packaging flows do not represent such a high share of overall production, the analysis above highlights that official statistics underestimate the total volume of trade in plastics packaging. Moreover, plastics packaging is the area where consumer willingness to change is perhaps greatest, and also where a number of countries are already actively seeking to produce and export alternatives to plastic. Further, for countries that are struggling to manage plastics waste within their borders, the imports of plastics packaging – either empty or associated with other products – can add considerably to this burden. This is particularly the case, for instance, for Small Island Developing States that have limited capacity for waste management and recycling and few possibilities to change the direction or trend in trade (Barrowclough and Vivas 2020).

3.3 Trade is multi-faceted and multi-directional

Another important finding from analysis of the life-cycle plastics database is that many countries play dual roles in the plastics sector. Some of the world's largest exporters of plastics products and inputs are at the same time among the world's largest importers, indicating that plastics trade is multi-faceted and multi-directional. The oil-producer Saudi Arabia is one of the world's largest exporters of plastics inputs, in the primary forms of pellets and nurdles and does not figure much as an importer. China is a major importer of primary plastics and exporter of derivative products. The United States and Germany, with significant interests in oil and gas production and the chemical industry as well as manufacturing more generally, feature heavily in both importing and exporting of plastics across the life cycle (Figure 2).

Tables 2 and 3 below highlights how the role of selected countries in trade varies across the stages in the life cycle of plastics in 2018. Notably, some countries rank among the top 10 exporters across all parts of the plastics value chain – such as the United States and several EU countries –while others are prominent in certain sectors only (such as Indonesia as an exporter of intermediate manufactured products and of synthetic textiles). Some of the world's largest exporters of plastics products and inputs are at the same time among the world's largest importers, indicating that plastics trade is multi-faceted and multi-directional. The oil-producer Saudi Arabia is one of the world's largest exporters of primary plastics and does not figure much as an importer of plastics. China is a major importer of primary plastics and a significant exporter of most derivative plastic products. The United States and Germany, with significant interests in oil production and the chemical industry as well as manufacturing more generally, feature heavily as both importers and exporters.

Figure 2. Key players snapshot – plastics trade is multi-faceted and multi-directional, 2018 ($US billions)



Source: Author's compilation, drawing on prototype UNCTAD Plastics Database, October 2020.

Table 2. Top ten exporters by volume and category (Rank 1-10, 2018)

Rank	Feedstocks	Additives	Primary Plastics	Intermediate Forms of Plastic	Intermediate Manufactured Products	Final Manufactured Products	Plastic Waste	Packaging	Synthetic Textiles
1	Rep. of Korea	Saudi Arabia	USA	China	China	China	Germany	China	China
2	Japan	USA	Saudi Arabia	Germany	Rep. of Korea	Germany	USA	Germany	Rep. of Korea
3	USA	Rep. of Korea	Rep. of Korea	Italy	Chinese Taipei	Thailand	Japan	France	India
4	Netherlands	Belgium	Germany	USA	India	Poland	United Kingdom	Vietnam	Chinese Taipei
5	Germany	Indonesia	Belgium	Rep. of Korea	Indonesia	USA	Belgium	Poland	Vietnam
6	Saudi Arabia	China	China	India	Thailand	Belgium	France	Netherlands	Indonesia
7	India	Chinese Taipei	Chinese Taipei	Chinese Taipei	USA	Japan	Netherlands	Italy	USA
8	Chinese Taipei	Malaysia	Netherlands	Turkey	Germany	France	Hong Kong	Belgium	Thailand
9	Belgium	Germany	Thailand	Belgium	Vietnam	BItaly	Mexico	Turkey	Germany
10	Singapore	Canada	Singapore	Poland	Turkey	Rep of Korea	Italy	Thailand	Belgium

Source: Authors' calculations, drawing on prototype UNCTAD Plastics Database, October 2020.

Table 3. Top ten importers by volume and category (Rank 1-10, 2018)

Rank	Feedstocks	Additives	Primary Plastics	Intermediate Forms of Plastic	Intermediate Manufactured Products	Final Manufactured Products	Plastic Waste	Packaging	Synthetic Textiles
1	China	China	China	USA	Vietnam	USA	Malaysia	USA	USA
2	Belgium	India	Germany	Germany	USA	Germany	Thailand	Germany	Vietnam
3	Netherlands	USA	USA	France	China	United Kingdom	Hong Kong	Japan	Germany
4	USA	Germany	Italy	China	Indonesia	France	Germany	United Kingdom	Turkey
5	Germany	Netherlands	India	United Kingdom	Turkey	Netherlands	Vietnam	France	China
6	Chinese Taipei	Belgium	Belgium	Belgium	Germany	Japan	Netherlands	Netherlands	Indonesia
7	Rep. of Korea	Rep. of Korea	Turkey	Italy	Bangladesh	Belgium	USA	Belgium	Brazil
8	India	Spain	Vietnam	Turkey	Mexico	Canada	Chinese Taipei	Spain	United Kingdom
9	Mexico	Italy	France	Vietnam	India	Spain	Turkey	Poland	Mexicoy
10	France	Indonesia	Mexico	Poland	Brazil	Italy	Indonesia	Italy	Japan

Source: Authors' calculations, drawing on prototype UNCTAD Plastics Database, October 2020.

4. Findings: Plastics trade by phases of the plastics life-cycle, by country and region

The following pages highlight some initial findings on plastics trade according to the various phases of the plastics life-cycle, starting at inception and ending with waste, by country and region.[19] We shows both volume, a measure that is of particular interest in terms of pollution, and also value, a measure that indicates the economic weight of the category. Figures for each phase are shown in full in Annex 2, and some are also highlighted in the text below. We also zoom in further in on a few interesting sub-groups of products, notably plastic packaging, synthetic textiles and fishing nets. Finally, a full list of the HS codes that were used to extract data relevant to each sub-heading can be found in Annex 1, along with explanatory notes.

4.1. Feedstocks and precursors used in plastics

Fossil-fuel feedstocks and related precursors for plastics production, consisting mostly of petroleum products from crude oil and hydrocarbons found in natural gas, are at the earliest stage of the plastics value chain and are the basis for a sequence of further transformations that result in final plastic products. Although the value of the trade in this category reached US$94 billion in 2018, this is comparatively small compared to the value of trade across the life cycle of plastics, the importance of this category was highlighted by the large share of feedstocks and precursors traded internationally in terms of volume, reaching 100 million metric tonnes. In terms of volume, fossil fuel feedstocks and precursors represent the second largest category of trade in the plastics value chain. However, while the items included in the database for this category represent a sub-group of fossil fuels and precursors specifically identified as inputs for plastics production, they may also be inputs for other sectors; the data does not allow us to determine what portion of the value and volume of these that were specifically devoted to plastics. Notably, this category is also a significant category in terms of contribution

[19] Note: In the charts and aggregations that follow, the United States includes Puerto Rico and United States Virgin Islands; Belgium includes Luxemburg; France includes Monaco; Chinese Taipei is reported as "Other Asia, not elsewhere specified"; Switzerland includes Liechtenstein; Rest of World is the sum of all other countries.

to pollution, including CO^2 emissions as well as through oil, gas and chemical mishaps and leakages during international transportation.

Leading oil and gas producers made up the top-20 exporters of feedstocks and chemical precursors used in plastics in 2018, including the United States, Saudi Arabia, Canada, Kuwait and Russia, as one would expect (Annex 2 Figures 1a - d). However non-oil exporting countries with refining capacities were also significant players including, in particular the Republic of Korea (with 15 million tonnes) and Japan (with 10 million tonnes). China does not enter the top exporters because China uses its domestic fossil fuel production locally and imports fulfill outstanding needs, thus ranking first by far in terms of imports.

4.2. Additives used in plastics

Chemical additives are an essential component of plastics. Although not consisting of plastics themselves, these chemical additives are critical ingredients for the scale and diversity of plastics on the global market, enabling the multitude of colours, textures, characteristics, properties and features that have made plastics such as useful material. More importantly, they have been pointed at due to the suspected danger they represent for health[20]. The product codes included in this category are listed in the Annex and may warrant further review for future studies. The additives listed may not be used exclusively for plastics, and further research is required as to how these should most correctly be included in the database. At its present definition, trade in additives potentially used in plastics was worth US$81 billion in 2018, corresponding to 55 million metric tonnes.

The United States lead exports in additives used in plastics in terms of value, exporting almost US$9 billions of such additives in 2018, before China with around US$7 billion. Saudi Arabia was ranked 3rd with US$6 billion but ranked first in trade by volume, which might reflect a specialization in heavier additives compared to other countries (Annex 2 Figures 2a-d). In terms of imports, countries which were the large plastics producers (China, Germany, United States) were unsurprisingly the largest buyers as additives are an essential component for the production of final goods. China imported US$14 billion of additives used in plastics, corresponding to 18% of the total imports in additives in 2018, more than twice the value of imports from Germany.

4.3. Primary forms of plastics

Primary forms of plastic are a very important category of plastics trade as they enter the production of the immense range of all final products that contain plastic. In 2018, trade in primary forms of plastic (including resin pellets, synthetic fibres and synthetic rubber in primary forms) reached some US$348 billion, corresponding to almost 200 million metric tonnes.

As shown below, and in the Annex as Figures 3a-d, the United States was the top exporter of primary forms of plastics with approximately US$37bn of exports in 2018, while Germany and the Republic of Korea followed with respectively around US$31 and US$27 billion each, before Belgium and Saudi Arabia, with the latter ranked second in terms of volume. In this context, Saudi Arabia, as one of the most important oil producers,

[20] One of the best known additives is Bisphenol A, commonly known as BPA, which is an endocrine disrupter. While widely banned for use in baby bottles, it continues to be widely used in many food and beverage storage containers.

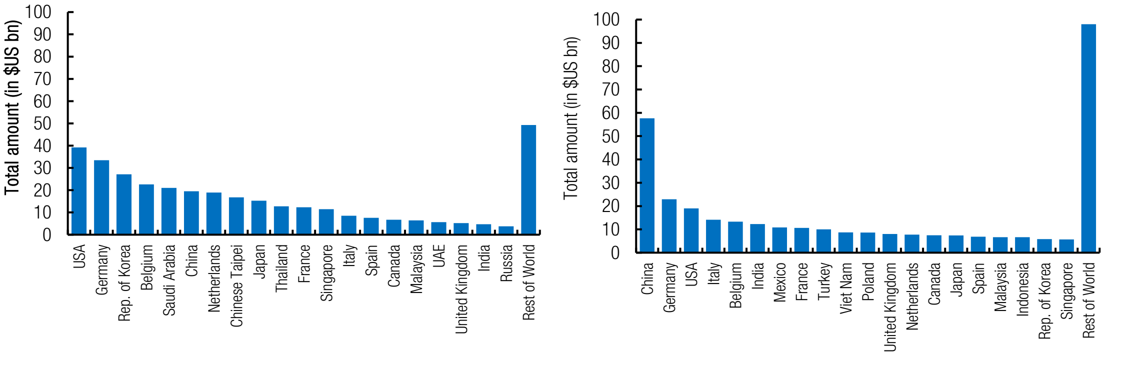
has all the necessary resources and knowledge required to supply such an industry. Actors are relatively concentrated in few geographical locations, between Europe, Asia, Middle East and North America.[21]

In terms of total exports in primary forms of plastic in 2018, the United States and Germany each represented approximately one tenth of the global trade market, while the subsequent four countries each represented approximately 6-8% of global trade in primary plastics.

Some of the world's largest exporters of plastic products are also importers of an array of inputs to plastic production. A number of developing countries make a significant contribution to converting, manufacturing and trade of intermediate or finished goods, including India, Mexico, Turkey and Vietnam (Annex 2 Figures 3 a-d). China, while ranking 6th in terms of exports of plastic raw material was by far the largest importer of primary forms of plastic, importing 17% of the total market, an amount which was almost three times as much as Germany (which although in 2nd position can also count on domestic production of plastic raw materials). A core explanation for this is the scale of China's domestic market for plastics and the scale of its manufacturing output for global markets, generating huge demand for inputs. If one could incorporate the full plastics value chain, to include all the plastic embedded in final manufactured products, the scale of China's exports would be even larger.

Notably, production of primary plastics generally requires both reliable access to fossil fuels as well as chemical industrial knowledge and infrastructure. Most of the top producers of primary plastics, but not all, have both of these assets. Germany, for instance, relies on the strength of its chemical industry for competitive advantage, while others like Saudi Arabia has rapidly build petrochemical capacity to leverage its oil wealth.

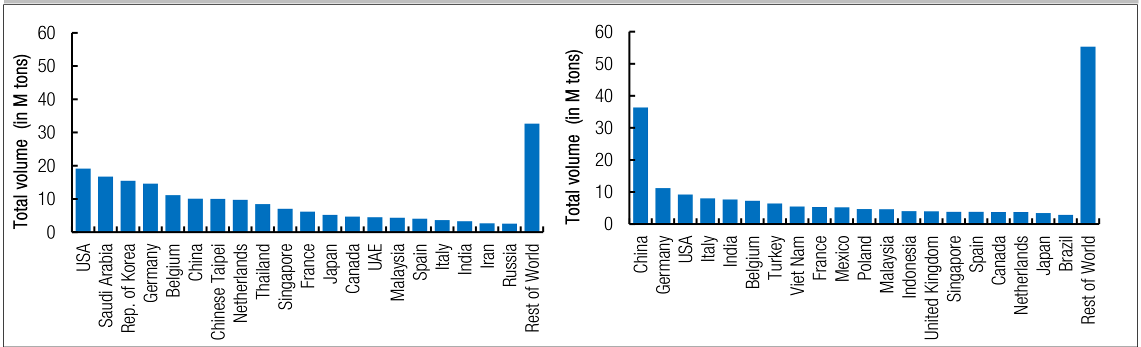
Figure 3. Value exports (left) and imports (right) in primary forms of plastics – 2018



Source: Authors' compilation, drawing on prototype UNCTAD Plastics Database, October 2020. USA includes Puerto Rico and United States Virgin Islands; Belgium includes Luxemburg; France includes Monaco; Chinese Taipei is reported as "Other Asia, not elsewhere specified" in the BACI Database; Switzerland includes Liechtenstein; Rest of World is the sum of all other countries.

[21] This national level trade data reinforces industry data on the world's top producers of virgin primary plastics. Countries and firms ranked in descending order the United States (Exxon Mobile, Chevron Phillips and Dow chemicals); Germany (BASF and Lanxess); Italy (Eni); Saudi Arabia (SABIC); United Kingdom (Ineos); Korea (LG Chem) and Netherlands (Lyondell Bassell). See Barrowclough and Deere (2020).

Figure 4. Volume exports (left) and imports (right) in primary forms of plastics – 2018



Source: See Figure 3.

4.4. Intermediate forms of plastics

Intermediate forms of plastic products include products that are still at an early stage in the plastics value chain. They consist of primary plastics that have already been processed and assembled into larger elements – such as sheets, films, plates and yarns – that will then be further molded, shaped, manufactured, assembled to produce intermediate and final manufactured products. Intermediate forms of plastics represented a large share of trade in plastic products, at US$158 billion and 39 million metric tonnes in 2018.

With only a few exceptions, the same countries enter the rankings both as largest exporters and importers of intermediate forms of plastics. While large manufacturing countries unsurprisingly led the rankings in terms both of exports and imports of plastics in intermediate forms (e.g., China accounted for exports worth US$22 billion and imports worth US$12 billion; the United States for $14 billion exports and US$13 billion imports, and Germany US$21 billion in export and US$11 billion imports, as shown in Annex 2 Figures 4 a-d), several large oil producers that export plastic feedstocks or primary plastics did not appear in the list of top exporters of intermediate plastics. Saudi Arabia, for example, was ranked 5th in terms of exports of primary forms of plastic (2nd in terms of volume) but was outside the top 20 for the subsequent phases of the lifecycle of plastic. This reflects the fact that the plastics conversion and manufacturing business requires important industrial capacity.

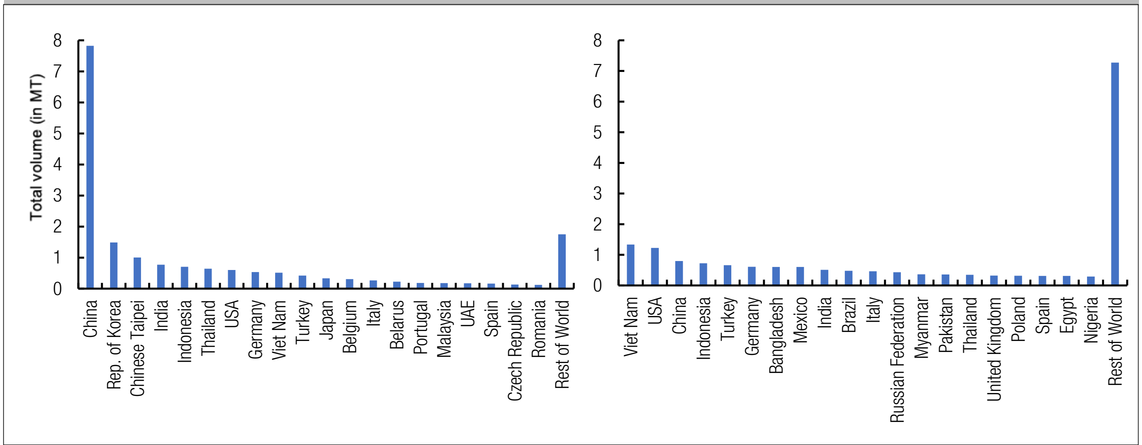
4.5. Manufactured plastic goods - Intermediate

In order to refine the analysis, we further split our analysis of manufactured goods into two categories – intermediate and final manufactured goods. The total value of exports in the former category – intermediate manufactured plastic goods – summed up to US$83 billion and 18 million metric tonnes in 2018. A number of intermediate manufactured plastic products are then further manufactured into final plastic products (e.g., woven synthetic textiles are manufactured into clothing) or used as inputs into other final manufactured products or by other sectors (e.g., plastic parts for the automobile industry and construction, household appliances, and fishing equipment). The explanatory notes in Annex 1 provide a detailed explanation of what we have included in this category.

In 2018, exports of intermediate manufactured plastic goods were dominated by Asian economies (Annex 2 Figure 5a), with China capturing 40% of the total exports in this category in terms of value (US$33 billion), followed by the Republic of Korea (US$6 billion and 7%), Chinese Taipei (US$5 billion and 5%) and then the United States and Germany (each with US$4 billion and 4% of total exports). When looking at volumes, the importance of Asia in exports is even more salient, with Asian countries making up the top-6 exports by volume, including India, Indonesia and Thailand, and 68% of total exports in this category by volume. The importance of the Asian region in exports category of intermediate manufactured plastic products can be explained by the large share of intermediate synthetic textile products in this category.

Asian economies also play a major role in imports of intermediate manufactured plastics (Figure 5). Vietnam, for example, a well-known exporter of final manufactured synthetic clothing, needs intermediate synthetic textile products as inputs to production. In 2018, Vietnam imported US$9 billion of intermediate plastic goods, accounting for 11% of the global total. Other Asian countries known for exporting final manufactured clothes, namely Bangladesh and Indonesia, were also among the top-5 importers by value of intermediate plastic goods (alongside the United States, China and Mexico).

Figure 5. Volume exports (left) and imports (right) in intermediate manufactured goods – 2018, million metric tonnes (MT)



Source: See Figure 3.

4.6. Total intermediate plastic products

Focusing in on trade in intermediate plastic products – including both intermediate forms and intermediate manufactured plastic — provides a clear picture of the importance of trade at this stage of the plastics life cycle and of the key players located in the middle of the value chain of plastics. In 2018, the combined value of exports in intermediate plastic products was US$241 billion and 57 million metric tonnes.

China (capturing 23% of trade by value) led the ranking of exporters of all intermediate plastic products combined, exporting more than twice the value as Germany in second position (with 10%). The products traded in this category are likely to be transformed and reexported further but necessitate the capacity to process early forms of plastics domestically. In this context, very few developing countries enter the top-20 exporters. For imports on the other hand, Vietnam, a well-known producer of manufactured clothes, ranks 4th by value due to its reliance on synthetic textile fabrics. Notably, the highest share of the total value of imports in this category is just 7%, held by equally by the United States and China, followed by German (6%) and Vietnam (5%). The remaining share of imports by volume and value is spread relatively evenly across a much larger group of countries than for other categories; the remaining top-20 importers each imported 2-3% of the total value and volume, as did numerous countries outside the top-20.

4.7. Final manufactured plastic goods

The picture for trade in final manufactured goods differs slightly to intermediate manufactured goods due to high demand for imports of final goods from advanced economies with large domestic markets. While final manufactured goods made up 21% of total plastics trade in terms of volume in 2018, thus ranking third behind feedstocks and primary forms, they were the highest value category of plastics trade along the life cycle – representing 41% in terms of value – thus illustrating the importance of value addition in final manufactured plastic goods.

In terms of the value of exports, China led exports by far (with 27% of the total), exporting almost three times as much as Germany in second (with 10% of the total) and more than six times as much as countries like the United States, Japan, Italy or France in 2018 (below and Annex 2 Fig 6a). When looking at imports, countries with large domestic markets led the rankings, notably the United States and European countries (accounting for over 50% of the total). Interestingly, China only ranked 9th in terms of value of imports in final manufactured goods, probably because it relies on its own domestic production to fulfil demand rather than importing from other countries (below and Annex 2 Fig 6b).

Figure 6a, 6b. Value exports (left) and imports (right) in final manufactured goods – 2018

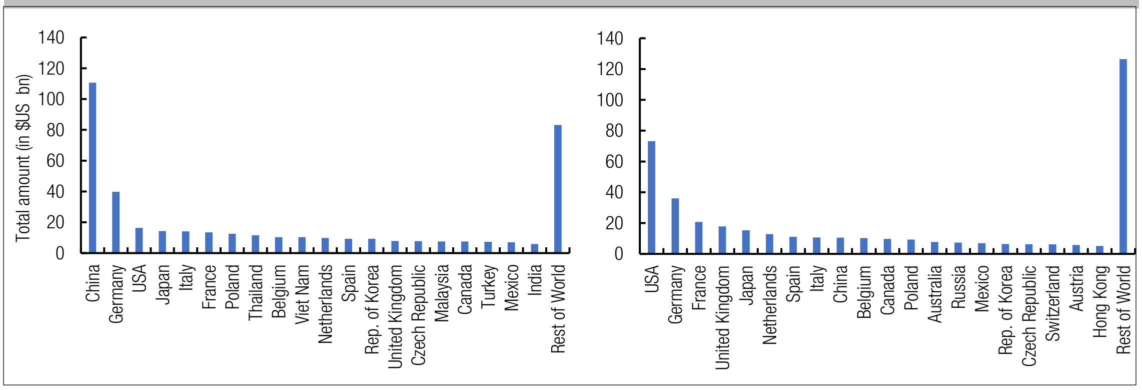
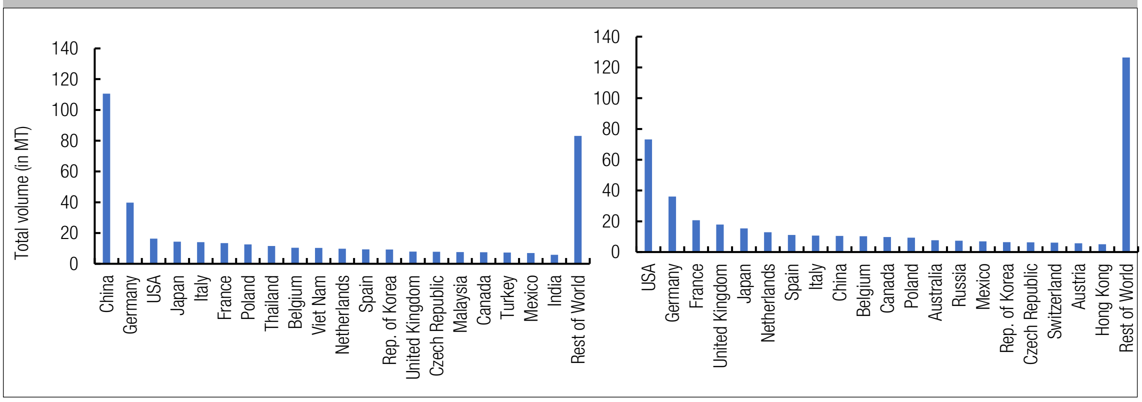


Figure 6c, 6d. Volume exports (left) and imports (right) in final manufactured plastic goods – 2018 (MT)



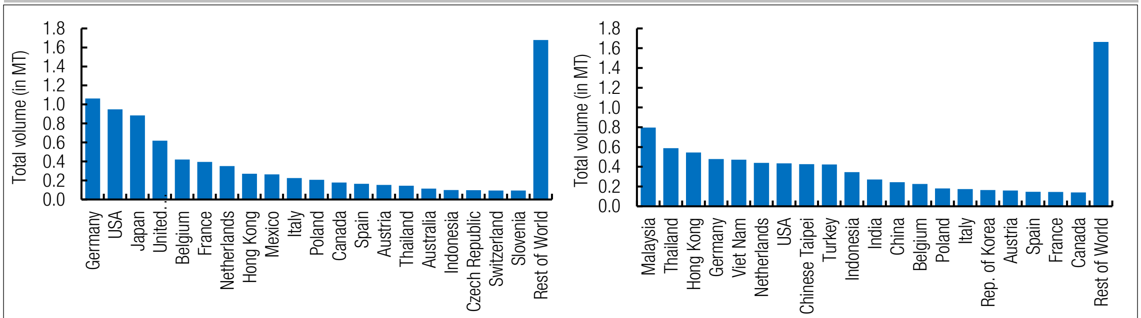
Source: As Figure 3.

4.8. Plastic waste

At the end of the plastics life-cycle comes waste. This category covers all types of wastes produced along the value chain. In addition, such flows have been subject to an increase of international interest in recent years since the Chinese import ban on plastic waste, an action which was then followed by many countries in South East Asia. However, although this category is the one that attracts most interest in the media, as it is the most directly linked to pollution, the total amount of trade is actually small. In 2018, it was smaller by a factor of almost 100 compared to the categories discussed above, amounting for around US$3.3 billion and 8 million metric tonnes for exports and imports, respectively (although its multiplier values may be significantly higher when taking into account the employment effects of the many people involved in waste processing).

Most of the top-20 waste exporting countries are high-income economies as defined by the World Bank, with the exception of Mexico, Thailand, China, Indonesia and the Philippines (below and Annex 2 Fig 7a). Somewhat unexpectedly, leading the imports of plastic waste are some of the largest economies in the world including United States and Germany. This is surprising because these countries lack sufficient national recycling capacity and the option of exporting waste has been frequently viewed as cheaper and more economically efficient (GRID-Arendal 2019). Limitations of the data mean that it is not clear whether these countries re-export the waste or whether they dispose of it domestically (Jambeck et al 2018), so this remains a somewhat puzzling element for further research. In the meantime, it is worth noting evidence that most waste shipped abroad has not in fact been recycled and that enormous environmental and health consequences have been associated with sending waste off-shore to countries that do not have capacity to manage waste in an environmentally sound manner. It is notable that despite the high-profile bans of importing waste in recent years many South East Asian countries were still among the top-20 importers in 2018 (below and Annex 2 Fig 7 b). More importantly, this ranking included Malaysia, China, Vietnam, Thailand, Indonesia and the United States, which are countries that are also among the top 20 in terms of contribution to plastic waste mismanagement (Lavendar Law et al 2020).

Figure 7. Volume exports (left) and imports (right) in plastic waste – 2018, million metric tonnes (MT)



Source: As Figure 3.

As noted in the introduction, after key importing countries, starting with China in mid-2018, introduced restrictions on imports of certain plastics waste, the global market for plastic waste evolved considerably, and further changes are expected with the implementation by countries from early 2021 of the plastics amendments to the Basel Convention, which aim to better regulate plastic waste trade (BRS 2019). Further study of the shift in trade flows in plastic waste before and after 2018 will be of considerable value to policymakers.

4.9. Zooming in on illustrative sub-categories

(a) Synthetic textiles

A large proportion of the world's clothing is now made of synthetic fibers, which are cheaper than natural products such as wool or cotton. In consequence, the textile sector is a major consumer and producer of plastic products. According to Geyer et al. (2017), the textile sector was the fourth major industrial sector in terms of production of primary plastic with 47 million metric tonnes produced in 2015, accounting for about 14% of total global plastics production, compared to the largest category, the packaging sector (over 35% of the total and around 146 million metric tonnes) and the building and construction sector (16% of the total and some 65 million metric tonnes). Trade flows of synthetic textiles are also found to be of primary importance in our prototype database, as reported in Figures 8a and b below, which display the top-20 exporters and importers of synthetic textiles both in value and volume. (Note that synthetic textile is broadly defined here as including all stages of synthetic textile production, from man-made filaments to manufactured clothes.)

In 2018, China dominated the ranking by far (Annex 2 Fig 8a) exporting the equivalent of 40% of the US$209 billion of total exports of synthetic textiles. Germany, the Republic of Korea, and Vietnam followed with respectively 5%, 4%, 4% of the total value of exports, followed by a long list of countries exporting between 1% and 3% of the global total.

Turning to the importers' side (Annex 2 Fig 8b), the ranking in 2018 was led by the United States, which imported the equivalent of US$27 billion of synthetic textiles, corresponding to 13% of total imports that year. Vietnam and Germany were second and third respectively, importing slightly more than they export. As mentioned above, countries like Vietnam and Indonesia import intermediate manufactured plastic products (woven fabrics) to be assembled into final manufactured products; they also export considerable volumes of both intermediate and final manufactured products made from synthetic textiles.

Annex 2 Figures 8 c and d report the top-20 exporters in synthetic textile by volume. Again, China led the ranking by far with almost 50%, followed by five major Asian economies typically known as important textile exporters: the Republic of Korea, India, Chinese Taipei, Vietnam and Indonesia. The difference in ranking between value and volume figures could reflect the fact some economies might be specialized in exporting higher-value products, as is the case here for Germany which only ranked 9th in volume but 2nd in value. A more careful analysis of bilateral trade relations might shed light on these differences.

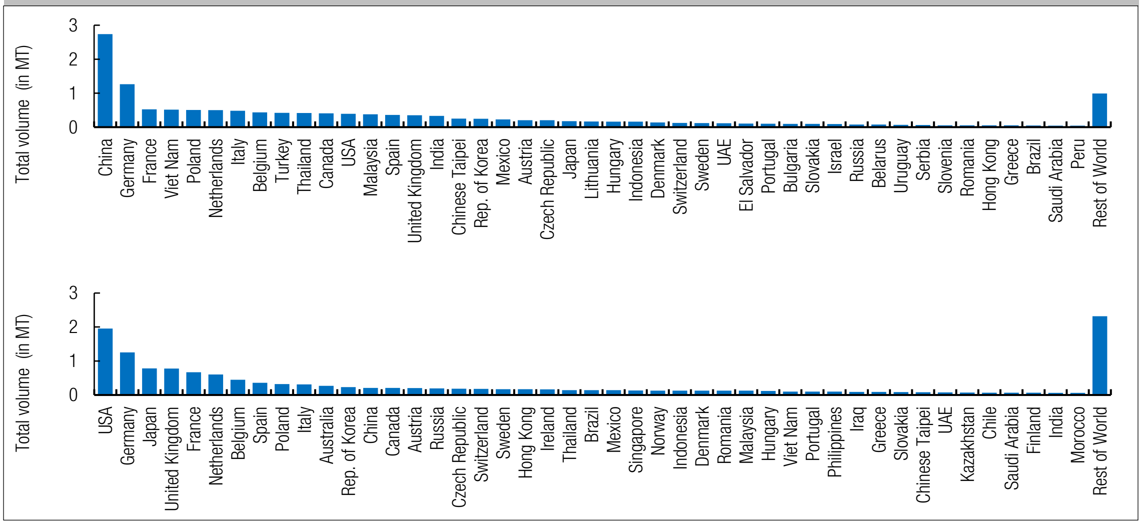
(b) Plastic packaging

The greatest component of plastic pollution in the world's oceans is the result of mismanaged plastic packaging waste. Most packaging is single-use and few countries have adequate waste collection, management and recycling facilities to stop such waste entering the environment. Much plastic packaging waste is also technically difficult to recycle because it is contaminated, combined with non-recyclable materials or contains toxic materials that present health and environmental hazards when recycled. To fight against such pollution, many countries have implemented national bans against single-use plastic and there are numerous company initiatives to reduce unnecessary use of plastic packaging and other single use products in their stores and products.

Our dataset suggests the major economies are also the biggest exporters in plastic packaging by value, with China exporting 19% of the total $US53 billion exported in 2018, while Germany exported 10%. France, the United States and Italy follow, with exports from 5% to 4% of the total. Regarding imports, United States accounted for 15% of total imports in 2018, while Germany accounted for 8%.

In terms of volume, the extent of trade taking place in plastic packaging – 14 million tonnes in 2018 – is much smaller than the other categories discussed above. However, such products are typically used one single time before ending up in bins (see Figure 9).

Figure 9. Volume exports (above) and imports (below) in plastic packaging – 2018 MT



Source: As Figure 3.

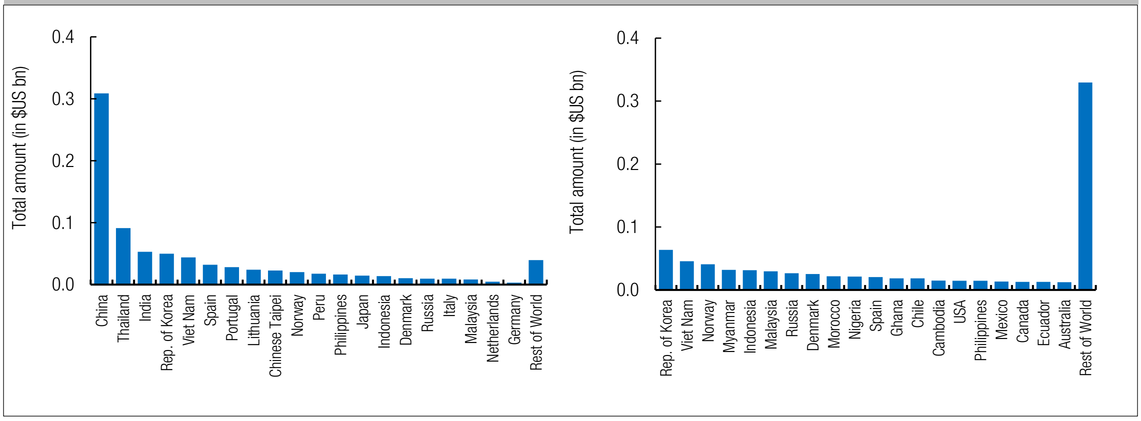
Notably, as discussed above, this data on plastic packaging flows, also shown in Annex 2 Figs 9 a-d, under-estimate both the value and volume of packaging that is trade internationally because the data reported only include plastic packaging products which cross borders to be sold as such. They do not include domestic production or packaging directly wrapped around products or packaging used to protect goods in transportation (in this sense, some packaging may be traded twice – once as 'empty' packaging and later as packaging used in boxes to protect goods in transportation). In consequence, figures presented here largely under-estimate the extent of the packaging trade flows.

(c) Plastic fishing nets

While fishing nets do not appear in Chapter 39 of the HS, the majority of fishing lines and nets are plastic. Although much smaller than the categories discussed above in terms of trade, amounting only $0.82 billion and 0.16 million tonnes in total, trade in 'made-up fishing nets' provides an important example of the breath of plastic products traded internationally and are also worthy of consideration due to the pollution they create when discarded in the ocean. The following data on trade in fishing nets refers only items covered by HS 560811 'made-up fishing nets'; additional HS codes related to fishing lines and nets were not included here

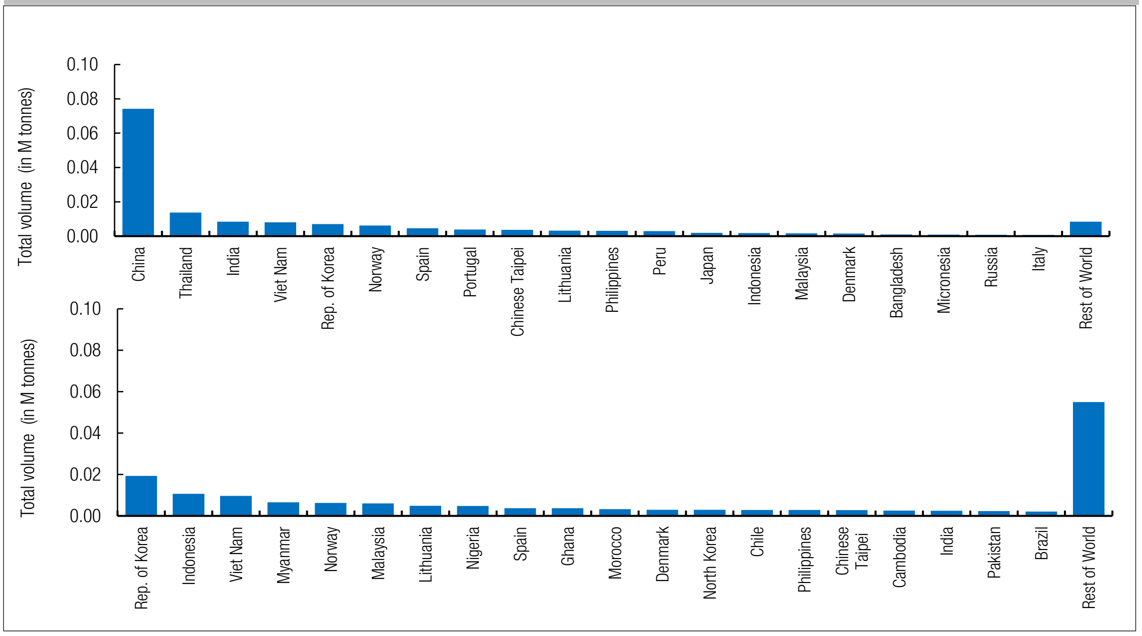
As shown below and in Annex 2 Figs 10 a-d, countries with important fishing industries appear in the top-20 importers and exporters of 'made-up fishing nets, often for the first time in the plastics life-cycle. More importantly, the Asian countries that were important traders of fishing nets both in terms of imports and exports were also those that identified as key entry points for marine litter into the ocean. Notably, this sub-category of plastics trade is the first one in this study where African countries have appeared among the top-20 importers by value, with Nigeria and Ghana, both countries for which the fishing industry is an important part of the GDP, ranking respectively 10th and 12th for the import of fishing nets.

Figure 10a,b. Value exports (left) and imports (right) in plastic fishing nets – 2018,



Source: As Figure 3.

Figure 10c,d. Volume exports (above) and imports (below) in plastic fishing nets –

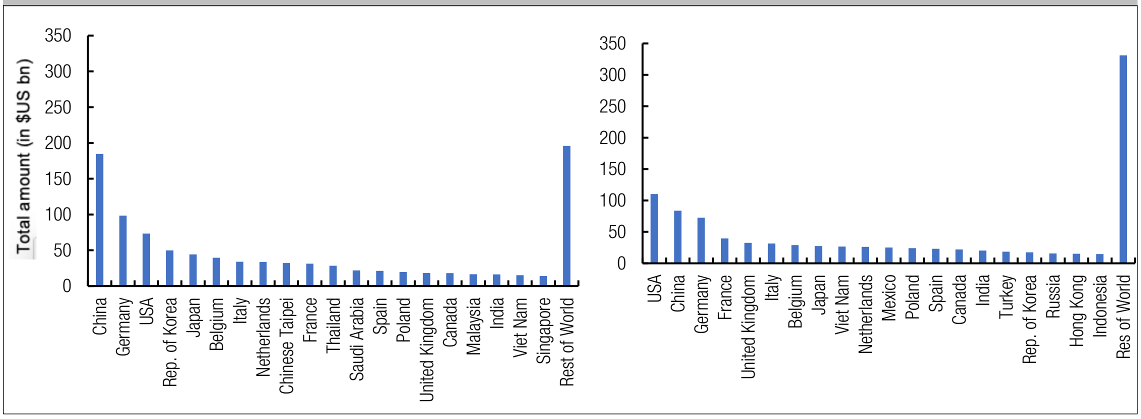


Source: As above.

4.10. Total plastic products

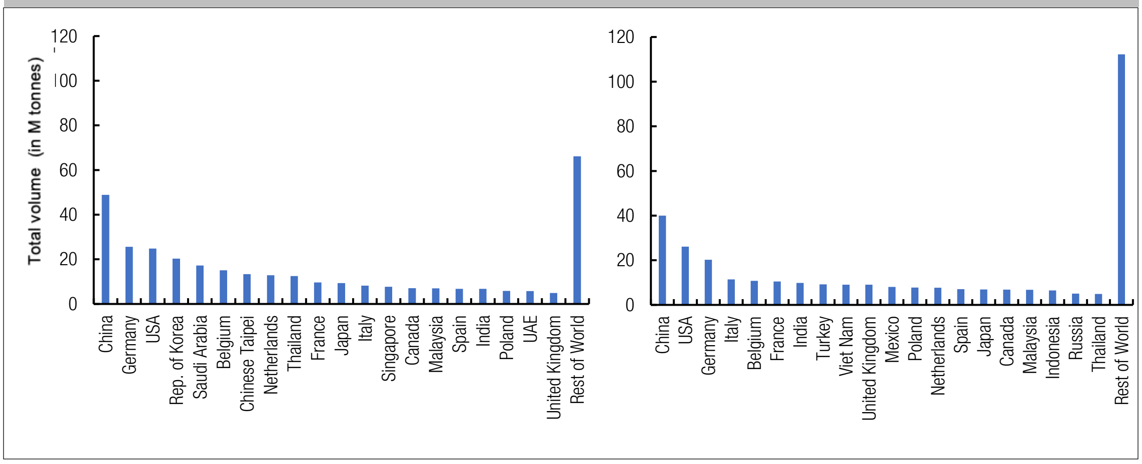
Total trade in plastic products (excluding feedstocks and additives) reached the value of US$1008 billion in 2018. As shown below and in Annex 2 Figs 11 a-d. most trade was concentrated in Europe and in Asia, with China and Germany being the largest exporters in both volume and value terms, and China being notable as the world's largest importer and also exporter of plastics by volume; although the United States was an important player too.

Figure 11a,b. Value exports (left) and imports (right) in total plastic products – 2018, $US bn



Source: As Figure 3.

Figure 11c,d. Volume exports (left) and imports (right) in total plastic products –



Source: As Figure 3.

5. Bilateral trade flows

Now that we have identified the main actors in each category of products, it is interesting to map the main bilateral trade relations taking place annually. One striking feature is that almost all trade in plastics, regardless of the stage of the production life cycle, appears to occur horizontally between Asia, Europe and North America. The trend of north-south or south-north trade prevalent in other products, or south-south trade patterns of recent years, do not occur. Further, Africa and Latin America (with the exception of Mexico) account only marginally for trade in this industry. The figures below show the top-50 bilateral flows. The circles indicate whether the country is a net exporter or a net importer in the sample: white circles indicate more outgoing, while blue circles indicate more incoming.

5.1. Feedstocks and precursors

Beginning with pre-primary inputs to plastics, consisting of feedstocks and precursors, China was clearly the biggest importer, importing mostly from the Republic of Korea, Japan, Taiwan and Saudi Arabia (Annex 2 Fig 12). Another interesting feature was the relatively small importance of Europe in terms of bilateral trade, with only two relations in the top-50 linking Europe with countries outside the continent, namely the US and Saudi Arabia.

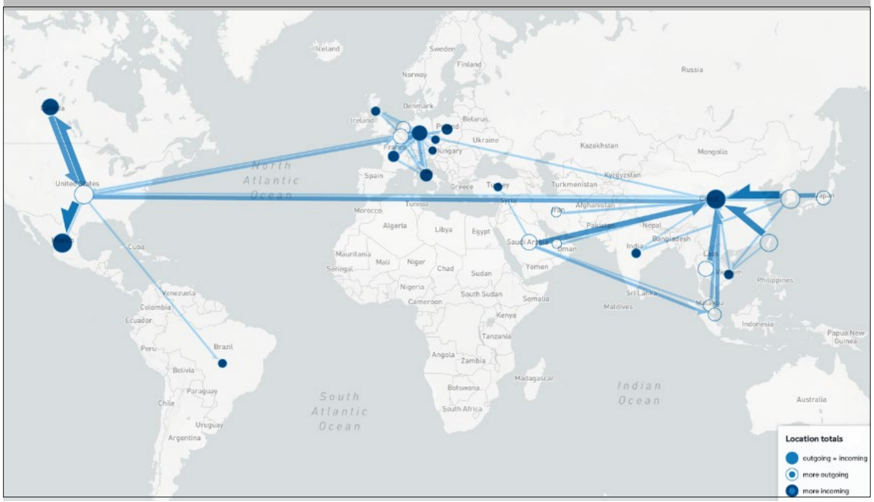
5.2. Additives

While major bilateral trade relations for feedstocks and precursors focused primarily at the regional level, with a lot of activity taking place within Asia and around China in particular, the top-50 rankings for trade in additives that can be used in plastics feature much more distant trading partners (Annex 2 Fig 13). Most of these net importers are major producers of intermediate and manufactured plastic products for which additives are a key input. The largest relation links Saudi Arabia and China, which traded almost twice as much by value as the second largest trade relation, which links Chinese Taipei and China. As in the case of feedstocks and precursors in Annex 2 Figure 12, Europe as a whole has a relatively small share of overall global trade in additives that can be used in plastics.

5.3. Primary Forms of Plastic

As noted above, the United States, Germany and the Republic of Korea were the top-3 exporters in this category in terms of value, with China, Germany and the United States as the top-3 importers. Consequently, the main bilateral links are between these countries, and there seems to be a trend of trade between close as opposed to distant neighbors (see Figure 14). The United States, for example, exported primary forms of plastics worth US$8.4 billions to Mexico in 2018. Similarly, China imported US$8.33 billions of such products from the Republic of Korea.

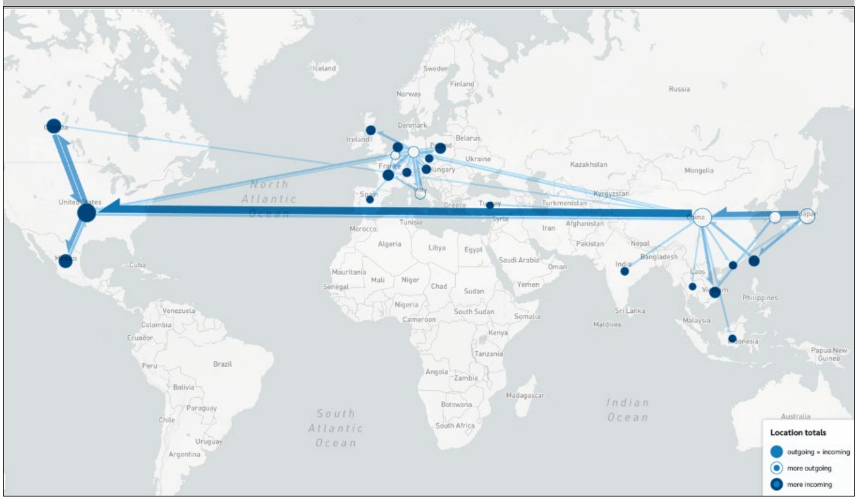
Figure 14. Value of bilateral trade flows in primary plastics – 2018



5.4. Intermediate forms of plastics

Bilateral trade flows in intermediate forms of plastics reflect the path of many global value chains in manufacturing production and trade (see Figure 15). Figure 15 illustrates the complexities of the plastics ecosystem, whereby many developing countries have charted a path to economic diversification and trade through being part of these chains, which involve many countries and companies, ranging from major international corporations at the headquarters level to small and medium enterprises comprising the factory floor.

Figure 15. Value of bilateral trade flows in intermediate forms of plastics – 2018



5.5. Manufactured plastic goods - intermediate

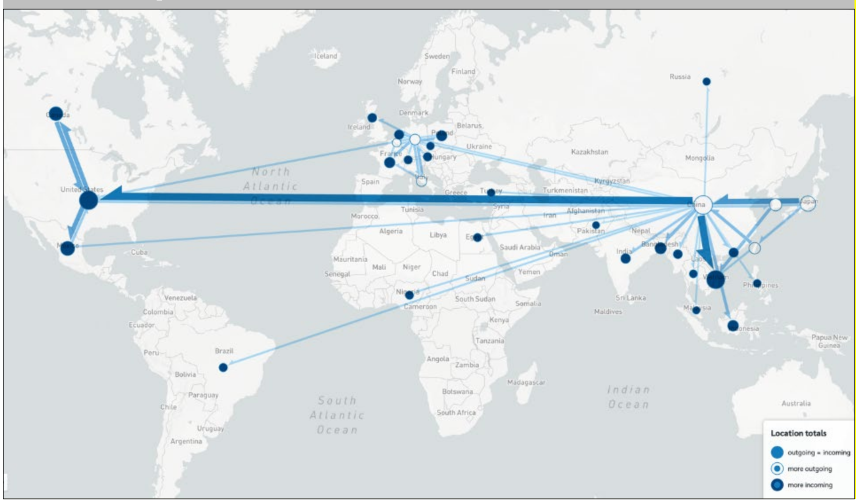
Compared to intermediate forms of plastics shown above, trade in intermediate manufactured goods looks quite different. The striking feature was that almost all of the top-50 bilateral trade relations in 2018 involved exports from China to all regions of the world, with almost all other countries being net importers from China (See Figure 16). Another striking feature is that we see for the first-time trade flowing to Africa entering the largest bilateral trade relations, with Nigeria, Kenya, Morocco and Egypt importing non-negligible amounts from China.

Figure 16. Value of bilateral trade flows in intermediate manufactured goods – 2018

5.6. Total intermediate plastic products

Total intermediate plastic products, which combine intermediate forms of plastics and intermediate manufactured products, appear to be even more globally oriented than total plastic products when we focus on the top-50 bilateral trade relations. At least two countries on the African continent, namely Egypt and Nigeria, imported intermediate plastic products from China to a significant extent (see Figure 17). In addition, and similar to the case of intermediate manufactured goods discussed above, China was a net exporter to almost all regions of the world, while all other countries that appear on the map tend to have the largest trade relations with their regional neighbors.

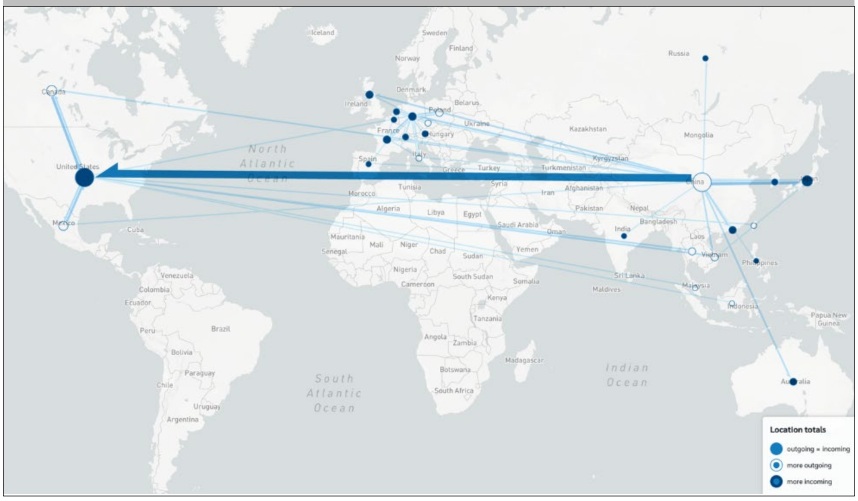
Figure 17. Value of bilateral trade flows in total intermediate plastic products – 2018



5.7. Manufactured plastic goods - final

For final manufactured plastic goods, China remained a key player, with many exports as one would expect given China's role in global manufacturing. The United States imported a significant share final manufactured plastics goods, mostly from Asia, which might also reflect the outsourcing strategy of many US firms relocating their production in countries with lower cost of labor (see Figure 18).

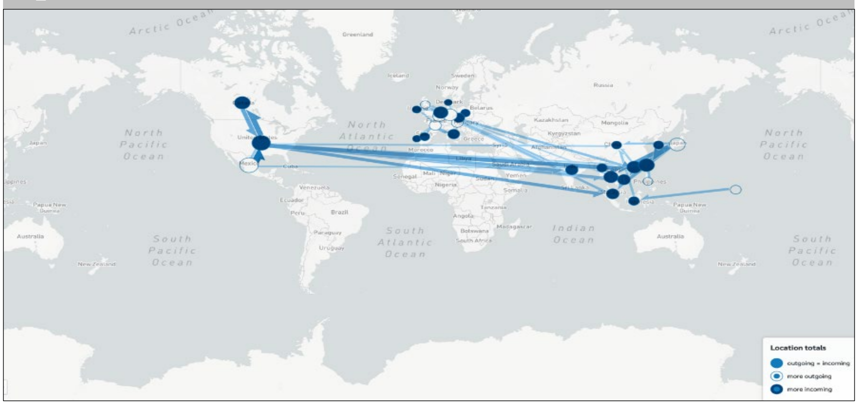
Figure 18. Value of bilateral trade flows in final manufactured goods – 2018



5.8. Plastic waste

When focusing on plastic waste, a striking feature is that the dominant direction of export flows was toward China and South East Asia in 2018 (Figure 19 below). However, as this data is based on the year 2018, it does not capture the impact of a number of plastic waste import bans implemented in this region in the middle of that year, and notably by China. As a number of these bans became effective only late in the year or in 2019, Asia was still strongly represented as the destination for plastic waste exports in the dataset (Brooks et al 2018; GRID-Arendal 2019).

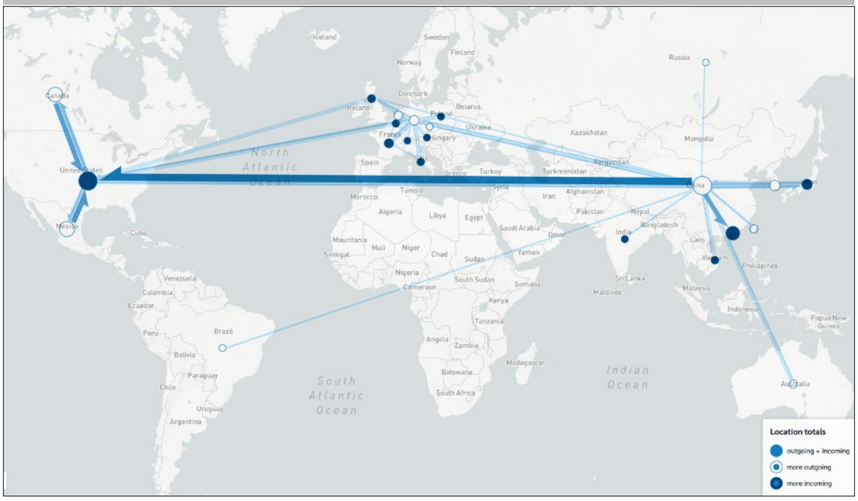
Figure 19. Value of bilateral trade flows in waste – 2018



5.9. Total plastic products

Given the ever-present nature of plastic in seemingly all goods today, even when "hidden plastics" are not yet accounted for, it is not surprising that the largest global traders are also major actors in plastic products. China, the US and Europe were hubs of trade in these products, with the highest share of the value of goods flowing from China to the US (see Figure 20). Overall, the US was a net importer of total plastic products in 2018, while China was a net exporter.

Figure 20. Value of bilateral trade flows in total plastic products – 2018

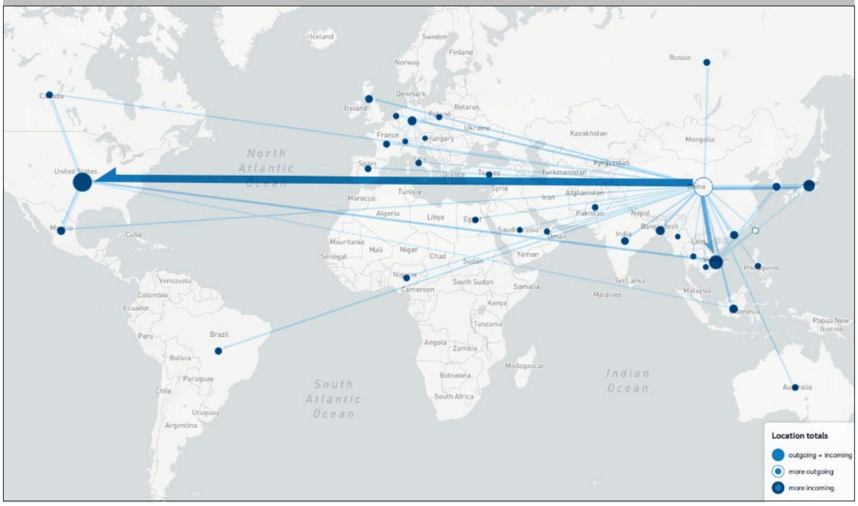


5.10. Synthetic textiles

In the case of synthetic textiles, trade is centered around Asia, and China in particular. Here, the data reflected below include synthetic textiles across the value chain – from primary forms of synthetic fibres to intermediary yarns to intermediate manufactured fabrics and a vast array of final manufactured synthetic textiles (ranging from clothes and clothing accessories to ropes and synthetic sacks as well as fishing nets).

The value chain for these final products involves a diverse array of countries playing different roles. Figure 21 highlights that the average distance of the main trade flows was longer than for many other types of plastic and that most of the combined flows leave from China. The main trade flows consisted of exports from China to the United States, from China to Vietnam, from China to Japan, and from Vietnam to the United States, amounting US$13.1, US$6.8, US$4.5 and US$2.76 billion respectively. This last flow, as well as flows from Indonesia to the United States, illustrates the specialization of Vietnam and Indonesia in the production of manufactured clothes for sale in the United States. Notably, the data also reveal that countries such as Bangladesh, Brazil, the Philippines, Egypt, Indonesia and Pakistan feature as importers of intermediate forms of synthetic, which are manufactured into final products by companies strategically located where the cost of labour is comparatively low.

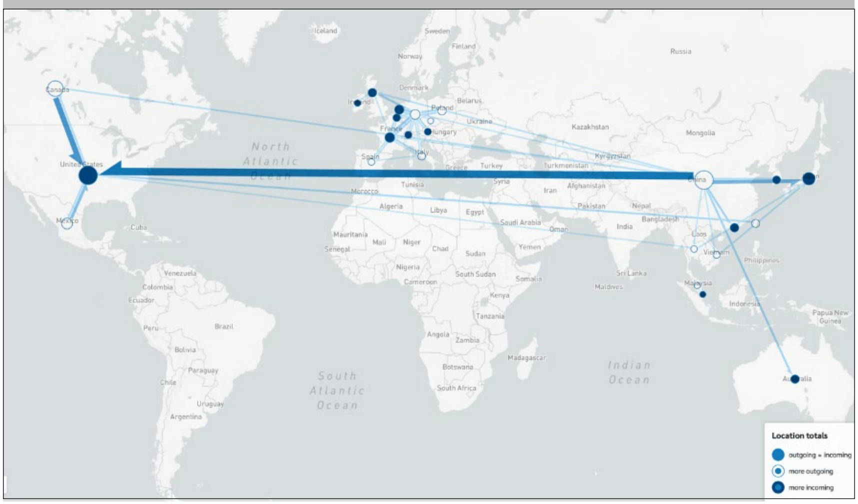
Figure 21. Value of bilateral trade flows in synthetic textiles – 2018



5.11. Plastic packaging

Similar to primary forms of plastic, trade in plastic packaging happens mostly within regions, except for the main flow of exports from China to the United States (amounting to US$2.6 billion). As underscored above, Figure 22 only shows flows in plastic packaging per se (i.e., empty plastic packaging) but not goods pre-packaged or transported in plastics. As such, the flows illustrated considerably under-state the total volume and value of plastic packaging that flows across borders; nor does it provide the full picture of the direction of packaging trade either.

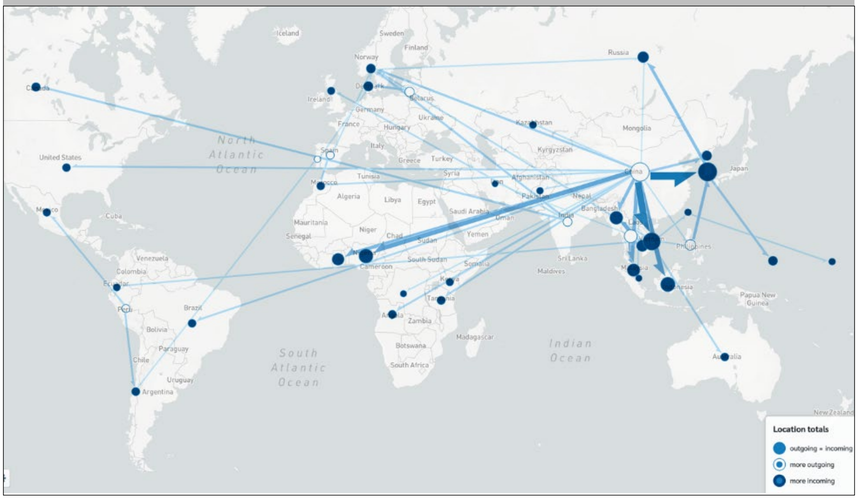
Figure 22. Value of bilateral trade flows in plastic packaging – 2018



5.12. Fishing nets

Of the plastic products analysed here in detail, fishing nets offer the most global picture in terms of bilateral trade relation. As noted in Part 4, many African and South American countries as well as small Pacific Islands appear in Figure 23 as among the top 20 importers of plastic fishing nets, reflecting the importance of fishing in their economies, whether for export or for subsistence.

Figure 23. Value of bilateral trade flows in fishing nets – 2018



6. Conclusion and further research

This paper has offered new evidence and insights about trade flows along the plastics value chain as a contribution to the wider goal of identifying policy levers and instruments that can help reduce the world's excessive use of plastic.

Based on a granular review of official international trade statistics and their classifications as reported by governments of importing and exporting countries, the data and analysis in this paper has gone considerably beyond the limited view of plastics trade revealed by an analysis of trade data covered by the "the plastics chapter" (Chapter 39) of the Harmonised System classifications. By identifying previously "semi-hidden" plastics components as well as the "known" plastics components, as well as trade in critical inputs to plastics production, this paper provides a clearer understanding of trade across the entire life-cycle of plastics.

Using a unique prototype dataset, the paper finds that value of global trade in plastics is at least 40% larger than previously envisaged, and greater still if trade in 'hidden' plastics were also to be included. Importantly, this dataset also highlights trade in inputs to plastics production – fossil fuel feedstocks and precursors to polymerization as well as additives. Trade is also found to be extremely broad, multi-directional and multi-faceted with many countries acting as both importers and exporters at different phases of the life-cycle and sometimes even at the same phase.

The new dataset's findings also give us a first indication of how the global plastic value chain is geographically organized at different points along the plastics life cycle. We have identified key actors at different stages of the production chain, with some countries consistently ranked among top importers and exporters. Such countries have high stakes in this industry and will therefore be important actors to bring to the discussion to help find ways to better regulate and eventually reduce the excessive use of plastic. Some countries and companies are already contributing to this effort, but much more can be done and it is hoped this first-cut empirical study will help.

In addition to identifying important individual countries in the plastics value chain, and highlighting bilateral trade flows between them, the paper importantly underscores the fact that the plastics economy is extremely global. In addition to globally distributed raw inputs into the plastics process, starting from fossil fuel producers but opening rapidly across the globe through the export of polymer resins, markets for subsequent plastic products and eventually plastic waste are global. International trade is thus deeply relevant to efforts to address plastic pollution.

At the same time, the analysis presented in this paper remains preliminary and, as with any new approach, it is hoped there will be future iterations and improvements to come. One obvious limitation, as described in section 2 above, is that much needs to be done at the national and international level to ensure that truly systematic, standardized and timely reporting of trade statistics is the norm. Further, it will be important to get a better grip on the extent of trade flows in what we have called "hidden plastics" alongside the non-hidden and semi-hidden flows. Even within the limitation of existing classifications and measures, we need to examine trade across a wider cross-section of countries and to examine trends over time. Notably, the prototype database under development will provide data back to 2002. In addition, further research may lead to recommendations to update the range of codes included in our database and their categorization. We encourage such research and suggested improvements. One specific area for further research is on the extent to which those feedstocks, precursors and additives used in plastics are indeed traded specifically for use as inputs into plastics among other potential uses. In addition, more detailed research on the share of plastics that are traded internationally – both at different points along the life cycle and in relation to specific kinds of plastic products – will improve understanding of the role of trade and its potential effectiveness as a policy lever. Finally, there are long-standing gaps in analysis of national waste management capacities for plastics mapped against their consumption of plastics – both through domestically-produced plastics and imported plastics.

Improving data collection and dissemination on these dimensions of plastics trade will be an important step towards greater understanding of the challenges that are involved in transforming the plastics economy. It will help clarify the international interlinkages and interdependencies on the production side of the plastic industry and the role of trade at different stages of the production chain. It would offer rich insights on the relationship between production, consumption and trade.[22] It will also help to uncover more of the "hidden" plastics trade that remains a mystery (although vigorous efforts are under way to better understand this, including by this project team). To build up on these elements, we need to learn more about the market structure of the plastic sector, namely employment, prices, revenues, costs, value-added, investment and capacity utilization. It is the hope of the authors that the trade database will help support future researchers in these areas.

[22] In the interest of encouraging on-going research, UNCTAD's Statistics Division notes that while this data is not available at a disaggregated level, one could do a macro analysis using WIOD or TIVA. This difficult task would require merging chemical and economic/statistical expertise to devise appropriate ratios for each economic sector.

One way in which the database is already supporting new policy-related research is through its identification of potential market opportunities for countries that can provide products that offer some of the benefits of plastics, without the negatives. The database is highlighting trade in some points during the life-cycle where non-plastic substitutes and alternatives can already be found. This includes synthetic textiles, for which alternatives include textiles made from cotton, wool, and vegetable fibres, and packaging, where many substitutes and alternatives are already entering markets, based on plant cellulose or milk-based wrappings, among others (Barrowclough and Vivas 2020). At the earliest stage of the plastic production cycle, there are also bio-based alternatives to fossil fuel-based virgin plastic feedstocks, although the overall environmental credentials of such 'bio-plastics' are a matter of considerable debate (Robbins 2020).

The paper has also underlined the need for further research on potential amendments to HS classifications that could help policymakers better track trends in plastics trade and address their sustainability implications (Deere Birkbeck and Sugathan 2021). Although amendments to the HS are a lengthy and complex process of negotiations that occur through 5-year review cycles, deeper understanding of the limitations and gaps in current classifications would simultaneously strengthen the knowledge base for ongoing discussion of plastics trade and its sustainability implications.

While much remains to be done, the main message from this paper is that international trade plays an important role across the life cycle of plastics. Both the volume and value of trade are higher than commonly estimated and efforts to properly capture such trade face a number of methodological challenges. We hope that the prototype basis will provide a useful foundation for further research on the role of international trade in the plastics sector and on the potential for trade policies to support efforts to reduce plastic pollution.

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Annex 1: Inputs to the UNCTAD plastics database (prototype, as of October 2020)

Feedstocks and precursors used in plastics
Harmonized Commodity Description and Coding Systems (HS) - Revision 2017

Code	Description
270710	Oils and products of the distillation of high temperature coal tar; benzol (benzene)
270720	Oils and products of the distillation of high temperature coal tar; toluol (toluene)
270730	Oils and products of the distillation of high temperature coal tar; xylol (xylenes)
270740	Oils and products of the distillation of high temperature coal tar; naphthalene
271091	Waste oils; of petroleum or obtained from bituminous minerals, not crude; and preparations n.e.c., weight 70% or preparations of the same, containing polychlorinated biphenyls (PCBs), polychorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs)
271114	Petroleum gases and other gaseous hydrocarbons; liquefied, ethylene, propylene, butylene and butadiene
280610	Hydrogen chloride (hydrochloric acid)
290121	Acyclic hydrocarbons; unsaturated, ethylene
290122	Acyclic hydrocarbons; unsaturated, propene (propylene)
290123	Acyclic hydrocarbons; unsaturated, butene (butylene) and isomers thereof
290124	Acyclic hydrocarbons; unsaturated, buta-1,3-diene and isoprene
290129	Acyclic hydrocarbons; unsaturated, n.e.c. in heading no. 2901
290211	Cyclic hydrocarbons; cyclohexane
290220	Cyclic hydrocarbons; benzene
290230	Cyclic hydrocarbons; toluene
290241	Cyclic hydrocarbons; o-xylene
290242	Cyclic hydrocarbons; m-xylene
290243	Cyclic hydrocarbons; p-xylene
290244	Cyclic hydrocarbons; mixed xylene isomers
290250	Cyclic hydrocarbons; styrene
290260	Cyclic hydrocarbons; ethylbenzene
290315	Saturated chlorinated derivatives of acyclic hydrocarbons; ethylene dichloride (ISO) (1,2-dichloroethane)
290321	Unsaturated chlorinated derivatives of acyclic hydrocarbons; vinyl chloride (chloroethylene)
290322	Unsaturated chlorinated derivatives of acyclic hydrocarbons; trichloroethylene
290323	Unsaturated chlorinated derivatives of acyclic hydrocarbons; tetrachloroethylene (perchloroethylene)
290329	Unsaturated chlorinated derivatives of acyclic hydrocarbons; n.e.c. in item no. 2903.2
290941	Ether-alcohols and their halogenated, sulphonated, nitrated or nitrosated derivatives; 2,2-oxydiethanol (diethylene glycol, digol)
290943	Ether-alcohols and their halogenated, sulphonated, nitrated or nitrosated derivatives; monobutyl ethers of ethylene glycol or of diethylene glycol
290944	Ether-alcohols and their halogenated, sulphonated, nitrated or nitrosated derivatives; monoalkylethers of ethylene glycol or of diethylene glycol n.e.c. in heading no. 2909
291010	Epoxides, epoxyalcohols, epoxyphenols and epoxyethers; with a three-membered ring and their halogenated, sulphonated, nitrated or nitrosated derivatives; oxirane (ethylene oxide)
291020	Epoxides, epoxyalcohols, epoxyphenols and epoxyethers; with a three-membered ring and their halogenated, sulphonated, nitrated or nitrosated derivatives, methyloxirane (propylene oxide)
291030	Epoxides, epoxyalcohols, epoxyphenols and epoxyethers; with a three-membered ring and their halogenated, sulphonated, nitrated or nitrosated derivatives, 1-chloro-2,3-epoxypropane (epichlorohydrin)
291040	Epoxides, epoxyalcohols, epoxyphenols and epoxyethers; with a three-membered ring and their halogenated, sulphonated, nitrated or nitrosated derivatives, dieldrin (ISO, INN)
291050	Epoxides, epoxyalcohols, epoxyphenols and epoxyethers; with a three-membered ring and their halogenated, sulphonated, nitrated or nitrosated derivatives, endrin (ISO)
291090	Epoxides, epoxyalcohols, epoxyphenols and epoxyethers; with a three-membered ring and their halogenated, sulphonated, nitrated or nitrosated derivatives, n.e.c. in heading no. 2910
291211	Aldehydes; acyclic, without other oxygen function, methanal (formaldehyde)
291260	Paraformaldehyde

Note: The HS sub-headings in this category reflect a selection of key feedstocks and precursors readily identifiable as commonly used in plastics production. Importantly, not all trade in such products enters into the plastics life cycle; many products in this category may also have other end-uses. No attempt is made in this study to determine the share of traded products included under each classification that are destined specifically for plastics production. Recommendations on further HS classifications that cover further feedstocks and chemicals used in plastics production are welcome.

Additives Used in Plastics
Harmonized Commodity Description and Coding Systems (HS) - Revision 2017

Code	Description
282410	Lead; lead monoxide (litharge, massicot)
282490	Lead oxides; n.e.c. in heading no. 2824
282510	Hydrazine and hydroxylamine and their inorganic salts
290371	Halogenated derivatives of acyclic hydrocarbons containing two or more different halogens; chlorodifluoromethane
290372	Halogenated derivatives of acyclic hydrocarbons containing two or more different halogens; dichlorotrifluoroethane
290373	Halogenated derivatives of acyclic hydrocarbons containing two or more different halogens; dichlorofluoroethanes
290375	Halogenated derivatives of acyclic hydrocarbons containing two or more different halogens; dichloropentafluoropropanes
290376	Halogenated derivatives of acyclic hydrocarbons containing two or more different halogens; bromochlorodifluoromethane, bromotrifluoromethane, and dibromotetrafluoroethanes
290377	Halogenated derivatives of acyclic hydrocarbons containing two or more different halogens; n.e.c. in headings 290371 to 290376, perhalogenated only with fluorine and chlorine
290378	Halogenated derivatives of acyclic hydrocarbons containing two or more different halogens; perhalogenated derivatives, other than those only with fluorine and chlorine, n.e.c. in item no. 2903.71 to 2903.76
290379	Halogenated derivatives of acyclic hydrocarbons containing two or more different halogens; n.e.c. in item no. 2903.7
290381	Halogenated derivatives of cyclanic, cyclenic or cycloterpenic hydrocarbons; 1,2,3,4,5,6-Hexachlorocyclohexane (HCH (ISO)), including lindane (ISO, INN)
290382	Halogenated derivatives of cyclanic, cyclenic or cycloterpenic hydrocarbons; aldrin (ISO), chlordane (ISO), and heptachlor (ISO)
290383	Halogenated derivatives of cyclanic, cyclenic or cycloterpenic hydrocarbons; mirex (ISO)
290389	Halogenated derivatives of cyclanic, cyclenic or cycloterpenic hydrocarbons; n.e.c. in item no. 2903.8
290391	Halogenated derivatives of aromatic hydrocarbons; chlorobenzene, o-dichlorobenzene, and p-dichlorobenzene
290392	Halogenated derivatives of aromatic hydrocarbons; hexachlorobenzene (ISO) and DDT (ISO) (clofenotane (INN), and 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane)
290393	Halogenated derivatives of aromatic hydrocarbons; pentachlorobenzene (ISO)
290394	Halogenated derivatives of aromatic hydrocarbons; hexabromobiphenyls
290399	Halogenated derivatives of aromatic hydrocarbons; n.e.c. in item no. 2903.91, 2903.92, 2903.93 and 2903.94
290513	Alcohols; saturated monohydric, butan-1-ol (n-butyl alcohol)
290531	Alcohols; acyclic, diols; ethylene glycol (ethanediol)
290532	Alcohols; acyclic, diols; propylene glycol (propane-1, 2-diol)
290621	Alcohols; aromatic alcohols and derivatives, benzyl alcohol
290711	Monophenols; phenol (hydroxybenzene) and its salts
290713	Monophenols; octylphenol, nonylphenol and their isomers, salts thereof
290722	Polyphenols; hydroquinone (quinol) and its salts
290723	Polyphenols; 4,4'-isopropylidenediphenol (bisphenol A, diphenylolpropane) and its salts
290911	Ethers; acyclic, and their halogenated, sulphonated, nitrated or nitrosated derivatives, diethyl ether
291413	Ketones; acyclic, without other oxygen function, 4-methylpentan-2-one (methyl isobutyl ketone)
291533	Acids; saturated acyclic monocarboxylic acids; n-butyl acetate
291570	Acids; saturated acyclic monocarboxylic acids; palmitic acid, stearic acid, their salts and esters
291732	Acids; aromatic polycarboxylic acids; dioctyl orthophthalates
291733	Acids; aromatic polycarboxylic acids; dinonyl or didecyl orthophthalates
291735	Acids; aromatic polycarboxylic acids; phthalic anhydride
291736	Acids; aromatic polycarboxylic acids; terephthalic acid and its salts
291737	Acids; aromatic polycarboxylic acids; dimethyl terephthalate
291910	Esters; phosphoric, and their salts, including lactophosphates, their halogenated, sulphonated, nitrated or nitrosated derivatives; tris(2,3-dibromopropyl) phosphate
291990	Esters; phosphoric, and their salts, including lactophosphates, their halogenated, sulphonated, nitrated or nitrosated derivatives; other than tris(2,3-dibromopropyl) phosphate
292113	Amine-function compounds; acyclic monoamines and their derivatives, and salts thereof, 2-(N,N-Diethylamino)ethylchloride hydrochloride
292121	Amine-function compounds; acyclic polyamines and their derivatives, ethylenediamine and its salts
292122	Amine-function compounds; acyclic polyamines and their derivatives, hexamethylenediamine and its salts
292141	Amine-function compounds; aromatic monoamines and their derivatives, aniline and its salts
292142	Amine-function-compounds; aromatic monoamines and their derivatives, aniline derivatives and their salts
292143	Amine-function compounds; aromatic monoamines and their derivatives, toluidines and their derivatives; salts thereof
292151	Amine-function compounds; aromatic amines and their derivatives; o-, m-, p-phenylenediamine, diaminotoluenes and their derivatives; salts thereof
292800	Organic derivatives of hydrazine or of hydroxylamine
293060	Organo-sulphur compounds; 2-(N,N-Diethylamino)ethanethiol
293110	Organo-inorganic compounds; tetramethyl lead and tetraethyl lead

293120	Organo-inorganic compounds; tributyltin compounds
293133	Organo-inorganic compounds; organo-phosphorus derivatives, diethyl ethylphosphonate
293135	Organo-inorganic compounds; organo-phosphorus derivatives, 2,4,6-tripropyl-1,3,5,2,4,6-trioxatriphosphinane 2,4,6-trioxide
320420	Dyes; synthetic organic products of a kind used as fluorescent brightening agents
320490	Dyes; synthetic organic products n.e.c. in heading no. 3204 (e.g. of a kind used as luminophores), whether or not chemically defined
320611	Colouring matter; pigments and preparations based on titanium dioxide, containing 80% or more by weight of titanium dioxide calculated on the dry matter
320620	Colouring matter; pigments and preparations based on chromium compounds
320641	Colouring matter; ultramarine and preparations based thereon
320642	Colouring matter; lithopone and other pigments and preparations based on zinc sulphide
381111	Anti-knock preparations; based on lead compounds
381121	Lubricating oil additives; containing petroleum oils or oils obtained from bituminous minerals
381129	Lubricating oil additives; not containing petroleum oils or oils obtained from bituminous minerals
381190	Oxidation and gum inhibitors, viscosity improvers, anti-corrosive preparations, other prepared additives for mineral oils or liquids used as mineral oils (including gasoline), n.e.c. in heading no. 3811
381220	Plasticisers, compound; for rubber or plastics
381231	Anti-oxidising preparations and other compound stabilisers; for rubber or plastics, mixtures of oligomers of 2,2,4-trimethyl-1,2-dihydroquinoline (TMQ)
381239	Anti-oxidising preparations and other compound stabilisers; for rubber or plastics, other than mixtures of oligomers of 2,2,4-trimethyl-1,2-dihydroquinoline (TMQ)
382312	Industrial monocarboxylic fatty acids, acid oils from refining; oleic acid
382313	Industrial monocarboxylic fatty acids, acid oils from refining; tall oil fatty acids
382319	Industrial monocarboxylic fatty acids; acid oils from refining; (other than stearic acid, oleic acid or tall oil fatty acids)
382370	Industrial fatty alcohols
382481	Chemical products, mixtures and preparations; containing goods specified in Subheading Note 3 to this Chapter; containing oxirane (ethylene oxide)
382482	Chemical products, mixtures and preparations; containing goods specified in Subheading Note 3 to this Chapter; containing polychlorinated biphenyls (PCBs), polychlorinated terphenyls (PCTs) or polybrominated biphenyls (PBBs)
382483	Chemical products, mixtures and preparations; containing goods specified in Subheading Note 3 to this Chapter; containing tris(2,3-dibromopropyl) phosphate
382484	Chemical products, mixtures and preparations; containing aldrin, camphechlor (toxaphene), chlordane, chlordecone, DDT (chlorfenotane, 1,1,1-trichloro-2,2-bis(p-chlorophenyl)ethane), dieldrin, endosulfan, endrin, heptachlor or mirex
382485	Chemical products, mixtures and preparations; containing goods specified in Subheading Note 3 to this Chapter; containing 1,2,3,4,5,6-hexachlorocyclohexane (HCH (ISO)), including lindane (ISO, INN)
382486	Chemical products, mixtures and preparations; containing goods specified in Subheading Note 3 to this Chapter; containing pentachlorobenzene (ISO), or hexachlorobenzene (ISO)
382487	Chemical products, mixtures and preparations; containing goods specified in Subheading Note 3 to this Chapter; containing perfluorooctane sulphonic acid, its salts, perfluorooctane sulphonamides, or perfluorooctane sulphonyl fluoride
382488	Chemical products, mixtures and preparations; containing goods specified in Subheading Note 3 to this Chapter; containing tetra-, penta-, hexa-, hepta- or octabromodiphenyl ethers
382491	Chemical products, mixtures and preparations; consisting mainly of (5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl methylphosphonate and bis[(5-ethyl-2-methyl-2-oxido-1,3,2-dioxaphosphinan-5-yl)methyl] methylphosphonate
810720	Cadmium; unwrought, powders
810790	Cadmium; other than unwrought, n.e.c. in heading no. 8107

Note: The HS sub-headings in this category reflect a selection of key additives readily identifiable as commonly used in plastics production. Importantly, not all trade in such products enter into the plastics life cycle; many products in this category also have other end-uses. No attempt is made in this study to determine the share of traded products included under each classification that are destined specifically for plastics production. Recommendations on further HS classifications that cover further additives used in plastics production are welcome.

Plastics in Primary Forms
Harmonized Commodity Description and Coding Systems (HS) - Revision 2017

Code	Description
390110	Ethylene polymers; in primary forms, polyethylene having a specific gravity of less than 0.94
390120	Ethylene polymers; in primary forms, polyethylene having a specific gravity of 0.94 or more
390130	Ethylene polymers; in primary forms, ethylene-vinyl acetate copolymers
390140	Ethylene polymers; in primary forms, ethylene-alpha-olefin copolymers, having a specific gravity of less than 0.94
390190	Ethylene polymers; in primary forms, n.e.c. in heading no. 3901
390210	Propylene, other olefin polymers; polypropylene in primary forms

390220	Propylene, other olefin polymers; polyisobutylene in primary forms
390230	Propylene, other olefin polymers; propylene copolymers in primary forms
390290	Propylene, other olefin polymers; n.e.c. in heading no. 3902, in primary forms
390311	Styrene polymers; expansible polystyrene, in primary forms
390319	Styrene polymers; (other than expansible polystyrene), in primary forms
390320	Styrene polymers; styrene-acrylonitrile (SAN) copolymers, in primary forms
390330	Styrene polymers; acrylonitrile-butadiene-styrene (ABS) copolymers, in primary forms
390390	Styrene polymers; in primary forms, n.e.c. in heading no. 3903
390410	Vinyl chloride, other halogenated olefin polymers; poly(vinyl chloride), not mixed with any other substances, in primary forms
390421	Vinyl chloride, other halogenated olefin polymers; non-plasticised poly(vinyl chloride), in primary forms, mixed with other substances
390422	Vinyl chloride, other halogenated olefin polymers; plasticised poly(vinyl chloride), in primary forms, mixed with other substances
390430	Vinyl chloride, other halogenated olefin polymers; vinyl chloride-vinyl acetate copolymers, in primary forms
390440	Vinyl chloride, other halogenated olefin polymers; vinyl chloride copolymers, in primary forms n.e.c. in heading no. 3904
390450	Vinyl chloride, other halogenated olefin polymers; vinylidene chloride polymers, in primary forms
390461	Halogenated olefin polymers; fluoro-polymers, polytetrafluoroethylene, in primary forms
390469	Halogenated olefin polymers; fluoro-polymers (other than polytetrafluoroethylene), in primary forms
390490	Vinyl chloride, other halogenated olefin polymers; n.e.c. in heading no. 3904
390512	Poly(vinyl acetate); in aqueous dispersion, in primary forms
390519	Poly(vinyl acetate); (other than in aqueous dispersion), in primary forms
390521	Vinyl acetate copolymers; in aqueous dispersion, in primary forms
390529	Vinyl acetate copolymers; (other than in aqueous dispersion), in primary forms
390530	Poly(vinyl alcohol); whether or not containing unhydrolysed acetate groups
390591	Vinyl acetate, vinyl ester polymers, vinyl polymers; n.e.c. in heading no. 3905, in primary forms, copolymers
390599	Vinyl acetate, vinyl ester polymers, vinyl polymers; n.e.c. in heading no. 3905, in primary forms, other than copolymers
390610	Acrylic polymers; poly(methyl methacrylate), in primary forms
390690	Acrylic polymers; (other than polymethyl methacrylate), in primary forms
390710	Polyacetals; in primary forms
390720	Polyethers; in primary forms, excluding polyacetals
390730	Epoxide resins; in primary forms
390740	Polycarbonates; in primary forms
390750	Alkyd resins; in primary forms
390761	Poly(ethylene terephthalate); in primary forms, having a viscosity of 78ml/g or higher
390769	Poly(ethylene terephthalate); in primary forms, having a viscosity of less than 78ml/g
390770	Poly(lactic acid); in primary forms
390791	Polyesters; n.e.c. in heading no. 3907, unsaturated, in primary forms
390799	Polyesters; n.e.c. in heading no. 3907, saturated, in primary forms
390810	Polyamides; polyamide-6, -11, -12, -6,6, -6,9, -6,10 or -6,12, in primary forms
390890	Polyamides; n.e.c. in heading no. 3908, in primary forms
390910	Amino-resins; urea and thiourea resins, in primary forms
390920	Amino-resins; melamine resins, in primary forms
390931	Amino-resins; n.e.c. in heading no. 3909, in primary forms, poly(methylene phenyl isocyanate) (Crude MDI, polymeric MDI)
390939	Amino-resins; n.e.c. in heading no. 3909, in primary forms, other than poly(methylene phenyl isocyanate) (Crude MDI, polymeric MDI)
390940	Phenolic resins; in primary forms
390950	Polyurethanes; in primary forms
391000	Silicones; in primary forms
391110	Petroleum resins, coumarone, indene or coumarone-indene resins and polyterpenes; in primary forms
391190	Polysulphides, polysulphones and similar products of chemical synthesis n.e.c. in chapter 39; in primary forms
391211	Cellulose acetates; non-plasticised, in primary forms
391212	Cellulose acetates; plasticised, in primary forms
391220	Cellulose nitrates (including collodions); in primary forms
391231	Cellulose ethers; carboxymethylcellulose and its salts, in primary forms
391239	Cellulose ethers; (other than carboxymethylcellulose and its salts), in primary forms
391290	Cellulose and its chemical derivatives; n.e.c. in item no. 3912, in primary forms
391310	Polymers, natural; alginic acid, its salts and esters, in primary forms
391390	Polymers, natural and modified natural; in primary forms (excluding alginic acid, its salts and esters)
391400	Ion-exchangers; based on polymers of heading no. 3901 to 3913, in primary forms
400211	Rubber; synthetic, styrene-butadiene rubber (SBR) and carboxylated styrene-butadiene rubber (XSBR) latex, in primary forms or in plates, sheets or strip
400219	Rubber; synthetic, styrene-butadiene rubber (SBR) and carboxylated styrene-butadiene rubber (XSBR), (other than latex), in primary forms or in plates, sheets or strip
400220	Rubber; synthetic, butadiene rubber (BR), in primary forms or in plates, sheets or strip

400231	Rubber; synthetic, isobutene-isoprene (butyl) rubber (IIR), in primary forms or in plates, sheets or strip
400239	Rubber; synthetic, halo-isobutene-isoprene rubber (CIIR or BIIR), in primary forms or in plates, sheets or strip
400241	Rubber; synthetic, chloroprene (chlorobutadiene) rubber (CR), latex, in primary forms or in plates, sheets or strip
400249	Rubber; synthetic, chloroprene (chlorobutadiene) rubber (CR), (other than latex), in primary forms or in plates, sheets or strip
400251	Rubber; synthetic, acrylonitrile-butadiene rubber (NBR), latex, in primary forms or in plates, sheets or strip
400259	Rubber; synthetic, acrylonitrile-butadiene rubber (NBR), (other than latex), in primary forms or in plates, sheets or strip
400260	Rubber; synthetic, isoprene rubber (IR), in primary forms or in plates, sheets or strip
400270	Rubber; synthetic, ethylene-propylene-non-conjugated diene rubber (EPDM), in primary forms or in plates, sheets or strip
400280	Rubber; mixtures of natural and synthetic rubbers of heading no. 4001 and 4002, in primary forms or in plates, sheets or strip
400291	Rubber; synthetic, n.e.c. in heading 4002, latex, in primary forms or in plates, sheets or strip
400299	Rubber; synthetic, n.e.c. in heading 4002, (other than latex), in primary forms or in plates, sheets or strip

Note: This category focuses on plastics in primary forms. For several sub-headings, however, the classification includes both plastic in primary forms as well as plastics already in 'intermediate forms' (such as plates, sheets or strip) (e.g., HS.codes 400211 to 400299 related to synthetic rubber). While we have a separate category for such 'intermediate forms,' those HS codes with both are included in the primary forms category. Further research could determine the extent to which the main volumes traded in this category are indeed in primary or intermediate forms, and thus which categorization makes most sense. Finally, although it can be debated whether subheadings such as HS 391211 'Cellulose acetates; non-plasticised, in primary forms' and related cellulose related classifications (e.g., HS 391212, 391220, 391231, 391231, 391239, 391290) are plastics as commonly defined, we have taken the view that as these are included in the HS 39 Chapter on 'Plastics and articles thereof' they should also be included them in our database.

Intermediate Forms of Plastic
Harmonized Commodity Description and Coding Systems (HS) - Revision 2017

Code	Description
391610	Ethylene polymers; monofilament, of which any cross-sectional dimension exceeds 1mm, rods, sticks and profile shapes, whether or not surface-worked but not otherwise worked
391620	Vinyl chloride polymers; monofilament, of which any cross-sectional dimension exceeds 1mm, rods, sticks and profile shapes, whether or not surface-worked but not otherwise worked
391690	Plastics; monofilament, of plastics n.e.c. in heading no. 3916, cross-sectional dimension exceeds 1mm, rods, sticks and profile shapes, whether or not surface-worked but not otherwise worked
391721	Plastics; tubes, pipes and hoses thereof, rigid, of polymers of ethylene
391722	Plastics; tubes, pipes and hoses thereof, rigid, of polymers of propylene
391723	Plastics; tubes, pipes and hoses thereof, rigid, of polymers of vinyl chloride
391729	Plastics; tubes, pipes and hoses thereof, rigid, of plastics n.e.c. in heading no. 3917
391731	Plastics; tubes, pipes and hoses thereof, flexible, having a minimum burst pressure of 27.6MPa
391732	Plastics; tubes, pipes and hoses thereof, other than those of item no. 3917.31, not reinforced or otherwise combined with other materials, without fittings
391733	Plastics; tubes, pipes and hoses thereof, other than those of item no. 3917.31, not reinforced or otherwise combined with other materials, with fittings
391739	Plastics; tubes, pipes and hoses thereof, n.e.c. in item no. 3917.30
391740	Plastics; tube, pipe and hose fittings (e.g. joints, elbows, flanges)
391910	Plastics; plates, sheets, film, foil, tape, strip, other flat shapes thereof, self-adhesive, in rolls of a width not exceeding 20cm
391990	Plastics; plates, sheets, film, foil, tape, strip, other flat shapes thereof, self-adhesive, other than in rolls of a width not exceeding 20cm
392010	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of polymers of ethylene, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392020	Plastics; of polymers of propylene, plates, sheets, film, foil and strip (not self-adhesive), non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392030	Plastics; of polymers of styrene, plates, sheets, film, foil and strip (not self-adhesive), non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392043	Plastics; polymers of vinyl chloride, containing by weight not less than 6% of plasticisers; plates, sheets, film, foil and strip (not self-adhesive), non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392049	Plastics; polymers of vinyl chloride, containing by weight, less than 6% of plasticisers; plates, sheets, film, foil and strip (not self-adhesive), non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392051	Plastics; of acrylic polymers, polymethyl methacrylate, plates, sheets, film, foil and strip (not self-adhesive), non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392059	Plastics; of acrylic polymers (excluding polymethyl methacrylate), plates, sheets, film, foil and strip (not self-adhesive), non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392061	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of polycarbonates, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392062	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of poly(ethylene terephthalate), non-cellular and not reinforced, laminated, supported or similarly combined with other materials

392063	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of unsaturated polyesters, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392069	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of polyesters n.e.c. in heading no. 3920, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392071	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of regenerated cellulose; non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392073	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of cellulose acetate, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392079	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of cellulose derivatives n.e.c. in heading no. 3920, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392091	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of poly(vinyl butyral), non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392092	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of polyamides, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392093	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of amino-resins, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392094	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of phenolic resins, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392099	Plastics; plates, sheets, film, foil and strip (not self-adhesive), of plastics n.e.c. in heading no. 3920, non-cellular and not reinforced, laminated, supported or similarly combined with other materials
392111	Plastics; plates, sheets, film, foil and strip, of polymers of styrene, cellular
392112	Plastics; plates, sheets, film, foil and strip, of polymers of vinyl chloride, cellular
392113	Plastics; plates, sheets, film, foil and strip, of polyurethanes, cellular
392114	Plastics; plates, sheets, film, foil and strip, of regenerated cellulose, cellular
392119	Plastics; plates, sheets, film, foil and strip, of plastics n.e.c. in heading no. 3921, cellular
392190	Plastics; plates, sheets, film, foil and strip, other than cellular
540110	Sewing thread; of synthetic filaments, whether or not put up for retail sale
540211	Yarn, synthetic; filament, monofilament (less than 67 decitex), of high tenacity yarn of nylon or other polyamides, textured or not; of aramids, not for retail sale, not sewing thread
540219	Yarn, synthetic; filament, monofilament (less than 67 decitex), of high tenacity nylon or other polyamides, textured or not; other than aramids, not for retail sale, not sewing thread
540220	Yarn, synthetic; filament, monofilament (less than 67 decitex), of high tenacity yarn of polyesters, whether or not textured, not for retail sale, not sewing thread
540231	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, of nylon or other polyamides, measuring per single yarn not more than 50 decitex, not for retail sale, not sewing thread
540232	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, of nylon or other polyamides, measuring per single yarn more than 50 decitex, not for retail sale, not sewing thread
540233	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, of polyesters, not for retail sale, not sewing thread
540234	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, of polypropylene, not for retail sale, not sewing thread
540239	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, other than of nylon or other polymides, polyesters, or polypropylene, not for retail sale, not sewing thread
540244	Yarn, synthetic; filament, monofilament (less than 67 decitex), other than high tenacity or textured yarn, elastomeric, single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540245	Yarn, synthetic; filament, monofilament (less than 67 decitex), of nylon or other polymides (not high tenacity or textured), single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540246	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polyesters (not high tenacity or textured), partially oriented, single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540247	Yarn, synthetic; filament, monofilament (less than 67 decitex), polyesters (not high tenacity or textured), not partially oriented, single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540248	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polypropylene (not high tenacity or textured), single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540249	Yarn, synthetic; filament, monofilament (less than 67 decitex), other than high tenacity or textured yarn, single, untwisted or twisted 50 turns or less per metre, n.e.c. in heading no. 5402, not for retail sale, not sewing thread
540251	Yarn, synthetic; filament, monofilament (less than 67 decitex), of nylon or other polymides (not high tenacity or textured), single, twisted more than 50 turns per metre, not for retail sale, not sewing thread
540252	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polyesters (not high tenacity or textured), single, twisted more than 50 turns per metre, not for retail sale, not sewing thread
540253	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polypropylene (not high tenacity or textured), single, twisted more than 50 turns per metre, not for retail sale, not sewing thread
540259	Yarn, synthetic; filament, monofilament (less than 67 decitex), other than high tenacity or textured yarn, single, twisted more than 50 turns per metre, n.e.c. in heading no. 5402, not for retail sale, not sewing thread
540261	Yarn, synthetic; filament, monofilament (less than 67 decitex), of nylon or other polymides (not high tenacity or textured), multiple (folded) or cabled, not for retail sale, not sewing thread

540262	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polyesters (not high tenacity or textured), multiple (folded) or cabled, not for retail sale, not sewing thread
540263	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polypropylene, other than high tenacity or textured yarn, multiple (folded) or cabled, not for retail sale, not sewing thread
540269	Yarn, synthetic; filament, monofilament (less than 67 decitex), other than high tenacity or textured yarn, multiple (folded) or cabled, n.e.c. in heading no. 5402, not for retail sale, not sewing thread
540411	Elastomeric monofilament; of 67 decitex or more and of which no cross-sectional dimension exceeds 1mm
540412	Monofilament of polypropylene; of 67 decitex or more and of which no cross-sectional dimension exceeds 1mm
540419	Monofilament n.e.c. in heading no 5404; of 67 decitex or more and of which no cross-sectional dimension exceeds 1mm
540490	Filament, synthetic; strip and the like (e.g.. artificial straw), of synthetic textile materials of an apparent width not exceeding 5mm
540500	Monofilament, synthetic; of 67 decitex or more and of which no cross-sectional dimension exceeds 1mm, strip and the like (e.g. artificial straw), of synthetic textile materials with width not over 5mm

Note: The category 'intermediate forms' includes plastics that have been transformed or converted from primary forms into inputs – such as sheets, filaments, yarns, plates, sheets, film, foil and strip, sticks and shapes as well as synthetic yarns and filaments that are–used either: a) further manufactured into intermediate manufactured or final manufactured plastic goods; or b) used directly as inputs for construction. We welcome feedback on whether HS codes referring to tubes, pipes and hoses, such as HS 391271, 391722, 391723, 391729, 391731, 391732, 391733, 391739, and 391740, should be categorised instead under intermediate manufactured or final manufactured plastic goods.

Intermediate manufactured plastic goods
Harmonized Commodity Description and Coding Systems (HS) - Revision 2017

Code	Description
540710	Fabrics, woven; from high tenacity yarn, of nylon, other polyamides or of polyesters
540720	Fabrics, woven; from strip or the like, of synthetic textile materials
540730	Fabrics, woven; from synthetic filament yarn, adhesive or thermal bonded
540741	Fabrics, woven; containing 85% or more by weight of filaments of nylon or other polyamides, unbleached or bleached
540742	Fabrics, woven; containing 85% or more by weight of filaments of nylon or other polyamides, dyed
540743	Fabrics, woven; containing 85% or more by weight of filaments of nylon or other polyamides, of yarns of different colours
540744	Fabrics, woven; containing 85% or more by weight of filaments of nylon or other polyamides, printed
540751	Fabrics, woven; containing 85% or more by weight of textured polyester filaments, unbleached or bleached
540752	Fabrics, woven; containing 85% or more by weight of textured polyester filaments, dyed
540753	Fabrics, woven; containing 85% or more by weight of textured polyester filaments, of yarns of different colours
540754	Fabrics, woven; containing 85% or more by weight of textured polyester filaments, printed
540761	Fabrics, woven; containing 85% or more by weight of non-textured polyester filaments
540769	Fabrics, woven; containing 85 % or more by weight of poyster filaments; Other
540771	Fabrics, woven; containing 85% or more by weight of synthetic filaments (excluding nylon or other polyamides and polyesters), unbleached or bleached
540772	Fabrics, woven; containing 85% or more by weight of synthetic filaments (excluding nylon or other polyamides and polyesters), dyed
540773	Fabrics, woven; containing 85% or more by weight of synthetic filaments (excluding nylon or other polyamides and polyesters), of yarns of different colours
540774	Fabrics, woven;containing 85% or more by weight of synthetic filaments (excluding nylon or other polyamides and polyesters), printed
540781	Fabrics, woven; containing less than 85 % by weight of synthetic filaments, mixed mainly or solely with cotton,un-bleached or bleached
540782	Fabrics, woven; containing less than 85 % by weight of synthetic filaments, mixed mainly or solely with cotton,dyed
540783	Fabrics, woven; containing less than 85 % by weight of synthetic filaments, mixed mainly or solely with cotton, of yarns of different colours
540784	Fabrics, woven; containing less than 85 % by weight of synthetic filaments, mixed mainly or solely with cotton, printed
550110	Fibres; synthetic filament tow, of nylon or other polyamides
550120	Fibres; synthetic filament tow, of polyesters
550130	Fibres; synthetic filament tow, acrylic or modacrylic
550140	Fibres; synthetic filament tow, of polypropylene
550190	Fibres; synthetic filament tow, of synthetic materials n.e.c. in heading no. 5501
590210	Textile fabrics; tyrecord of high tenacity yarn of nylon or other polyamides
590220	Textile fabrics; tyrecord of high tenacity yarn of polyester
590310	Textile fabrics; impregnated, coated, covered or laminated with poly vinyl chloride
590320	Textile fabrics; impregnated, coated, covered or laminated with polyurethane

590390	Textile fabrics; impregnated, coated, covered or laminated with plastics, (excluding polyvinyl chloride, polyurethane and those of heading no. 5902)
550311	Fibres; synthetic staple fibres, of aramids, not carded, combed or otherwise processed for spinning
550319	Fibres; synthetic staple fibres, of nylon or other polyamides other than aramids, not carded, combed or otherwise processed for spinning
550320	Fibres; synthetic staple fibres, of polyesters, not carded, combed or otherwise processed for spinning
550330	Fibres; synthetic staple fibres, acrylic or modacrylic, not carded, combed or otherwise processed for spinning
550340	Fibres; synthetic staple fibres, of polypropylene, not carded, combed or otherwise processed for spinning
550390	Fibres; synthetic staple fibres, of synthetic materials n.e.c. in heading no. 5503, not carded, combed or otherwise processed for spinning
550510	Fibres; waste (including noils, yarn waste and garnetted stock), of synthetic fibres
550610	Fibres; synthetic staple fibres, of nylon or other polyamides, carded, combed or otherwise processed for spinning
550620	Fibres; synthetic staple fibres, of polyesters, carded, combed or otherwise processed for spinning
550630	Fibres; synthetic staple fibres, acrylic or modacrylic, carded, combed or otherwise processed for spinning
550640	Fibres; synthetic staple fibres, of polypropylene, carded, combed or otherwise processed for spinning
550690	Fibres; synthetic staple fibres, n.e.c. in heading no. 5506, carded, combed or otherwise processed for spinning
550810	Sewing thread; of synthetic staple fibres, whether or not put up for retail sale
550911	Yarn; (not sewing thread), single, of synthetic staple fibres, containing 85% or more by weight of nylon or other polyamides, not put up for retail sale
550912	Yarn; (not sewing thread), multiple (folded) or cabled yarn, of synthetic staple fibres, containing 85% or more by weight of nylon or other polyamides, not put up for retail sale
550921	Yarn; (not sewing thread), single, of synthetic staple fibres, containing 85% or more by weight of polyester, not put up for retail sale
550922	Yarn; (not sewing thread), multiple (folded) or cabled yarn, of synthetic staple fibres, containing 85% or more by weight of polyester, not put up for retail sale
550931	Yarn; (not sewing thread), single, of synthetic staple fibres, containing 85% or more by weight of acrylic or modacrylic, not put up for retail sale
550932	Yarn; (not sewing thread), multiple (folded) or cabled, of synthetic staple fibres, containing 85% or more by weight of acrylic or modacrylic, not put up for retail sale
550941	Yarn; (not sewing thread), single, containing 85% or more by weight of synthetic staple fibres, n.e.c. in heading no. 5509, not put up for retail sale
550942	Yarn; (not sewing thread), multiple (folded) or cabled yarn, containing 85% or more by weight of synthetic staple fibres, n.e.c. in heading no. 5509, not put up for retail sale
550951	Yarn; (not sewing thread), of polyester staple fibres, mixed mainly or solely with artificial staple fibres, not put up for retail sale
550952	Yarn; (not sewing thread), of polyester staple fibres, mixed mainly or solely with wool or fine animal hair, not put up for retail sale
550953	Yarn; (not sewing thread), of polyester staple fibres, mixed mainly or solely with cotton, not put up for retail sale
550959	Yarn; (not sewing thread), of polyester staple fibres, mixed mainly or solely with fibres n.e.c. in item no. 5509.5, not put up for retail sale
550961	Yarn; (not sewing thread), of acrylic or modacrylic staple fibres, mixed mainly or solely with wool or fine animal hair, not put up for retail sale
550962	Yarn; (not sewing thread), of acrylic or modacrylic staple fibres, mixed mainly or solely with cotton, not put up for retail sale
550969	Yarn; (not sewing thread), of acrylic or modacrylic staple fibres, mixed mainly or solely with fibres n.e.c. in item no. 5509.6, not put up for retail sale
550991	Yarn; (not sewing thread), of synthetic staple fibres, mixed mainly or solely with wool or fine animal hair, n.e.c. in heading no. 5509, not put up for retail sale
550992	Yarn; (not sewing thread), of synthetic staple fibres, mixed mainly or solely with cotton, n.e.c. in heading no. 5509, not put up for retail sale
550999	Yarn; (not sewing thread), of synthetic staple fibres, mixed mainly or solely with fibres (other than wool, fine animal hair or cotton), n.e.c. in heading no. 5509, not put up for retail sale
551110	Yarn; (not sewing thread), of synthetic staple fibres, containing 85% or more by weight of synthetic staple fibres, put up for retail sale
551120	Yarn; Of synthetic staple fibres, containing less than 85 % by weight of such fibres
551211	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of polyester staple fibres, unbleached or bleached
551219	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of polyester staple fibres, other than unbleached or bleached
551221	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of acrylic or modacrylic staple fibres, unbleached or bleached

551229	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of acrylic or modacrylic staple fibres, other than unbleached or bleached
551291	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of such fibres n.e.c. in heading no. 5512, unbleached or bleached
551299	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of such fibres n.e.c. in heading no. 5512, other than unbleached or bleached
551311	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; unbleached or bleached;Of polyester staple fibres, plain weave
551312	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; unbleached or bleached;3-thread or 4-thread twill, including cross twill, of polyester staple fibres
551313	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; unbleached or bleached; Other woven fabrics of polyster staple fibres
551319	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; unbleached or bleached; Other woven fabrics
551321	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; dyed; Of polyester staple fibres, plain weave
551323	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; dyed; Other woven fabrics of polyster staple fibres
551329	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; dyed; Other woven fabrics
551331	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; Of yarns of different colours;Of polyester staple fibres, plain weave
551339	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; Of yarns of different colours;Other woven fabrics
551341	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; Printed;Of polyester staple fibres, plain weave
551349	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; Printed ;Other woven fabrics
551411	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; unbleached or bleached;Of polyester staple fibres, plain weave
551412	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; unbleached or bleached;3-thread or 4-thread twill, including cross twill, of polyester staple fibres
551419	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; unbleached or bleached; Other
551421	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed; Of polyester staple fibres, plain weave
551422	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed; 3-thread or 4-thread twill, including cross twill, of polyester staple fibres
551423	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed;Other woven fabrics of polyester staple fibres
551429	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed; Other woven fabrics
551430	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed; Of yarns of different colours
551441	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; printed; Of polyester staple fibres, plain weave
551442	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; printed; 3-thread or 4-thread twill, including cross twill, of polyester staple fibres
551443	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; printed; Other woven fabrics of polyester staple fibres
551449	Fabrics,woven; of synthetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; printed; Other woven fabrics
551511	Fabrics, woven; of polyester staple fibres n.e.c. in chapter 55, mixed mainly or solely with viscose rayon staple fibres
551512	Fabrics, woven; of polyester staple fibres n.e.c. in chapter 55, mixed mainly or solely with man-made filaments
551513	Fabrics, woven; of polyester staple fibres n.e.c. in chapter 55, mixed mainly or solely with wool or fine animal hair
551519	Fabrics, woven; of polyester staple fibres n.e.c. in chapter 55, mixed mainly or solely with fibres n.e.c. in item no. 5515.1
551521	Fabrics, woven; of acrylic or modacrylic staple fibres n.e.c. in chapter 55, mixed mainly or solely with man-made filaments
551522	Fabrics, woven; of acrylic or modacrylic staple fibres n.e.c. in chapter 55, mixed mainly or solely with wool or fine animal hair
551529	Fabrics, woven; of acrylic or modacrylic staple fibres n.e.c. in chapter 55, mixed mainly or solely with fibres n.e.c. in item no. 5515.2
551591	Fabrics, woven; of synthetic staple fibres n.e.c. in chapter 55, mixed mainly or solely with man-made filaments
551599	Fabrics, woven; of synthetic staple fibres n.e.c. in chapter 55, mixed mainly or solely with fibres n.e.c. in heading no. 5515

560741	Twine; binder or baler twine, of polyethylene or polypropylene
560749	Twine, cordage, ropes, cables; of polyethylene or polypropylene (excluding binder or baler twine), whether or not plaited, braided or rubber or plastic impregnated, coated, covered or sheathed
560750	Twine, cordage, ropes, cables; of synthetic fibres other than polyethylene or polypropylene, whether or not plaited, braided or impregnated, coated, covered or sheathed with rubber or plastics
600330	Fabrics; knitted or crocheted fabrics, other than those of heading 60.01 and 60.02, of a width not exceeding 30 cm, of synthetic fibres
600535	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres specified in Subheading Note 1 to this Chapter
600536	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres, bleached or unbleached
600537	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres, dyed
600538	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres, yarns of different colours
600539	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres, printed
600631	Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of synthetic fibres, unbleached or bleached
600632	Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of synthetic fibres, dyed
600633	Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of synthetic fibres, of yarns of different colours
600634	Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of synthetic fibres, printed

Note: The category 'intermediate manufactured plastic goods' includes plastics that have been manufactured from intermediate forms and that are then further manufactured into final manufactured plastic goods. This category currently consists entirely of textiles.

Notably, we have included here HS codes that cover products having 85% or more by weight of synthetic textiles as well as HS codes having less than 85% by weight. The category does not include a number of additional HS codes that include products described as containing synthetic textiles, but for which the proportion of synthetic textile in the products is listed as 'less than 5%' or in a broad range, such as '5% or more' (e.g., HS 600240 refers to 'knitted or crocheted fabrics of a width not exceeding 30 cm; containing by weight 5 % or more of elastomeric yarn, but not containing rubber thread; other than those of heading 6001', and HS 600410 refers to 'knitted or crocheted fabrics of a width exceeding 30 cm, containing by weight 5 % or more of elastomeric yarn, but not containing rubber thread; other than those of heading 6001'). While it is possible that some such categories represent significant additional volumes of plastics, significant further methodological work would be required to determine if the average proportion of plastic in the products included in these sub-headings means that the relevant HS code should be included in this category.

It could be argued that the problem of determining the share of synthetic material in products equally applies to HS sub-headings currently included that refer to having 'less than 85% by weight' of synthetic materials. In this instance, we made a judgement call that such products were more likely to contain a high proportion of plastics than those deemed to have 5% or more. As such we have included mixed woven fabrics classified under HS sub-headings 540781, 540782, 540783 and 540784, which refer to woven fabrics with 'less than 85% by weight of synthetic material, mixed mainly or solely with' different kinds of cotton, as well as 551120, 'yarn; of synthetic staple fibres, containing less than 85% by weight of such fibres.' Similarly, 23 separate HS subchapters (i.e., HS 551441, 551442, 551443, 551449, 551311, 551312, 551313, 551319, 551321, 551323, 551329, 551331, 551339, 551341, 551349, 551411, 551412, 551419, 551421, 551422, 551423, 551429, and 551430) may represent significant additional volumes of plastics but further methodological work would be required to determine if the average proportion of plastic included in these products means that each of the sub-headings should remain in this list or if the volumes of plastics covered by those codes should be analysed using a methodology to estimate volumes of hidden plastics trade. This issue of selection is ripe for further research and feedback is welcome. In the meantime, from the perspective of monitoring trade that has implications for plastics pollution – and given the volume and value of trade in these products – these HS subheadings have been included.

As noted in the main text of this paper, there are thousands of additional intermediate manufactured products that contain embedded plastics traded internationally – ranging from construction materials to car parts and components for electrical appliances – that are then incorporated into final manufactured products. At this prototype stage, the authors have clustered also such products excluded from the list above for further study rubric of 'hidden' plastic products. Feedback on whether some of those excluded codes noted above can be considered predominantly plastics and thus relevant for inclusion in the database is welcome.

Notably, we did not include in this category a number of additional HS codes related to manufactured products where the HS description specifically refers to plastics, but where the plastic component is relatively small. These include, for instance, a number of HS codes related to construction materials: HS 721070 'flat-rolled products of iron or non-alloy steel, of a width of 600 mm or more, clad, plated or coated; other-painted, varnished or coated with plastics'; 721240 'flat-rolled products of iron or non-alloy steel, of a width of less than 600 mm; painted, varnished or coated with plastics'; and 731442 'cloth (including endless bands), grill, netting and fencing, of iron or steel wire; expanded metal of iron or steel; coated with plastics'; as well as HS 5910.00 'transmission or conveyor belts or belting, of textile material, whether or not impregnated, coated, covered or laminated with plastics, or reinforced with metal or other material.' In each case, an unknown volume and value of plastics crosses borders as a share of the main product.

Final manufactured plastics goods
Harmonized Commodity Description and Coding Systems (HS) - Revision 2017

Code	Description
320810	Paints and varnishes; based on polyesters, dispersed or dissolved in a non-aqueous medium
320820	Paints and varnishes; based on acrylic or vinyl polymers, dispersed or dissolved in a non-aqueous medium
320910	Paints and varnishes; based on acrylic or vinyl polymers, dispersed or dissolved in an aqueous medium
391810	Floor, wall or ceiling coverings; of polymers of vinyl chloride, whether or not self-adhesive, in rolls or in the form of tiles
391890	Floor, wall or ceiling coverings; of plastics (excluding polymers of vinyl chloride), whether or not self-adhesive, in rolls or in the form of tiles
392210	Plastics; baths, shower-baths, sinks and wash-basins
392220	Plastics; lavatory seats and covers
392290	Plastics; bidets, lavatory pans, flushing cisterns and similar sanitary ware n.e.c. in heading no. 3922
392310	Plastics; boxes, cases, crates and similar articles for the conveyance or packing of goods
392321	Ethylene polymers; sacks and bags (including cones), for the conveyance or packing of goods
392329	Plastics; sacks and bags (including cones), for the conveyance or packing of goods, of plastics other than ethylene polymers
392330	Plastics; carboys, bottles, flasks and similar articles, for the conveyance or packing of goods
392340	Plastics; spools, cops, bobbins and similar supports, for the conveyance or packing of goods
392350	Plastics; stoppers, lids, caps and other closures, for the conveyance or packing of goods
392390	Plastics; articles for the conveyance or packing of goods n.e.c. in heading no. 3923
392410	Plastics; tableware and kitchenware
392490	Plastics; household articles and hygienic or toilet articles
392510	Plastics; builders' ware, reservoirs, tanks, vats and similar containers of a capacity exceeding 300 litres
392520	Plastics; builders' ware, doors, windows and their frames and thresholds for doors
392530	Plastics; builders' ware, shutters, blinds (including venetian blinds) and similar articles and parts thereof
392590	Plastics; builders' ware, n.e.c. or included in heading no. 3925
392610	Plastics; office or school supplies
392620	Plastics; articles of apparel and clothing accessories (including gloves, mittens and mitts)
392630	Plastics; fittings for furniture, coachwork or the like
392640	Plastics; statuettes and other ornamental articles
392690	Plastics; other articles n.e.c. in chapter 39
401110	Rubber; new pneumatic tyres, of a kind used on motor cars (including station wagons and racing cars)
401120	Rubber; new pneumatic tyres, of a kind used on buses or lorries
401130	Rubber; new pneumatic tyres, of a kind used on aircraft
401140	Rubber; new pneumatic tyres, of a kind used on motorcycles
401150	Rubber; new pneumatic tyres, of a kind used on bicycles
401170	Rubber; new pneumatic tyres, of a kind used on agricultural or forestry vehicles and machines
401180	Rubber; new pneumatic tyres, of a kind used on construction, mining or industrial handling vehicles and machines
401190	Rubber; new pneumatic tyres, of a kind used on light commercial vehicles
401211	Retreaded tyres ; of a kind used on motor cars (including station wagons and racing cars)
401212	Retreaded tyres; of a kind used on motor buses or lorries
401213	Retreaded tyres; of a kind used on aircraft
401219	Retreaded tyres; other than of a kind used on motor cars (including station wagons and racing cars), buses and lorries and aircraft
401220	Rubber; used pneumatic tyres
401290	Rubber; tyres n.e.c. in heading no. 4012
401310	Rubber; inner tubes, of a kind used on motorcars (including station wagons and racing cars), buses and lorries
401320	Rubber; inner tubes, of a kind used on bicycles
401390	Rubber; inner tubes, n.e.c. in heading no. 4013
401410	Rubber; vulcanised (other than hard rubber), sheath contraceptives
401490	Rubber; vulcanised (other than hard rubber), hygienic or pharmaceutical articles (excluding sheath contraceptives), with or without fittings of hard rubber
401511	Rubber; vulcanised (other than hard rubber), surgical gloves
401519	Rubber; vulcanised (other than hard rubber), gloves, mittens and mitts other than surgical gloves
401590	Rubber; vulcanised (other than hard rubber), articles of apparel and clothing accessories (other than gloves, mittens and mitts)
401610	Rubber; vulcanised (other than hard rubber), moulded rubber mats and mats of non-rectangular shape made by cutting from the piece, of cellular rubber
401691	Rubber; vulcanised (other than hard rubber), floor coverings and mats, of non-cellular rubber
401692	Rubber; vulcanised (other than hard rubber), erasers, of non-cellular rubber
401693	Rubber; vulcanised (other than hard rubber), gaskets, washers and other seals, of non-cellular rubber
401694	Rubber; vulcanised (other than hard rubber), boat or dock fenders, whether or not inflatable, of non-cellular rubber
401695	Rubber; vulcanised (other than hard rubber), inflatable articles (other than boat or dock fenders), of non-cellular rubber

401699	Rubber; vulcanised (other than hard rubber), articles n.e.c. in heading no. 4016, of non-cellular rubber
401700	Rubber; ebonite and other hard rubbers in all forms, including waste and scrap, and articles of hard rubber
430400	Fur, artificial; articles thereof
560811	Made-up fishing nets
570320	Carpets and other textile floor coverings; tufted, of nylon or other polyamides, whether or not made up
610323	Ensembles; men's or boys', of synthetic fibres, knitted or crocheted
610333	Jackets and blazers; men's or boys', of synthetic fibres, knitted or crocheted
610343	Trousers, bib and brace overalls, breeches and shorts; men's or boys', of synthetic fibres, knitted or crocheted
610413	Suits; women's or girls', of synthetic fibres, knitted or crocheted
610423	Ensembles; women's or girls', of synthetic fibres, knitted or crocheted
610433	Jackets; women's or girls', of synthetic fibres, knitted or crocheted
610443	Dresses; women's or girls', of synthetic fibres, knitted or crocheted
610453	Skirts and divided skirts; women's or girls', of synthetic fibres, knitted or crocheted
610463	Trousers, bib and brace overalls, breeches and shorts; women's or girls', of synthetic fibres, knitted or crocheted
611130	Garments and clothing accessories; babies', of synthetic fibres, knitted or crocheted
611212	Track suits; of synthetic fibres, knitted or crocheted
611231	Swimwear; men's or boys', of synthetic fibres, knitted or crocheted
611241	Swimwear; women's or girls', of synthetic fibres, knitted or crocheted
611521	Hosiery; panty hose and tights (other than graduated compression hosiery), of synthetic fibres, measuring per single yarn less than 67 decitex, knitted or crocheted
611522	Hosiery; panty hose and tights (other than graduated compression hosiery), of synthetic fibres, measuring per single yarn 67 decitex or more, knitted or crocheted
611596	Hosiery and footwear; without applied soles, of synthetic fibres, knitted or crocheted (excluding graduated compression hosiery, panty hose, tights, full or knee-length hosiery measuring per single yarn less than 67 decitex)
611693	Gloves, mittens and mitts; of synthetic fibres, knitted or crocheted, (other than impregnated, coated or covered with plastics or rubber)
620312	Suits; men's or boys', of synthetic fibres (not knitted or crocheted)
620323	Ensembles; men's or boys', of synthetic fibres (not knitted or crocheted)
620333	Jackets and blazers; men's or boys', of synthetic fibres (not knitted or crocheted)
620343	Trousers, bib and brace overalls, breeches and shorts; men's or boys', of synthetic fibres (not knitted or crocheted)
620413	Suits; women's or girls', of synthetic fibres (not knitted or crocheted)
620423	Ensembles; women's or girls', of synthetic fibres (not knitted or crocheted)
620433	Jackets and blazers; women's or girls', of synthetic fibres (not knitted or crocheted)
620443	Dresses; women's or girls', of synthetic fibres (not knitted or crocheted)
620453	Skirts and divided skirts; women's or girls', of synthetic fibres (not knitted or crocheted)
620463	Trousers, bib and brace overalls, breeches and shorts; women's or girls', of synthetic fibres (not knitted or crocheted)
620930	Garments and clothing accessories; babies', of synthetic fibres (not knitted or crocheted)
621430	Shawls, scarves, mufflers, mantillas, veils and the like; of synthetic fibres (not knitted or crocheted)
630140	Blankets (other than electric blankets) and travelling rugs; of synthetic fibres
630312	Curtains (including drapes) and interior blinds; curtain or bed valances, knitted or crocheted, of synthetic fibres
630392	Curtains (including drapes) and interior blinds, curtain or bed valances; of synthetic fibres, not knitted or crocheted
630493	Furnishing articles; of synthetic fibres, not knitted or crocheted (excluding bedspreads and articles of heading no. 9404)
630533	Sacks and bags; of a kind used for the packing of goods, of man-made textile materials, of polyethylene or polypropylene strip or the like, not flexible intermediate bulk containers
630612	Tarpaulins, awnings and sunblinds; of synthetic fibres
630622	Tents; of synthetic fibres
670210	Flowers, foliage and fruit, artificial, and parts thereof; articles made of artificial flowers, foliage or fruit, of plastics
670411	Wigs; complete, of synthetic textile materials
670419	False beards, eyebrows and eyelashes, switches and the like; of synthetic textile materials
854720	Insulating fittings; of plastics, for electrical machines, of insulating material only (except minor assembly parts), excluding those of heading no. 8546
900311	Frames and mountings; for spectacles, goggles or the like, of plastics
940370	Furniture; plastic
940592	Lamps and light fittings; parts thereof, of plastics
950632	Golf balls
960621	Buttons; of plastics, not covered with textile material
960860	Refills for ballpoint pens, comprising the ball point and ink-reservoir
961511	Combs, hair-slides and the like; Of hard rubber or plastics
961900	Sanitary towels (pads) and tampons, napkins and napkin liners for babies and similar articles, of any material

Note: There are many millions of additional final manufactured goods that are either entirely plastic or contain a high proportion of plastic that are included in codes under other HS Chapters and sub-headings. For the purposes of this study, we have included only those most clearly identifiable as items made entirely or mostly plastics. We erred on the side of caution for many items. For instance, there are many final manufactured goods such as clothing and apparel that are comprised almost entirely from synthetic textiles and plastics but that are not included here. Examples of relevant codes include HS 420212 'trunks, suit-cases and vanity cases and various types of bags: with outer surface of plastics or of textile materials'; HS 420222, 'handbags, whether or not with shoulder strap, including those without handle; with outer surface of sheeting of plastics or of textile materials,' HS 420232, 'articles of a kind normally carried in the pocket or in the handbag; with outer surface of sheeting of plastics or of textile materials,' and HS 420292, which includes 'other trunks, bags and containers; with outer surface of sheeting of plastics or of textile materials'. This list also excludes HS subheadings for footwear and safety headgear that contain different kinds of plastics, but for which the value and volume of that content was impossible for the authors to estimate. For instance, leather shoes with synthetic rubber soles can not simply be classified as plastic products although many sport shoes are almost entirely made of synthetic textiles and rubber.

As such, at this prototype stage, the authors have clustered also such products excluded from the list above for further study rubric of 'hidden' plastic products. Feedback on whether some of those excluded codes noted above can be considered predominantly plastics and thus relevant for inclusion in the database is welcome.

Synthetic Textiles

Code	Description
391810	Floor, wall or ceiling coverings; of polymers of vinyl chloride, whether or not self-adhesive, in rolls or in the form of tiles
391890	Floor, wall or ceiling coverings; of plastics (excluding polymers of vinyl chloride), whether or not self-adhesive, in rolls or in the form of tiles
430400	Fur, artificial; articles thereof
540110	Sewing thread; of synthetic filaments, whether or not put up for retail sale
540211	Yarn, synthetic; filament, monofilament (less than 67 decitex), of high tenacity yarn of nylon or other polyamides, textured or not; of aramids, not for retail sale, not sewing thread
540219	Yarn, synthetic; filament, monofilament (less than 67 decitex), of high tenacity nylon or other polyamides, textured or not; other than aramids, not for retail sale, not sewing thread
540220	Yarn, synthetic; filament, monofilament (less than 67 decitex), of high tenacity yarn of polyesters, whether or not textured, not for retail sale, not sewing thread
540231	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, of nylon or other polyamides, measuring per single yarn not more than 50 decitex, not for retail sale, not sewing thread
540232	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, of nylon or other polyamides, measuring per single yarn more than 50 decitex, not for retail sale, not sewing thread
540233	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, of polyesters, not for retail sale, not sewing thread
540234	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, of polypropylene, not for retail sale, not sewing thread
540239	Yarn, synthetic; filament, monofilament (less than 67 decitex), textured, other than of nylon or other polymides, polyesters, or polypropylene, not for retail sale, not sewing thread
540244	Yarn, synthetic; filament, monofilament (less than 67 decitex), other than high tenacity or textured yarn, elastomeric, single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540245	Yarn, synthetic; filament, monofilament (less than 67 decitex), of nylon or other polymides (not high tenacity or textured), single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540246	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polyesters (not high tenacity or textured), partially oriented, single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540247	Yarn, synthetic; filament, monofilament (less than 67 decitex), polyesters (not high tenacity or textured), not partially oriented, single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540248	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polypropylene (not high tenacity or textured), single, untwisted or twisted 50 turns or less per metre, not for retail sale, not sewing thread
540249	Yarn, synthetic; filament, monofilament (less than 67 decitex), other than high tenacity or textured yarn, single, untwisted or twisted 50 turns or less per metre, n.e.c. in heading no. 5402, not for retail sale, not sewing thread
540251	Yarn, synthetic; filament, monofilament (less than 67 decitex), of nylon or other polymides (not high tenacity or textured), single, twisted more than 50 turns per metre, not for retail sale, not sewing thread
540252	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polyesters (not high tenacity or textured), single, twisted more than 50 turns per metre, not for retail sale, not sewing thread
540253	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polypropylene (not high tenacity or textured), single, twisted more than 50 turns per metre, not for retail sale, not sewing thread
540259	Yarn, synthetic; filament, monofilament (less than 67 decitex), other than high tenacity or textured yarn, single, twisted more than 50 turns per metre, n.e.c. in heading no. 5402, not for retail sale, not sewing thread
540261	Yarn, synthetic; filament, monofilament (less than 67 decitex), of nylon or other polymides (not high tenacity or textured), multiple (folded) or cabled, not for retail sale, not sewing thread
540262	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polyesters (not high tenacity or textured), multiple (folded) or cabled, not for retail sale, not sewing thread
540263	Yarn, synthetic; filament, monofilament (less than 67 decitex), of polypropylene, other than high tenacity or textured yarn, multiple (folded) or cabled, not for retail sale, not sewing thread
540269	Yarn, synthetic; filament, monofilament (less than 67 decitex), other than high tenacity or textured yarn, multiple (folded) or cabled, n.e.c. in heading no. 5402, not for retail sale, not sewing thread
540411	Elastomeric monofilament; of 67 decitex or more and of which no cross-sectional dimension exceeds 1mm

540412	Monofilament of polypropylene; of 67 decitex or more and of which no cross-sectional dimension exceeds 1mm
540419	Monofilament n.e.c. in heading no 5404; of 67 decitex or more and of which no cross-sectional dimension exceeds 1mm
540490	Filament, synthetic; strip and the like (e.g.. artificial straw), of synthetic textile materials of an apparent width not exceeding 5mm
540500	Monofilament, synthetic; of 67 decitex or more and of which no cross-sectional dimension exceeds 1mm, strip and the like (e.g. artificial straw), of synthetic textile materials with width not over 5mm
540710	Fabrics, woven; from high tenacity yarn, of nylon, other polyamides or of polyesters
540720	Fabrics, woven; from strip or the like, of synthetic textile materials
540730	Fabrics, woven; from synthetic filament yarn, adhesive or thermal bonded
540741	Fabrics, woven; containing 85% or more by weight of filaments of nylon or other polyamides, unbleached or bleached
540742	Fabrics, woven; containing 85% or more by weight of filaments of nylon or other polyamides, dyed
540743	Fabrics, woven; containing 85% or more by weight of filaments of nylon or other polyamides, of yarns of different colours
540744	Fabrics, woven; containing 85% or more by weight of filaments of nylon or other polyamides, printed
540751	Fabrics, woven; containing 85% or more by weight of textured polyester filaments, unbleached or bleached
540752	Fabrics, woven; containing 85% or more by weight of textured polyester filaments, dyed
540753	Fabrics, woven; containing 85% or more by weight of textured polyester filaments, of yarns of different colours
540754	Fabrics, woven; containing 85% or more by weight of textured polyester filaments, printed
540761	Fabrics, woven; containing 85% or more by weight of non-textured polyester filaments
540769	Fabrics, woven; containing less than 85% by weight of non-textured polyester filaments
540771	Fabrics, woven; containing 85% or more by weight of synthetic filaments (excluding nylon or other polyamides and polyesters), unbleached or bleached
540772	Fabrics, woven; containing 85% or more by weight of synthetic filaments (excluding nylon or other polyamides and polyesters), dyed
540773	Fabrics, woven; containing 85% or more by weight of synthetic filaments (excluding nylon or other polyamides and polyesters), of yarns of different colours
540774	Fabrics, woven; containing 85% or more by weight of synthetic filaments (excluding nylon or other polyamides and polyesters), printed
540781	Fabrics, woven; containing less than 85 % by weight of synthetic filaments, mixed mainly or solely with cotton,un-bleached or bleached
540782	Fabrics, woven; containing less than 85 % by weight of synthetic filaments, mixed mainly or solely with cotton,dyed
540783	Fabrics, woven; containing less than 85 % by weight of synthetic filaments, mixed mainly or solely with cotton, of yarns of different colours
540784	Fabrics, woven; containing less than 85 % by weight of synthetic filaments, mixed mainly or solely with cotton, printed
550110	Fibres; synthetic filament tow, of nylon or other polyamides
550120	Fibres; synthetic filament tow, of polyesters
550130	Fibres; synthetic filament tow, acrylic or modacrylic
550140	Fibres; synthetic filament tow, of polypropylene
550190	Fibres; synthetic filament tow, of synthetic materials n.e.c. in heading no. 5501
550311	Fibres; synthetic staple fibres, of aramids, not carded, combed or otherwise processed for spinning
550319	Fibres; synthetic staple fibres, of nylon or other polyamides other than aramids, not carded, combed or otherwise processed for spinning
550320	Fibres; synthetic staple fibres, of polyesters, not carded, combed or otherwise processed for spinning
550330	Fibres; synthetic staple fibres, acrylic or modacrylic, not carded, combed or otherwise processed for spinning
550340	Fibres; synthetic staple fibres, of polypropylene, not carded, combed or otherwise processed for spinning
550390	Fibres; synthetic staple fibres, of synthetic materials n.e.c. in heading no. 5503, not carded, combed or otherwise processed for spinning
550510	Fibres; waste (including noils, yarn waste and garnetted stock), of synthetic fibres
550610	Fibres; synthetic staple fibres, of nylon or other polyamides, carded, combed or otherwise processed for spinning
550620	Fibres; synthetic staple fibres, of polyesters, carded, combed or otherwise processed for spinning
550630	Fibres; synthetic staple fibres, acrylic or modacrylic, carded, combed or otherwise processed for spinning
550640	Fibres; synthetic staple fibres, of polypropylene, carded, combed or otherwise processed for spinning
550690	Fibres; synthetic staple fibres, n.e.c. in heading no. 5506, carded, combed or otherwise processed for spinning
550810	Sewing thread; of synthetic staple fibres, whether or not put up for retail sale
550911	Yarn; (not sewing thread), single, of synthetic staple fibres, containing 85% or more by weight of nylon or other polyamides, not put up for retail sale
550912	Yarn; (not sewing thread), multiple (folded) or cabled yarn, of synthetic staple fibres, containing 85% or more by weight of nylon or other polyamides, not put up for retail sale
550921	Yarn; (not sewing thread), single, of synthetic staple fibres, containing 85% or more by weight of polyester, not put up for retail sale
550922	Yarn; (not sewing thread), multiple (folded) or cabled yarn, of synthetic staple fibres, containing 85% or more by weight of polyester, not put up for retail sale
550931	Yarn; (not sewing thread), single, of synthetic staple fibres, containing 85% or more by weight of acrylic or modacrylic, not put up for retail sale
550932	Yarn; (not sewing thread), multiple (folded) or cabled, of synthetic staple fibres, containing 85% or more by weight of acrylic or modacrylic, not put up for retail sale

550941	Yarn; (not sewing thread), single, containing 85% or more by weight of synthetic staple fibres, n.e.c. in heading no. 5509, not put up for retail sale
550942	Yarn; (not sewing thread), multiple (folded) or cabled yarn, containing 85% or more by weight of synthetic staple fibres, n.e.c. in heading no. 5509, not put up for retail sale
550951	Yarn; (not sewing thread), of polyester staple fibres, mixed mainly or solely with artificial staple fibres, not put up for retail sale
550952	Yarn; (not sewing thread), of polyester staple fibres, mixed mainly or solely with wool or fine animal hair, not put up for retail sale
550953	Yarn; (not sewing thread), of polyester staple fibres, mixed mainly or solely with cotton, not put up for retail sale
550959	Yarn; (not sewing thread), of polyester staple fibres, mixed mainly or solely with fibres n.e.c. in item no. 5509.5, not put up for retail sale
550961	Yarn; (not sewing thread), of acrylic or modacrylic staple fibres, mixed mainly or solely with wool or fine animal hair, not put up for retail sale
550962	Yarn; (not sewing thread), of acrylic or modacrylic staple fibres, mixed mainly or solely with cotton, not put up for retail sale
550969	Yarn; (not sewing thread), of acrylic or modacrylic staple fibres, mixed mainly or solely with fibres n.e.c. in item no. 5509.6, not put up for retail sale
550991	Yarn; (not sewing thread), of synthetic staple fibres, mixed mainly or solely with wool or fine animal hair, n.e.c. in heading no. 5509, not put up for retail sale
550992	Yarn; (not sewing thread), of synthetic staple fibres, mixed mainly or solely with cotton, n.e.c. in heading no. 5509, not put up for retail sale
550999	Yarn; (not sewing thread), of synthetic staple fibres, mixed mainly or solely with fibres (other than wool, fine animal hair or cotton), n.e.c. in heading no. 5509, not put up for retail sale
551110	Yarn; (not sewing thread), of synthetic staple fibres, containing 85% or more by weight of synthetic staple fibres, put up for retail sale
551120	Yarn; Of synthetic staple fibres, containing less than 85 % by weight of such fibres
551211	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of polyester staple fibres, unbleached or bleached
551219	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of polyester staple fibres, other than unbleached or bleached
551221	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of acrylic or modacrylic staple fibres, unbleached or bleached
551229	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of acrylic or modacrylic staple fibres, other than unbleached or bleached
551291	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of such fibres n.e.c. in heading no. 5512, unbleached or bleached
551299	Fabrics, woven; of synthetic staple fibres, containing 85% or more by weight of such fibres n.e.c. in heading no. 5512, other than unbleached or bleached
551311	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; unbleached or bleached;Of polyester staple fibres, plain weave
551312	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; unbleached or bleached;3-thread or 4-thread twill, including cross twill, of polyester staple fibres
551313	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; unbleached or bleached; Other woven fabrics of polyster staple fibres
551319	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; unbleached or bleached; Other woven fabrics
551321	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; dyed; Of polyester staple fibres, plain weave
551323	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; dyed; Other woven fabrics of polyster staple fibres
551329	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; dyed; Other woven fabrics
551331	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; Of yarns of different colours;Of polyester staple fibres, plain weave
551339	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; Of yarns of different colours;Other woven fabrics
551341	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; Printed;Of polyester staple fibres, plain weave
551349	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight not exceeding 170 g/m²; Printed ;Other woven fabrics
551411	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; unbleached or bleached;Of polyester staple fibres, plain weave
551412	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; unbleached or bleached;3-thread or 4-thread twill, including cross twill, of polyester staple fibres
551419	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; unbleached or bleached; Other

551421	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed; Of polyester staple fibres, plain weave
551422	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed; 3-thread or 4-thread twill, including cross twill, of polyester staple fibres
551423	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed;Other woven fabrics of polyester staple fibres
551429	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed; Other woven fabrics
551430	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; dyed; Of yarns of different colours
551441	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; printed; Of polyester staple fibres, plain weave
551442	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; printed; 3-thread or 4-thread twill, including cross twill, of polyester staple fibres
551443	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres,mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; printed; Other woven fabrics of polyester staple fibres
551449	Fabrics,woven; of sythetic staple fibres, containing less than 85 % by weight of such fibres, mixed mainly or solely with cotton, of a weight exceeding 170 g/m²; printed; Other woven fabrics
551511	Fabrics, woven; of polyester staple fibres n.e.c. in chapter 55, mixed mainly or solely with viscose rayon staple fibres
551512	Fabrics, woven; of polyester staple fibres n.e.c. in chapter 55, mixed mainly or solely with man-made filaments
551513	Fabrics, woven; of polyester staple fibres n.e.c. in chapter 55, mixed mainly or solely with wool or fine animal hair
551519	Fabrics, woven; of polyester staple fibres n.e.c. in chapter 55, mixed mainly or solely with fibres n.e.c. in item no. 5515.1
551521	Fabrics, woven; of acrylic or modacrylic staple fibres n.e.c. in chapter 55, mixed mainly or solely with man-made filaments
551522	Fabrics, woven; of acrylic or modacrylic staple fibres n.e.c. in chapter 55, mixed mainly or solely with wool or fine animal hair
551529	Fabrics, woven; of acrylic or modacrylic staple fibres n.e.c. in chapter 55, mixed mainly or solely with fibres n.e.c. in item no. 5515.2
551591	Fabrics, woven; of synthetic staple fibres n.e.c. in chapter 55, mixed mainly or solely with man-made filaments
551599	Fabrics, woven; of synthetic staple fibres n.e.c. in chapter 55, mixed mainly or solely with fibres n.e.c. in heading no. 5515
560741	Twine; binder or baler twine, of polyethylene or polypropylene
560749	Twine, cordage, ropes, cables; of polyethylene or polypropylene (excluding binder or baler twine), whether or not plaited, braided or rubber or plastic impregnated, coated, covered or sheathed
560750	Twine, cordage, ropes, cables; of synthetic fibres other than polyethylene or polypropylene, whether or not plaited, braided or impregnated, coated, covered or sheathed with rubber or plastics
560811	Made-up fishing nets
570320	Carpets and other textile floor coverings; tufted, of nylon or other polyamides, whether or not made up
590210	Textile fabrics; tyrecord of high tenacity yarn of nylon or other polyamides
590220	Textile fabrics; tyrecord of high tenacity yarn of polyester
590290	Textile fabrics; tyrecord of high tenacity yarn of viscose rayon
590310	Textile fabrics; impregnated, coated, covered or laminated with poly(vinyl chloride)
590320	Textile fabrics; impregnated, coated, covered or laminated with polyurethane
590390	Textile fabrics; impregnated, coated, covered or laminated with plastics, (excluding polyvinyl chloride, polyurethane and those of heading no. 5902)
600240	Knitted or crocheted fabrics of a width not exceeding 30 cm;Containing by weight 5 % or more of elastomeric yarn, but not containing rubber thread; other than those of heading 6001
600330	Fabrics; knitted or crocheted fabrics, other than those of heading 60.01 and 60.02, of a width not exceeding 30 cm, of synthetic fibres
600410	Knitted or crocheted fabrics of a width exceeding 30 cm,Containing by weight 5 % or more of elastomeric yarn, but not containing rubber thread; other than those of heading 6001
600535	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres specified in Subheading Note 1 to this Chapter
600536	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres, bleached or unbleached
600537	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres, dyed
600538	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres, yarns of different colours
600539	Fabrics; warp knit (including those made on galloon knitting machines), other than those of headings 60.01 to 60.04, of synthetic fibres, printed
600631	Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of synthetic fibres, unbleached or bleached
600632	Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of synthetic fibres, dyed
600633	Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of synthetic fibres, of yarns of different colours
600634	Fabrics; knitted or crocheted fabrics, other than those of headings 60.01 to 60.04, of synthetic fibres, printed

610323	Ensembles; men's or boys', of synthetic fibres, knitted or crocheted
610333	Jackets and blazers; men's or boys', of synthetic fibres, knitted or crocheted
610343	Trousers, bib and brace overalls, breeches and shorts; men's or boys', of synthetic fibres, knitted or crocheted
610413	Suits; women's or girls', of synthetic fibres, knitted or crocheted
610423	Ensembles; women's or girls', of synthetic fibres, knitted or crocheted
610433	Jackets; women's or girls', of synthetic fibres, knitted or crocheted
610443	Dresses; women's or girls', of synthetic fibres, knitted or crocheted
610453	Skirts and divided skirts; women's or girls', of synthetic fibres, knitted or crocheted
610463	Trousers, bib and brace overalls, breeches and shorts; women's or girls', of synthetic fibres, knitted or crocheted
611130	Garments and clothing accessories; babies', of synthetic fibres, knitted or crocheted
611212	Track suits; of synthetic fibres, knitted or crocheted
611231	Swimwear; men's or boys', of synthetic fibres, knitted or crocheted
611241	Swimwear; women's or girls', of synthetic fibres, knitted or crocheted
611521	Hosiery; panty hose and tights (other than graduated compression hosiery), of synthetic fibres, measuring per single yarn less than 67 decitex, knitted or crocheted
611522	Hosiery; panty hose and tights (other than graduated compression hosiery), of synthetic fibres, measuring per single yarn 67 decitex or more, knitted or crocheted
611596	Hosiery and footwear; without applied soles, of synthetic fibres, knitted or crocheted (excluding graduated compression hosiery, panty hose, tights, full or knee-length hosiery measuring per single yarn less than 67 decitex)
611693	Gloves, mittens and mitts; of synthetic fibres, knitted or crocheted, (other than impregnated, coated or covered with plastics or rubber)
620312	Suits; men's or boys', of synthetic fibres (not knitted or crocheted)
620323	Ensembles; men's or boys', of synthetic fibres (not knitted or crocheted)
620333	Jackets and blazers; men's or boys', of synthetic fibres (not knitted or crocheted)
620343	Trousers, bib and brace overalls, breeches and shorts; men's or boys', of synthetic fibres (not knitted or crocheted)
620413	Suits; women's or girls', of synthetic fibres (not knitted or crocheted)
620423	Ensembles; women's or girls', of synthetic fibres (not knitted or crocheted)
620433	Jackets and blazers; women's or girls', of synthetic fibres (not knitted or crocheted)
620443	Dresses; women's or girls', of synthetic fibres (not knitted or crocheted)
620453	Skirts and divided skirts; women's or girls', of synthetic fibres (not knitted or crocheted)
620463	Trousers, bib and brace overalls, breeches and shorts; women's or girls', of synthetic fibres (not knitted or crocheted)
620930	Garments and clothing accessories; babies', of synthetic fibres (not knitted or crocheted)
621430	Shawls, scarves, mufflers, mantillas, veils and the like; of synthetic fibres (not knitted or crocheted)
630140	Blankets (other than electric blankets) and travelling rugs; of synthetic fibres
630312	Curtains (including drapes) and interior blinds; curtain or bed valances, knitted or crocheted, of synthetic fibres
630392	Curtains (including drapes) and interior blinds, curtain or bed valances; of synthetic fibres, not knitted or crocheted
630493	Furnishing articles; of synthetic fibres, not knitted or crocheted (excluding bedspreads and articles of heading no. 9404)
630533	Sacks and bags; of a kind used for the packing of goods, of man-made textile materials, of polyethylene or polypropylene strip or the like, not flexible intermediate bulk containers
630612	Tarpaulins, awnings and sunblinds; of synthetic fibres
630622	Tents; of synthetic fibres
670210	Flowers, foliage and fruit, artificial, and parts thereof; articles made of artificial flowers, foliage or fruit, of plastics
670411	Wigs; complete, of synthetic textile materials
670419	False beards, eyebrows and eyelashes, switches and the like; of synthetic textile materials

Note: Notably, we have included here HS codes that cover products having 85% or more by weight of synthetic textiles as well as HS codes having less than 85% by weight. The category does not include a number of additional HS codes that include products described as containing synthetic textiles, but for which the proportion of synthetic textile in the products is listed as ‘less than 5%’ or in a broad range, such as ‘5% or more’ (e.g., HS 600240 refers to ‘knitted or crocheted fabrics of a width not exceeding 30 cm; containing by weight 5 % or more of elastomeric yarn, but not containing rubber thread; other than those of heading 6001’, and HS 600410 refers to ‘knitted or crocheted fabrics of a width exceeding 30 cm, containing by weight 5 % or more of elastomeric yarn, but not containing rubber thread; other than those of heading 6001’). While it is possible that some such categories represent significant additional volumes of plastics, significant further methodological work would be required to determine if the average proportion of plastic in the products included in these sub-headings means that the relevant HS code should be included in this category.

It could be argued that the problem of determining the share of synthetic material in products equally applies to HS sub-headings currently included that refer to having ‘less than 85% by weight’ of synthetic materials. In this instance, we made a judgement call that such products were more likely to contain a high proportion of plastics than those deemed to have 5% or more. As such we have included mixed woven fabrics classified under HS sub-headings 540781, 540782, 540783 and 540784, which refer to woven fabrics with ‘less than 85% by weight of synthetic material, mixed mainly or solely with’ different kinds of cotton, as well as 551120, ‘yarn; of synthetic staple fibres, containing less than 85% by weight of such fibres.’ Similarly, 23 separate HS subchapters (i.e., HS 551441, 551442, 551443, 551449, 551311, 551312, 551313, 551319, 551321, 551323, 551329, 551331, 551339, 551341, 551349, 551411, 551412, 551419, 551421, 551422, 551423, 551429, and 551430). Some of these HS codes may represent significant additional volumes of plastics but further methodological work would be required to determine if the average proportion of plastic included in these products means that each of the sub-headings should remain in this list or if the volumes of plastics covered by those codes should be analysed using a methodology to estimate volumes of hidden plastics trade. This issue of selection is ripe for further research and feedback is welcome. In the meantime, from the perspective of monitoring trade that has implications for plastics pollution – and given the volume and value of trade in these products – these HS subheadings have been included.

This list also does not include a number of final manufactured produts that are described in the HS as containing plastic, suh as HS 420212 'trunks, suit-cases and vanity cases and various types of bags: with outer surface of plastics or of textile materials'; HS 420222, 'handbags, whether or not with shoulder strap, including those without handle; with outer surface of sheeting of plastics or of textile materials', HS 420232, 'articles of a kind normally carried in the pocket or in the handbag; with outer surface of sheeting of plastics or of textile materials' and HS 420292, which includes 'other trunks, bags and containers; wiith outer surface of sheeting of plastics or of textile materials.'

This list also excludes HS subheadings for footwear that contains different kinds of plastics, but where the value and volume of that content was impossible for the authors to estimate. For instance, leather shoes with synthetic rubber soles, cannot simply be classified as plastic products although many sport shoes may indeed be entirely of synthetic textile and rubber.

As such, at this prototype stage, the authors have clustered also such products excluded from the list above for further study rubric of 'hidden' plastic products. Feedback on whether some of those excluded codes noted above can be considered predominantly plastics and thus relevant for inclusion in the database is welcome.

Notably, we have not included any HS subheadings for artificial fibres, such as viscose rayon and cellulose acetate, glass or metallic fibres. We also note that HS 961900 'sanitary towels (pads) and tampons, napkins and napkin liners for babies and similar articles, of any material' is included in our list of final manufactured products and should likely also be included in this list of synthetic textiles, which will be amended in the online version of our database.

Plastic waste

Code	Description
391510	Ethylene polymers; waste, parings and scrap
391520	Styrene polymers; waste, parings and scrap
391530	Vinyl chloride polymers; waste, parings and scrap
391590	Plastics n.e.c. in heading no. 3915; waste, parings and scrap

Note: This category does not currently include rubber waste and scrap referred to in HS 401700 (Rubber; ebonite and other hard rubbers in all forms, including waste and scrap, and articles of hard rubber) because it was not possible to determine the share of waste among other products included in this category. It also does not include HS 550510 'Waste (including noils, yarn waste and garnetted stock) of synthetic fibres. However, this sub-heading is included under synthetic textiles above.

Fishing nets
Harmonized Commodity Description and Coding Systems (HS) - Revision 2017

Code	Description
560811	Made-up fishing nets

Note: HS Chapter 56 includes a number of other sub-headings for fishing-related products that are likely to be largely made of plastics – such as fishing buoys and fishing line, as well as small fishing vessels. Further study may clarify the proportion of plastics embedded in products included in other fisheries-related HS codes such that some of these may properly be included in this database. At this prototype stage, the authors have included such products on the list of 'hidden' plastic products for further investigation.

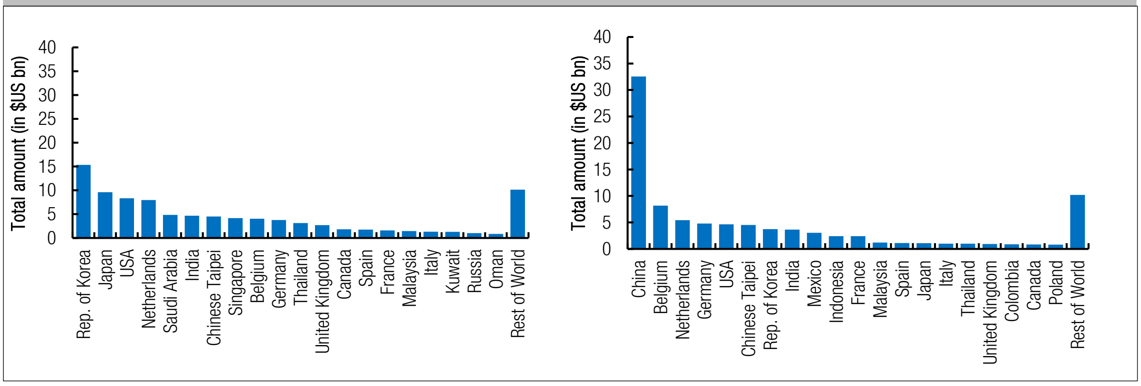
Plastic packaging
Harmonized Commodity Description and Coding Systems (HS) - Revision 2017

Code	Description
392310	Plastics; boxes, cases, crates and similar articles for the conveyance or packing of goods
392321	Ethylene polymers; sacks and bags (including cones), for the conveyance or packing of goods
392329	Plastics; sacks and bags (including cones), for the conveyance or packing of goods, of plastics other than ethylene polymers
392330	Plastics; carboys, bottles, flasks and similar articles, for the conveyance or packing of goods
392340	Plastics; spools, cops, bobbins and similar supports, for the conveyance or packing of goods
392350	Plastics; stoppers, lids, caps and other closures, for the conveyance or packing of goods
392390	Plastics; articles for the conveyance or packing of goods n.e.c. in heading no. 3923
630533	Sacks and bags; of a kind used for the packing of goods, of man-made textile materials, of polyethylene or polypropylene strip or the like, not flexible intermediate bulk containers

Note: This category – and the HS system – includes only on 'empty' plastic packaging traded as a product in its own right. It does not include the considerable volume of plastic packaging associated with pre-packaged goods, such as processed food products, or that accompanies household goods, personal electronic devices) and is used by international transporters and distributors of goods that cross international borders. See also discussion on page 10 of this paper.

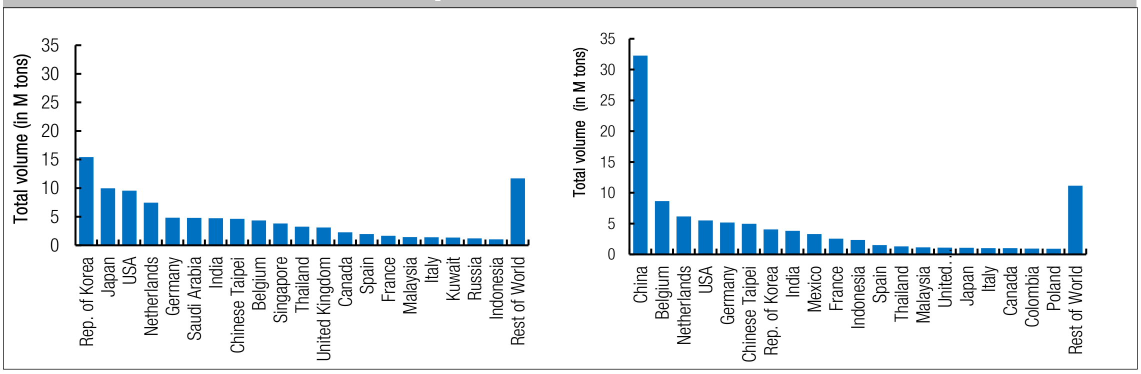
Annex 2: Supplementary figures on plastic trade flows

Figure 1a, b. Value of exports (left) and imports (right) in feedstocks & precursors that can be used in plastics – 2018



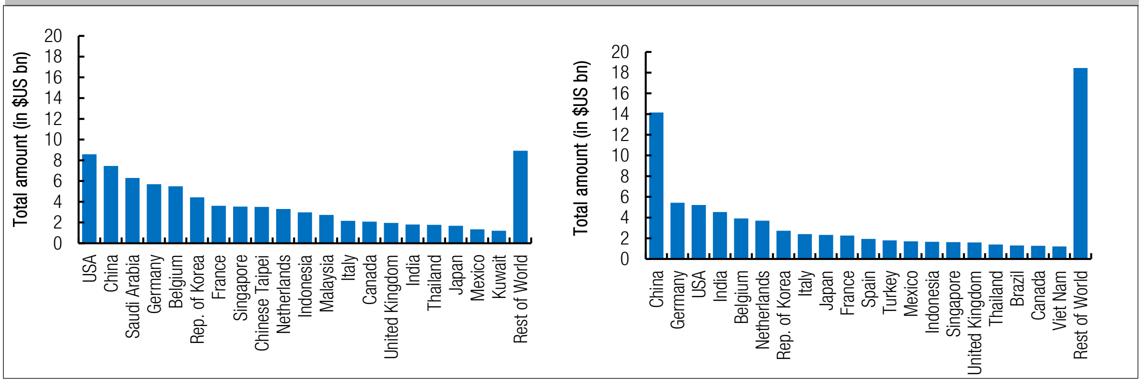
Source: All computations are based on the UNCTAD Plastics database prototype, as of October 2020.
Notes: In all computations, USA includes Puerto Rico and United States Virgin Islands; Belgium includes Luxemburg; France includes Monaco; Chinese Taipei is reported as "Other Asia, not elsewhere specified; Rest of World is the sum of all other countries.

Figure 1c, 1d. Volume of exports (left) and imports (right) in feedstocks & precursors that can be used in plastics – 2018



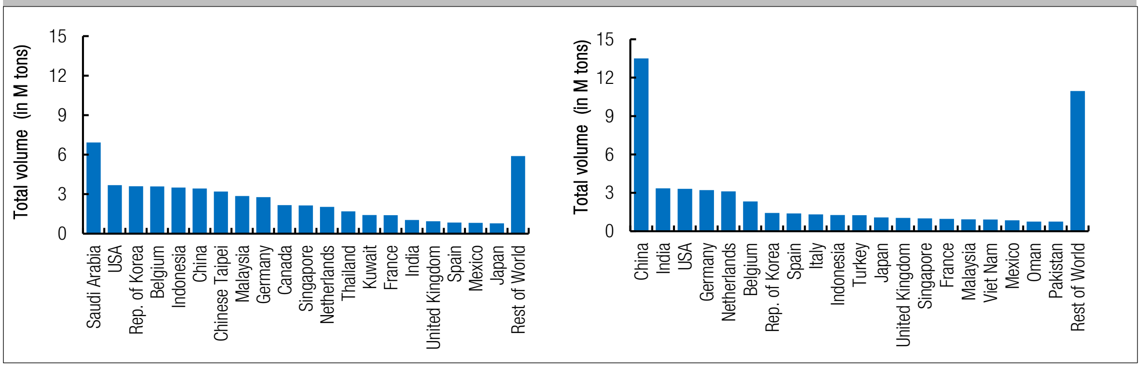
Source: As Fig 1 a,b.

Figure 2a, 2b. Value of exports (left) and imports (right) in additives that can be used in plastics – 2018



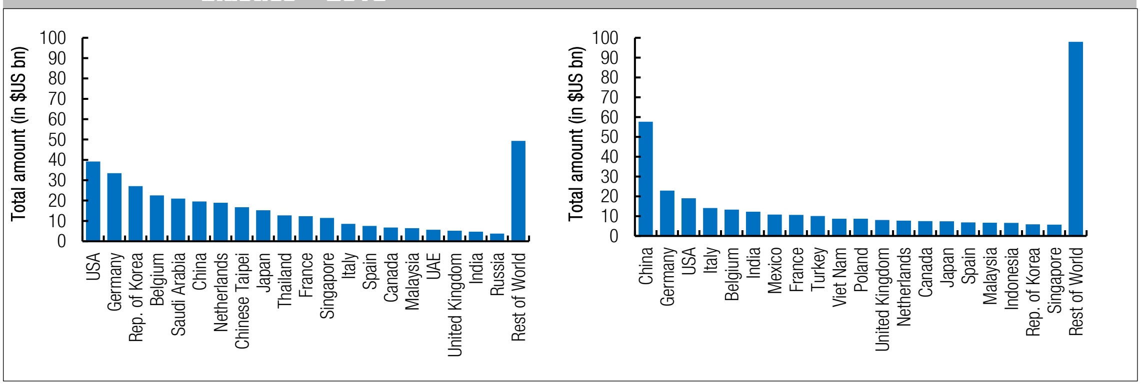
Source: As Fig 1 a,b.

Figure 2c, 2d. Volume of exports (left) and imports (right) in additives that can be used in plastics – 2018



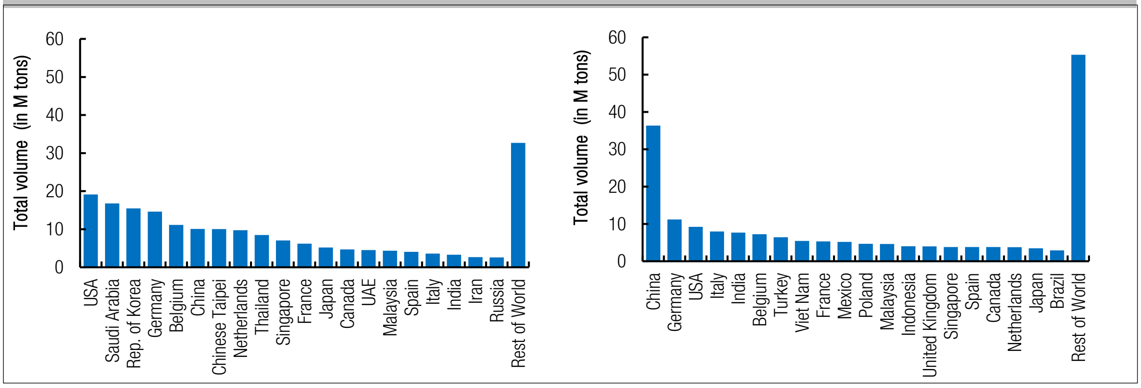
Source: As Fig 1 a,b.

Figure 3a, 3b. Value of exports (left) and imports (right) in primary forms of plastics – 2018



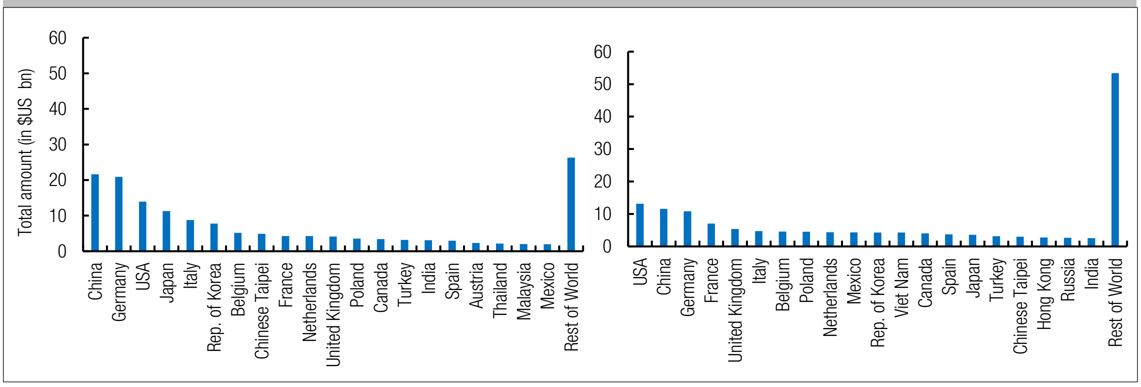
Source: As Fig 1 a,b.

Figure 3c, 3d. Volume of exports (left) and imports (right) in primary forms of plastics – 2018



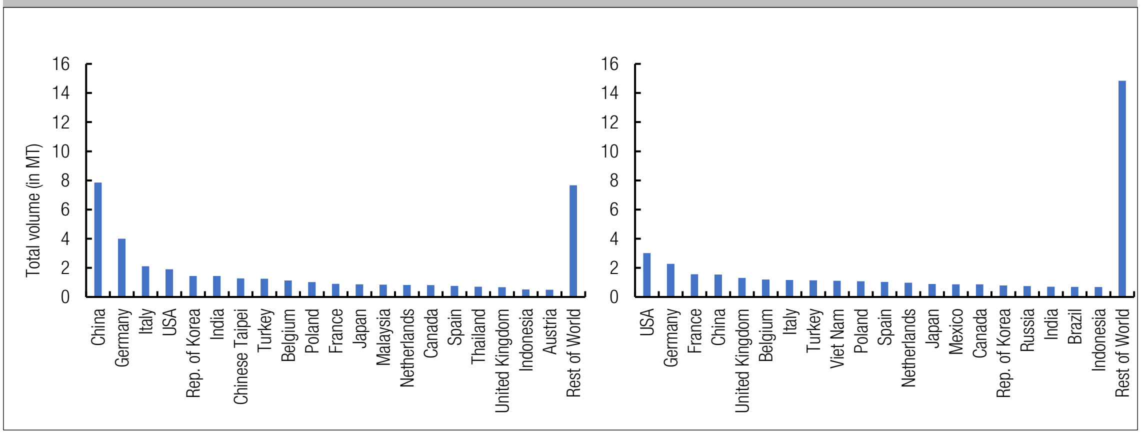
Source: As Fig 1 a,b.

Figure 4a, 4b. Value of exports (left) and imports (right) in intermediate forms of plastics – 2018



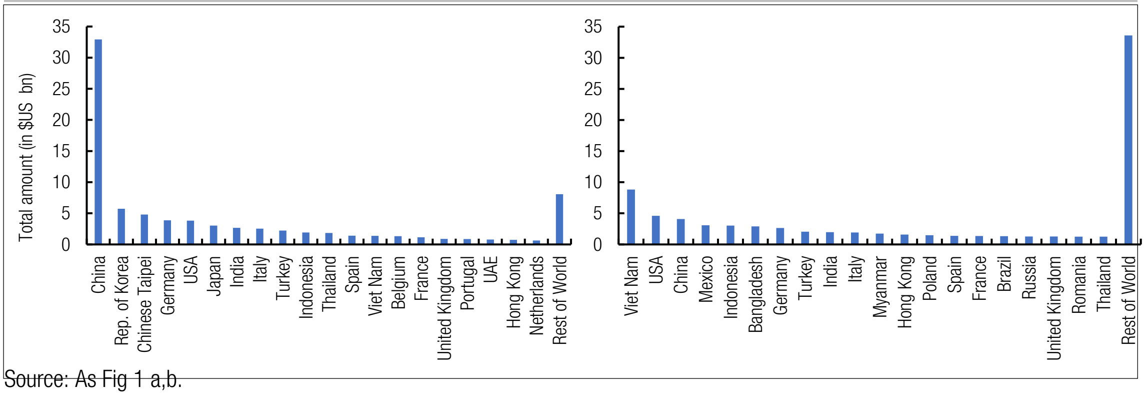
Source: As Fig 1 a,b.

Figure 4c, 4d. Volume of exports (left) and imports (right) in intermediate forms of plastics – 2018, million metric tonnes (MT)



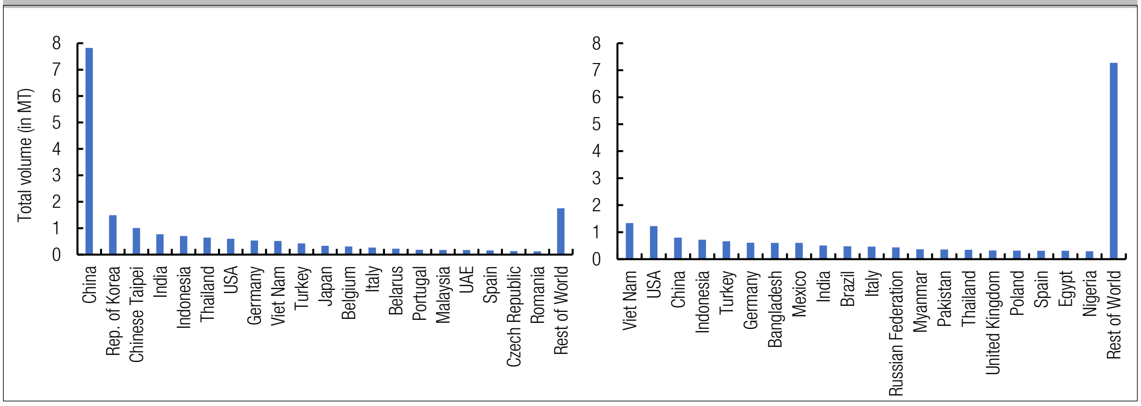
Source: As Fig 1 a,b.

Figure 5a, 5b. Value of exports (left) and imports (right) in intermediate manufactured plastic goods – 2018



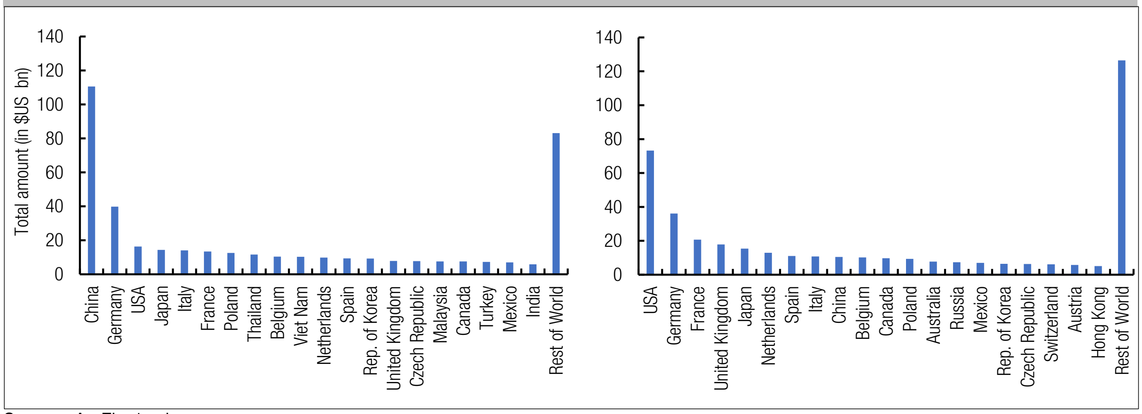
Source: As Fig 1 a,b.

Figure 5c, 5d. Volume of exports (left) and imports (right) in intermediate manufactured plastic goods – 2018, million metric tonnes (MT)



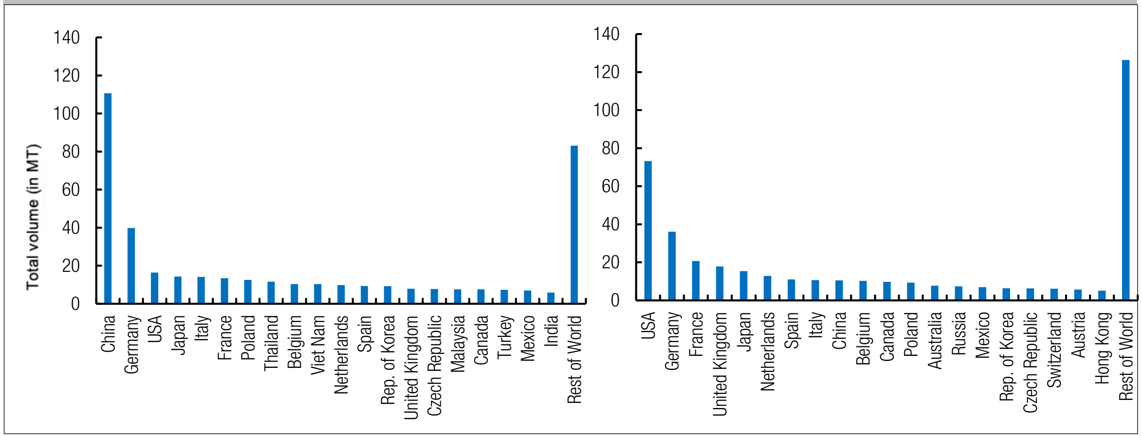
Source: As Fig 1 a,b.

Figure 6a, 6b. Value exports (left) and imports (right) in final manufactured goods – 2018



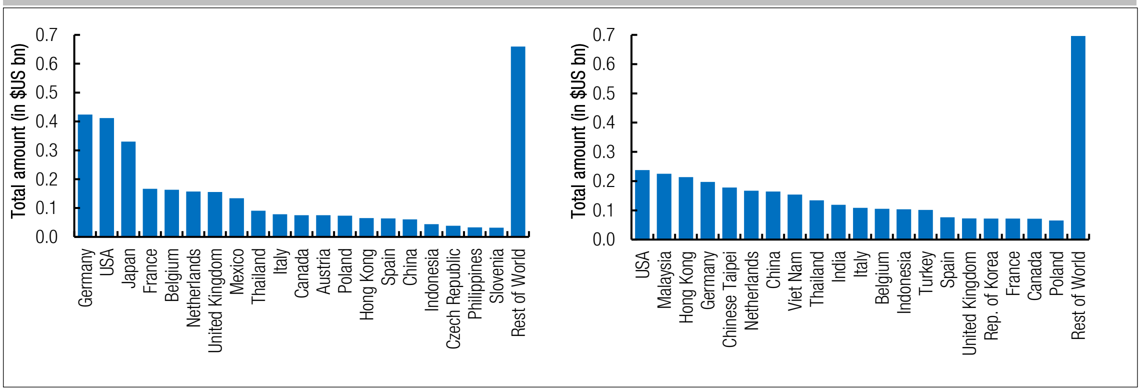
Source: As Fig 1 a,b.

Figure 6c, 6d. Volume exports (left) and imports (right) in final manufactured plastic goods – 2018 (MT)



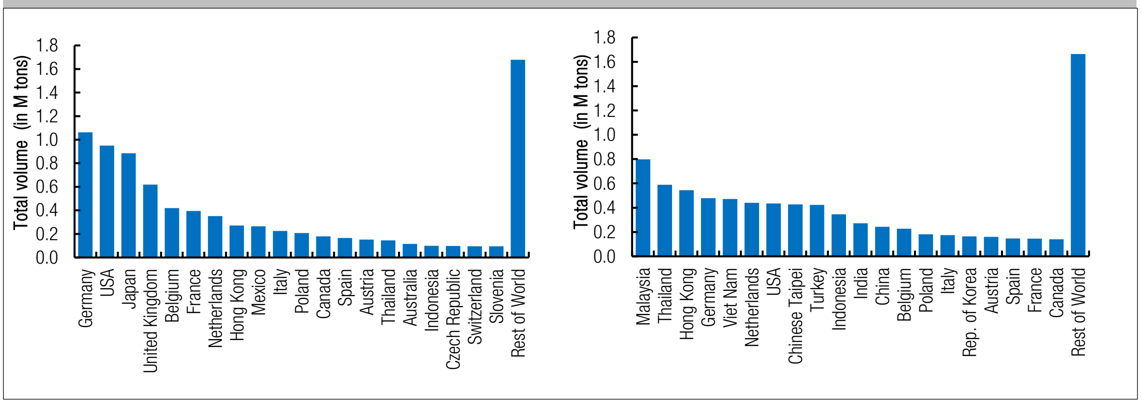
Source: As Fig 1 a,b.

Figure 7a, 7b. Value exports (left) and imports (right) in plastic waste – 2018



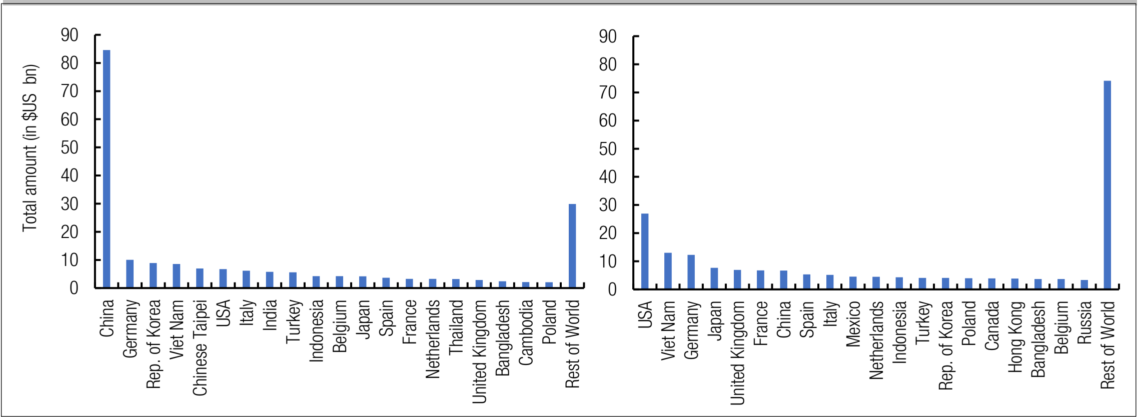
Source: As Fig 1 a,b.

Figure 7c, 7d. Volume exports (left) and imports (right) in plastic waste – 2018



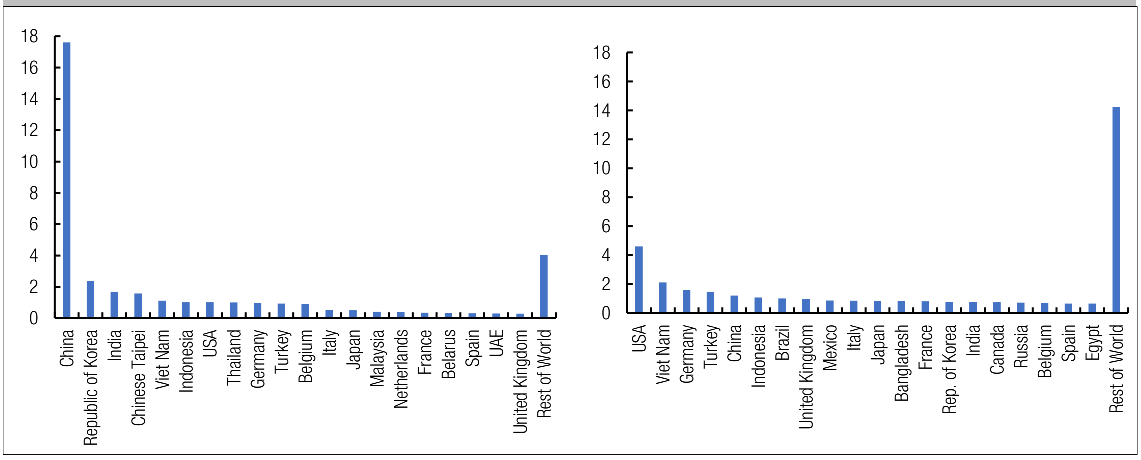
Source: As Fig 1 a,b.

Figure 8a, 8b. Value exports (left) and imports (right) in synthetic textiles – 2018



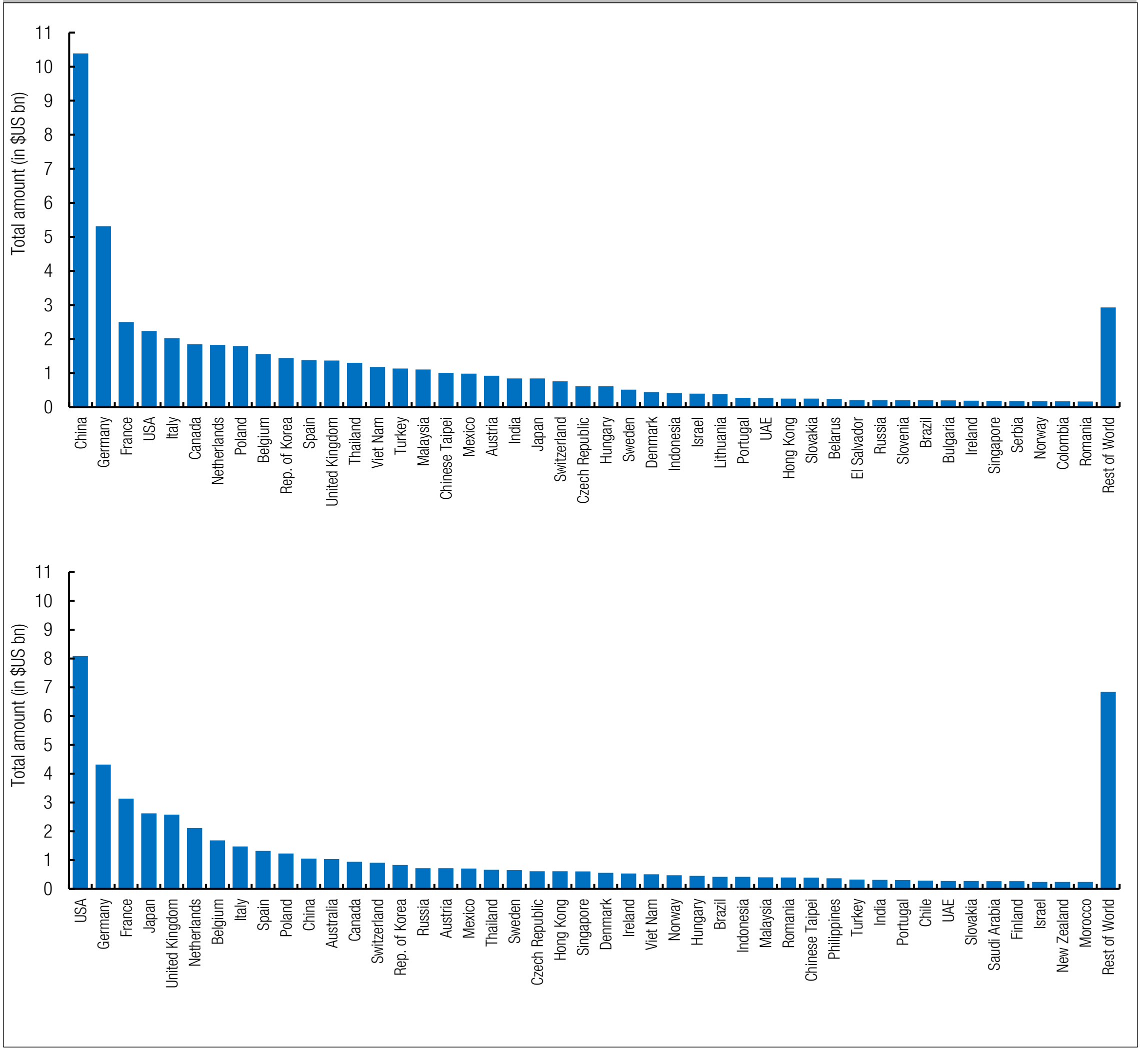
Source: As Fig 1 a,b.

Figure 8c, 8d. Volume exports (left) and imports (right) in synthetic textiles – 2018



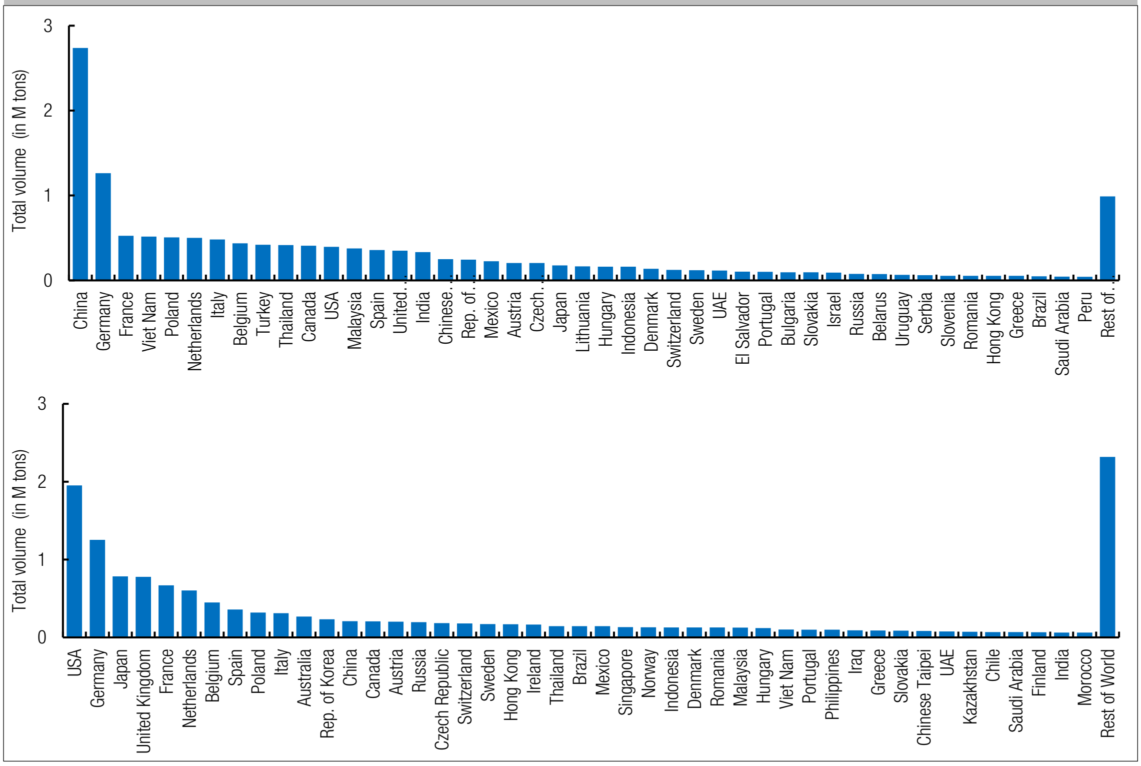
Source: As Fig 1 a.

Figure 9a, 9b. Value exports (top) and imports (bottom) in plastic packaging – 2018



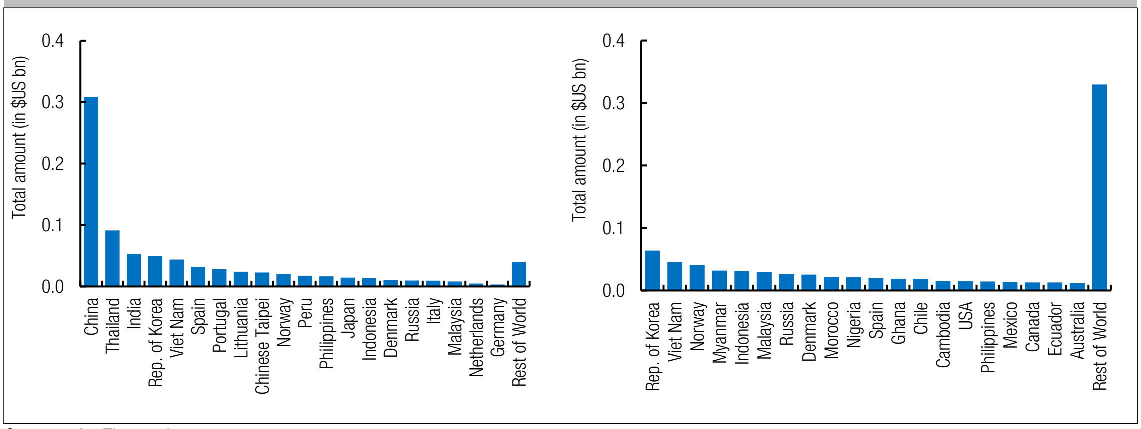
Source: As Fig 1 a,b.

Figure 9c, 9d. Volume exports (top) and imports (bottom) in plastic packaging – 2018



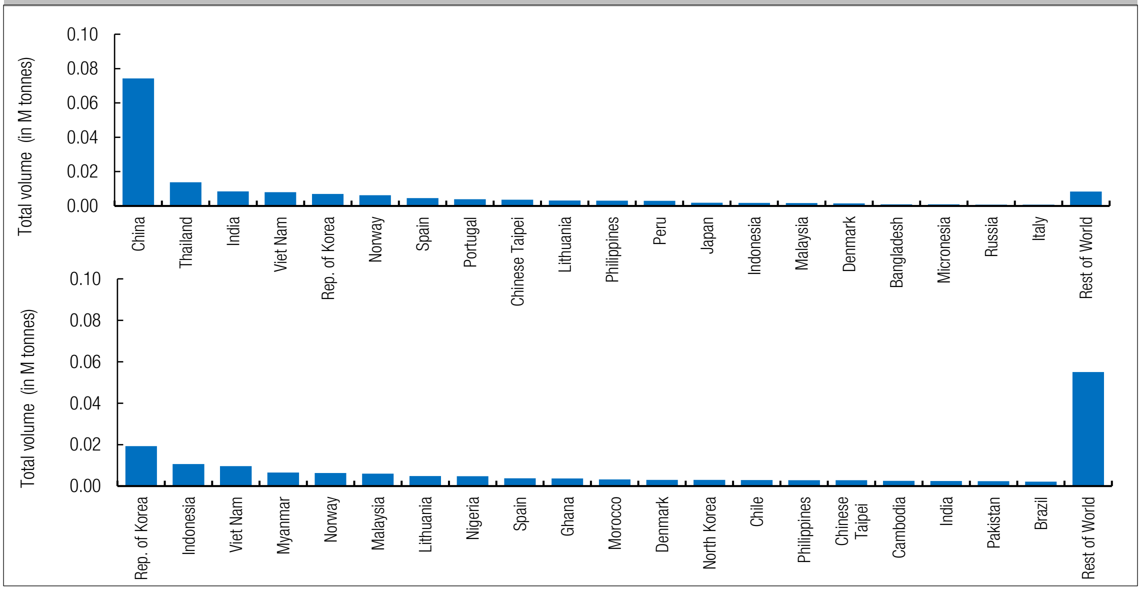
Source: As Fig 1 a,b.

Figure 10a, 10b. Value exports (left) and imports (right) in fishing nets – 2018



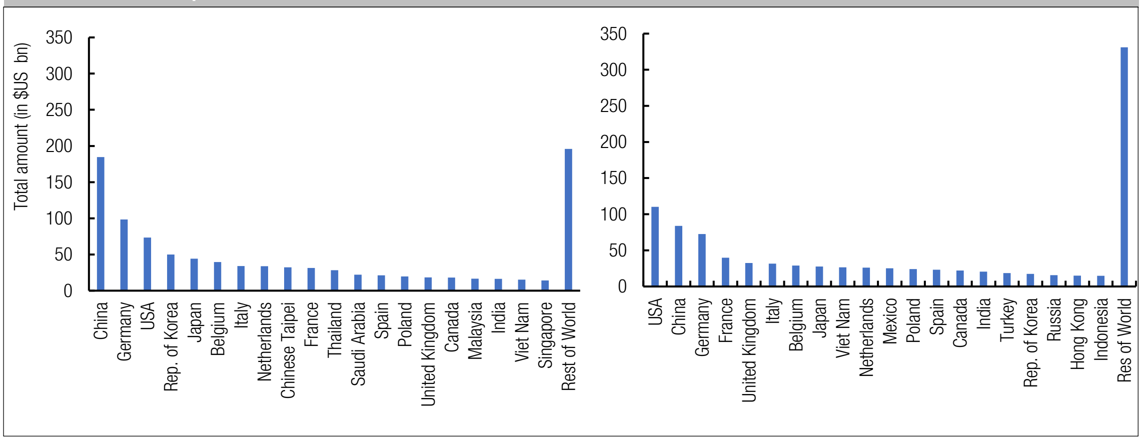
Source: As Fig 1 a,b.

Figure 10c, 10d. Volume exports (left) and imports (right) in fishing nets – 2018



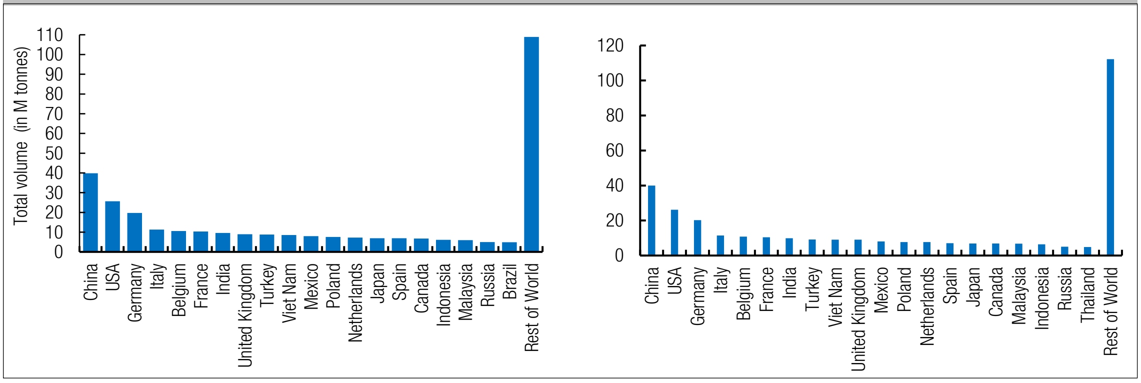
Source: As Fig 1 a,b.

Figure 11a,b. Value exports (left) and imports (right) in total plastic products – 2018, $US bn



Source: As Fig 1 a,b.

Figure 11c,d. Volume exports (left) and imports (right) in total plastic products –

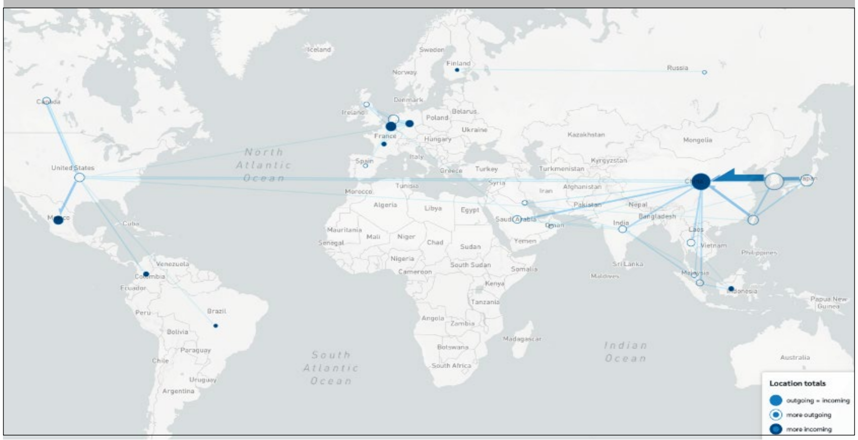


Source: As Fig 1 a,b.

Figure 12. Bilateral trade flows – feedstocks and precursors

Source: As Fig 1 a,b.

Figure 13. Bilateral trade flows – additives



Source: As Fig 1 a,b.

GLOBAL ECONOMIC GOVERNANCE PROGRAMME

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Transforming the Global Plastics Economy

The Political Economy and Governance of Plastics Production and Pollution

Diana Barrowclough and Carolyn Deere Birkbeck

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Transforming the Global Plastics Economy: The Political Economy and Governance of Plastics Production and Pollution

Diana Barrowclough and Carolyn Deere Birkbeck*

Abstract

Despite growing alarm about plastic pollution, the production and use of plastics is forecast to continue to expand over coming decades. Efforts on the part of governments, civil society and business to reduce plastics pollution are encouraging signs of awareness and an appetite for engagement but are, nonetheless, failing to stem the tide of growing plastic production, use and waste.

To date, there has been remarkably little scholarly interest in the global plastics economy. Both the global political economy and root causes of the plastics crisis are vastly under-studied. Most efforts towards change (whether voluntary or regulatory) have been focused on the 'end of life' of the plastics value chain, rather than its starting point. Attention to the upstream dimensions of the plastics economy – that is, to the production end of the plastics life cycle – is not yet central to international policy discussions nor are the international policy frameworks needed to address them.

This paper seeks to spur discussion on an integrated set of policies – and an enabling international framework – to support an effective transformation of the plastics economy, including a just and sustainable transition, away from excessive plastic production and unnecessary use. It brings together, for the first time in the literature, a first step toward an integrated analysis of what we call the missing 'political economy piece' of evolving global discussions of challenges and responses to plastic pollution. It highlights some critical policy steps that can be taken to help face these structural challenges and transform our economy away from the grip of plastics, along with a policy-oriented research agenda.

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Introduction

Despite growing alarm about plastic pollution, the production and use of plastics is forecast to continue to expand over coming decades. Efforts on the part of governments, civil society and business to reduce plastics pollution are encouraging signs of awareness and an appetite for engagement but are, nonetheless, failing to stem the tide of growing plastic production, use and waste. Even before the coronavirus crisis, it was evident that bolder steps were needed to help restore a better balance between humanity and the environment. This paper aims to highlight some critical policy steps that can be taken, sooner rather than later, to help face these structural challenges and transform our economy away from the grip of plastics.

Considerable efforts have been invested over the last few years in identifying and assessing sources and impacts of marine plastic pollution (Beaumont et al 2019; Boucher et al 2019). Consumer-led campaigns, business initiatives, and government-led policy efforts have all come into play at the national level. In terms of international cooperation, a wide range of intergovernmental processes and organisations are involved in some aspects of the plastic pollution challenge. At present, the most prominent inter-governmental processes, such as those associated with the UN Environment Assembly, focus on reducing plastic pollution in the world's oceans and marine environment, and on mobilising cooperation and resources 'downstream' to boost the quality and scale of waste management and recycling.

On the scholarly front, there has been growing interest in how international environmental policy and law could be strengthened to tackle marine plastic pollution, including its land-based sources (Haward 2018; Simon 2017; Raubenheimer & McIlgorm 2018; Tiller and Nyman 2018; Vince and Hardesty 2017, 2018). Several studies make the case for a new international treaty to address marine plastic pollution. At the same time, the global attention to marine plastic pollution is also spurring calls for widening the frame to recognise and tackle challenges of plastic pollution across the life cycle of plastics – from extraction through manufacturing to consumption and disposal – as well as the wider social, health and development challenges. In particular, amidst efforts to reduce carbon emissions and stem climate change, the carbon-intensity of the plastics, over 98% of which are based on virgin fossil-fuel derived feedstocks, adds a compelling new reason to rethink plastic production and use (Azoulay et al 2019).

To date, most efforts towards change (whether voluntary or regulatory) have been focused on the 'end of life' of the plastics value chain, rather than its starting point. Meanwhile, attention to the upstream dimensions of the plastics economy – that is, to the production end of the plastics life cycle – is not yet central to international policy discussions nor are the international policy frameworks needed to address them (Nielsen et al 2020). At the international level, action 'upstream' currently relies primarily on voluntary business efforts and corporate commitments, pressure from citizens and NGOs, hope that new technologies will fix key challenges, and a disparate set of uncoordinated national policies.

A broader perspective, which is the starting point for this research, builds on and goes beyond the focus on marine litter and pollution, to explore the role of the upstream challenges related to plastic production, and most importantly the production of excessive, unnecessary and problematic plastics.

To date, there has been remarkably little scholarly interest in the global plastics economy. Both the global political economy and root causes of the plastics crisis are vastly under-studied. Beyond the chemistry literature on plastics, most scholarly attention has focused on understanding marine plastic pollution and on options for boosting international environmental law and cooperation on marine plastic pollution. Beyond a handful of histories of the chemical and plastics industry (Aftalion 2001; Fenichell 1996) and studies of the cultural anthropology of plastics consumption and pollution (Frankel 2011; Gabrys et al 2017; Hawkins, 2018; Hawkins et al 2015; Liboiron 2016), wider interdisciplinary attention has been limited (Vince and Stoett 2018). Although economics and politics of regulating chemicals has attracted scholarly attention for several decades (see, for instance, Hough 1998 and 2008; Swanson 1995, 1998), only a handful of studies address the challenges of global chemical governance, and these offer limited specific attention to plastics (Khan and Honkonen 2017; Escobar-Pemberthy et al 2018; Selin 2010; Tuncak & Ditz 2013). Although the political economy of plastic waste and waste trade is attracting growing attention from the media, think tanks and some scholars (Grosz 2011, GRID-Arendal 2019, Brook et al 2018; O'Neill 2018), it has not been a central theme in recent scholarly literature on the global governance of global waste and toxic waste trade (Grosz 2011; Khan 2016; Minter 2015; Pellow 2017). While interest of political scientists to the politics of plastics regulation and the framing of the plastics problem is growing, to date, there has been little systematic political or economic assessment of the range of global policy, regulatory and governance options for better responding to the 'upstream' causes of expanding plastic production and pollution.

Moving beyond voluntary business initiatives and appeals to consumer power and societal good will, this paper seeks to spur discussion on an integrated set of policies – and an enabling international framework – to support an effective transformation of the plastics economy, including a just and sustainable transition, away from excessive plastic production and unnecessary use.

The underlying thesis of this paper (and the wider project of which it is a part) is that moving beyond our excessive reliance on plastics requires greater scholarly and policy attention to the global political economy of the plastics economy – and specifically to the strong economic and commercial forces that propel expansion of the global plastic economy. Plastics is a big business, developed over several decades that employs millions of people around the world and is driven by a myriad of underlying socio-economic, institutional and political factors. The fossil fuel and petrochemical industries that underpin growth of the plastics sector – are among the world's most powerful in terms of economic might and political influence – have strong interests in "business as usual", or at least for as long as it can last, even whilst some important players in the industry have embraced the need to experiment with new, more sustainable alternatives. Further, the use of plastics has become so integral to many aspects of industrialization, development and trade – whether as manufactured products (ranging from television sets, the car and toy industries and synthetic clothes, or as packaging (including food products shipped to world supermarkets).

Amidst the COVID-19 pandemic, the struggle to ensure access to adequate personal protective equipment, much of which is plastic – from masks and gloves to bottled disinfectant – has underlined the practical benefits and applications of plastics but does not diminish the case for a more environmentally sustainable plastics economy. Rather, it underscores the need for recognising the many types of plastics with different purposes, degrees of necessity, potential for reuse and recycling, environment and health impacts, and durability. A clear case remains for minimizing plastics production for unnecessary, excessive and wasteful end-uses; promoting less environmentally harmful alternatives and substitutes; and reducing production and use of virgin plastics in the plastics economy. Indeed, for many, the Covid-19 is a timely warning of another enduring crisis – the climate crisis – predicted to have even more far-reaching social, economic and environmental effects, and to which the plastics sector contributes greatly in terms of greenhouse gas emissions. On the positive side, as government seek to spur economic recovery from the Covid-19 crisis, they have an opportunity to transform and re-start production processes in a more sustainable way and to reflect the newfound possibilities of consumers to change long-held habits and preferences. On the negative side, the plunge in oil and gas prices associated with Covid-19 is putting further downward pressure on the already low price of fossil fuel feedstocks that drive expanding virgin plastic production, which may put at risk sustainability efforts in the plastics sector (CIEL 2020; ICIS 2020). So long as virgin plastic is cheap, market incentives to recycle plastic, to reduce certain kinds of production and to invest in alternatives will be limited.

Transforming the plastics economy, as with wider low-carbon transformation, will demand attention to economic considerations such as the barriers to adaptation and how to address stranded assets, including those related to fossil fuels and petrochemical production, as well as a recognition that vested interests may not adapt quickly and will deploy political resources to defend the status quo (Ansari and Holz 2020). It will require attention to the links between the upstream and downstream phases of the plastics economy – as exemplified by circular economy approaches that aim to create synergies between recycling, more recycled content in plastics and the redesign of plastics to make them more easily recycled EMF and WEF 2017; OECD 2019a). Further, in today's highly integrated global economy, where money and products flow easily across many borders, concerted international policy co-ordination and action will be essential to support national regulatory efforts to address plastic pollution - no single country can succeed alone.

In this context, this paper brings together, for the first time in the literature, a first step toward an integrated analysis of what we call the missing 'political economy piece' of evolving global discussions of challenges and responses to plastic pollution. It offers an introductory mapping of global production in plastics, the market structure of the plastics economy; the key stakeholders and commercial players in the global plastics economy – traders, investors and financial institutions – and their strategies; as well as the international finance, investment and trade flows that propel current trends. It also aims to improve understanding of the political economy of existing responses from the private sector, citizens and government as key designing appropriate legislative policies, rules and norms. In so doing, it identifies gaps in data and in the literature on the policy and regulatory responses necessary to transform the global plastics economy and reduce plastic pollution.

Looking ahead, this paper argues that a bold, integrated coordinated policy approach is needed, which reflects the complexity of the plastics sector and the multifaceted aspects of the plastics challenge. Critically, the success of efforts to sustainably transform the global plastics economy in order to reduce our excessive consumption of plastics and to find a new, less polluting and low-carbon path, will depend on providing support for various adaptation and transition phases, to get 'buy in' for the necessary leaps and to stay on track. There are two sides of the same coin that need to be addressed – namely promoting a *just transition* as part of the process to secure a *sustainable transformation* away from conventional plastics toward a more sustainable future. Here, there is a parallel with wider calls for a Global Green New Deal for a carbon-neutral economy (UNCTAD 2017 and 2019), which represent a potentially significant nexus of economic and environmental sensibilities that also argue for a sustainable transformation of the economy and a just transition away from environmentally and socially degrading economic processes.

Outline of this paper

Part 1 of this paper reviews the evolving framing of the plastics crisis and views on appropriate responses, highlighting the wide range of initiatives on the part of government, business and civil society – from the voluntary to legally enforceable. Part 2 maps key trends in the political economy of plastic production, identifying key phases and stakeholders in the plastic value chain and key drivers of expanding production. Parts 3 reviews the evolution of the international policy landscape over three phases. Drawing on this background, Part 4 identifies strategic debates on future directions for global governance of plastic pollution and plastics, arguing that an integrated policy approach that integrates environment and economic policy tools – supported by an enabling international framework – is needed to promote sustainable transformation of the plastics industry. Part 5 presents a summary of findings and research gaps. To conclude, Part 6 of the paper argues for a policy-oriented research agenda that focuses attention on information and analytical gaps in relation to: 1) political economy and drivers of the ongoing growth and dispersion of the global plastics economy; and 2) strategic international measures for improved global regulation and governance.

1. Evolving definitions of the 'problem' and solutions

1.1. An overview of the reframing of the plastics crisis

Heightened public consciousness about the scale and impact of plastic pollution has soared over the past 10 years, especially due to the efforts of powerful environmental advocacy groups and natural history broadcasters to show visually the shocking impact of "leakage" of plastic into the ocean. Scientists have underscored that in addition to larger pieces of marine debris and litter – from plastic bags and bottles to discarded fishing equipment and plastic pellets—much smaller plastic particles, known as microplastics, are also extremely damaging to marine biodiversity, ecosystems, wildlife and fisheries (GESAMP 2015; GRID-Arendal 2020; Jambeck et al 2015).[1] Key sources of microplastic pollution include washing of synthetic textiles (by households and industrial facilities), tyre abrasion and erosion of paint coatings, as well as the breakdown of larger plastic little into smaller components (Boucher and Friot 2017).

This heightened awareness has also been accompanied by important evolutions in both perceptions and understanding of the nature of the world's plastics crisis and appropriate solutions. In the policy arena, discussions have been reframed in several ways, as evidence and advocacy on the complexity of the challenges at hand have grown. Further, there are ongoing efforts to further shift the focus of the policy debates and responses.

[1] There is a wealth of scientific and environmental literature on this topic, including Jambeck et al, (2015), estimating the scale and impact of marine pollution; Boucher and Friot 2017, on the danger of micro-plastic particles less than 5mm in size; Eriksen et al (2014) estimates there are 5.25 trillion plastic pieces floating in the ocean, or 720 pieces per person on the planet. Plastic debris of any size can be dangerous for marine ecosystems (Halpern et al 2008; UNEP 2016a).

Broadly speaking, the framing of the plastic pollution problem over the past decade has expanded from:

- a concern focused tightly on marine plastic litter as well as microplastics at the 'downstream' end of the plastics life cycle toward a recognition of the land-based sources of ocean pollution, and the challenges of plastic pollution on land;
- toward a wider interest in plastic pollution across the life cycle and the range of sustainable development implications;
- and finally, toward challenges 'upstream' related to the production of plastics, including a new recognition of the contribution of plastics to carbon emissions and global warming.

There are also feedback loops between these debates and not all evolved sequentially. Moreover, some of these wider concerns have been on the table for decades (e.g., regulation of chemicals used in plastics). Nonetheless, the simplified framework in Box 1 provides a useful entry-point for understanding the layering of concerns in the mainstream media and political discussion. [The evolution of responses is addressed in part 1.3).

In terms of the 'downstream' concerns, a core aspect of the plastics problem is that as plastic production and use have grown, the world's capacity to manage the enormous volume of plastic waste generated has not kept up (WWF, 2019). Only a minor fraction – an estimated 10% – of all plastic waste produced has been recycled.[1] In 2015, of 141 million tonnes of packaging waste, only an estimated 10% of plastic packaging was effectively recycled, the majority of the rest was landfilled (40%), incinerated (14%) or leaked into the environment – that is, into fields, streets, rivers and oceans. Further, with growing plastic production and use, plastic waste generation is also still growing with an increase of 41% expected by 2030 (WWF 2019).

Box 1. Layering of frames about plastics pollution

Layer 1	**Layer 2**	**Layer 3**
'Downstream' plastic pollution in oceans	Array of sustainable development challenges across the life cycle of plastics from production to disposal	'Upstream' challenges
- Marine litter - Microplastics ○ as well as in rivers and on land in sewage systems, agriculture fields, and roads	- Chemical pollution - Health impacts - Carbon footprint - Economic & fiscal costs …Especially in developing countries and poor communities	- improving plastic design + production - reducing unnecessary use - reducing production of certain products + virgin plastic inputs; - effective recycling markets …a more circular global plastic economy

Among the many campaigns about plastics, it is the impact of plastic pollution on the world's oceans and marine environment that has most captured the attention of the public, media and policymakers over the past decade. Overall, conservative estimates are that 100 million tons of plastic have leaked into the world's oceans, and that an estimated one third of all plastic packaging leaks into the world's oceans (WEF 2017). Critically, between 80-90% of that marine plastic pollution comes from land-based sources and the rest from sea-based activities (Ocean Conservancy 2015; Ryan 2015; Gallo 2018).

The recognition of land-based sources of plastic pollution has spurred attention to the challenges many countries – especially developing countries – face with managing plastic waste. This has prompted a growing body of research on methodologies and strategies to identify sources of plastic waste and to prevent leakage into oceans and manage its multiple impacts on land as well (Boucher et al 2020; Qantis and EA 2020). It is well known that many developing countries, including the poorest and small island developing states, are engulfed by marine litter on beaches, and in their coastal environments and their fishing zones. Beyond the seas, many developing countries faced blocked sewage systems, clogged rivers and water ways, soil and air pollution due to mismanaged landfills and open dumping of plastic waste, as well as toxic emissions and by-products due to poor quality infrastructure for recycling and incineration. Vulnerable low-income economies are the least likely to have the resources and infrastructure to address these challenges.

Together, the leakage of plastic waste into the environment represents a huge loss of material value to the global economy. On the commercial side, the failure to recycle or recapture the value of plastic has been estimated to represent a loss of between $80 and $120 billion in value to the plastics industry annually (WEF 2017). The broader economic costs, including environmental and health costs of plastic pollution are much higher. For many developing countries, for instance, plastic pollution presents significant economic challenges and fiscal burdens arising from the need to address: i) the environmental and health impacts associated with landfill and incineration of plastic waste, as well as sewage and other infrastructure clogged with plastic; ii) damage to sewage system and infrastructure; iii) infrastructure and systems to improve waste management, including waste that can neither be recycled nor composted; and iv) threats to local tourism, agriculture, fisheries and shipping industries (Schröder 2017a, b, 2018a; GAIA & Greenpeace East Asia 2019; Williams et al 2019).

Alongside an enduring central preoccupation with these multiple downsides associated with plastic waste leaking into the environment, a growing array of environmental experts are presenting evidence on environment, health and development challenges present across the life cycle of plastics (Steensgaard et al 2017). Arresting as is the impact of plastic waste on the environment, the focus on plastic pollution in terms of volume of waste, they call for attention to linked environment, health and human rights impacts of chemical pollution across the life cycle of plastics – from the chemical safety aspects of food packaging, to toxic pollutants present in plastic waste, and the interactions of toxic chemicals and microplastics (Azoulay et al 2019). In addition to the visible aspects of plastic pollution, there is growing scientific evidence of toxic chemicals and additives (including persistent organic pollutants) present in plastic particles that pollute land and air, eventually making their way into the food chain. The growing body of scholarly work and evidence on the health and environmental impacts has been harnessed by the Break Free From Plastic civil society movement, in its framing of the plastics crisis as a global environmental justice issue, highlighting the environment, health and fiscal burden on poor communities, both in developed and developing countries where plastic is produced, and developing countries used as a dumping ground for plastic waste.

A further critical issue element in the current framing of the plastics problem relates to the nexus between the climate and plastics crises in and beyond the world's oceans, and specifically to the contribution of the plastics sector to the climate crisis (Stoett and Vince 2019; Azoulay 2019). As more than 98% of plastic production relies on fossil fuel feedstocks, the sector's relevance to efforts to reduce climate emissions is clear. On the one hand, industry proponents highlight that plastics products have attributes that can contribute to reduction of climate emissions (e.g., light-weight plastic packaging can reduce emissions associated with transportation of goods; plastic components for motor vehicles to reduce their weight and fuel needs; and certain products, like plastic insulation, are important to energy conservation and save more energy than used for their production). On the other hand, amidst growing pressures for 'Green New Deals' national and globally, the plastics like all sectors of economic activity face pressure to adjust to contribute to efforts toward a carbon-neutral global economy (UNCTAD 2019). In Europe, for instance, the plastics industry is one of the top four largest sources of GHG emissions (the top four are steel, plastics, aluminium and cement) (Material Economics, 2018a: 3). Important to consider is that climate costs are present at each stage of the life cycle of plastic need to be considered: extraction and transport of fossil fuels for plastic production; refining and manufacturing;[2] waste management (such as in plastic waste incineration processes); and waste re-use and recovery (Azoulay 2019). In addition, the impacts of plastic pollution on ocean carbon sequestration are being studied. Across the plastics value chain, CO2 emissions are expected to increase 50% by 2030 (WWF 2019, CIEL 2019c). If current trends in plastics usage continue as expected, the plastics sector will account for 20% of total oil consumption and 15% of the global annual carbon budget by 2050 (Barra et al 2018; WEF 2017; CIEL 2017).

1.2. Perspectives on sources of plastic pollution and root causes

As alluded to above, differences in definitions and perspectives on the scope of the 'plastics problem' lead to differences of opinion on root causes and reasons for plastics pollution, and thus also on appropriate responses (addressed in Part 1.3.)

Conventional explanations

The dominant explanation for plastic pollution, and specifically the leakage of plastic pollution into the marine environment, is that countries have insufficient waste management capacity to collect and sort waste, and then safely recycle, incinerate, landfill or reuse that waste. One challenge is that products are not designed in ways that make them easily sorted or cost-effectively recycled (e.g., they are mixed with cardboard, aluminium or different types of plastic), or that their chemical composition makes it difficult for them to be compostable, biodegradable or recyclable, or that the presence of toxic elements in plastics or the contamination of products makes them too dangerous to recycle. The key responses to such problems are financial and technical – to invest in waste management capacity, better design plastics and plastic products, to remove toxic chemical properties from plastics, and to ensure a higher market value for plastic waste – by ensuring profitable markets for recycled waste materials. A related challenge is that consumers are increasingly

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[2] In 2015, for instance, the refining and manufacturing of plastics was estimated to have contributed between 184 million to 213 million metric tons of greenhouse gases (equivalent to about 45 million vehicles driven for a year) (CIEL 2019c). Efforts to manage plastic waste, mostly via incineration, were estimated to have contributed a further 16 million metric tons of greenhouse gases in 2015 (CIEL 2019c).

confused – if well-meaning – about the options for recycling plastics and recycling behaviour and rates vary widely between types of plastics (Henriksson et al 2010).

A subset of this story is that the core problem of plastic pollution relates to mismanagement of plastic waste by developing countries. In terms of the sources of plastic waste leaking into oceans, it is true that the top 6 sources of plastic pollution in the oceans are estimated to be, in order, China, Indonesia, Philippines, Vietnam, Sri Lanka, Thailand. Indeed, all of the top 20 countries sources of leakage are developing countries. Clearly, one aspect of the problem is that these countries lack the regulatory framework, institutional capacity and business infrastructure to safely manage the scale of plastic waste at hand. For some developing countries, the scale of the plastics problem they face has three dimensions: they import plastic products and products that contain plastics, which then become waste they can't manage; and they also produce plastic products domestically; and they also import plastic waste from other countries.

As developed country governments have struggled over the past decade to manage rising volumes of plastic waste produced and used within their borders, their exports of plastic waste have risen significantly. In 2018, the United States, Japan, Germany, Britain and Belgium were the main exporters of plastic waste, most of which was destined for developing countries, especially in Asia. Contrary to assumptions that such countries had a comparative advantage in processing waste, most were already struggling to manage the growing scale of mismanaged, domestic plastic waste. Still, the global waste trade was seen as a strong growth industry for waste management and recycling companies in developing countries, and was a lucrative industry for plastic waste traders and transporters who profited, sometimes through corruption, abuse and fraud, from the trade in plastic waste (Laville 2018).[3] To give a sense of the financial stakes at hand, the global plastic waste management market was estimated to be worth some US$32.6 billion in 2019 (Marketsandmarkets 2019). The export plastic waste also provided a solution for retailers and local authorities in developed countries under pressure to manage their waste – by shipping growing volumes to unseen destinations abroad.

This wider political economy of plastic pollution only became prominent in the public eye when, over the past two years when countries at the receiving end of (mixed and unsorted) plastic waste from foreign sources started refusing these problematic shipments. Until 2018, China imported over two-thirds of the volume of global plastic waste trade. In 2018, after China's 2018 'National Sword' policy introduced an import ban on most plastic wastes, this plastic scrap was redirected to less regulated countries such as Malaysia, Vietnam and Thailand, and then to Indonesia, South Korea, Taiwan, India and Turkey (GRID-Arendal 2019). Some of these countries too sought to implement import bans and other controls to limit the entry of plastic wastes they deemed themselves unable to effectively manage (including in some instances, sending unwanted plastic waste back to its country of origin). While a subset of developing countries may indeed be an immediate source of leakage due to inadequate waste management, attention to the global plastic waste trade and the unveiling of the myths of recycling have reveals that the root sources of marine plastic pollution lie elsewhere (Ananthalakshmi and Chow, 2019; Franklin-Wallis 2019). Restrictions on plastic waste imports have provoked a considerable decline in global trade flows in

[3] Concerns are growing, for instance, about fraud related to waste export licenses and 'laundering' of plastics wastes, as exporters seek to arbitrage different rules in different locations, or even using third-locations and 'round-tripping' as a hide to commit fraud, as has occurred in the trade of other goods and services.

plastic waste over the past two years. On the one hand, this has forced policymakers in exporting countries to act swiftly on ways to reduce plastic waste, but there are also concerns that if not carefully manage it can reduce incentives for the collection of waste (if there is nowhere for it to go) and threaten global markets for recycling and recycled plastic materials (Staub 2017).

Changing plastics

As noted above, plastics is a catch all phrase for a variety of products that serve a variety of purposes and functions with different chemical properties. One argument is that it is not plastics that are the root cause of the problem per se, but the ways in which they are designed and used, and the absence of adequate capacity to clean up and re-use waste.

Here for instance, there is broad consensus that single use plastics, that are designed to be used only once over a short time span before being thrown away and that are found widely as pollution in the ocean environment, are especially problematic – as is the excessive and unnecessary use of plastic, such as in the case of much single-use plastic packaging, especially where it is not readily recyclable. There has been less public attention or concern, for instance, about plastics used in construction materials because these remain in use sometimes for several decades.

For some, the challenge is simply however to design plastics with different properties so that they do not persist as waste in the natural environment. Many major plastic producers and brands are now partnering with or buying firms engaged in bioplastics, recycling and recycled plastics as ways to ensure they have access to cutting edge materials to mix with or replace conventional plastics (WRAP 2019). While PET is mostly associated with plastic bottles, the fact that PET is more readily recyclable than other plastics is spurring efforts to use PET for a range of other plastics applications. Further, there has been much focus on biodegradable plastics and compostable plastics, or the use of recycled plastic materials to make new products out of recycled plastics. However, while there is considerable optimism about these innovations, and reports of edible plastics and of micro-organisms that can eat plastics, few provide the clear-cut solutions that proponents declare (Royte 2019). A 2015 UN Environment report on biodegradable plastics concluded that on the balance of current scientific evidence “the adoption of plastic products labelled as ‘biodegradable’ will not bring about a significant decrease either in the quantity of plastic entering the ocean or the risk of physical and chemical impacts on the marine environment…” (UNEP 2015). Amongst other factors, the report noted that the “complete biodegradation of plastics occurs in conditions that are rarely, if ever, met in marine environments,” and that the idea that an item may be biodegradable may mean users are more likely to discard it inappropriately.

In addition, as concerns about the climate impact of plastics have grown, there has also been growing interest and investment in “biorefineries” for so-called ‘bioplastics’ made from non-fossil fuel-based feedstocks (Bauer 2018; Marshall 2007). According to their proponents, some bio-based plastics offer features such as better compostability and renewability (in the sense that their feedstocks are renewable) than conventional plastics, but here too questions remain about the potential for the integration of bioplastics into conventional recycling processes (Alaerts et al 2018). As with other efforts to build the profile and legitimacy of new sustainable technologies, there are also questions about the degree to which the terminology of ‘bioplastics’ is misleading by overstating the green credentials of these products (Bauer 2018; Krieger 2019; Krisna et al 2017). An example of a product that aims to address many of concerns about plastics is bio-based PET, that its promoters describe as a biomass-derived, fully recyclable, biodegradable, compostable, and renewable bioplastic material. However, the verifiability and robustness of such sustainability claims, the definitions of appealing terms such as 'recyclable', and the practical environmental implications of these technologies remain subject to debate.

Further, some argue that while it is important to minimize wasteful use of plastics, the fact of plastic waste is not a problem per se so long as it is kept out of the environment and reused or recycled. Here, three challenges emerge – first, recycling is a carbon intensive activity and associated with environmental and health hazards in many settings around the world; second, the scale of investment in recycling facilities required to meet the growing volume of plastic waste is enormous and this capacity will take decades to build around the world to keep up; and third, the price of virgin plastic is so low that recycled plastic inputs struggle to be competitive (CIEL 2019). Indeed, recycling industry faces a triple dilemma of cheap price of competing materials (virgin plastics), which limits demand, which in turn means that recyclers struggle to find buyers willing to pay for recycled plastics, there by diminishing the economic incentives for collecting and processing plastic for recycling.

1.3. Mapping today's policy landscape – evolving responses and approaches by governments, industry and civil society

Just as the framing of the plastics problem – and with it the different problems that stakeholders aim to solve - has become increasingly complex, so too has the question of appropriate responses and possible solutions. This section presents a conceptual framework that categorizes the range of responses and the policy landscape, starting with the key stakeholders involved, and concludes with some observations on challenges and shortcomings with current landscape of responses.

Efforts to address plastic pollution encompass:

- Government efforts at the national, regional or international level on a diverse landscape of topics that have a bearing on plastic pollution, reflecting the varied sources and pathways by which plastic becomes a problem.
- Voluntary efforts by companies include individual commitments to reducing plastic pollution (see Table 1), as well as participation in multi-stakeholder efforts to reduce plastic pollution.
- Citizen initiatives and NGO campaigns

Multi-stakeholder partnerships, some led by industry and others by UN agencies, NGOs or philanthropic foundations (see Annex 1). Looking across the efforts of these actors, it is possible to discern seven dominant goals driving responses (see Table 2): cleaning up, reducing waste leakage, reducing consumption, recycling and reuse; investing in alternatives and new markets for plastic waste, reducing production, and reducing pollution along life cycle.

To date, the dominant focus of attention has been on voluntary efforts by citizens and industry to prevent and clean up plastic waste in the marine environment and improve plastic waste management. In addition, Table 1 and Annex 1 highlight a growing range of private sector commitments, most of which focus on recycling, using recycled plastics and reducing use of single-use plastics.

Table 1. Sample of sustainability commitments by individual companies

Company Category	Company Name	Goals & Commitments
Consumer Products	Colgate Palmolive	• Commitments to reduce the use of plastic in packaging • Use 25% recycled content in plastic packaging • Make 100% of packaging recyclable
Food	Danone S.A.	• Circular economy of packaging • Goal is to make packaging 100% circular by 2025 • Investing also in private initiatives that strengthen circular infrastructure, especially in countries that lack formal collection systems or where there is a high risk of leakage of plastic waste into the environment • Aim to offer consumers bottles made from 100% bioplastic
Fashion and Textile	H&M Group	• To become 100% circular and renewable, taking a circular approach to whole value chain • Eliminating packaging that is not recyclable or compostable • Designing all packaging for recyclability and, where relevant, composability (still being a recyclable packaging) as well as by using recyclable materials • Compostable, non- recyclable packaging will only be used for specific targeted applications • Where relevant, the packaging will be designed for reusability • Has shifted the shopping bag from plastic to paper
Consumer Products	Johnson and Johnson	• Project Phoenix: a program that help people generate value from waste • Care to Recycle Program: increase consumer recycle of personal care products • 2025 plastic packaging commitment: select 2 new recyclable packaging design solutions for introduction by 2021
Food	Kellogg Company	• Sustainable Packaging, one of the three pillars on their global packaging strategy • Eliminate unnecessary plastic packaging by 2025 through priority programs, partnerships with suppliers, and engagement with other companies in platforms • Working towards 100% reusable, recyclable or compostable packaging by end 2025
Cosmetic	L'Oréal	• SPOT: an evaluation tool to assess the social and environmental performances of a product throughout its life cycle • SPICE Initiative: founded to share L'OREAL's SPOT-methodology with the industry to collectively shape the future of sustainable packaging
Food and Beverages	Nestlé	• Investment of up to CHF 2 billion to lead the shift from virgin plastics to food-grade recycled plastics, and to accelerate the development of innovative packaging solutions • Aim to have 35% recycled content in PET water bottled by 2025 • In the US, target of using 50% recycled PET in all water bottles by 2025 • In Europe, aim for minimum of 25% recycled content for polyolefin applications in non-food content applications, and the maximum possible level for polyolefin food contact materials
Food and Beverages	PepsiCo	• Design 100% of packaging to be recyclable, compostable or biodegradable by 2025 • By 2025, PepsiCo will reduce virgin plastic use across our beverage portfolio by 35%, equating to the elimination of 2.5 million metric tons of cumulative virgin plastic when taking into account business growth. • All in For Recycling challenge→ work to increase recycling rates
Beverages	The Coca-Cola Company	• Plan to collect and recycle a bottle or can for every one sold by 2030 • World Without Waste plan→ target of 100% recyclable packaging by 2025 • Coca-Cola Freestyle technology to re-imagine the role of packaging in how to deliver products to consumers, piloting refillable cup and bottle models
Consumer Products	Unilever	• Moving towards a circular economy • Less Plastic, Better Plastic, No Plastic • Investing in alternative models of consumption which harness refills and reusable packaging • Participation in Loop: an innovative new delivery model for durable packaging which is shipped directly to the consumer, returned and refilled
Supermarket chain	Walmart	• Design for recyclability for 100 percent of packaging by 2025. • Increase use of recycled content or bio-based materials by 20 percent by 2025. • Lessen the weight of packaging by 10 percent by 2020. • Switch from corrugate containers to reusable packaging containers (RPCs) to reduce damages by 20 percent by 2019.
Supermarket chain	Carrefour	• 100% recyclable packaging for its own-brand products by 2025 • Offering consumers the right to bring their own containers to the stores.
Supermarket chain	Waitrose	• Aim is to eliminate unnecessary plastic and make all own-brand packaging reusable or made out of widely recyclable or home-compostable material by 2023. • no longer provide disposable coffee cups in our stores, have stopped selling packs of disposable plastic drinking straws and have switched our plastic stem cotton buds to paper • Experimenting with new reuse and refill schemes for some of its products
Toys manufacturer	Lego	• By 2025 LEGO packaging should be renewable: 100% of LEGO boxes, bags, and special packaging are to be made from recycled or sustainably sourced plant-based materials • Efficient: ongoingly exploring ways to optimize packaging, balancing consumer appeal with environmental action • Recyclable: designing packaging that facilitates consumers to recycle in our major markets

Electronics manufacturer	Sony	• One Blue Oceans Project to reduce ocean plastic pollution by promoting reduced plastic usage worldwide and encouraging the collection and cleanup of litter from rivers, beaches and other locations around the world • Commitment to reduce its environmental footprint to zero by 2020
Car manufacturer	Volvo	• By 2025, at least 25% of plastics used in new Volvo car models will come from recycled materials • Volvo Cars pledges to remove single-use plastics from their offices, canteens and events across the globe by the end of 2019.

The dominant framing of the plastic pollution challenge is that at the heart of the plastic challenge is lack of adequate infrastructure and systems to collect and manage household and municipal waste; inadequate recognition in society of waste as a valuable resource, such as for recycled plastic; and the need to improve consumer behaviour with regard to recycling. The rise of corporate social responsibility initiatives and industry public relations campaigns is having a significant influence on the rise of this framing of the plastic problem and appropriate solutions (Clapp 2012; Clapp 2012; Clapp and Swanson 2009; Dauvergne 2018b; London-Lane 2018). The challenge is that many of the proposed solutions remain voluntary with limited accountability mechanisms, and rely on the good will and motivation of businesses and consumers (Rucevska and Villarrubia-Gómez 2020).

The Ellen Macarthur Foundation's Plastics Pact represents the current 'cutting edge' of efforts to push forward voluntary and government efforts, drawing together a network of local and regional stakeholder initiatives (engaging government, business and citizens) working toward a circular economy for plastic under a common platform with targets for reaching five goals[4]:

- Eliminate unnecessary and problematic plastic packaging through redesign and innovation
- Move from single-use to reuse where relevant
- Ensure all plastic packaging is reusable, recyclable, or compostable
- Increase the reuse, collection, and recycling or composting of plastic packaging
- Increase recycled content in plastic packaging

A number of governments – from the UK and South Africa to a group of European governments – are working on national or regional Plastic Pacts, and have joined the EMF's Plastics Pact network, which given the significant engagement from large companies in the plastics sector as well, makes it one of the most powerful initiatives defining the agenda and priorities for action on plastics pollution.

Prevailing Policy Strategies and Tools and Critique

Both developed and developing countries are implementing a broad array of policy efforts, albeit with widely different scope of ambition and targets. In the policy arena, the greatest focus of attention has been on government support and policies to boost better waste management of the land-based sources of plastic pollution (e.g., increase collection and improve sorting of plastics, support recycling, and improve the quality of incineration) as well as legal and fiscal frameworks relevant to waste management, recycling and reducing the use of single-used plastic and plastic packaging (Missing thus far, however, are systematic assessments of what kinds of measures have been most effective).

Table 2. Key goals driving responses to plastic pollution

[4] https://www.newplasticseconomy.org/projects/plastics-pact.

Goal	Examples
Cleaning up	- Cleaning up existing pollution in landfill, public lands and marine and coastal environment.
Reducing waste leakage	- Reducing plastic waste leakage sub-national and local level efforts, including among cities, and along company supply chains; - improve end-of-life waste collection and management (including improved recycling rates), and introduction of more efficient waste management technologies (that are able, for instance, to better manage waste streams that combine mixed and dirty materials) (Ocean Conservancy 2017, WEF 2017). - improving the environmental performance of incineration and recycling facilities in developing countries. - Encouraging more efficient recycling practices by citizens - Limiting imports of plastic products and waste - Assesing plastics footprints and profiles to help determine where plastic pollution is being leaked into nature (e.g., Plastic Leaks Project).
Reducing consumption	- Reducing consumer use of certain single-use plastics, 'zero waste' initiatives and efforts to change consumer behaviour to reduce individual 'plastic footprints - Reducing the overall amount of plastic and plastic packaging used by brands and retailers - disclosing plastic footprints of companies (UNEP 2014; EMF 2019a). - Consumer boycotts of certain products and retailers deemed irresponsible in their use of plastic packaging (Break Free from Plastic 2018). - Reducing import of plastics products that become plastic waste. A growing number of countries have been passing legislation and regulations to reduce use or ban use of certain of single-use plastics and/or certain microplastics, including Canada, India and Rwanda among others (See Box 2).
Increasing Recycling & Reuse	- Building markets for recycled plastic waste, re-use of plastic (e.g., 'upcycling') and the use of waste for energy generation (waste to fuel technologies)
Investment in alternatives and new markets for plastic waste	- investment, R&D, and scale-up of alternative plastics (such as biodegradable, bio-based, edible, compostable plastics), more easily recyclable plastics, and plastics with higher recycled content - technologies and scientific innovations that could reduce plastic waste (such as bacteria that can eat plastic) - more easily recyclable and less toxic types of plastics and plastic products - more efficient waste management technologies (that can deal with waste that includes mixed and dirty materials) - technologies that can boost recovery, recycle and conversion of plastic waste into new raw materials and new products (e.g., mechanical recycling and large-scale chemical recycling processes) - Investment in and testing of new business models that reduce or eliminate plastic use (aluminium cans for drinks, re-fill projects in supermarkets). - less toxic types of plastics and plastic products
Reducing plastic production	- Reducing global plastic production including by reducing the production of virgin plastic as well as the production and use of certain types of plastic, especially unnecessary and problematic single-use plastics (EIA 2019, CIEL 2019) - Reducing plastic use by ending use of problematic and unnecessary plastic packaging and single use plastics - including PVC and single-use plastic straws and carrier bags - Piloting or expanding business models that use less plastic, including reuse and refill schemes - Reduced production of some kinds of plastics, such as polystyrene and plastic products, such as microbeads
Reducing pollution across life cycle	- Reducing or removing toxic or harmful chemicals in plastics production processes and products. - Reducing use of virgin plastics

Governments are deploying and studying an array of policy tools to influence consumer and producer behaviour across the life cycle of plastics, albeit with different degrees of ambition, focus and decisiveness in terms of enforceability (see Table 3). These include, for instance, policies that target financial incentives to change consumer behaviour, such as taxes and fees on certain types of plastics

Table 3: Conceptual framework of existing initiatives – by actor and degree of enforcement

Focus	Voluntary	Regulated and enforced
Disposal and end-of-life focused	- Clean up initiatives - Commitments to invest in waste management and recycling initiatives in developing countries.	- Bans on imports of plastics wastes (China, Malaysia, Thailand, Vietnam and others) - Mandated producer responsibility for single-use plastics, including deposit refunds, product take-back and recycling targets
Consumer and retailer focused	- Commitment to convert to less plastic packaging and single use packaging - Commitments to trial and use less plastic-intensive business models - Commitments to use 'greener' plastics and substitutes - Zero waste initiatives	- EU, Canada, India and Rwanda among others ban on retail use of single-use plastics, such as regulation on plastic bags - Taxes and consumer fees on single-use, take out containers and cups - Import bans on single use plastics
Producer focused	- Commitments to increase recycled content - Commitments to ensure products are recycled - Commitments to reduce plastic packaging	- Bans on specific plastic products, materials or production levels, e.g., of plastic bags - Bans on production and use of microbeads in products - Regulation on chemicals and chemical inputs into plastics

Source: authors, based on annual reports, UN agreements and individual NGO and national publications.

(on the price consumers pay for take-out containers and cups for beverages), and incentives to participate in some specific forms of recycling. There are also policies that restrict the use of non-recyclable packaging, ban the disposal of certain kinds of plastics, require a certain percentage of recycled content, or define the kinds of waste management schemes that must be in place in different locations.[5] Others include the use of rules, bans and restrictions on the sale, use or disposal of certain types of plastic, single-use plastics (such as plastic bags),[6] and microbeads, as well as import bans or restrictions (Larcom et al 2017; Ritch et al 2009; UN Environment & WRI 2019).[7] A number of developed countries are also including support for action in developing countries on plastics pollution within the overseas development policy and assistance. In 2019, for instance, the United Kingdom's 25-year Environment Plan included a pledge to demonstrate global leadership on MPP including by using UK aid to do more to help developing nations to take pollution and reduce plastic waste. The UK announced, for instance, that it would double its aid support for recycling

[5] In Sweden, for instance, the Pant token system has been around for over three decades. Consumers return plastic bottles to recycling machines and receive a token (a pant) in exchange worth either 1 SEK for a small bottle or 2 SEK for a large one. The token can be used for charitable donations, go back into a PayPal account or offset against food shopping bills at supermarkets. England, for instance, plans to adopt a similar recycling scheme that would see consumers pay a deposit on all drink containers. See https://www.theguardian.com/environment/2018/mar/27/bottle-and-can-deposit-return-scheme-gets-green-light-in-england.

[6] In line with its 2015 Plastic Bags Directive, supermarkets in many EU countries no longer give out free bags and nor do some clothing stores. In 2015, the EU's 1994 Directive on Packaging and Packaging Waste was amended to oblige Member States to take measures to achieve a sustained reduction in the consumption of lightweight plastic carrier bags. For a review of different policy approaches to the regulation of plastic bags, see Nielsen et al (2019).

[7] By July 2018, for instance, 127 countries (of 192 reviewed) have adopted some form of legislation to regulate plastic bags, from outright bans in the Marshall Islands to progressive phase outs and laws that incentive the use of reusable bags.

projects, plastic 'clean-up' schemes and research into plastic innovations from £3m in 2018 to £6m in 2019.[8]

In a growing number of cases, governments are extending responsibility to producers for the collecting and managing the waste that they produce. The EU, Australia and India, for instance, have EPR laws that oblige producers to be financially or physically responsible for the clean-up or recycling of their products (taking into account impacts of a product in all stages of production, distribution, use, collection, re-use, recycling, reprocessing and disposal) and several governments are exploring ways to strengthen EPR measures that make companies responsible for collecting and recycling plastic products they put on the market (such as beverage bottles) (DEFRA 2019). Further, there are policies aimed at regulation of the transportation of plastics and the chemicals used therein, to reduce the risk of leakage of hazardous chemicals and plastic pellets during transportation.

Only in a limited number of cases have governments introduced measures directly designed to reduce production and manufacturing of plastic in the first place. In most instances, such measures on specific items, such as bans on the manufacture of plastic bags (UN Environment & WRI 2019), but there are also bans or restrictions on certain toxic chemicals used in plastics and plastic materials (such as polystyrene).

A key policy development has been the growing links made between efforts to reduce plastic waste and the 'production' side of the plastics economy through policies that aim to promote a more circular plastics economy. The focus of circular economy strategies is to move businesses from a one-direction (take-make-waste) business model to a 'circular' (take-make-take-make) business model, and thereby to value, capture and reuse the material resources used in production (see for instance Ocean Conservancy and McKinsey 2017; WASTE 2016; Ellen Macarthur Foundation and WEF 2017; EMF 2019b; OECD 2019b). Within this approach, there is recognition that tackling the waste end of the plastic cycle demands attention to root causes, including the design of plastics to prevent leakage into the environment and reducing the use of certain plastics (such as reducing the amount of plastic and recyclability of plastic used in packaging) (WRAP 2019). A core theme of the circular approach is to spur innovations in the design and manufacture of plastics and plastic products so that the value of plastic waste can be better captured and used a resource (for instance, in a closed loop systems, plastic bottles can be recycled into other plastic bottles) (Cripa et al 2019). The circular approach combines, for instance, a focus on making plastic products last longer and easier to reuse, recycle and collect, while also ensuring plastic waste has a commercial value so that it can be recycled or 'upcycled' to produce plastic-based fabrics and consumer goods (ranging from shoes to tables) and building materials (EMF 2019c; Packaging Insights 2020; OECD 2018b).

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[8] The scheme includes a project in Bangladesh that aims to create a market for recycled plastic fibres to be used in garment manufacturing; a scheme in Ghana focused on improving waste management and recycling infrastructure by leveraging private sector investment (Unilever Ghana, Dow Chemical Company and the Coca-Cola Bottling Company of Ghana are collaborating in the venture); and a drive to increase the amount of single-use plastic bottles recovered and recycled in Uganda. A crucial aspect of this scheme is better pay and working conditions for waste collectors living in Kampala, with all schemes required to focus on the improvement of social and economic conditions as well as local environments. DFID has additionally announced that it will match all funding raised through Tearfund's plastics appeal, which is now aiming to raise £3m after surpassing its £2m target ahead of schedule. The money will be used to set up plastic recycling "hubs" across Pakistan, with the aim of preventing 150 million plastic bottles from polluting marine and land habitats annually. https://www.edie.net/news/5/UK-doubles-aid-support-for-plastic-recycling-in-developing-nations/.

Europe has an especially most integrated policy package in regard to various aspects of plastic pollution and more circular plastics economy (see Box 2). In the context of Europe's 2015 Circular Economy Package (European Commission 2015), the EU adopted the world's first comprehensive European Plastics Strategy in 2018 (European Commission (2018a, b). The strategy aims to raise consumer awareness and consumer behaviour with an eye to reducing the demand (and eventually supply) of some forms of plastic, starting with single-use plastics for which substitutes are easily available and affordable. For other products, the focus is on limiting their use through national reduction in consumption; on design and labelling requirements; and on waste management/clean-up obligations for producers. As noted above, in 2020, some 17 European governments, along with 90 business organisations (but only 3 NGOs) also announced the creation of a European Plastics Pact (2019b) (see Box 1 and Annex 1).

Over the past year, growing interest has emerged among a number of governments in introducing taxes on virgin plastic inputs into plastics manufacturing, although some appear to have been paused in the context of the Covid-19 pandemic (both the UK and Italy have such taxes under consideration). On the private sector side, the Sea the Future initiative hosted by the Mindaroo Foundation proposed a market-based approach to reducing virgin plastic production, whereby participating companies would agree to pay a fee on virgin plastic inputs as a way to support markets for recycled plastics and to boost incentives for recycling.

Box 2. Sample of European policy approaches to plastics pollution

Key components of Europe's Plastics Strategy and approach to plastic pollution include:

- Single-use Plastics Directive, which introduces a ban by 2021 of 10 forms of single-use plastics that represent the majority – 70 percent - of marine litter and for which alternatives are easily available and affordable (including straws, single-use cutlery, food and beverage containers made of expanded polystyrene and all products made of oxo-degradable plastic and other disposable plastics) and sets out the goal of ensuring all plastics packaging in Europe is recyclable by 2030 (European Commission 2018 a, b, 2019).[1]
- An EU Circular Plastics Alliance, bringing together key industry stakeholders from across the plastics value chain to spur efforts to reduce plastic littering, improve the functioning of EU markets for recycled plastics, increase the share of recycled plastics (as well as the economics and quality of plastics recycling) and stimulate market innovation. A first assessment of the pledges was presented in 2019.
- Further, in 2020, some 17 European governments and over 70 businesses committed to a European Plastics Pact (2020) through which they commit to a set of 2025 targets, including:
    - Make all plastic packaging and single-use plastic products reusable where possible, and in all cases recyclable;
    - Reduce the need for virgin plastic products and packaging by at least 20 percent;
    - Increase the collection, sorting and recycling capacity of all plastics used in packaging and single-use products in participating countries by at least 25 percentage points;
    - Boost the use of recycled plastics as much as possible, with an average of at least 30 percent recycled plastics across single-use plastic products and packaging.

The Pact members agreed to a cross-border approach with the aim of cooperating across the value chain on a European scale, including by harmonizing guidelines, standards, and national supporting frameworks.

From voluntary to mandatory – with a focus on root causes

To date, many of the efforts to reduce plastic pollution appeal directly to, and rely heavily on, individual consumers. However, the focus on changing consumption behaviour of individual consumers, while important, diverts attention from placing greater responsibility on industries and companies that produce and supply plastic products in the first place (Clapp 2012; Clapp and Swanson 2009). On this point, there is growing frustration among a number of civil society groups that the majority of policy initiatives are 'adapting and managing' initiatives that aim to better manage, recycle and reuse plastic waste, rather than responding to the root causes of expanding plastic production and sustainable development impacts across the plastic life cycle (Carlini and Kleine 2018; CIEL 2017, 2019; Dauvergne 2018a). Further, it is not yet clear how much the changes in consumer choices, voluntary commitments from business, and the introduction of governments restrictions impact overall demand for plastics, the relative use of virgin versus recycled plastics, and the proportion of conventional versus alternative plastics on the market.

Although companies have published an impressive array of targets and commitments and are investing resources in joint action plans with other companies, NGOs and governments, there are important challenges in regard to the accountability of voluntary efforts and assessing their impact. In early 2019, the Ellen Macarthur Foundation's New Plastics Economy lead argued that the pledges made by companies that have joined its Global Commitment are still far "from truly matching the scale of the problem, particularly when it comes to the elimination of unnecessary items and innovation towards reuse models" and the scale of investments, innovation and transformation needed (Ellen Macarthur Foundation 2019a). Transparency remains nonetheless an important step forward. While some 31 global brands publicly disclosed their packaging volumes as part of the Global Commitment (including Coca-Cola, MARS, Nestlé, Unilever, Colgate Palmolive, and Carrefour), this represented only 20% of all the plastic packaging used globally. One first step would be for governments to make it mandatory for companies to disclose their plastic footprints as a baseline for reductions.

A further challenge is that while plastics producers introducing and promoting an array of eco-friendly initiatives and more environmentally friendly plastics, their array of sustainability claims are many and are difficult to verify. Beyond the circumstances under which a specific end-product is indeed biodegradable, for instance, there is also a need to look at the environmental impact across the life cycle, including how such waste is to be managed, carbon emissions, water emissions, and the safety of the product itself, as well as the environmental performance of supply chain partners (Rucevska et al 2020).

In addition, the expectation that stakeholders can be relied upon to voluntarily make the leap to alternatives to plastics – especially given the low and decreasing cost of traditional plastics – is highly questionable (UNEP 2015). Although there is indeed consumer demand for change, experience has shown that we cannot normally expect commercial stakeholders for example, to turn their back on well-tried processes and products that yield profits, in favour of new and experimental ones where the costs are likely to be high for a long time and profits uncertain. Typically, this kind of intervention needs to rely on integrated policy frameworks. As discussed in Section 5 below, this would involve the full panoply of tools for governance including industrial policy and financial sector mechanisms to guide credit towards an alternative paradigm.

The fact of ever-growing plastic production – and production capacity – is prompting calls for more radical action from citizens groups and some parliamentarians. There are mounting calls from the global Break Free From Plastics movement, consisting of over 1000 NGOs and millions of citizens worldwide, to phase-out the production and use of many types and applications of plastic altogether, including harmful plastic packaging (Waldersee 2019). GAIA agued "[c]ountries can tackle the plastic pollution problem while protecting the climate, by focusing on reducing plastics and shifting to Zero Waste systems free from dirty technologies like incineration or plastic-to-fuel" (see Break Free from Plastic, 2019). Zero waste initiatives by local governments and citizens' organisations are also on the rise, calling into question the assumptions and claims about the need for plastic packaging, including by arguing for new approaches to thinking about claims that throw-away single-used plastic packaging is necessary to prevent food waste (Schweitzer et al 2018).

Environmental organisations also emphasise the need for greater attention to toxic chemicals used to make plastics, including additives to use plastics, arguing that this reinforces the need for extended producer responsibility and for producers to pay costs relate to handling and cleaning up toxic plastic waste. Importantly, the prevailing policy focus on greater recycling and recyclable plastics, diverts attention from the important challenges related to sorting and management of hazardous, toxic and contaminated plastic wastes that are not recyclable or for which the recycling process is associated with dangerous health and environmental threats (Leslie et al 2016). The Indonesian Zero Waste Alliance observes, for instance, that "[f]raming marine litter as only a waste management problem is nonsense when it is actually a reflection of the industry's refusal to take responsibility for the plastic pollution crises…We can't recycle toxic plastics and pretend that the marine litter chaos is a waste issue; it's a toxic product issue" (BFFP 2019). Even more traditional environmental NGOs, like WWF, recognises the need to go beyond improved plastic waste management toward more systemic change, now calling for limiting or cutting plastic production (WWF 2019).

Notably, a number of companies and industry collaborations now acknowledge the need to reduce the virgin plastic feedstocks in production, though few commitments exist in this respect. To date, there is no legislation specifically targeting a reduction in the production of virgin plastic feedstocks, although there are some efforts to limit expanding production of plastics, including recently proposed legislation in US Congress supported by the Break Free From Plastics movement. Similarly, some British MPs are urging policymakers to implement laws to stop the UK from "passing the plastic buck" to the world's poorest communities – including by introducing a national "plastics budget" that would introduce ever-stricter legally binding goals to reduce plastic production.

A number of plastic divestment campaigns target institutional investors have also emerged (Break Free From Plastic 2018). However, the resolutions still focus largely on the waste management end of the problem, missed any calls for reducing the production of plastics or other chemical materials, thus largely setting aside the significant role the plastic products and consumer goods industry will need to play in preventing plastic pollution and marine litter (CIEL 2019b). Campaigns aimed at corporations that are directly or indirectly responsible for marine plastic pollution, for example soft drink producers who use non-returnable plastic bottles, supermarkets who provide customers with free plastic bags, and other companies located in less public view in supply chains (see, for instance, Greenpeace 2019; GAIA 2019). At the same time, there are also calls for the financial sector to step up to invest in accelerating what is estimated to be a multi-billion dollar transition of the plastics economy, demanding investment new business models, materials, and technologies (EMF 2019a).

Environmental advocates are increasingly calling on governments to put greater responsibility on plastics producers for plastic pollution internationally. The idea is to go beyond voluntary efforts by companies to take firmer regulatory action through, including, for instance, through civil liability of commercial and individual polluters for plastic pollution (precedents for such liability exist in regard to oil pollution damage),[9] the creation of plastic super funds, and laws that demand international extended producer responsibility (EPR) (OECD 2018a). In 2019, WWF announced that it would promote the use of EPR to put pressure on the private sector and more major producers of plastic products to take greater responsibility for reducing waste and implementing waste management protocols across the world, including by promoting EPR legislation in developing countries to help scale-up and increase the effectiveness of waste reduction, collection, re-use and recycling (WWF 2019). These efforts to turn the responsibility onto global supermarkets, retailers and providers of packaged goods are particularly important as they expand their presence in developing country markets. Notably, the call for international extended producer responsibility is not new – this has been discussed (but not adopted) in the context of the Global Partnership on Marine Litter's 2011 Honolulu Strategy and more recently in discussions on marine plastic pollution in the UNEA context.

1.4. Missing development dimensions

To date, there has been limited attention to the national economic and industrial frameworks necessary to transform the plastics economy in developing countries. Socio-economic dimensions, especially those relevant to developing countries, are only just beginning to receive the attention they deserve in discussion, analyses and policy proposals on international action on plastic pollution and the circular economy (Schröder 2018a, b, 2020; Williams et al 2019).

Although there is growing interest in the environmental potential and economic development opportunities that stronger waste management industries and plastics alternatives and substitutes could present for developing countries (Ettinger 2015; Van de Klundert & Lardinois 2017; Schröder 2017a,b, 2018), systematic study of the development constraints on their adoption and on national and international policies that could spur transformation is only nascent (Vince and Hardesty 2017).

Efforts to reduce plastic use in developing countries also call for attention to development dimensions as well. In addition to plastic waste imported from abroad, developing country markets are increasingly deluged with plastic waste generated through national consumption. Rising incomes and consumption increases demand for products packaged in plastic and the availability of cheap plastic has made it a dominant material also for use in local markets. Global value chains and imported retail companies and products have pushed out local industry and business models that used less plastic. In addition, inadequate local infrastructure, such as for the provision of fresh water, has also spurred growing used of clean water packaged in plastic bottles. In some cases, developing countries have become major converters and manufacturers of plastic products – for both the domestic and

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[9] See the CLC Convention on Civil Liability for Oil Pollution Damage, for instance, which entered into force in 1975.

international market – and also have economic and employment interests tied to incineration and recycling businesses. Indeed, the latter can also be important foreign currency income-earning businesses. From a political economy perspective, there are also important special interests at hand - plastic waste brokers and traders, for instance, have significant commercial stakes – and may resist efforts to reduce plastic waste trade. Many countries also have significant informal economic activity linked to the collection, sorting, re-use and management of plastic waste, albeit often with significant health impacts for local populations dealing with collection and treatment of plastic (Dias 2016; Gutberlet 2019). Local waste pickers, for instance, may resist modern waste management practices that threaten their livelihoods. Retailers in local markets may have become dependent on plastic to sell their produce and for consumers to transport it home.

The recent experience of India is instructive. In 2019, legislation introduced in India to stop plastic bags and single-use plastics stumbled, due to push back from local businesses and citizens (Phartiyal and Jadhav 2018). As many as 4 million people are estimated to be employed in the sector in India, the sudden change was considered untenable economically and politically led India to retreat from its new policy (BBC 2019; Staub 2019). This experience highlights the need, as argued in this paper, for a concerted system of policies to address the just transition effects of weaning off plastics, as well as the transformative ones (See Part 5). Even if change is voluntary, in the sense of being sparked by changes in consumer demand, or – more likely – induced by regulations or trade rules, serious policy attention will be needed to the package of policies needed to facilitate sustainable transformation and transition.

A further factor relates to the export interests of developing countries. A number of developing countries are actively engaged in production of primary plastics (e.g., Brazil) as well as their manufacture and conversion. In some instances, they are major players on the global scale (e.g., Brazil), and in other instances, while not globally significant, plastics manufacturing remains significant to the national economy, export earnings and national employment. In addition, over 25 developing countries derive important merchandise export earnings from fossil fuels, which are increasingly destined for plastics production, with some countries (such as Iraq, Venezuela, and Nigeria) deriving over 90 percent of their export revenues from oil and gas alone (IEA 2020). A further factor that warrants consideration is that as developing countries work to move into more value-added processing, diversity exports of food and other fresh products to international markets, plastic packaging is currently a vital part of their business model and necessary to comply with regulations in export markets (such as phyto-sanitary rules).

Finally, there are opportunities for developing countries to produce plastic substitutes (and alternative feedstocks for bio-based plastics) using cellulose-based and natural fibre alternatives such as jute, abaca, coir, kenaf, sisal (known collectively as JACKS), bamboo fibre, hemp, milk casein and pineapple as well as wood-based packaging, such as paper and cardboard. These may not necessarily replace all plastics use but can be used strategically, especially in areas where some of the properties of plastic are dispensable (Material Economics 2018b). The fact this is seen already as a budding business opportunity is reflected in the numerous business start-ups that are emerging to respond to consumer demand for alternatives to plastic products (Excell 2019). However, there is a long way to go before these and other products are likely to be widely seen as direct substitutes for plastics but the interest from both consumers and suppliers is growing. Further, although offering lower CO2 emissions than conventional plastics, there are concerns about sustainable production of such inputs too (Chang 2013).

2. Mapping the economic landscape for plastics production and waste – scale and economic drivers

Today's crisis of plastic pollution stems from the extremely rapid growth of plastics production and its presence in so many global value chains for an enormous range of products and services. The expansion of plastic production and consumption highlights both the utility and versality of plastics for a vast array of applications.

Overall, plastic production has increased 20-fold since 1950, when it was less than 5 million tons and distributed across a population of some 2.5 billion people - and continues to grow (WEF et al 2016, GRID-Arendal 2019). In 2016, global production of plastic reached 415 million tonnes, combining plastic resin pellets (335 million tonnes), synthetic rubber (15 million tonnes) and synthetic textile fibres (65 million tonnes) (Billard and Boucher 2019).

Despite growing global concerns about the world's inability to manage the waste generated by prior and current levels of plastic production, business-as-usual projections forecast annual global production of plastic to grow by 40% by 2030, creating a volume of some 600 million metric tons (Ryan 2015; WEF 2017; WWF 2019).[10] .

This section aims to map the political economy landscape for expanding plastics production and waste. It begins by underlying the diversity of purposes and characteristics of plastics, as well as of plastic products produced and used. It then reviews the market structure, stakeholders of the plastic life cycle, focusing attention on neglected upstream dimensions, and continues with a preliminary analysis of political economy factors that explain the expanding plastics economy.

2.1. Plastics and plastic products are many

Plastic can serve many useful purposes. The number and diversity of products in the global marketplace that contain plastics is immense. Plastic is everywhere in our daily lives – in personal hygiene products, cars, buses and trains, computers, phones, household appliances, construction materials, clothing, office equipment and furniture, medical devices, hospital equipment, and in pervasive plastic packaging. Figure 1 breaks down global plastic production by sector, highlighting the prominence of plastic packaging, building and construction materials, and synthetic textiles, followed by consumer and institutional products. Notably, as much as one quarter of total plastic production is for plastic packaging, much of it single use. In 2018, for instance, companies produced an estimated 5 trillion plastic bags (WRI and UN Environment 2019), many of which are used just the once.

Although the word 'plastic' is widely used as a catch-all term, the plastics industry makes over 30 main different types of plastic polymers, which have distinctive properties, applications, and potential for recycling, reuse, biodegradability and composability. Some plastic products are in use for a very short time (especially single use plastics such as packaging), while others (such as household insulation) can remain in use over several decades.

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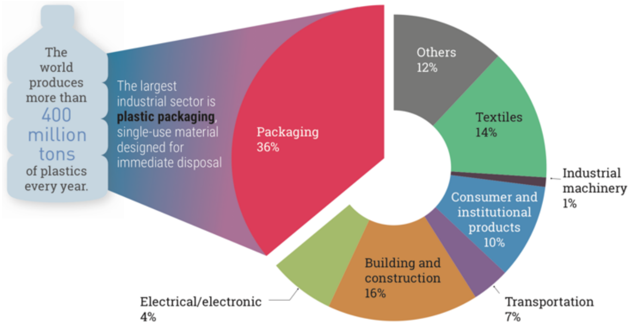
[10] Assuming global population growth up to 8 billion people by this time, that means an additional 33 billion tonnes of plastic will have accumulated around the planet by 2050. See CIEL (2019c), Geyer et al (2017), PlasticsEurope (2018).

Figure 1. Global plastic production by industrial sector (2015)



Source: UNEP (2018) *Single-use Plastics: A Roadmap for Sustainability*, UNEP, Geneva, p.4., adapted from Geyer et al (2017).

The most common plastic polymers produced in 2016 were high and low density polyethylene (or polythene) (PE) (36%), polypropylene (21%), and polyvinyl chloride (PVC) (12%), followed by polyethylene terephthalate (PET),[11] polyurethane, and polystyrene (<10% each) (Geyer et al 2017). Other well-known examples of plastic polymers include nylon (i.e., polyamide - PA), polypropylene (PP), acrylic (i.e., polyacrylonitrile -PAN), teflon (polytetrafluoroethylene (PTFE), and polycarbonate (PC). Across the global plastics economy, numerous individual companies hold patents and related intellectual property rights to a vast number of proprietary types of speciality plastics too numerous to list here. In addition, bio-based plastics (derived from cellulose-based, non-fossil fuel feedstocks) are a minor (less than 1%) but growing component of overall plastic production (e.g., bio-derived PET, polylactic acid (PLA), polybutylene succinate (PBS), starch-based plastics, and polyolefin elastomer (PE)).

In terms of their physical properties and uses, plastic polymers can be divided into three groups:[12]

- thermoplastics - such as PE, PVC, PP, PS and PET, which are often used for clothing, containers and packaging, and which can be recycled under certain conditions);
- thermosetting plastics - such as epoxy, silicon, polyester and phenolic resins, and polyurethanes, which cannot be reshaped by heating, and which are used for car parts and construction, as well as for toys, varnishes, boat hulls and glues. These polymers cannot be recycled but can sometimes be reused in other applications; and
- elastomers - rubbery polymers that can be used to make products such as tyres, rubber bands, and sealing rings.

The diversity of plastic polymers, products and the many combinations of plastics with other materials impact on their life-span; the types and scale of pollution associated with their production, use and disposal; and the presence of toxic and other hazardous chemicals, as well as range of possible options for waste management, recyclability and reuse. Together, these factors underscore the need for tailored approaches.

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[11] More than 60% of the world's PET production is for synthetic fibres (in textile applications, PET is usually referred to as polyester), while plastic bottles account for around 30%. See https://www.plasticsinsight.com/resin-intelligence/resin-prices/polyethylene-terephthalate/.

[12] Some materials, such as polyester, can occur in both thermoplastic and thermoset versions. Whereas the components of thermoplastics are generally stored as pellets, the components of thermoset polymers are stored in liquid form, usually in large tanks or containers. All three types may also take the form of fibres.

2.2. The plastics life cycle: market structure, stakeholders and global supply chains

Analysis of the political economy of the plastics economy requires attention to the market structure and stakeholders across the plastics life cycle.

Table 4 presents a basic overview of 9 steps in the plastics life cycle, focusing attention on the neglected 'upstream' dimension of the plastics economy – that is, its production or supply side. Whereas the downstream of the plastics economy (steps 7 to 9) along with oil & gas extraction (step 1) have been studied in considerable detail elsewhere, our focus is on building understanding of and responses neglected 'upstream' dimension of the plastics economy – that is, the production or supply side described in steps 2 to 6.

For the purposes of this preliminary overview, we do not distinguish in Table 4 between the different forms of plastics, although this will be an important issue for future discussion of appropriate policy levers. (We also do not visually depict feedback loops, such as between recycled plastics and their insertion into the manufacturing phase.) Importantly, Table 4 highlights that there are many stakeholders and the complexity of factors to consider when attempting to reduce plastic pollution, transform the plastics industry and promote transition. Indeed, across the life cycle of plastics, a huge industry has emerged around the life cycle of plastics involving a broad set of commercial stakeholders – from major global companies to MSMEs – and millions of employees and informal sector workers across the world (see Box 3 for a snapshot of actors with a commercial stake in the sector). Among and within these categories, individual firms have different capacities and interests in supporting change, alternatives, and market pressures.

Box 3. Stakeholders in the global plastics economy: A sample of relevant players

- Oil and gas industry (supplying fossil fuel-based feedstocks for virgin plastic)
- Bio-based raw material producers
- Petrochemical and chemical sector (conversion) (suppliers to plastic manufacturing industry producing convention and alternative plastics);
- Manufacturers of different plastic products and applications (including packaging producers;
- Brands and product suppliers that use plastic to package their goods (packaged goods companies);
- Durable goods producers (e.g., household goods, construction materials, medical equipment, + car parts)
- Retailers and hospitality companies;
- Distributors that use plastic;
- Transporters across the value chain;
- Waste management companies, including collection, sorting and recycling industries;
- Plastic waste traders;
- Informal waste sector; and
- Plastic recycling and incineration firms.

Table 4 illustrates that plastic most often begins as a by-product of the extraction of fossil fuels (Step 1) and then refining components of crude oil or natural gas through a 'cracking process' to produce hydrocarbon monomers such as ethylene and propylene (Step 2). For both Steps 1 and 2, the major industry stakeholders are oil and gas companies, and in some instances, petrochemical companies through joint ventures or business integration (discussed below).

Table 4. Steps in the plastic life cycle and key stakeholders

Steps in Plastic Life Cycles	1. Discovery, extraction, and provision of feedstocks	2. Refining and production of feedstocks	3. Conversion - production of plastic polymers	4. Plastic manufacturing - intermediate	5. Plastic manufacturing – final applications	6. Plastic Use	7. Collection & transportation of plastic waste	8. Plastic waste treatment	9. Plastic reuse
Description of activity	- Extraction, storage and transport of fossil fuels (oil and gas) - Growth and provision of bio- or plant-based feedstocks	- Refining components of crude oil or natural gas through a 'cracking process' produce ethylene and propylene - Refining of bio-based feedstocks - Production of chemical additives used for plastics	- Production of virgin plastic (from refined fossil fuels) and bio-based plastics, in the form of resin pellets and fibres through polymerisation	- Manufacture of diversity of intermediate plastic products	- Manufacture of diversity of final plastic products	- Use of plastic products, products with embedded plastic, products packaged in plastic, and plastic packaging by final consumers, brands, institutions, retailers, distributors	- Collecting and recovering disposed plastic waste - Sorting waste - Transporting waste	- Treatment of sorted plastic wastes - Landfill - Incineration - Chemical or mechanical recycling - Dumping	- Reuse of plastic after reprocessing waste into a secondary material (e.g., recycled plastic) or use in waste to fuel processes
Examples of stakeholders	- Oil and gas companies - Transportation companies that ship crude and refined oil and gas products - Commodity traders	- Oil and gas companies - Petrochemical companies - Chemical companies - Producers of bio-based feedstocks - Transportation companies that ship feedstocks - Commodity traders	- Petrochemical and chemical companies, - Oil and gas companies that rely on sales to chemical companies - Transportation companies that ship plastic pellets and fibres - Companies who make the machinery and equipment for polymerization	- Companies involved in the 'intermediate' moulding and preparation of plastics for further manufacturing - Companies involved in the 'intermediate' spinning, drawing & cutting of synthetic fibres (PP, PA & PET fibres)	- Companies involved in manufacture of final applications for packaging, transportation, construction consumer products, electrical/electronic, personal care products, coatings and markings, etc - Companies producing non-plastic materials that can be combined plastic during production process	- Producers of packaged household goods - Wholesale & retail companies, including supermarkets & online retailers - Building and construction companies - Clothing companies - Institutional consumers of packaged foods, beverages and consumer	- End consumers - Local or national authorities - Waste management companies, - Transport companies - Plastics converters - Informal waste pickers & street cleaners	- Local and national government - Waste management authorities - Plastics producers and converters - plastic converters, informal waste pickers (including children).	- Plastics recyclers and converters - Secondary waste traders - Manufacturers and users of upcycled plastic goods (plastic bricks and road surfaces) - Waste to fuel companies - Informal economy (including artists that reuse plastics etc).

				- Companies producing non-plastic materials that can be combined plastic during intermediate process - Companies involved in the provision of machinery		goods – airlines, hotels, Individual end-consumers - Governments that procure plastic products – from paints for road markings to hospital equipment & packaged beverages/food - Distributors and transporters of goods (including couriers) - Producers of fruit and vegetables packaged to access foreign markets			
Enablers	- Investors, banks, insurance companies, development banks, and governments are key enablers across the life cycle of plastics, playing a central role in provision of finance, subsidies, loans, tax incentives and insurance. - Companies engaged in storage, transport and associated logistical enterprises of plastic inputs, machinery and products.								

Source: Authors derivation, expanding on WWF (2019) and UNEP (2018c).

In Step 3, fossil fuel (99%) feedstocks are then transformed (usually through polymerization) into different forms of 'primary' plastics or plastic polymers that generally take the form of resin pellets (sometimes referred to as nurdles) and fibres. Primary plastics that are derived from fossil fuel feedstocks are widely referred to as 'virgin' plastic polymers. Looking at closer detail, Step 3 involves the conversion of ethylene and propylene to produce monomers such as styrene, vinyl chloride, ethylene glycol, terephthalic acid and many others. These monomers are then chemically bonded into chains called polymers. This process involves different combinations of monomers and the incorporation of a range of chemical additives (for properties such as flexibility and heat resistance) and colorants to yield an array of different plastic polymers with distinctive characteristics and features.[13]

The business that are the world's largest producers of virgin plastic polymers are primarily headquartered in the United States followed by Germany, as shown in Table 5 below, although this does not necessarily mean that all of their production takes place in those countries (van Doorn 2020). The Brazilian petrochemical company, Braskem, which is a top thermoplastic resins producer in the Americas, has over 35 industrial plants spread across Brazil, the United States, Mexico and Germany. Notably, the Table also shows that the share of plastic production in Asia (primarily in China) and the Middle East is growing, which although largely for domestic markets also represents a growing portion of world trade. Only around 1% of global plastic production is derived from 'bio-based' feedstocks.[14]

Key stakeholders in Step 3 of the plastics value chain include chemical companies focused on petrochemicals production (which can include plastics, high value chemicals, or agricultural chemicals) as well as oil and gas companies (Bridge 2020). Relationships between the fossil fuel (oil and gas), petrochemical and chemical sectors are becoming increasingly important (e.g., through shared knowledge bases, integrated conglomerates, joint ventures and collaborations), as evidenced by growing ties between Saudi Aramco (extraction) and SABIC (petrochemicals) (Bennett 2007, 2012; Bridge 2020, Diapola 2018). Of particular relevance to the plastics sector is the growing forward integration of oil and gas producers into petrochemicals and the production of virgin plastics as a key anticipated source of future growth (e.g., long-established players such as Exxon as well as China's rising giant Sinopec) as well as the backward integration of petrochemical producers into oil and gas production (e.g. INEOS) (Tullo 2019, Bridge 2020).

While the countries and firms involved in the manufacture of plastics in a primary form (e.g., pellets and fibres) are frequently linked with oil and gas extraction, the manufacturing sector of final plastic products and products that contain plastic are more dispersed – both geographically and in terms of concentration – because the plastic resins and fibres are transported to other countries and manufactured into plastic products there.

The converting phase has two components – an intermediate stage (step 4) and a final application stage (step 5). Step 4 involves the production of plastic sheet, rod, tube, film, resin, pipe, fittings and valves as well as those involved in their fabrication (by bending, machining, welding or bonding stock plastic as well as those engaged in film conversion (which involves includes fabricators, machine shops and film converters). It also involves the spinning, drawing and cutting of synthetic fibres. In addition, it involves companies that

[13] See Hahladakis et al (2017) for a detailed review of the chemical and industrial processes related to the use of additives. On the impacts of plastic additives in the marine environment, see Hermabassiere et al (2017).
[14] https://www.european-bioplastics.org/bioplastics/.

Table 5. A sample of top 25 producers of primary plastics (2018)

Ranking	Company	Headquarters	Chemical sales 2018 ($ billion)	Change from 2017 (%)	Chemical operating profit ($ billion)	Ownership
1	DowDuPont	US	85,9	37.6	8,4	Private
2	BASF	Germany	74,06	2.36	7,4	Private
3	Sinopec	China	69,2	22.4	3,9	Public
4	SABIC	Saudi Arabia	42,1	12	9,5	Public
5	Ineos	UK	36,9	2.07	4,2	Private
6	Formosa Plastics	Taiwan	36,89	11.6	4,02	Private
7	ExxonMobil	US	32,4	13.01	4,16	Private
8	LyondellBasell	Netherlands	30,7	8.7	5,6	Private
9	Mitsubishi Chemical	Japan	28,7	7.15	2,38	Private
10	LG Chem	South Korea	25,6	9,67	2,04	Private
11	Reliance Industries	India	25,16	37.3	4,7	Private
12	PetroChina	China	24,8		1,18	Private
13	Air Liquide	France	24,3	2.83	2,3	Private
14	Toray Industries	Japan	18,6	8.66	1,3	Private
15	Evonik Industries	Germany	17,7	4.2	2,078	Private
16	Covestro	Germany	17,2	3.38	2,9	Private
17	Sumitomo Chemical	Japan	16,08	8.68	1,18	Private
18	Braskem	Brazil	15,8	17.7	2,2	Private
19	Lotte Chemical	South Korea	15,05	4,22	1,79	Private
20	Shin-Etsu Chemical	Japan	14,4	10.6	3,6	Private
21	Mitsui Chemicals	Japan	13,4	11.6	0.846	Private
22	Solvay	Belgium	13,4	3.7	1,6	Private
23	Chevron Phillips Chemical	United States	11,3	24.8	n/a/	Private
24	DSM	The Netherlands	10,9	7.4	1,4	Private
25	Indorama	Thailand	10,7	21.2	0.903	Private

Authors' adaptation of Chemical and Engineering News, https://cen.acs.org/business/finance/CENs-Global-Top-50-chemical/97/i30, July 2019. Note: Drawing on the CEN's list of the world's top 50 chemical companies, this table lists the top 20 chemical companies that were active in the plastics sector in 2018. The sales and profit listed in the table relate to the entire activities of the companies included, not only those related to plastics. Some chemical companies further down the CEN's top 50 list may be significant players in the plastics business.

provide machinery for these activities, as well as stocking and wholesale distribution for use in further manufacturing. The manufacture of these intermediate products is more dispersed and involves a broad range of companies.

Next, these polymers are manufactured (Step 5) into a vast range of final plastic applications or products, ranging from plastic films and packaging, household and consumer goods, industrial goods, car parts, adhesives, foams, paints, coatings and sealants, as well as a range of synthetic fibres (such as polyester and polypropylene) and rubber tyres. A growing percentage of recycled plastics are also added into plastic production processes during this step. In final products, plastic components are also often combined with other materials. Plastic packaging, for instance, is often coupled with cardboard and aluminium. As in Step 4, the manufacture of different plastics products and applications in Step 5 involves a broad range of companies.

Within Europe, for instance, the conversion sector is by far the largest sector in terms of the number of employees and companies, and also in terms of turnover (although it less dominant in this respect), with its own set of industry associations with expert groups.[15] Whereas less than 8% of employees in the European plastic industry and 2000 companies are engaged in plastics production/manufacture, some 90% of employees in the sector (1,6 million people) are employed by some 50,000 companies active in the conversion industry (EPDA 2018).

Step 6 encompasses the final use of plastic products, products with embedded plastic, products packaged in plastic, and plastic packaging by final individual consumers, brands, institutions, retailers, distributors. This can include the use of plastics by brands and product suppliers to package their goods, and by individuals to do their shopping. Here, four of the largest users of plastic packaging in the food and beverage sector together use over 6 million tonnes of plastic per year: Coca-Cola (3 million tonnes, including 1/5 of the world's annual PET bottle output), Nestlé (1,700,000 million tonnes), Danone (750,000 tonnes) and Unilever (610,000 tonnes) (Heinrich Böll and Bund 2019:3).[16] Other major uses of plastics packaging are brands that sell personal care products such as Johnson, Colgate-Palmolive, and Proctor & Gamble (Ellen Macarthur Foundation 2019). A diversity of retailers (such as supermarket, retail chains, and online retailers) use plastics as part of their business model. Some of these have their 'own brands' but also use plastic to facilitate the sale and conservation of products, and in their home delivery services.

Steps 7 to 9 – the 'downstream' side of the global plastics economy – concerned with the collection, management, recycling and reuse of plastic waste also engage a diverse set of globally-distributed businesses, from waste management companies to plastic waste traders, as well as recycling and incineration firms. These steps also involve a vast informal sector of waste gatherers, pickers and sorters in developing countries. Notably, Step 9, represents a growing and increasingly dynamic segment of the global plastics economy as investors and innovators focus on the role that secondary waste markets can play as sources of feedstocks for plastics (e.g., recycled plastics), as inputs for a diversity of

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[15] In Europe, for instance, industry associations in this sub-sector include the European Plastic Fuel Tanks and Systems Manufacturers Association (PlasFuelSys), Plastic Recyclers Europe, Vinyl Films and Sheets Europe, European Singly Ply Waterproofing Association (ESWA), PET Sheet Europe, Plastic Sheet and Films Association (IVK Europe), European Plastics Films (EUPF), Engineering Polymer, MedPharmPlast, and European Engineered Thermoplastic Sheet Extrusion (EPEX).

[16] Other major companies in the food and beverage sector also have a significant plastic footprint, such as the MARS Corporation, but have not publicly disclosed this.

products (from construction materials to shoes), and in waste-to-fuel or energy from waste technologies (Gregson and Crang 2019). Importantly, as explored later in this paper, the emphasis on reducing plastic pollution and improving circularity in the plastics economy is increasingly highlighting and promoting links between the downstream and upstream of the plastics economy. For instance, the effort to promote recycling is linked to initiatives to boost the upstream use of recycled content in plastic production.

Finally, there are key enablers across the life cycle of plastics, including investors, banks, insurance companies, development banks, and governments that, play a central role in provision of finance, loans, tax incentives, and insurance.[17] Extensive government subsidies to fossil-fuels industry in key producing countries, for example, are a significant enabler because they keep the price of plastic feedstocks artificially low (Skovgaard and van Asselt 2019). Further, across these stages in the plastics economy and the life cycle of plastics, companies engaged in storage, transport and associated logistical enterprises are also relevant.

Indeed, across the life cycle of plastics, from Step 1-8, the plastics economy is global. In addition to globally distributed production, markets for plastic inputs and products, as well as and waste. Although international trade in plastic waste has attracted particular attention over the past two years, international trade plays a central role in global supply chains across the plastic life cycle – from production and consumption to disposal (see Box 4) (OECD 2018c). Preliminary estimates of the value of plastics trade are in the order of hundreds of billions of dollars for just one year (2018) even for just the categories of primary plastics, synthetic textiles, and waste – e.g., excluding plastics used for packaging and in manufactured goods or construction, which can also be assumed to have considerable value (Barrowclough et al, forthcoming). This fact underscores the importance too of further research to better understand cross-border trade, investment and supply chains – and related policy frameworks – to understanding the status quo and how we can change it.

Although clearly a global affair, the geography of the plastics economy varies across the plastics life cycle in terms of the geographical location of productive activity, ownership, intensity of consumption, waste generation and waste accumulation. Whereas Europe and North America long dominated global plastic production – from primary forms through to final products – both now face significant competition from developing countries, and especially Asia. Overall, for instance, the world's largest producers (by volume and value) of primary plastics production in 2018 were China (between 25 and 30% of the total) followed by Europe, and North America (US, Mexico and Canada, with around 1/5th each, followed by other Asian countries and the Middle East (Plastics Europe 2019). As the developing country share of overall plastics production, which includes converting, processing and manufacturing, grows so too is number of direct and indirect jobs associated with the plastics sector.

[17] On the role of insurance in the plastics industry, see Client Earth (2018) and UNEP (2019b).

Box 4. International trade flows across the life cycle of plastics

International trade is significant across the plastic life cycle and global supply chains. This includes trade flows in:

- fossil fuel feedstocks
- chemical additives
- primary plastics (resins + fibres) (for which exports represent 42% of annual global production)
- plastic packaging
- plastic final products (huge diversity)
- synthetic textiles
- products containing plastic
- products packaged in plastic
- products transported in plastic
- synthetic textiles (where exports represent 60% of the value of annual global production)
- plastic conversion and manufacturing machinery
- plastic waste
- secondary waste products, including recycled material

2.3. Explaining expanding production

How can we explain the fact there is no sign of a reduction ahead, despite the growing concerns about plastics pollution and the efforts already underway at the consumer level and by many governments and companies?

The first reason is that the cost of the core feedstocks for plastics – ethylene and propylene – is low and could still get cheaper. Shale fracking in the United States has resulted in a boom in low-cost natural gas. In China, optimism about the potential of coal-to-olefins technology to convert underused coal is spurring investment there too (CIEL 2017).[18] More recently, the falling price of oil in response to the COVID-19 crisis is also reducing the price of virgin plastic (International Commodity Intelligence Services 2020, CIEL 2020). As by-products of the oil and gas refining, direct and indirect government subsidies to the oil and gas sector contribute to low price of feedstocks for plastics (Tobin 2012). Subsidies to the fossil fuel sector were estimated to be over 5 trillion US$ in 2017, according to the latest estimates by the IMF (IMF 2019).

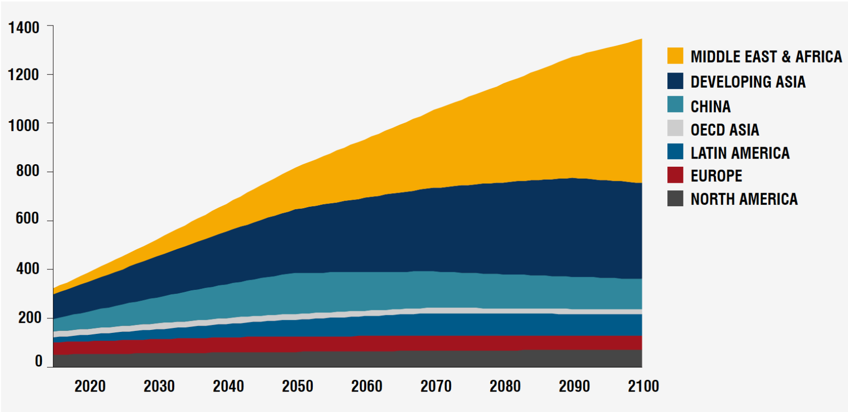
The second reason is that projected demand remains high and growing (Figure 2). While developed countries account for more than half of total plastic consumption, the developing country share is growing (already accounting for 44% in 2016) (UNEP 2018d). Annual per capita consumption of plastic in developing countries (estimated at 27kg), although currently lower than in North America (139kg) and Europe (136kg), is growing rapidly due to rising incomes, urbanisation, and changing consumer behaviour. Business as usual predictions are for increasing demand from growing populations in developing countries in the Middle East and Africa, as well as in developing Asia (Material Economics 2018).

A third reason is that investment in the petrochemical sector is expanding by private and public actors. Moreover, investors are actively supporting new, expanded capacity for plastic-related production around the world, often with government support (American Chemical Council 2018; CIEL 2017b,d; Gourmelon 2015, The Guardian 2018). Just as oil and gas companies, like Saudi Aramco, have been expanding into petrochemicals, private

[18] Once new production facilities, such as 'cracker plants' are built, they spur ongoing demand for new fracking to provide continuing supplies of feedstock (CIEL 2017).

finance from banks and sovereign wealth funds, for instance, that have existing interests in oil and gas are expanding their investments to the petrochemicals sector as well.

Figure 2. Projected increased in plastics demand by region (Mt per year, 2015-2100)



Source: Material Economics (2018) *The Circular Economy: A Powerful Force for Climate Mitigation,* Material Economics: Stockholm, p. 78.

Although data has not yet been systematically compiled and analysed, there is also important evidence of a broad array of direct and indirect public financing for the petrochemicals and plastics industry – from subsidies to fossil fuel exploration, extraction and refining to plastic conversion and manufacturing. Such subsidies can include direct financing and investment (e.g. from national oil companies and other partially or fully state-owned enterprises), financial support in the form of loans (on favourable rates) or guarantees, from governments, multilateral development banks or development agencies. A key consideration is that public subsidies can be key to leveraging larger amounts of private finance, since the presence of a public investment or loan will decrease the risk of private investment, especially if the public investment takes on a larger share of the risk.

A fourth reason is the failure to internalize environmental costs. In addition to the low price of fossil fuel inputs, the failure to internationalize the myriad of environmental costs associated with the life cycle of plastics helps explain the low price of plastics.

A fifth reason is that the production of products and services provided generate significant revenues and profits, supported by significant investments and sunk costs in business infrastructure, facilities and equipment. Entire communities, cities or regions may be wedded to and economically dependent on activities from plastics production to waste picking. Taking simply the issue of employment – in Europe more than 1.45 million people are working in 60,000+ companies (mainly small and SMES) involved in the business of converting nurdles into plastic products. Their turnover is some $350b per annum (Plastics Europe and EPRO 2018). In the United States, the plastics industry is the third largest manufacturing sector and the plastics products industry is the 8th largest industry overall. In 2017 it employed around 1 million people in the United States, and earned over $432 b in revenues (Plastics Industry Association 2019). Similarly in China, estimates are that there are already some 15,000 plastic manufacturing companies, with total sales revenues US$366 billion in 2018 (Bühring 2018).

A final factor relates to the political strategies and influence of those with a commercial stake. Included among the key producers of plastic are some of the world's most powerful commercial interests with significant sunk investment costs, as well as state-owned enterprises (e.g., in China and Saudi Arabia). A first glimpse at the commercial politics of plastics reveals that, like firms in other sectors of the economy, firms in the chemical and petrochemical industries (Hurel 2015; Corporate Europe 2018), as well as in the plastics conversion and distribution sectors, are working hard to protect existing investments and to maintain potential for growth in plastic production and plastic product markets, including of more so-called 'sustainable plastics' (Fernandez-Pales and Levi 2018). In some instances, including where the companies involved as state-owned enterprises, the public policy goals of petrochemical and related fossil fuel industries are linked to wider strategic economic, geopolitical and security interests of governments (e.g., around production and supply of oil and gas outputs).

Table 6 presents a snapshot of the vast array of industry associations focused on the performance of the plastics distribution supply chains, bringing together companies that distribute, manufacture, and recycle plastics among others, in some instances with affiliated or linked expert groups or research centres. For many of these, the policy goals of companies and industry associations are to ensure a regulatory context conducive to sustained, and preferably, expanded markets for their products (Romer & Foley 2011).

Table 6. Sample of lobbying associations associated with plastics industry across life cycle

Fossil fuel industry	Primary plastics producers, manufactures and distributors	Retailers/Brands	Recyclers
American Petroleum Institute, National Propane Gas Association	Plastics Europe, Plastics Industry Association (US), British Plastics Association, Canadian Plastics Industry Association, the American Chemistry Council, European Plastics Distributors Association, Association for Rubber Products Manufacturers (US), International Institute of Synthetic Rubber Producers (IISRP), National Association of Manufacturers, Association for Plastics Processors (US), World Plastics Council, International Association of Plastic Distribution (IAPD).	EuroCommerce (which brings together European retail giants such as Tesco, Lidl, Carrefour and Metro), National Retail Federations and Associations	European Association of Plastics Recycling and Recovery Organisations (EPRO), Institute of Scrap Recycling Industries (a business association largely comprised of waste brokers)

Both Table 1 and Annex 1 provides an overview of the impressive emphasis that companies across the plastics economy are making in their communications and marketing strategies to address – and be seen to address – plastic waste. Already in 2011, for instance,75 plastics organisations and allied industry associations issued a joint Declaration of the Global Plastics Associations for Solutions on Marine Litter. Since then, the array of industry initiatives by individual companies and through stakeholder partnerships has multiplied. Importantly, the stakes and responses vary according to the location of companies within the wider plastics economy.

Major brands and retailers that directly face consumer pressure may be more open to reducing plastic use in their products, such as through reduced plastic packaging, more recycled content in their packaging, the use of substitutes, and experimentation with new business models that use reusable, durable packaging. Unilever, Nestlé and Procter &

Gamble, for instance, are working with Loop, a shopping service that uses durable packaging that can be returned and refilled.[19]

For companies invested in plastic production, the focus may be on persuading brands and retailers they can supply more sustainable alternatives to conventional plastics – such as those deemed to be more recyclable or biodegradable – or looking to new markets, such as in developing countries where consumer awareness may not be so strong. For many companies, engagement in voluntary initiatives to address plastic pollution reflects both a view that market-based, private solutions are more efficient and effective than regulatory solutions, and a broader view that voluntary action may help them avert binding regulatory or legislative agendas, which they consider more likely damage their business or be counterproductive to the achievement of the intended environmental goals (Forrest et al 2019; Packaging Insights 2019).

Stepping back and to summarise, Table 7 presents an illustrative sample of the multiple sources of systemic failure at all stages of the plastics life-cycle and value chain that contribute to the over-production of plastics in the first place, the excess production of single-use plastic in particular, and limited success in efforts to collect and re-cycle plastic at its life-end, which have led to the current plastic pollution crisis. Moving beyond the prevailing focus on plastic waste collection, treatment and secondary waste markets, it highlights that system failures across the life cycle mean transition will be a challenge – there are significant interests and economic ecosystems vested in the status quo, creating inertia and large costs for change – and underlines that an array of policy levers and intervention points will need to be brought into play.

3. The evolution of the international policy environment

Concern about marine plastic pollution has spurred a number of scholarly studies that survey the range of relevant international processes, institutions and legal frameworks, as well as the evolving state of partnerships, national policies and regional efforts that could be supported through improved international cooperation. At the national level, government policies on plastics vary widely in terms of the degree of ambition and scope, are unevenly spread across the world, do not reach critical parts of the plastics value chains, and are poorly coordinated across countries and regions. There is a lack of transparency across the patchwork of efforts and as yet there is no single global framework that draws together the many dimensions of the plastics problem and multilayered governance responses in an integrated and coordinated fashion.

This section sketches out key moments over three phases in the emergence and evolution of an international policy framework for the growing concerns about plastic. Although important strides have been made over the years, it shows that international efforts, legal arrangements and policy frameworks to address plastic pollution remain both inadequate and piecemeal (Villareubia-Gómez et al 2018; Xanthos & Walker 2017; RECIEL 2018). There is no overarching legal regime or framework, but rather a collection of international laws, commitments and initiatives that address different aspects of plastics pollution, especially marine plastics pollution and single use plastics (Xanthos & Walker 2017). At the international level, the core thrust of existing intergovernmental efforts, public private partnerships, industry efforts, and environmental advocacy remain on: 1) building

[19] https://www.greenbiz.com/article/loops-launch-brings-reusable-packaging-worlds-biggest-brands.

Table 7: Examples of system failures – and potential targets for policy

1. Discovery, extraction, and provision of feedstocks	2. Refining and production of feedstocks	3. Production of plastic polymers	4. Plastic conversion and manufacturing - intermediate	5. Plastic Manufacturing – final applications	6. Plastic Use	7. Collection & transportation of plastic waste	8. Plastic waste treatment	7. Secondary Waste Markets and plastic re-use
Low prices of fossil fuel-based feedstocks, including due to new sources (e.g., from fracking) Prices do not reflect true value (environmental externalities) Fossil fuel feedstock production is supported by subsidies – latest estimated worth $5 trillion (IMF 2019)	Governments subsidies for construction and operation of infrastructure for refining, cracker plants, and virgin plastic feedstock production	Low price of virgin plastics does not reflect negative externalities to the environment. Large chemical companies benefit from preferential costs of capital compared to smaller or experimental companies. Development Banks are under-financed for risk-taking IP rules do not encourage sharing or technology transfer of new innovations among countries	Companies trying to invent/promote plastics alternatives and substitutes (cellulose packaging) typically find it more difficult to borrow on capital markets, face higher costs of capital, short loan maturities. IP for new alternatives may not be available. Technology transfer of alternative products is not occurring.	Existing manufacturers may find it difficult to finance transformation to new and unknown processes. Individual manufacturers are part of global value chains and cannot readily exit existing processes.	Consumers do not face the true price of plastics' environmental externalities. Consumers do not receive full information (about chemical composition, additives, recyclability, environmental footprint, etc). Collective action problems – consumers are many &not as organised as are plastics suppliers to intervene in regulatory and policymaking processes.	Consumer confusion about waste sorting, management and recycling options for many plastics Low collection rates and limited waste sorting in many regions Waste sorting is complex as plastic waste may be mixed or contaminated. Unrecyclable waste exported to those countries that will still accept it	Low recycling rates and waste mismanagement in many countries and for different types of plastics Inadequate investment and access to technology for efficient recycling and incineration with high environmental performance	Failures in the waste collection and recycling processes create inferior quality or low value secondary material. Market price of recycled plastics not high enough to spur expanded recycling at scale & cost needed to compete with virgin primary plastics. High osts of re-using or upscaling plastics products compared to low cost of virgin plastic.

cooperation on cleaning up marine plastic pollution; 2) building capacity to support waste management and recycling; 3) supporting the push for a more circular plastics economy – with a primary focus on more recycling and on the design and use of plastics that are more readily recyclable; and 4) voluntary commitments rather than regulatory obligations.

There is no international legal framework – nor ongoing inter-governmental mandate to create one – that addresses concerns about the environmental and climate change impacts of plastics production, consumption and waste across their life cycle. The greatest hope on this front appears to be the rise of discourse and policy action around the 'circular economy,' although much of the practical implementation remains mostly focused on recycling and recyclability, and on national and regional efforts rather than a framework for more circularity globally. Stemming the tide in plastics production, or "turning off the tap", is still far from centre stage – although recognition of the need to reduce production and reliance on virgin plastics is growing and is attracting growing attention in circular economy discussions.

Phase I – first awakenings to marine litter and emergent responses (1972-2012)

The first international efforts to address plastics pollution occurred 40 years ago, inspired by the first reports of the impact of marine plastic debris on marine species (see Table 8). Numerous international agreements, resolutions, action plans and stakeholder initiatives emerged over the subsequent decades to address aspects of the marine litter problem. None of these, however, addressed the growing scale of marine litter, or its land-based sources (see Simon 2017; Raubenheimer & McIlgorm 2018; Ocean Plastics Initiative 2018).

Two of the earliest and most significant international frameworks relevant to marine plastic pollution were the 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, and the 1982 UN Law of the Sea, which was the first international convention to draw attention to marine pollution from land-based sources, focusing on the release of toxic harmful substances (although without specifically mentioning plastic).

In 2005, the prominence of the marine plastic litter reached the UN General Assembly, which delivered its first resolution specific to marine plastic. For much of the subsequent decade, the primary concern was on the scale marine litter and how to better manage waste, rather than dealing with their sources. The periodic meetings of the UN's Regional Seas Conventions and Action Plans continued to highlight marine litter as a priority issue and continue to work to strengthen laws preventing both individuals and industrial actors from dumping waste into the seas. Even as recently as 2012, for instance, the focus of Rio+20 was on reducing marine debris and litter. Only with the UN's 2012 Global Platform on Marine Litter's (GPML) Honolulu Strategy did an explicit focus on economic related factors, calling on actors to "promote resource efficiency and economic development through waste prevention e.g. 4Rs (reduce, re-use, recycle and re-design) and by recovering valuable material and/or energy from waste."[20]

[20] https://www.unenvironment.org/explore-topics/oceans-seas/what-we-do/addressing-land-based-pollution/global-partnership-marine.

Table 8. Phase 1 – Evolving Policy Frameworks on Marine Litter: Sample of Example

Year	Event
1969	Creation of Joint Group of Experts on Scientific Aspects of Marine Environmental Protection (GESAMP): it's an advisory body that advises the UN system on scientific aspects of marine environmental protection.
1972	London Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter: one of the first global conventions to protect the marine environment from human activities. The convention was replaced in 1996 by the London Protocol, to regulate the dumping of wastes at sea.
1973	International Convention for the Prevention of Pollution from Ships (MARPOL) prohibits discharging plastics by ships into the sea and obliges governments to ensure adequate port reception facilities to receive ship waste.
1974	Launch of UN Environment's Regional Seas programme for the protection of marine and coastal environments includes marine debris within its work. Numerous regional sea Conventions administered by UN Environment include references to pollution from land-based sources (including framework conventions protecting the marine environment in the Caspian Sea, Caribbean, North-east Atlantic, Middle East, Baltic Sea, Mediterranean, Black Sea, Central and West Africa).
1982	UN Convention on the Law of the Seas includes legal requirements to "prevent, reduce and control pollution of the marine environment from any source" (Article 194.1).
1989	Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention) aims to reduce movements of hazardous waste between nations, and to prevent transfer of hazardous waste from developed to less developed countries.
1995	Over 100 governments launch the UN Global Programme of Action for the Protection of the Marine Environment from Land-based activities (GPA), to respond to the issue of land-based pollution.
1998	African Union's Convention on the Ban of the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa (Bamako Convention), to regulate the import of hazardous wastes into the African continent.
2004	UN General Assembly delivers its first resolution specific to marine debris. Since then, the issue of marine litter has been addressed annually by the General Assembly.
2011	The Honolulu Strategy, a framework document catalysed by the 5th International Marine Debris Conference to prevent and manage marine debris, with technical support from NOAA and UNEP.
2011	Declaration of the Global Plastics Associations for Solutions on Marine Litter signed by 75 plastics organisations and allied industry associations in 40 countries.
2012	65 governments plus the European Commission agreed to the Manila Declaration, to develop policies to reduce and control wastewater, marine litter and pollution from fertilizer.
2012	Rio+20 conference included attention to reducing marine debris and litter, and strong statements were presented in favour of a "Blue Economy" approach.
2012	Governments committed to a UN Global Partnership on Marine Litter, seeking to protect human health

Phase 2 – Intensified and wider focus on plastics pollution (2014 to 2017)

As it became increasingly clear that gaps in legal frameworks were facilitating the growing crisis in marine plastic litter, and that voluntary measures were not sufficient to stop marine plastic pollution, intergovernmental efforts to boost cooperation intensified (see Table 9).

Table 9: Intensified and broadening focus on plastics pollution: 2014 to 2017

Following a first UNEA resolution on plastics in 2014, efforts to spur international action in the form of binding targets on plastic waste increased. Numerous commitments on marine litter were made in the context of the UN's 2015 Sustainable Development Goals (SDGs), and in particular in SDG Target 14.1 (to conserve and sustainably use the oceans, seas and marine resources for sustainable development), which calls on states to "prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution" by 2025. Alongside, various UN agencies and platforms issued a mounting range of publications to inspire action and guide policymaking to reduce marine litter (UNEP 2014, 2016a). In 2016, a global partnership on waste management, which included marine litter as one of its six themes, was launched in the context of efforts to advance implementation of the UN SDGs (UN 2016).

Alongside concern about plastic litter in the marine environment, international attention to the contribution of microplastics to ocean pollution grew (GESAMP 2015), as reflected in a 2016 UNEA Resolution on marine plastic and microplastics (UNEP 2016b) and the focus of the 2016 Informal Consultative Process on Oceans and the Law of the Seas on marine debris, plastics and microplastics (Lebada 2016).

In parallel to processes primarily concerns about oceans and marine litter, there was increasing concern about the noxious and harmful chemicals present in plastics, and their impact on the marine environment and public health. The UN's Chemicals and Waste platform (which brings together UNEP, BRS Secretariats and FAO to facilitate access to

Year	Event
2014	2014 – Marine plastic pollution on the agenda of the first UN Environment Assembly (UNEA), resulting in a resolution of UNEA-1 (Resolution number 1/6), which encourages governments, NGOs, industry and other relevant actors to cooperate with the Global Partnership on Marine Litter on the implementation of the Honolulu Strategy.
2015	The fourth session of the International Chemical Management (ICCM4) endorsed an implementation plan for meeting the 2020 goal on sound chemical management, assisting the work of the Strategic Approach to International Chemicals Management (SAICM) framework..
2015	UN Sustainable Development goals include marine pollution targets in SDG 14.1.
2015	G7 Action Plan to Combat Marine Litter
2016	UNEA, 2 governments issue resolution on marine plastic and microplastics
2016	UN Open-ended Informal Consultative Process (ICP) on Oceans and the Law of the Sea (created to facilitate annual review of developments in ocean affairs) focuses on marine debris, plastics and micro-plastics.
2016	UN Global Partnership on Waste Management launched as part of implementation efforts related to the UN SDGs, including marine litter as one of its 6 themes.

information on implementation of international conventions on chemical and waste) and Strategic Approach to International Chemicals Management (SAICM) (2014), for example, each launched work on chemical pollution aspects of marine plastic pollution, including their impacts on human health (WHO 2016).

Phase 3 – Widening focus on plastic pollution, growing concerns about production and action on plastic waste trade (2017-present)

Only in 2017 did the need to address the *production* of plastics appeared explicitly on the international policy agenda, and even then, it was not a central focus (Table 10). In June 2017, the final declaration "Our Ocean, Our Future; Call for Action" of the Ocean Conference (a UN Conference to support the implementation of SDG14) included some 178 intergovernmental commitments to act on marine plastic pollution. Although one of these commitments makes reference to the wider goal, embodied in the SDGS, of the need to "develop sustainable consumption and production patterns" (UN 2017),[21] it is somewhat lost in the multiple references and concerns about marine litter and waste management.

Six months later, UNEA-3 issued a further, non-binding, resolution on marine litter and marine plastics, which contained ten articles calling on states to take action of various kinds on marine pollution and marine plastics.[22] In the resolution, governments underlined the importance of long-term elimination of plastics going into the ocean, establishing an Ad Hoc Open-Ended Expert Group on the subject, but did not take up calls for an international agreement on legally-binding reduction targets for reduced ocean plastic (due to opposition from US, China and India, among others (Embury-Dennis 2017, CIEL et al 2018).[23]

In 2017, the Ad Hoc Open-Ended Expert Group called upon members to take a whole life-cycle approach, highlighting the importance of efficiency in resource use as well as pollution (UNEP 2018a). It recommended the development of indicators for reporting on the potential adverse effects of plastic pollution on human health, and the creation of a multi-stakeholder platform within UNEP as a repository of assessments and guidelines, including on technical and scientific information. Of particular interest for the broader, life-cycle perspective highlighted in this paper, it requested the elaboration of guidelines on plastic use and production, including information on standards and labels that could inform consumers and help them change their behaviour, and also incentivise businesses and retailers to adopt sustainable practices and products (UNEP 2018a, para 10). The Expert Group also called for governments to promote the use of information tools and incentives to foster more sustainable consumption and production. These remain working group recommendations, however, and have not yet been taken further in formal intergovernmental processes. In its

[21] The document calls on countries to: (i) Accelerate actions to prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris, plastics and microplastics ... and abandoned, lost or otherwise discarded fishing gear; ii) Promote waste prevention and minimization, develop sustainable consumption and production patterns, adopt the 3Rs- reduce, reuse and recycle - including through incentivising market-based solutions to reduce waste and its generation, improving mechanisms for environmentally-sound waste management, disposal and recycling, and developing alternatives such as reusable or recyclable products, or products biodegradable under natural conditions; and (iii) Implement long-term and robust strategies to reduce the use of plastics and microplastics, particularly plastic bags and single use plastic (UN 2017).

[22] Notably, UNEA-3's Ministerial Declaration 'Towards a Pollution-free Planet' included the objective of a pollution-free ocean within its aim of a pollution free planet, but did not specifically mention marine litter.

[23] Instead, Article 2.2 of the resolution calls on all actors to "step up actions" by 2025, to prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution" and encouraged members to "prioritise policies" that avoided marine little and micro plastics entering the marine environment.

subsequent 2018 report, the Expert Group presented options for monitoring and international governance, emphasising the importance of multi-layered governance (UNEP 2018b).

Table 10. Phase 3 – An emerging widening to plastic pollution

Year	Event
2017	Declaration of UN Ocean Conference Our Ocean, Our Future, Our Action includes need to address consumption patterns and their impact on marine pollution, including mentioning plastics and microplastics.
2017	Ad hoc Open Ended Expert Group created on eliminating plastic pollution of the ocean, but without being mandated for action. Third meeting of this group highlights the need for a life-cycle approach to plastics use and production. Calls for efforts to incentivise consumers and producers to change their behaviours.
2017	17 African countries signed the Abidjan Convention to reduce marine waste. This was then extended to 38 countries.
2018	UNEA Expert Group presents options for monitoring and international governance of plastics but has still not tried to reduce the production of plastics in first place, nor is there support for legally binding constraints.
2018	The International Maritime Organization (IMO)'s Marine Environment Protection Committee adopted an action plan to enhance existing regulations and introduce new supporting measures to reduce marine plastic litter from ships (IMO 2018).
2018	G7 Ocean Plastic Charter: G7 countries committed to take action towards a resource-efficient lifecycle management approach to plastics in the economy.
2019	Interpol decided that pollution is crime, because the criminal disposal of waste illegally can pollute the air we breathe, the water and the soil
2019	Regional Action Plan on Marine Litter 2019, to consolidate, coordinate, and facilitate cooperation, and implement the necessary environmental policies, strategies and measures for sustainable, integrated management of marine litter in the East Asian Seas region.
2019	UNEA Group considers life-cycle governance of plastics but did not agree on proposals for this; did not accept proposals to phase out single use plastic, nor to consider a legally binding instrument on marine pollution, but did agree to extend the work of the Group.
2019	The Basel Convention's 2019 'plastic amendments' where 187 governments agreed to add plastic waste to the Convention's list of controlled substances. Contaminated and unrecyclable plastics, along with certain other types of plastic waste, will require prior consent from importing countries before they can be exported. Countries also agreed to a partnership on plastic waste to mobilise companies, civil society and other stakeholders in support of implementing the new Basel decision.
2019	Implementation Framework for Actions on Marine Plastic Litter Action: it will complement the UN Environment Programme's work on marine litter and single-use plastics and it aims at facilitating further actions on marine litter while taking into account national policies, approaches and circumstances
2019	UN Decade of Ocean Science for Sustainable Development (2021-2030), to support efforts to reverse the cycle of decline in ocean health and gather ocean stakeholders worldwide behind a common framework that will ensure ocean science can fully support countries in creating improved conditions for sustainable development of the Ocean.

Meanwhile, among the many ongoing efforts to address plastic pollution through the work of UNEP and other international initiatives noted in Table 11,[24] were efforts to update the Stockholm Convention, which aims to eliminate or restrict the production and use of Persistent Organic Pollutants (POPs), with important links to both the production and disposal of plastics. The updates aim to address a range of POPs relevant to plastics, including chemical additives used in the plastics industry, such as flame retardants and polychlorinated biphenyls (PCBs), as well as dioxins emitted from the burning of plastic waste and polychlorinated dibenzofurans resulting from the production of PCBs and incomplete combustion during waste incineration.

Further, in May 2018, amidst growing evidence of plastic waste trade to countries with inadequate waste management capacity, and following a proposal spearheaded by Norway, the Conference of the Parties to the Basel Convention on the control of transboundary movement of hazardous waste and their disposal agreed to establish an Open-ended Working Group (OEWG) to consider options available under the Convention to address marine plastic litter and micro-plastics, and develop proposals for possible further actions. International attention to the issue spiked in July 2018 with China's ban imports of most plastic wastes. By September 2018, the OEWG had adopted a suite of decisions on marine plastic litter, including a proposed new partnership on plastic waste (focused on public private cooperation and at source measure to minimise and more effectively manage plastic waste), and proposed possible amendments to Annexes of the convention to assist countries to better minimise and control transboundary movement of plastic waste (Wingfield 2018).[25] Finally, in May 2019, more than 180 countries (with the notable exception of the United States) agreed to: a) amend the Basel Convention to help regulate and improve transparency of plastic waste exports, focusing specifically on contaminated, mixed, and unrecyclable plastic waste (BRS 2019);[26] and b) establish a new 'Partnership on Plastic' to help mobilise stakeholders to assist in implementing the new measures and to share tools, best practices, technical and financial assistance.[27]

Further, there were several important moves in the wider UN Environment framework in 2019. First, at UNEA-4, governments approved four resolutions that directly considered or referred to plastic pollution (primarily in regard to marine plastic litter and microplastics) and also agreed to extend the work of the Ad Hoc Open Ended Expert Group.[28] The UNEA-4

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[24] For instance, the subject of plastic pollution remained high on the agenda of UN Environment, including through its Clean Clean Seas initiative, the GPML, and the Regional Seas programmes, as well as Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP).

[25] The 2019 BRS Conference of the Parties also yielded a new Household Waste Partnership under the Basel Convention, aiming for an integrated approach for household waste management (acknowledged as one of the key challenges related to waste management faced by national governments, particularly in developing countries); enhanced cooperation with World Customs Organisation to strengthen the Harmonized Commodity Description and Coding System (used by customs authorities to improve the control of wastes crossing borders); finalisation of the draft Manuals on Extended Producer Responsibility, which when completed can assist Parties with concrete actions for promoting the life-cycle approach in the manufacturing of products through to recycling.

[26] The amendments, originally proposed by Norway, require exporters to obtain the prior consent of receiving countries before shipping most contaminated, mixed, or unrecyclable plastic waste, bolstering the right of countries to refuse unwanted or unmanageable plastic waste.

[27] Implementation of the amendment will rely on encouraging states to designate general plastic waste as 'hazardous' within the domestic laws. The amendment will effectively act as an export ban for the EU because EU legislation bans exports of waste included under the Convention to developing countries. The implications of US opposition for plastic waste trade will demand further study as it is not a party to the Basel Convention.

[28] They agreed that the Group's work should, building on existing work, include taking stock of existing activities and actions; identifying technical and financial resources or mechanisms; encouraging partnerships; and

resolutions also included commitments to develop inventories of plastics litter sources, which reflect recognition of the need to address sources of the problem, and invited governments to 'reduce the discharge of microplastics through phase-out of products that contain microplastics, where possible,' thus pointing toward the importance of the reduction of production of certain products.

Blocked by the United States, backed by a handful of countries such as Saudi Arabia, governments did not, however, agree to proposals to begin formal consideration through the UNEA process of a legally-binding instrument on marine plastic pollution (which had been proposed by Norway, Japan and Sri Lanka) or a global agreement on the phase-out of single-use plastics (which had been proposed by India). Although these proposals reflected a growing recognition of the need to address plastic across its whole life-cycle – from production to disposal; to move from voluntary and ad hoc initiatives to a binding and coordinated international framework; and to reduce the production of plastics in the first place, these have not yet achieved support as a core policy objective by the most powerful governments and are resisted by a sub-set of prominent and influential industry groups and individual companies (CIEL et al 2018). Meanwhile, the existence of the Open-ended Expert Group keeps open the possibility of a legally binding instrument in the future. Indeed, the Nordic Council of Environmental Ministers has commissioned work on what the possible approaches and elements of such a new global agreement might be (Nordic Council 2019). Notably, although the end-goal is to stop plastic litter from land and sea-based sources from entering the oceans, the Council have called for an approach that would address the whole lifecycle of plastics.

4. Strategic debates and new directions for global governance of plastics and plastic pollution

4.1. International environmental negotiations

Recent scholarly work has offered numerous proposals to address the gap in international cooperation on marine plastic pollution – ranging for action plans for improved ocean governance, to a new international environmental agreement, and appeals to make better use of instruments such as the UN Law of the Sea (Haward 2018; Simon 2017; Raubenheimer & McIlgorm 2017, 2018; RECIEL 2018; Tiller and Nyman 2018). There are different views among environmental experts too on the most efficient and effective way forward.

One focus of proposals is on a proposed new international environmental treaty to address land-based and sea-based sources of marine plastic pollution (Simon 2017; Raubenheimer & McIlgorm 2018). Here, the focus is squarely on international cooperation around marine plastic pollution, with attention to supporting national efforts for plastic clean-up and remediation efforts; improved waste management systems and technologies to prevent plastic waste entering the ocean; and boosted incentives for innovations in more environmentally sustainable and recyclable plastics. Much of the focus is on modalities for cooperation, financing and technical assistance, monitoring, and sharing of information and best practices. Meanwhile, there is considerable work to be done related to the implementation of the Basel Convention's plastic amendments and their ultimate impacts on

analysing the effectiveness of existing and potential responses at all levels. The Group is to report to UNEA-5 in February 2021.

the plastic waste trade, plastic production and recycling markets are not year (GRID-Arendal 2019; Brook et al 2018).

Among those calling for greater use of existing provisions in international law, Client Earth, for instance, argues that while a new convention might demand more specific action, the political energy needed for a new international agreement could be put to better use, such as through the launch of disputes calling on countries to adhere to existing obligations in international law (such as those included in UNCLOS). This approach seeks to focus political pressure primarily on those countries from which the majority of plastic leaks into the ocean (rather than the source countries of plastic production or pollution).[29]

In addition, there are also proposals to integrate plastic into negotiations launched in 2017 for a new international instrument on the protection of biodiversity in areas beyond national jurisdiction (BBNJ). Rather than waiting for a treaty that is plastics specific, proponents argue for incorporating plastic into the BBNJ negotiations, since plastic is interweaved as a substantial stressor to biodiversity in all areas of the ocean (Tiller and Nyman 2018).[30]

Others argue that a binding global agreement on marine plastic pollution should tackle plastic pollution at its roots by including explicit targets and legally-binding measures both for reducing plastic leakage into oceans and also, critically, by reducing waste generation at source by putting caps on certain kinds of production of plastic. Here, some scholars call for a new treaty modelled on the successful Montreal Protocol on ozone-depleting substances (that aimed to reduce and replace use of CFCs) (Raubenheimer & McIlgorm 2017).

Further, there are proposals that any new treaty should address plastic pollution more broadly and address the whole plastics lifecycle, including its production in the first place. A key international network of civil society groups associated with the Break Free From Plastics movement has, for instance, called for an international agreement that would identify and address sources of plastic pollution across the life cycle of plastic and stop the development of new petrochemical and plastics production infrastructure (CIEL 2019). Underpinning their approach is a conviction that while important, the international community should not rely on voluntary initiatives from business but must also deploy the enforcement powers of regulations and law. Here too, there are questions on, whether the ongoing efforts to produce a marine plastics treaty could be harnessed and enlarged to address these goals, including through protocols on specific technical issues; whether complementary international processes and legal frameworks could be used; or whether a completely new framework is needed (and viable).

In our view, an essential and complementary next step is to situate the plastic problem within the wider political economy of its production, trade and consumption, with a stronger focus on how economic tools and instruments can play a role in promoting transformation and transition of the global plastics economy to reduce plastic pollution across the plastic life

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[29] See for instance proposals for an Ocean Plastic Legal Initiative (2018). Also see https://www.bbc.com/news/science-environment-43115486.

[30] In 2015, the UN General Assembly adopted UNGA resolution 69/292,2 on 'Development of an international legally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction' (BBNJ). Under the resolution, the General Assembly decided to "develop an international legally-binding instrument under the Convention on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction ... [N]egotiations shall address the topics identified in the package agreed in 2011, namely the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, in particular, together and as a whole, marine genetic resources, including questions on the sharing of benefits, measures, such as area-based management tools, including marine protected areas, environmental impact assessments and capacity-building and the transfer of marine technology."

cycle. Attention to how a multi-layered framework for international cooperation based in UN Environment and its multilateral environmental treaties – can include and link to approaches that tackle the political economy of the plastics sector and the kinds of economic policy tools needed to promote and incentivize transformation.

4.2. Vital complementary approaches: international approaches to reducing plastics at source

Pulling out of excessive and problematic use of plastics will need a multi-faceted and integrated approach that addresses all actors and stakeholders in the plastics economy. We need to ensure that attention to the downstream dimensions of the plastics pollution and in the marine environment are complemented by strategic integrated policy efforts to address underlying 'upstream' causes of plastic pollution across the life cycle and support structural change required across that life cycle.

To reduce plastics pollution, it is vital that we amplify attention to how we can slow plastic pollution at the source by:

- reducing the production and use of excessive, unnecessary and problematic plastics, most obviously non-essential single-use plastic items which can simply be discontinued or substituted by other materials or business models; and
- ensuring more sustainably designed plastics where plastic use is necessary and unavoidable within a broader net zero circular economy framework that includes phasing out the use of virgin plastics and increasing effective recycling measures and re-use in ways that environmentally credible and meaningful.

On both fronts, this approach demands attention to industrial, financial and trade policies – and enabling development and global policy frameworks – necessary to promote structural transformation toward a more sustainable plastic economy and to ease the transition for those that will suffer during the process. This entails greater attention to the technical, financial and economic aspects of structural transformation as well as the political economy aspects relating to the institutional geometry between business and government that is needed for successful transformation (Barrowclough and Kozul-Wright 2017). Table 11 presents a preliminary framework for considering the range of policy tools required in an integrated framework to achieve those ends. Figure 3 underlines the importance of enabling international policy environmental for both the transformation and transition needed to address the multiple policy challenges involved in reducing plastic pollution.

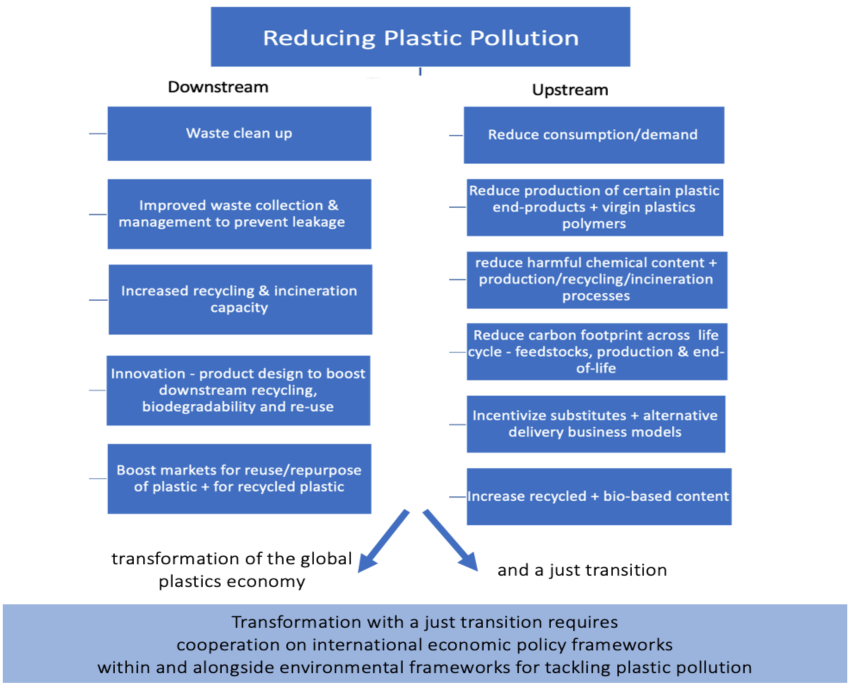
Critically, the economic constraints and trade-related challenges in regard to transforming the plastic economy may differ in developing countries from those in more advanced economies, or where the plastics industry has been longer invested. There is particular need for attention to the financial and industrial policy environment necessary for the growth of innovative and environmentally friendly "sunrise" industries (Barrowclough 2020) that reduce the use of plastic and in particular plastics waste, while producing economic opportunities for developing countries.

As noted above, some developing countries have comparative advantages in bio-based feedstocks for plastics as well as in the production of non-plastic substitutes (UNCTAD, forthcoming), such as from cellulose products that can be produced locally, assuming relevant technology is shared and intellectual property not a barrier. Some countries already plastic substitutes as a development opportunity and have ambitions to expand production of non-plastic products, especially in regard to packaging. However, developing country

Table 11. Integrated policy framework for sustainable transformation of the global plastics economy and a just transition

Promoting *sustainable transformation* across the life cycle of the plastics economy	Ensuring a *just transition* to support the process of transformation
- **Policies, rules and regulations** to require and enforce change toward more sustainable production (including taxes, charges and extended producer responsibility). - **Trade policies** to support national efforts to reduce unsustainable plastics production and consumption and to encourage alternatives – including targets for reducing trade in certain plastics; boosting trade in more sustainable plastics and substitute products or delivery modes. - **Correct pricing** of plastics and environmental impacts, **disciplines on subsidies** or other incentives that sustain/boost harmful production. - **Financial and industrial policy levers** to give incentives for industry to adapt production and use of existing processes and products in favour of reduced plastic use, more sustainable plastics and non-plastics alternatives. - **Support for development banks** and institutions to finance transformative leaps away from plastics by firms and investors; ▪ Incentives and disincentives related to ownership of technologies and related IP; ▪ **Incentives for producers** to adapt existing process and products; and ▪ Boosted **demand and supply of alternatives** through procurement policies at national and regional level. - **Sustainability standards** for products and production methods; certification of environmental standards.	- **Support for research**, technical assistance and Aid for Trade to support developing countries active in GVCs involving plastics. - **Technology transfer** for developing countries to adapt existing methods and introduce new ones (consideration of ownership of alternative & substitute technologies as well as opportunities for MSMEs from developing countries needed). - **Capacity building** and support for domestic production and trade in waste management services and technologies. - Clear **sun-set periods** for removal of existing incentives for the production of (single-use) plastics. - **Social policies, including Incomes support for temporarily** displaced workers, social services for permanently displaced works, and transitionary support for removal of subsidies. - R&D, education and skills policies for re-training in use of new processes and products. - Cooperation with other international organisations and processes. - **Information-exchange**, monitoring and assessment (e.g., on trade-related measures on plastic pollution).

Figure 3. Enabling international economic policy environment vital for advancing an integrated policy framework for reducing plastics pollution



businesses working on plastic alternatives and substitutes face many challenges and obstacles compared to the large and well-known businesses, with proven credit and profit histories.

Addressing constraints to such technological shifts and bringing about structural transformation will need the careful and strategic use of industrial policies and financial sector policies, as well as new government and industry regulations, and wider global governance measures and international rules, including on trade. Much can be learned from the examples where this has been successfully achieved in other sectors – indeed there is no case in history where a country has achieved the structural transformation of moving from subsistence agriculture to industrialisation without the use of such policies, and even today they are still greatly used by many countries, if not most, for the move to revolutionary new technologies such as solar power, the internet and the iphone (Mazzucato 2013, 2018; UNCTAD 2017).[31]

Constraints to transformation may also be related to intellectual property rights and licensing for alternative plastics and non-plastic technologies, for instance, or to subsidies that support fossil fuel production. Industrial policies will be needed to promote the research and development into new forms of plastics alternatives because these are unlikely to emerge from the market without some form of government support or incentives.

Financial policies will be needed to help create capital and guide it to new uses. Without this, there will be little incentive for plastics manufacturers or users in the private sector to take the leap involved, moving away from tried and tested markets and choosing rather the unknown and risky. The tricky part is in balancing the rents that are created, and those that are taken away; also in ensuring that the privileges of receiving support are temporary, and that incentives do not continue to be paid to those that do not meet the performance targets agreed (Barrowclough and Kozul-Wright 2017). The transition phase is important too because such changes bring about winners and losers through the periods of leaving one phase and starting another, and some of these may be long-lasting and even permanent.

On the finance side, promoting a move away from plastics will require that an articulated and supportive system ideally starting at the head, with Central Banks, and filtering down to the various specialist banks can finance plastics-related loans and investments to firms. Here, the move away from plastics can actually be seen as one specific element of the wider calls for a Global Green New Deal, with similar financing needs (UNCTAD 2019; Barrowclough 2020). Central banks may be required to revisit their more engaged stances as in the past, creating credit and guiding it to the more desired plastics alternatives and substitutes, rather than privileging – even if unintentionally – the very large and long-standing petro-chemical companies that make plastics or the large brands and retailers that use it. In Europe, for instance, the European Investment Bank (the EU's regional bank) is playing a supporting role in the transition to a circular economy by providing both financial and advisory support, which can also be harnessed for the plastics economy. Credit rating firms will also need to pave the way forward. Already in 2019, a leading international credit rating firm observed that the credit ratings of European Packaging firms were under threat due to public concerns about plastic packaging (Moody's 2019). A related, supportive move will be required from

[31] In this view, a move away from dependence on plastics and towards the creation and use of different kinds of product or processes is an example of the process of "creative destruction" identified by Schumpeter as characteristic of transformation.

insurance companies to signal the reputational risk to investors and companies from over-exposure to plastics in the context of public concern about environmental impacts and the potential for stronger international regulation in this field. In 2019, UN Environment led the way for future research with a first study examining plastics-related risks to insurance and investment portfolios (UNEP 2019b).

At the same time, in a fully articulated system of finance, well financed and suitably experimental development banks at the national and regional levels will also be needed to provide preferential finance for sectors and activities that can help to identify, research and develop alternative plastics and substitutes. Regional development banks can, for example, pool finances and help to lend money for inter-regional projects as well as reducing costs for individual countries. In some countries this is already occurring with respect to greening investments, although not yet for plastics in particular.

Returning to the theme of political economy and governance in the title of this paper, it will also be essential that countries have sufficient national policy space for such policies – and this will need to be supported at global level.

Here, trade policy also has an important role to play as part of an enabling international policy environment. As the pressure for a carbon neutral and circular global economy grows, interest in the intersection of trade and sustainability issues is rebuilding. At present, trade-related gaps in international cooperation on plastics pollution exist on several fronts (Deere Birkbeck 2020a, b):

- Transparency – there is no common platform for publicly accessible data, monitoring and analysis of trends in global plastic production, trade flows and supply chains, as well as on their implications for the design of trade policy measures to reduce plastic pollution.[32] In addition, there is poor transparency of trade-related measures and sustainability standards relevant to plastics and plastic pollution, their economic impacts and environmental implications;
- Policy coherence – trade policy frameworks are not well aligned with domestic measures to reduce plastic pollution or with the WTO objective of sustainable development;
- Dialogue and cooperation – national approaches to trade and plastic pollution are being developed in an uncoordinated, piecemeal and disjointed manner, which diminishes their effectiveness. Innovative companies and exporters are at risk of increasingly complex and diverging regulatory frameworks across global supply chains;
- Development dimensions – there is inadequate attention to the trade-related challenges and opportunities for developing countries related to reducing plastic pollution;
- Cooperation among international organisations – there is no process to promote cooperation among international organisations on trade-related issues that arise in efforts to reduce plastic pollution; and
- Research and analysis – challenges and opportunities at the intersection of trade flows, trade policy and plastic pollution, as well as the international trade policy frameworks needed to spur the transformation and transition necessary to reduce plastic pollution.

At present, there is also no clear venue for addressing the trade dimensions of the global plastics economy and plastic pollution. A core strategic question is where to pursue such action. In the past year, the trade dimension of the plastic waste crisis has spurred not only

[32] Although market analysis firms gather important information on global plastic markets, such data is not freely available in the public domain.

the Basel Convention's Plastic Amendments but also growing interest at the WTO.[33] China's ban on imports of non-industrial plastic waste, for instance, was raised for discussion in the WTO's Committee on Technical Barriers to Trade (WTO, 2018f)[34] and recent meeting of the WTO Committee on Trade and Environment have touched on plastics and marine litter. The trade and plastics intersection has also been underlined by the growing number of notifications by governments to the WTO of trade restrictions they have put in place related to plastics (Deere Birkbeck 2020a, b). Further, China and Fiji have attracted the interest of a group of 20+ developed and developing countries in launching a plastic initiative at the WTO to explore and advance options for using trade policy to support other international efforts to reduce plastic pollution and promote a more sustainable plastics economy. In principle, action on trade and plastic at the WTO could support a multi-layered approach anchored at UN Environment.

At the same time, governments and stakeholders can and should also explore the range of possible international processes and mechanisms – global, regional and national - for harnessing trade policy for these goals and assess the prospects of meaningful outcomes through different approaches (Deere Birkbeck 2020a, b).

5. Summary of key findings and research gaps

This paper has highlighted the need for greater understanding of the political economy dimensions of reducing plastic pollution and giving closer attention to the range of international economic tools and strategies available for transforming the global plastics economy. In so doing it has underlined that the dominant framing of the 'plastics' problem around solving challenges associated with marine plastic pollution, is being challenged by a framing that incorporates concerns for a wider set of development, environmental and health challenges related to plastic pollution across the entire plastic life cycle.

In addition to efforts to reduce leakage of plastic pollution – such as improving waste collection, management and recycling – addressing the root causes and 'upstream' challenges of plastic pollution demands attention to the drivers of the expanding scale of plastic production and use. More specifically, there is a need for systematic study of:

- the global political economy of plastic production and the factors enabling its expansion, as well as the regulatory behaviour of key commercial actors. Without an understanding of the political economy dynamics of the plastic industry and global value chains – market structure and concentration, location of production, investment and trade flows, and employment – we cannot identify effective solutions.

- industrial policies that can spur the structural transformation needed for greater sustainability, targeting multiple economic sectors and stakeholder groups. Promoting change demands attention to technical, socio-economic and institutional aspects of structural transformation. In developing countries, the constraints and challenges may be different from those in more advanced countries where the plastics industry has been invested for longer.

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[33] Exports of domestically prohibited goods, in particular hazardous waste, have long been a subject of discussion at the WTO and in its predecessor the GATT, as developing countries sought to limit 'dumping' of toxic wastes.

[34] Notably, exports of domestically prohibited goods, in particular hazardous waste, has long been a subject of discussion at the WTO and in its predecessor the GATT, as developing countries sought to limit 'dumping' of toxic wastes.

- the international economic regulatory environment and international policy frameworks relevant to the production of plastics and their substitutes, alongside hard and soft law instruments for international environmental cooperation.

Our review of literature and policy landscape on plastic pollution reveals research gaps in the following five areas.

- Global political economy of global value chains in the plastics economy. Although several studies on global trade and value chains in plastic waste exist, the dynamics and composition of global trade in plastic inputs, such as feedstocks, additives, pellets/nurdles, and global trade in final plastic products have received little attention outside the industry itself. Further, there has thus are been no focused analysis of 'hidden trade' in plastics – that is in the multitude of internationally traded products that contain some plastic or are packaged or transported in plastic. Key outstanding questions include: What are the trends in investment and trade flows in the global plastics economic? Which countries and companies are the main players in the global value chains for plastics and what is the market structure along supply chains? Where could the most strategic policy interventions along supply chains could be made?
- Drivers of plastic production. What are the key factors driving expanding plastic production on the demand and supply side? How is demand for plastic – from industry and from consumers – changing? Who are the key investors in the plastic industry and what forms does their financing take?
- The political economy of the policy and regulatory framework for the plastic economy. Which are the key firms and industry groups active vis-à-vis key global and national policymaking and regulatory processes relevant to plastic? What are their key priorities with regard to the plastic pollution crisis, and how is this shaping their regulatory and voluntary responses?
- Policy frameworks for structural transformation of the plastic economy. What are main constraints and opportunities that developing countries face? What is the policy environment necessary for the growth of innovative and environmentally friendly "sunrise" industries that reduce plastic production, use and waste, and improve waste management? Can lessons be learned from how some countries became global leaders in wind and solar power products, having started at zero or low base? What transition factors are going to be most important, such as with respect to employment?
- The global regulatory environment. How does the international economic regulatory framework shape the plastics industry? What international economic instruments and policy tools could help transform it, including by reducing production and trade of virgin plastics and certain plastic products? How these could be integrated into relevant international legal frameworks in the economic and/or environmental arena?

6. Policy-relevant research agenda

On the basis of analysis in this paper, priorities for a policy-relevant research agenda on transforming the global plastics economy, with a "development dimension" should include the following three areas:

Global Political Economy: Key Trends, Drivers and Actors

- An analysis of global trends in the value and volumes of international trade in key plastic inputs and outputs along the plastics value chain – from plastic feed-stocks, plastic materials used in manufacturing, final plastic products, plastic waste, waste by-products and secondary waste – identifying key countries and stakeholder groups with an economic stake.

- An analysis of financial trends and drivers of expanding plastic production, conversion and use, along with an identification of key financial flows and actors (including governments, companies, investors and insurers) in global value chains for plastics and their interests.

- A review of the evolving demand side for plastic production, conversion and use.

- A critical review of the regulatory and lobbying strategies and influence of key commercial actors across the lifecycle of the plastics industry as well as their responses to public concerns about plastic pollution.

- A review of trade policy and border measures undertaken to limit inflows of some kinds of plastic and plastic waste, such as in China, Malaysia, Vietnam and Rwanda.

Spurring Change: Industrial policy for sustainable transformation

- Exploration of industrial policy measures – national and global – that could promote sustainable transformation of the global plastics economy. This should include consideration of economic opportunities and constraints that developing countries face in trying to 'make the leap' to produce and use alternative plastics and non-plastic substitutes, as well as analysis of where a sample of developing countries are currently located – and could potentially be located – in global value chains in the plastics economy (such as in plastic conversion and recycling) and how plastic packaging is relevant to key global value chains in which they participate (such as in fresh fruit and vegetables). This effort should also include a focus on the financial sector, in particular the role of national and regional development banks and other public banks or public financial assets, and how these can better intersect with the private sector to incentivise and finance the move to a more sustainable, circular plastics economy. Finally, it should also explore how efforts to build waste management capacity with strong environmental performance could better address the socio-economic context in developing countries and strengthen local employment opportunities.

Effective Global Regulation and Cooperation

- Analysis of how the current global regulatory and policy environment shapes the growth of the plastics economy and prospects for transformation. This should include a typology of legislation and policy frameworks at the national level in the United States, China and the European Union (key players in the plastics industry) that could address the production, conversion and use of plastic, including, for instance, caps and bans on the production and use of certain types of plastics; legislation on chemicals; rules in regard to taxation, subsidies and government procurement, intellectual property and technology transfer; supply chain certification and 'placing on market' restrictions; standards; investment requirements related to disclosure of investments in plastic and sustainable finance; and international extended producer responsibility.
- A review of how trade policies are and could be used to address some aspects of the plastic crisis, including a review of trade policy and border measures taken to limit imports or exports of some kinds of plastic and plastic waste.
- A typology and inventory of international economic policy and regulatory instruments – in international trade, investment, finance and development finance – that could be deployed to address plastic pollution.

By producing new evidence and solutions, work on this research agenda would help advance international cooperation to reduce plastics pollution and promote a more sustainable, circular plastics economy.

Annex 1. Sample of corporate social responsibility efforts and partnerships on plastics

Partnership	Launched	Organizer	Purpose	Examples of Participating Companies
Waste Free Oceans	2011	European Plastic Converters	• Dedicated to transforming ocean plastics • By mobilising fisheries, recyclers, manufacturers and policy makers, WFO aims to reduce, reuse and ultimately recycle marine litter, mitigating the impact on both the environment and natural resources • It is committed to cleaning not only the oceans, but also the beaches, by organising beach clean-up events regularly around the world, together with local organisations	Airbus, Alpla, Baume, biodermic, eco modus, pielleitalia, packed, Prowin international
Operation Clean Sweep	2012	American Chemistry Council and The Plastics Industry Association	• It is a campaign dedicated to helping every plastic resin handling operation achieve zero pellet, flake and powder loss • By signing this, companies make a commitment to adhere to best practice and implement systems to prevent plastic pellet loss	Balmoral Tanks, Basell UK Ltd, Coveris, Data Platics, Energystore Ltd, Epwin Group, Luxus, Logoplaste, Palagan, Skymark Renew ELP, Solent Composites, Viridor
Bioplastic Feedstock Alliance	2013	WWF and eight of the world's leading consumer brand companies such as Nestle	• It provides thought leadership on the responsible sourcing of bioplastics, and the role of bioplastic in circular systems. It aims to ensure bioplastics ultimately contribute to a more sustainable flow of materials, to create lasting value for present and future generations	CocaCola Foundation, Danone, Ford, Nestle, Unilever, P&G, Lego
World Plastics Council	2014		• It works to promote the ethic of sustainability and the responsible use of plastics • It works with leaders in the Asia-Pacific region, where ocean plastic inputs are the highest, to catalyse investment in municipal solid waste collection and recycling programs • It works with the UN to provide technical expertise and a range of commitments under the Global Partnership on Marine Litter	Shell Global, Borealis, ExxonMobile, Total, Sibur, SCG, Kolon, Chevron Phillips, Braskem
The Ocean Cleanup	2014	CEO is Boyan Slat	• Aim is to clean up 90% of ocean plastic pollution • Development of advanced technologies to rid the ocean of plastic: for example, The Ocean Cleanup has developed the first scalable solution to efficiently intercept plastic in rivers before it reaches the oceans	Maersk, Deloitte, Latham and Watkins, Macquarie, AkzoNobel, BCG,
NaturALL Bottle Alliance	2017	Danone, Nesté Waters,	• To accelerate the development of innovative packaging solutions made with 100% sustainable and renewable resources	Danone, Nestlé Waters, Origin Materials, PepsiCo

		Origin Materials	• The Alliance also provided a progress report in its goal of developing and launching a PET plastic bottle made from bio-based material • The Alliance uses biomass feedstocks, such as previously used cardboard and sawdust, so it does not divert resources or land from food production for human or animal consumption→ the Alliance aims to make this technology available to the entire food and beverage industry	
Clean Seas Campaign	2017	UNEP	• Campaign to engage governments, the public and the private sector in addressing the root-cause of marine litter by targeting the production and consumption of non-recoverable and single-use plastic. • The campaign contributes to the goals of the Global Partnership on Marine Litter.	60 governments + collaboration with the Volvo Ocean Race + Volvo Cars.
Close the Plastic Tap	2017	IUCN	• Program focused on seeking solutions to close the plastic tap and tackle plastic pollution at its source • It involves the mobilisation of a wide range of stakeholders (governments, industries and society) • It also involves enhancing our understanding of the problem through research and the compilation of the latest science and data on the issue	Coca-Cola Foundation, NORAD
ISWA Marine Litter Task Force	2017	ISWA	• The Marine Litter Task Force is an international partnership led and facilitated by ISWA, with the aim of exploring and clearly establishing the link between efficient waste management and the prevention of plastic waste reaching our oceans • The main aims of the Litter Task Force are: - Prevent the littering and dumping of waste items - Develop and implement practices for sound collection, treatment and disposal of municipal waste - Identify and demonstrate realistic best practices - Promote a global evolution of efficient resource management - Promote the value of secondary plastics as part of a resource efficient circular economy	ARA, ASCON, BGE, IFAT, Expra, VEOLIA, INECO.
Next Wave Plastics	2017	Dell and Lonely Whale	• It is a consortium of multinational technology and consumer brands gathering in the spirit of collaboration and transparency to rapidly decrease the volume of plastic litter entering the ocean by developing the first global network of ocean-bound plastic supply chains. • Member companies pursue this vision through the development of commercially viable and operational supply chains and the integration of non-virgin plastic material into products and packaging • Member companies are committed to diverting a minimum of 25,000 metric tons of plastic—the equivalent of 1.2 billion single-use plastic water bottles—from entering the ocean by the end of 2025.	Ikea, HP, Dell, HermanMiller, Interface, TREK

Circular Plastics Alliance	2018	European Commission	• Signatories voluntarily pledge to 'take action to boost the EU market for recycled plastics up to 10 million tonnes by 2025.	209 companies and industry associations. For the full list, see: https://ec.europa.eu/docsroom/documents/40583
Global Plastic Action Partnership	2018	World Economic Forum	• Global platform for plastic action that enables public, private and civil society leaders and their initiatives to come together • The goal is to drive the transition towards a circular plastics economy while helping to restore natural systems and creating growth opportunities.	Supporters include Pepsico, Nestlé, the Dow Chemical Company, and the Coca-Cola Company
Friends of Ocean Action – World Economic Forum	2018	World Economic Forum and World Resource Institute	• The mission of Friends of Ocean Action is to use our knowledge, means and influence to help the international community take the urgent steps needed to “conserve and sustainably use our ocean, seas and marine resources for sustainable development • Plastic Pollution Action: stop growth in plastic pollution by demonstrating ‘investible and scalable’ circular economy solutions in three coastal economies by 2020, ready to be adapted and implemented globally	Supporters include the Coca-Cola Company, The Dow Chemical Company, PepsiCo Foundation
The New Plastics Economy Initiative	2018	Ellen MacArthur Foundation and UN Environment	• Aims to overcome the limitations of today’s incremental improvements and fragmented initiatives, many focused solely on downstream solutions • It is based on the vision of Eliminate, Innovate and Circulate • The initiative is based on 5 elements: - Dialogue mechanism→ Cross-value chain collaboration to solve challenges that no organisation can address on its own - The Global Commitment→ Aligning stakeholders with a common vision and set of concrete targets - The Plastic Pact→ Driving the implementation of the common vision in a concerted way around the world - Innovation→ Continuously developing the knowledge that underpins the initiative and catalysing innovation to redefine what is possible - Outreach and stakeholder engagement→ Engaging with the key stakeholders to learn, inform, and amplify what works	Nestle, Pepsico, Unilever, Target, Walmart, Keurig Dr Pepper, Tupperware, Graham Packaging, Berry Global Inc., Danone, L’Oreal, Carrefour, Colgate Palmolive, MARS, Coca-Cola Company
New Plastics Economy Global Commitment	2018	Ellen MacArthur Foundation and UN Environment	• Through the Global Commitment, businesses and governments commit to change how we produce, use, and reuse plastic. They will work to eliminate the plastic items we don’t need; innovate so all plastic we do need is designed to be safely reused, recycled, or composted; and circulate everything we use to keep it in the economy and out of the environment • Targets include to: eliminate problematic or unnecessary plastic packaging and move from single-use to reuse packaging models; innovate to ensure 100% of plastic packaging can be easily and safely reused, recycled, or composted by 2025; and circulate the plastic produced, by significantly increasing the amounts of plastics reused or recycled and made into new packaging or products. • Improve transparency of the plastic footprints, calling on signatories to publish annual data on their progress.	Signatories include major global consumer brands such as Apple, Barilla, Tetra Pak, and L’OCCITANE; Danone, H&M Group, L’Oreal, Mars, Incorporated, PepsiCo, The Coca-Cola Company, and Unilever; major packing producers such as Amcor; plastics producers including Novamont, and resource management specialist Veolia, as well as the Government of Rwanda and the cities of Sáo Paulo (Brazil) and Ljubljana (Slovenia) in addition to 26 financial institutions with USD 4.2. trillion worth of assets under their management to help finance the

			•The vision of the Global Commitment has six points: - Elimination of problematic or unnecessary plastic packaging through redesign, innovation, and new delivery models is a priority - Reuse models are applied where relevant, reducing the need for single-use packaging - All plastic packaging is 100% reusable, recyclable, or compostable - All plastic packaging is reused, recycled, or composted in practice - The use of plastic is fully decoupled from the consumption of finite resources - All plastic packaging is free of hazardous chemicals, and the health, safety, and rights of all people involved are respected	transition to a circular economy for plastics (Ellen Macarthur Fund 2019: 17).
Cutting River Plastic Waste	2018	Benioff Ocean Initiative and Coca-Cola Foundation	• Partnership to provide $11 million to empower dedicated and collaborative problem-solvers combating the flow of plastic waste from rivers to the oceans	Coca-Cola Foundation
Alliance to End Plastic Waste	2019		• Develop, deploy, and bring to scale solutions that will minimize and manage plastic waste and promote post-use solutions • Emphasis is on recycling, reusing and repurposing of plastic to keep it out of the environment • Promote higher standards for responsible plastic waste management • Awareness raising, its key goals are to Infrastructure development to collect and manage waste and increase recycling; innovation to advance and scale up new technologies that make recycling and recovering plastics easier and create value from post-use plastics; clean-up of concentrated areas of plastic waste in the environment, particularly the major conduits of waste, such as rivers, that carry land-based waste to the ocean •Financial commitment: investing $1.5 billion over the next 5 years	BASF, Berry Global, Braskem, Chevron Phillips Chemical Company LLC, Clariant, Covestro, CP Group, Dow, DSM, ExxonMobil, Formosa Plastics Corporation USA, Henkel, LyondellBasell, Mitsubishi Chemical Holdings, Mitsui Chemicals, NOVA Chemicals, OxyChem, PolyOne, Procter & Gamble, Reliance Industries, SABIC, Sasol, Shell, Suez, SCG Chemicals, Sumitomo Chemical, Total, Veolia, and Versalis (Eni)
The Plastics Leak Project	2019	Quantis and EA	• Created a methodology with which businesses have a standardized, science-driven way to map, measure and forecast plastic (including microplastic) leakage across their value chains→ The Plastic Leak Project (PLP) Guidelines • The PLP guidelines provide businesses at all stages of the value chain with a robust, standardized method for calculating and reporting estimates of plastic and microplastic leakage at both the corporate and product level. Based on a leading-edge life cycle assessment approach, the guidelines lay out the sources and pathways of plastic leakage across the globe. With a plastic leakage assessment, companies can locate hotspots, understand how much leakage is occurring and identify the factors contributing to plastic pollution across their value chains.	Adidas, Arla Foods, Braskem, CITEO, Cotton Incorporated, Cyclos, Decathlon, DOW, Eastman, Enel X, European Bioplastics, European Tyre & Rubber Manufacturers' Association, International Wool Textile Organization, Mars, Incorporated, McDonald's Corporation, PlasticsEurope, RadiciGroup, Sympatex Technologies and The Woolmark Company
Basel Convention's	2019	Secretariat of the Basel,	• Established to mobilise business, government, academic and civil society resources, interests and expertise to improve and promote the	

Plastic Waste Partnership		Rotterdam and Stockholm Conventions	environmentally sound management of plastic waste at the global, regional and national levels and to prevent and minimize its generation • Activities include: - Identify the gaps and barriers to the prevention, minimization, collection and environmentally sound management of plastic waste and identify best practices, lessons learnt and possible solutions to the same; - Promote the development of policy, regulation and strategies on the prevention and minimization of plastic waste	
Sea the Future	2019	Minderoo Foundation	• The initiative aims to raise $20 billion annually for global recycling, collection and environmental remediation • Market-based strategy calls for a voluntary contribution payable on plastics produced from fossil fuels to drive demand for recycled plastics, as a cheaper alternative, throughout the value chain and turning plastic waste into a cashable commodity.	AGC Chemicals Europe, INEOS, Inovyn, Victrex, Vynova, ELIX Polymers, Arkema, BASF, Covestro LLC, Lanxess, Lyondell Bassell
No Plastic Waste Pledge	2019	Minderoo Foundation	• The aim is to create a circular economy where plastic is considered a commodity, rather than waster after its first use: the solution needs to be market-driven • Promoting awareness of the issues of rising plastic waste, advocating for an industry response and action to address this crisis, and supporting innovative technologies that will bring forward the transition to a circular economy	AGC Chemicals Europe, INEOS, Inovyn, Victrex, Vynova, ELIX Polymers, Arkema, BASF, Covestro LLC, Lanxess, Lyondell Bassell
Clean Cities, Blue Ocean (CCBO)	2019	USAID	• The program works globally to target ocean plastics directly at their source, focusing on rapidly urbanizing areas that contribute significantly to the plastic that flow into the ocean each year • It promotes and provides support for strategies to reduce, reuse, recycle, and better manage solid waste • It enhances policy and governance for increased effectiveness • It builds partnerships with the private sector for maximal impact and sustainability • It has a grant program, designed to identify and implement locally led, sustainable solutions and approaches that support the program's objectives and combat ocean plastics pollution directly at the source	
Global Tourism Plastics Initiative	2020	UNWTO	• It aims to articulate, support and scale-up action by tourism stakeholders and is building a global alliance to fight plastic pollution. • The Initiative requires tourism organization to make a set of concrete and actionable commitments by 2025, such as eliminate problematic unnecessary plastic packaging and items by 2025 and take action to move from single use to reuse models by 2025	ABTA The Travel Association, ACCOR, Betterfly Tourism, Considerate, Hostelling International, Iberostar Group, International Tourism Partnership, Monty's Bakehouse, PATA, RADISSON HOTEL GROUP

European Plastics Pact	2020	WRAP	• Reusability and recyclability: Design all plastic packaging and single-use plastic products placed on the market to be reusable where possible and in any case recyclable by 2025; • Responsible use of plastics: Move towards a more responsible use of plastic packaging and single-use plastic products, aiming to reduce virgin plastic products and packaging by at least 20% (by weight) by 2025, with half of this reduction coming from an absolute reduction in plastics; • Collection, sorting and recycling: Increase the collection, sorting and recycling capacity by at least 25 percentage points by 2025 and reach a level that corresponds to market demand for recycled plastics; • Use of recycled plastics: Increase the use of recycled plastics in new products and packaging by 2025, with plastics using companies achieving an average of at least 30% recycled plastics (by weight) in their product and packaging range.	17 European governments, 70 businesses, 13 business-related organisations and 3 NGOs.

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Material Substitutes to Address Marine Plastic Pollution and Support a Circular Economy: Issues and Options for Trade Policymakers

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Acronyms and abbreviations

APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
ASTM	ASTM International (former American Society for Testing and Materials)
DIN	Deutsches Institut für Normung
EEP	environmentally preferable product
EGA	environmental goods agreement
FAO	Food and Agriculture Organization of the United Nations
FTA	free trade agreement
GATS	general agreement on trade in services
GATT	general agreement on tariffs and trade
GHG	greenhouse gas
GSP	Generalized System of Preferences
GSTP	Global System of Trade Preferences
HFJU	Intergovernmental Group on Jute, Kenaf and Allied Fibres
HS	Harmonized System
ISO	International Organization for Standardization
ITC	International Trade Centre
JACKS	jute, abaca, coir, kenaf and sisal
LDC	least developed country
LDPE	low-density polyethylene
MFN	most favoured nation
OECD	Organization for Economic Cooperation and Development
PBAT	poly (butylene adipate-co-terephthalate)
PHA	polyhydroxyalkanoates
PLA	polylactic acid
REACH	registration, evaluation, authorisation and restriction of chemicals
RTA	regional trade agreement
SDG	sustainable development goal
SNIS	Swiss Network of International Studies
SPS	sanitary and phytosanitary measures
TiSA	Trade in Services Agreement
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
VAT	value added tax
WCO	World Customs Organization
WTO	World Trade Organization

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Executive summary

The growing challenge of plastic waste worldwide, including its impact on vulnerable marine and terrestrial ecosystems, has spurred the quest for viable alternatives to replace plastic as part of a range of solutions to deal with the crisis. This is challenging given some of the inherent flexibility, versatility and low production costs of plastics. Techno-economic factors and evaluation of health and environmental including overall life-cycle impacts will determine whether substitution of plastic would be preferable to other solutions (such as better waste collection and disposal). Particularly problematic plastic pollution sources such as single-use plastic bags and other items are areas where substitution would be highly desirable.

Substitutes for plastic can be broadly categorized into two. Traditional materials are based on naturally occurring polymers of plant and animal origin as well as non-renewable mineral substances found in nature. On the other hand, bio-based polymers are derived from natural polymers, but undergo extensive physical, chemical and abiotic transformations. Many bio-based polymers are only compostable under specific industrial composting conditions and, for this reason, are not a solution in places where such facilities are few or non-existent, particularly in developing countries. Developing countries could, therefore, explore various traditional materials where they may already enjoy inherent production and export-related advantages as substitutes for plastic. Many natural fibres and value-added products, particularly jute, abaca, coir, kenaf and sisal (JACKS fibres), for example, are produced and exported by several developing countries thereby benefiting smallholder farmers. Others include widespread traditional materials that are biodegradable such as bamboo and cotton as well as mineral-based ones such as glass and aluminum that can be easily recycled.

Trade policy initiatives such as lowering tariffs and non-tariff barriers for plastic substitutes such as JACKS fibres could provide incentives for scaling-up their production and deployment. Import tariffs on value-added products are often high in many large developing countries, and hence lowering them could encourage greater South–South trade in plastic substitutes. Such market access initiatives could be pursued unilaterally, bilaterally, regionally, plurilaterally as well as multilaterally under the World Trade Organization (WTO) through liberalization initiatives including as part of a broader environmental goods liberalization package such as an Environmental Goods Agreement (EGA). At the same time, given that many developing countries are also major exporters of conventional plastic materials, consideration should be given to economic and livelihood impacts in these sectors. Addressing fossil-fuel subsidies that keep prices of plastic low would also help in the uptake of substitutes.

Other trade-related supportive initiatives for the scale-up and diffusion of environmental-friendly plastic substitutes include: (i) reviewing and amending the Harmonised System (HS) to enable their greater visibility; (ii) pursuing trade and investment initiatives related to end-of-life management and disposal of both conventional plastics as well as substitutes; (iii) attracting foreign investment in the plastic substitutes sector particularly in developing countries; and (iv) pursuing technical and technology co-operation, assistance and capacity building measures to build supply-side capacities and introducing appropriate regulatory frameworks. All these measures are essential building blocks in the creation of a circular economy.

1. INTRODUCTION

Plastics are ubiquitous in modern life. They are used in a vast diversity of products, ranging from consumer durables such as televisions, toys and clothes, to construction materials, vehicles, clothing and packaging for food and beverages (Barrowclough and Birkbeck, 2020). In addition to health end-uses, such as protective clothing against infectious viruses and for various single-use medical devices, plastics are deployed for a range of environmental end-uses, including the use of plastic sheets to prevent soil erosion or leaching of chemicals from waste sites. Plastics are also used to preserve food, helping to reduce food-waste, and they can help reduce fuel consumption over long distances when used as lightweight materials for vehicles or transportation containers (OECD, 2018). In many markets, plastics have displaced traditional materials such as metal, wood, concrete paper, natural fibres and glass due to their versatility and useful properties, including high strength-to-weight ratio, high malleability into a diversity of shapes, impermeability to liquids, insulation properties and resistance to physical and chemical degradation and, critically, their relatively low cost (OECD, 2018).

However, the negative environmental impact of plastic pollution, especially in the world's oceans, is widely recognized and acknowledged. To date, the focus of efforts to reduce plastic pollution has been largely on minimizing marine pollution as well as on 'end of life' disposal and clean-up solutions. There is, however, growing recognition of the need to focus on upstream part of the plastics life cycle, including measures to reduce production and use of conventional polymers.

The United Nations Sustainable Development Goals (SDGs), 2015 provide a broader mandate for efforts to tackle plastics pollution (United Nations, 2015). SDG 12 calls for efforts to "ensure sustainable production and consumption." SDG Target 12.4 sets the goal by 2020 to "...achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment…" This target continues to be relevant today. SDG Target 12.5 sets the goal by 2030 to "...substantially reduce waste generation through prevention, reduction, recycling and reuse." In addition, SDG 14 calls upon countries to "conserve and sustainably use the oceans, seas and marine resources" for sustainable development. SDG Target 14.1 aims by 2025 to "... prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution…"

Some attention was paid to the plastics pollution aspect as part of the 2017 Declaration of the United Nations Ocean Conference *Our Ocean, Our Future: Call for Action* (UNGA, 2017). The Declaration makes reference to the need to address consumption patterns and their impact on marine pollution, including mentioning plastics and micro-plastics. Among others, it also called on countries to: (i) "promote waste prevention and minimization, develop sustainable consumption and production patterns, adopt the 3Rs – reduce, reuse and recycle – including through incentivizing market-based solutions to reduce waste and its generation, improving mechanisms for environmentally-sound waste management, disposal and recycling, and developing substitutes such as reusable or recyclable products, or products biodegradable under natural conditions; and (ii) Implement long-term and robust strategies to reduce the use of plastics and micro plastics, particularly plastic bags and single use plastic."

Recognizing both the advantages of plastics as well as the negative environmental impacts linked to the production, use and disposal of plastics, two essential questions to ask are:

a. is the use of plastics for a particular application useful, justified and appropriate?
b. is the use of plastic for a particular application useful and convenient, but inappropriate?

Plastic substitutes are best developed in cases where the answer is affirmative in the case of (b) (UNEP, 2017).

This paper explores options that exist to promote plastic substitutes along with the issues, challenges and considerations that policymakers are likely to face, particularly from a trade and sustainable development perspective. Section II provides a categorization of the plastic substitutes. Section III explores conceptual and definitional issues, particularly around the concept of biodegradability, and sets out some key criteria that could be used to evaluate the merits and demerits of various types of plastic substitutes. Section IV provides a preliminary assessment of market and trade-related trends in selected examples of plastic substitutes with an emphasis on natural fibres of export interest to developing countries. Section V examines some of the main tariff and non-tariff measures affecting market access for select plastic substitutes. Section VI explores what could be some short, medium, and long-term trade policy initiatives that could be pursued to support the scale-up of plastic substitutes, as well as some additional considerations for policymakers as catalysts for trade-led action. Section VII concludes the discussion with some observations and also identifies a few knowledge gaps that might need to be addressed in future so as to constructively inform policymaking initiatives on plastic substitutes.

2. CATEGORIZATION OF PLASTIC SUBSTITUTES

A range of possible substitutes exist for hydrocarbon-based conventional plastic polymers and products derived from them. These include alternative plastics (such as recycled plastics and bio-based polymers) and non-plastic substitutes (e.g., natural fibre-based substitutes). Non-hydrocarbon-based substitutes for conventional plastics can be derived from organic matter of plant or animal origin or from inorganic material of non-hydrocarbon mineral origin found in nature. Such substitutes can further be categorized into:

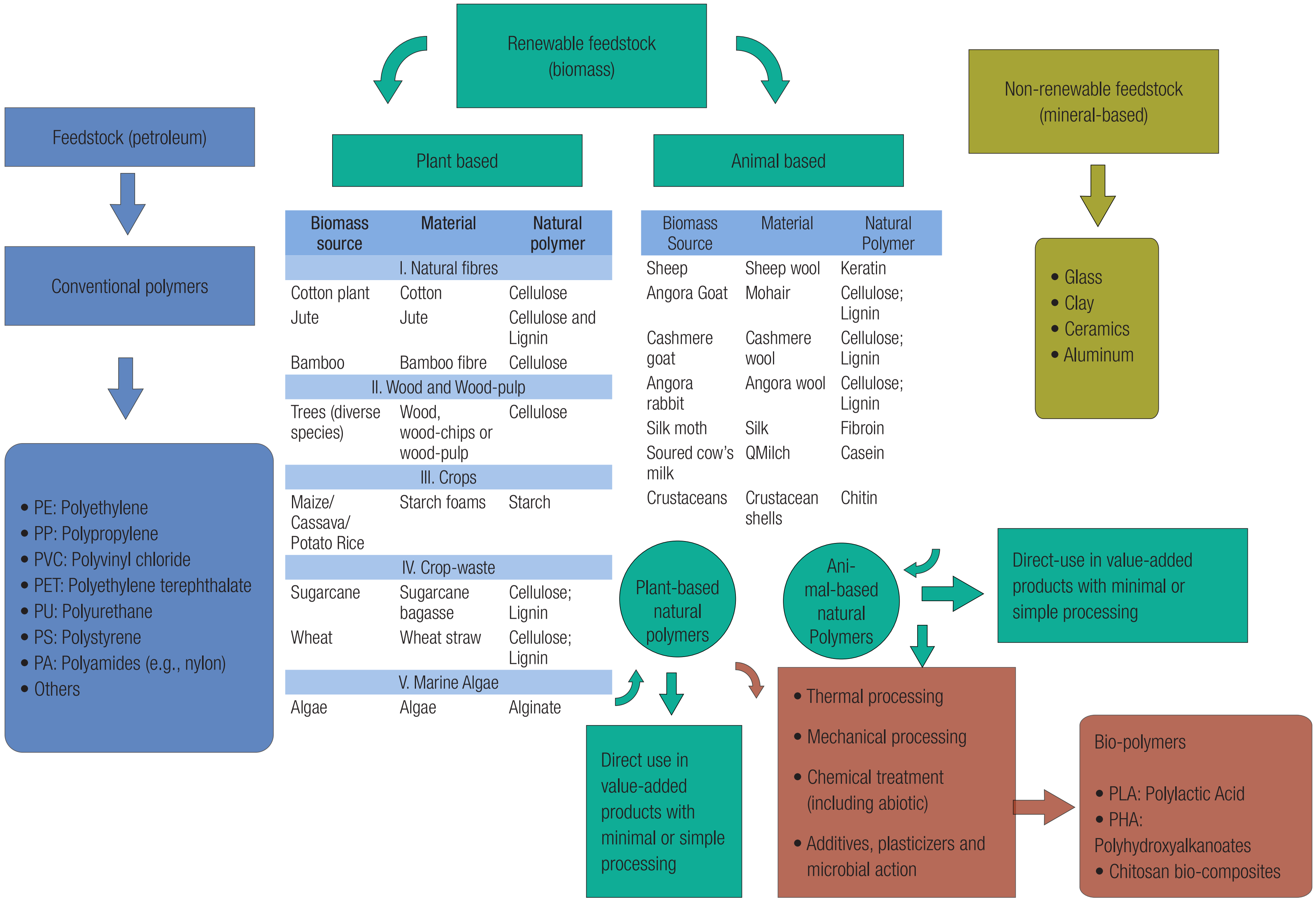
1. *traditional materials*: based on naturally occurring polymers found in animals and plants (renewable) such as cellulose, chitin and lignin as well as non-renewable mineral substances found in nature such as clay and mica; or
2. *synthetic or semi-synthetic bio-based polymers:* derived from natural polymers of renewable origin, but undergo extensive physical, thermal or mechanical processing or chemical treatment (in the case of semi-synthetic bio-based polymers) or transformation of polymers using chemical abiotic routes (in the case of synthetic bio-based polymers).

Examples of semi-synthetic bio-based polymers include rubber made from latex (produced through vulcanization with sulphur), rayon from wood chips and thermoplastic starch from starch. “Polylactic acid is an example of a synthetic bio-based polymer; it is synthesized by polymerisation of lactic acid, which is produced by the bacterial fermentation of sugars derived from a variety of biomass sources.” Biodegradable bio-based polymers can also be synthesized by microorganisms; polyhydroxyalkanoates (PHA), for instance, is made from bacteria acting on sugars contained in agricultural and plant wastes. Bio-based polymers can be blended with conventional polymers as well. However, this often complicates or hinders their recyclability (UNEP, 2017; Lackner, 2015).

In Sections III and IV, this paper focuses on opportunities and challenges associated with scaling up production, use and trade of the first category of plastic substitutes, namely traditional materials and especially natural fibres, given their commercial importance to a large group of developing countries and their biodegradability under natural conditions. Both sections will, however, also touch upon examples of potentially biodegradable bio-based polymers that could see significant growth in the future, including examples of trade flows in polylactic acid (PLA), which is a commercially established bio-based polymer.

Figure 1[1] provides an overview of conventional polymers as well as their substitutes. Tables A1–A4 provide a longer list of traditional materials and two bio-based polymers with specific examples of use-cases as well as some sustainability aspects, particularly regarding disposal under natural conditions, and home and industrial composting.

Figure 1. Conventional polymers and illustrative list of potential substitutes (non-exhaustive)



3. PLASTIC ALTERNATIVES AND SUBSTITUTES: EVALUATING RELATIVE MERITS AND DRAWBACKS

Before reviewing the merits and challenges associated with alternatives to conventional plastic polymers and non-plastic substitutes, it is important to briefly discuss some key terms and definitions. At present, there is considerable confusion about commonly used terms such as "bio-plastics" and concepts related to the end-of-life disposal for plastics such as biodegradability widely used for product labelling. Hence, the European Commission" has recommended that the use of the term "bioplastics" should be avoided (European Commission, 2018). "Bio-based plastic" would be a better term for a plastic derived from biomass or "biodegradable plastic" (if indeed the plastic does biodegrade). The Commission notes that "[b]oth categories overlap but there also are bio-based plastics that are not biodegradable as well as biodegradable plastics that are not bio-based".[2] Biodegradable plastics can be derived from both conventional and bio-based polymers (Figure 2).

A distinction also needs to be made between degradation in general and biodegradation, as well as between biodegradability and compostability under industrial or domestic (household) conditions (Table 1).

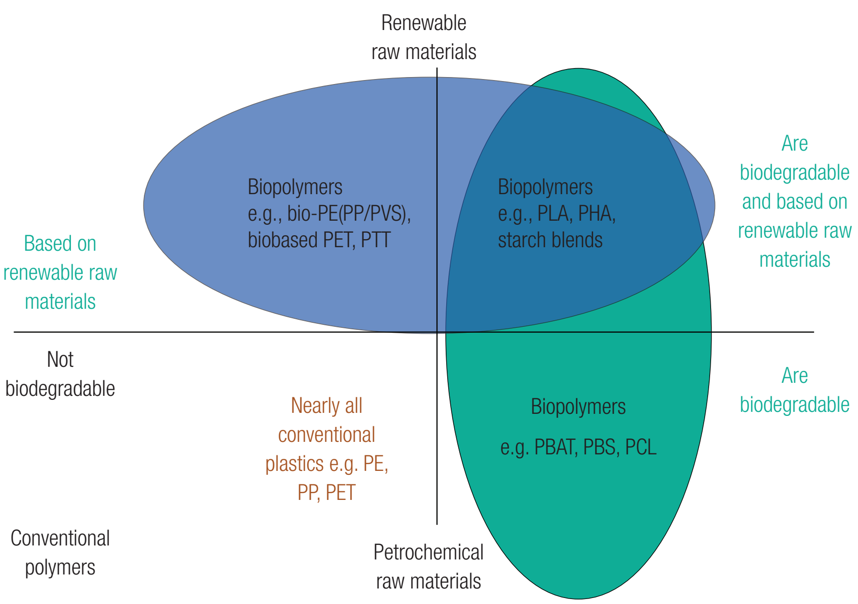
Table 1. Illustrative definitions of degradation, biodegradation and compostable

Term	Definition
Degradation	Partial or complete breakdown of a polymer due to some combination of ultraviolet radiation, oxygen attack, biological attack, and temperature. This implies alteration of the properties, such as discoloration, surface cracking, and fragmentation
Biodegradation	Biologically-mediated process involving the complete or partial converted to water, carbon dioxide/methane, energy, and new biomass by microorganisms (bacteria and fungi)
Composting-industrial (C-i)	Capable of being biodegraded at elevated temperatures under specified conditions and time scales, usually only encountered in an industrial composter (standards apply)
Composting-domestic (C-d)	Capable of being biodegraded at low to moderate temperatures, typically found in a domestic household compost system

Source: UNEP (2017).

Countries exploring options for domestic and trade policies to promote alternatives to conventional plastic and non-plastic substitutes need to consider a range of different sustainability and sustainable

Figure 2. Biodegradable and non-biodegradable polymers with examples



Source: Lackner (2015).

Box 1. Biodegradability and composting standards

ISO 17088 is an international standard that lays down specifications for compostable plastics. Others with similar requirements include EN 13432 and ASTM D6400. ASTM D6400 (United States) and EN 13432 (European Union) require 84 days for disintegration and 180 days for mineralisation. “Additional requirements include limits on heavy metals content, ecotoxicity analysis, and the level of compost quality, determined by a plant growth test. “Standards for industrial composting include DIN V 54900-1 (Germany), EN-13432 (European Union), ASTM 6400-04 (United States) and GreenPla (Japan). Several voluntary certification systems also exist worldwide with regard to compostability such as DIN CERTCO, Vinçotte and European Bioplastics (Europe), BPI (United States), JBPA (Japan) and ABA (Australia). These systems are all based on the same international standards (EN 13432, ASTM D6400, and ISO 17088) with similar requirements. Vinçotte a certification and standards agency based in Belgium also provides certification for materials being biodegradable in soil (OK SOIL) and under marine conditions (OK MARINE).

Sources: Lackner (2015); UNEP (2017).

development-related criteria. A sample of some of the core issues to be considered include:

a) Impacts on natural environment and human, animal and plant health upon disposal

Not all substitutes for conventional plastic have the same impact on the environment when disposed of in a landfill or littered openly. From an environmental perspective, the distinction between natural biodegradation and composting that occurs only under specific conditions is critical.

Traditional materials that are transformed into products using non-hydrocarbon, natural feedstocks quite often biodegrade naturally (with differing time-frames) and, in most cases, in a benign, non-toxic manner (if no harmful additives are used). Traditional plant-based materials such as cotton, hemp, flax, jute, ramie (from China-grass), abaca (from *musa textilis* banana leaf-stems), pina fibre (from pineapple leaves) and sisal, for instance, each exhibit high biodegradation rates in both terrestrial as well as aquatic environments, whereas coir’s biodegradation rate in an aquatic environment is somewhat lower. The same high rate of natural biodegradability is also seen in animal-based polymers such as those found in wool, mohair and silk. All these materials also exhibit high compostability under both domestic as well as industrial composting conditions.

By contrast, bio-based polymers biodegrade only under specific conditions made available through industrial composting. Similarly, bio-based polymers (Tables A1–A4) such as PLA and PHA exhibit high rates of compostability only under industrial composting conditions or by anaerobic digestion at the end of life (UNEP, 2017). Several national and international standards have been developed for biodegradability and compostability as illustrated in Box 1.

In addition, the use of chemical additives with toxic effects must also be considered when assessing suitability of alternative plastics, such as bio-based polymers. Such additives are used to adjust the properties and enhance performance of polymers, but can leach into the surrounding environment when disposed, with an array of negative environmental and health impacts. Many of these additives include “known endocrine disruptors that may be harmful at extremely low concentrations for marine biota, thus posing potential risks to marine ecosystems, biodiversity and food availability” (Gallo et al 2018). While it is unlikely that traditional natural fibres, such as cotton and jute used in textiles, would have such adverse effects, leaching from any added chemical additives and colorings could still be a concern.

A further environmental challenge related to bio-based polymers is that few developing countries have the closed-loop industrial composting systems required to handle bio-based polymers. The end-use versatility and potential of bio-based polymers to replace a wide range of conventional polymers certainly make them attractive for numerous applications relative to many natural materials. However, further advancements in synthetic bio-based polymers as well as the establishment of an organized collection and waste management system to deal with bio-based polymer waste, particularly in developing countries, are needed before advocating the expanded use and scale-up of their production and trade.

Box 2. Case examples of production and use of natural materials and bio-based polymers to replace conventional polymers

Case Example 1: Bio4Pack

Bio4Pack is a German company that has been a specialist in the field of compostable, sustainable packaging has reportedly developed the "first meat tray in the entire world which is completely compostable in accordance with the strict EN-13432 norm." The tray, transparent film, label and absorption pad will all be bio-based and compostable and indistinguishable with the product being produced at only a fraction higher than the cost of a traditional plastic tray. Production of the tray has been a challenge. Given the fragility of PLA relative to other types of plastic, the use of approved additives has been necessary. The package is also required to have "good barrier properties and be able to be mechanically processed with ease." Retailers also benefit by being exempt from packaging tax. The company also manufactures paddy-straw trays that can be used for packing fruits and vegetables made from paddy straw waste generated in the paddy fields of Malaysia thus providing farmers there a new source of income and avoiding other negative environmental externalities such as the air-pollution and groundwater pollution in the region caused by burning of paddy-waste. In addition to complying with the EN13432 composting standard, the Paddy Straw Trays may also be disposed of with the waste paper after use.
Website: https://www.bio4pack.com/

Case Example 2: Piñatex by Ananas Anam

Pinatex is a substitute for products made out of leather (or polymer-based leather substitutes) such as shoes, bags, furnishings as well as automotive interiors. Manufactured by London-based company Ananas Anam with subsidiaries in the Philippines and Spain, the raw material consists of pineapple leaves from commercial pineapple cultivation in the Philippines. Textile fibres are extracted from pineapple leaves following a process involving the mechanical removal of the outer layers of the leaf (decorticating), followed by de-gumming. The collection and processing of leaves provide an additional income for farmers cultivating pineapples. The waste biomass from the process can be used as a natural fertilizer or to produce biogas. The fabric receives a resin top-coat to strengthen the material and increase durability and can also be recycled after use. However, as the composition of the product is 80 per cent pineapple leaf fibre and 20 per cent PLA the product is biodegradable only under controlled industry conditions. The coating used is polyurethane does not have any detectable volatile compounds and is therefore registration, evaluation, authorisation and restriction of chemicals (REACH) compliant. The company's website states that it has optimized the maximum amount of bio-based polyurethane that they can use while still ensuring longevity of their materials.
Website: https://www.ananas-anam.com/

Case Example 3: Envigreen

Envigreen is an Indian company that produces 100 per cent organic, biodegradable, and eco-friendly bags to replace conventional single end-use plastic bags. The bags are made out of 12 ingredients, including potato, tapioca, corn, natural starch, vegetable oil, banana, and flower oil. The raw materials are converted into liquid form and then taken through a six-step procedure before the end product is ready. According to the company no chemicals are used and the paint used for printing on the bags is also natural and organic. The bags are water-soluble and don't melt, or release any toxic fumes when burnt, unlike conventional plastic bags and have undergone numerous tests by various government agencies. The ingredients are also edible and do not harm animals that consume it. In addition to India the company's bags are available in 13 countries including Qatar, the United Arab Emirates, the United States, the United Kingdom and Kenya.
Website: http://envigreen.in/

Sources: Bio4Pack. See https://www.bio4pack.com/; Ananas Anam, See https://www.ananas-anam.com/; EnviGreen. See http://envigreen.in/; "This start-up makes plastic bags of potato and tapioca that degrade in 60 days!" The New Indian Express-Edex Live, 10 April 2019. Available at https://www.edexlive.com/people/2019/apr/10/this-start-up-makes-plastic-bags-of-potato-and-tapioca-that-degrade-in-60-days-5736.html; DiCiancia C (2017). The textile of the future: Piñatex. Welum. 28 November 2017. Available at https://welum.com/article/textile-future-pinatex/; Singh T (2016). These 'plastic' bags are actually made of potato and tapioca-and can become animal food on disposal! The Better India. Available at https://www.thebetterindia.com/77202/envigreen-bags-organic-biodegradable-plastic/

b) Durability and functionality for desired end-uses

Substitutes to conventional plastic will be successful where they fulfil the function and replicate some of the desirable attributes that make conventional polymers so attractive. This is a tough challenge. For instance, the versatility, ease of use, lightweight and impermeability of various types of conventional polymers to moisture, temperature and bacteria make them particularly suited for long-distance transportation of perishable products such as fresh fruits, vegetables and meat. In such cases, it may be challenging to find traditional natural materials that can readily replace conventional polymers. As an alternative, some companies are working instead to develop compostable bio-based polymers (Box 2). For certain other single-end use plastic products such as drinking straws and take-away food containers, there are a wide variety of traditional natural materials that are already being used with a key challenge being the ability to scale-up their production in a sustainable and cost-competitive manner. Bamboo can be used for drinking straws as well as food-boxes, baskets, wall coverings, window-blinds as well as woven into textiles. Palm leaves and wood are often used to create disposal plates and cutlery and glass can be used for bottling and re-used or recycled indefinitely. Agricultural waste such as pineapple leaves are being used to make consumer goods such as bags, shoes, and furnishings such as the example of Piñatex developed by the Ananas Anam company (Box 2). In addition, starch from agricultural crops can be used to make fully biodegradable (including in water) plastic bags that would be ideal for single-use purposes. This could open opportunities for developing countries to serve not only their own domestic markets, but also tap into possible export opportunities, as in the case of EnviGreen, an Indian company (Box 2). Further, it would be important to mention the diverse range of textiles and products made from natural plant fibres such as cotton and jute of which developing countries are already well-established exporters. An illustrative list of many such materials and their end-uses is provided in Tables A1--A4.

According to analysis by the Pew Charitable Trusts,[3] paper, coated paper, and compostable materials (including compostable plastic and non-plastic material) "could substitute 17 per cent of plastic waste generated by 2040, equivalent to 71 million metric tons of plastic, without fundamentally decreasing the performance, affordability, or social and environmental acceptability of packaging and single-use items." Ninety-five per cent of this potential substitution comes from six key product applications for which known material substitutes already exist at some level of scale: monomaterial films; other rigid monomaterial packaging; sachets and multilayer films; carrier bags; pots, tubs, and trays; and food service disposables (Table 2).

(c) Environmental and social impacts of production and economic feasibility

Substitutes for conventional polymers also need to be assessed in light of the environmental and social impacts arising from their production and manufacture across their life cycle, including land-use, water-use and GHG emissions, in addition to impacts arising from disposal.

A range of life-cycle assessments have been carried out for traditional natural materials as well as bio-based polymers, but they differ widely in terms of their results owing to choices of assumptions and approach. For example, the environmental impact of cotton production varies depending on whether it is grown in an organic manner or based on industrialized farming systems involving machinery, heavy fuel, and fertilizer use.[4] Bamboo, due to its rapid growth and lower resource-requirements, is frequently marketed as a 'green product', but there are concerns about its contribution to deforestation in some regions (Vögtlander, van der Lugt and Brezet, 2010). In the case of natural fibres such as flax, adequate environmental management will be needed (e.g., water supply management is required when leaves are soaked in water to separate fibres to avoid contamination). Tables A5–A7 present the results of an initial environmental assessment by UNEP of "cradle-to factory, manufacture and end-of-life stages" of range of natural, semi-synthetic and synthetic biomass-based polymers.[5]

The UNEP assessment highlights that from harvesting to manufacture, several natural fibres like organic cotton, jute, and coir have relatively good performance in terms of water, energy, fertilizer and biocide use, low overall socio-ecological impact as well as low impact on human health. Bio-based polymers such as PLA and PHA, on the other hand, are more resource-intensive especially in terms of energy use, but have a higher potential of use of waste material. Compared to natural fibres (which the study indicates score well across all the manufacturing-related environmental indicators), the manufacturing of PLA and PHA requires particularly high energy use as well as use of chemical processes relative to natural fibres. The sustainability indicators for use and end-of-life phases reveal that natural fibres have overall better scores for domestic compostability and especially biodegradability in seawater (and consequently low environmental impact in the oceans) as compared to the synthetic bio-based polymers PLA and PHA.[6] Notably, the expanded use of PLA and PHA in the retail sector would require industrial composting and/or anaerobic digestion facilities to be provided first. UNEP underlines that bio-based polymers are unsuited for uncontrolled use in retail sectors such as the 'fast-food' industry.[7]

In terms of mineral-based substitutes, such as glass

Table 2. Global substitution potential of plastic in 2040 for six plastic subcategories

Plastic subcategory	Paper	Coated paper	Compostables	Explanatory notes
Percentage plastic subcategory substituted in 2040; million metric tonnes of plastic substituted in 2040.				
Monomaterial films				
41%; 45 million metric tonnes	6.5%; 7 million metric tonnes	9%; 10 million metric tonnes	25.5%; 28 million metric tonnes	Paper/coated paper where water barrier properties not necessary; compostable plastic, cellulosics, or alginates where transparency is essential or food contamination risk is high
Other rigid monomaterial packaging				
23%; 9.5 million metric tonnes	18.5%; 7.5 million metric tonnes	0%	4.5%; 2 million metric tonnes	Subcategory does not require food contact: paper and compostable substitutes readily available for expanded polystyrene and other protective packaging
Sachets and multilayer films				
7%; 4 million metric tonnes	2%; 1 million metric tonnes	3%; 2 million metric tonnes	2%; 1 million metric tonnes	Coated paper and compostable alternatives available today with adequate performance for dry or short-life goods
Carrier bags				
13%; 4 million metric tonnes	3%; 1 million metric tonnes	0%	10%; 3 million metric tonnes	Compostable bags where water resistance required (for meat fish, etc.); paper bags widespread today
Pots, tubs, and trays				
12%; million metric tonnes	5.5%; 1 million metric tonnes	6.5%; 2 million metric tonnes	0%	Paper punnets for fresh produce; coated paper for other
Food service disposables				
17%; 2 million metric tonnes	4%; 0.5 million metric tonnes	4%; 0.5 million metric tonnes	9%; 1 million metric tonnes	Widely available alternatives, e.g., bamboo cutlery, paper/ coated paper clamshells and cups, banana leaf wraps
Column total	18.5 million metric tonnes (out of a total 19 million metric tonnes paper potential)	14 million metric tonnes (out of a total 14 million metric ton coated paper potential)	35 million metric tonnes (out of total 38 million metric tonnes compostable potential)	

Source: The Pew Charitable Trusts and SYSTEMIQ (2020).
Note: Columns may not sum to column total due to rounding of decimals.

and aluminum, which can be re-used and recycled indefinitely, these could play an important role in replacing rigid mono-material plastics as well as certain single-use items (like coffee cups). However, widespread re-use and re-cycling of glass and aluminium products require effective collection, re-use and recycling systems, which may not be present everywhere, particularly in developing countries. Further, most of the rigid mono-materials they are meant to replace are less problematic globally for the environment relative to flexible plastic, because they have higher collection and re-cycling rates. In a single-use context, glass and aluminium can also have negative trade-offs in terms of GHG emissions, recycling rates and costs compared to mono-material plastics. Costs are also an important consideration in shaping consumer decisions to switch to alternative materials. For example, aluminium cans and glass bottles are 33 per cent and 167 per cent more expensive, respectively, than a PET bottle.[8] This underlines the wider point that domestic regulatory and taxation policies will be needed to can help reduce the cost-differential between conventional plastics (that often benefit from cheap fossil-fuel prices and fossil-fuel subsidies) and enable the greater uptake of non-plastic substitute materials.

To minimize land-use, water and energy-related impacts – and related food security considerations – of cultivating crops for natural fibre-based substitutes, the focus should be on using the waste materials from agricultural food crops. Using degraded or waste land for the cultivation of crops for natural fibres would also be more sustainable than land clearance. As costs decline, marine algae-based biodegradable, bio-based polymers could also potentially reduce reliance on food-crops and pressure on land-based agriculture, although a range of environmental considerations would require analysis and attention.

(d) Sustainable development opportunities for developing countries

A major consideration for policymakers seeking to promote substitutes for conventional plastic should be the potential sustainable development opportunities for developing countries. A large number of developing countries already cultivate plant-based fibres such as cotton, jute, abaca, coir, kenaf, sisal, bamboo, hemp, milk casein and pineapple, and also manufacture wood-based packaging, such as paper and cardboard. While these products may not necessarily replace all plastics use, they ”can be used strategically, especially in areas where some of the properties of plastic are dispensable” (Barrowclough and Birkbeck, 2020). In some instances, they may also be readily available to supply the market where bans, taxes or other restrictions on single-use plastics are implemented at the national level. Sisal, for example, is produced in many least-developed countries and can thrive in drought conditions where other agricultural crops fail. However, loss of traditional market for sisal has led to declining production, along with a loss of export-earnings and income for local communities. A focus on replacing synthetic fibres with natural fibres such as sisal could present an opportunity to reverse such trends and open new markets. Agricultural crops can also yield waste material that can be used as feedstock to produce cellulose or lignin-based bio-based polymers.

Importantly, most natural materials can be domestically composted; in remote and poor communities, this also make them suitable for other beneficial purposes, such as reuse for soil conditioning.[9] On the other hand, the infrastructure for recycling or safely disposing off plastic waste is well-short of what is needed in developing countries (both to cope with the plastic waste generated domestically or imported, and also waste arising from imported plastic goods). This is especially true in rural communities where mass-produced consumer goods made from plastic are increasingly available, but without corresponding collection, recycling, or safe disposal systems in place.

New innovations are emerging based on research and development (R&D), such as ongoing efforts to produce PHA with the help of methane-eating bacteria, which could lower costs of production and bring multiple benefits. However, it will be some time before such innovations are commercially available and the necessary recycling and composting eco-systems are created.

In the interim, sustainable exploitation of existing natural materials would seem to be the most appropriate source of benefits for developing countries and help in the realization of the SDGs.

4. PRELIMINARY ASSESSMENT OF MARKET AND TRADE-RELATED TRENDS

This section provides an illustrative overview and preliminary assessment of market trends and trade flows for selected examples in three categories of materials:

First, it reviews a select group of natural materials: jute, abaca, coir, kenaf and sisal, commonly known as the JACKS. These are already well-established sectors and products of interest to a number of developing countries as well as potential substitutes for common synthetic fibre-based items textiles, rope, cord and packaging materials, all of which are known marine polluters.

Second, it reviews trends for conventional plastic packaging as well as alternative cellulose-based packaging materials. It compares, three HS 2017 subheadings namely boxes, cases, crates as well as sacks and bags made of polymers of ethylene as well as other plastics (HS 3923.10, HS 3923.21 and 3923.29) with trade flows for paper, paperboard and cellulose-based packaging material (found under the four-digit heading HS 4819, which in turn contain subheadings covering cartons, boxes, cases, bags and other packing containers, of paper, paperboard, cellulose wadding or webs of cellulose fibres; box files, letter trays, and similar articles, of paper or paperboard, of a kind used in offices, shops or the like).

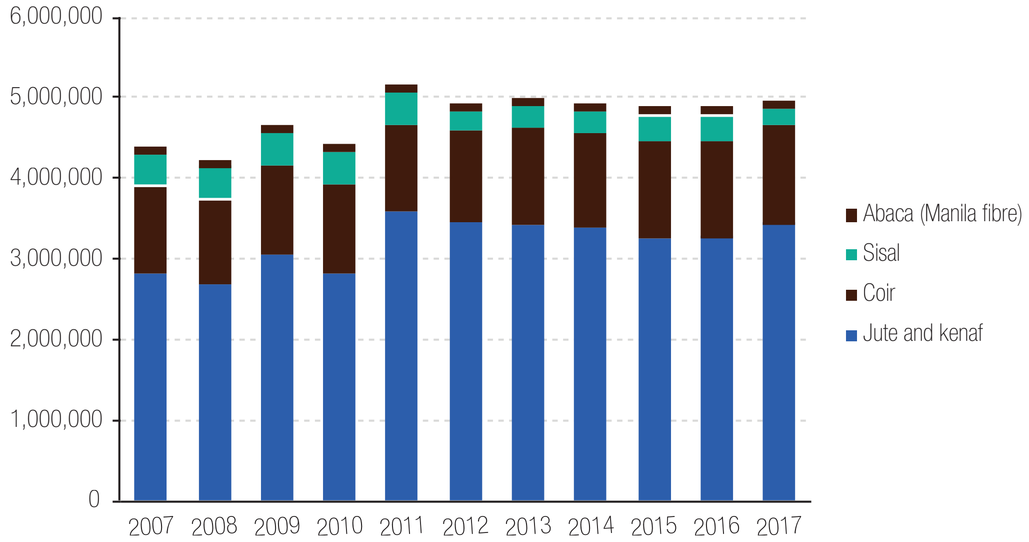
Third, it reviews an example of a biodegradable (under specific composting conditions) bio-based polymer, namely, PLA. This bio-based polymer was selected for attention because it is already used in a number of commercial applications, including food packaging.

4.1. Evaluation of global markets and trade for JACKS fibres

In 2017, global production of JACKS fibres was 4.62 million tonnes. Jute and kenaf accounted for the largest share of production (75 per cent) followed by coir, sisal, and other fibres. Figure 3 shows global production of JACKS over a ten-year period of 2007–2017.

The production of JACKS fibres is concentrated in developing countries. India and Bangladesh dominate jute and kenaf production, accounting for more than 95 per cent of the global output. They are also the biggest global exporters of jute and jute products, accounting for more than 93 per cent of exports. Bangladesh alone accounts for more than 80 per cent of jute fibre and goods exports, especially for buyers in India. China, India, Nepal and Pakistan account for three-quarters of the global imports of jute. In 2017, world import of jute goods totaled 941.7 thousand tonnes, an increase of 11.4 per cent compared to 2016. Asia is the largest importing region accounting for 75 per cent of global imports of jute goods. Within that region, Turkey is the largest importer followed by India and China. Smaller markets for jute goods

Figure 3. World JACKS production (tonnes), 2007–2017



Source: FAO (2019).

Table 3. Top producers, exporters and importers of JACKS fibres

Fibre type	Production (thousand tonnes)	Exports (thousand tonnes)	Imports (thousand tonnes)
Raw jute, kenaf and allied fibres	India – 1,56 (2016–2017) World – 3380 (2016–2017)	Bangladesh – 219.7(2016–2017) World – 254.1 (2016–2017)	Pakistan – 78.3 (2017) World – 284.1 (2017)
Sisal fibres	Brazil – 69.4 (2017) World – 216.8 (2017)	United Republic of Tanzania – 25.5 (2017) World – 75.1 2017)	Europe (including European Union – 28) – 14.3 (2017)
Abaca	Philippine – 71.9 (2017) World – 84.2 (2017)	Philippines (fibre) – 18.2 (2017) World (fibre) - 28.1 (2017)	Europe (fibre)(European Union – 28) – 17.7 (2017) World (fibre) – 30.6 (2017)
Coir fibre	India (brown, white and curled fibre) – 623.8 (2017) [Data for India do not include coir pith] World – 975.4 (2017)	India – 930 (2017) World - 1450.8 (2017) [Data for India and World also include coir pith]	China – 662.9 (2017) World – 1028.4 (2017)

Source: FAO (2018).
Note: Calculations based on data tables given in FAO (2018). Jute, kenaf, sisal, abaca, coir and allied fibres. Statistical Bulletin 2018.

include the European Union, Africa and North America (FAO, 2019).[10]

Sisal-producing countries are more diversified. Brazil leads sisal production accounting for 32 per cent of global output followed by China (29.1 per cent), United Republic of Tanzania (17.8 per cent), Kenya (10.4 per cent) and Madagascar (2.9 per cent). Wordwide, there has been an overall decline in sisal production from around 300 000 tonnes to just over 200 000 tonnes in 2017 and exports have also declined. The supply shortfalls in recent years has been caused by lower output in Brazil due to severe drought conditions. Brazil, the largest producer, is also the main exporter of sisal fibres and goods accounting for nearly 30 per cent of sisal fibre exports and nearly 50 per cent of sisal-based manufactured goods in 2017. Other exporters include Kenya and United Republic of Tanzania, which mainly provide sisal products for use in the construction industry, with the main destinations being Saudi Arabia, Nigeria, Morocco, Spain and Egypt. China remains, by far, the largest import market of sisal fibre, accounting for 48.2 per cent of global imports and the United States remains the main import market of sisal-based manufactured goods, with a share of 38.9 per cent, followed by the European Union (24.1 per cent) and Asia (15.7 per cent).[11]

Like jute, the production of abaca, which amounted to 84.16 thousand tonnes in 2017, is also relatively concentrated, with most production taking place in the Philippines (85 per cent of global total) and Ecuador (12 per cent of the global total). Most of the Philippines' production of abaca fibre (75 per cent) is destined for domestic consumption, while Ecuador exports most of its production. Abaca fibre exports have more than doubled from a little below 15,000 tonnes in 2013 to just above 30,000 tonnes in 2017, driven by increasing demand in the world market, while exports of abaca-based manufactured goods and abaca pulp have declined in overall terms since 2011.[12]

Global production of coir fibre was 975.4 thousand tonnes in 2017. India is by far the largest producer of coir fibre, accounting for 64 per cent in 2017, followed by Sri Lanka, Viet Nam and Indonesia. World exports of coir fibre (including coir pith from India) reached 1.45 million tonnes in 2017 (Table 3). India again accounts for the major share of coir fibre and product exports accounting for 74.2 per cent of global exports followed by Sri Lanka, Viet Nam and Indonesia. Major importers of coir fibre in 2017 include the European Union, the United States and the Republic of Korea. Top importers of coir products in 2017 include the European Union and the United States.[13]

The medium-term outlook for JACKS fibres production and trade is varied. Falls in crude oil prices could, for instance, lower some input costs such as fertilizer and transportation for JACKS production, but could also lead to price reductions in competing non-natural or synthetic fibres, particularly polypropylene. In the past, reductions in crude oil prices have led to lower demand for JACKS, except for abaca, which has remained competitive with synthetic fibres due to the superior properties of its fibre (especially for its main end-use, which is for specialty papers).[14] Historically demand for JACKS has been more consistent in large producing countries, such as China and India, compared to smaller countries reliant on export markets. Increasing trade in agricultural commodity crops such as coffee, for which jute is often used as packaging material, as well as the preference of many commodity buyers (in domestic markets) for the use of jute packaging for sugar, are both major sources of demand for jute (Chang, 2013).

Looking ahead, increases in crude-oil prices, combined with the growing range of environment-related bans and regulatory measures on certain plastics, could boost demand for JACKS to grow and provide an impetus for stronger research and commercialization efforts on the use of JACKS fibres in bio-composites.[15] In developing countries, for instance, efforts to discourage the use of single-use plastics, particularly plastic bags, have largely taken the form of partial or total bans, while in the developed world they have taken the form of taxes or levies on suppliers, retailers or consumers. In some cases, there have also been proactive measures to favour and reduce the costs of substitutes, such as the removal of Value Added Taxes (VAT) on biodegradable alternatives in St. Vincent and the Grenadines to lower their cost (Table A13). Despite varying degrees of success, the growing trend towards such regulations and restrictions on conventional plastics could further provide encouragement for production of packaging material based on natural fibres. National policies on agricultural production, including those for food crops, also influence planting decisions by farmers that could impact the production of JACKS. For example, in United Republic of Tanzania, inter-cropping sisal with food crops is a common occurrence (Chang, 2013).

Experience to date also underlines the importance of policies that help bridge the cost differences between available substitutes and cheap single-use plastics, such as through taxes on single-use plastics that are set at a level that provides a sufficient disincentive or through effective enforcement of measures such as bans (UNEP, 2018).

From a sustainable development perspective, policies that encourage the production of JACKS fibres could support the substitution of synthetic fibres and lead to environment and development benefits for developing countries that both produce and consume JACKS fibres. At present, production of JACKS fibres provides an important source of income for many smallholder farmers, especially in India, Bangladesh, Sri Lanka, China, Brazil, Ecuador, United Republic of Tanzania and Kenya. Further, investment in the production of value-added goods derived from JACKS products could also provide an important source of income and employment, as well as export revenues that would contribute favourably to the balance of payments of these countries. In all cases, policies to enhance production would need to be carefully developed to also reflect land-use, food security, and environmental priorities and considerations.

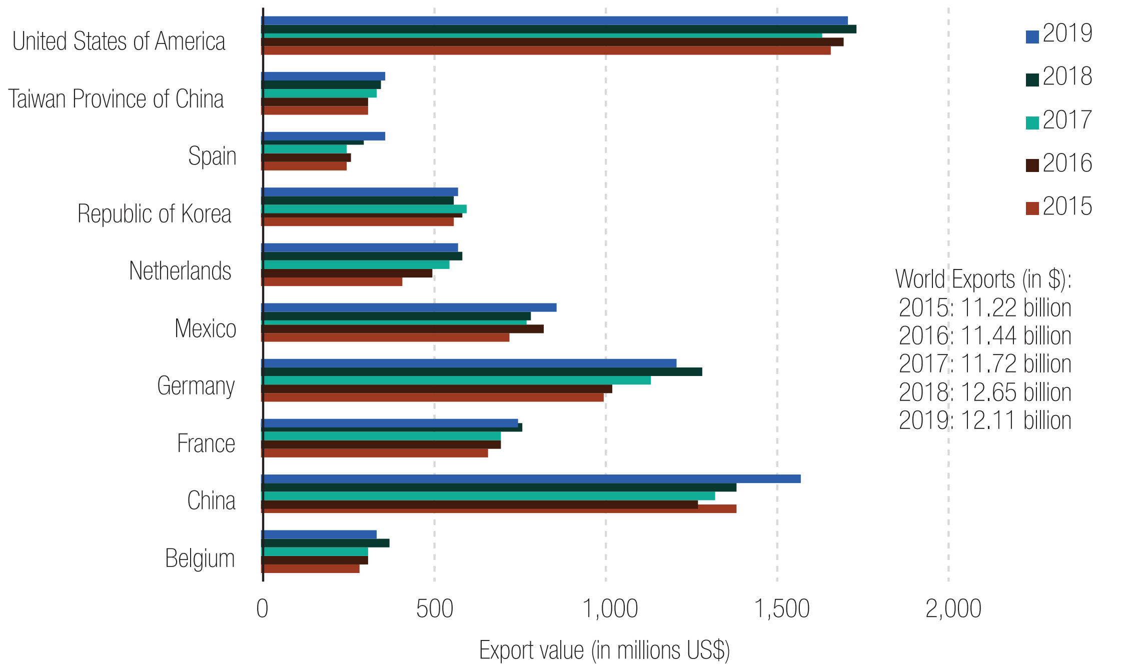
4.2. Evaluation of trade flows in cellulose and synthetic polymer-based packaging material

The production figures for plastics show considerable difference in size and scale compared to JACKS fibres. In 2019, the total value of plastic trade was over US$ 1 trillion (Deere Birkbeck and Sugathan, 2021). Trade in primary plastics alone had a total value of a little more than US$ 294 billion in 2019.

Figures 4–11 provide a comparison of trade-flow values over the period 2015–19 for an illustrative set of materials that are highly relevant for plastic packaging. Tables 4–5 show trade flows (by value) as well as the top 10 exporters and importers (based on 2019 figures) for three categories of packaging related to conventional polymers, namely: (i) Plastic boxes, cases, crates for conveyance or packaging of goods (HS 392310), (ii) Plastic sacks and bags made of ethylene polymers, and (iii) Plastic sacks and bags made of polymers other than ethylene. These trade flows are compared with trade flows in another four-digit HS heading category, namely HS 4819 (Cartons, boxes, cases, bags, and other packing containers, of paper, paperboard, cellulose wadding). This heading (HS 4819) is likely to include most types of packaging made of paperboard or other cellulosic material derived from plant materials such as starches.

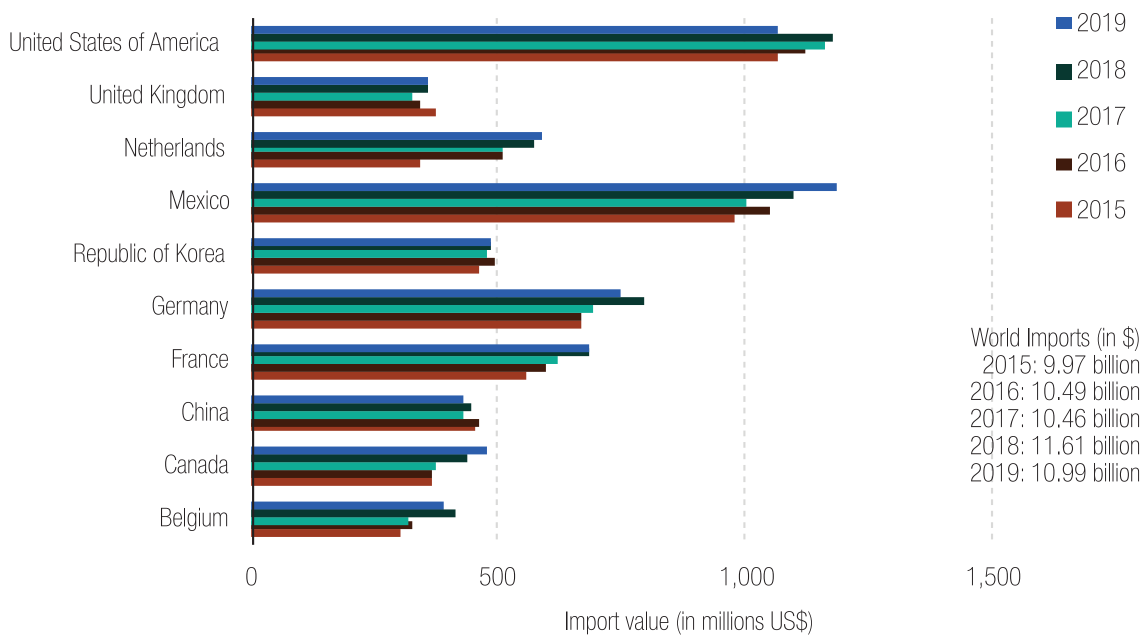
The analysis shows that the trade-flow values for packaging material of paper, paperboard and cellulose wadding are similar to the combined values

Figure 4. Top ten global exporters of HS 392310, 2015–2019 (in millions US$)



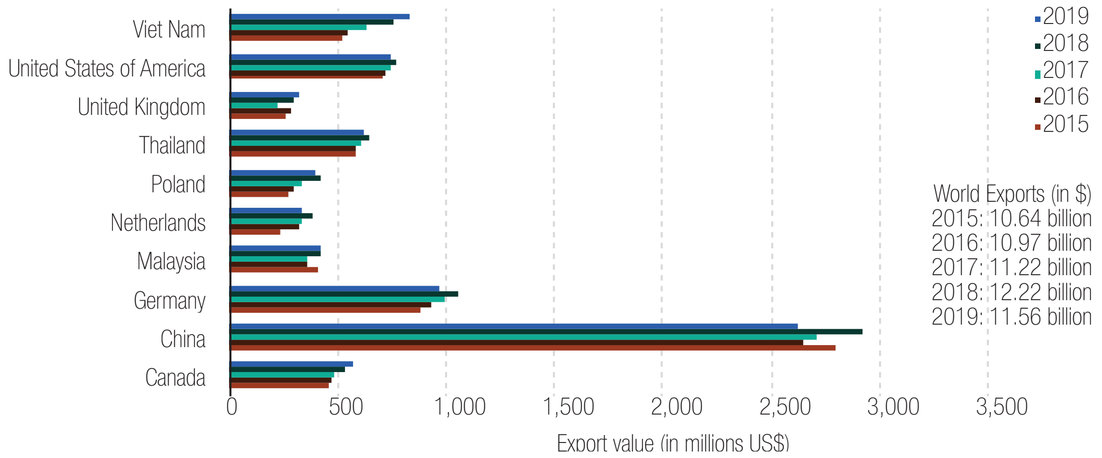
Sources: ITC calculations based on UN Comtrade and ITC statistics (2020).
Note: The world aggregation represents the sum of reporting and non-reporting countries.

Figure 5. Top ten global importers of HS 392310, 2015–2019 (in millions US$)



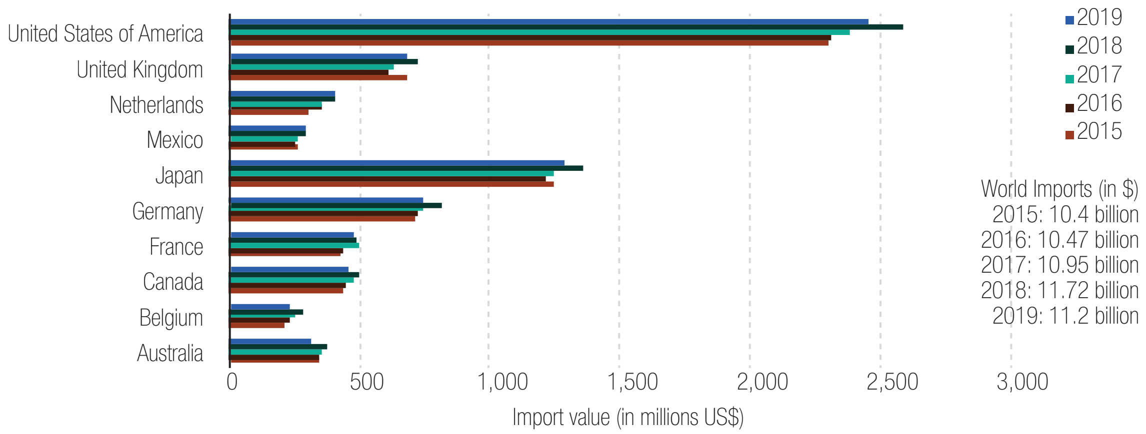
Sources: ITC calculations based on UN Comtrade and ITC statistics (2020).
Note: The world aggregation represents the sum of reporting and non-reporting countries.
HS 392310: Boxes, cases, crates and similar articles for the conveyance or packaging of goods, of plastics.

Figure 6. Top ten global exporters of HS 392321, 2015–2019 (in millions US$)



Sources: ITC calculations based on UN Comtrade and ITC statistics (2020).
Note: The world aggregation represents the sum of reporting and non-reporting countries.
HS 392321: Sacks and bags, incl. cones, of polymers of Ethylene.

Figure 7. Top ten global importers of HS 392321, 2015–2019 (in millions US$)

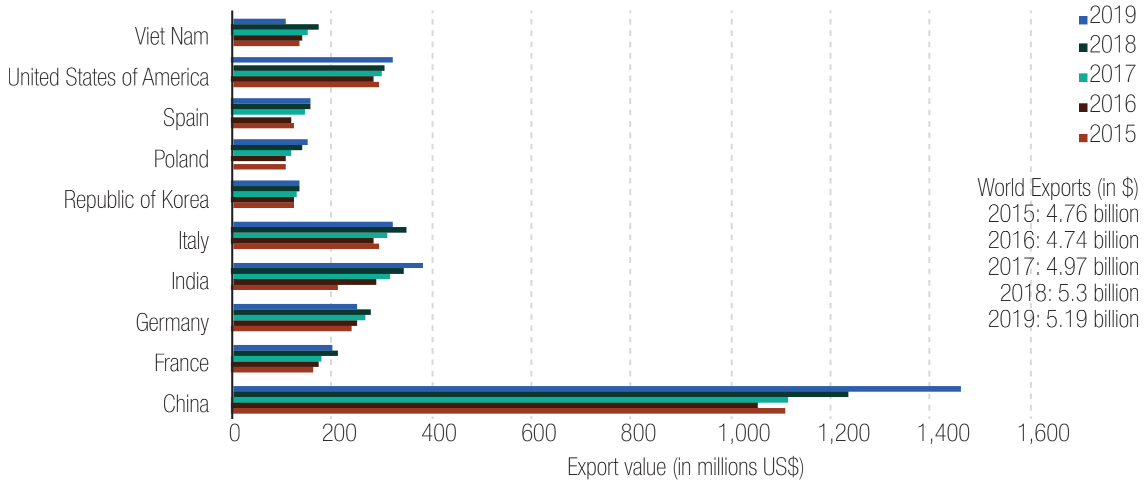


Sources: ITC calculations based on UN Comtrade and ITC statistics (2020).
Note: The world aggregation represents the sum of reporting and non-reporting countries.
HS 392321: Sacks and bags, incl. cones, of polymers of Ethylene.

for trade in plastic packaging material. Most of the top 10 exporters in the conventional plastics categories include not only OECD countries (not counting the European Union as a single entity), but also a number of large or middle-income developing countries such as China, India, Viet Nam, Thailand, Malaysia and Mexico. The top importers are mostly developed countries, with some exceptions (such as Mexico that emerges as the top importer in 2019 of HS 392310 – plastic boxes, cases, and crates in addition to being the fourth largest exporter in 2019).

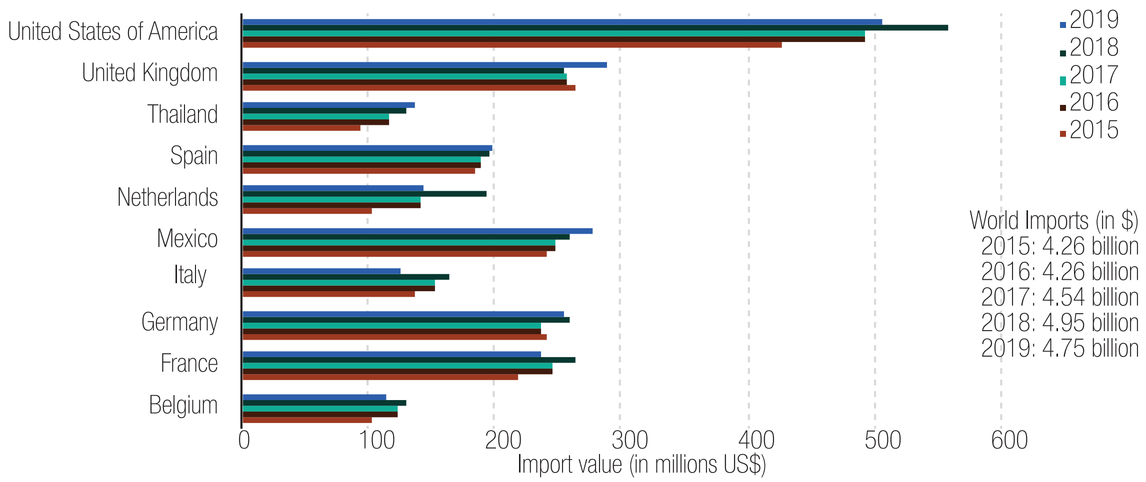
This shows that domestic and trade policy measures aimed at discouraging conventional plastic packaging materials will clearly have an impact on their exporters mostly in large developing countries, as well as impact export revenues and jobs in related industries. On the other hand, the top 10 exporters of paper, paperboard and cellulose wadding are mainly developed countries (not counting the European Union as a single entity) except for China, which emerged as the top exporter in this category in 2019. The top 10 global importers again are all developed countries apart from Mexico, which emerged as the fifth largest importer.

Figure 8. Top ten global exporters of HS 392329, 2015–2019 (in millions US$)



Sources: ITC calculations based on UN Comtrade and ITC statistics (2020).
Note: The world aggregation represents the sum of reporting and non-reporting countries.
HS 392329: Sacks and bags, incl. cones, of plastics (excluding those of polymers of Ethylene).

Figure 9. Top ten global importers of HS 392329, 2015–2019 (in millions US$)



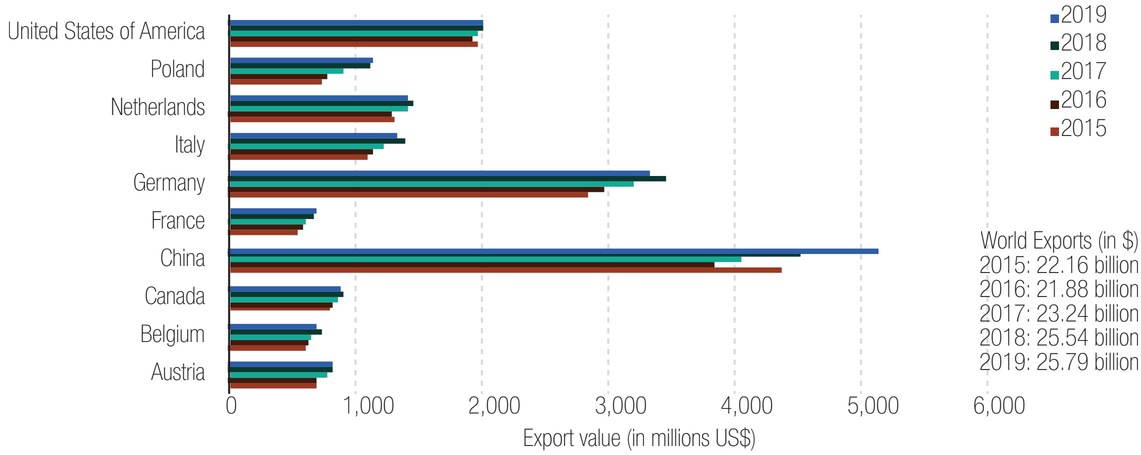
Sources: ITC calculations based on UN Comtrade and ITC statistics (2020).
Note: The world aggregation represents the sum of reporting and non-reporting countries.
HS 392329: Sacks and bags, incl. cones, of plastics (excluding those of polymers of Ethylene).

Any trade policy initiatives to expand market access for manufactured substitutes for alternative packaging material may need to go beyond paper, paperboard and cellulosic packaging material and include many more substitutes to plastic in order to be attractive to a larger set of developing countries. In this regard, JACKS fibres and particularly value-added manufactured products may be of interest to include in multilateral and regional market access liberalization initiatives. Such initiatives should go beyond such raw materials including cellulose sources where developing countries may face lower barriers (as described in section V).

4.3. Evaluation of trade flows of a bio-based polymer – PLA

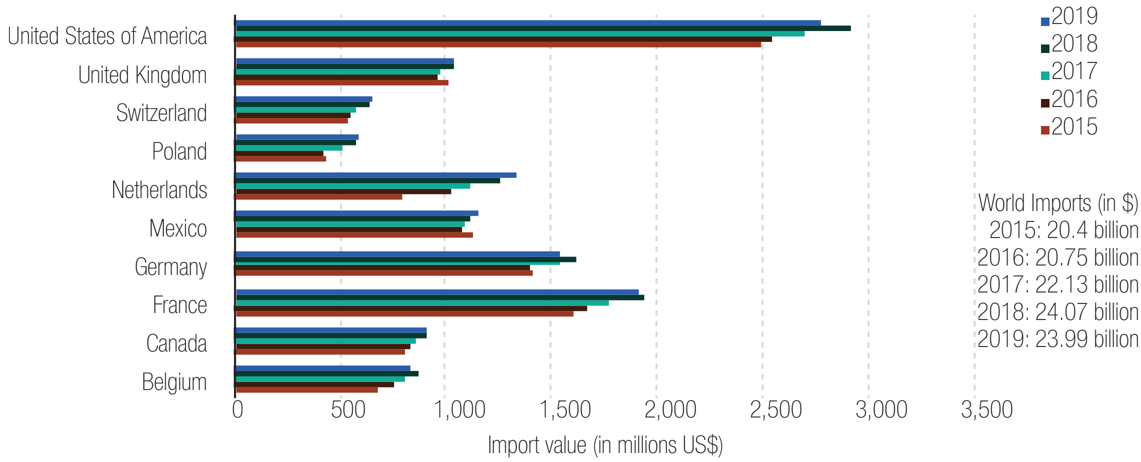
PLA is obtained from the monomer lactic-acid

Figure 10. Top ten global exporters of HS 4819, 2015–2019 (in millions US$)



Sources: ITC calculations based on UN Comtrade and ITC statistics (2020).
Note: The world aggregation represents the sum of reporting and non-reporting countries.
HS 4819: Cartons, boxes, cases, bagsbags, and other packing containers, of paper, paperboard, cellulose wadding.

Figure 11. Top ten global importers of HS 4819, 2015–2019 (in millions US$)



Sources: ITC calculations based on UN Comtrade and ITC statistics (2020).
Note: The world aggregation represents the sum of reporting and non-reporting countries.
HS 4819: Cartons, boxes, cases, bagsbags, and other packing containers, of paper, paperboard, cellulose wadding.

produced from the microorganism-catalyzed fermentation of sugar or starch obtained from plant material such as corn starch, sugarcane, and tapioca (starch extracted from cassava root) (Lackner, 2015).[16] Catering sector demand has led to a rise in PLA's popularity as a replacement for conventional plastics. Here, food waste together with used PLA cups, plates and cutlery can be collected and dispatched for industrial composting or anaerobic digestion. However, this is most suited for a "controlled closed-loop environment" such as those found within institutional catering environment in hospitals and companies preventing cross-contamination of PLA plastics with conventional plastics allowing composting for the former and recycling for the latter.

Such an approach minimizes the problem of compromising the composting/digestion of PLA (and other biodegradable bio-based polymers

Table 4. Top ten global exporters of HS 390770 polylactic acid in primary forms, 2015–2019 (US$ thousand)

Exporters	2015	2016	2017	2018	2019
World	183,024	188,728	238,476	307,130	417,588
United States of America	104,184	116,465	145,314	173,858	203,918
Netherlands	65,877	48,958	65,473	97,504	135,723
Thailand	13	288	1 035	4,175	46,563
Belgium	3,952	3,125	4,290	5,884	8,846
Italy	92	529	1,167	2,345	2,608
Switzerland	380	293	310	431	1,391
France	191	43	194	151	832

Note: The world aggregation represents the sum of reporting and non-reporting countries.
Sources: ITC calculations based on UN Comtrade and ITC statistics.

such as PHA) by conventional polymers, as well as compromising the recycling of conventional polymers by PLA. It allows the products of composting or anaerobic digestion to become the feedstock of the next generation of PLA (UNEP, 2017).

Biodegradable plastics (comprising PLA, PHA, starch blends and others) make up more than 55.5 per cent (over 1 million tonnes) of the global bioplastics production capacities in 2019. The share of PLA production capacity is about 13.9 per cent. The production of biodegradable plastics is expected to increase from about 1.17 million tonnes in 2019 to 1.33 million tonnes in 2024 especially due to PHA's significant growth rates (European Bioplastics, 2019). Production capacity of PLA is expected to double by 2023 (ECTC, 2019). Packaging currently accounts for the major share of the global bio-PLA market (Mordor Intelligence, 2021). The global market was led by North America, which had a revenue share of 35.86 per cent in 2019. Important drivers for PLA market growth are government and private support towards PLA market development, and the increasing use of bioplastics in food packaging. However, the fastest growing region for the PLA market, in terms of both revenue and volume is the Asia-Pacific (Inkwood Research, 2019).

Tables 4 and 5 show the top 10 exporters and importers of PLA.

Table 4 clearly shows that in 2019 the United States followed by the Netherlands were the dominant exporters of PLA in its primary form, followed by Thailand and China. The Netherlands also emerged as the largest importer followed by China as well as a few other larger developing economies such as Taiwan Province of China and Republic of Korea. The import figures also reveal the rapid growth in demand over the period 2016–19, particularly in China and some European Union countries.

Notably, given the very limited degradation of PLA at ambient temperatures in soil and domestic composting, only a further expansion of waste management and biopolymer composting facilities in developing countries provide a conducive and sustainable environment for further uptake. One

Table 5. Top ten global importers of HS 390770 polylactic acid in primary forms, 2015–2019 (US$ thousand)

Importers	2015	2016	2017	2018	2019
Netherlands	40,405	32,661	52,233	62,062	92,552
Taiwan Province of China	30,335	36,807	41,919	53,948	50,727
Belgium	5,798	6,832	4,347	6,757	21,848
Republic of Korea	8,427	9,674	10,830	14,626	18,032
United Kingdom	3,515	5,464	5,403	7,141	6,606

Source: ITC calculations based on UN COMTRADE and ITC statistics.
Note: The world aggregation represents the sum of reporting and non-reporting countries.

advantage in such a scenario is that starch-based raw-materials are also readily available in developing countries. If this involves the use of crops grown for food, then implications on food security should also be considered in any life cycle assessment, together with the use of water, fertilizer, biocides and energy. Using agricultural waste and the products of composting or anaerobic digestion in the production of PLA and PHA would improve their environmental credentials (UNEP, 2017).

5. TRADE POLICY MEASURES AFFECTING ALTERNATIVE PLASTICS AND NON-PLASTIC SUBSTITUTES

This section explores some of the main tariff and non-tariff barriers (NTBs) that currently affect or could affect market access for exports of non-conventional alternative plastics and non-plastic substitutes. Bound and applied most-favoured nation (MFN) tariffs for a section of developed and developing countries are examined for JACKS natural fibres and for selected examples of derived manufactured goods (with a focus on packing material and cords, ropes or twine made from JACKS fibres). Import tariffs in major markets are also analysed for conventional and cellulosic packaging material and PLA. The analysis could give some indication of where trade policy initiatives related to tariffs could provide a boost to alternative plastics and non-plastic substitutes, with a focus on natural fibres of interest to developing countries. While it is beyond the scope of this paper to exhaustively examine the various non-tariff measures affecting JACKS, cellulosic packaging and PLA, some observations based on literature review are also provided. Similarly, although the analysis does not attempt a detailed examination of tariff-elimination schedules for JACKS and other substitutes under various RTAs, it offers some observations on the implications and issues for RTAs and preferential agreements.

5.1. Import tariffs on JACKS fibres and derived goods

Table A8 provides an overview of the average applied MFN as well as bound tariffs on JACKS goods and select manufactures derived from JACKS fibres in several major markets in both developed and developing countries. The data suggest that large developing countries generally apply higher tariffs on JACKS fibres and on listed manufactured goods such as twine, cordage, sacks and bags and floor coverings. The United States market appears to be particularly attractive due to import tariffs being bound at zero for a few fibres as well as manufactures. In the European Union, there is scope for further reduction or elimination of applied MFN tariffs for value-added products such as coir-floor matting and for cords and ropes of sisal and abaca (where average applied tariffs range from 7 to 12 per cent).

On the other hand, it is also worth keeping in mind that two of the largest LDC exporters, namely Bangladesh (for jute) and United Republic of Tanzania (for sisal), already enjoy duty-free quota free access to the European Union market under the ‘Everything but Arms’ initiative. A number of other developing country exporters to certain developed country markets might also benefit from various unilateral preferential schemes (Chang, 2013). In such cases, it will be important to examine whether the benefits of such preferential access may be adversely impacted by any reduction in overall applied MFN tariffs or through reciprocal trade agreements (so called tariff erosion). Another issue is that many developing countries and LDCs have been unable to take advantage of preferential schemes “due to stringent product specific rules of origin provisions,” such as exist in the case of the European Union’s Generalised System of Preferences (GSP) and its Everything but Arms initiative (Ibid). In the case of the United States, developing countries and their producers also express concerns that the availability of preferences is uncertain over time, as “GSP treatment is suspended if imports of an eligible product from a single country exceeds a specified threshold limit” (Ibid) (which can be waived in certain cases).[17]

In many large developing countries, there is scope to reduce tariffs on JACKS fibres and derived goods or at least to bind them (in cases where tariffs are presently unbound and can be raised without any ceiling limits). At present, a pattern of tariff escalation is present in many developing countries, where applied tariffs for manufactured goods are higher than that those of raw fibres. Major jute fibre producing countries such as China and India are also key importers of jute fibre; in such cases, it is possible that the higher tariffs, particularly in India and in smaller producers such as Thailand, may be in place to retain the flexibility to protect domestic jute industries.[18] This observation underlines that while opening up developing country markets may be desirable from the perspective of greater uptake of natural fibres, any market opening strategy will also need to respond to concerns of domestic fibre producers and manufacturers. In line with the wider interest of many developing countries in promoting South–South trade, it would be useful to explore specific options for South–South market openings for trade in JACKS fibres and derived goods (e.g., such as through UNCTAD’s Global System of Trade Preferences among developing countries).[19]

5.2. Import tariffs on packaging material of conventional polymers, paper and cellulosic and PLA

Average applied MFN import tariffs for packaging material made from conventional polymers in major developed country markets, such as the United States and European Union, are generally below 6.5 per cent, whereas they are bound at zero for packaging made out of paper and paperboard as well as cellulosic wadding. For PLA, applied import tariffs are fairly low at 3.3 per cent in the United States (a major producer) and at zero for the European Union. Thus, overall average of applied tariffs on conventional polymer packaging is equivalent to the bound rates ranging from 1.5 to 3 per cent in the United States and 3.3 to 6.6 per cent in the European Union. This also means that applied tariffs cannot be increased on these products beyond these bound ceilings. This has implications on the extent to which these countries can use import tariffs as a trade policy tool to disincentivize conventional packaging material relative to bio-based substitutes.

Developing countries listed in Table A9 generally do not reveal a tariff preference skewed in favour of paper and cellulose-based packaging, except for Republic of Korea, which has a zero rate for both applied and bound duties for paper and cellulose-based packaging, and China, where applied tariffs for paper and cellulose-based packaging are half the rates prevailing for conventional polymer-based packaging. In Thailand and Mexico, the average applied tariffs on paper and cellulose-based packaging are higher than packaging material made of conventional polymers (such as in the case of ethylene-polymer-based packaging in Mexico). Import tariffs on PLA are generally in the same range as those applying to conventional polymer packaging except in the case of Mexico, which applies zero tariffs to PLA packaging (while still maintaining high bound tariffs at 35 per cent). Developing countries may wish to consider providing greater import tariff-based incentives to paper and paper-based packaging as well as cellulosic packaging.

5.3. Non-tariff measures affecting non-plastic substitutes

Exporters of JACKS face an array of NTBs, including “strict packaging and labelling requirements, sanitary and phytosanitary (SPS) measures, complex and bureaucratic customs and administrative procedures and import licensing requirements on the exports of processed fibre products.”[20]

One challenge relates to the use of chemical products to fumigate fibres. Methyl bromide has been widely used to fumigate fibres placed in wooden crates or packed in wooden pellets. Several countries have banned or phased out the use of methyl bromide pursuant to obligations to phase-out its use under the Montreal Protocol on Substances that Deplete the Ozone Layer. The Protocol initially set deadlines for phase-out of methyl bromide by 2005 and 2015 for developed and developing countries, respectively.[21] In practice, it has been difficult to find an effective low-cost alternative fumigant to deal with a large number of pests[22] and its use is still permitted for phytosanitary and biosecurity purposes.[23] Many countries have, however, banned its use, while others such as China and India still use it.[24] This has created a lot of confusion for exporters.[25] There are also a plethora of standards in importing countries that has also raised compliance costs. For example, “in Australia, sacks and woven fabrics require certification that industrially processed JACKS have originated from pest-free crops, while Japan requires additional certification for blended products depending on the specific percentage of certain JACKS in the fabric.”[26] Harmonization and simplification of many of these standards could be considered. In addition, there are also numerous private standards regarding health, environment, child labour, fair wages and working hours. These are often legitimate requirements, but can raise costs for producers. Capacity building efforts as well as developing country and producer engagement in negotiations around standards will be necessary to overcome implementation-related challenges.

In the area of domestic support (subsidies) and other trade-distorting measures, JACKS fibres are not subject to reduction commitments as the major producing and exporting countries—(mainly developing countries), typically do not provide any support. Natural bio-based competing products such as flax and linseed are also usually not subject to export-related support. However, support provided to conventional polymers including fossil-fuel subsidies at the upstream stage could enable price distortion in favour of conventional polymers.

Some of the biggest impacts on the use of paper and cellulosic packaging could come from evolving packaging- related requirements such as those based on the European Union's Circular Economy Action Plan (European Union, 2020). The Plan prioritizes the reduction of over packaging and packaging waste. It provides an impetus to design reusable and recyclable packaging and to make packaging materials simpler. Further, the Plan also considers among others the following measures:

- Mandatory plastic requirements for recycled content;
- Waste reduction measures for key products such as packaging address intentionally added micro plastics;
- Labelling and regulatory measures on unintentionally released micro plastics; and
- Policy frameworks on the use of bio-based plastics.

In order to ensure that all packaging on the European Union market is reusable or recyclable in an economically viable way by 2030, the European Commission will review its Directive 94/62/EC27 to reinforce the mandatory essential requirements for packaging to be allowed in the European Union market and consider additional measures, with a focus on:

- Reducing (over) packaging and packaging waste, including by setting targets and other waste prevention measures;
- Driving design for re-use and recyclability of packaging, including considering restrictions on the use of some packaging materials for certain applications, in particular where alternative reusable products or systems are possible or consumer goods can be handled safely without packaging; and
- Considering reducing the complexity of packaging materials, including the number of materials and polymers used.

As part of the initiative to harmonize separate collection systems, the European Union will also assess the feasibility of European Union-wide labelling that facilitates the correct separation of packaging waste at source and establish rules for the safe recycling of plastic materials into food contact materials other than PET (Packaging Insights, 2020). It is too early to assess the impacts of these measures on exporters of plastic substitutes including JACKS fibres and other natural materials or bio-based biodegradable polymers. However, it is clear that there will certainly be an impact given the importance of the European Union as an export market. Some of the requirements may have to be balanced against other environmental, health or safety considerations, which may continue to necessitate the use of plastics, particularly for perishable food products. However, it is becoming increasingly clear that for single-use plastics and other applications where the use of plastics may not be strictly necessary, there are good opportunities for considering substitution. This applies particularly for traditional natural materials that are sustainably produced and that can lead to economic benefits for developing countries. In order to give plastic substitutes a better edge in competing with conventional polymers, trade policy initiatives can also play an important role.

6. TRADE POLICY INITIATIVES TO SUPPORT PLASTIC SUBSTITUTES: FROM EARLY HARVESTS TO A LONG-TERM GAME PLAN

Trade policy initiatives can make a positive contribution towards levelling the playing field between conventional polymers (which often benefit from fossil-fuel subsidies) and their environmental-friendly (and friendlier) substitutes. Addressing tariff and NTBs impeding the freer global flows of substitutes would lower the cost of access, and consequently the cost of deployment and environmental compliance with regulatory requirements aimed at reducing plastic waste through substitution with eco-friendly substitutes. It would also incentivize further production of such substitutes and spur the creation of green jobs, particularly in rural areas in developing countries that produce the necessary feedstock for those substitutes. At the same time, trade-related measures aimed at opening markets would also need to be accompanied by complementary flanking policies targeted at sustainable consumption and production through environmental regulation and sustainability standards, as well as strategic market opening and investments in allied goods and services (such as those related to agriculture, forestry, recycling and waste management) to achieve maximum impact (UNEP, 2018).

Trade policy initiatives to promote plastic substitutes can be pursued through several channels. Some of them, such as unilateral trade and related domestic measures, can be taken fairly immediately in the short term. Other options such as the pursuit of plurilateral, regional and bilateral agreements aimed at liberalizing environmental goods and services and involving major plastic producing and consuming nations could take longer time frame. Such agreements could build-in ‘early-harvest’ initiatives to promote plastic substitutes. A truly multilateral initiative, ideally involving all WTO members, is desirable, but will require a more long-term perspective given the challenges of multilateral negotiations that can encompass a diverse set of issues and sectors.

6.1. Options for liberalization

6.1.1. Unilateral trade policy action

Unilateral trade policy action is a fairly easy step for any country provided that the measures taken are compliant with WTO rules and the country’s trade obligations. These measures can be introduced and implemented quickly. *Unilateral border measures* could include unilateral reduction or elimination of applied and/or bound tariffs on plastic substitutes (with bound tariff levels providing certainty on ceiling levels up to which a country may raise tariffs if need be). Countries can also introduce bindings on any tariff-levels that are unbound as well. They also have the option of raising import tariffs on conventional polymers up to permissible bound levels under their individual tariff schedule commitments under WTO. One issue of course is that many countries usually aim at ambitious elimination of import duties on all, if not most of their tariff lines, as part of commitments under various regional or bilateral trade agreements. In such cases, it may be impossible to raise those import tariffs back up again on conventional polymers without violating their obligations towards their bilateral or regional trade agreement partners.

In addition, countries can take unilateral *behind the border measures* that could have a trade impact, but may be permissible under WTO law if they are non-discriminatory among trade-partners (Article 1 of the GATT – “Most-Favored Nation”) and if they do not discriminate between imported and domestic “like-products” (Article III of GATT – “Non-discrimination”). Such measures could include taxes, charges or regulatory requirements. Further, countries could follow “green-procurement” policies, whereby procurement preference was granted by government entities to plastic-substitutes or to firms that used them whether produced domestically or imported. Other measures could be aimed at unilateral liberalization of environmental services sectors such as waste management and plastic recycling services (including facilities that could safely compost or recycle biodegradable bio-based polymers such as PLA and PHA) with the aim of attracting foreign investment in these sectors (in effect ‘Mode 3’-type of services trade liberalization that involves foreign investment). Complementary domestic regulatory measures would then also need to be introduced.

In the interests of promoting greater “South-South” trade in natural fibre products as well as lowering costs of access (particularly where domestic production is minimal), developing countries could also consider eliminating or at least significantly lowering their import tariffs from the current high levels unilaterally or by extending non-binding preferential tariff treatment to each other through UNCTAD's Global System of Trade Preferences (GSTP). This would enable greater uptake of natural fibres such as jute and their products and give it a competitive leg-up in levelling the playing field with conventional polymers that very often benefit from upstream fossil-fuel subsidies unlike natural fibres. In 2019, developing countries highlighted the urgency of revitalizing South-South trade cooperation under the GSTP during the 31st session of the Committee of Participants in Geneva, Switzerland (UNCTAD, 2019). One option could be to call for further ratifications and the entry into force of the Sao Paulo Round among developing countries and to promote a new green round of the GSTP to foster South-South cooperation on trade in non-plastic substitutes and other environmental goods.

6.1.2. Trade agreements to fast-track liberalization of environmental goods and services

Another trade policy related initiative for the medium term would be to consider the inclusion of natural substitutes to plastics, such as traditional fibres, as environmental goods for accelerated liberalization within plurilateral, bilateral or regional trade negotiations. Such negotiations could either be stand-alone negotiations on environmental goods such as the plurilateral negotiations for an Environmental Goods Agreement (EGA) that were launched on 8 July 2014 by 18 participants[27] representing 46 WTO members (including European Union member states). Once operationalized, the EGA will be an open plurilateral agreement, where its benefits are to be extended on an MFN basis to all WTO members. While the negotiations have been stalled since December 2016, owing to a lack of agreement on the final coverage of the list, as well as on a draft agreement text, it is possible that the talks may be revived once again (ICTSD, 2016). This could be an opportunity for more developing countries to participate and push for the inclusion of plastic substitutes, such as natural fibres for example, within any environmental goods list.

While the complete list of 304 products, including the 15 sensitive ones that were under consideration in 2016 (UNEP, 2018) are not yet in the public domain, an earlier list of 650 products nominated by participants for EGA negotiations has also been published by Transport and Environment, a Brussels-based non-governmental organization (Transport and Environment, 2015). This organization analyzed the later list and highlighted products with positive as well as negative environmental effects. Among the environmentally endorsed products in that list Transport and Environment pointed towards a number of bio-based polymers such as bio-polyethylene (LDPE and PE), bio-polyethylene terephthalate (PET) as well as polyester pellets recycled from other used polyester products as environmental-endorsed products. It also includes bio-polyester fibres, building materials made of sustainable natural materials, mats and screens made of natural materials (including biodegradable vegetable materials).[28] However, some of the traditional natural fibres of interest to many developing countries and LDCs such as jute, abaca, coir, kenaf and sisal have not been explicitly included in the list. A number of conventional polymer items put forward by many WTO members have been categorized under a list of 'environmentally rejected items' by Transport and Environment.[29] Notably, the proposing WTO members have justified the inclusion of these items based on their environmental end-use applications as well as on basis of being recycled. For example, plastic geomembranes have been proposed for their soil protection and water-tightness. This also highlights the dilemma around many kinds of polymers where their environmental end-uses may be beneficial given their durability of use, though many experts and stakeholders might have different perspectives as their inclusion in the list of environmentally rejected reveals.

Bilateral and regional trade agreements (RTAs) also hold out promise for inclusion of plastic substitutes. All 164 members of the WTO are now party to at least one RTA; as of 2019, each member had on average 11 RTA partners. However, a review of bilateral trade agreements and RTAs reveals that most agreements aim to liberalize trade across the board and most, if not all, goods would be subject to low or zero duties. Broad-based liberalization across HS 6-digit tariff headings would, therefore, not only automatically capture environmental goods including many plastic substitutes, but also conventional polymers. It is revealing that of the 270 RTAs notified to the GATT or the WTO between 1956 and 2016, provisions referring to trade in environmental goods, services and technologies are found in 129 agreements: 26 refer to the promotion of trade in environmental goods and services, 101 agreements contain schedules of commitments on environmental services, and only two contain an agreed list of duty-free environmental goods (UNEP, 2018). These include the New Zealand-Taiwan

Province of China FTA (ANZTEC), which includes a separate annex listing environmental goods, where tariffs were to be eliminated immediately upon entry into force of the agreement.[30] The ANZTEC annex list does not include any specific substitutes to plastic, but it does contain provisions on addressing non-tariff measures and further "encourage the application of good regulatory principles to the design of any future standards and regulations relating to environmental goods and services, including transparency, proportionality, a preference for least trade-distorting measures, and the use of internationally agreed standards."[31] These kind of provisions as well as a number of other provisions included in numerous other RTAs that relate to technical co-operation and capacity building as well as provisions on not weakening or failing to enforce existing environmental laws and in certain RTAs, pledges to achieve high levels of environmental protection, often accompanied by a pledge to strengthen the relevant laws over time could also be relevant and useful templates for other future agreements where plastic substitutes may be included. Thus, substitutes to plastics should be promoted not just through trade liberalization efforts, but placing them in a broader context where the strengthening of overall environmental laws facilitate their deployment.

A number of references have been made, for example, that are relevant to sustainable production and consumption and the circular economy in many of the FTAs signed by the European Union and may also have implications for the promotion of plastic substitutes. A listing of such agreements is provided in Table A12.

Another regional initiative (albeit voluntary), and the only one covering environmental goods specifically, is the Vladivostok APEC Agreement on environmental goods. The agreement was concluded by 21 Asia-Pacific Economic Co-operation (APEC) economies in Vladivostok on 9 September 2012 whereby they agreed to voluntarily reduce applied tariffs on 54 product categories or HS six-digit subheadings containing environmental goods to no more than 5 per cent.[32] The list of products, however, only contains one example of a natural plastic alternative, namely 'Other Assembled Flooring Panels, Multilayer, of Bamboo'.[33]

6.1.3. Multilateral agreement on environmental goods under the WTO

Ideally, a multilateral agreement on environmental goods concluded within the WTO framework could be an excellent opportunity for inclusion of plastic substitutes. While a plurilateral agreement could offer the same benefits once extended on an MFN-basis, non-participation in plurilateral negotiations by many developing countries and LDCs may lead to the risk of exclusion of such products. Multilateral negotiations, on the other hand, may take longer to conclude given the diversity of interests among the larger WTO membership on the coverage and level of ambition of environmental goods liberalization. The challenges would be even greater if such talks were part of a 'single-undertaking' round of negotiations that comprised many other issues and sectors unrelated to environmental goods. A single-undertaking that has so far been the model adopted by WTO members allows for cross-linkages and 'give and take' between various negotiating agendas such as agriculture, industrial goods, services, and rules. However, they also increase the risk that a successful outcome of environmental goods is dependent on the outcome in other negotiating arenas as well.

This is well illustrated by the stalling of multilateral negotiations on environmental goods and services that were launched as part of the Doha Round in 2001. While there were a number of views on what should be considered as an 'environmental good' as well as on negotiating modalities, the talks saw a number of environmentally preferable products (EPPs) including natural fibres being proposed for inclusion. New Zealand, for instance, included products based on end-use or disposal characteristics such as organic fertilizers, soaps made from natural oils and biodegradable sacks and bags (including those made from jute). The United States included seven products from a list of 152 potential EPPs that were previously identified by UNCTAD (UNCTAD, 1995). These included sisal and other textile fibres from raw agave, yarn of vegetable textile fibres, jute sacks and bags as well as twines, ropes and cables made of sisal and similar fibres (WTO, 2019). The European Union and a few other members proposed various vegetable textiles fibres, pulp of natural fibres derived from recovered fibrous cellulosic material and not chemically treated, paper and paperboard items and Japan proposed recycled paper. Other notable examples of EPPs proposed by Switzerland include: (a) ceramic articles; (b) natural polymers (e.g., alginic acid); (c) modified natural polymers (e.g. hardened proteins and chemical derivatives of natural rubber); (d) natural rubber, balata, gutta-percha, guayule, chicle and similar natural gums; (e) agglomerated cork; and (f) natural fibres such as flax, jute and agave. In addition, many countries also proposed conventional plastic items with environmental applications as well as polystyrene waste and scrap and other plastic waste and scrap for recycling. All these products and materials could be of potential interest to consider for future initiatives including for a plurilateral EGA as well.

Despite this, Doha round talks on environmental goods stalled given the overall challenge of reaching an agreement on several other negotiating mandates. Defining and classifying environmental goods threw up specific challenges, and sensitivities also arose around the impact of liberalization on domestic manufacturing and services sectors. Lack of perceived export opportunities resulted in less than proactive engagement on the part of many developing countries. Issues such as non-tariff measures and questions of dealing with technological change and technology transfer were also not addressed, although certain proposals on addressing non-tariff measures on all industrial goods were made in the context of WTO Non-Agricultural Market Access negotiations (UNEP, 2018).

6.2. Other trade-related measures

In addition to specifically including natural substitutes to plastic as part of market access package within negotiations, four other trade-related measures could be supportive of the overall scale-up and diffusion of bio-based and biodegradable substitutes to conventional plastic.

6.2.1. Greater clarity and visibility of conventional plastic substitutes within the Harmonized System

It may be a good option to further review the extent to which plastic substitutes are clearly reflected within the Harmonized System (HS). While a number of natural fibres, such as jute, coir and sisal, as well as some derived products and polylactic acid (a biopolymer) may have their own specific HS-6 subheadings, this may not be the case with a number of other plastic substitutes (e.g., chitosan). Identification of certain niche categories of alternative natural materials and bio-based polymers at the HS 6-digit subheading is desirable as it easily facilitates global comparison of trade flows, but it may be difficult to implement. The World Customs Organization (WCO) sets a trade volume threshold of US$50 million for a product group to obtain a HS-6-digit subheading, and US$100 million threshold to obtain a 4-digit subheading. However, in previous review cycles of the WCO (that take place every 5 years), exceptions have been made for social and environmental reasons.[34] There have also been additions and amendments of categories and HS 6-digit subheadings to help countries comply with their obligations under the multilateral environmental agreements to combat illicit trafficking in endangered species. This could provide countries with an opportunity to propose specific amendments as they deem appropriate at the WCO to ensure better visibility for natural materials and bio-based polymers as production and trade begin to scale-up.

6.2.2. Trade and investment-related initiatives on plastics recovery, recycling and compositing

Plastics-related waste management, recovery and recycling involve the deployment of technologies combined with the provision of services. It is necessary for countries to have adequate number of facilities that can adequately treat both conventional as well as bio-based polymers separately to enable an ecosystem that facilitates recycling and recovery of conventional plastic as well as to promote greater use of non-conventional substitutes such as bio-based polymers. There may be a role for private sector to provide such services in developing countries as well. In that regard, trade negotiations on environmental services may be as important to pursue as those on environmental goods. Trade in environmental services normally takes place through the following modes of delivery:

a. Mode 1: Cross-border trade in services (e.g., the provision of environmental consulting services through the internet);
b. Mode 2: The movement of consumers abroad to consume a service in the country of origin (e.g., environmental services industry professionals attending a paid training or university programme abroad);
c. Mode 3: Commercial presence involving the establishment of a foreign environmental service provider in the host country (e.g., a German or French wastewater treatment company establishing a subsidiary in China to deliver services); and
d. Mode 4: Temporary movement of natural persons abroad to deliver a service in the host country (e.g. temporary movement of Indian professionals to install air-pollution control equipment in a factory in Bangladesh).

Both as part of the WTO General Agreement on Trade in Services (GATS) 'built-in' agenda on services liberalization as well as in subsequent regional trade agreements (RTAs), several countries have tabled market access offers on various types of environmental services. The classification approaches on environmental services followed have been Services Sectoral Classification List (also called W/120) issued by the WTO Services Trade Council and is based on the United Nations' Central Product Classification (CPC). The W/120 list contains 12 categories, four of which are specific to environmental services: (i) sewerage services, (ii) refuse disposal services, (iii) sanitation and similar services, and (iv) other (cleaning services for exhaust gases, noise abatement services, nature and landscape protection, and other environment services not elsewhere classified).

Other members such as the European Union have proposed more updated classifications. The European Union's proposed classification system comprised 'core' services that could be classified as 'purely' environmental and correspond to environmental media (such as air, water, solid and hazardous waste, noise, etc.), in addition to a 'cluster' of services such as design, engineering, R&D and consulting with an environmental end-use (Claro et al. 2007). Presently, Members are free to make use of their own classification and can also specify and limit liberalization to distinct sub-sectors such as "plastics recovery and recycling" within a broader category such as "Solid and Hazardous Waste Management." If they liberalize the entire solid and hazardous waste management sector, then plastics recovery and recycling would presumably automatically be included. Members can also specify conditions associated with the liberalization of a service sector. For example, they can require that training be provided to domestic workforce in using certain technologies or can also specify the type of technologies that companies need to utilize to provide the service. Further research could be conducted on how environmental services liberalization has worked on the ground and whether it has also led to the creation of new and better recovery, recycling and waste management facilities for conventional and bio-based polymers.

At the WTO, requests and offers for market access in various environmental services sectors have been made, both under the multilateral Doha round of WTO negotiations as well as under plurilateral negotiations on a Trade in Services Agreement (TiSA) that was being negotiated by 23 WTO members,[35] accounting for 70 per cent of world trade in services (European Commission, 2016). These have included requests and offers applying to broad service categories such as solid waste management. They do not, however, to the best of the authors' knowledge (given the confidential nature of many requests and offers) contain specific requests, offers or carve-out clauses pertaining to plastics-related services. No binding commitments have yet been made under the WTO Doha round or under TiSA on environmental services.

On the other hand, "a large number of RTAs, namely 101 agreements include specific commitments on the liberalisation of environmental services" (Monteiro, 2016). A complete review of the environmental services commitments encountered in RTAs was outside the scope of this paper, but a preliminary analysis conducted at the WTO shows that specific commitments already made have covered environmental services such as "sewage services, refuse disposal services, sanitation services, cleaning of exhaust gases, noise abatement services, nature and landscape protection services, and other environmental protection services" (Monteiro, 2016). Under the positive list method to services liberalization, only the services sectors and the matters covered by liberalization or open to partner countries are included in the scheduling list (Setiawan, 2018). In some cases, environmental services commitments are 'GATS plus'. Under the Mexico–Costa Rica RTA, for instance, Mexico has fully liberalized trade in environmental services, except for horizontal limitations on public services or public utilities, which were completely excluded from its GATS schedule.

Some RTAs follow a 'negative list' approach. In such cases, "all covered sectors and sub-sectors are assumed to be liberalised, unless non-conforming measures are incorporated in the annex to the RTA. In other words, an environmental service is assumed to be liberalised, unless it is explicitly listed in the RTA." In a number of RTAs, some specific environmental services, such as "the provision of water supply, wastewater services, solid and hazardous waste management, and sanitation services, are subject to some restrictions and included on negative lists." The reservations that countries include take various forms, and have included references to the existence of a public monopoly, nationality requirements, concession requirements, or an obligation for foreign service providers to establish a local commercial presence (Monteiro, 2016). Tables A10 and A11 provide an overview of RTAs from the ASEAN region, noting those that follow a positive or negative list approach.

6.2.3. Attracting foreign investment for plastic substitutes

Smaller developing countries including LDCs could consider incentives that could attract foreign investment to build manufacturing capacity and support new innovative products from raw natural fibres, such as food-grade packaging and non-plastic substitutes for synthetic materials used in the interiors of cars. As in other sectors, however, investors may still need certain pre-conditions such as political stability and a predictable regulatory regime. There could also be scope for South–South investment flows given the similarity of raw materials and conditions that might prevail. Bilateral investment agreements and eventually a multilateral investment framework could be a good vehicle for supporting the development of an attractive regime for investors. Countries may also wish to assess the scope for improving their domestic investment regimes and regulatory frameworks to attract foreign investors.

6.2.4. Technical and technology co-operation, assistance and capacity building measures

In order to build both supply-side capacities for the production of natural substitutes in addition to enabling developing countries and LDCs to access technologies and know-how as well as introduce regulatory frameworks (such as on worker safety and health), pursuing technical and technology co-operation, assistance and capacity building measures are important. These will be required as part of a holistic response to not just dealing with conventional plastic and bio-based polymer waste, but also on setting up modern re-use, recovery and recycling systems that will be essential to reduce marine pollution and enable a circular economy. Access to technologies and know-how may happen through greater liberalization of services but then again, they may not if various other market and regulatory factors that encourage investors are not present. Further, technologies also need to be appropriate to the needs, priorities and realities of developing countries as well.

A clearer understanding of the dynamics of how trade as well as additional factors such as intellectual property policies and licensing can drive technology adoption and diffusion within the plastics-related environmental services. In addition, a better understanding of what ecosystems for recovery, recycling and re-use work or not in different country contexts will also be desirable for better policy formulation. The role of the private sector will be critical and existing initiatives could be leveraged further with the specific aim of technologies and know-how not only to enable better recycling and disposal of conventional polymers, but also substituting plastics using fully compostable materials that are as versatile and close to the desired end-use characteristics of single-use plastics. Initiatives such as WIPO Green, an online platform for technology exchange that connects providers and seekers of environmentally friendly technologies, is one example of collaborative initiative that can directly benefit the private sector. The platform assembles technologies ranging from prototypes to marketable products at various stages of development in a single place. The technologies listed on the platform are reportedly available for license, collaboration, joint ventures and sale. The platform includes eco-friendly technologies as well as technology 'needs' in its database (WIPO, 2021).

7. CONCLUSION AND RESEARCH GAPS

Plastic substitutes can prove to be reliable substitutes to conventional polymers for many types of end-uses. At the same time, they can face a number of opportunities as well as challenges for scale-up depending on the material under consideration. These relate to factors such as costs, physical properties, and versatility of use as well as environmental impacts at the production, use and disposal compared to conventional polymers. For most developing countries, traditional materials such as natural fibres may represent the 'lowest-hanging fruit' for substitution given that they are producers of many of the related natural feedstocks which also provide opportunities for exports and jobs including in rural areas. Further, many developing countries may lack the widespread industrial composting facilities that are required to deal with bio-based polymers, which do not biodegrade in the natural environment. Single-use packaging as well as textiles, which are a major source of plastic pollution, could be particularly amenable to the use of natural materials. At the same time scaling up the production and trade in natural materials could also have land-use, food security and other environmental implications such as pollution and energy use. As far as possible, it may be preferable to rely on agricultural and other plant waste as compared to food crops.

Regarding wood and forestry for cellulose, care should be taken as far as possible to acquire such material from certified sustainable sources. Tariff and NTBs still need to be addressed by developing countries to take full advantage of market access opportunities for many traditional materials such as natural fibres. Unilateral, bilateral, regional and plurilateral trade initiatives can play a positive role in this regard. In particular, by liberalizing trade in natural materials, trade policy can play a role in levelling the playing field particularly given the cost-advantages that conventional polymers enjoy (quite often due to fossil-fuel subsidies provided upstream).

The time horizon for implementation will vary depending on the type of trade initiative and some may represent good opportunities for an 'early harvest', whereas a multilateral deal involving all WTO members will need a long-term perspective. However, in additional to trade liberalization for natural materials, several other supportive measures if taken can have a positive impact and further strengthen benefits. These could include enabling greater clarity and visibility of conventional plastic substitutes within the Harmonized System, pursuing trade and investment-related initiatives related to plastics recovery, recycling and composting under environmental services negotiations and pursuing technical and technology co-operation, assistance and capacity building measures. These will enable developing countries in particular to establish a proper ecosystem comprising regulations, infrastructure, technology and know-how to enable effective recovery, recycling and composting where possible for conventional plastics and bio-based polymers as well as safe collection and disposal of plastic waste through solid waste management systems (which services trade and investment flows can also help strengthen).

Looking ahead, there are a number of information and knowledge gaps that need to be addressed in order to inform sound and effective policymaking around plastics substitutes. These include (but are not limited to) the following:

- To what extent can better clarity and visibility be provided for alternative materials (natural materials, bio-based polymers as well as ecofriendly additives) as well as products manufactured from them within the Harmonized System? This could help trade officials during negotiations as well as officials, researchers and others in better monitoring and tracking trade-flow data for these materials and products.
- To what extent are the necessary regulations and infrastructure (such as industrial composting facilities) available for bio-based polymers across countries and particularly in developing countries? Do plastic pollution hotspots have access to adequate recovery, recycling and disposal facilities for conventional polymers? Can a mapping be done of such facilities worldwide? What lessons or best practices can be learnt from specific country experiences? This could also help with formulating strategies for these countries with regard to trade and investment in environmental services such as solid waste management systems to deal with plastic wastes and bio-based polymers as well as enable a better channeling of technical assistance efforts.
- To what extent has trade liberalization and foreign investment enabled developing countries to have access to technologies and know how required for effective management of plastic wastes as well

as to handle bio-based polymers? What roles do intellectual property regimes and licensing issues play? Are there lessons that can be learnt from actual country experiences in this regard?

- What impacts will the European Union circular economy action plan have on plastics and packaging industries across the world? Will the European Union standards become the global normal as supply chains adjust to them? What opportunities will it open for developing countries for use of different types of plastic substitutes? What compliance-related challenges will it bring for developing country exporters?

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ANNEX

Table A1. Plant-based materials, polymer(s), plant source and common uses: biodegradable and composting properties

Material	Polymer	Common biomass source	Examples of common uses	Terrestrial			Aquatic
				C-d	C-i	B	B
Cotton	Cellulose	Cotton plant (Gossypium sp.)	Clothing, other fabrics	H	H	H	H
Hemp	Cellulose	Hemp (Cannabis sativa)	Clothing, other fabrics	H	H	H	H
Flex/Linen	Cellulose	Flax/linseed (Linum usitatissimum)	Clothing, other fabrics	H	H	H	H
Jute	Cellulose and lignin	(Corchorus sp.)	Sacks, carpets, clothing, rope, other fabrics	H	H	H	H
Coir fibre	Cellulose and lignin	Coconut (outer shell)	Mats, brushes, sacking, rope, fishing nets	H	H	H	M
Ramie	Cellulose	China grass (Boehmeria nivea)	Clothing, other fabrics, industrial sewing thread	H	H	H	H
Abaca/Manila hemp	Cellulose, lignin and pectin	Banana (Musa textilis, inedible)	Teabags, banknotes, matting, rope	H	H	H	H
Piña	Cellulose and lignin	Pineapple leaf (Ananas comosus)	Clothing, other fabrics	H	H	H	H
Sisal		(Agave sislana)	Textiles, bags, rope, twine	H	H	H	H

Source: UNEP (2017). Exploring the potential for adopting alternative materials to reduce marine plastic litter. Available at https://www.unenvironment.org/resources/report/exploring-potential-adopting-alternative-materials-reduce-marine-plastic-litter

Note: Based on reported observations, where available, otherwise estimated: domestic composting (C-d); industrial composting (C-i); biodegradable (B);. Degradation rate: high (H), medium (M) or low (L).
Qualitative sustainability indicator: blue-high, medium-grey, low-green.

Table A2. Animal-based materials, polymer(s), animal source and common uses: qualitative biodegradable and composting properties

Material	Polymer	Common biomass source	Examples of common uses	Terrestrial			Aquatic
				C-d	C-i	B	B
Sheep's wool	Keratin	Sheep (e.g. Merino)	Knitwear, carpets Other fabrics	H	H	H	H
Mohair	Keratin	Angora goat	Clothing other fabrics and carpets	H	H	H	H
Angora wool	Keratin	Angora rabbit	Knitwear	H	H	H	H
Alpaca wool	Keratin	Alpaca	Clothing, other fabrics	H	H	H	H
Cashmere wool	Keratin	Cashmere goats	Clothing, other fabrics	H	H	H	H
Silk	Fibroin	Silk moth (Bombyx mori)	Clothing, other fabrics	H	H	H	H
QMilch™	Casein	Cow's milk (soured)	Clothing, other fabrics	H	H	H	H

Source: UNEP (2017). Exploring the potential for adopting alternative materials to reduce marine plastic litter. Available at https://www.unenvironment.org/resources/report/exploring-potential-adopting -alternative-materials-reduce-marine-plastic-litter

Note: Based on reported observations, where available, otherwise estimated: domestic composting (C-d); industrial composting (C-i); biodegradable (B); degradation rate: high (H), medium (M) or low (L). Qualitative sustainability indicator: blue-high, medium-grey, low-green.

Table A3. Starch-based polymers, biomass source and common uses: biodegradable and composting properties

Material	Polymer	Common biomass source	Examples of common uses	Terrestrial			Aquatic
				C-d	C-i	B	B
Starch-based mixes							
Expanded starch foams	Starch	Maize, cassava, potato, rice	Loose packaging fill	H	H	H	H
Thermoplastic starch TPS	Starch	Maize, cassava, potato, rice	Thin-film bags	M	H	M	M
TPS-polymer composite	Starch-PCL/PLA	Maize	Mater-Bi®, films, agricultural mulch	M	H	M	M
TPS-biocomposites	Starch cellulose	Alpaca	Clothing, other fabrics	M	H	M	M

Source: UNEP (2017). Exploring the potential for adopting alternative materials to reduce marine plastic litter. Available at https://www.unenvironment.org/resources/report/exploring-potential-adopting -alternative-materials-reduce-marine-plastic-litter

Note: Based on reported observations, where available, otherwise estimated: domestic composting (C-d); industrial composting (C-i); biodegradable (B); degradation rate: high (H), medium (M) or low (L). Qualitative sustainability indicator: : blue-high, medium-grey, low-green.

Table A4. Starch-based polymers, biomass source and common uses: qualitative assessment of worst-case biodegradable and composting properties

Material	Polymer	Common biomass source	Examples of common uses	Terrestrial			Aquatic
				C-d	C-i	B	B
PHA	Polyhydroxyalkanoates	Biomass-derived sugars	Films, packaging, catering products	L	H	L	L
PLA	Polylactic acid	Maize, cassava starch	Films, packaging, hygiene products, catering products	L	H	L	L

Source: UNEP (2017). Exploring the potential for adopting alternative materials to reduce marine plastic litter. Available at https://www.unenvironment.org/resources/report/exploring-potential-adopting-alternative-materials-reduce-marine-plastic-litter

Note: Based on reported observations, where available, otherwise estimated: domestic composting (C-d); industrial composting (C-i); biodegradable (B); degradation rate: high (H), medium (M) or low (L). Qualitative sustainability indicator: : blue-high, medium-grey, low-green. The degree and rate of decomposition will depend on the application, for example a bottle vs. thin agricultural film, and the presence of additional co-polymers such as PCL.

Table A5. Qualitative indicators of sustainability for the production of textiles and other products from biomass sources, from harvesting to the manufacturer

	Natural									Natural by-products		Semi-synthetic				Synthetic	
Polymer	Cot.	Org Cot	Hem	Lin	Jute	Abac	Rami	Woo	Silk	Coir	Piña	Sta	TPS	TPS CP	Ray	PLA	PHA
Sustainability characteristics																	
Land use	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Potential to use waste material	L	L	L	L	L	L	L	L	L	H	H	H	H	H	H	H	H
Water use	H	H	L	L	L	H	L	L	H	L	L	M	M	M	L	M	M
Energy use	L	L	L	L	L	L	L	L	L	L	L	L	M	M	M	H	H
Fertiliser use	H	L	L	L	L	H	L	L	H	L	H	M	M	M	L	M	M
Biocide use	H	L	L	L	L	L	L	M	M	L	H	M	M	M	L	M	M
Environmental impact (combined)	H	M	L	L	L	L	M	L	M	M	M	M	M	M	M	M	M
Human health impact	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Overall socio-ecological impact	H	L	L	L	L	L	L	L	M	L	M	M	M	M	M	M	M

Source: UNEP (2017). Exploring the potential for adopting alternative materials to reduce marine plastic litter. Available at https://www.unenvironment.org/resources/report/exploring-potential-adopting-alternative-materials-reduce-marine-plastic-litter

Note: Indicators are based on estimates of the relative environmental and human health impact, for a series of stages or characteristics in the production process, from sources cited in the text or by inference; where Blue indicates high, Grey indicates medium and Green indicates low sustainability. In addition, the relative importance or impact of each stage is assigned a value of low (L), medium (M) or high (H). (Cot = cotton, Org = organic, Hem = hemp, Lin = linen, Abac = abaca, Rami = ramie, Woo = wool, Sta = starch, TPS = thermoplastic starch, CP - composite, Ray = rayon).

Table A6. Qualitative indicators of sustainability for the production of textiles and other products from biomass sources during manufacture

	Natural									Natural by-products		Semi-synthetic				Synthetic	
Polymer	Cot.	Org Cot	Hem	Lin	Jute	Abac	Rami	Woo	Silk	Coir	Piña	Sta	TPS	TPS CP	Ray	PLA	PHA
Sustainability characteristics																	
Water use	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Energy use	L	L	L	L	L	L	L	L	L	L	L	M	M	M	H	H	H
Chemical Processes	M	M	M	M	M	M	M	M	M	M	M	M	M	M	H	H	H
Waste production	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L
Human health impact	L	L	L	L	L	L	L	L	L	L	L	L	L	L	H	L	L
Environmental health Impact	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	L	L

Source: UNEP (2017). Exploring the potential for adopting alternative materials to reduce marine plastic litter. Available at https://www.unenvironment.org/resources/report/exploring-potential-adopting-alternative-materials-reduce-marine-plastic-litter

Note: Indicators are based on estimates of the relative environmental and human health impact, for a series of stages or characteristics in the production process, from sources cited in the text or by inference; where Blue indicates high, Grey indicates medium and Green indicates low sustainability. In addition, the relative importance or impact of each stage is assigned a value of low (L), medium (M) or high (H). (Cot = cotton, Org = organic, Hem = hemp, Lin = linen, Abac = abaca, Rami = ramie, Woo = wool, Sta = starch, TPS = thermoplastic starch, CP - composite, Ray = rayon).

Table A7. Qualitative indicators of sustainability for the production of textiles and other products from biomass sources during use and at the end-of-life

	Natural									Natural by-products		Semi-synthetic				Synthetic	
Polymer	Cot.	Org Cot	Hem	Lin	Jute	Abac	Rami	Woo	Silk	Coir	Piña	Sta	TPS	TPS CP	Ray	PLA	PHA
Sustainability characteristics																	
Compostable-d	H	H	H	H	H	H	H	H	H	H	H	H	M	M	H	L	L
Compostable-i	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Anaerobic digestion	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
Generation of fibres	H	H	H	H	H	H	H	H	H	H	M	M	M	M	H	M	M
Entry to ocean via wastewater	H	H	H	H	H	H	H	H	H	H	M	M	M	M	H	M	M
Biodegradable in sea	H	H	H	H	H	H	H	H	H	H	H	H	M	M	H	L	L
Overall environment impact in ocean	L	L	L	L	L	L	L	L	L	L	L	L	M	M	L	H	H

Source: UNEP (2017). Exploring the potential for adopting alternative materials to reduce marine plastic litter. Available at https://www.unenvironment.org/resources/report/exploring-potential-adopting-alternative-materials-reduce-marine-plastic-litter

Note: Indicators are based on estimates of the relative environmental and human health impact, for a series of stages or characteristics in the production process, from sources cited in the text or by inference; where

Blue indicates high, Grey indicates medium and Green indicates low sustainability. In addition, the relative importance or impact of each stage is assigned a value of low (L), medium (M) or high (H). (Cot = cotton, Org = organic, Hem = hemp, Lin = linen, Abac = abaca, Rami = ramie, Woo = wool, Sta = starch, TPS = thermoplastic starch, CP - composite, Ray = rayon).

Table A8. Bound and applied MFN tariffs (per cent) on JACKS fibres and select manufactured goods in key markets

HS codes (HS 2017 version)	HS sub-heading description	United States of America (a) average applied (b) bound	European Union (a) average Applied (b) bound	China (a) average applied (b) bound	India (a) average applied (b) bound	Republic of Korea (a) average applied (b) bound	Thailand (a) average applied (b) bound[36]	Brazil (a) average applied (b) bound	Mexico (a) average applied (b) bound
5303.10	Jute and other fibres, raw or retted	(a) 0.0 (b) 0.0	(a)0.0 (b) 0.0	(a)5 (b)5	(a)25 (b)40	(a)2 (b) 2	(a)5 (b) Unbound	(a)8 (b)35	(a) 0.0 (b)35
5303.90	Jute and other fibres processed but not spun; tow and waste	(a) 0.0 (b) 0.0	(a) 0.0 (b) 0.0	(a)5 (b) 5	(a) 25 (b) 40	(a) 2 (b) 2	(a) 5 (b) Unbound	(a)8 (b)35	(a) 0.0 (b) 35
6305.10	Sack and bags of jute for packing goods	(a) 0.0 (b) 0.0	(a)3 (b) 3	(a)4 (b)10	(a) 25 (b) Unbound	(a)8 (b)13	(a)10 (b) Non-AV duty -30% or 15 Baht/ kg (higher applies)	(a)35 (b)35	(a) 15 (b) 35
5305.00	Raw sisal/abaca/ coir fibre	(a) 0.0 (b) 0.0	(a)0.0 (b) 0.0	(a)4.8 (b)54.3	(a) 25 (b) 40	(a) 2 (b) 2	(a) 5 (b) Unbound	(a)6 (b)35	(a) 0.0 (b) 35
5607.21	Binder or baler twine of sisal)	(a) 0.0 (b) 0.0	(a)12 (b) 12	(a)5 (b) 5	(a)20 (b) 20	(a) 10 (b) 13	(a) 5 (b) 30	(a)18 (b)35	(a)10 (b) 35
5607.29	Other twine, cordage, ropes of sisal	(a)3.6 (b)3.6	(a)12 (b) 12	(a) 5 (b)5	(a) 20 (b) 20	(a) 10 (b) 13	(a) 5 (b) 30	(a)18 (b)35	(a) 10 (b) 35
5607.90	Other fibres, abaca cordage	(a)1.9 (b)1.9	(a)7 (b)7	(a)5 (b)5	(a) 20 (b) 20	(a) 10 (b) 13	(a) 5 (b)30	(a)12.7 (b)35	(a)6.7 (b) 35
5308.10	Coir yarn	(a) 0.0 (b) 0.0	(a)0.0 (b) 0.0	(a)5 (b)6	(a) 25 (b) 40	(a) 8 (b)13	(a) 5 (b)15	(a)18 (b)35	(a) 0.0 (b) 35
5702.20	Floor coverings of coir fibres	(a) 0.0 (b) 0.0	(a):4 (b) 4	(a)6 (b) 14	(a) 25 (b) Unbound	(a) 10 (b)30	(a) Same as bound (b) Non-AV duty -30% or 21 Baht/ kg (higher applies)	(a)35 (b)35	(a)15 (b) 35

Source: WTO tariff download facility. http://tariffdata.wto.org/default.asp

Note: Based on the latest reporting year. The number of actual tariff lines under bound and applied values may differ due to different HS versions used with earlier HS versions used for bound values in most, if not all cases. In some cases, this can cause average of bound levels to appear lower than the average of applied tariffs).

Table A9. Bound and average of applied MFN tariffs in key markets

HS codes (HS 2017 version)	HS sub-heading description	United States of America (a) average applied (b) bound	European Union (a) average applied (b) bound	China (a) average applied (b) bound	India (a) average applied (b) bound	Republic of Korea (a) average applied (b) bound	Thailand (a) average applied (b) bound[37]	Brazil (a) average applied (b) bound	Mexico (a) average applied (b) bound
3923.10	Boxes, cases, crates and similar articles for the conveyance or packaging of goods, of plastics	(a) 1.5 (b) 1.5	(a)3.3 (b) 6.5	(a)10 (b) 10	(a) 15 (b)Unbound	(a)3.3 (b) 3.3	(a)10 (b) Non-AV duty -30% or 7 Baht/kg (higher applies)	(a)18 (b)25	(a)15 (b)35
3923.21	Sacks and bags, incl. cones, of polymers of ethylene	(a) 3.0 (b) 3.0	(a) 6.5 (b) 6.5	(a) 10 (b) 10	(a) 15 (b)Unbound	(a) 6.5 (b) 6.5	(a)2.5 (b) Non-AV duty -30% or 7 Baht/kg (higher applies)	(a) 18 (b) 25	(a)0.0 (b) 35
3923.29	Sacks and bags, incl. cones, of plastics (excluding those of polymers of ethylene)	(a) 3.0 (b) 3.0	(a) 6.5 (b) 6.5	(a) 10 (b) 10	(a) 15 (b)Unbound	(a) 6.5 (b) 6.5	(a)5.0 (b) Non-AV duty -30% or 7 Baht/kg (higher applies)	(a) 18 (b) 25	(a) 0.0 (b) 35
4819	Cartons, boxes, cases, bags and other packing containers, of paper, paperboard, cellulose wadding	(a) 0.0 (b) 0.0	(a) 0.0 (b) 0.0	(a) 5.2 (b)6.7	(a)10 (b)Unbound	(a)0.0 (b) 0.0	(a)10 (b) Unbound for cartons, boxes and cases of non-corrugated paper or paperboard-for other subheadings Non-AV duty -30% or 4.68 Baht/kg (higher applies)	(a)16 (b)35	(a)3.3 (b) 35
3907.70	Poly lactic Acid	(a) 3.3 (b)6.5	(a)0.0 (b)3.3	(a)6.5 (b) 6.5	(a)10 (b)40	(a) 6.5 (b) 6.5	(a)5.0 (b) Non-AV duty -30% or 6 Baht/kg (higher applies)	(a)14 (b)20	(a) 0.0 (b) 35

Source: WTO Tariff Download facility. See http://tariffdata.wto.org/default.aspx ; World Customs Organization (2017). HS Nomenclature 2017 edn. Available at http://www.wcoomd.org/en/topics/nomenclature/instrument-and-tools/hs-nomenclature-2017-edition/hs-nomenclature-2017-edition.aspx

Note: Tariff on packaging material, sacks and bags of conventional polymers; paper, paperboard and cellulosic wadding and PLA based on the latest reporting year.

Table A10. ASEAN and nonASEAN FTAs/RTAs with positive list for services sectors

Full positive list or mostly positive list		
Lao People's Democratic Republic–The United States BTA	Australia–Thailand FTA	EFTA–Republic of Korea FTA
Mainland– Hong Kong SAR CEPA	Indonesia–Japan EPA	EFTA–Singapore FTA
Mainland–Macao SAR CEPA	Japan–Brunei Darussalam EPA	Jordan–Singapore FTA
AFAS	Japan–Malaysia EPA	New Zealand–Singapore FTA
ASEAN–China FTA	Japan–Philippines EPA	Viet Nam–The United States BTA
ASEAN–Republic of Korea FTA	Japan–Singapore EPA	MERCOSUR
ASEAN–Australia New Zealand FTA	Japan–Thailand EPA	
	India–Singapore ECA	

Source: Setiawan S (2018). Negative list in services liberalisation for ASEAN developing countries. International Journal of Economics and Financial Issues. 8(5): 11–20. Available at https://ideas.repec.org/a/eco/journ1/2018-05-3.html

Table A11. ASEAN and nonASEAN FTAs/RTAs with negative list for services sectors

Full negative list or mostly negative list		
Australia–Singapore FTA	Mexico–Northern Triangle FTA	Chile–Colombia FTA
Chile–Republic of Korea FTA	CACM–Dominican Republic FTA	Canada–Peru FFTA
Guatemala–Taiwan Province of China FTA	Nicaragua–Taiwan Province of China FTA	Colombia–Northern Triangle FTA
Japan–Chile EPA	Chile–CACM FTA	Colombia–Canada FTA
Japan–Mexico EPA	CACM–Panama FTA	Colombia– The United States FTA
Japan–Switzerland EPA	Chile–The United States FTA	Panama–The United States FTA
Trans-Pacific EPA	Mexico–Uruguay FTA	Panama–Singapore FTA
Panama–Taiwan Province of China FTA	CARICOM FTA	Singapore–The United States FTA
North American FTA (NAFTA)	Andean Community FTA	Canada–Panama FTA
Costa Rica–Mexico FTA	CAFTA–Dominican Republic-The United States FTA	Mexico–Peru FTA
Canada–Chile FTA	Chile–Panama FTA	Nicaragua–Taiwan Province of China FTA
Mexico–Nicaragua FTA	Peru–The United States FTA	Republic of Korea–Singapore FTA
Chile–Mexico FTA	Chile–Peru FTA	Panama–Singapore FTA
		Singapore–The United States FTA

Source: Setiawan S (2018). Negative list in services liberalisation for ASEAN developing countries. International Journal of Economics and Financial Issues. 8(5). 11–20. Available at https://ideas.repec.org/a/eco/journ1/2018-05-3.html

Table A12. Assessing the uptake and integration of circular economy in the European Union FTAs

Agreement	Status	Relevance in the context of circular economy (CE)
Southern African Development Community – Economic Partnership Agreement (SADC–EPA)	In force since February 2018	No mention of CE or any relevant measures
Bosnia and Herzegovina – Stabilisation and Association Agreement (SAA)	In force since June 2015	Cooperation policies – Environment: – Parties shall establish cooperation, which could centre on the development of strategies to significantly reduce local, regional and trans-boundary air and water pollution, including waste and chemicals, to establish a system for efficient, clean, sustainable and renewable production and consumption of energy, and to execute environmental impact assessment and strategic environmental assessment
Georgia – Association Agreement (AA)	In force since July 2016	Trade and sustainable development (TSD) chapter: – Call to facilitate the removal of obstacles to trade or investment concerning goods and services of particular relevance to climate change mitigation, such as energy efficient products and services. May include the adoption of appropriate technologies and the promotion of standards that respond to environmental and economic needs and minimize technical obstacles to trade – Agreement to promote trade in goods that contribute to enhanced social conditions and environmentally sound practices, including goods that are the subject of voluntary sustainability assurance schemes such as fair and ethical trade schemes and eco-labels – Promotion of private and public certification, traceability and labelling schemes, including eco-labelling
Republic of Moldova – Association Agreement (AA)	In force since July 2016	Trade and sustainable development (TS) chapter: – Agreement to promote trade in goods that contribute to enhanced social conditions and environmentally sound practices, including goods that are the subject of voluntary sustainability assurance schemes such as fair and ethical trade schemes, eco-labels, and certification schemes for natural resource-based products – Promotion of private and public certification, traceability and labelling schemes, including eco-labelling
Republic of Korea – FTA	In force since July 2016	Trade and sustainable development (TSD) chapter: – Parties shall strive to facilitate and promote trade and foreign direct investment in environmental goods and services, including environmental technologies, sustainable renewable energy, energy efficient products and services and eco-labelled goods, including through addressing related non-tariff barriers – Parties shall strive to facilitate and promote trade in goods that contribute to sustainable development, including goods that are the subject of schemes such as fair and ethical trade and those involving corporate social responsibility and accountability
Comprehensive Trade Agreement with Colombia, Peru and Ecuador (CTA)	Partly in place – provisionally applied since July 2013	Trade and sustainable development (TSD) title: – Considering the global objective of a rapid transition to low-carbon economies, Parties will promote the sustainable use of natural resources and will promote trade and investment measures that promote and facilitate access, dissemination and use of best available technologies for clean energy production and use, and for mitigation of and adaptation to climate change
Central America – Association Agreement (AA)	Partly in place – provisionally applied since 2013	Cooperation part: – Cooperation shall in particular address: […] the fight against pollution of fresh and marine waters, air and soil, including through the sound management of waste […] – Cooperation may involve measures such as: […] promoting sustainable production and consumption patterns, including through the sustainable use of ecosystems, services and goods Trade part, TSD title: – Parties shall endeavour to facilitate and promote trade in products that respond to sustainability considerations, including products that are the subject of schemes such as fair and ethical trade schemes, eco-labelling, organic production, and including those schemes involving corporate social responsibility and accountability

Agreement	Status	Relevance in the context of circular economy (CE)
Cuba – Political Dialogue and Cooperation Agreement	Partly in place – provisionally applied since 2017	Cooperation part: – Cooperation shall in particular address […] the fight against the pollution of fresh and marine waters, air and soil, including through the sound management of waste […] – Cooperation may involve measures such as: […] promoting sustainable production and consumption patterns, including through the sustainable use of ecosystems, services and goods. Trade and Trade cooperation part Trade and SD article: – Parties agree to cooperate in supporting the development of an enabling framework for trade in goods and services contributing to sustainable development, including through the dissemination of corporate social responsibility practices
Kazakhstan – Enhanced Partnership and Cooperation Agreement	Partly in place – provisionally applied since May 2016	Trade and Business title, Trade & SD chapter: – Parties agree to promote the use of sustainability assurance schemes, such as fair and ethical trade or eco-labelling Cooperation title: – Cooperation shall be pursued in […] waste management (cooperation in the area of environment) – Parties shall cooperate in […] productivity and efficiency of resource use (Cooperation in the area of industry)
Eastern and Southern Africa (ESA) – interim Economic Partnership Agreement	Partly in place – provisionally applied since May 2012	Economic and development cooperation chapter: – Parties agree to cooperate in […] supporting the production and facilitate trade of goods and services for which eco-labelling is important; waste management
Ukraine – Association Agreement	Partly in place – provisionally applied since January 2016	Trade and SD chapter: – Parties shall strive to facilitate and promote trade and foreign direct investment in environmental goods, services and technologies, sustainable renewable-energy and energy-efficient products and services, and eco-labelled goods, including through addressing related non-tariff barriers Cooperation title: – Cooperation shall aim at preserving, protecting, improving, and rehabilitating the quality of the environment, […], prudent and rational utilisation of natural resources, in the areas of: […] waste and resource management
Singapore – FTA	Pending – signed in October 2018, awaiting ratification	Trade and SD chapter: – Parties shall pay special attention to facilitating the removal of obstacles to trade or investment concerning climate-friendly goods and services, such as sustainable renewable energy goods and related services and energy efficient products and services
Viet Nam – FTA	Pending – texts agreed on in July 2018, awaiting agreement by the Council	Trade and SD chapter: – Parties may work together in […] sharing information and experience about trade-related aspects concerning the definition and implementation of green growth strategies and policies, including but not limited to sustainable production and consumption, climate change mitigation and adaptation, and environmentally sound technology
Mercosur Association Agreement	Under negotiation since 2016	Trade and SD chapter (European Union proposal): – Parties shall (…) facilitate trade and investment in environmental goods and services, including those of particular relevance for climate change mitigation such as sustainable renewable energy and energy efficient products and services, through inter alia addressing related non-tariff barriers, (…) promote trade in goods that contribute to enhanced social conditions and environmentally sound practices, including goods that are the subject of voluntary sustainability assurance schemes such as fair and ethical trade schemes and eco-labels
The United States – Transatlantic Trade and Investment Partnership (TTIP)	Negotiations launched in 2013, stopped in 2016	Trade and SD chapter (European Union proposal, 2015): – Parties shall (…) cooperate to promote globally the environmentally sound management of all types of waste, reduction of waste generation and using waste as a resource; take effective measures and cooperate to combat globally illegal shipments of all types of waste – Parties shall consult and cooperate on areas that may include (…) sustainable consumption and production; strategies and policies to promote trade contribution to resource efficiency, the green economy and the circular economy, including eco-innovation, and promoting participation in relevant international instruments

Agreement	Status	Relevance in the context of circular economy (CE)
New Zealand – FTA	Negotiations launched in June 2018	Energy and Raw materials chapter (European Union proposal, 2018): – Parties shall cooperate with a view to (…) promote the efficient use of resources (i.e. improving production processes as well as durability, reparability, design for disassembly, ease of reuse and recycling of goods) Trade and SD chapter (European Union proposal, 2019): – Parties shall work together to strengthen their cooperation on trade-related aspects of environmental policies and measures, bilaterally, regionally and in international fora, as appropriate, including in the United Nations High-level Political Forum for Sustainable Development, United Nations Environment Programme (UNEP), United Nations Environment Assembly (UNEA), Multilateral Environmental Agreements (MEAs), or the WTO. Such cooperation may cover inter alia: (a) initiatives on sustainable production and consumption, including those aimed at promoting a circular economy and green growth and pollution abatement
Australia –FTA	Negotiations launched in June 2018	Energy and Raw materials chapter (European Union proposal, 2018): – Parties shall cooperate with a view to (…) promote the efficient use of resources (i.e. improving production processes as well as durability, reparability, design for disassembly, ease of reuse and recycling of goods). Trade and SD chapter (European Union proposal, 2019): – The Parties shall promote trade and investment in goods and services beneficial to environment or contributing to enhanced social conditions such as goods and services that are the subject of voluntary sustainability assurance schemes, for example fair and ethical trade schemes and eco-labels
Mexico – Trade part of the modernized global agreement	Under negotiation – agreement in principle announced April 2018, but technical details remain within the texts	Energy and Raw materials chapter: – Parties shall cooperate to promote the efficient use of resources (i.e. improving production processes as well as durability, reparability, design for disassembly, ease of reuse and recycling of goods) Trade and SD chapter: – Parties shall promote (…) inclusive green growth and circular economy so as to foster economic growth while ensuring the protection of the environment and promoting social development (in Objectives) – Parties shall promote (…) trade in goods that contribute to enhanced social conditions and environmentally sound practices, including goods that are the subject of voluntary sustainability assurance schemes such as fair and ethical trade schemes and eco-labels – Parties may work jointly in (…) the promotion of inclusive green growth and circular economy; the sound management of chemicals and waste
Canada – Comprehensive Economic and Trade Agreement (CETA)	Partly in place – entered into force provisionally in September 2017	Trade and SD chapter: – Each Party shall strive to promote trade and economic flows and practices that contribute to enhancing decent work and environmental protection, including by: (…) encouraging the development and use of voluntary schemes relating to the sustainable production of goods and services, such as eco-labelling and fair trade schemes Trade and Environment chapter: – Parties commit to cooperate in areas such as promotion of life-cycle management of goods, including carbon accounting and end-of-life management, extended producer-responsibility, recycling and reduction of waste, and other best practices
Japan – Economic Partnership Agreement (EPA)	Entered into force February 2019	Trade and SD chapter: – Parties shall strive to facilitate trade and investment in goods and services of particular relevance to climate change mitigation, such as those related to sustainable renewable energy and energy efficient goods and services, in a manner consistent with this Agreement – Parties shall strive to promote trade and investment in goods that contribute to enhanced social conditions and environmentally sound practices, including goods that are the subject of labelling schemes

Source: Kettunen M, Gionfra S and Monteville M (2019). EU circular economy and trade: Improving policy coherence for sustainable development, IEEP Brussels/London. 48. See https://ieep.eu/news/eu-circular-economy-and-trade-improving-policy-coherence-for-sustainable-development

Table A13. Summary of countries that have announced imminent action on plastic bags and Styrofoam products

Country/ Region	Year	Measures (in Force)
Benin	2018	Ban on import, production, sale and use of non-biodegradable plastic bags
Botswana	2007	Levy on retailer. No enforcement upon retailers to charge for plastic bags. Retailers decide if and how much to charge.
Rwanda	2008	Ban on the production, use, importation and sale of all polyethylene bags.
Senegal	2016	Ban on the production, importation, possession and use of plastic bags <30µ.
China	2008	Ban on non-biodegradable plastic bags <25µ and levy on consumer for thicker ones.
India	2016	National ban on non-compostable plastic bags <50µ7, in addition various state-level bans.
Sri Lanka	2017	Ban on the import, sale, and use of polyethylene bags <20µ and Styrofoam containers.
Viet Nam	2019	Non-biodegradable plastic bags are taxed by weight with Resolution No. 579/2018 setting the tax at VND50,000 (around $2) per kilo.
Ecuador	2015	Ban on plastic bags in the Galápagos Islands.
Brazil	2009	Levy (local for Rio de Janeiro) "Requirement to substitute polyethylene and polypropylene bags with alternatives, or, if not done, to take back any quantity of plastic bags from any source and dispose of them properly and compensate the public by giving them a discount if they bring their own bag, or to pay them with food products for every 50 plastic bags they bring."
Brazil	2015	Ban on non-biodegradable plastic bags in Sao Paulo.
St. Vincent and the Grenadines	2017	Import ban on Styrofoam products used for sale or storage of food; and removal of value added tax (VAT) biodegradable alternatives to lower their cost.
European Union	2015	European Union directive 2015/720 of the European Parliament and the Council). "Member states must ensure that by the end of 2019 no more than 90 lightweight (< 50µ) bags are consumed per person per year. By the end of 2025 that number should be down to no more than 40 bags per person. Member states can choose whether to introduce bans, taxes, or other policy tools."
Vanuatu	2018	Ban on manufacture, use and import of single-use plastic bags, straws and polystyrene takeaway food containers. Bags to wrap and carry fish or meat are exempt.

Source: Compilation based on UNEP (2018). Single-Use Plastics. A Roadmap for Sustainability. Available at https://www.rsi.ch/news/mondo/Il-report-Single-use-plastic-dellONU-10549367.html/BINARY/Il%20report%20%22Single%20use%20plastic%22%20dell'ONU#:~:text=Rwanda%2C%20a%20pioneer%20in%20banning,cows%20from%20an%20unhealthy%20diet ; Pham L (2019). What are Vietnam's moves to minimize plastic waste? Hanoi Times, 17 September 2019. See http://hanoitimes.vn/what-are-vietnams-moves-to-minimize-plastic-waste-45854.html.

Endnotes

1 Figure generated based on review of examples of alternatives in UNEP (2017).
2 Ibid.
3 The Pew Charitable Trusts and SYSTEMIQ (2020). Breaking the plastic wave: A comprehensive assessment of pathways towards stopping ocean plastic pollution. Available at https://pew.org/32KPsgf.
4 UNEP (2017). 97.
5 UNEP (2017). 48--49.
6 UNEP (2017).48, 49, 89.
7 UNEP (2017). 106.
8 The Pew Charitable Trusts and SYSTEMIQ (2020). 35.
9 UNEP (2017). 104.
10 FAO (2019). 4--5.
11 Ibid. 6--8.
12 Ibid. 8--9.
13 Ibid. 10--11.
14 FAO (2019). 12.
15 Starch-based micro and nano bio-composites are produced by combining a thermo-plastic starch polymer with a filler such as cellulose or lignin fibres to improve properties of the final product. Thermo-plastic starch can also be produced from sources other than cellulose, such as alginate and chitosan (UNEP, 2017). 72.
16 Lackner (2015). 21.
17 United States. Customs and border protection, generalized system of preferences (GSP). https://www.cbp.gov/trade/priority-issues/trade-agreements/special-trade-legislation/generalized-system-preferences.
18 Based on observation of MFN applied tariffs on jute. WTO Tariff Download facility. Available at http://tariffdata.wto.org/default.aspx WTO Tariff Download facility. http://tariffdata.wto.org/default.aspx.
19 See https://unctad.org/topic/trade-agreements/global-system-of-trade-preferences.
20 Chang (2013). 10.
21 Chang (2013). 11.
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23 Stakeholders in Methyl Bromide Reduction: FAQs: Phytosanitary fumigation for export logs and timber products. Available at http://www.stimbr.org.nz/methyl-bromide-faqs.html.
24 Ibid.
25 WTO (2017). WTO members adopt report on food safety agreement, WTO news, 13--14 July 2017. Available at https://www.wto.org/english/news_e/news17_e/sps_13jul17_e.htm.
26 Chang (2013). 11.
27 Participants include Australia, Canada, China, Costa Rica, European Union, Iceland, Israel, Japan, Republic of Korea, New Zealand, Norway, Singapore, Switzerland, Liechtenstein, Turkey, the United States, Hong Kong (China) and Taiwan Province of China.
28 Ibid. Annex 1: Environmentally Endorsed Items. Available at https://www.transportenvironment.org/sites/te/files/publications/EGA%20Annex%201_revised_0.pdf.
29 Ibid. Transport and environment briefing: Environmental goods agreement. Annex 2: Environmentally rejected items. Available at https://www.transportenvironment.org/sites/te/files/publications/EGA%20Annex%202_revised.pdf.
30 Agreement between New Zealand and Taiwan Province of China on Economic Cooperation. See https://www.nzcio.com/en/anztec/anztec-agreement/.
31 Ibid.
32 Annex C - APEC list of environmental goods. See https://www.apec.org/Meeting-Papers/Leaders-Declarations/2012/2012_aelm/2012_aelm_annexC.aspx.
33 Ibid.

34 For example, “New text was added to subheading 0106.12 to identify separately not only whales and dolphins, but a new group of endangered marine mammals requiring close monitoring (i.e., seals, sea lions and walruses).” See WTO (2010). Committee on market access: Minutes of the meeting, 29 April 2010. G/MA/M/51. Available at https://docsonline.wto.org/dol2fe/Pages/SS/DirectDoc.aspx?filename=t%3A%2Fg%2Fma%2Fm51.doc&.

35 The 23 TiSA members comprise Australia, Canada, Chile, Colombia, Costa Rica, the European Union, Iceland, Israel, Japan, Liechtenstein, Mauritius, Mexico, New Zealand, Norway, Pakistan, Panama, Peru, Republic of Korea, Switzerland, Turkey, the United States, Hong Kong (China) and Taiwan Province of China.

36 In many cases, Thailand’s tariff schedule provides for alternative duties. “An alternative duty involves the choice between an ad valorem and a specific rate; the higher of the two is applied provided the WTO tariff binding commitments are met.” WTO (2008), Thailand Trade Policy Review. Report by the Secretariat-Revision, 6 February 2008. WT/TPR/S/191/Rev1. p. 50, footnote 28.

37 In many cases, Thailand’s tariff schedule provides for alternative duties. “An alternative duty involves the choice between an ad valorem and a specific rate; the higher of the two is applied provided the WTO tariff binding commitments are met.” See WTO (2008), Thailand Trade Policy Review. Report by the Secretariat-Revision, 6 February 2008. WT/TPR/S/191/Rev1. p. 50, footnote 28. https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=Q:/WT/TPR/S191R1-03.pdf&Open=True.

BANKS, BONDS AND THE PETROCHEMICALS/PLASTICS INDUSTRY

GREENING THE PATH FROM COPENHAGEN AGREEMENT, COVID AND BEYOND[1].

By

Diana Barrowclough and Guy Finkill

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Introduction

This paper reports recent trends in finance to the fossil fuel, petrochemical and plastics economy, with a particular focus on public and so-called "green" sources of finance. It tracks the gradual decline in financial flows over the last decades against a surprising counter-trend new increase in financing in the last Covid period, which is at odds with the commitments from governments, industry and civil society to reduce CO2 emissions and plastics pollution to meet the climate-sensitive needs of the 21st century. Public finance in particular is on a squarely downward trend and the latest rise is due to private financial flows, but none the less the continued State support for this sector is significant. Not all government support is necessarily a clash if it is helping the industry transform to more sustainable processes and products, or if it is guiding a just transition and there needs to be room for this in the debate; however, support to the status quo will obviously not help this aim. Equally complex is the world of green finance, which appeared to offer enormous potential and is already measured in the trillions of dollars; however, it is associated with claims of green washing amid other issues. Much needs to be done to improve transparency and to better align these new financial instruments with the growing concern about the environment on the part of the investment community and civil society.

More positively, the challenge is not insurmountable. Firstly, sustainability goals are not limited to governance and public institutions, as private sectors and civil society are joining the push for decarbonisation with net-zero pledges and emissions reductions from energy and industry to the world of finance (Ciplet & Roberts, 2017; Ampersand Partners & NZE, 2020). There is also strong investment interest in the search for new and less problematic alternatives to fossil fuel, petrochemicals and plastics. Secondly, some governments are already, even if in a small way, starting to promote alternative pathways and much more could be done if they resumed their catalytic and developmental roles of the past (Mazzacuto etc,). Third, a lot can be achieved by governments simply stopping their financial support of the sector, even without taking the next step to turn it around, and if the new and emerging "green bond" universe joined in too. This third more modest element is where this paper is focused.

Structure of the paper
Section 1 describes recent trends in the geographical dispersal of petrochemical finance, and its purposes, showing the predominance of plastics production and fertiliser, which will become even more significant as the world starts transitioning away from fossil fuels for energy or transport. The reasons why this matters are set out in Box 1. *Section 2* digs deeper into the recent finance flows to the petrochemical industry, tracing the declining path from the Copenhagen Agreement, through the Paris Accord and then the shock to the global economy caused by Covid-19. It teases out the different contributions of public and private financial flows, including the role of equity holdings and loans by development banks and public institutions. It shows that private finance is now taking the lion's share when it comes to financial flows such as bonds and loans; although public funds are still significant and

potentially with symbolic value that belies the monetary value. Finally it shows the state is still significantly involved in equity holdings.

Because the sector will still need massive investment in order to transition and transform itself, *Section 3* pivots to the rapidly growing “green bonds” market. This promises a kind of middle ground between traditional publicly-oriented financing from governments or development banks, and the short-termist profit-maximising imperative of the private sector. Can this new and rapidly growing category of finance meet the industry’s transition needs, for example through low-cost loans, venture capital or equity positions that give the industry breathing space and the tools with which to change its path. Our findings are not very encouraging.

Section 4 concludes the paper by calling for governments and public financial institutions to take more seriously the contribution of this sector to global warming, carbon emissions and pollution. By continuing to fund the status quo, it delivers the message that change is not needed. On the other hand, public financial institutions such as central banks and development banks can help to finance the transition and transformation of this sector – hence it is not necessarily a question of stopping all financial flows to this both useful and problematic sector, but rather in helping not better guide it.

Methodological approach - significant moments in the path from Copenhagen to Covid-19

The paper uses three broad time frames based around major international agreements on global climate governance as the lens through which to examine the trends in financing and production. The starting point is the Copenhagen Accord of December 2009, which was an important landmark for the petrochemical industry and environmental regulation. It marked the closing of the UNFCC climate negotiations, widely regarded as a failure to achieve meaningful progress on climate governance. The second frame come six years later, with the Paris Agreement signing in December 2015 was by comparison commended as a breakthrough moment for climate ambition and breaking down of political boundaries on the issue of common but differentiated responsibility (Pauw et al., 2019). The third phase begins in February 2020, an approximate timing of the start of global social, economic and financial measures undertaken to curb the economic impact of Covid-19, and the “build back better” debate linking Covid recovery with a greener future.

Box 1: *Why it matters: Petrochemicals, pollution and climate change.*

While most attention in the climate debate typically goes to the fossil fuels sector, in fact petrochemicals and plastics have long been considered extremely problematic for their impact on pollution and now their contribution to global warming. CO2 emission are set to rise by 50% if the world continues to use plastic at current trends (CIEL 2019c, WWF 2019). Plastic also absorbs a surprisingly large proportion of the total carbon budget – it is forecast to account for 20% of total oil consumption and 15% of the annual carbon budget by 2050 (Barra et al 2018: WEF 2017; CIEL 2017). Plastic-related emissions are estimated to reach 1.34 gigatons per year, equivalent to emissions released by more than 295 new 500-megawatt coal-fired power plants. By 2050, estimates are that plastic's emissions could account for over 56 gigatons (CIEL 2019c). While plastic raises attention because it is the single largest component of petrochemicals financing, the global production of chemicals is also predicted to double in the next decade. There are therefore very high opportunity costs associated with the current practices.

One challenge is that the petrochemicals and plastics sector is huge, deeply rooted and powerful. It will not be easy for governments to transform their economies away from the excessive reliance that has arisen over decades, and to do it in a way that is just and sustainable. This must however be done if countries are to meet their commitments and pledges to the Paris Agreement and the Agenda 2030 (Atteridge & Strambo, 2020; Jenkins et al, 2020) Sustainable Development Goals (SDGs).

Another challenge is that petrochemicals are so ubiquitous in daily existence. Sometimes described as the "building blocks of life", given their use in an incredibly diverse range of products from fertilisers and pharmaceuticals to plastic carpets, pipes, fishing lines and synthetic clothes. Their production and use have created jobs and income generating opportunities through economic diversification and trade that raised living standards across the globe through the latter half of the 20th century. Plastics are at the heart of much light manufacturing; exports of food products; and the synthetic clothing business, for example. However, given petrochemicals' dependency on fossil fuels as a primary feedstock, their use is under greater scrutiny as the world looks to decouple economic growth from the nagging increase in GHG emissions.

Despite growing recognition of the problem, things are going in the wrong direction. A significant increase in petrochemical production is expected over the next decade (IEA[2]). Via a combination of energy efficiency improvements, decarbonising areas of transport and a projected increase in demand for petrochemical-derived products given an increase in global population and living standards, the percentage of petrochemical driven oil demand is projected to rise to more than a third by 2030, and nearly half by 2050 (ibid). Ongoing improvements in recycling and successes in phasing out of products like single-use plastics, but these incremental reductions will be far outstripped by sharp increases in demand and consumption for petrochemical products in emerging economies. The petrochemical industry is renowned for being a hard-to-abate sector, similar to the production of steel and cement, given its carbon-intensive lifecycle (see lifecycle Table). If it is unable to decarbonise in a timely manner, it will continue to guarantee future emissions, hindering any meaningful attempt to achieve net-zero commitments by 2050. Heavy quantities of

[2] International Energy Agency

emissions are sadly not the only negative externality linked with petrochemicals; there are also multiple causes of concern linked to pollution, environmental racism, and climate justice issues.

Section 1: Geographical and product trends

Where does the money go in the petrochemicals sector, and for what purpose? This section uses six Sankey diagrams to tease out the flows in terms of geographical trend and product space.

Copenhagen to Paris

More than 140 separate financial transactions (debt instruments relating to primary financing, additional financing and re-financing) with a total value of $129 billion USD were instigated during the six years from signing the Copenhagen Accord and up until the Paris Agreement. These covered at least 100 individual projects and facilities (data sourced from IJ Global). These show in Column C of the diagram below that the components that go into making plastics account for the largest degree of financing flows, at 72.28%; with fertiliser related production coming in second with 14.10% of the flows. Both of these uses are problematic for the green transition. The remaining ~14% is evenly distributed across a range of petrochemical outputs used for mostly industrial purposes.

In geographical terms, the Middle East and North Africa and Asia Pacific regions dominate much of the new and existing production, reflecting growing consumer demand in these areas from a low baseline. The sources of finance rather stem from North America and Europe, due to the global-spanning reach of the commercial and investment banking sector that have their headquarters residing in these regions.

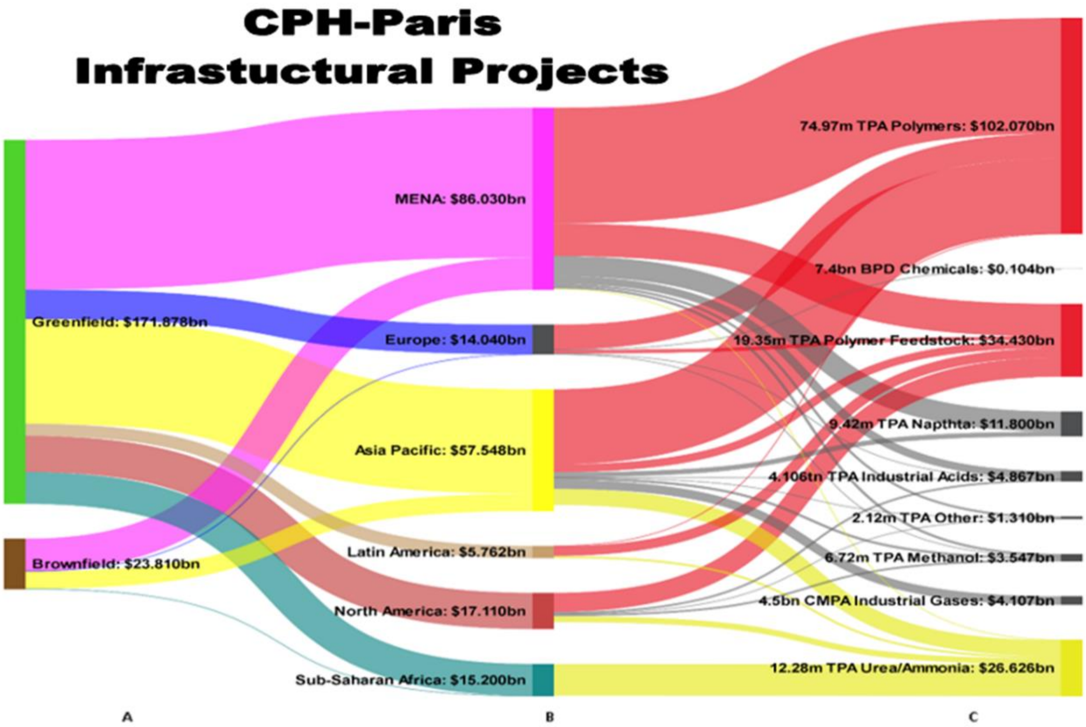

Figure 1 – CPH-Paris Infrastructural Projects. Sankey diagram detailing the financing of petrochemical assets between since the Copenhagen Accord to the signing of the Paris Agreement. 15/12/09-12/12/15. Finance flows from left to right with values equating to the convergence of flows into each solid node. Column A depicts the quantity of money being invested into either Greenfield or Brownfield projects. Column B disaggregates these quantities on a geographical basis corresponding to where the project is situated. Column C marks the end of the flow with a disaggregation of final petrochemical output with plastics related flows highlighted in red and fertiliser related flows highlighted in yellow. Note: Data derived from IJ Global.

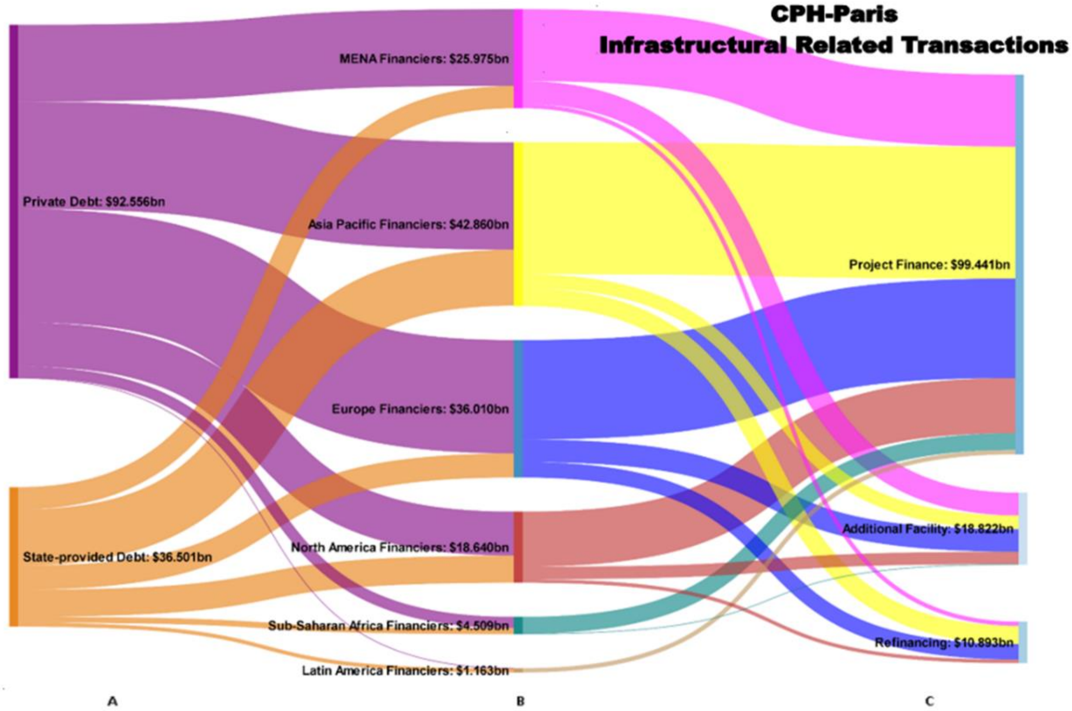

Figure 2 – CPH-Paris Infrastructural Related Transactions. Sankey diagram detailing the flows of state and private debt into financing the infrastructural related operations of the petrochemical since the Copenhagen Accord to the signing of the Paris Agreement. 15/12/09-12/12/15. Finance flows from left to right with values equating to the convergence of flows into each

solid node. Column A displays the division between the start-points of financing, from either state or private interests. Column B shows the geographical distribution of financing based on the company/institutions' HQs. Column C depicts the purposes for which the financing is used, all related to either new or existing infrastructural projects. Note: Data derived from IJ Global.

From Paris to Covid

Following the Paris accord, changes are apparent, both in the total amount of financing, and where it is headed. More than 750 separate financial transactions (debt instruments relating to primary financing, additional financing and re-financing) were recorded, dealing with 102 individual projects and companies. The geographical trends change, and North America overtakes the MENA region in regards to total petrochemical output – although this continues again to be mostly driven by the plastics industry. Asia Pacific remains a dominant collector of financing – mostly for two new petrochemical plants that had not confirmed their specific type of output at the time of writing. Once again, Europe and North America are the two largest sources of financing, with an almost negligible quantity of production capacity staying within Europe's borders, 3.57% of global output compared to 34.48% of global financing. This showcases the "exporting emissions" nature of modern-day industry and manufacturing (Kanemoto et al, 2012; Liddle, 2018), where high-income countries that are eager to lower their territorial emissions duly boost production capacity in emerging economies with much of the end-use products being imported back into the high-income regions while the associated emissions are exported to the countries of production (Scott & Barrett, 2015; Jiborn et al, 2018).

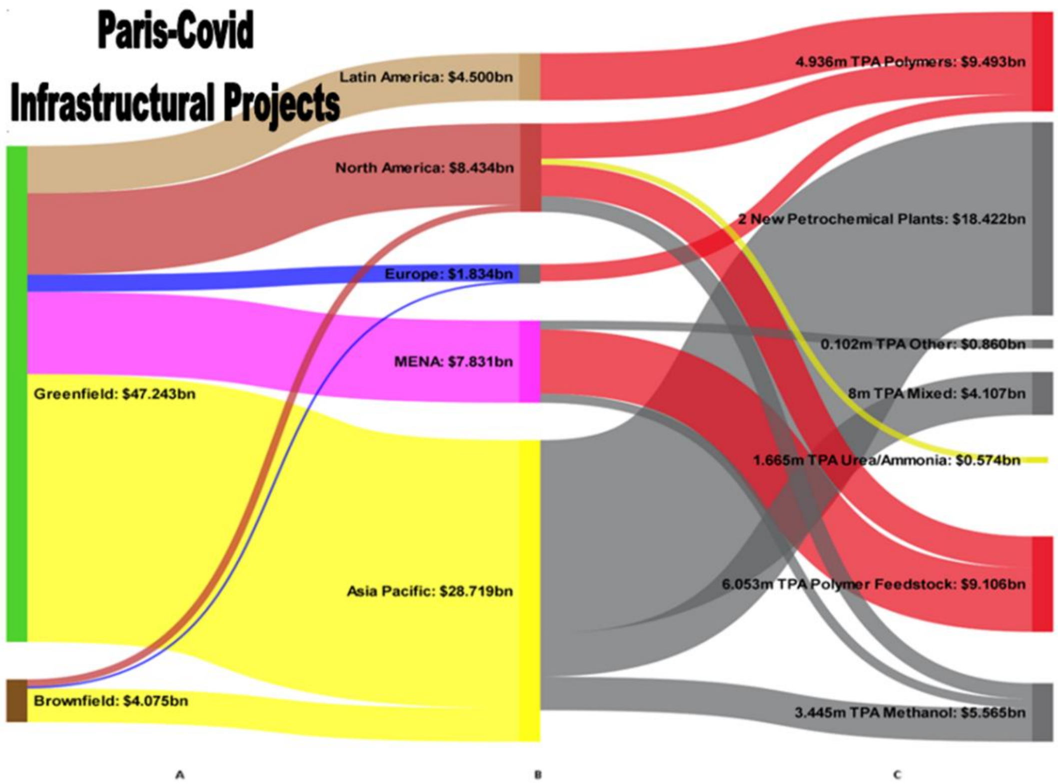

Figure 3 – Paris-Covid Infrastructural Projects. Sankey diagram detailing the financing of petrochemical assets between since the Paris Agreement and the beginning of the Covid global impact. 12/12/15-01/02/21. Finance flows from left to right with values equating to the convergence of flows into each solid node. Column A depicts the quantity of money being invested into either Greenfield or Brownfield projects. Column B disaggregates these quantities on a geographical basis corresponding to where the project is situated. Column C marks the end of the flow with a disaggregation of final petrochemical output with plastics related flows highlighted in red and fertiliser related flows highlighted in yellow. Note: Data derived from IJ Global.

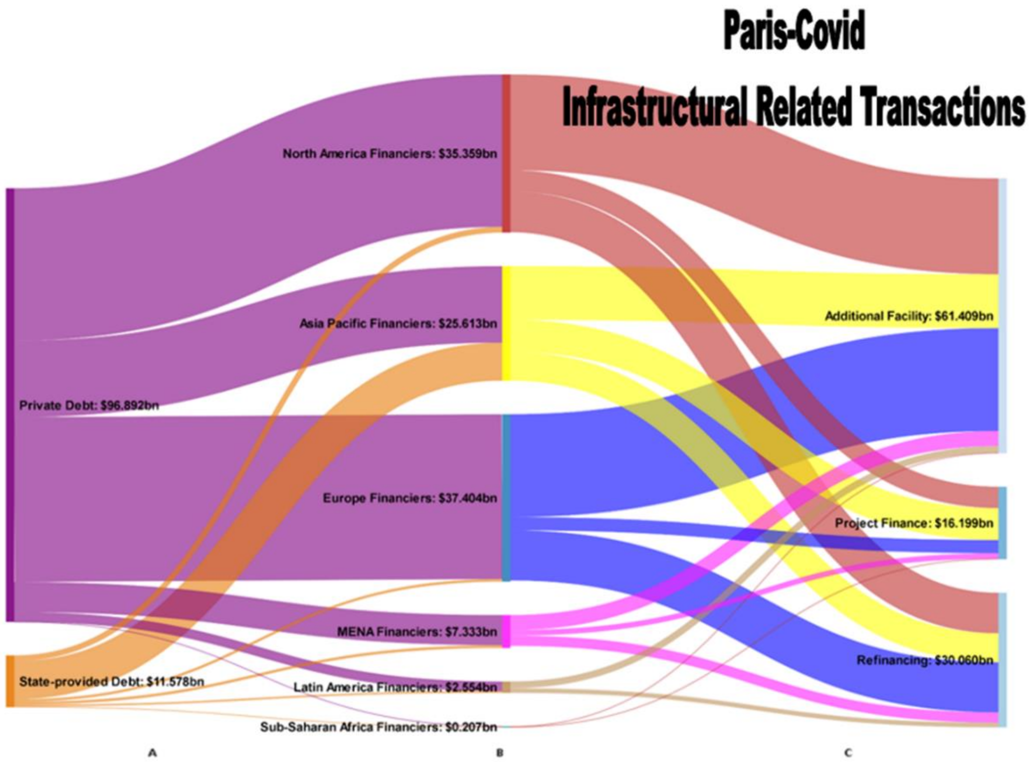

Figure 4 – Paris-Covid Infrastructural Related Transactions. Sankey diagram detailing the flows of state and private debt into financing the infrastructural related operations of the petrochemical since the Paris Agreement and the beginning of the Covid global impact. 12/12/15-01/02/21. Finance flows from left to right with values equating to the convergence of flows into each solid node. Column A displays the division between the start-points of financing, from either state or private interests. Column B shows the geographical distribution of financing based on the company/institutions' HQs. Column C depicts the purposes for which the financing is used, all related to either new or existing infrastructural projects. Note: Data derived from IJ Global.

The Covid Era (to August 2021)

What happened during Covid? As the world reeled under the economic and health shocks of coronavirus, there seem to have been contradictory trends – although this is the shortest time period that was assessed for the purpose of this report and is not standard on any measures. Starting from February 2020 as the approximate beginning of global lockdown restrictions due to the Covid-19 pandemic, the data show that despite many promises and pledges to ensure a green transition as part of the economic recovery, this has not happened – in the petrochemicals sector at least.

Despite the small timeframe, the private flow of financing into the petrochemical industry shows no sign of slowing down, $83.472 billion in less than 18 months, with over 80% of that being used for additional facility purposes, extending the longevity of pre-existing debt financing to accommodate the industry's need to bounce back from the economic downturn and to meet expected future demand (Mullin, 2021). New plastics production looks set to dominate global output, the majority in the MENA region but also significant plastics production taking place across North America and the Asia Pacific region. Financing once again originating from Europe (34.69%) and North America (38.04%) but also a marked increase coming from the Asia Pacific region (23.28%).

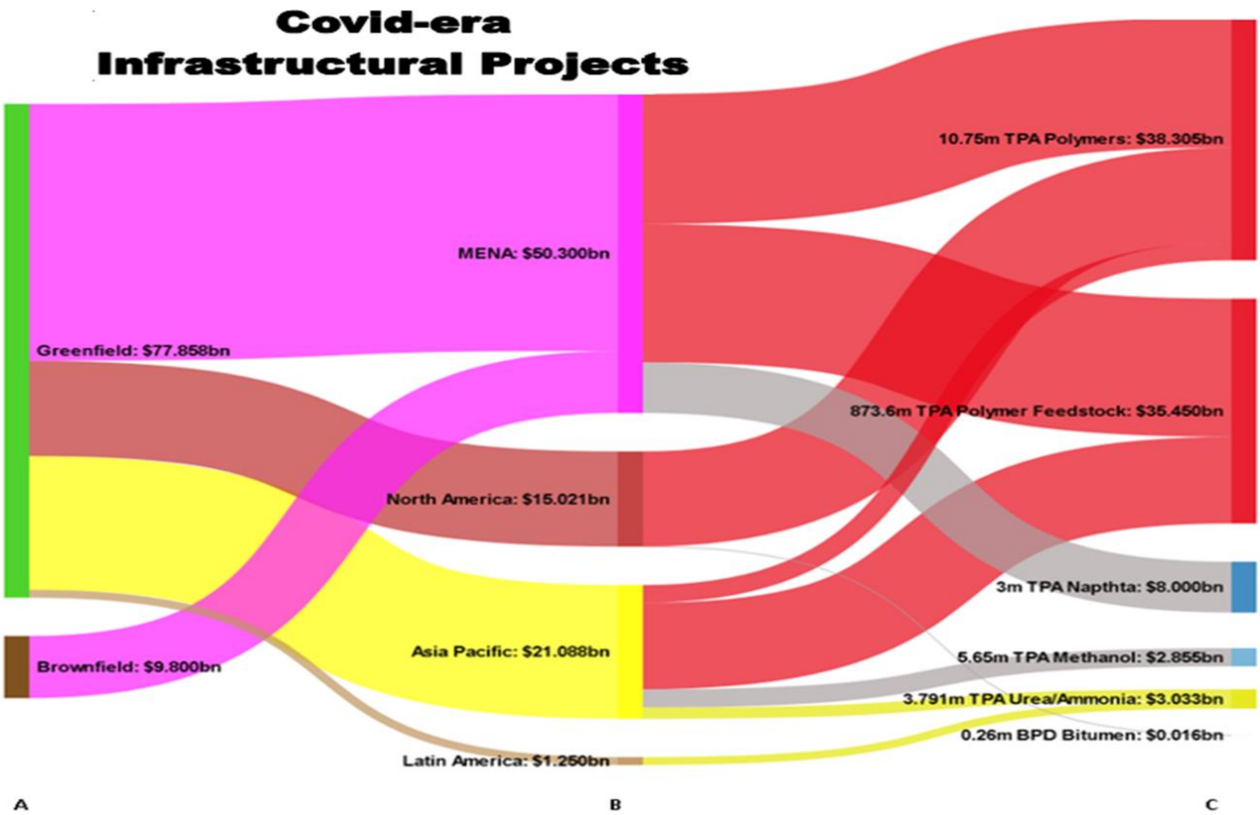

Figure 5 – Covid-era Infrastructural Projects. Sankey diagram detailing the financing of petrochemical assets between since the start of the Covid-pandemic to present day. 01/02/20-15/06/21. Finance flows from left to right with values equating to the convergence of flows into each solid node. Column A depicts the quantity of money being invested into either Greenfield or Brownfield projects. Column B disaggregates these quantities on a geographical basis corresponding to where the project is situated. Column C marks the end of the flow with a disaggregation of final petrochemical output with plastics related flows highlighted in red and fertiliser related flows highlighted in yellow. Note: Data derived from IJ Global.

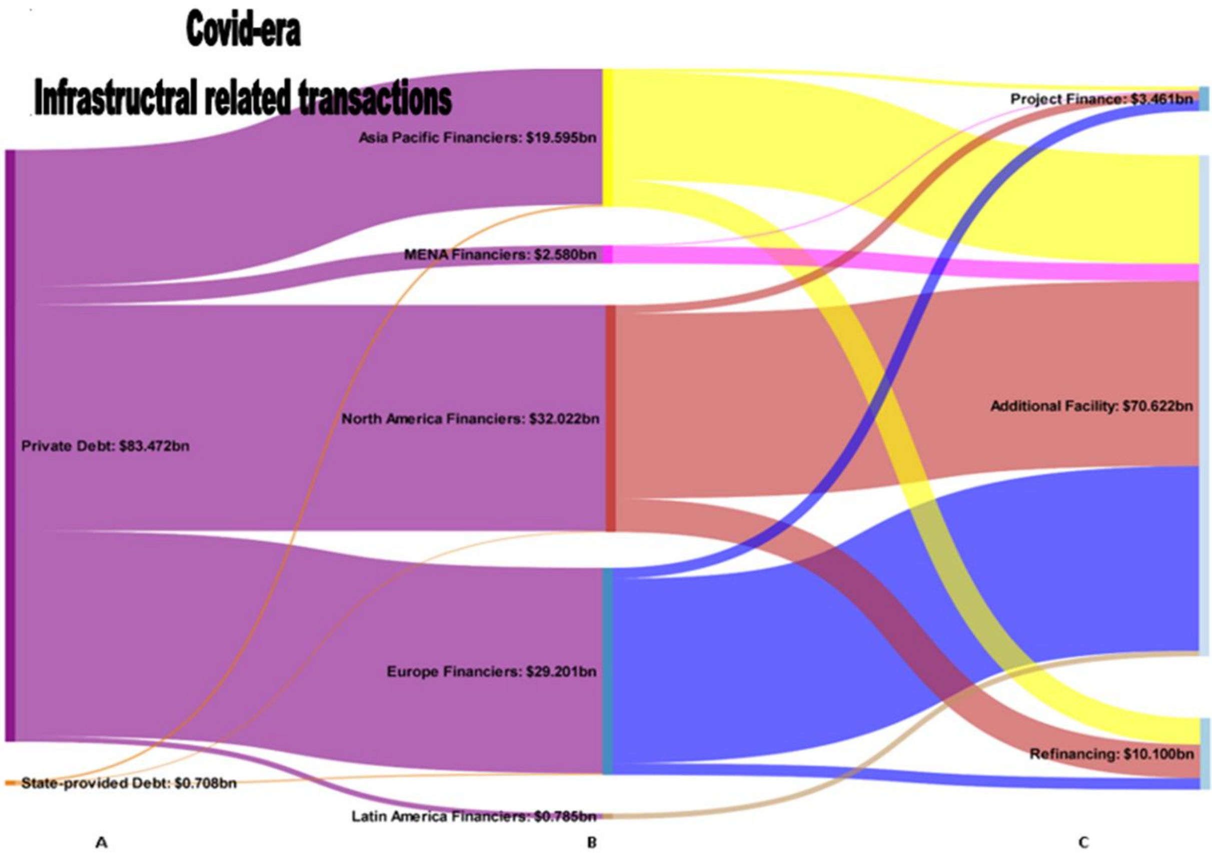

Figure 6 – Covid-era Infrastructural Related Transactions. Sankey diagram detailing the flows of state and private debt into financing the infrastructural related operations of the petrochemical industry since the start of the Covid-pandemic to present day. 01/02/20-15/06/21. Finance flows from left to right with values equating to the convergence of flows into each solid node. Column A displays the division between the start-points of financing, from either state or private interests. Column B shows the geographical distribution of financing based on the company/institutions' HQs. Column C depicts the purposes for which the financing is used, all related to either new or existing infrastructural projects. Note: Data derived from IJ Global.

Summing up from Copenhagen to Covid

Looking at the three periods in terms of financing totals, rather than the granular view of the Sankey diagrams above, it seems initially that funding to the petrochemical industry is falling, especially in terms of finance from governments or government institutions. As shown in Figure 7, in the years between Copenhagen and before the Paris Agreement in 2015, financial flows totalled some $129 billion, falling to $108 billion after Paris and to $83 billion since the economic lockdown of Covid-19. The fall is marked in State finance flows; in the years after Copenhagen signalled the start of a new perspective but before Paris sealed the deal, governments from 28 countries had provided funding of around $36.5bn new and existing petrochemical projects around the world. This was around 28% of the total finance to the sector – so relatively small but still significant. After Paris, the State share dropped quickly both in absolute terms to $11.578 billion and in relative share to just below 11%, because the private sector fell more slowly (to $96.892 billion). In the year and a half since the Covid-19 outbreak, the public sector share fell to $1 billion and less than 1% of the total. It is so negligible by comparison with private financial flows that it does not even show in the Figure below.

However, these encouraging trends disappear when looking at annual averages of financial flows without the framing lenses of political support as reflected in signed multilateral environmental agreements. The signs of a definite fall after Copenhagen and Paris may encourage environmentalists and others concerned about the climate impacts of the petrochemical sector, but Covid-19 provoked a different story. As shown in Figure 8, the annual average investment in the Covid period has leapt above pre-Paris levels. This is due to a surge of investment by the private sector and may be the consequence of rapidly falling interest rates and the subsequent search for yield on the part of fund managers and other financial market institutions. It may also reflect the impact of privileged corporate bond purchases implemented by central banks around the world as part of the Covid Response and Recovery packages put in place by many governments. By tradition bond purchases are not named by firm but central banks' intentions to make "market neutral" purchases means they likely choose the largest and longest-standing firms, which are most likely to be high-carbon and potentially include petrochemical and fossil fuels[3]. This is not to say the State financial flows are negligible – as will be shown in subsequent parts of this paper – but the driving force of the post covid investment surge is coming from private funds.

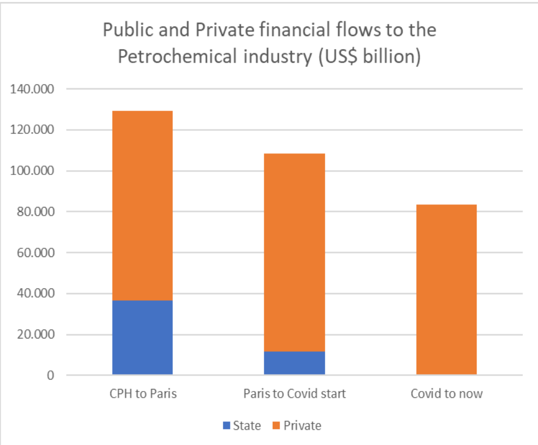

Figure.7: Financial flows 2009-2021 ($bn)

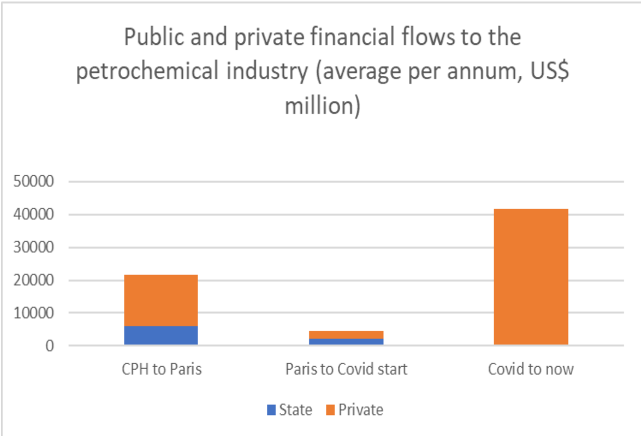

Fig. 8: Average annual flows 2009-2021 ($bn)

Section 2: Financial flows and their sources

This section digs deeper into the types of funders and financial instruments, following Figure 9, which depicts the current situation of all financial flows in the sector, currently active. This could for example include loans taken out in the Copenhagen or Paris periods which have still

[3] The central bank holdings were estimated by cross-referencing Bloomberg bond data with the Central Bank published data, making it possible to attribute the quantities coming from the public sector. It may not be the full figure because if petrochemical companies are borrowing in secondary markets from commercial banks, investment firms and others that have benefited from central bank support, this would not show up as public financed flows but rather as private ones. Unfortunately, it was not possible to disaggregate this further.

not yet matured, as well as new loans taken out in recent months. Whereas the previous graphs focused just on project and asset financing, this now includes all flows of finance – ie including those for general operations, general corporate purposes as well as the refinancing, additional finance and primary financing purposes in the previous graphs. The following pages discuss in more detail the break-down between public and private financing (Column A), types of financial institution (Column B) and purpose (Column C).

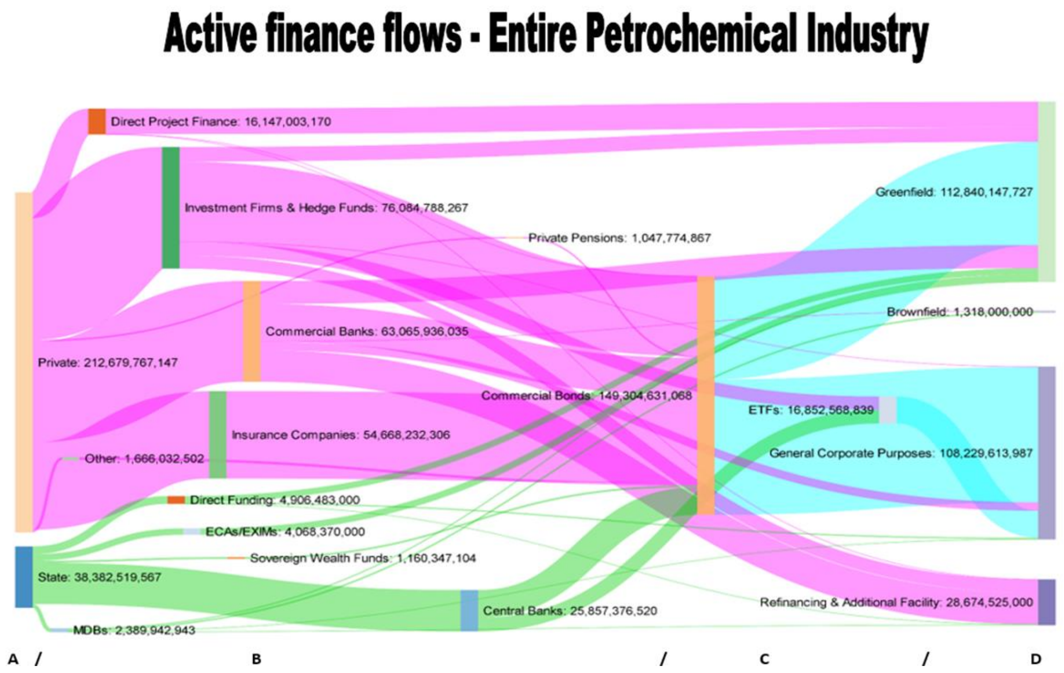

Figure 9 – Sankey diagram detailing current flows of state and private financing the petrochemical industry as of 15/06/21. Finance flows from left to right with values equating to the convergence of flows into each solid node. Column A displays the division between the start-points of financing, from either state or private interests. Column B disaggregates this into various forms of financial institution. Column C depicts the forms of corporate issued bonds flowing into the petrochemical industry. Column D shows the end-use of finances within the petrochemical industry. All terms can be found in the figure glossary.
Notes

1) *Data derived from IJ Global, Bloomberg, Orbis, independent websites of financial institutions.*
2) *The refinancing and additional facility in this overview are not limited to asset projects but all of the petrochemical industry.*
3) *State finance flows highlighted in green, private in purple. When mixed they become turquoise.*
4) *The figures are relatively dynamic due to changeable exchange rates.*

Public finance to the petrochemical sector

As shown in Figure 9, total state financial flows to the petrochemical sector in the period currently stands at some $38 billion, with the lion's share coming from central bank activities ($25.9 billion), direct government finance of $4.9 billion (directly funnelled to greenfield projects), then $6.5 billion through export and multilateral development banks, and another $1.6 billion through Sovereign Wealth Funds. Most of the funds given were directed to what are described as "general corporate" activities and only a small proportion for "brownfield" activities; greenfield projects are financed by the ECAS, EXIMS.

While state finance is a small proportion of the total current financial flows to the petrochemical industry, it can be significant beyond its weight because, in addition to the actual capital it provides, government involvement may give confidence to the private sector whether implicitly or explicitly (as in the case of a guarantee). Many projects might not get off the ground where it not for the involvement of government investment, loans and guarantees, and other expertise. These can be provided through multiple sources including direct payment from the budget or indirectly through government-owned development banks (NDBs and MDBs), export-import banks (EXIMs), and ECAs, and Overseas Development Assistance (ODA), especially when projects are in emerging economies that lack integrated infrastructure. In some cases, technical expertise and management skills come as well as money, especially through development and public banks.

Notable in the diagram above is that State funding delivered via central banks is the lion's share at $26 billion (67%) and that development or other public banks are quite a small proportion at around $6.5 billion (17% of the state total). Sovereign Wealth Funds are also only lightly involved, providing some 3% of the total state share.

Central Banks account for a high proportion of current public flows into the sector through their open market operations, where they buy bonds from (ie lend money to) commercial companies; or because they lend to development banks and government ministries. In the period immediately after the Covid-19 lockdown, central banks throughout the world increased liquidity and lending through quantitative easing and corporate sector purchase schemes (CSPP) on an unprecedented scale in their efforts to stabilise the economy and stop things coming to a grinding halt. Across the world central banks initiated emergency pandemic purchase programmes PEPP on a massive scale. Such schemes are based on principles of market neutrality, but whether this is possible, let alone desirable given the needs of climate change, is increasingly being questioned by writers who argue that this as a missed opportunity to encourage new directions and continues to privilege large firms that are strongly incumbent in the wrong direction (Gabor, Monasterolo, Dikau and Voltz, and TDR2019 among others).

Given the large size and scale of petrochemicals corporations in the financial markets it is not surprising that a market neutral philosophy means that central banks' operations would include these companies, despite broader goals of transitioning to net zero. They included the European Central Bank, which bought around 131 corporate bonds in companies active in the petrochemicals industry, out of total purchases worth €281bn (ECB, 2020) through the conventional CSPP and another 33.68 bn via the pandemic emergency purchase programmes (PEPP). Like most central banks, ECB do not provide exact figures of the percentages of individual bonds purchased, arguing this would affect market behaviour. However, the sectoral breakdown of procurement scheme is public record, and it indicates that 4% of the €281.73 bn resides in the chemicals sector (ECB, 2020 and 2021) at the time of writing, ie around €12.6 billion.[4] A conservative estimate at prevailing exchange rates put ECB's holdings in the petrochemical industry via the combined programmes at around $14.8bn.

The US Fed does not hold the same quantity as the ECB of bonds in the petrochemical industry in a direct fashion, with only $147m across 30 bonds issued by 12 petrochemical companies. However, it has significant holdings in 16 high-performing exchange-traded-funds (ETFs). These commonly high-yielding ETFs are comprised of thousands of separate bondholdings and indices that provide daily updates on the performance of their portfolios, unlike mutual funds that provide quarterly updates. The Fed has holdings in ETFs valued at just under $3.4bn (US Fed, 2021) which in turn have 0.91-4.86% of their funds invested in bonds issued by the petrochemical industry (Bloomberg data, 2021). Some of these funds are also linked to other forms of unsustainable investments that, while it is not clear if they involve petrochemicals, they are linked with other concerns that may clash with green ambitions[5].

The Bank of England (BoE) also instituted a very large scale corporate bond purchase scheme (CBPS) as part of the covid-recovery programme, which offered liquidity at extremely low costs to borrowing firms. At its special meeting on 19 March 2020 the MPC voted unanimously to increase the Bank's holdings of UK government bonds and sterling non-financial investment-grade corporate bonds by £200 billion to a total of £645 billion, financed by the issuance of central bank reserves (Bank of England, 2020). AT the time of writing it had increased to £870 billion (Bank of England 2021a). This includes an unspecified amount Total SA and BASF (Bank of England 2021; Cbonds 2021), two dominant actors n the petrochemical industry. This is not to say the Bank is unaware of the inconsistencies, especially since it was one of the first central banks in the world to raise concerns about financial risks associated with global warming and climate change (Carney 2009, 2015). It noted in 2021 that only 40% of the firms currently eligible for the scheme have an emissions reduction target based on either science or a 'transition pathways initiative' methodology" (BoE 2021: TPT 2021).

Whether the Bank will lend less to petrochemical or fossil fuel companies in the future is unclear. In May 2021, BoE released a discussion paper titled "Options for greening the Bank of England's Corporate Bond Purchase Scheme" (Bank of England, 2021), which listed three principles for greening their CBPS: 1) Incentivise companies to take decisive action to achieve net zero; 2) Lead by example, learn from others; 3) Ratchet up requirements over time. How far the Bank is prepared to go in in terms of incentives is one issue; another is the use of disincentives. For example, the bank notes it may be unlikely to disinvest from high-emitting

[4] Although this figure may include chemicals that are not petroleum-based, it is also likely that it does not include procurements made into companies manufacturing plastics and artificial fertilisers that rely on petrochemicals as primary feedstocks

[5] These FED-invested ETFs has proportions of funds residing in company-issued bonds and indices that are recognised by the MSCI as UN Global Compact violators – disappointing those who hope to see responsible investment principles in place for a fund that is receiving significant investment from a Central Bank. One could go further and argue that such beneficiaries should adhere to a higher threshold of ESG principles

companies, arguing this would mean losing the influence a key investor can have over the operations and portfolio allocation decisions of a company. The Bank states that as the data for transition pathways becomes more accurate and firm-level emissions improve, it will become progressively more demanding in expectations and qualifying parameters.

Critics may argue that this rationale legitimises continued financial support for already well-established companies that may or may not be financially viable and which are paying lip-service to strategies of decarbonisation and renewables rollout, whilst continuing high-carbon and polluting practices. It also enables companies to use green activities as a kind of Trojan Horse, where they profile desirable activities whilst continuing with undesirable ones. Eg BP's mass-purchasing of solar fields (Ambrose, 2021) in the US has been called a chance for the company to clean up a small portion of its portfolio while continuing to invest in new methods of extraction and exploitation (Christophers, 2021) that will outweigh the relative reductions in their portfolio emissions from the solar fields procurement.

The question of whether market neutrality was possible or not, or desirable, has long been debated but it has an extra bite today in tension between goals to 'build back better' after Covid-19 and the reappraisal taking place of the appropriate role of central banks (Matikainen, Campiglio, Zenghelis, 2017; Lepers, 2018; Dikau, Robins, Volz, 2021; TDR 2019). An emerging problem with trying to be market neutral is that it emboldens the status quo of well-established companies, including those that have been reliantly profitable through practices that are inherently unsustainable, exploitative, and polluting (Dikau, Robins, Volz, 2021) while simultaneously freezing out niche-level monetary policies and responsible investing that look to transform these practices and radically boost climate ambition (ibid). Please refer to [section number] for our policy recommendations on how to overcome this.

In June 2021, the ECB hinted at a gradual move away from the market neutrality principle towards a model of market efficiency (ECB 2021b). This recognises "that a supposedly neutral market allocation may be suboptimal in the presence of externalities… the CSPP currently exhibits an inherent bias towards large firms in carbon-intensive industries" (ibid). While this could be encouraging for the move towards financing alternative and more sustainable activities, it is not fast. The ECB's tilting strategy of gradually making incremental adjustments to monetary policy operations to align with sustainability considerations is being criticised for moving slowly, while at the same time considering the hurdles to overcome with changes to risk exposure. These finding therefore support the argument made by Tearfund (2021) and others that Covid response programmes largely missed the opportunity to link emergency finance with a green recovery.

ECAs – Export Credit Agencies

Government-owned Export Credit Agencies (ECAs) play important roles in many countries, helping firms cover financial risks associated with importing and exporting, including delays in payment due to transport or exchange rate problems, or as most recently due to complete economic lockdown. They may be particularly important in multi-lateral infrastructural projects involving petrochemicals and fossil fuels that have private and state actors from a range of companies, banks, financial institutions, and development funds. ECA's offer direct financing and underwriting loans and can therefore also give legitimacy and credibility to projects or private companies that would be otherwise considered as a risky venture (Hopewell, 2019). Recent research findings have found that ECAs have directly financed petrochemical projects to the tune of $31.191bn since 2000 until mid-June 2021, while offering loan guarantees worth $23.270bn during the same period (own data research but reference each ECA in references and OECD and IJ Global). Since the start of the Covid-19 Pandemic, ECAs have continued to buttress petrochemical projects (ibid) at the same time as their owner governments and multi-lateral institutions pledged to support the principles of a green economic recovery.

Multilateral Development Banks

Much like ECAs, Multilateral Development Banks (MDBs) provide essential financial support and legitimacy for large-scale infrastructural projects, especially in developing or emerging economies (Humphrey, 2018). Via an analysis of the following MDBs, it has been found that these state-funded institutions have directly financed projects in the petrochemical industry totalling $6.978bn since 2000 until mid-June 2021. Further discussion on the role of MDBs in this sector will be explored in a follow-up paper to this one.

Inter-American Development Bank (IADB)	European Investment Bank (EIB)	European Bank for Reconstruction and Development (EBRD)
Asian Development Bank (ADB)	African Development Bank (AFDB)	Asian Infrastructure Investment Bank (AIIB)
New Development Bank (BRICS)		

Public Equity Holdings

Much of this report has focused on recent finance flows and transactions within the petrochemical industry but it is important to remember that much of the financial clout of the petrochemical industry within its ongoing operations comes from the equity held in each individual company. While the public involvement in annual flows may be declining, state ownership and equity of petrochemical companies remains significant. This has potentially important implications not only to the extent it clashes with the political ambitions expressed in the landmark Paris agreement; there may also be further costs going forward. It means that governments, public pension funds or other PFIs[6] continue to be directly exposed to "climate Minsky shocks" (Carney, 2016; Nikolaidi, 2017), as well as being indirectly exposed in the case of financial shock to private firms deemed "too big to fail" – meaning the state is expected to

[6] Public Finance Institutions

bail them out. There is also the opportunity cost of not deploying those resources elsewhere, in new "sunrise" industries for example (Horton et al, 2018). On the other hand, if public investors use their equities to insist companies change, this could be a positive thing.

Looking at the fifty largest petrochemical companies according to a 2020 C&EN report (Tullo, 2020; ORBIS data, 2020), there is major state involvement in only a handful of companies. (Private equity owners rather are represented more evenly across all the companies.)

At the same time, there may be state investment via private sector funds or financial institutions. Three notable investing institutions that are particularly active are the juggernauts BlackRock and Vanguard and also the Norwegian Sovereign Wealth Fund, operating under the investing name of Norges Bank Investment Management, but commonly known as the Norwegian Oil Fund or the Government Pension Fund. Table 1 below depicts a summary of the equity holdings in the 10 largest petrochemical companies, with an aggregations of companies 11-50. The full disaggregated table of 50 companies can be found in the annex.

Company	Country Involved	State Quantity1 (in $)	State Quantity2 (in $)	Black Rock (in $)	Vanguard (in $)	SSGA (in $)	Norges (in $)	Total value of Equity / Capitalization (in $)
BASF SE	NA	-	-	-	1.791	-	0.674	72.45
Sinopec	China	1.28	-	0.028	0.029	-	0.012	5.13
Dow Inc.	NA	-	-	1.055	3.715	2.387	0.458	47.28
SABIC (inc Agri-Nutrients Company)	Saudi Arabia, Sweden (via AP7)	72.02	0.065	0.892	1.072	-	-	111.67
Ineos Ltd.	Private Limited Company	-	-	-	-	-	-	32.90
Formosa Plastics (inc Petrochemicals)	Taiwan	0.192	-	-	0.552	-	-	60.93
ExxonMobil	NA	-	-	6.147	21.473	16.008	2.586	273.74
Mitsubishi Chemical	NA	-	-	0.322	0.264	-	-	11.88
LyondellBasell	NA	-	-	0.597	0.023	1.169	-	34.08
Companies 11-40	10 others	104.99	1.95	17.59	52.22	23.56	11.96	1,442.47

Table 1 - Table Depicting the free-floated equity holdings in the 10 largest petrochemical companies with the 40 next largest companies aggregated in the bottom row. All figures are represented in billions of US Dollars (USD). Light green is related to state involvement, yellow is purely private based. Data derived from C&EN, 2020; Orbis, 2020; MarketScreener, 2021.

State equity holdings are a small proportion of total equity but the numbers are so large these could be significant if deployed elsewhere - for the top 50 petrochemical companies in the world, state holdings are worth some $179 billion. To put this in context, this is around 45 time more than assessed PFIs have invested in or subsidised green infrastructure projects since making bold pledges towards ratcheting up climate finance. These funds could potentially be released and used to finance other greener activities – such as alternatives to plastics and petrochemicals. For some of the larger companies the State holding is directly through government as in the case of Sinopec, owned by the Peoples Republic of China, or SABIC, a subsidiary arm of Saudi Aramco, which is majority owned by the Kingdom of Saudi Arabia; and also in some smaller companies, such as the South African government's holding of Sasol, the Chinese government ownership in Syngenta or the government of Austria's joint venture with the UAE in Borealis.

Even when governments are not directly involved, the State may be indirectly involved through public pension funds with equity holdings, such as South Korea, which holds equity investments in several petrochemical companies. Sweden, Thailand, and most notably Norway have a portion of their state pension funds tied up across a range of large-scale petrochemical companies. Even if their holdings represent only single figure percentages of the total free-floated equity – a publicised divestment would send a strong message (Bergman, 2018) to the market that public money should not be used for the purposes of maintaining an industry that continues their highly-polluting practices and will be left with extensive quantities of stranded assets. The same can be said if the investment firm giants would follow suit and divest, even if the divestment decision is based upon a contrasting motivation. BlackRock have recently made some moves towards cleaning up their portfolio, moving out of thermal coal related investments and joining the Climate100+ group (Farnworth, 2021). If BlackRock, Vanguard, and other investment firm juggernauts, many of which manage the assets of public pension funds (Aubry et al, 2020; Bloomberg, 2021), withdrew their equity holdings out of the petrochemical companies, it would show a strong vote of no confidence in the future profitability of the industry as alternatives come to the fore, no longer the safe bet it has been for decades (Helm, 2017), as investors look to limit their portfolio risk exposure.

Even when the State is not a direct equity holder, this does not mean that it is immune from the risk of an economic downturn in the industry. As seen during the economic crisis of 2007-2008 and again during the current Covid-19 health crisis, governments are expected to step in when the private sector is in trouble and given the very high amounts of capital held by private financial institutions in this sector, it is likely that should there be a "climate Minsky shock" that sharply undermined such markets deemed "too big to fail" (Carney, 2016; Nikolaidi, 2017; Omarova, 2019), governments would be expected to step in. At present, just three financial institutions – Vanguard, BlackRock and SSGA hold a total of $151 billion of petrochemical equities in the top 50 companies (see Table 4). This is 7% of the total capitalization – a share that may not be so significant as to rock the entire sector but certainly a shock to these funds would have a major reverberation through the financial markets and subsequently to the rest of the economy (TDR2019).

Another way in which the State is always exposed to the petrochemical sector is that governments are also expected to step in to help ensure the eventual process of transition into more sustainable alternatives is just and does not create further shocks throughout the broader economy (Galgóczi, 2018). This could include for example providing social and income support for "sunk workers" who are jolted into unemployment as the sector starts to change (Kizu et al, 2018). In this regard it could be possible that these employees would experience a double hit as pension funds that have invested in this sector would also be depleted.

Section 3: Can green bonds be a way forward?

As the financial sector races to decarbonise, there has been a surge of interest in greening asset and investment portfolios. In 2006, the UN-supported Principles for Responsible Investment (PRI) were developed by an international group of institutional investors with the goal of mainstreaming environmental, social and corporate governance (ESG) issues within investment practices (UNPRI, 2021). At present, the PRI have more than 1,400 signatories from over 50 countries representing $59 trillion of assets. While the guiding principles for more responsible investment are relatively clear, there remains lacklustre definitions on what actually constitutes "responsible" or a "green" form of investment (Hansen et al, 2021). There is also not a clear methodology on how the monitoring of progress should be measured. The OECD reports 400 sustainability disclosure schemes in use across both state and private institutions relating to climate alone, yet no single common definition of green finance exists (ibid). By some estimates, notable the Climate Bonds Initiative, certified green bonds are more in the region of $100 billion not the trillions of dollars cited.

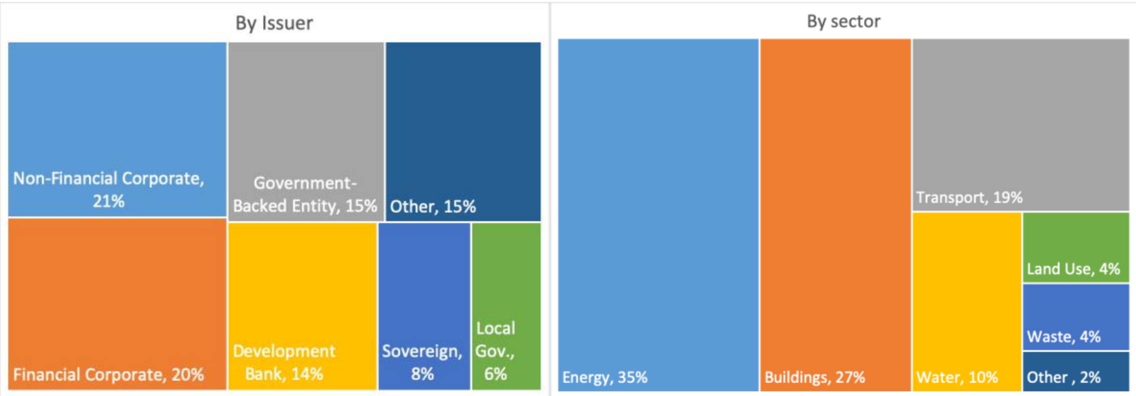

Figure. 10 Green bonds issued 2014-2021. Source: UNCTAD TDR (2021). Secretariat calculation based on Climate Bond Initiative database.

The PRI is not the only group keen to boost its ESG commitments, the Institutional Investors Group on Climate Change (IIGCC, 2021) is a European membership body for investor collaboration on climate change. The IIGC acts in collaboration with other continent-wide schemes under the umbrella of the Global Investor Coalition on Climate Change (GIC, 2021). There are also the UN-led UNGC 's Business Ambition for 1.5ºC (UNGC, 2021), and NAZCA's multi-lateral alliances such as the 15 cooperative finance initiatives (NAZCA, 2021), including the Net Zero Asset Owner Alliance that possess a transition investment portfolio of more than $2.4 trillion globally that are committed to net-zero GHG emissions by 2050 (ibid).

It is clear that the financial industry is not lacking in institutional actors that have the will, motivation, and capacity to facilitate a low-carbon transition. One of the primary financial tools at their disposal is the use of a green bond premium, commonly known as a 'greenium'. The Climate Bonds Initiative is an international organisation "working solely to mobilise the largest capital market of all, the $100 trillion bond market, for climate change solutions" (CBI, 2021). The CBI works on, amongst other initiatives, developing a trusted standard for international best practice for labelling green investments, i.e., setting the credibility parameters to be classified as a 'greenium'. This demand for reliable, transparent, and certifiable standards for 'green' SPVs[7] such as bond premium procurement is of the utmost importance if the use of financial instruments is to adequately contribute to a low-carbon transition.

Currently, there are just over 3600 investable corporate green bonds available in the bond market, as well as around 460 green bonds issued by state-run banks or municipalities (Bloomberg data, 2021). The total value of these bonds tallies at over $1.2tn with over $250bn being issued in each of the last three years. Government issued green bonds are valued at $280bn, 22.56% of the global total. European governments and public funds being the largest state issuers with just over $200bn, 71.94% of the state-issued total. However, the bulk of the green bond market lies in the corporate world, with a total corporate issuance of $961bn (ibid).

These Green Bonds are not all uniform, in fact they can vary widely in their purpose, how the proceeds will be used and how this usage will be reported on, monitored and ultimately verified. Green has several shades in the bond market, which can make it tricky for investors to deduce where their money would be most responsibly invested. There can be bonds issued for the purposes of directly financing a greenfield project such as infrastructural development of wind turbines or solar fields. This is easy enough to label as a dark green bond as it is providing long-term environmental solutions, whereas light green bonds are often seen in connection to short-term benefits such as companies having relative reductions in emissions intensity. The label 'green' can apply somewhat conveniently to a wide range of bond types.

Bonds can be issued for general corporate purposes or refinancing with tranches linked to environmental social governance or sustainability behaviour until the maturity of the bond. These are often labelled as Sustainability Linked Bonds or SLBs, where the coupon rate of a tranche is often on a sliding scale that can drop or gain BPS depending on how a third-party organisation judges their progress on climate action. There are also green indices that work

[7] Special Purpose Vehicles

across a portfolio of green bonds that meet a pre-determined standard for inclusion. The progress of the companies can be monitored, and the bonds can fall from the indices if they fall below the adherence of the index sustainability framework. Brown-to-green (or transition) bonds are also of interest as they allow companies with traditionally high reliance on fossil fuels and high-emitting practices to enter the green bond market in order to stimulate financing that can be utilised for transitioning away from these increasingly obsolete practices.

Setting the green bond ratings, principles, and standards is a process that incorporates multiple third-party organisations that act as the gatekeepers of what type of bond can qualify as 'green'. Frameworks initiated by rating agencies such as Moody's, S&P, Fitch, Sustainalytics, and Cicero set thresholds (theCityUK, 2018) and averages that bond issuing companies must adhere to in order to maintain a high green rating. Institutions, such as the aforementioned Climate Bond Initiative, develop frameworks and standards for green bonds while also monitoring and reporting on the ESG and climate progress made by the issuing company over the duration of the bond's maturity.

As can be seen, there is a surge of green rhetoric and outlaying of climate commitments from the world of finance, despite this, a significant amount of public and private finance flows continues to be funnelled into the petrochemical industry via the commercial bond market, a carbon-intensive industry that is almost wholly dependent on fossil fuels for material feedstocks and production. Recent Bloomberg data (2021) shows that just under $200bn flows directly from the commercial bond market into the coffers of the petrochemical industry. The magnitude of how much the commercial bond market buttresses the petrochemical industry is glaringly clear to see in the Sankey diagrams shown in this paper, detailing the current overview of finance flows in the industry, dwarfing most other types of direct financing.

22 of the active bonds (Bloomberg, 2021) issued by the petrochemical industry are currently listed as "green instruments". The approximate value of these bonds, depending on exchange rates is $7.89bn (ibid). According to the prospectuses of these 22 bonds, the use of proceeds met standards that were set in-house by the issuing companies or adhered to the frameworks in alignment with the Green Bond Principles published by the International Capital Markets Association. At least 5 of the 22 bonds were for the purposes of financing specific new-build projects or designs, such as Kaneka Corp's research and development of Biodegradable Polymer PHBH (Kaneka Corporation, 2019) and Arkema's world-scale plant in Singapore to be 100% dedicated to producing a bio-based amino 11 monomer and a Rilsan polyamide 11 from renewable and sustainable feedstocks. The others are spread across existing operations and general corporate purposes. The question is how to increase the green proportion of 2439 investable bonds issued by the petrochemical industry from a paltry 22 to a figure that will give significant impetus to transitioning the industry away from a fossil fuels reliance.

Section 4: Conclusions and new directions

Figure 9 in this paper showed all of the currently active finance flows into the petrochemical industry by the different sources in the public and private sectors, and showing where the funds were directed in terms of particular end purpose. The Sankey diagram is not comprehensive due to lack of data or transparency across certain regions and does not include the more typically static equity holdings within the industry. However, it offers an insight into the predominant types of financing that allow the continued and new operations of the petrochemical industry. The total flow of financing is just a touch over $251bn, with private financing dominating with almost 85% of the current flows, coming mostly from investment firms and hedge funds, insurance companies, and commercial banks.

As shown across the pages above, the remaining 15% of funding is funnelled through a mix of state-managed financial instruments, with major central banks dominating – in part due to the emergency corporate bond purchase schemes brought into action via quantitative easing as part of the global economic recovery to the ravaging Covid-19 Pandemic[8]. With such a relatively small proportion of ownership in the total, do governments and public finance have much of a voice in this sector? One response is that although the state-based funding only makes up a small fraction of the overall value of current finance flows, the involvement of central banks, MDBs, ECAs and EXIMs lends a degree of legitimacy and credibility from their mere presence as financiers. Without strong cross-government leadership, it remains difficult to imagine that the private market will push for more sustainable alternatives as long as governments continue to prop up this high-emitting and polluting industry. Hence the corporate, national and international pledges and agreements emerging today are hugely important.

In conclusion, the findings shown in this paper reinforce calls for governments and public financial institutions to take more seriously the contribution of this sector to global warming, carbon emissions and pollution, and their potential role in supporting it. By continuing to fund the status quo, it delivers the message that change can be avoided or is not needed. On the other hand, public financial institutions such as central banks and development banks can help to finance the transition and transformation of this sector – hence it is not necessarily a question of stopping all financial flows to this both useful and problematic sector, but rather in helping to better guide it.

[88] Greenfield projects listed include new infrastructural builds that have been greenlit or started construction across the range of eras covered in the infrastructural Sankeys in the background section, hence the large value of approximately USD 125bn.

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Working paper

Tackling Plastic Waste Pollution through Trade: The Interplay between WTO Law and the Basel Convention after the Plastic Waste Amendments

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Content

1. Introduction

The issue of plastic waste has recently gained centre stage in international fora due to the increased awareness of the environmental and health hazards entailed by plastic pollution. An important aspect around which concerns have revolved is how to make the existing international regime on transboundary movement of waste suitable to tackle the immense challenge of managing the exponentially growing volume of annually produced plastic waste sustainably.[1] Trade in plastic waste has in fact reportedly contributed to plastic waste mismanagement to the extent that transboundary transfers have long followed a North-to-South pattern, whereby developed countries have been 'exporting the problem'[2] to middle- and low-income countries with limited recycling capacity and less stringent or effective environmental standards.[3]

Against this backdrop, the international community has identified the *Basel Convention on Control of Transboundary Movements of Hazardous Wastes and their Disposal*[4] as the ideal setting to tackle the issue of plastic waste pollution at a global level. As a multilateral environmental agreement (MEA) set to protect human health and the environment from the adverse effects of 'hazardous wastes' and 'other wastes', the Convention indeed restricts transboundary movements of hazardous wastes, except where they are perceived to be in accordance with the principles of environmentally sound management. Furthermore, for an otherwise permissible covered export to take place, it requires the prior consent of all states concerned.[5] In keeping with the spirit of the Convention, the *Plastic Waste Amendments* (hereinafter, the Amendments)[6] were adopted in May 2019 by the Basel Convention's nearly universal membership and recently entered into force on 1 January 2021 with the aim of promoting sustainable trade in plastic waste.[7] The Amendments clarify the Convention's coverage, setting clear that plastic wastes – except uncontaminated, pre-sorted plastic materials prepared and suitable for immediate

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[1] For instance, in November 2020 a group of World Trade Organization (WTO) Members launched the Informal Dialogue on Plastic Pollution and Environmentally Sustainable Plastics Trade (IDP), with the goal of addressing the rising environmental, health and economic cost of plastics pollution. See: <https://www.wto.org/english/news_e/archive_e/ppesp_arc_e.htm>. The Organisation for Economic Co-Operation and Development (OECD) undertakes considerable efforts to find solutions for achieving a sustainable plastics economy. *See*: <https://www.oecd.org/env/waste/global-forum-on-environment-plastics-in-a-circular-economy.htm>.

[2] United Nations Environment Programme, Marine plastic debris and microplastics. Global lessons and research to inspire action and guide policy change (UNEP 2016), p. 53.

[3] Mirina Grosz, Sustainable Waste Trade under WTO Law: Chances and Risks of the Legal Frameworks' Regulation of Transboundary Movements of Wastes (Nijhoff 2011) p. 3-4.

[4] *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal*, (adopted 22 March 1989, entered into force 5 May 1992) 1673 UNTS 57 (hereinafter Basel Convention).

[5] For a more detailed analysis of the basic architecture of the Basel Convention, see Section 3.

[6] Proposal to Amend Annexes II, VIII and IX to the Basel Convention from 17 December 2018, U.N. Doc. UNEP/CHW.14/27.

[7] Decisions BC-14/12, Amendments to Annexes II, VIII and IX to the Basel Convention, from 24 September 2019.

recycling – are subject to the Convention's strict rules. These clarifications will support Parties in identifying the types of wastes subject to transboundary movements and in their determination of whether they wish to agree to such movements, including to assess whether they have capacity to manage imports.

Perhaps not surprisingly, the centrality acquired by the issue of plastic waste, as epitomized by the negotiation of the Amendments, has coincided with an upsurge in the use of import restrictions on low-grade plastic scrap by a number of large plastic-receivers –*in primis* China, by far the greatest importer of plastic waste in the world, but also Vietnam, Thailand, Malaysia and India. [8] And yet, the introduction of such measures may pose challenges to the extent that they constitute trade restrictions subject to the World Trade Organization (WTO) rules. The number and nature of claims submitted by traditional plastic waste exporters to the WTO Committee on Technical Barriers to Trade (hereinafter, the TBT Committee) illustrate how the use of such measures has already sparked much controversy.[9] With the entry into force of the Amendments, and the plastic waste emergency ever more crucial, the issue is furthermore set to remain highly contentious.

This article aims at exploring the implications of the Basel Conventions' Plastic Amendements under WTO law. In particular, it attempts at illustrating whether and, if so, to which extent the WTO regime could/should accommodate for policy space for Members to introduce and/or maintain (at least certain typologies of) import restrictions with a view to foster, rather than frustrate, sustainable trade in plastic waste in line with the Amendments. This complex issue cannot be separated from the broader question of how the WTO regime should interact with MEAs to enhance environmentally friendly outcomes endorsed multilaterally – notoriously a *vexata quaestio*, which has not yet received a formalized, systematic answer despite its crucial importance to make the WTO a modern institution that can effectively contribute, in a proactive rather than reactive fashion, to the most pressing challenges of the 21th century.

Accordingly, this article first gives an account of the magnitude and scale of plastic waste pollution in Section. Particular attention is dedicated to environmental and health implications caused by plastic pollution as well as to how such implications have been amplified by the consolidation of North-to-South trade patterns. Section 3 will then illustrate the basic architecture of the Basel Convention while focusing on the innovations

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[8] Amy L. Brooks, Shunli Wang and Jenna R. Jambeck, 'The Chinese import ban and its impact on global plastic waste trade', Science Advances vol. 4 no. 6, 20 June 2018, p. 2. The authors reveal that since 1988 approximately 50% of global plastic waste destined for recycling has been sent to China and another 25% to other East Asian and Pacific (EAP) countries. The data refers to plastic waste flows, regardless whether they fall under the Basel Convention's scope of application. Further, it does not differentiate between several operations covered by Annex IV B Basel Convention, such as resource recovery, recycling reclamation, direct re-use or alternative uses.

[9] The measures were also claimed to grant less favourable treatment to foreign products, and to affect public health and the environment to the detriment as they redirect reusable plastics from productive purposes to the waste stream. In particular the United States submitted that "a ban with such a broad scope was more trade-restrictive than necessary to fulfil its objectives". *See*: Committee on Technical Barriers to Trade (TBT Committee), Minutes of the meeting from 21-22 March 2018, G/TBT/M/74, para. 2.234 *See also*: Statement by the United States to the Committee on Technical Barriers to Trade 21-22 March 2018, G/TBT/W/468, para. 6f.

introduced by the Plastic Waste Amendements to cope with the plastic pollution emergency. Section 4 is built around a case study on the import restriction on plastic waste introduced by China in 2018. The Section analyzes the merits of complaints put forward by other WTO Members, with a view to shed light on on the main legal hurdles under WTO law that import restrictions on plastic waste may face. Section 5 elaborates on whether WTO law has the potential to foster, rather than frustrate, sustainable trade in plastic waste by means of accommodating for measures covered under the Basel Convention's Plastic Amendements – bearing in mind the uncertainties that still remain as to the relationship between WTO and MEAs rules. Finally, Section 6 concludes.

2. Plastic wastes as a global concern

2.1 Health and environmental hazards associated with the accumulation of plastic waste

There has been an exponential growth in the production and use of plastics since the 1950s. It is estimated that 6 300 million tonnes of plastics waste have been generated between 1950 and 2015, and production is still expanding.[10] This trend, in combination with poor end-of-life waste management, has resulted in widespread, persistent plastics pollution. Of all plastic wastes generated only 9% were recycled and 12% incinerated, leaving nearly 80% to accumulate in landfills or the natural environment.[11]

Marine plastic debris is of particular concern for the global community. The ocean may already contain over 150 million tonnes of plastic, and the amount of plastic debris is estimated to reach 250 million tonnes by 2025 as additional 5 to 13 million tonnes are introduced every year.[12] Plastics are extremely durable (degradation in marine conditions may take hundreds of years), but can break up into micro- and nanoplastics over shorter timescales, which facilitates their uptake by marine species. Further, plastics may contain chemical additives and contaminants harmful for marine wildlife at extremely low concentrations.[13] Ingestion of plastics or entanglement harms marine species, which has negative implications for ecosystem health and the overall sustainability of fisheries. In sum, plastics pollution endangers food safety and availability, and implies considerable economic costs.[14]

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[10] United Nations Environment Programme, Single-Use Plastics: A Roadmap for for Sustainability (UNEP 2018), p. vi.

[11] OECD Environment Policy Paper No. 12, Improving Plastics Management: Trends, policy responses, and the role of international co-operation and trade, September 2018 (OECD 2018), p.4.

[12] United Nations Environment Programme, Marine plastic debris and microplastics. Global lessons and research to inspire action and guide policy change (UNEP 2016), p. 42.

[13] Frederic Gallo, Cristina Fossi and Roland Weber, 'Marine litter plastics and microplastics and their toxic chemicals components: the need for urgent preventive measures', Environmental Sciences Europe (2018) vol. 30 no. 13 (Gallo et al. 2018), pp. 2-4.

[14] OECD 2018, p.5.

Plastics pollution also puts human health at risk. Beyond seafood, contaminations are found in sea salt and both bottled and tap water. Scientific evidence on the health effects of plastics (including knowledge on the role and hazards of nanoplastics, potentially the most hazardous area of marine plastics) is limited. Nevertheless, given the nature and scale of possible health effects, the precautionary principle shall be applied.[15]

Plastic pollution in oceans has been a growing concern since the rise of the plastic industry in the mid-1950s. But the scale and importance of the problem has not received due attention until the past decade.[16] In 2015, the United Nations General Assembly has expressed concern about the negative effects of marine debris and microplastics, and urged the global community to take action.[17] Upon this call, the United Nations Environment Assembly (UNEA) initiated a study on marine plastic pollution and an assessment on available governance approaches.[18] These works emphasized that the problem of plastic pollution must be tackled at source (cleaning measures such as 'fishing for—floating macro—plastic' are not efficient and economically viable in an oceanic scale)[19] and identified initiatives that could be undertaken in the context of the Basel Convention.

2.2 North-to-South patterns in plastic waste trade

As already mentioned, waste mismanagement occurs predominantly in middle- and low-income countries[20], while improved waste management in developed countries, to a certain extent, has been achieved by 'exporting the problem'.[21] Developed countries have been the primary exporters of plastic waste during the last two decades, contributing to 87% of all exports. If taken together, the EU-28 ranks first among plastic exporters (accounting for 31% of all exports), followed by the US and Japan. An analysis of 28 years of import and export data suggests that plastic waste trade largely occurred between OECD and East Asia and Pacific countries. In result, wealthier nations (with relatively high

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[15] Gallo et. al 2018, p. 7. *See also*: OECD 2018, p.5; UNEP 2016, p. 101f.

[16] UNEP 2016, p. xvii.

[17] Resolution 70/235 on oceans and the law of the sea adopted by the General Assembly from 23 December 2015, A/RES/70/235.

[18] United Nations Environment Assembly of the UNEP, Combating Marine Plastic Litter and Microplastics: An Assessment of the Effectiveness of Relevant International, Regional and Subregional Governance Strategies and Approaches, from 15 February 2018, UNEP/AHEG/2018/INF/3.

[19] Patrick ten Brink, Jean-Pierre Schweitzer, Emma Watkins, Michiel De Smet, Heather Leslie and Francois Galgani, 'T20 Task Force Circular Economy: circular economy measures to keep plastics and their value in the economy, avoid waste and reduce marine litter' (G20 Insights 2017) < https://science.vu.nl/en/Images/G20_2017_The-circular-economy-plastic-and-marine-litter_tcm296-847678.pdf>.

[20] OECD 2018, p. 4; Jenna R. Jambeck, Roland Geyer, Chris Wilcox, Theodore R. Siegler, Miriam Perryman, Anthony Andrady, Ramani Narayan and Kara L. Law, 'Plastic waste inputs from land into the ocean', Science, vol. 347 no. 6223 (February 13 2015), p. 769.

[21] UNEP 2016, p. 53.

domestic management costs) have been sending plastic waste towards developing countries (with less developed waste management infrastructure) throughout the last three decades; importantly, 45% of the world's plastics waste has been imported by China between 1992 and 2016.[22]

2.3 The North end: causes and consequences

While it has consolidated over time, the traditional North-to-South pattern in plastic waste trade developed out of both practical and economic arguments. On the one hand, it is often contended that allowing the export of waste plastics to countries with a comparative cost advantage in sorting or recycling can help boost global recycling rates, while also generating increased shared economic benefits and improving environmental outcomes. This line of reasoning especially holds true if waste collection in the destination country is, absent appropriate incentives, insufficient, and relies on often less stringent environmental standards. Therefore it may be seen as a casuistry that "invoke[s] 'the circular economy' as a justification for dispensing with controls on transboundary movements of wastes".[23]

Further, the "circular economy argument" must be seen in the context of insufficient disposal capacities for plastic waste in developed countries. This phenomenon is, in part, a result of the so-called 'not in my backyard' (NIMBY) syndrome.[24] Especially in the US, due to the population's resistance faced with the potentially deleterious effects of hazardous wastes, plans for disposal sites could not be realized. As a result, waste treatment capacities decreased, while volumes of wastes generation continued to rise.

Finally, recycling plastic is at present not economically competitive. Recycled plastic's greenhouse gas footprint of is a fraction of virgin plastic's, and recycling has the potential to divert material from landfill and reduce the use of virgin material. But the external costs of virgin plastic production are not sufficiently internalized, which holds back potential suppliers of recycled plastics from investing in sorting and recycling capacity.[25]

In light of the foregoing, exporting wastes to third countries, often with less stringent environmental requirements, was regarded as a much easier solution than improving domestic markets for recycled plastic and increasing local disposal capacities - despite their potential contribution to an environmentally sound management of plastic wastes.

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[22] 23 of 36 EAP countries are low- or middle-income countries; 33 of 35 OECD countries are considered high income countries. Amy L. Brooks, Shunli Wang and Jenna R. Jambeck, 'The Chinese import ban and its impact on global plastic waste trade', Science Advances vol. 4 no. 6, 20 June 2018, p. 2. The study refers to plastic waste flows, regardless whether they fall under the Basel Convention's scope of application. Further, it does not differentiate between several operations covered by Annex IV B Basel Convention, such as resource recovery, recycling reclamation, direct re-use or alternative uses.

[23] Joint letter of the European Environmental Bureau, the Basel Action Network, the International Pollutant Elimination Network and CIEL to the European Commission Director General Environment from 8 July 2019 <https://mk0eeborgicuypctuf7e.kinstacdn.com/wp-content/uploads/2019/07/NGO-Letter-OECD-Basel-Plastics.pdf>.

[24] *See*: <http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx>.

[25] OECD 2018, p. 13f.

2.4 The South end: a boomerang solution?

Exports of plastics waste towards destinations with limited recycling capacity and less stringent treatment standards have however not only exposed affected receiver countries to negative environmental impacts on both the national and regional levels; the challenges posed to developing countries by rapidly growing export volumes has also ultimately led to detrimental effects on the global level.[26] For example, from the coastlines of China an estimated 1.3 million to 3.5 million of metric tonnes of plastic may enter the oceans annually[27], as the country is still developing domestic waste management infrastructure. The contribution of imports is estimated to count for 10-13% additional mass to the plastic waste generated domestically, which is already difficult to manage.[28]

3. The Basel Convention and its Plastic Waste Amendments

3.1 The Basel Convention's basic architecture

3.1.1 Aim and coverage

The Basel Convention, adopted in 1989 and entered into force in 1992, is today's central international legal framework addressing international waste trade.[29] It has nearly universal coverage, encompassing 188 Parties as of September 2021.[30] The overall objective of the Convention is "to protect, by strict control, human health and the environment against the adverse effects which may result from the generation and management of hazardous wastes and other wastes".[31] Accordingly, it covers two categories of wastes: 'hazardous wastes' and 'other wastes'. Hazardous wastes are those that belong to any category contained in Annex I, unless they do not possess any of the characteristics in Annex III; as well as wastes defined as or considered to be hazardous by domestic legislation and notified as such. 'Other wastes' are those in any category contained in Annex II subject to transboundary movement. Until 1 January 2021 'other

[26] United Nations Environment Assembly of the UNEP, Possible Options under the Basel Convention to Further Address Marine Plastic Litter and Microplastics, from 29-31 May 2018, UNEP/AHEG/2018/1/INF/5, p. 3.

[27] Jambeck et al. 2015, p. 769.

[28] Brooks et al. 2018, p. 3.

[29] The convention entered into force in 1992, Grosz 2011, p.136f.

[30] The US and Haiti have signed, but not ratified the Convention. The list of the Parties is available at <http://www.basel.int/?tabid=4499>.

[31] Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention), U.N.T.S. vol. 1673, p. 57, Preambular para. 24.

wastes' encompass household waste and residues from the incineration thereof, which is likely a significant source of marine plastic litter.[32]

3.1.2 Control procedure

The Convention is built upon three fundamental regulatory pillars: i) reduction of the generation of hazardous waste and the promotion of environmentally sound management of hazardous wastes wherever the place of disposal, ii) the reduction of transboundary movements of hazardous wastes except where it is in accordance with the principles of environmentally sound management, and iii) a control system applying to cases where transboundary movements are permissible.[33]

3.1.3 Environmentally Sound Waste Management

The first pillar includes general provisions requiring Parties to observe the fundamental principles of environmentally sound management (ESM) of hazardous and other wastes.[34] The Convention defines ESM as "taking all practicable steps to ensure that hazardous wastes

or other wastes are managed in a manner which will protect human health and the environment against the adverse effects which may result from such wastes".[35] However, critics argue that this definition is overly vague, for example it is not clear whether the criteria for environmentally sound is to be determined by the importing or the exporting country.[36]

3.1.4 Prior informed consent procedure

The second pillar consists of a regulatory system on the transboundary movements of wastes. In all cases where export is not, in principle, prohibited, it may take place only if it represents environmentally sound management and is carried out in accordance with the Convention's control procedure, which is based on the concept of prior informed consent

(PIC). The PIC allows for the transboundary movement of covered wastes provided that the authorities of the exporting Party notify the authorities of the prospective states of import and transit, providing them with the information set out in the Convention on the

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[32] United Nations Environmental Programme (UNEP), Possible options under the Basel Convention to further address marine plastic litter and microplastics, from 22 May 2018, UNEP/AHEG/2018/1/INF/5, p. 5.

[33] Grosz 2011, p. 141; Jonathan Krueger, International Trade and the Basel Convention (Earthscan 1999), pp 53ff.

[34] Article 4 Basel Convention.

[35] Article 2.8 Basel Convention.

[36] Krueger 2011, p. 29, referring to David J. Abrams, 'Regulating the International Hazardous Waste Trade: A Proposed Global Solution' Columbia Journal of Transnational Law, vol. 28 nr. 3 at p. 801. Parties have been undertaking considerable efforts to address these shortcomings. For instance, both general and waste stream specific technical guidelines have been adopted and an expert working group has been mandated. *See*: Framework for the environmentally sound management of hazardous wastes and other wastes, adopted by the eleventh meeting of the Conference of the Parties in decision BC-11/1 on follow-up to the Indonesian-Swiss country-led initiative, UNEP/CHW.11/3/Add.1/Rev.1.

intended movement. The movement may only proceed if and when all states concerned have given their written consent.[37] To facilitate this procedure, the Parties have adopted notification and movement documents, which are to be used and follow each movement of covered wastes.

3.1.5 Reduction of transboundary movement of hazardous wastes

The third pillar contains a number of prohibitions: hazardous wastes may not be exported to Antarctica, to a Party having banned the import of hazardous wastes, or to a non-Party.[38] Parties may, however, enter into bilateral, multilateral or regional arrangements or agreements regarding transboundary movement of hazardous wastes or other wastes (also with non-parties), provided that such agreements are "no less environmentally sound" than the Basel Convention.[39]

Further, the Convention has evolved to include a version of the north-south trade ban sought by some parties since 1989.[40] The Ban Amendment[41] (adopted in 1995, entered into force in 2019) provides for the prohibition of exports of hazardous wastes that are destined for disposal in any of the operations listed in Annex IV[42] from countries listed in Annex VII to the Convention (i.e. Parties that are members of the OECD, EU and Liechtenstein) to all other Parties. [43]

The most controversial aspect of the Ban Amendment is the ban on exports of wastes intended for operations in Annex IV B to the Convention, as it might negatively impact an economically beneficial trade in wastes.[44] Further, market limitations for recyclables could lead to price increases for second-hand materials, particularly in non-Annex VII

[37] *See*: Articles 6 and 7 Basel Convention. The Basel Convention also provides for cooperation between parties, ranging from exchange of information on issues relevant to the implementation of the Convention to technical assistance, particularly to developing countries (Articles 10 and 13 Basel Convention). The Secretariat is required to facilitate and support this cooperation, acting as a clearing-house (Article 16). In the event of a transboundary movement of hazardous wastes having been carried out illegally, *i.e.* in contravention of the provisions of Articles 6 and 7, or cannot be completed as foreseen, the Convention attributes responsibility to one or more of the States involved, and imposes the duty to ensure safe disposal, either by re-import into the State of generation or otherwise (Articles 8 and 9 Basel Convention) <http://www.basel.int/TheConvention/Overview/tabid/1271/Default.aspx>.

[38] Article 4 Basel Convention.

[39] Article 11 Basel Convention.

[40] Krueger 2011, p. 43.

[41] Decisions III/1, Amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal, from 22 September 1995, UNEP/CHW.3/35.

[42] Annex IV lists operations which do not lead to the possibility of resource recovery, recycling, reclamation, direct re-use or alternative uses.

[43] Article 4A Basel Convention. *See also*: Katharina Kummer Peiry, Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, (United Nations Audiovisual Library of International Law, 2010), p. 5. <https://legal.un.org/avl/pdf/ha/bcctmhwd/bcctmhwd_e.pdf>.

[44] Krueger 1999, p. 32.

countries, while growing demand for primary materials can result in an adverse impact on the environment.[45] For example, a study investigating the 1996 Chinese import ban on waste plastics points to the fact that the measure resulted in a significant shortage of raw materials used for the production of 'secondary resin', which was substituted by imports of 'primary resin'.[46] However, such negative environmental impact may be reversed by increasing the efficiency in the collection of domestic waste.[47]

3.2 The Plastic Waste Amendments

3.2.1 Aim and coverage

Prior to its recent amendments, the Basel Convention did not cover a large part of plastic wastes that could enter the sea, such as plastics from industrial or commercial packaging, unless they were classified or defined as either hazardous or other wastes, e.g. household wastes. For this reason, it was noted that there was scope to consider extending the definition of 'hazardous' under the Convention.[48]

Based on UNEA's work, in 2018 Norway proposed to amend the annexes to the Basel Convention; a revised version of the proposal was adopted by consensus during the 14th meeting of the Conference of the Parties (COP-14) on 10 May 2019. The decision amends Annexes II, VIII and IX to the Convention by clarifying, extending and replacing certain existing entries on plastic wastes or inserting new ones.[49]

The amendments acknowledge various parts of plastic wastes require special consideration. After the revision, only certain one-polymer plastics and certain mixed waste fractions thereof fall outside the Convention's scope of application, and only if destined for recycling and almost free from contamination and other types of wastes.[50]

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45 Grosz 2011, p. 171.

46 Anantha K. Duraiappah, Zhou Xin and Pieter J. Van Beukering, 'Issues in production, recycling and international trade: Analysing the Chinese plastic sector using an optimal life cycle (OLC) model' *Environment and Development Economics,* vol. 7 no. 1, February 2002, pp. 47-74, at p. 60.
Plastic resin is produced by the cracking of hydrocarbons. For the production of primary resin virgin materials (often products of crude oil refinement) are used, while secondary resin is made of reprocessed plastic. Secondary resin is mostly used in combination with primary resin to manufacture final products; thus, it has the potential to divert material from landfill and to decrease the use of virgin material. Further, the greenhouse gas footprint of recycled plastic is a fraction of that of virgin plastic (OECD Environment Policy Paper No. 12, Improving Plastics Management: Trends, policy responses, and the role of international co-operation and trade, September 2018, p.13).

47 Pieter J. Van Beukering, Yongjoiang Li, Zhaou Yumin and Zhou Xin, 'Trends and Issues in Plastic Recycling in China, with Special Emphasis on Trade and Recycling, CREED Working Paper Series no. 16, 1997. Further, Article 11 Basel Convention might allow the export of hazardous wastes even between two parties to the Ban Amendment (Grosz 2011, p. 169).
48 UNEP/AHEG/2018/1/INF/5, p. 5.

49 UNEP/CHW.14/27.

50 One-polymer plastics that may fall outside the Convention's scope of application are polyethylene, polypropylene and polyethylene-terephthalate. In the case of mixed plastics, these must be destined for separate recycling.

The new entry in Annex II adopted as part of the Amendments establishes a presumption of plastic wastes to be covered by Annex II with certain exceptions only, thereby subjecting them to the PIC procedure[51] and the prohibition of international trade with non-Parties absent an 'Article 11 Agreement'.[52]

In particular, the Amendments consist of:

i. a new entry 'Y48' in Annex II, which expands the category of 'other wastes' subject to the PIC procedure by including solid plastic waste that falls outside the scope of Annex IX;
ii. a new entry 'A3210' in Annex VIII that clarifies which plastic wastes are considered or defined as 'hazardous';
iii. a revised entry 'B3011' in Annex IX that clarifies the criteria when solid plastic wastes are not considered hazardous wastes and would not be subject to the PIC procedure,[53]

The new entry in Annex VIII clarifies when plastic wastes are hazardous; making them subject to the PIC procedure, as well as to the Ban Amendment in relevant movements involving Parties that have consented to be bound by that amendment. As regards Annex IX, the amendment relates to plastic waste listed in that entry destined for *recycling* in an environmentally sound manner and almost free from contamination and other types of wastes. It also sets out requirements on the extent to which the waste must prepared for recycling: Only pre-sorted, single polymer plastic waste almost free from contamination and other types of wastes and suitable for recycling may continue to be traded subject to the Basel Convention's regulatory system after the new entries adopted in the Amendment become effective.

3.2.2 Open questions

The new entries in the Amendments have become effective on 1 January 2021.[54] However, at this stage there still remain questions in relation to how Parties will interpret and implement these Amendments.

For example, it is uncertain what treatment they imply for waste plastics containing additives. Additives such as colorants, plasticizers and flame-retardants are present in nearly all plastics. At the end of a product's lifecycle their negative impact predominates, as they can reduce the materials' recyclability and pose risks to human and ecological health.[55] Hagen *et al.* suggest that "[t]he reference in the text [of Annex IX] to wastes

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[51] Article 4.1 Basel Convention.

[52] Meaning a bilateral or regional agreement with provisions that require not less environmentally sound waste management than foreseen by the Basel Convention (Articles 4.5 and 11 Basel Convention). Given the Basel Convention's nearly universal Membership, this obligation concerns transboundary movement of wastes only with a few Parties, including the US. A significant example is the OECD Control System on Waste Recovery. *See*: *infra* at Section 3.2.3.

[53] Explanatory note from the Government of Norway on its proposals to amend Annexes II, VIII and IX to the Basel Convention from 31 January 2019, UNEP/CHW.14/INF/18, p. 6.

[54] Possible options under the Basel Convention to further address marine litter and microplastics, from 11 May 2019, UNEP/CHW.14/28, p. 56 ff.

[55] OECD 2018, p 14.

containing "one polymer" seems to be used as shorthand for the idea of single-stream, presorted & cleaned plastic fractions (as opposed to bales of mixed plastics), rather than an effort to truly limit the scope of B3011 to "single polymer" materials."[56] However, deleting the phrase 'copolymers' from the current entry's chapeau, listing presumptively nonhazardous plastics, arguably suggests an interpretation to the opposite.

Furthermore, guidance has yet to be developed as to the coverage of B3011 and in particular what Parties understand to be the meaning of 'almost free of contamination and other types of wastes'. At the time of writing it is uncertain what weight percentage and kind of contamination is tolerated under B3011, although the Amendment provides that international and national specifications may offer a point of reference. Also, some Parties feel that it may not be necessary to include cured resins and fluorinated polymers under B3011. Discussions on the exact coverage of the entries and technical guidelines for the Amendments' implementation are ongoing.[57]

As the European Recycling Industries' Confederation noted, clarifications at the appropriate level are instrumental to ensure a harmonized implementation and avoid distortions in waste shipment approvals and inspections resulting from different national interpretations" increasing legal uncertainty.[58] The Conference of the Parties adopted a number of actions to clarify the Amendments' meaning, which will hopefully reflect the ambitious goals of the amended Norwegian Proposal, as adopted by the Parties in May 2019.[59]

3.3 The OECD Control System for Waste Recovery

The OECD Council was the first actor to address waste management on the supranational level. Fueled by media reports of waste generated in industrialized countries being dumped in developing countries, the 1976 OECD Council's Recommendation outlined a comprehensive supranational waste management policy.[60] The framework has been continuously developed; later conclusions and recommendations on the transfer of hazardous wastes to third countries included the

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[56] Paul E. Hagen, K. Russell LaMotte and Dacia T. Meng, 'Basel Convention Recasts the Circular Economy for Plastics', The National Law Review, May 17 2019 <https://www.bdlaw.com/publications/basel-convention-recasts-the-circular-economy-for-plastics/>.

[57] *See*: Further consideration on Plastic Waste. Note by the Secretariat, UNEP/CHW.15/10 from 9. February 2021.

[58] Statement of the European Recycling Industries' Confederation: EU position for implementation of Basel decisions into the OECD <https://www.euric-aisbl.eu/position-papers/item/299-euric-statement-eu-position-for-implementation-of-basel-decisions-into-the-oecd>.

[59] The actions include, for instance, the update of the existing technical guidelines for the Identification and Environmentally Sound Management of Plastic Wastes and for their Disposal *See*: Decision BC-14/13: Further actions to address plastic waste under the Basel Convention, available at <http://www.basel.int/TheConvention/ConferenceoftheParties/Meetings/COP14/tabid/7520/Default.aspx>.

[60] Recommendation of the Council of on a Comprehensive Waste Management Policy from 28 September 1976 [C(76)155(Final)]. The 1976 Recommendation was a first step to further environmental protection and the rational use of energy and resources, followed by eight Council Acts between 1984 and 1992 on the transboundary movement of wastes.

principle that OECD Member Countries will not apply any less strict controls, nor will they allow exports to occur without the consent of the importing and the transit countries.[61] Still, the OECD rules apply only to those movements of wastes where i) both the country of export and the country of import are OECD Member Countries and ii) the wastes are destined for recovery.[62]

In 2001, the OECD control system was amended with the goal to harmonize its procedures and requirements with those of the Basel Convention. Today, two control procedures exist. The OECD Green control procedure is applied to Basel Annex IX wastes, while the Amber control procedure is applied to Basel Annexes II and VIII wastes.[63] With similar lists of waste operations and hazardous waste criteria in place, the control systems are congruent to a large extent.[64]

In contrast to the Basel Convention, the OECD's approach does not intend to reduce the volume of trade, but merely aims to promote waste recovery alongside with an environmentally sound and economically efficient waste management. This is not least because trade in recyclables has become a substantive market within the OECD area. This difference is reflected in the regulatory framework's stringency: the OECD Green list includes additional materials that members countries agreed to subject to the Green Control Procedure, while the Amber Control Procedure involves considerably shorter notification periods for the country of import, and an assumption of tacit consent in case no objection has been lodged.[65]

OECD Council Decisions are international agreements that create binding commitments on member countries. While most OECD member countries are also parties to the Basel Convention, the US has signed, but not ratified the Convention. Therefore, its consent to the 'Amended 2001 OECD Decision' is of key importance as it subjects it to obligations comparable to those of the Basel Convention – at least with regard to the transboundary movement of hazardous and other wastes towards OECD member countries, *i.e.* Mexico.

The Basel Convention's later amendments are largely incorporated into the 'Amended 2001 OECD Decision'. Incorporation happens automatically 60 days following the

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[61] Resolution of the Council on International Co-operation concerning Transfrontier Movements of Hazardous Wastes from 20 June 1985 [C(85)100], Recommendation V. Council Decision C(92)39/FINAL on the Control of Transfrontier Movements of Wastes Destined for Recovery Operations established a three-tier system, known as the "red, amber, green" control system; the number of lists was reduced to two in 2002, by Council Decision C(2001)107/FINAL. "

[62] Council Decision C(2001)107/FINAL defines transboundary movement as "any movement of wastes from an area under the national jurisdiction of a member country to an area under the national jurisdiction of another member country".

[63] OECD, Guidance Manual for the Implementation of Council Decision C(2001)107/FINAL, as amended, on the Control of Transboundary Movements of Wastes Destined for Recovery Operations, 2009. <https://www.oecd.org/env/waste/guidance-manual-control-transboundary-movements-recoverable-wastes.pdf> p. 9.

[64] Grosz 2011, p. 173.

[65] Grosz 2011, 173-174.

adoption of the Basel Convention's amendment, unless objections are lodged before that date.[66]

On July 3 2019, the US has invoked the objection provision to incorporating the Basel Convention's three plastic amendments to the 'Amended 2001 OECD Decision'. In its opposition letter, the United States Environmental Protection Agency (US EPA) argues that "subjecting plastic scrap to the Amber Control Procedure would impede trade for recycling and could reduce the level of recycling among OECD countries." [67] Further, it warns that "[a]s a result [of adopting the amendment], in OECD countries, plastic recycling could decrease and landfilling of plastic scrap could increase, reducing the environmental and economic benefits that are achieved through recycling". [68] Therefore, the US suggested that transboundary movements of plastic scrap shipped between OECD countries should be subject to the Green Control Procedure.[69] The US's proposal would have effectively maintained the *status quo* allowing for free trade of all plastic scrap for recovery purposes within the OECD.[70] Ultimately, however, OECD Members agreed to integrate the provisions of the amendment to Annex VIII of the Basel Convention, thereby making plastic wastes containing hazardous substances subject to the OECD control procedures when traded among its members for recovery.[71] Conversely, they could not reach a consensus on how other plastic wastes should be treated in the context of trade between OECD Members. It will be reviewed in 2024 whether consenus can be achieved.[72]

4. Import restrictions on plastic waste and WTO law

As explained above, in the latest years an increasing number of developing countries have started and/or continued to halt or reduce imports of plastic waste.[73] The restrictions

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[66] Article 3.b OECD Council Decision C(92)39/FINAL.

[67] The US EPA's objection letter to the Secretary-General is available at: <http://wiki.ban.org/images/4/4f/US_EPA_Plastics_Objection_Letter.pdf>.

[68] *See*: *Ibid*.

[69] *See*: *Ibid*. The letter asserts that "[l]ess than one percent of plastic waste is mismanaged in OECD countries". However, nine of the 36 OECD countries have waste mismanagement rates higher than 1%. Turkey, for instance, has a 16% mismanagement rate and a 1% domestic recycling rate (Jambeck et al. 2015, p. 769).

[70] *See:* CIEL,"Legal Analysis of the Conswequences of the OECD Non-Consensus Determination on the Basel Plastic Amendment", available at: <https://www.ciel.org/reports/legal-analysis-of-the-consequences-of-the-oecd-non-consensus-determination-on-the-basel-plastic-amendment/>; For more information on the US alternative proposal, *see*: CIEL, "Legal Analysis of the Implications of the Basel Convention's Decision on Plastic Wastes Trade for OECD Countries", available at: <https://www.ciel.org/wpcontent/uploads/2020/07/Analysis-Basel-Plastic-Wastes-Trade-OECD-Countries.pdf>.

[71] Decision C(2001)107/Final of the OECD Council concerning the revision of Decision C(92)39/Final on control of transboundary movements of wastes destined for recovery operations.

[72] *See*: Decision of the Council on the Control of Transboundary Movements of Wastes Destined for Recovery Operations, OECD/LEGAL/0266.

[73] *See*: *supra* Section 2.2.

maintained by China since 2018 have undoubtedly sparked the most controversy due to Bejing's unmatched centrality as a plastic waste receiver at the global level, but they also triggered a domino effect. For instance, in response to exporters' search for alternative destinations, Vietnam, Thailand and Malaysia announced their own import restrictions the same year, while India's import ban came into effect in September 2019.[74]

While an analysis of the minutiae of the various measures currently implemented is beyond the scope of this paper, this Section will focus on the measures introduced by China as a relevant case study to assess how import restrictions on plastic waste of the types that are covered under the Basel Convention (and specifically under the Plastic Waste Amendements) may fare under the WTO rules. In particular, the question of whether and, if so, to which extent, trade measures under the Basel Convention regime may be held compatible with the WTO Agreement will allow to make some more general inferences about the relationship between WTO and MEAs rules.

4.1 Case study on Chinese import restricitons

Almost half of the world's plastic waste exports allegedly destined for recycling was taken up by China between 1992 and 2016; other East Asian and Pacific (EAP) countries imported further 25%.[75] Main exporters have been the EU and the US, with approximately 87% and 78% of their plastic waste directed to China.[76]

Owing to its alleged difficulties in coping with growing volumes of plastic waste, China has started introducing restrictive waste import policies since the late 2000s. As a first measure, it restricted physical contamination in imports of waste plastics to a maximum of 1.5 weight percent in 2009.[77] Faced with difficulties in implementing the applicable contamination limits, it launched the Green Fence Operation in 2013 with the aim to enforce the import legislation. The operation highlighted the global dependence on a single importer: "Inspections slow[ed] down port operations, shippers [saw] rising demurrage costs as they pay[ed] ports to hold containers until they [were] inspected".[78]

While the Green Fence operation was temporary, in 2017-2018 China announced permanent import restrictions on solid waste. With effect from January 2018, it

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[74] CIEL 2019, p. 62, referring to Colin Staub, Thailand Bans Scrap Plastic Imports, Plastics Recycling Update from 27 June 2018 <https://resource-recycling.com/plastics/2018/06/27/thailand-bans-scrapplastic-imports>.

[75] Brooks et al. 2018, p.2.

[76]The data stems from 2012 and thus applies to the EU-27. Costas A. Velis, Global recycling markets - plastic waste: A story for one player – China. Report prepared by FUELogy and formatted by D-waste on behalf of International Solid Waste Association - Globalisation and Waste Management Task Force, September 2014, pp. 27 and 30.

[77] Velis 2014, pp 42 and 46; Chinese Ministry of Environmental Protection 'Announcement on Amending Catalogues of Imported Wastes Management (Extract)' no.36 from 3 July 2009 <http://english.mee.gov.cn/Resources/Policies/policies/Solidwastes/200909/P020090911322248259263.pdf>.

[78] Jerry Powell, 'Operation Green Fence is deeply affecting export markets', Post on Resource Recycling from 12 April 2013 <https://resource-recycling.com/recycling/2013/04/12/operation-green-fence-is-deeply-affecting-export-markets/>.

prohibited the importation of 24 kinds of solid waste, including post-consumer plastic wastes ("plastic wastes from living sources").[79] As of March 2018 the import ban was complemented by a set of technical specifications that allow for the importation of waste materials if they comply with ambitious maximum acceptable levels of contamination set out in the legislation.[80] With regard to post-consumer plastic waste and scrap a 0.5 percent maximum level of contamination by non-recyclable materials was introduced, which is a much higher bar than the previous level of 1.5 percent. The new standard might be seen as "almost impossible to meet", given that plastic material entering recycling facilities in the US may contain up to 15 – 25 weight percent contamination.[81]

Lastly, China prohibited the importation of further 16 types of solid wastes, including industrial waste and scrap of plastic, effective from December 2018.[82] The measures' stated rationale is the protection of human, animal and plant life and health, and the protection of the environment, and more specifically, to tackle environment pollution emerging from imports of polluted and hazardous wastes. [83]

4.1.1 The measures scope and the Plastic Amendments

Significantly, the measures at issue have been recognized by the OECD as acts consistent with China's rights and obligations as a party to the Basel Convention.[84]

Indeed, the wastes covered by Measures 1 and 3 arguably fall under Annex II to the Basel Convention.[85] Thus, Article 4.1 Basel Convention allows China to exercise a right to prohibit the import of these wastes and needs to inform the other Parties of such a decision.[86] Such a notification leads to an obligation on the State of export to prohibit or not permit the export of hazardous wastes and other wastes to Parties which have prohibited imports.

A different conclusion can only be drawn if the plastic wastes i) almost exclusively consist of a single polymer/mixed waste fractions of clean polyethylene, polypropylene, and polyethylene terephthalate ii) are destined for (separate) recycling and ii) are "almost free from contamination and other types of wastes". Measure 2 embodies the domestic implementation of these criteria, staying within the limits of a reasonable interpretation.

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[79] G/TBT/N/CHN/1211 and G/TBT/N/CHN/1212 notified on 18 July 2017.

[80] G/TBT/N/CHN/1233 notified on 15 November 2017; *see also*: G/TBT/N/CHN/1234 notified on 15 November 2017 concerning environmental protection requirements on imported compressed piece of scrap automobile.

[81] Plastic Atlas 2019, Heinrich Böll Foundation and Break Free From Plastic, 2nd edn, December 2019, p. 38.

[82] Chinese Ministry of Environmental Protection, Announcement on Adjustment to the Catalogue for the Administration of Import Solid Waste, Announcement no. 6 from 13 April 2018. The importation of further 16 types of solid wastes, not affecting plastic, is prohibited with effect from December 2019.

[83] *See*: The notifications by China to the TBT Committee at *supra* fn. 79 and 80.

[84] OECD 2018, p.10.

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[86] This conclusion also holds true if the wastes are to be qualified as 'hazardous'.

Table 1: Overview of the Chinese import restrictions on plastic waste

<table>
<tr><th colspan="3">Overview of the Chinese import restrictions on plastic introduced since 2017</th></tr>
<tr><td colspan="2">Products covered by the measures:
Waste and scrap of
• Ethylene polymers and remnants (HS 3915100000);
• Vinyl benzene polymers and remnants (HS 3915200000);
• Cholroethylene polymers and remnants (HS 3915300000);
• Polyethylene terephthalate and remnants (HS 3915901000);
• Other waste and scrap plastics and remnants (HS 3915909000)</td><td>Not covered (by the definition of solid waste) are:
• any substances that may be utilized as per their original use without repairing and processing
• substances that are directly returned to the original production process or its generation process without storage or piling up</td></tr>
<tr><td>Measure 1
(G/TBT/N/CHN/1211 and G/TBT/NCHN/1212 notified on 18 July 2017, in effect from 31 December 2017)</td><td>Covers only post-consumer plastic (“plastic waste from living sources”)</td><td>Import ban</td></tr>
<tr><td>Measure 2
(G/TBT/N/CHN/1233 notified on 15 November 2017, in effect from 1 March 2018)</td><td>Covers any waste and scrap of plastic</td><td>Import restrictions related to the contamination of plastic products, setting i.e. a maximum contamination level of
– 0.01 weight percentage with
i) ashes of plastic;
ii) hazardous wastes as defined in domestic legislation;
iii) used, intact or sealed plastic containers
– 0.5 weight percentage of other carried wastes</td></tr>
<tr><td>Measure 3
(Published in April 2018, no WTO notification publicly available, in effect from 31 December 2018)</td><td>Industrial waste and scrap of plastic

In particular thermoplastic remnant materials, leftover materials, and inferior products produced in the manufacture of plastics and processing of plastic products.</td><td>Import ban</td></tr>
</table>

4.1.2 The measures’ immediate implications

The three acts in combination largely stemmed the flow of plastic waste and scrap to China. The volume of imports from the EU and the US fell from 100 000 tonnes in June

2017 to less than 10 000 tonnes in January 2018, and from 75 000 tonnes in January 2017 to 6 000 tonnes in December 2018, respectively.[87]

Growing waste stockpiles surged, thereby obliging exporting countries to find alternative destinations, resulting in significantly higher trade inflows for countries such as Thailand, Malaysia, Vietnam, Turkey, and India during the second half of 2017.[88] The poorly developed plastics recycling facilities and relatively weak environmental treatment standards in the new destination countries gave cause to concerns about the health and environmental impacts in the importing states. Occurrences included illegal imports to Thailand, the establishment of almost 40 illegal recycling factories in Malaysia dumping toxic wastewater into waterways, and a Vietnamese shipping terminal that amassed more than 8,000 containers loaded with plastic and paper for recycling.[89] These occurrences highlight the role of the Basel Convention's Ban- and Plastic Amendments in preventing marine plastic pollution, and the necessity for their effective implementation in exporting and importing States alike.

Since 2017, the affected countries introduced or strengthened trade restrictions on waste plastic, including total import bans announced or already in place in India, Malaysia, Thailand and Vietnam. These prohibitions followed on less trade-restrictive import regulations, associated with considerable difficulties at the implementation level. Also, they failed to restrict the volume of imported waste plastics to a level possible to manage in accordance with ESM.[90]

Exporting countries' immediate responses include, besides their search for alternative destinations, increased landfill and incineration.[91] This reaction is enhanced by the fall of domestic waste plastic prices, and is associated with detrimental effects on the environment and human health. At the same time, the Chinese measures seem to have accelerated the adoption of ambitious circular economy strategies. The EU and Australia

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[87] OECD 2018, p.10; More recent data suggests a drop by 99.1 percent in 2018 compared with 2017 comprising all imports. Colin Staub, 'China: Plastic imports down 99 percent, paper down a third', Post on Resource Recycling from 29 January 2019 <https://resource-recycling.com/recycling/2019/01/29/china-plastic-imports-down-99-percent-paper-down-a-third/>.

[88] Qiao Huang, Guangwu Chen, Yafei Wang, Shaoqing Chen, Lixiao Xu and Rui Wang, 'Modelling the global impact of China's ban on plastic waste imports, Resources, Conservation and Recycling, vol. 154, March 2020, p. 74.

[89] Plastic Atlas 2019, p. 38.

[90] Plastic Atlas 2019, p. 38. With regard to China, Xia writes for example: "The Chinese government introduced a number of restrictions – such as the environmental license, waste import license, and overseas supplier registration – to raise the barriers for entering into the formal recycling industry with the objective of protecting the environment. However, most of these measures have suffered from ineffective implementation because of local protectionism, corrupt practices, and subordination of environmental protection to economic development goals in policy decision-making. As a consequence, state regulations have functioned as barriers for entrance into the formal economy without achieving the intended policy objectives." Ying Xia, 'China's Environmental Campaign: How China's War on Pollution is Transforming the International Trade in Waste', New York University Journal of International Law and Politics, vol. 51 no. 4 from June 2019, p. 1177.

[91] Brooks et al. 2018, p. 2.

adopted comprehensive legislative frameworks in 2018, including ambitious waste reduction, recovery and recycled content goals. These programs also aim to extend domestic recycling capacity and to phase out exports of recyclables. As short-term highlights, the EU strategy banned the use of certain single-use plastics, while Australia adopted strict export restricitons on plastic waste in lie with the Basel Convention's Plastic Amendments – both measures effective since 2021.[92] Against this background, the Chinese import restrictions may trigger positive environmental and health effects in the long term, largely depending on exporting countries' responses.

In China itself, the import restrictions caused a sudden feedstock shortfall for the domestic recycling industry, which led to increased black market trading and a heavier reliance on virgin materials.[93] However, the measures' negative environmental and health impacts are expected to be short-term. The import restrictions may be seen as a stepping-stone towards improving domestic waste collection and sorting in China. As the volume of imports shrinks, prices for domestic plastic wastes rise, setting an economic incentive for their collection.[94]

Further, the Chinese measures are likely to reduce the volume of plastic dispersion into the environment.[95] The trade restrictions are part of a comprehensive policy action that includes the establishment of municipal waste sorting and disposal systems in major cities by 2020, and the promotion of waste-to-energy projects in rural areas, accompanied by public education. Further steps include a cradle-to-grave waste management system to monitor the generation, transport, processing, and disposal of solid wastes.[96] This way the import restrictions may contribute to protecting the environment, and human, animal and plant life and health – both within the country and abroad.

4.2. The Chinese measures under WTO scrutiny

Ever since China notified its measures to the WTO TBT Committee,[97] the use of import restrictions on plastic waste has triggered heated discussion among Members. Major exporters, including the US, the EU, Canada, Australia and Japan, have expressed complaints relating to both the measures' procedural and material aspects. The analysis

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[92] *See, for instance*: Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment <https://eur-lex.europa.eu/eli/dir/2019/904/oj>; Australian Government, Exports of Plastic Waste <http://www.environment.gov.au/protection/waste/exports/plastic>. Furthermore, a number of US cities and states enacted restrictions on the use of certain plastic utensils. In other regions still no restrictions are in place (Huang et al. 2020, p. 72).

[93] OECD 2018, p.12.

[94] *Ibid.*

[95] Xia 2019, p. 1147f.

[96] *Ibid.*

[97] Members use the TBT Committee i.e. to discuss trade concerns related to specific laws, regulations or procedures that affect their trade, usually in response to notifications.

of such complaints sheds light on the main WTO hurdles that these types of measures may face when subject to WTO scrutiny. At the same time, China's insistence on the centrality of such import restrictions for health and environmental protection protection, and its reiterated calls upon other Members to "follow the letters and spirit of the Basel Convention, and reduce, process, and recycle hazardous and other wastes produced within their own territory"[98] allow some reflections on whether and, if so, under which conditions may the fact that import restrictions on plastic waste are covered by the Basel Convention increase their chances to successfully justify them under available WTO flexibilities.

4.2.1 Complaints raised in relation to the Chinese measures in the TBT Committee

China notified its measures to the WTO TBT Committee[99], triggering heated discussion among Members. The US, the EU, Canada, Australia and Japan have expressed complaints relating to both the measures' procedural and material aspects.

In sum, China was requested to observe the normal 60-day timeframe for comments and to provide for a reasonable implementation period.[100] Further, it was urged to "immediately halt implementation of its ban on the import of recovered materials as well as its import control standards for recovered materials that in many cases result in a de facto ban due to the technical infeasibility of those measures".[101] Lastly, it was asked to "revise these measures in a manner consistent with existing international standards for trade in recycled commodities", respectively to consider alternative, less trade-restrictive measures with a focus on waste from both foreign and domestic sources.[102]

In response, China declared that it has granted the reasonable implementation timeframes of six months, and fulfilled the applicable transparency obligation under the WTO Agreements.[103] While it submitted to attach great importance to all comments received, it also explained that the import restrictions were core elements of a comprehensive policy framework which aims to protect the environment and public health. To achieve these goals, China expressed its endeavor to "continue to pro-actively practice the values of 'sustainable development' and [...] unswervingly advance the reform of the solid waste import administration regime." [104] At last, it called upon other Members to follow the letters and spirit of the Basel Convention, and reduce, process, and recycle hazardous and other wastes produced within their own territory".[105] Below, we provide an overview and legal assessment of the arguments raised.

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[98] G/TBT/M/74, paras 2.17-2.18.

[99] Members use the TBT Committee i.e. to discuss trade concerns related to specific laws, regulations or procedures that affect their trade, usually in response to notifications.

[100] *See*: G/TBT/M/74, paras 2.9-2.16; G/TBT/W/472; G/TBT/W/468.

[101] G/TBT/W/468; *see similar*: G/TBT/M/74, paras 2.9-2.16; G/TBT/W/472.

[102] G/TBT/W/468; *see similar*: G/TBT/M/74, paras 2.9-2.16; G/TBT/W/472.

[103] G/TBT/M/74, paras 2.17-2.18.

[104] G/TBT/M/74, paras 2.17-2.18.

[105] G/TBT/M/74, paras 2.17-2.18.

4.2.2 Overview and legal assessment of the complaints: procedural aspects

The procedural submissions, in core, called upon China

i. to observe the normal 60-day timeframe for comment from other Members. The first measure's notification provided for a two-day commenting period, while the second measure allowed 30 days for comments. In both cases, China refused to extend the timeframes for comments or to re-notify the measures with a sufficient time to submit comments in line with the TBT Agreement.

ii. to afford reasonable implementation timeframes, customary 6 months after the timeframe for comments elapsed. The first act's proposed entry into force was set for 1 September 2017, 45 days after the notification on 18 July.[106] However, the measure was revised in order to clarify uncertainties relating to the its scope of application and entered into force in December 2017, leaving a six-month transition period for relevant industries and enterprises to adapt to the new requirements.[107] The second measure, too, entered into force upon a 6 months implementation period. However, in the EU's view a "more realistic transitory period" should not be inferior to nine months.[108]

Article 2.9.4 TBT Agreement calls upon Members to allow, without discrimination, a reasonable time for other Members to comment on notified draft technical regulations. Recommended is a 60 days normal time limit.[109] Further, Article 2.12 TBT Agreement obliges importing Members to provide a 'reasonable interval' – presumably not less than six months – between the technical regulation's publication and its entry into force.[110]

But these obligations are not absolute. If urgent problems of safety, health, environment protection or national security surround the adoption of a technical regulation[111], or in case a six-month timeframe would be ineffective to fulfil the legitimate objectives the

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[106] Committee on Technical Barriers to Trade, Minutes of the Meeting of 8-9 November 2017, G/TBT/M/73, paras 2.8-2.9. *See also*: Statement by the United States to the Committee on Technical Barriers to Trade from 21-22 March 2018, G/TBT/W/468.

[107] G/TBT/M/73, para. 2.14.

[108] However, according to the EU, only a period of 14 weeks elapsed between the draft measure's notification and their entry into force. Statement by the European Union to the Committee on Technical Barriers to Trade from 21-22 March 2018, G/TBT/W/472.

[109] Second Triennial Review of the Operation and Implementation of the Agreement on Technical Barriers to Trade from 13 November 2002, G/TBT/9, Annex 3. Article 2.9 TBT Agreement is only concerns cases where the regulation may have a significant effect on trade of other Members.

[110] Minutes of the Meeting held on 15 March 2002, G/TBT/M/26.

[111] As listed in Article 2.10 TBT Agreement. *See*: Panel Report, *United States – Measures Affecting the Production and Sale of Clove Cigarettes*, WT/DS406/R, adopted 24 April 2012, as modified by Appellate Body Report WT/DS406/AB/R, para. 7.502.

regulation aspires, Members may decide to omit the procedural requirements of Article 2.9 and 2.12 TBT Agreement.[112] Arguably, this opportunity is open to China.[113]

4.2.3 Overview and legal assessment of the complaints: material aspects

All commenting Members welcomed the Chinese efforts to protect the environment and public health. Still, the EU, the US, Australia, Canada and Japan expressed the following concerns in relation to the measures' material aspects:

i. The import restrictions adversely affect international trade and the circulation of resources, as they also apply to tradeable raw materials of commercial value. Examples of such materials are waste PET, associated with "extremely low" hazards, and industrial scrap and plastic that have been sorted and graded.
ii. The measures fail to provide equal treatment to imports, given that the use and sale of domestically sourced "recovered materials" are subject to regulations that allow for higher levels of impurities.
iii. China did not provide evidence on the import restrictions' contribution to their stated goals, i.e. by showing "why the standards previously in place are considered insufficient to reach the same goals, taking into account ability of commonly used industrial processes to handle impurities without any significant damage to the environment or public health."[114]
Further, the implementation of the notified measures will result in a negative impact on the environment (at least on the short term). This is because alternative recycling capabilities are not available in exporting countries. Thus, scheduled exportations end up in landfills or incineration, instead of being recycled in China and recovered for intermediate materials. For these reasons, the import restrictions in place are more trade-restrictive than necessary to achieve their stated aim to protect public health and the environment.

4.3 General remarks on the applicability of the WTO Agreements to import restrictions on plastic waste

As a preliminary issue, import restrictions on plastic waste are subject to WTO rules insofar as they adversely affect international trade in "goods" – implying the applicability of the relevant WTO Agreements. While the WTO Agreements do not define the notion of "goods", indications as to whether a commodity qualifies as such can be derived from Members' tariff schedules. These reflect Members' specific tariff concessions made in course of trade negotiations, and are based on the Harmonised Commodity Description and Coding System (HS).[115] In line with this, an item listed in the HS can generally be referred to as a good, implying the applicability of the respective WTO Agreements.

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[112] Appellate Body Report, *United States – Measures Affecting the Production and Sale of Clove Cigarettes*, WT/DS406/AB/R, adopted 24 April 2012, paras 275 and 290.

[113] Further, the obligations in Article 2.9 TBT Agreement only seem to concern measure 2, while the import bans are subject to the less ambitious requirements of Article X GATT.

[114] G/TBT/W/472, p. 1.

[115] That provides a classification for goods. Grosz 2011, p. 254.

Only in certain exceptional cases, when not shipped abroad as valuable resources for recovery, but *exclusively* as part of an environmental measure, wastes may not qualify as a "good".[116] This is because they are not offered for sale and do not compete on consumer markets. As a consequence, (limitations on) the transboundary movement would not trigger WTO rules – as they protect market access and the competitive opportunities of imports.

This argument was also considered in the US House of Representatives in relation to Canadian waste imports.[117] In the same context, a representative expressed its opinion on the current system of transnational waste trade being "one that rewards the environmentally irresponsible who don't make the expenditures to provide for disposal of the waste they generate, and punishes the environmentally responsible, those States which make the investments in landfills and then are unable to protect themselves from the import of out-of-State waste."[118]

In most cases, waste trade and related technical regulations are subject to international trade law. For example, in the *Brazil – Retreaded Tyres* case the fact that waste-related products were under scrutiny did not cause general explanations on the applicability of WTO law. Based on their (separate) HS entries (distinguishing them from used and new tyres), the products were classified as commodities.[119] This conclusion was not questioned by the Parties to the dispute.

The Chinese import restrictions identify the covered products by reference to their HS numbers, which in itself signalizes the applicability of the TBT Agreement and GATT. The fact that only a small portion of all imported plastic waste has been indeed recycled in China may not alter this conclusion. At a more general level, it can be inferred that import restrictions on plastic waste may come under the purview of WTO law to the extent that they also apply to tradeable raw materials of commercial value with an assigned HS code. Examples of such materials include, but are not limited to, waste PET, associated with "extremely low" hazards, and industrial scrap and plastic that have been sorted and graded.

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[116] Grosz 2011, p. 256.

[117] "With respect to quantitative restrictions, the prohibition on export restrictions, it is my view that if you look at the context in which those provisions occur both in the GATT and in the North American Free Trade Agreement's context, is clearly market access. In other words, it is prohibited to restrict exports or imports that are destined for a market in the other country. And this says nothing in my view about what you can or can't do with respect to material that is being transported across the boundary, not to be traded in the marketplace, but rather as a means of taking an environmental problem from one country and putting it into another." Prepared witness testimony of Robert Howse in the US House of Representatives, Hearing before the Subcommittee on Environment and Hazardous Materials of the Committee on Energy and Commerce, on Three Bills Pertaining to the Transport of Solid Waste: H.R. 382, H.R.411 and H.R. 1730, 23 July 2003, p. 77 <https://www.govinfo.gov/content/pkg/CHRG-108hhrg89003/html/CHRG-108hhrg89003.htm>.

[118] Opening words of Paul E. Gillmor, Chairman Subcommittee on Environment and Hazardous Materials Committee on Energy and Commerce, Hearing before the Subcommittee on Environment and Hazardous Materials of the Committee on Energy and Commerce, on Three Bills Pertaining to the Transport of Solid Waste: H.R. 382, H.R.411 and H.R. 1730, 23 July 2003, p. 4.

[119] Panel Report, *Brazil – Measures Affecting Imports of Retreaded Tyres*, WT/DS332/R, adopted 17 December 2007, as modified by Appellate Body Report WT/DS332/AB/, para 2.4.

4.3.1 The legality of import restrictions on plastic waste under basic WTO obligations

To the extent that import restrictions on plastic waste halt or reduce the volume of traded plastic goods, they may be captured by the GATT rules on quantitative restrictions. Article XI:1 GATT sets out a general prohibition on quantitative restrictions on imports and exports.[120] It is a comprehensive provision, covering any acts – be they *de jure* or *de facto* – to the extent that they exhibit an actual or potential limiting effect on the quantity or amount of a product being imported or exported. However, it does not apply to measures that deal with the quality, rather than the quantity of imports. The import-restrictive elements of such acts are to be considered under the TBT Agreement.[121] However, a set of measures "containing both prohibitive and permissive aspects, namely a ban and exceptions" may be challenged as a whole under both the GATT and TBT Agreement.[122]

Applying these considerations to the Chinese import restrictions, one may examine the three measures "as a whole" under Article XI:I GATT – with the likely outcome to find an initial conflict, given the measures' strong limiting effect on the quantity of plastic waste imported.[123] But this does not lead to the conclusion that the measures are in violation of WTO law. While at this stage of the inquiry the measures' motivation is not relevant, it can justify the deviation from Article XI:1 GATT under Article XX GATT.

At the same time, Article 2.1 TBT Agreement may be applicable to the extent that the measures at issue also incorporate a qualitative element. This holds true for the Chinese restrictions at issue to the extent that the use and sale of domestically sourced "recovered materials" are subject to regulations that allow for higher levels of impurities.[124] Article 2.1 TBT Agreement prohibits discriminatory treatment of foreign products, unless it is a sole result of the regulating Member's aim to achieve a legitimate policy aim. Technical regulations that impede the competitive opportunities of imports as compared to domestic goods (so-called national treatment obligation) are in principle prescribed. But discriminatory treatment again imports – like the one flowing from the Chinese import restrictions – may be justified under the TBT Agreement based on

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[120] Quantitative restrictions refer to any restriction other than duties, taxes or other charges on the importation (or exportation) of goods to the territory of Members. Quantitative import restrictions can take the form of explicit import bans, quotas and any other measures having an equivalent effect: i.e. restrictions on the issuance of import licenses or punitive fines affecting imports. For example, the import ban, the prohibition on the issuance of import licenses, and the fines on importing, marketing, transportation, storage, keeping or warehousing of retreaded tyres adopted by Brazil were found to be inconsistent with Article XI:I GATT – and this was not disputed by Brazil: Panel Report, *Brazil – Retreaded Tyres*, paras 7.15, 7.34 and 7.372-7.373.

[121] Decision on Notification Procedures for Quantitative Restrictions (G/L/59/Rev.1), para. 9.

[122] Panel Reports, *European Communities – Measures Prohibiting the Importation and Marketing of Seal Products*, WT/DS400/R and Add.1 / WT/DS401/R and Add.1, adopted 18 June 2014, as modified by Appellate Body Reports WT/DS400/AB/R / WT/DS401/AB/R, paras.7.660-7.663.

[123] Plastic Atlas 2019, p 38.

[124] G/TBT/W/472, p. 1.

considerations similar to those that can justify a measure's deviation from GATT principles under Article XX GATT.[125]

5. Import restrictions on plastic waste as a legitimate policy response

5.1 Prospects of provisional justification under available WTO exceptions

The WTO Agreements recognize Members' right to pursue important policy objectives, including the protection of human health and the environment. The existence of relevant flexibilities is aimed at striking a balance between trade and non-trade interests, respectively Members' rights to invoke an exception and their duty to respect the treaty rights of other Members.[126]

Article XX GATT allows Members to deviate from any GATT provisions (including Article XI:1) to the extent that they impose measures that i) can be provisionally justified under one of the paragraphs of Article XX GATT and ii) meet the requirements of the chapeau. While the list of legitimate policy goals under Article XX GATT is exclusive, Members have great discretion to set the level of protection they deem appropriate in a given situation.

Similar considerations – namely that the measure aims at a legitimate objective and is 'necessary' to achieve it at the level designated by the regulating Member – can render a discriminating or trade-restrictive measure consistent with the TBT Agreement.[127] Given the close relationship of the two agreements in terms of justification, the two provisions should be read harmoniously, in principle providing for the same consistent results.[128]

To the extent that import restrictions on plastic waste's declared goal is, as in the case of the Chinese measures at issue, the "Protection of human health or safety; Protection of

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[125] *See, for instance*: Appellate Body Report, *United States – Measures Concerning the Importation, Marketing and Sale of Tuna and Tuna Products*, WT/DS381/AB/R, adopted 13 June 2012, para. 321.

[126] The Appellate Body further notes that "Members have a large measure of autonomy to determine their own policies on the environment (including its relationship with trade), their environmental objectives and the environmental legislation they enact and implement. Sofar as concerns the WTO, that autonomy is circumscribed only by the need to respect the requirements of the General Agreement and the other covered agreements." Appellate Body Report, *United States – Standards for Reformulated and Conventional Gasoline*, WT/DS2/AB/R, adopted 20 May 1996, pp. 30-31. In the context of the TBT Agreement, *see*: Recital six of the Agreement. *See also*: Appellate Body Report, *United States – Measures Affecting the Production and Sale of Clove Cigarettes*, WT/DS406/AB/R, adopted 24 April 2012, para. 174.

[127] Appellate Body Report, United States – Measures Affecting the Production and Sale of Clove Cigarettes, WT/DS406/AB/R, adopted 24 April 2012, para. 182.

[128] On the relevance of Article XX GATT jurisprudence in the context of Article 2.1 TBT, *see*: Appellate Body Report, *US –Tuna II (Mexico) (Article 21.5 –Mexico)*, paras 7.88 and 7.92.

animal or plant life or health; Protection of the environment",[129] they may seek justification under the GATT and/or the TBT Agreement. These aims are in fact explicitly recognized as legitimate policy objectives, and may justify otherwise-inconsistent measures under both agreements.

5.1.1 Relevance of public health exceptions

Article XX(b) GATT allows for the justification of measures "necessary to protect human, animal or plant life or health".[130] Provisional justification presupposes that the measure:

- is designed to "protect human, animal or plant life or health", that is, it at least contributes to these goals (which have been interpreted as to include environmental policy measures aimed at protecting public health), and
- is "necessary" to achieve the goal to the level of ambition as defined by the enacting Member, meaning that there is no other measure less trade-restrictive reasonably available that would contribute to the policy aim to the same extent.

That import restrictions on plastic waste such as the Chinese measures aim to protect human, animal or plant life and health – implying that they come under paragraph b – has not been contested. Questioned is whether the measures are 'necessary' to achieve these goals.

The "necessity test" under Article XX(b) GATT involves "weighing and balancing a number of distinct factors", especially related to the: (i) importance of the values protected by the measure; (ii) its effective contribution to attaining those objectives; and (iii) its trade restrictiveness, especially considering the existence of less trade-restrictive and reasonably available alternatives that would allow to achieve the regulating member's desired level of protection.[131]

With regards to the first factor, only "few interests are more "vital" and "important" than protecting human beings from health risks" and that of "protecting the environment is no less important."[132] In some cases, severe restrictions on international trade were considered in principle eligible to be condoned to preserve these fundamental values.

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[129] See, for instance the Chinese notification to the TBT Committee: G/TBT/N/CHN/1233 notified on 15 November 2017. While adjudicators are not bound by a Member's characterization of the objectives it pursues through its measure, in this case neither evidence nor other Member suggest differently.

[130] In line with the Panel in *Brazil – Retreaded Tyre*s, reference to environment protection may be understood as a short form of animal and plant life and health. However, this does not exempt Respondents from substantiating risks specifically to animal and plant life and health. Panel Report, *Brazil –Retreaded Tyres*, para. 7.45.

[131] Appellate Body Report, *China –Measures Affecting Trading Rights and Distribution Services for Certain Publications and Audiovisual Entertainment Products*, WT/DS363/AB/R, adopted 19 January 2010, paras. 251-254.

[132] Appellate Body Report, *Brazil – Measures Affecting Imports of Retreaded Tyres*, WT/DS332/AB/R, adopted 17 December 2007, para. 144.

With regards to the second factor, while it is true that plastic wastes pose considerable risks on human and animal health, and that their detrimental impact in China as well as in many developing countries gets aggravated by low-quality imports, the import

restrictions' effective contribution to protecting these values, at least on the short term, may be questionable. However, it is worth-noting that successful justification does not require a measure to immediately contribute to its aim, nor must its adoption rely on quantitative projections to the goals it pursues. It lies in the nature of some state actions – for example those addressing climate change – that their effect can only be evaluated over time.[133] Arguably, the same reasoning could hold true in the case of import restrictions addressing plastic pollution, and perhaps most likely in the case of measures that – like the Chinese measures at issue – are integral part of a comprehensive policy framework apt to induce sustainable changes in the practices of the domestic recycling industry, and to result in a better waste management and a higher domestic recycling rate. Testing this hypothesis, supported by evidence, could suffice for the imposing country to comply with its burden of proof under the necessity test.[134]

Finally, as regards the third factor, whether a reasonably available alternative measure exists depends on factors such as: (a) the extent to which the alternative measure contributes to the realization of the policy goal; (b) difficulties of implementation that would impede its tolerance level chosen; and, (c) the trade impact of the alternative compared to the measure at issue. In core, this last step is an evaluation of whether the alternative measure is less trade restrictive *while* preserving China's right to achieve its desired level of protection.[135] Accordingly, a measure justified on public health or environmental grounds cannot be rejected by pointing to a less trade restrictive alternative unless that provides at least the same level of protection.[136] In the case of import restrictions on plastic waste, decisive factors include whether the supposed alternative measures, including "the standards previously in place" can bring about the same contribution to the protection of human and animal health[137] and whether plastic receiver countries do have adequate domestic capabilities to cope with non-compliant imports rather than limiting or *de facto* banning the entry of plastic waste.

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133 Appellate Body Report, *Brazil –Retreaded Tyres*, para. 154.

134 Indeed, "a panel might conclude that [a measure] is necessary on the basis of a demonstration that [it] is apt to produce a material contribution to the achievement of its objective. This demonstration could consist of quantitative projections in the future, or qualitative reasoning based on a set of hypotheses that are tested and supported by sufficient evidence". Appellate Body Report, *China –Publications and Audiovisual Products*, paras. 251-254.

135 Appellate Body Report, *Dominican Republic – Measures Affecting the Importation and Internal Sale of Cigarettes*, WT/DS302/AB/R, adopted 19 May 2005, para. 70.

136 Gabrielle Marceau, 'The Interface between the Trade rules and climate Change Actions', in Deok-Young Park (ed), Legal Issues on Climate Change and International Trade Law (Springer 2016) p.17.

137 For instance, in contesting the Chinese import restrictions, plastic exporters contended that China not provide evidence on the measures' contribution to their stated goals, i.e. by showing "why the standards previously in place are considered insufficient to reach the same goals, taking into account ability of commonly used industrial processes to handle impurities without any significant damage to the environment or public health." G/TBT/W/472, p. 1.

In this vein, the generally recognized insufficiency of developing countries' waste management capabilities[138] may provide with a strong argument in favour of the necessity of such measures, even where – as in the case of the Chinese restrictions – they are designed to halt all imports covered by the Basel Convention, and to avoid the generation of further risks – to the *greatest possible extent* available under international trade law. In this perspective, furthermore, it seems unlikely that the import restrictions could be defeated on the basis of reasonably available alternatives. As already below, a comprehensive interpretation of WTO law that takes into account the Basel Convention (explicitly allowing Parties to restrict the importation of covered wastes) as a relevant context, leads to the same conclusion.

5.1.2 Relevance of environment protection exceptions

Article XX(g) GATT concerns measures "relating to the conservation of exhaustible natural resources, if such measures are made effective in conjunction with restrictions on domestic production or consumption". In line with existing jurisprudence, this exception not only encompasses living "resources" like fisheries, but also depletable resources of human value like clean air and renewable resources like biological species. Provisional justification presupposes that the measure:

- "relates to" its stated aim, meaning that a real and close relationship between the trade-restrictive act and its objective exists.
- be "made effective in conjunction with restrictions on domestic production or consumption", that is, there is a requirement of even-handedness in the imposition of restrictions on imported and domestic products, which however does not mandate the equal treatment of imported and domestic products.

That the Chinese measures relate to the conservation of clean water and marine resources – and thus may come under the scope of the exception – is arguably not controversial. However, the question whether they are made effective in conjunction with restrictions on domestic production or consumption merits further comment. The requirement of even-handedness in the imposition of restrictions on imported and domestic products demands that the measure relates to its stated goal in a reasonable fashion. In case all limitations are placed upon imported products alone, a measure cannot be accepted as primarily or even substantially designed for implementing its stated aim.[139] The Chinese measures are part of a comprehensive policy framework, which speaks in favor of the conclusion that restrictions on foreign and domestic products are imposed in an even-handed manner.

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[138] See above, Section 2.

[139] In contrast, if "[...] no restrictions on domestically-produced like products are imposed at all, and all limitations are placed upon imported products alone, the measure cannot be accepted as primarily or even substantially designed for implementing conservationist goals. The measure would simply be naked discrimination for protecting locally-produced goods." Appellate Body Report, *United States – Gasoline*, p. 21. *See also*: Marceau 2016, p. 18.

5.1.3 Whether import restrictions on plastic waste may be definitively justified under available WTO exceptions

A measure provisionally justified under one of the paragraphs of Article XX GATT must comply with the provision's introductory clause. This second part of the analysis, commonly referred to as the 'chapeau test', no longer deals with the objective of the measure, but asks whether it is applied and implemented in a reasonable manner and in good faith. This concerns both substantive and procedural elements and serves to prevent the abuse or illegitimate use of the exceptions.[140] Comparable considerations apply under the TBT Agreement as its recital 6 meets the exact wording of the chapeau.

To exclude the misuse or abuse of the exceptions for protectionist purposes, the chapeau prohibits 'arbitrary or unjustifiable discrimination' that occurs 'between countries where the same conditions prevail' and'disguised restrictions on international trade'. It must however be noted at the outset that no standardized test exists for the chapeau test's application. Rather it is a delicate search for the appropriate equilibrium between Members' right to adopt trade-restrictive measures in the pursuit of important societal values and the right of other Members to trade.[141]

The first condition has been interpreted to proscribe, on the one hand, discrimination that is not rationally connected to the pursuit of the policy objective and, on the other hand, to require Members to consider differences in conditions between countries, rather than to apply a measure in a rigid and inflexible manner. In relation to the Chinese import restrictions, paramount questions to be addressed in this context are, firstly, whether the discrimination between domestic and imported waste plastics is rationally related to the protection of public health and the environment, rather than revealing 'arbitrary' or 'unjustifiable' conduct. Elements to be factored in the analysis could include whether the measures are coherently incorporated into a comprehensive policy framework aimed at achieving clear environmental benefits or whether they may result in a negative impact on the environment (at least on the short term), for instance by deterring recycling in alternative destinations and making increased volumes of scheduled exportations end up in landfills or incineration, instead of being recycled in China and recovered for intermediate materials. At a more general level, with regard to import restrictions other than a ban, market access requirements set out in terms of performance rather than in terms of specific procedures (for instance, by mandating a certain level of recycled material content / biodegradability of plastic products, or a maximum level of impurities in plastic waste) are examples that could facilitate a measure's compliance with the chapeau requirements.[142]

[140] Marceau 2016, pp. 15 and 19.

[141] Appellate Body Report, United States – Import Prohibition of Certain Shrimp and Shrimp Products, WT/DS58/AB/R, adopted 6 November 1998, para. 157. Further considerations include whether the application of a measure is flexible enough to take into account the specific conditions prevailing in the exporting Member's economy (Marceau 2016, p. 19).

[142] Based on reasonings in X and X cases, references

As to the second condition, it has been interpreted in conjunction with the previous criteria of arbitrary or unjustifiable discrimination in a way that is aimed at overall avoiding situations of disguised protectionism. In line with this, any restrictions on the international trade in plastics, including possible exceptions, must clearly be driven by the measure's stated goal. In the past, one manner to demonstrate that a measure was not a *disguised* restriction was to refer to Members' to undertake good faith efforts to *negotiate* (with no obligation to reach) an across-the-board solution before resorting to a unilateral measure. Thus, before enacting trade restrictions on (plastic) products, it may be useful that Members reach out in a bilateral, plurilateral or multilateral agreement to other affected (plastic exporting) Members so as to better reflect their major considerations. In the case of the Chinese restrictions, and of any other restrictive measure imposed on plastic waste covered under the Basel Convention, it could likely be argued that this condition is fulfilled.[143]

5.2. On the relevance of the Basel Convention for justifying import restrictions on plastic wastes covered by the Plastic Waste Amendments

While the analysis above shows that import restrictions on plastic waste, such as the measures recently adopted by China, may be considered admissible under WTO law, chances arguably increase to the extent that the measures are covered by the Basel Convention. It is well-known that the WTO Agreements must be clarified "in accordance with customary rules of interpretation of public international law".[144] Therefore "any subsequent agreement between the parties regarding the interpretation of the treaty or the application of its provisions", as well as "any relevant rules of international law applicable in the relations between the parties" must be taken into account.[145] The term 'any relevant rules of international law' indicates a wide mandate to examine public international law sources. These include international custom, general principles of international law and international conventions establishing rules recognized by all

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[143] This is unambiguously the case for import restrictions implemented after the adoption (and *a fortiori*) the entry into force of the Plastic Amendments. Regarding measures that were introduced before that, the fulfilment of this condition may depend upon whether the specific wastes subject to the restrictions could still be considered to be covered by the Basel Convention. In the case of the specific Chinese restrictions at issue, this distinction does not appear dispositive as the measures at issue were already considered to be consistent with China's rights and obligations as a party to the Basel Convention before the entry into force of the Amendments (see Section 4.1.1 above).

[144] Article 3.2 Dispute Settlement Understanding (DSU). We note that the same conclusion was to be drawn without the explicit confirmation in Article 3.2 DSU, given the WTO Agreements' nature as treaties under public international law. Read in this context, the provisions' last sentence "Recommendations and rulings of the DSB cannot add to or diminish the rights and obligations provided in the covered agreements" merely clarifies that the WTO judiciary cannot modify the Agreements, but does not limit the extent to which Members may conclude other treaties that can *influence their mutual WTO rights and obligations*. (Joost Pauwelyn, 'How to Win a World Trade Organization Dispute Based on Non-World Trade Organization Law? Questions of Jurisdiction and Merits', Journal of World Trade (Law-Economics-Public Policy) vol. 37 no. 6, 2003, pp. 1001–1003).

[145] Article 31(3) of the Vienna Convention on the Law of Treaties (VCLT).

parties.[146] Accordingly, MEAs like the Basel Convention play an important role in interpreting the WTO Agreements: in a trade dispute between Parties to the Basel Convention[147], the treaty shall be taken into account when applying WTO provisions to restrictions on the transboundary movement of covered wastes.

In addition, a MEA with a broad membership indicates a genuine and globally recognized environmental problem, and reflects a response agreed on by the international community.[148] In line with this, the Plastic Waste Amendments' adoption by the Convention's nearly universal membership denotes the recognition of management of plastic wastes as a global environmental and human health[149] concern, and indicates trade control measures as a justifiable response. Therefore measures explicitly permitted by the Basel Convention shall arguably be found 'necessary' under Article XX(b) GATT. *Mutatis mutandis*, this line of reasoning also holds true when it comes to evaluating the measures' compatibility in line with the chapeau of Article XX GATT and/or the sixth recital of the TBT Agreement. Restrictions under the Basel Convention – that is, restrictions imposed only on the importation of covered plastic wastes – arguably qualify as a justifiable (that is, rationally connected) response to the risks posed by them on human health and the environment. Furthermore, to the extent that the Basel Convention is a MEAs with quasi-universal membership, and that the Plastic Waste Amendments were approved by consensus, it could safely be contended that adequate opportunities have been provided to all exporting Members to negotiate a common solution before resorting to trade-restrictive measures.

Furthermore, and despite the failure to provide an unambiguous answer to the matter within the WTO up until now, one may even argue that this conclusion should hold true irrespective of whether both the imposing Member/s and the affected Member/s did ratify the Convention.[150] Such a reasoning would be consistent with the objective to seek avenues for making WTO responsive to the challenge of promoting sustainable trade in plastic waste in line with the mandate to endorsed in the Preamble to the WTO Agreement.

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[146] *Cf.* Article 38 para. 1 Statute of the International Court of Justice.

[147] The determination whether a treaty is relevant for the purposes of interpretation shall be made on a case-by-case basis and take into account the subject of the dispute and the content (i.e. subject-matter) of the rules under consideration (Gabrielle Marceau, 'Conflicts of Norms and Conflicts of Jurisdictions: The Relationship between the WTO Agreement and MEAs and Other Treaties', Journal of World Trade (Law-Economics-Public Policy) vol. 35, no. 6, 2001, p. 1087. It may not be contested that the Basel Convention is a relevant treaty in interpreting trade-restrictions imposed on the transnational movement of covered wastes.

[148] Marceau 2001, p. 1097.

[149] Scientific evidence on the health effects of plastics is limited. However, given the nature and scale of possible human health effects, the precautionary principle shall be applied. Gallo et al. 2018, p. 7; OECD 2018, p.5; UNEP 2016, p. 101f.

[150] This conclusion is supported by the general principle of interpretation against conflicts (developed under Article 30 VCLT) and the obligation to interpret treaty provisions in the context of other rules of international law applicable between the parties (Article 31.3(c) VCLT). Applying the *lex specialis* rule leads to the same result. In line with this principle WTO Members that are parties to the MEA consented that the specific circumstances addressed by the MEA would be authorized pursuant to Article XX GATT. (Marceau 2001, p. 1097; *see similar*: Pauwelyn 2003, p. 1024).

Lastly, and accordingly, the existence of a MEA shall not hinder Members to take more ambitious measures as agreed by the international community. Article 4 of the Basel Convention itself states "Nothing in this Convention shall prevent a Party from imposing additional requirements that are consistent with the provisions of this Convention and are in accordance with the rules of international law, in order to better protect human health and the environment."[151] As Marceau notes, "Article XX permits certain unilateral actions to be taken to promote environmental goals, even in the absence of a MEA on the subject-matter. It would be illogical if a WTO Member, acting in furtherance of the goals of a relevant MEA as a party to such an MEA, were to be placed in a worse position than if no such MEA existed."[152] Consequently, trade restrictions that go beyond the Basel Convention may be justified on a case-by-case basis.

6. Conclusion

Evidence on the detrimental health and environmental effects of plastic pollution, together with data on the magnitude of the problem, helped to increase public awareness and to trigger policy action. The Basel Convention embodies a unique interntional legal framework set to address the adverse affects of wastes, including rules on their transboundary movement. Given its material scope and nearly universal membership, this MEA has been identified as the ideal setting to tackle the issue of plastic waste pollution at a global level.

Since the 1 of January 2021, most plastic wastes – except uncontaminated, pre-sorted plastic materials prepared and suitable for immediate recycling – are subject to the Basel Convention's rules. This will support Parties their determination of whether they wish to agree to such movements, including to assess whether they have capacity to manage and contribute to sustainabale trade in plastic wastes. Important questions concerning the Amendments' impelementation, however, still remain to be answered by the Parties. In addition, the US's absence from the Basel Convention implies some uncertainty with regard to the treatment of its plastic waste exports. They are only subject to legally binding rules within the OECD Control System for Waste Recovery, to date restrictied to "hazardous" plastic waste due to the US's objection to incorporate all three Plastic Waste Amendments to the Basel Convention.

This study evidences, however, that trade measures with a genuine design to address the adverse environmental and health impacts of plastic pollution – including import restrictions on plastic wastes – do not contrast with WTO rules. WTO rules leave ample room to accommodate for measures that strive to achieve legtimiate policy goals – fostering, rather than frustrating, sustainable trade in plastic waste. Notwithstanding that the question on the relationship of MEAs and trade rules has never been addressed in WTO dispute settlement, the Basel Convention reaffirms this conclusion: as relevant context, it serves as guidance for the interpretation of trade rules. As a MEA with a broad membership, it indicates plastic pollution, that resuls from unregulated plastic waste

[151] Paragraph 11, Article 4 Basel Convention.

[152] Marceau 2001, p. 1096.

trade, as a genuine and globally recognized enivornmental and health problem and denotes trade control measures as a justifiable response. In sum, this contribution demonstrates the WTO’s potential to respond to 21th century challenges. At the same time, it underlines the challenges posed by sometimes limited political will, which holds back cooperation that could foster the fulfilment of shared environmental and climate change objectives.

Subsidies and Plastic Production – An Exploration

by

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1. Introduction

Perhaps no manufactured substance has had such a profound influence on the material culture of humankind – at least not since the beginning of the Bronze Age – than plastics. Plastics can be found in almost all manufactured items, from automobile fenders to zippers, from artificial fishing worms to children's yo-yos (Freinkel, 2011). Plastics are popular because they are light, malleable, and inexpensive. Because they are inexpensive to buy, however, they are particularly suited to objects such as plastic eating utensils and packaging that can be used once and disposed of.

Although some plastic production occurred during the first half of the 20th century, its volume was insignificant until after the Second World War. In 1967, at the time that Benjamin Braddock, the 21-year-old disaffected hero played by Dustin Hoffman in the film *The Graduate* is given one word of advice, and that word was "plastics", annual worldwide production of these polymers was around 36 million tonnes (Mielkle, 1997: 3). Today it is ten times that, and continuing to expand, driven by both population growth and increasing per-capita demand for plastic articles, particularly packaging (Geyer et al., 2017).

This expansion in demand and supply would be good news for the world were it not for the many problems created as a consequence of plastic's longevity and persistence in the natural environment. Of the approximately 10 billion tonnes of plastic that have been produced in the world since 1950, it is estimated that only 9% has been recycled. In 2015, the recycling rate had increased to just 20%, with 25% being incinerated (25%), and 55% simply discarded – some of that to controlled landfills, but more of it in open dumps, from which much will eventually reach the world's oceans, or released directly at sea (Ritchie, 2018). Because most plastics are resistant to microbial action, any that are not recycled or incinerated are expected to remain in the environment as long-chain polymers for millennia, perhaps even for millions of years.

The problems that plastics cause in the oceans are particularly worrisome. In their original form, they can entrap or clog the digestive systems of marine birds, mammals, turtles, and fish. As they degrade, through the action of sunlight and wave action, they simply reduce in size, ending up in the guts of ever-tinier marine fauna, but also in the bodies of the larger animals that prey on them, including humans. Not only do plastic particles displace nutritional food, but they carry chemical toxins that become entrained in the plastic matrix (Gallo et al., 2018).

The two main controlled disposal methods for plastics have their own environmental problems. Plastics placed in landfills, when subject to the heat given off by other items decomposing, can leach out chemicals such as phthalates and bisphenol A (BPA), contaminating groundwater (Wilk et al., 2019). Incinerating plastics gives off carbon dioxide, the world's leading greenhouse gas by volume, but also potentially heavy metals (e.g., cadmium from PVC) and persistent organic pollutants, such as dioxin and furans, into the air and ash waste residues. Sophisticated technologies have been developed, and continue to be improved, that minimize such emissions, but they are expensive to operate and maintain in working order (Royte, 2019).

The preferred post-consumption handling of plastic waste therefore is recycling. Increasing the rate of recycling above its currently low rate is made more difficult by contamination of plastic waste by non-plastic waste and the heterogeneity of plastics, some of which are easier to recycle than others. Obtaining plastic resins from recycling that are as pure and uncontaminated as those made from virgin materials is thus costly compared with the cost of producing new resins from oil or natural gas. To the extent that those new resins benefit from the subsidies to the raw materials from which they are made, or to the manufacturing plants used to fabricate them, the relative competitive standing of recycled plastic is rendered that much more difficult.

This paper seeks to provide a first step towards answering the question of "To what extent does the production of virgin plastic benefit from subsidies?" To understand that question, it is necessary to understand the different stages of the chain from basic raw materials to final plastic product manufacturing, as well as its industrial structure – where plastic is produced, and what companies produce it, which successive stages are vertically integrated, and which are not. Section 2 provides an introduction to these matters.

The question of what constitutes a subsidy is addressed in the section that follows. The starting point for any discussion of subsidies is the definition of a subsidy contained in Article 1 of the World Trade Organization's (WTO's) Agreement on Subsidies and Countervailing Duties ("SCM Agreement"). That definition is fairly concise, however, and comprises only subsidies that involve government expenditure, or potential government expenditure. Section 3 argues that, consistent with the OECD definition of "government support", support conferred to producers through import tariffs should also be considered.

Section 4 then reviews sources of data that might shed some light on the scale and nature of subsidies to plastic production. This evidence provided is by no means complete, but is intended to point to avenues of research that could be pursued to provide a more complete picture.

Section 5 considers what options exist through the application of existing rules in international trade to address subsidies to articles of plastic, plastics in their primary form, and the raw materials from which they are produced, and briefly what new or more targeted subsidy disciplines could look like.

Section 6 concludes the paper with suggestions for further work.

2. The structure of the plastics industry

The term *plastics* covers a wide range of synthetic or semi-synthetic organic compounds that can be molded into solid objects. The two major divisions are between *thermoplastics* and *thermosets*. Thermoplastics can be melted and cooled many times, making them amenable to recycling. These are dominated by two polyolefins, polyethylene and polypropylene (Table 1). Thermosets create a three-dimensional network as they are formed and cool, and so cannot be re-melted and reformed. Examples are epoxy, silicone, polyurethane and phenolic. Some materials, such as polyester, can be made into either thermoplastic or thermoset versions.

Table 1. Global synthetic polymers and plastics production, 2015.

Polymer type	Production, 2015 (tonnes)	Share of total polymers
Polyethelene (PE)[1]	116	30.4%
Polypropylene (PP)	68	17.8%
Fibers of polyphthalamide (PPA)	59	15.4%
Polyvinyl chloride (PVC)	38	9.9%
Polyethylene terephthalate (PET)	33	8.6%
Polyurethane (PUR)	27	7.1%
Polystyrene (PS)	25	6.5%
Other	16	4.2%
Total polymers	**382**	**100%**
Additives	25	–
Total plastics	**407**	–

1. Of which LD and LDPE accounted for 64 million tonnes, and HDPE 52 tonnes.

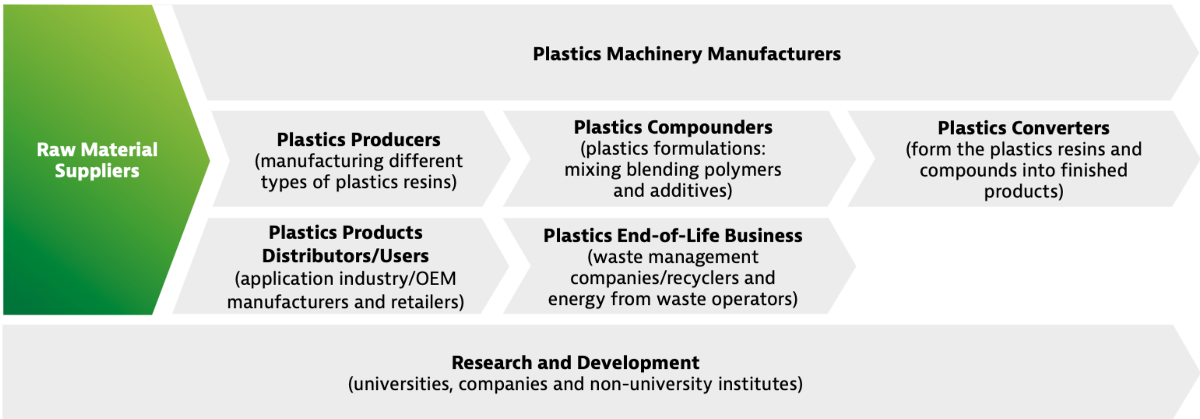
Source: Geyer et al. (2017).

All of these plastics and most others are made by transforming one of two, closely related chemicals called *olefins*. Propylene is the platform chemical from which polypropylene is made, and ethylene for four other plastics listed in Table 1. The majority of polystyrene is produced from styrene, via ethylbenzene, which in turn is produced via a Friedel–Crafts reaction between ethylene and benzene, another petrochemical.

Most propylene is produced as a minor co-product of ethylene production. Both chemicals can be produced from steam cracking liquid feedstocks such as naphtha (a product of refining crude petroleum), liquefied petroleum gas (LPG), or natural gas liquids (NGL), but the shares of propylene differ depending on the cracking temperature used.[2]

Generally, NGL cracking produces less propylene than naphtha, and some NGL crackers are now being designed that yield little to no propylene at all. In response, some producers have built facilities to produce propylene deliberately, instead of as a co-product, using propane (a gas extracted during the refining of crude petroleum) as the raw material.

Figure 1. Stages in the life cycle of plastics



Source: PlasticsEurope Deutschland e.V., GTAI 2018.

Structural changes in the markets for petroleum and natural gas are having profound changes on the market for plastics. With demand for gasoline and diesel stagnating in many countries (even before the Covid-19 pandemic), many multinational oil companies have been looking to shift more of their refinery output towards producing raw materials for plastics (Taylor, 2017). At the same time, Middle East hydrocarbon producers see investment in the plastic industry as a way to increase the value added from their petroleum and natural gas. Similarly, plastics manufacturing is increasingly being viewed within oil and natural-gas (which is expensive to export) company boardrooms as a way to move up the value chain.

Downstream from the producers of ethylene and propylene are the manufacturers of hydrocarbon monomers and carbon monomers, which in turn are sold in the form of plastic resins (MJS Packaging, 2014). This stage is energy-intensive, requiring the superheating and pressurizing of the the unreacted monomer to isolate pure hydrocarbon chains that can be combined (polymerized) to form resin pellets of pure plastic. The amounts of heat and pressure applied are varied to create plastic resin pellets of different densities. For example, polyethylene products requiring high tensile strength, such as carrier

[2] Another minor source is off-gases produced in fluid catalytic cracking units in some refineries (Akah and Al-Ghrami, 2015).

bags and agricultural tarps, are often made from a high-density plastic (HDPE), while thin plastic films are made from low-density plastic (LDPE or LLDPE). (Greentumble, 2018)

The polymer resins are then processed by plastics compounders, who create more specialized plastics formulations by blending polymers with additives, such as plastic colorants (dyes and pigments). The final polymer resins are generally produced in the forms of beads or pellets.

Plastics converters, in turn, take the plastics resins and compounds and fashion them into finished products. Depending on the end product, there are several processes involved in this stage. Injection molding is used to form *solid articles* such as bottle caps, car parts, and PVC piping, whereas blow molding is used to make *pliable articles* such as PET water bottles.

To produce *plastic bags*, raw HDPE, LDPE, or LLPDE plastic pellets are reheated and pressurized to form a uniform molten liquid, into which air is pumped from below. This step produces a long, thin balloon of pliable plastic film that passes through a tall vertical corridor,

cooling as it expands upwards. The film is then passed through multiple rollers that stretch the plastic into thin sheets. Two sheets are then pressed at their edges to form the bags' sides (Greentumble, 2018).

The final participants in the value chain are the companies that sell and distribute plastic articles such as water bottlers to final users, and companies (both private and public) involved in collecting plastic waste and disposing or recycling it. In OECD countries, what is done with collected plastics varies considerably among recycling, combustion and energy recovery, or burying in landfills.

3. Subsidy definitions and subsidy analysis

The notion of what counts as a subsidy has evolved over time. The most common reference point, in no small part because of its acceptance by over 160 countries, is the WTO's definition, set out in Article 1 of the WTO Agreement on Subsidies and Countervailing Measures (SCM Agreement). The WTO definition stresses the mechanism through which a subsidy is delivered, and lists three involving a financial contribution by a government or any public body in which a benefit is conferred:

(i) a direct transfer of funds (e.g. grants, loans, and equity infusion), potential direct transfers of funds, or liabilities (e.g. loan guarantees);

(ii) government revenue that is otherwise due is foregone or not collected (e.g. fiscal incentives such as tax credits); and

(iii) a government provides goods or services other than general infrastructure, or purchases goods;

Article 1 then clarifies that a subsidy is also deemed to exist if "a government makes payments to a funding mechanism, or entrusts or directs a private body to carry out one or more of the type of functions illustrated in (i) to (iii) above which would normally be vested in the government and the practice, in no real sense, differs from practices normally followed by governments."

Finally, Article 1(a)(2) deems a subsidy to exist if "there is any form of income or price support in the sense of Article XVI of GATT 1994." Article XVI(1) of GATT 1994, which also refers to "any form of income or price support", does not explicitly say so, but is assumed to not include price support conferred through import tariffs, as import tariffs do not involve "a financial contribution by a government".

For the purpose of the indicators used by the Organisation for Economic Co-operation (OECD), market price support (MPS) provided through any border measure, including import tariffs, *is* included in their sectoral indicators for government support. For the purposes of this study, it is proposed that this broader definition be used.

Table 2 shows examples of government support defined within a two-dimensional matrix, from a study of sectoral support to the aluminum industry (OECD, 2019). The rows, which represent transfer mechanisms, correspond to those included in Article 1 of the SCM Agreement, with the proviso that "induced transfers" also include transfers between consumers and producers, or vice-versa, created by government policies. The columns represent statutory or formal incidence – that is, the aspect of production or consumption to which the support is tied.

Common forms of government support to the different stages in the value chain include

- *Raw-material providers:* Tax breaks related to investments by, or the income of, primary producers of crude oil and natural gas; credit-related support or tax breaks for refineries.
- *Plastic resin producers and compounders:* Investment incentives for plastic-resin producing plants.
- *Plastics converters:* Investment incentives for plants producing final products.
- *Final users of plastics:* Government-procurement preferences for locally produced articles of plastic.
- *Plastics collectors and recyclers:* Bounties to companies for collecting or recycling plastic; investment incentives for recycling plants.

Various types of government entities provide support, both to firms operating within the sovereign territory of the government, and to companies that invest in or operate facilities abroad. Any types of subsidies can be provided by central or sub-national governments to firms operating within their borders.

In addition, some countries provide assistance – generally in the form of government loans or loan guarantees, but also through favorable tax treatment – to firms investing or acquiring existing companies abroad. The issue of "foreign subsidies" – especially those provided by central governments to firms operating outside their territory – has recently been highlighted by the EU (European Commission, 2020). According to the EU definition (Annex 1), such subsidies would include export financing, unless the export financing is provided in line with the OECD Arrangement on officially supported export credits.

Table 2. Illustrative matrix of support measures, by transfer mechanism and formal incidence.

			Statutory or formal incidence (to whom and what a transfer is first given)							
			Production							Consumption
						Costs of value-adding factors				
			A: Output returns	B: Enterprise income	C: Cost of intermediate inputs	D: Labour	E: Land and natural resources	F: Capital	G: Knowledge	H: Direct support to consumers
Transfer Mechanism (how a transfer is created)	1: Direct transfer of funds		Output bounty or deficiency payment	Operating grant	Input-price subsidy	Wage subsidy	Capital grant linked to acquisition of land	Grant tied to the acquisition of assets, including foreign ones	Government R&D	Unit subsidy
	2: Tax revenue foregone		Production tax credit	Reduced rate of income tax	Reduction in excise tax on input	Reduction in social charges (payroll taxes)	Property-tax reduction or exemption	Investment tax credit	Tax credit for private R&D	VAT or excise-tax concession
	3: Other government revenue foregone			Waiving of administrative fees or charges	Under-pricing of a government good or service		Under-pricing of access to government land or natural resources	Debt forgiveness or restructuring	Government transfer of intellectual property rights	Under-pricing of access to a natural resource harvested by final consumer
	4: Transfer of risk to government		Government buffer stock	Third-party liability limit for producers		Assumption of occupational health and accident liabilities	Credit guarantee linked to acquisition of land	Loan guarantee; non-market-based debt-equity conversion		Price-triggered subsidy
	5: Induced transfers		Import tariff or export subsidy; local-content requirements; discriminatory GP	Monopoly concession	Monopsony concession; export restriction dual pricing	Wage control	Land-use control	Credit control (sector-specific); non-market mergers and acquisitions	Deviations from standard IPR rules	Regulated price; cross subsidy
		– Including advantages conferred through state enterprises						Below-market loan, including by state-owned bank		

Note: This matrix is a work in progress and may be refined in the future. Some measures may fall under a number of categories (e.g. debt-equity conversions may involve elements of both risk transfers and revenue foregone). GP = Government procurement. Adapted from OECD (2018[illegible]).

Source: OECD (2019), "Measuring distortions in international markets: the aluminium value chain", *OECD Trade Policy Papers*, No. 218, OECD Publishing, Paris, https://doi.org/10.1787/c82911ab-en.

Financial assistance is also provided to specific sectors or projects by multilateral financial institutions, such as the African Development Bank, Asian Development Bank, European Investment Bank, Inter-American Development Bank, and the World Bank (Annex 2). Besides offering short-term loans at market rates, or longer-term loans at better than market rates, some also take equity positions in certain facilities.

Because international trade disciplines on subsidies have been concerned mainly with the policies targeted at individual sectors in GATT or WTO members, and the effects of those policies on domestic producers, subsidy inventories have generally focused on countries as the main unit of account. Such an approach is appropriate for primary products of agriculture or fisheries, which are produced by hundreds or thousands of individual entities in each country. It is less useful for understanding the overall effects of subsidies provided by multiple countries on parts of a product's supply chain dominated by large, vertically integrated multinational corporations (Table 3).

Table 3. Leading multinational producers of polyolefins, polymers, resins or plastics in primary forms and production sites

Corporation	Main production sites	Main products
Dow	BRA, CAN, JAP, MEX, NIG, SAU, USA, VEN	Polyethelene resins; performance plastics; plastic additives
LyondellBasell	AUS, BRA, CHN, DEU, ESP, FRA, GBR, IND, ITA, MEX, NLD, THA, USA	Polypropylene resins and compounds; polyethelene
ExxonMobil	USA + many others	Raw fossil-fuel feedstocks; polyolefins and other polymers and resins.
SABIC	CHN, DEU, IND, MEX, NLD, SAU, USA	Raw materials, various polymer resins.
Ineos Group Ltd.	CHE + 24 countries	Plastics, resins and intermediates
BASF	DEU + 200 countries	Polymers, plastic additives
ENI	ITA + 72 other countries	Raw fossil-fuel feedstocks; plastics and synthetic rubbers
LG Chem	KOR	Polyolefins, PVC, polystyrene, synthetic rubbers and specialty polymers
Chevron Phillips Chemical	BEL, KOR, QAT, SAU, SGP, USA	Petrochemicals, polyolefins.
Lanxess	CHN, DEU, FRA, IND, JPN, KOR, UAE, USA	Plastics, synthetic rubbers, intermediates
DuPont	CHN, IND, USA	Specialty plastics; polystyrene
Formosa Plastics Corporation	CHN, IDN, PHL, TWN, USA, VNM	Refined oil products, olefins, polypropylene, polyethylene, suspension and dispersion PVC

Sources: Polymer Properties Database "Crow's top 10 plastics and resins producers", no date; Al Root, "DowDuPont is splitting into 3 companies: Here's everything you need to know", *Barron's*, 30 April 2019; corporate web sites.

That is certainly the case for the crucial hydrocarbon inputs to plastic production. According to the Center for International Environmental Law (CIEL, 2017), just five companies – BP, Chevron, China National Petroleum Corporation, ExxonMobil, and Shell – account for over half of global sales of naphtha. Moreover, because of the necessity of locating plastic produc–tion with refineries, there is a high degree of vertical integration between the industries: major integrated oil and gas producers, such as BP, Chevron, ExxonMobil, Saudi Aramco, and Shell, own plastics companies; and some major plastics producers own oil or gas com–panies (DowDuPont, LyondellBasell), or refine petroleum products (Formosa Plastics).

Ideally, a thorough analysis of subsidies to the plastics industry would identify subsidies all along the value change at both the national level and at the company level for the most concentrated parts of the industry. Attempting to identify subsidies to companies downstream from raw-material providers would be a much more dauting task, by comparison. For example, in Germany – Europe's leading producer of plastic resins and plastic products – the number of companies that process plastics and fabricate products made of plastic numbered around 2,900 as of 2016 (GTAI, 2018).

4. Subsidies along the value chain: sources and examples

Considerable information exists on subsidies to plastics production, in government budget and tax-expenditure reports, in databases assembled by non-governmental organizations (NGOs), and in the annual reports of the plastics companies themselves. But it is scattered and has not yet been assembled in a systematic way. By contrast, over the last decade organizations such as the Organisation for Economic Co-operation and Development (OECD), International Energy Agency (IEA), and the International Monetary Fund (IMF), have constructed large databases on government support to the production and consumption of petroleum and natural gas, which are the raw-material feedstocks from which most plastics are derived. Additional insights on such support can be gleaned from the peer review reports of members of the Asia-Pacific Economic Co-operation (APEC) economies and the Group of Twenty (G20) economies.

The recent history of trade disputes and unilateral trade-defense actions involving plastic products also provides some indication, albeit imperfectly, of which producing countries have been most frequently accused of subsidizing primary plastics or plastic products, and which products are the ones most frequently implicated. As explained in Section 5, such disputes and actions have concerned mainly producers in the Middle East, South Asia, and eastern Asia, and most often polyethylene terephthalate (PET) in its primary form, or products made from it, such as PET films.

Finally, even the companies themselves complain about other companies' subsidies. One of the largest, LyondellBasell, wrote in its most recent *Annual Report* (2020: 22):

> [W]e face increased competition from companies that may have greater financial resources and different cost structures or strategic goals than us. These include large integrated oil companies (some of which also have chemical businesses), government-owned businesses, and companies that receive ***subsidies or other government incentives*** to produce certain products in a specified geographic region. [Highlighing added by author.]

4.1. The basic raw materials: hydrocarbons derived from petroleum and natural gas

Fossil fuels are a logical starting point for considering the impact of subsidies on the relative competitiveness of virgin plastics. For modern-day plastics, the main fossil fuels of interest are crude petroleum and natural gas.

The OECD reports on government support to fossil-fuel production that are provided through grants or tax breaks for 45 countries: the whole OECD membership, most G20 countries that are not OECD members (Argentina, Brazil, China, India, Indonesia, Russia, and South Africa), and six Eastern European countries (Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine).[3] Of these, the main countries that are both significant producers of oil or natural gas, and of primary plastics, are Brazil, Canada, China, India, Indonesia, Mexico, Netherlands, Russia, and the United States, plus Iran, Saudi Arabia, and the United Arab Republics (U.A.E.).

Various non-governmental organizations, such as Oil Change International, report the face value of government mediated loans and loan guarantees to many of these countries. The subsidy equivalent

[3] https://www.oecd.org/fossil-fuels/data/.

values of these supports add up to several tens of billions of dollars annually, perhaps as much as USD 100 billion, but the degree to which they affect final prices for petroleum and natural gas sold within each of the countries has not been systematically studied.

In the OECD countries, market prices for crude petroleum are set competitively with world (import or export) reference prices. Nonetheless, the effect of their budgetary support and tax breaks on world prices themselves is likely to be downward overall. Also, it is possible that there may be some instances in which refineries, particularly those situated far from coastal ports, are being supplied with oil or natural gas at prices significantly lower than world market prices. In several of the non-OECD countries, their petroleum and natural gas industries are controlled by state-owned enterprises that may be cross-subsidizing chemical inputs to plastic manufacturing by charging higher prices for other products.

Likely the largest subsidies benefitting the plastics industry are the result of policies that depress domestic prices for crude petroleum and natural gas expressly. Data published by the International Energy Agency (IEA) and the International Monetary Fund (IMF) do not separately identify the subsidy value of cheap crude-oil inputs to petroleum refineries, nor subsidies benefitting natural gas liquids, but rather estimates of subsidies to final petroleum products (particularly transport fuels, and kerosene and LPG for cooking) and natural gas broadly. These numbers therefore are mainly useful in suggesting the degree to which (pre-tax) domestic prices for petroleum and natural gas fall short of international reference prices.

Neither the IEA nor the IMF make public their price gaps estimates, only the total value of the consumption price support (= price gap *x* volume consumed). Table 4 lists the world's top 20 primary plastic producing countries and whether the IEA measures any petroleum or natural gas subsidies benefitting consumers. What it suggests, but does not prove, is that oil refineries or natural gas processing plants may be benefitting from low-priced hydrocarbon inputs in China, the largest producing country, and Middle East petroleum and gas producing countries, plus India and Indonesia.

Table 4. Top 20 producing countries of primary plastic in 2019, and consumer price subsidies for petroleum and natural gas in 2019

Country	Primary plastic production, 2015, MT	Petroleum consumption subsidies, 2019 (USD billion)	Natural gas consumption subsidies, 2019 (USD billion)
China	63.7	12.4	--
United States	36.0	--	--
Korea	14.4	--	--
Saudi Arabia	14.3	18.2	4.7
India	9.9	21.0	0.9
Japan	8.8	--	--
Germany	8.7	--	--
Chinese Taipei	7.8	--	--
Thailand	7.7	--	--
Brazil	6.1	--	--
Iran	6.0	18.0	16.3
Belgium	4.0	--	--
Russia	5.3	--	10.4
France	4.9	--	--
Canada	4.2	--	--
Netherlands	4.1	--	--
Mexico	3.3	--	--
Spain	3.3.	--	--
U.A.E.	2.9	0.2	5.0
Indonesia	2.5	19.2	--

Source: Data for plastic production from Euromap (2016, October), Plastics Resin Production and Consumption in 63 Countries Worldwide: 2009 – 2020, Frankfurt am Main: EUROMAP General Secretariat. https://www.pagder.org/images/files/euromappreview.pdf; data for consumer price subsidies from International Energy Agency; IEA - https://www.iea.org/data-and-statistics/charts/value-of-fossil-fuel-subsidies-by-fuel-in-the-top-25-countries-2019.

4.2. Refining and production of monomers and polymers, and production of plastics in primary form

Central-government subsidies to the primary plastic producers have not yet been assembled. There is ample evidence that such subsidies exist, nonetheless. The BASF Group in its Annual Report (2020), for example, mentions having received "government grants and government assistance" from several countries, amounting to €27 million (USD 30 million) in 2019, and €43 million (USD 50 million) in 2018. This assistance included regional business development subsidies in *China*, and grants for research projects and electricity price compensation in the 2019 fiscal year provided by unnamed countries (BASF, 2020: 230).

In the *United States*, with natural gas supply increasing due to hydraulic fracturing and horizontal drilling ("fracking"), several U.S. states are providing subsidies to commodity plastics production. These subsidies often take the form of state or local abatements to property or other *ad valorem* taxes, or subsidies for new job creation. Louisiana, for instance, gives a state-level board the power to exempt industrial facilities from local property taxes, which has caused problems for local communities.[4] Other state or federal levers to subsidize this type of infrastructure have often taken the form of subsidized credit, either through direct loans or sovereign guarantees. There could also be in-kind contributions (e.g., road or rail links) being made by from the state to support these facilities.[5]

Among OECD countries, such local investment incentives – to use the generic term – are likely most prevalent in the United States. The EU has strict rules on state aid that restrict its individual Member States from providing investment incentives. Most aid of this kind is provided through grants distributed in the context of regional development assistance. Most other OECD countries are too small to be able to afford investment incentives, or have pacts among their subnational units that limit their use.

One very helpful source on sub-national investment incentives in the United States is the Subsidy Tracker (https://www.goodjobsfirst.org/subsidy-tracker), maintained by the NGO, Good Jobs First. It contains information on state and local investment incentives since 2000 in a database that is searchable by industry or company. A quick perusal of this database shows substantial assistance provided to the parent companies of several leading plastics primary plastics producers (Table 5), mainly in the form of credits or rebates on state corporate income tax, or local property tax abatements. Some of these subsidies were complemented by federal grants. And in many cases the Subsidy Tracker analysts were unable to quantify the value of the subsidies. On the other hand, by no means have all of these subsidies benefitted plastic producers. In the case of LG Chemicals, for example, all of the subsidies have been targeted at plants involved with the manufacturing (or research on) fuel cells.

Nevertheless, the table does provide a broad impression of the degree to which the parent companies of plastic manufacturers have been able to tap into state and local investment incentives over the last two decades. Overall, the subsidies appear to be relatively modest. However, they have been provided in discrete amounts associated with particular plants, so may nevertheless have contributed a

[4] See, for example, "Why Louisiana stays poor, PT 1: the Louisiana paradox" (https://www.youtube.com/watch?v=RWTic9btP38). This link shows details for ExxonMobil.
[5] The U.S. energy-subsidy expert, Doug Koplow (President of Earth Track), has looked into the petrochemical industry's capture of supposedly more general subsidized bonds some years back, and has told the authors that he is looking for newer data in connection with work he's currently undertaking on natural gas subsidies.

significant share of these plants' overall up-front capital costs, as well as signaling to investors that the plants enjoyed local political support. A good example of that is the estimated USD 1.5 billion incentive package offered recently to Formosa Plastics Corp. USA to locate a USD 9.4 billion plastics facility in Baton Rouge, Louisiana (McConnaughey, 2018). Further scrutiny of the individual measures in the database and press reports would yield more precise information.

Table 5. Indicative sample of cumulative state and local subsidies provided to parent companies of leading plastics manufacturers in the United States

Parent corporation	Cumulative state and local subsidies (USD millions)	Time period within which subsidies were provided
Sasol	1,851	2008-2017
Royal Dutch Shell	1,815	2003-2021
Exxon Mobil	1 021	1983-2020
Dow	464	2000-2021
LG Chemicals	438	1996-2019
BASF	278	2003-2019
DuPont	189	2000-2018
Formosa Plastics	50	2008-2015
Lanxess	39	2000-2017
LyondellBasell Industries	17	2000-2016
Chevron Phillips Chemical	9	2001-2009
Ineos	3	2005-2016

Source: Steenblik (2021), based on Subsidy Tracker database: https://www.goodjobsfirst.org/subsidy-tracker, accessed on 21 April 2021.[i]
Note: Figures reflect subsidies to parent companies of leading plastic manufacturers; the subsidies indicated may also be directed to non-plastics activities within portfolio of business activities. This table does not include federal grants and allocated tax credits that a number of companies also received.

India is another country with sub-national investment incentives. Under its "Stand-up India" program, the Government of Gujarat administers a special "Scheme for Financial Assistance to [the] Plastics Industry", which has two components: 1) an interest subsidy of up to 7% of loans for five years for fixed capital investment in building new plants and machinery, and related assets; and 2) a 80% reimbursement of the net VAT paid for the first five years of commercial operation.[6]

The situation in the Gulf States is compounded not only by their very low fossil-fuel input prices, but also state ownership of key production capacity and related infrastructure. Saudi Arabia, the leading plastics producer in the region, includes plastics production and conversion as one of its strategic industries (Elaraby et al., 2016).[7] As the Kingdom's National Industrial Cluster Development Program website states in respect of the chemicals cluster generally, "Through *a number of financial incentives and a supportive national policy*, the Saudi Government encourages industrial joint ventures or technology licensing to substitute imports and make this industry competitive for export."[8] (Emphasis not in original.) Similarly, in China, Japan, Korea, and Chinese Taipei, the close links between governments, state-owned enterprises and private companies, and the active use of industrial policies to promote national industry, means that strong government subsidies could be playing a significant role, but it will take focused case study research to confirm whether or not this is the case.

Multilateral development banks have also become involved in financing refineries. In 2018, for example, the Arab Petroleum Investments Corporation (APICORP) contributed USD 100 million to the financing of Duqm, a USD 5.75 billion new refinery that is jointly owned by Oman Oil and the

[6] https://www.standupmitra.in/Home/SubsidySchemesForAll#State.
[7] https://www.ic.gov.sa/en/clusters/chemicals/opportunities/plastics-and-conversion/
[8] https://www.ic.gov.sa/en/clusters/chemicals/overview/

Kuwait Petroleum Corporation. The refinery's output is intended to "meet the forecast deficit in diesel and naphtha in high consumption regions, particularly Asia" (APICORP, 2019: 35).

4.3. Subsidies for the manufacturing of finished plastic products

No database currently exists that identifies subsidies to the thousands of plants across the world that transform plastic resins into finished products, like plastic bags, bottles, household items, or automobile parts. Some of the ones cited earlier (e.g., Subsidy Tracker for the United States) could be interrogated through searches on company names. A quick search of the EU's database on approved regional aid packages shows that plastic product manufacturers in the EU received at least € 130 million during 2006 and approximately 2014 period.[9] Obtaining similar data on subsidies in emerging economies would be much more of a challenge, however, given the state of publicly available information. However, a search of reports in the news media could provide insights into at least the nature of support provided in G20 countries like China, India, Indonesia, Japan, Korea, Mexico, and Russia, as well as non-G20 countries such as Viet Nam.

One policy that appears worthy of investigating is India's "Scheme for Setting Up of Plastic Parks", established in 2013.[10] This plan had the objective of "increase the competitiveness, polymer absorption capacity and value addition in the domestic downstream plastic processing industry" of the country. It provided grant funding up to 50% of the cost of each project, up to a ceiling of Rs 400 million (USD 6 million) per project. Other contributions were expected to be provided by state governments or state industrial development corporations or similar agencies of state governments, and loan from financial institutions.

5. Subsidy disciplines and other tools of the multilateral trading system

5.1. The use and potential use of existing subsidy disciplines

At the multilateral level, subsidies to goods are disciplined (i.e., sanctioned) according to the rules set out in the WTO's Agreement on Subsidies and Countervailing Duties. Subsidies that are challenged at the WTO by one or more of the organization's members and are found to be contingent on export performance or "on the use of domestic over imported goods" (i.e., upon meeting a minimum level of domestic content) are prohibited. All others are "actionable" and must be both "specific" in the context of Article 2 of the SCM Agreement and be found to be creating adverse trade effects in the member's domestic market or an export market.

Unilateral remedies in the form of countervailing duties (specific additional duties levied on imports from specified companies) are also available to members who allege adverse effects caused by subsidized imports. Such countervailing duties can be imposed only "pursuant to investigations initiated and conducted in accordance with the provisions of" the SCM Agreement, however. The advantage to importers seeking to protect their domestic industry from subsidized imports is that the period between initiating an investigation and imposing a CVD is usually much quicker and cheaper than to pursue a case at the WTO. The dispute between the United States and the EU over each

[9] See the EU's table of "Summary information regarding State aid granted by Member States and communicated in accordance with Article 9(4) of the General Block exemption regulation (OJ L 214, 9.8.2008, p. 3) [or previously: Article 8(2) of the Block exemption regulation for regional aid (OJ L 302, 1.11.2006, p. 29)]". https://ec.europa.eu/competition/state_aid/register/msf_2017.pdf
[10] See https://chemicals.nic.in/sites/default/files/FPP260613.pdf

others' subsidies to their respective manufacturers of civilian aircraft took 14 years to resolve, and cost each side millions of dollars in legal fees.

To date, no countries have made recourse to WTO rules in an attempt to end another country's subsidization of plastics or to the raw materials from which they are made. Some use has been made of unilateral countervailing measures to protect domestic manufacturers from subsidized imports, but to a lesser extent than for steel and steel products. Of all the products targeted, polyethylene terephthalate (PET) and PET films seem to have received the most attention.

There have also been no subsidy challenges relating to crude oil or refined petroleum or natural gas products mounted at the WTO (Steenblik et al., 2018). Neither have there been any CVDs applied to imported petroleum or natural gas products. The reason for this is likely because of the different perspectives of small and medium-sized hydrocarbon producers and refiners on the one hand, and the large multinationals on the other. The latter in particular are unlikely to support action taken against subsidized imports because one of their subsidiaries may be a beneficiary of those subsidies, or they may be reluctant to be seen as opposing the governments in which they operate even if they do not. This matters since a countervailing measure is required to enjoy the support of the majority of the producers of the product in question[11], and multinational oil or gas companies usually account for more than 50% of that product.

Regarding synthetic polymers, on a few occasions between 1980 and 2015 countries have imposed CVDs on them (Table 6). At least as many countervailing investigations were initiated but ended up concluding that the effect of the subsidy was insignificant, or the targeted country reached an agreement with the complainant. Among the countries targeted by countervailing measures, India stands out, followed by China, other south Asian countries, and Middle Eastern countries. In all but one instance the target product was polyethylene terephthalate (PET). There has been at least one subsidy-related case adjudicated by the WTO. In 2014, Pakistan initiated a challenge to imposition of provisional and definitive countervailing measures by the European Union on imports of certain polyethylene terephthalate from Pakistan; the case was finally concluded in May 2018.[12] In general, though, anti-dumping duties and safeguard measures have been used comparatively more often against such products.[13]

Table 6. Countervailing duties imposed on primary plastic polymers or resins between 1980 and 2015[1]

Country applying the CVD	Targeted exporting country(ies)	Targeted product	Year CVD first imposed
Brazil	India, South Africa	Polypropylene resin	2014
European Union	Iran, Pakistan, UAE	Certain polyethylene terephthalate (PET)	2010
European Union	Oman, Saudi Arabia	Certain polyethylene terephthalate (PET)	2011
United States	China, India	Certain polyethylene terephthalate (PET) resin	2015

[11] Article 11.4 of the SCM Agreement states that an application to determine whether the evidence is sufficient to justify the initiation of an CVD investigation "shall be considered to have been made 'by or on behalf of the domestic industry' if it is supported by those domestic producers whose collective output constitutes more than 50 per cent of the total production of the like product produced by that portion of the domestic industry expressing either support for or opposition to the application. However, no investigation shall be initiated when domestic producers expressly supporting the application account for less than 25 per cent of total production of the like product produced by the domestic industry."
[12] DS486: European Union — Countervailing Measures on Certain Polyethylene Terephthalate from Pakistan.
[13] For example, in 2007 the European Union imposed a definitive anti-dumping duty on imports of polyethylene terephthalate (PET) originating in India; see Council Regulation (EC) No. 192/2007 of 22 February 2007. In the same year, Argentina consultations with Brazil over anti-dumping measures on imports of certain PET resins from Argentina (DS355); in January 2008 the measures were suspended so the case was dropped.

1. Countries covered: Argentina, Australia, Brazil, Canada, Chile, China, Costa Rica, Egypt, European Union, India, Japan, Mexico, Pakistan, Peru, South Africa, Turkey, United States, and Venezuela.

Source: Bown, Chad P. (2012) "Temporary Trade Barriers Database", available at https://www.chadpbown.com/temporary-trade-barriers-database/

Countervailing duties have been imposed on plastic products much more often than on primary plastics (Table 7). Articles made from PET, particularly films or bags, have often been targeted. Also often targeted have been polyester fibers. Firms exporting from south, south-east and eastern Asia have been most frequently subject to CVDs. As has been the case for primary plastic products, there have been many more CVD investigations that have been initiated but later dropped.

No subsidies to finished plastic products have been challenged at the WTO, though there have been several cases relating to anti-dumping measures. Recently, for example, Peru requested consultations with Brazil regarding certain measures that concern the importation to and commercialization in Brazil of biaxially-oriented PET film from Peru.[14]

Table 7. Countervailing duties imposed on semi-finished or finished plastic products, 1980- 2013[1]

Country applying the CVD	Targeted exporting country(ies)	Targeted product	Year CVD first imposed
Brazil	India	Polyethylene terephthalate (PET) films	2008
European Union	Turkey	Polyester fibers and yarns	1991
European Union	Chinese Taipei	Certain woven glass fiber fabric(s)	1998 & 2000
European Union	India	Polyethylene terephthalate (PET) film	1999
European Union	Australia, Indonesia, Chinese Taipei	Synthetic polyester fibers	2000
European Union	India	Polyester textured filament yarn (PTY)	2002
European Union	India	Compact disks — recordable (CD-Rs)	2003
European Union	Malaysia, Thailand	Certain plastic sacks and bags	2006
European Union	China, India, Viet Nam	Polyester staple fibers	2013
Turkey	India	Polyethylene terephthalate (PET) films	2009
United States	Mexico	Yarns of polypropylene fibers	1983
United States	India	Polyethylene terephthalate (PET) film sheet and strip	2002
United States	Viet Nam	Polyethylene retail carrier bags	2010

1. Countries covered: Argentina, Australia, Brazil, Canada, Chile, China, Costa Rica, Egypt, European Union, India, Japan, Mexico, Pakistan, Peru, South Africa, Turkey, United States, and Venezuela.
Source: Bown, Chad P. (2012) "Temporary Trade Barriers Database", available at https://www.chadpbown.com/temporary-trade-barriers-database/

Could countries make more use of the WTO and unilateral measures to discipline subsidies to plastic? In theory, yes. But history does not instill confidence that it will happen, even with more attention focused on subsidies to plastics. The environmental, and to a lesser extent, adverse trade effects of subsidies to marine capture fisheries have not resulted in any uptick in either unilateral action against subsidized fish imports, nor cases brought to the WTO. Similarly, the commitments made by G20 and APEC members to phase out "inefficient fossil-fuel subsidies" have spawned no new trade measures against any country's fossil fuels.

When the major cross-border harm caused by subsidies is as much environmental as trade-related – as is the case with subsidies to plastic production – existing disciplines are generally only partially effective. For one, environmental damage, even if one country's products or pollution from producing those products, imposes tangible costs in another country or countries, those suffering the costs have

[14] See https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds596_e.htm.

no standing. The concept of "adverse effects" applies only to effects on competition in the markets in which the subsidized product is sold. The environment may nonetheless benefit to the extent that trade-related disciplines deter the provision of subsidies, thus over-production of the good in question, or inputs to that product's inputs.

The other side to this coin are production-related subsidies to environmentally preferable substitutes to plastics. A plastic derived from, say, biological feedstocks (e.g., vegetable oils), could be found to be benefitting from subsidies and challenged by producers of a chemically similar plastic derived from fossil-fuel feedstocks. If the bio-plastic had properties that differed substantially from those of the closest fossil-derived plastic (e.g., it was biodegradable), however, it could be immunized from disciplines brought by producers of those fossil-derived plastics if it was sufficiently unlike those conventional plastics. Nonetheless, those production-related subsidies could still be challenged by other producers of the bio-plastic.

Subsidies to research and development fall into more of a gray area. Article 8 of the SCM Agreement deemed certain kinds of subsidies as non-actionable, if they met objective criteria and were pre-notified. One category of non-actionable subsidy was assistance for research activities conducted by firms (or by higher education or research establishments on a contract basis with firms) if: the assistance covered not more than 75% of the costs of industrial research or 50% of the costs of pre-competitive development activity. Article 8 was never invoked by a WTO member in order to shield any subsidy from a possible challenge, and the Article was allowed to lapse at the end of 1999. Practically speaking, this expiration has had little impact, as government support for research or development that has benefitted particular industries has in practice rarely been challenged at the WTO. It was an issue in the long-running aircraft subsidy disputes, but only because the amount of support was large and contributed to a significant part of the total cost of bringing new civilian aircraft to market.

5.2. The challenge of creating new binding subsidy disciplines targeted at plastics

What, then, of the possibility of negotiating some kind of new Agreement on Plastics Subsidies, at the WTO or elsewhere? There are several subsidy negotiations that have taken place at the WTO or OECD over the last 35 years – some of which ended in formal agreements, many of which have not (yet) led to such an outcome – from which lessons can be drawn. The motivations for launching the earlier negotiations – related to farming (1986-94), shipbuilding (1990-94 and 2002-2005), and iron and steel production (early 1990s and early 2000s) – were essentially to reduce trade distortions and to end costly subsidy competition among countries. Avoiding trade conflicts and ensuring fair competition were also the main goals behind the world's first sector-specific international agreement limiting subsidies, the 1951 Paris Treaty, which created the European Coal and Steel Community (CVCE, 2015).

The attempt to develop more targeted and effective disciplines on subsidies to marine capture fishing, which began at the WTO in 2002 and is still on-going, is the notable exception: it is the first one that was inspired also by the environmental damage exacerbated by the subsidies, both to the fish stocks themselves but also to the broader marine environment.

More recently, attempts have been made to begin exploring how subsidies to fossil fuels could be addressed using trade policy. Subsidies to fossil fuels certainly contribute to trade frictions, but they are condemned most forcefully for their contribution to greenhouse-gas emissions. Formal subsidy disciplines would strengthen the non-binding commitments that have already been made by G20 and APEC leaders (in 2009) "to rationalize and phase out over the medium term fossil fuel subsidies that encourage wasteful consumption", by G7 leaders specifically by the end of 2025, and by UN members in the context of agreeing to the Sustainable Development Goals (SDGs), specifically SDG 12.c, which are supposed to be met by 2030. Given the close relationship between plastics and fossil fuels, any action to discipline subsidies benefitting fossil fuels could have direct relevance to the geographic pattern and level of plastics production.

The history of the international community successfully concluding binding sector-specific agreements to discipline subsidies has been mixed. In this area, the tension between the value of applying consistent rules to all economic activities in a non-discriminatory way, and the need to accommodate or address the particularities of individual industries, has been well described by Pagani (2008: 26) in reference to the OECD negotiations on shipbuilding and steel subsidies:

> WTO rules not only present shortcomings in providing strict subsidy control, but they are also general, in the sense that they apply indiscriminately to all industrial goods and they do not take into account the specificities of the various industrial sectors. This leads to a particularly ineffective discipline for certain types of industries, such as those which operate on a world-wide market, are labour-intensive and cyclical and are therefore traditional recipients of government aid.

Below are short summaries of the main subsidy initiatives negotiated to date.

- *Agricultural products:* The Uruguay Round of multilateral trade negotiations (1986-1994) created the first sector-specific subsidy agreement at the WTO, the Agreement on Agriculture. It is still in force.
- *Large ships:* A plurilateral Shipbuilding Subsidy Agreement was negotiated at the OECD, concluded and signed by seven OECD and WTO members[15], also in 1994; but it was never ratified by the U.S. Senate, so never went into force.
- *Steel:* In February 2002, the High Level Group of the OECD's Steel Committee created a Disciplines Study Group to develop "options for strengthening of disciplines on government interventions and other market distortions in steel", which would have also included disciplines on subsidies. In addition to the OECD member countries, other partipants included Argentina, Brazil, China, India, and Russia. However, in September 2005 the talks reached an impasse and were suspended (Pagani, 2008: 20).
- *Fish:* The WTO's Doha Round of multilateral trade negotiations (also launched in 2002) included language calling on its members to clarify or create new negotiations relating to fish subsidies. That agreement is still being negotiated, with hopes it will be concluded by the end of 2020.
- *Fossil fuels:* At the WTO's Eleventh Ministerial Conference (MC11) in Buenos Aires (December 2017), twelve WTO members[16] called on the organization to begin work on fossil fuel subsidies with the ultimate aim of starting negotiations on an agreement to strengthen disciplines on fossil fuels (WTO, 2017). To date, that proposal has not resulted in any new negotiations.

  Separately, on 25 September 2019, four of the WTO signatories to the aforementioned 2017 Ministerial Declaration – Costa Rica, Iceland, New Zealand, and Norway – plus Fiji, announced the commencement of negotiations to forge an Agreement on Climate Change, Trade and Sustainability (ACCTS). Switzerland joined the negotiations early in 2020. The ACCTS aims to address climate change through several trade-related measures, one of which is to phase out fossil fuel subsidies. This part of the negotiation, which started in 2020, once concluded will only apply to its six original parties. The Agreement would then be opened up to other countries to join.

[15] European Community, Finland, Japan, Republic of Korea, Norway, Sweden, and the United States of America. At the time, Finland and Sweden were not yet members of the European Community.
[16] Chile; Costa Rica; Iceland; Liechtenstein; Mexico; the Republic of Moldova; New Zealand; Norway; Samoa; Switzerland; the Separate Customs Territory of Taiwan, Penghu, Kinmen and Matsu; and Uruguay.

One distinguishing feature of the ACCTS negotiations, for which it is too early to know whether they will conclude successfully, is that – in contrast with all the other multilateral and plurilateral subsidy negotiations – it is starting with countries with economies far smaller than those that have typically dominated the negotiations over other types of subsidies. This approach mirrors to some extent the way that the Trans-Pacific Partnership (TPP) regional trade agreement developed. From an agreement initially between two small economies, New Zealand and Singapore, it expanded first to eight and then eventually twelve, including much larger economies, such as Canada, Japan, Korea and the United States.

Ignoring for the purpose of this paper political-economy challenges to developing new disciplines to constrain the use of subsidies to plastics (including special and differential treatment for developing countries), the range in the architecture that such disciplines can be structured varies widely between outright prohibition and phased elimination, and between no tolerance for any subsidies and the allowance for some.

The model provided by the WTO Agreement on Agriculture is the most data-driven one. WTO members subject to the agreement had to phase out export subsidies for agricultural products, and reduce their most trade-distorting subsidies by agreed percentages over a 10-year period. Yet other forms of government support, deemed non-trade-distorting, were allowed to be provided without limit. However, for that approach to work, extensive data had to be available to establish the base subsidy level for each member's industry, and the members had to be willing, and have the capacity, to report progress to reducing their subsidies.

At the other extreme was the 1951 Paris Treaty, which created the European Coal and Steel Community (CVCE, 2015). Article 4(c) of that treaty simply prohibits all "subsidies or state assistance, or special charges imposed by the state, in any form whatsoever". That prohibition did not last for long, however, for as soon as the industry faced a crisis, eight years later, derogations to the agreement were made, and subsidies to the EU's coal industry persisted until those tied to current production ended at the close of 2018 (Steenblik and Mateo, 2020).

Most other subsidy agreements have followed an approach analogous to the SCM Agreement itself, mainly identifying more precisely which subsidies that under the SCM Agreement would be actionable but would be prohibited under the sectoral agreement.

The OECD's "New Shipbuilding Agreement – Consolidated Text" (September 2005), which was supposed to have replaced the earlier ill-fated "Agreement Respecting Normal Competitive Conditions in the Commercial Shipbuilding and Repair Industry (21 December 1994)" but was abandoned in 2010, would have divided subsidies into prohibited, actionable, and non-actionable subsidies. The prohibited category was extensive and incidence-dependent, and would have included subsidies for the production of ships, subsidies for the continued operation of shipbuilding (including those to cover operating losses, as well as for debt repayment or restructuring), and subsidies for investment, "including those for the creation of new shipyards, those for investment in existing shipyards, and those for the establishment, expansion or addition of production facilities or capacity" (Pagani, 2008: 366-367).[17] It would have also prohibited subsidies for the "modernization, … conversion or technological upgrading of facilities, equipment or machinery, including those with the objective of reducing costs, improving productivity or product quality or meeting environmental standards." The category of actionable subsidies, by contrast, depended on an effects-test, specifically whether the subsidy caused adverse effects to the interests of another party or parties, or caused them "serious prejudice", such as through significant price undercutting.

Regarding steel subsidies, the last draft text of "Elements of an Agreement to Reduce or Eliminate Trade-Distorting Subsidies in Steel", of 12 May 2004, would have prohibited "any subsidy, within the

[17] Note: Much of this language was left between square brackets, indicating that it was merely proposed and was disputed or at least not fully endorsed by one or more of the negotiating parties.

meaning of paragraph 1 of the ASCM, which is specific within the meaning of Article 2 of that Agreement" to the extent that it benefitted, directly or indirectly, steel products, the manufacture of steel products, or a manufacturer of steel products (Pagani, 2008: 185). "As a working hypothesis", exceptions to these prohibitions would have been allowed for subsidies assisting the permanent closure of facilities (in whole or in part), to indemnify damage caused by a natural disaster, and a portion of the costs of research and development. The text also spelled out special provisions for subsidies provided for environmental purposes, training, the recruitment of disadvantaged or disabled workers, small and medium-sized enterprises, disadvantaged regions, and possible preferential treatment for developing economies and economies in transition.

What distinguishes the approach likely to emerge from the current WTO negotiations on subsidies to marine capture fishing is the degree to which prohibited subsidies would be contingent on the state of the fisheries resource, and the areas in which the fishing takes place. Such determinations, moreover, would not be made by the WTO but by other isntitutions. The final text of the WTO agreement on fisheries subsidies was still being hammered out at the time of this writing, but as of July 2020 its basic approach was known enough to be described as follows (Tipping and Irschlinger, 2020: 8, 11, and 16):

- Subsidies would be prohibited when a fish stock is overfished and that stock is either not recovering or there has been a continuous reduction in the stock, unless measures are in place to ensure the stock's recovery, implicitly limiting the prohibition to overfished stocks that are getting worse.
- Subsidies that contribute to overcapacity and overfishing would be prohibited under several circumstances: (1) subsidies for operational and capital costs if the rate of fishing or the capacity of the fleet exceeds sustainable levels as determined by the coastal state or regional fisheries management organization (RFMO), using maximum sustainable yield (MSY) or alternative reference points; (2) subsidies "contingent or tied to" fishing in all ABNJ; all subsidies supporting fishing on the high seas in areas outside the competence of an RFMO; subsidies to reflagged vessels.
- Any subsidies determined to be benefitting vessels or their operators engaged in illegal, unreported (IUU) fishing would be prohibited.

It is still too early to speculate about the shape of any future agreement that addresses fossil-fuel subsidies. Whatever its approach, it would presumably address one important, perhaps the *most* important, subsidy benefitting virgin plastic production: artificially cheap raw materials. Any attempt to phase out subsidies to plastic manufacturing could then focus on the downstream segments of the value chain.

All of the aforementioned sectoral agreements, whether in force, suspended, or still in negotiation, include, would have included requirements, or anticipate the notification of relevant subsidies and supporting data to the WTO or, in the case of the abandoned shipbuilding and steel subsidy agreements, to the OECD. However, only the Agreement on Agriculture, and the ongoing fishery subsidy and fossil-fuel subsidy negotiations had detailed and internationally comparable inventories of subsidy information already available (thanks to ongoing work by staff of the OECD) on government support at the start of the negotiations. Some information on subsidies to shipbuilding and steel manufacturing existed prior to the start of those agreements' negotiations, but that information was neither as systematic nor complete, and had depended – and still depends – on voluntary reporting by governments. Tellingly, one outcome of the abandonment of the second attempt to craft a new shipbuilding subsidies agreement was to strengthen and increase the frequency of the OECD's "Inventory of Government Subsidies and Other Support Measures" to shipbuilding (OECD, 2016a), which is essentially a survey. By contrast, the OECD staff servicing the Working Party on Shipbuilding (WP6), which oversees the work, has on at least one occasion compiled support measures taken by economies not participating in the WP6 Inventory – namely, Brazil, China, India, Indonesia, Malaysia, Singapore, Spain, the United States of America, and Viet Nam – on the basis of "public and specialized sources" rather than country responses to surveys (OECD, 2016b).

There are many reasons for the differences in outcomes across these various attempts to limit sector-specific subsidies. Some of these relate to the number and subsidizing practice of the main countries that would be limited by the agreements, and by the force of broader economic and geo-political currents. The Agreement on Agriculture was regarded by much of the GATT membership at the time as a *sine qua non* to making any further progress on other trade issues. Most of the other agreements have not enjoyed that status.

But another necessary condition has been the existence of detailed data on the nature and size of the subsidies to producers in the sector. As explained by Steenblik (2020), such data were already available when negotiations commenced in all the subsidy negotiations that eventually proceeded to an agreement. Moreover, none of those negotiations depended on data gleaned from formal member-country subsidy negotiations to the WTO. Rather, for a large part, those data had been collected by the OECD.

In short, while the prior existence of a detailed inventory of support measures produced by an independent but trusted source has not always ensured the commencement of serious international discussions to control subsidies to a particular sector, it certainly seems to have increased the likelihood of a successful outcome.

6. Conclusions and suggestions for further work

The foregoing survey provides a first impression of the role that subsidies play, or may play, in lowering the cost of producing primary plastics and finished plastic products. What it suggests is that there is a strong probability that at least some plastics production is benefitting from subsidized inputs, particularly olefins derived from petroleum or natural gas. It seems likely also that some, if not many, plants for producing primary plastics have benefitted from various investment-related subsidies.

At this point, however, it is not possible to cite an estimate of the value of subsidies flowing to particular products. Based on an initial review of countervailing-duty investigations that have been initiated over the last 20 years in response to alleged subsidization of primary plastics or products made of plastics, likely beneficiaries of subsidies include polyethylene terephthalate (PET) resins and films, and perhaps polypropylene resin and polyester fibers.

Certainly, more research would yield a clearer picture. But before advocating that kind of effort, one must answer the question, "To what purpose?". There would be, of course, a value to industrial economists, trade economists and researchers seeking to better understand the environmental consequences of subsidies to having detailed and internationally comparable information on subsidies to plastics. For the purpose of developing better policies, however, the amount and type of information needed would depend on the most likely approach taken towards subsidy reform.

An approach that seeks to restrict subsidies on the basis of their design can benefit from quantifying the scale of the subsidies, but rough estimates would be acceptable. What would be needed more than anything else is information on design characteristics: how, to whom and to what are the subsidies given. An internationally co-ordinated approach in which each country reduced subsidies by an agreed percentage over a designated period, by contrast, would have to meet higher standards of accuracy, replicability, and comparability for the data.

A research agenda that sought to provide data that met the lower standard but could be built on later to achieve the more stringent one is probably the most pragmatic approach. That would mean, as a first step, focusing on the main (e.g., top 20) producing countries and producing companies (e.g., the top 15) of primary plastics and perusing all publicly available sources of information on measures that support plastic production, identifying the segment(s) of the value chain that is (are) benefitting from the measure(s), and documenting whatever information is provided on the value of the subsidy. Such value information is unlikely to be comparable across countries in its raw form, for many reasons: it may refer to the gross value of loan guarantees, rather than their subsidy-equivalent value; or cover more beneficiaries than just the plastics industry; or cover several years. Processing these data to yield comparable estimates can be left to a second phase of the work.

Building an inventory of support measures benefitting primary plastics production would be no small task. Although international databases on subsidies to fossil fuels are available in English, as well as the annual financial reports of countries, the budgetary and tax-expenditure documents[18] of most countries for which English is not an official language are not. To review these documents accurately thus would require a team of researchers who are able to read documents in Arabic, Bahasa Indonesia, Japanese, Korean, Mandarin Chinese, Portuguese, and Russian, at a minimum. Fortunately, many of the same investigators who have undertaken this type of work in support of the fossil-fuel-subsidy databases of the OECD and for the Energy Policy Tracker[19], for example, could be engaged to undertake similar work on measures supporting plastics.

Reducing government support to the plastics industry will likely require a co-ordinated, multi-institutional effort, one that starts with ending support provided by international financial institutions for new investments in new or expanded production facilities. Countries could also pledge, perhaps at first in a non-binding way, to cease providing financing and subsidies to such facilities. Negotiations towards developing more formal, sectoral agreement that is binding could then be pursued at the WTO or, failing that, an inter-governmental organization such as the OECD (which has had some experience – not always successful – at crafting plurilateral sectoral subsidy agreements itself). Whatever approach is taken, the most difficult to address forms of support will be any that are provided on a continuous basis (e.g., via subsidized prices for feedstocks), support provided by sub-national entities, and support provided by state-owned enterprises.

[18] One database that could be drawn upon soon is the Global Tax Expenditure Database (GTED) – a joint project of the German Development Institute and the Council on Economic Policies – which is expected to become publicly available in March 2021.

[19] The core group supporting the Energy Policy Tracker includes staff of the Global Subsidies Initiative (GSI) of the International Institute for Sustainable Development, plus numerous others. See https://www.energypolicytracker.org/about/ .

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Annex 1: EU definition of a "foreign subsidy"

The following is a quote from Annex 1 of European Commission (2020, June 17), "White Paper on levelling the playing field as regards foreign subsidies", COM(2020) 253 final:

"For the purposes of this White Paper, a "foreign subsidy" refers to a financial contribution by a government or any public body of a non-EU State,[20] which confers a benefit to a recipient,[21] and which is limited, in law or in fact, to an individual undertaking or industry or to a group of undertakings or industries.

"Foreign subsidies would fall under any new legal instrument only insofar as they directly or indirectly cause distortions within the internal market. Thus, the current definition covers (i) foreign subsidies granted directly to undertakings established in the EU; (ii) foreign subsidies granted to an undertaking established in a third country where such subsidy is used by a related party established in the EU; and (iii) foreign subsidies granted to an undertaking established in a third country where such a subsidy is used to facilitate an acquisition of an EU undertaking or participate in public procurement procedures.

"The financial contribution can take various forms. For example, it can consist in

- the transfer of funds or liabilities (capital injections, grants, loans, loan guarantees, fiscal incentives, setting off of operating losses, compensation for financial burdens imposed by public authorities, debt forgiveness or rescheduling);
- foregone or not collected public revenue, such as preferential tax treatment or fiscal incentives such as tax credits;
- the provision of goods or services or the purchase of goods and services."

[20] According to this definition, a private body entrusted with functions normally vested in the government or directed by the non-EU government can also grant a "foreign subsidy".
[21] The recipient may be an undertaking established in the EU or in a third country.

Annex 2: List of international financial institutions (IFIs)[22]

The most influential IFIs are multilateral development banks (MDBs). These are institutions created by a group of countries that provide financing and professional advice. MDBs typically have large memberships and include both developed donor and developing borrower countries. MDBs finance projects via long-term loans at market rates, very-long-term loans (also known as credits) at below market rates, and grants. Some, like the Arab Petroleum Investments Corporation, also provide equity investment. The leading MDBs are generally considered to be (in alphabetical order):

African Development Bank (AfDB)
Arab Petroleum Investments Corporation (APICORP)
Asian Development Bank (ADB)
Asian Infrastructure Investment Bank (AIIB)
CAF - Development Bank of Latin America
Eastern and Southern African Trade and Development Bank (TDB)
European Investment Bank (EIB)
European Bank for Reconstruction and Development (EBRD)
Inter-American Development Bank Group (IDB, IADB)
Islamic Development Bank (IsDB)
New Development Bank (NDB)
World Bank

There are also several “sub-regional” MDBs whose membership typically includes only borrowing nations. The banks lend to their members, borrowing from the international capital markets. Because there is effectively shared responsibility for repayment, the banks can often borrow more cheaply than could any one member nation. These banks include:

Black Sea Trade and Development Bank (BSTDB)
Caribbean Development Bank (CDB)
Central American Bank for Economic Integration (CABEI)
Economic Cooperation Organization Trade and Development Bank (ETDB)
Eurasian Development Bank (EDB)
East African Development Bank (EADB)
West African Development Bank (BOAD)

Multilateral financial institutions (MFIs) are similar to MDBs but they are typically treated as distinct entities because of their more limited memberships, and because they often focus on financing certain types of projects.

Arab Bank for Economic Development in Africa (BADEA)
European Commission (EC)
International Bank for Economic Co-operation (IBEC)
International Investment Bank (IIB)
International Finance Facility for Immunisation (IFFIm)
International Fund for Agricultural Development (IFAD)
Nederlandse Financieringsmaatschappij voor Ontwikkelingslanden NV (FMO)
Nordic Investment Bank (NIB)
OPEC Fund for International Development (OFID)

[22] Source: https://en.wikipedia.org/wiki/International_financial_institutions

Annex 3: Plastics subsidies from international financial institutions

Table. Illustrative examples of the face value of loans and loan guarantees provided by a selection of international financial institutions to petrochemical projects in 2018-2020

Face value (USD millions)	Fiscal Year	Mech-anism[1]	Financial institution	Institution Type	Beneficiary	Purpose of financing	Facility location
35	2020	Loan	International Finance Corporation	Multilateral	Indorama Eleme Fertilizer & Chemicals Ltd.	Construct a feed conditioning unit (“FCU”), an add-on gas processing facility, which will help increase polymer production.	Nigeria
88.1	2019	Loan	National Westminster Bank	ECA	Currenta	Acquire a 100% stake interest in Currenta, which manages and operates three chemical sites in Germany.	Germany
188	2019	Loan	Export Development Canada	ECA	Canada Kuwait Petrochemical Limited Partnership	Procurement of various Canadian goods or services	Kuwait
185.4	2019	Loan	Export Development Canada	ECA	Alpek, S.A.B. de C.V.	Procurement of various Canadian goods or services. Alpek SAB de CV is one of the largest PET and PTA producers in the Americas and the sole producer of polypropylene and caprolactam in Mexico.	Mexico
9.8	2019	LG	UK Export Finance	ECA	Oman Methanol Company LLC	Production of methanol. Note: The financing is in the form of "Buyer Credit" (BC): BC is a finance facility in which, normally, a guarantee is given by UKEF to lenders supplying finance to an overseas borrower buying UK goods or services.	Oman
35	2019	Loan	International Finance Corp.	ML	Polymer & Chemicals Limited (“EPCL”)	Phase 3 of the Engro Polymer plant, the only fully integrated chlor-vinyl chemical complex in Pakistan. It is involved in manufacturing, marketing and distribution of poly-vinyl chloride (PVC) and chlor-vinyl allied products, including vinyl chloride monomer. NOTE: Vinyl chloride monomer is among the top twenty largest petrochemicals produced in the world.	Pakistan
432	2019	Loan	Japan Bank for International Co-operation	ECA	Japan Saudi Arabia Methanol Company, Inc. (JSMC)	Joint venture project producing methanol.	Saudi Arabia
76.1	2019	Loan	Export Development Canada	ECA	Methanex Corporation	Construction of a third production line connected to the existing Geismar 1 and Geismar 2 plants on mixed greenfield and brownfield land, owned by Methanex. Methanex Corporation is a Canadian company that supplies, distributes and markets methanol worldwide	USA (Louisiana)

Face value (USD millions)	**Fiscal Year**	**Mech-anism[1]**	**Financial institution**	**Institution Type**	**Beneficiary**	**Purpose of financing**	**Facility location**
103	2018	Loan	Japan Bank for International Co-operation	ECA	PT. Chandra Asri Petrochemical (CAP) Tbk	Establish a manufacturing plant for high-density polyethylene (HDPE), linear low-density polyethylene (LLDPE), and metallocene linear low-density polyethylene (mLLDPE) inside its petrochemical complex in Cilegon, located in the western part of the island of Java.	Indonesia
68.8	2018	LG	Nippon Export and Investment Insurance	ECA	PT. Chandra Asri Petrochemical (CAP) Tbk	To build a new polyethylene plant with capacity of 400 KTA in Cilegon, West Java, bringing CAP's total polyethylene production capacity to 736 KTA.	Indonesia
350	2018	Loan	Bank of China	Bilateral	Refinery and Petro-chemical Integrated Development (RAPID) Bridge Financing	Development of a plant to produce specialized chemicals such as synthetic rubbers and high-grade polymers for export to the rest of Asia.	Malaysia
350	2018	Loan	Industrial and Commercial Bank of China	Bilateral	Refinery and Petro-chemical Integrated Development (RAPID) Bridge Financing	Development of a plant to produce specialized chemicals such as synthetic rubbers and high-grade polymers for export to the rest of Asia.	Malaysia
75.1	2018	Loan	Export Develop-ment Canada	ECA	SKI Carbon Black (Mauritius) Limited	Procurement of various Canadian goods or services. Carbon black is an important additive used in plastics.	Mauritius
76.6	2018	Loan	Export Develop-ment Canada	ECA	Alpek, S.A.B. de C.V.	Support for working capital and general corporate purposes. Alpek SAB de CV is one of the largest PET and PTA producers in the Americas and the sole producer of polypropylene and caprolactam in Mexico.	Mexico
76.6	2018	Loan	Export Develop-ment Canada	ECA	Alpek, S.A.B. de C.V.	Procurement of various Canadian goods or services. Alpek SAB de CV is one of the largest PET and PTA producers in the Americas and the sole producer of polypropylene and caprolactam in Mexico.	Mexico
35	2018	Loan	German Investment & Development Corp.	Bilateral	Eleme Petrochemicals Plant Expansion	Development and construction of a urea complex at Port Harcourt, Nigeria. Once completed, the complex (which adjoined the existing 1.4million TPA urea complex) will be the largest integrated urea production facility in the world. Urea is used as a fertilizer, but also as a feedstock for plastic.	Nigeria
35	2018	Loan	Proparco	ECA	Eleme Petrochemicals Plant Expansion	Development and construction of a urea complex at Port Harcourt, Nigeria.	Nigeria
100	2018	Loan	CDC Group Plc	ECA	Indorama Eleme Petrochemicals Plant Expansion	Development and construction of a urea complex at Port Harcourt, Nigeria.	Nigeria
125	2018	Loan	European Investment Bank	Multilateral	Nigeria Fertilizers; Eleme Petrochemicals	Development and construction of a urea complex at Port Harcourt, Nigeria.	Nigeria

Face value (USD millions)	Fiscal Year	Mech-anism[1]	Financial institution	Institution Type	Beneficiary	Purpose of financing	Facility location
70.7	2018	Loan	African Development Bank	Multilateral	Indorama Eleme Fertilizer Project II	Development and construction of a urea complex at Port Harcourt, Nigeria.	Nigeria
120	2018	Loan	International Finance Corporation	Multilateral	Eleme Fertilizer II (Petrochemicals Plant Expansion)	Development and construction of a urea complex at Port Harcourt, Nigeria.	Nigeria
120	2018	Loan	International Finance Corporation	Multilateral	Eleme Fertilizer II (Petrochemicals Plant Expansion)	Development and construction of a urea complex at Port Harcourt, Nigeria.	Nigeria
300	2018	Loan	New Development Bank	Multilateral	Sustainable Infra–structure in Relation to “ZapSibNefteKhim” Project (SIBUR)	General infrastructure and environmental-protection measures. Once fully operational the complex would cover Russia’s demand for most polyolefins and increase export capacity of Russia’s petrochemicals sector.	Russian Federation
63.3	2018	Loan	National Commercial Bank	Bilateral	FPC Yanbu Petrochemical Complex	FPC Yanbu Petrochemical Complex in Saudi Arabia.	Saudi Arabia
319.9	2018	Loan	Saudi Industrial Development Fund	Bilateral	FPC Yanbu Petrochemical Complex	FPC Yanbu Petrochemical Complex in Saudi Arabia.	Saudi Arabia

1. LG = loan guarantee. 2. ECA = export-credit agency. *Note:* The table makes no claim of being exhaustive.

Source: Steenblik, R. (2020), Annex 1. Data extracted from Oil Change International’s “Shift the Subsidies Database”, http://priceofoil.org/shift-the-subsidies/ (version as of 13 November 2020), included over 146 petrochemical projects since 2013, a selection of which are noted here for illustrative purposes.

[i] Goods Jobs First Subsidy Tracker: Discover Where Corporations are Getting Taxpayer Assistance Across the United States. https://www.goodjobsfirst.org/subsidy-tracker

HOW CAN INTERNATIONAL TRADE POLICY HELP TACKLE PLASTIC POLLUTION?

POLICY OPTIONS AND PATHWAYS

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THE GRADUATE INSTITUTE GENEVA

GLOBAL GOVERNANCE CENTRE

How can international trade policy help tackle plastic pollution?

Trade and trade policies need to be better aligned with global efforts to reduce plastic pollution. This report brings together empirical evidence of the intersections between trade, plastics and plastic pollution with analysis of how trade policies could support international efforts to tackle plastic pollution. It provides a strategic assessment of how trade policies could support international efforts to reduce plastic pollution, suggests policy options and recommends pathways for aligning trade and trade policy with plastic pollution goals with the greatest prospect for meaningful outcomes across United Nations processes, multilateral environmental agreements, trade diplomacy, and others international processes and economic organisations, as well as at the regional and domestic level.

The challenge

- There has been a **20-fold increase** in plastic production over the past 50 years.
- Projections foresee a further **quadrupling** of annual plastic production by 2050
- Recycling has reached only **9 per cent** of plastic waste produced since the 1950s.
- International trade is central to the expanding global plastics economy; trade across the life cycle of plastics is worth over **USD 1 trillion** or more than 5% of global trade.
- International trade in avoidable, unnecessary, problematic and hazardous plastics includes an array of single-use plastics and plastic packaging, **71 per cent of which cannot be recycled**.
- Currently, policy frameworks on plastic pollution and on trade are **incoherent and often contradictory**.
- Existing trade policy measures targeting plastic pollution offer a foundation to build on but are **disjointed, ad hoc, uncoordinated, and lack transparency.**

Recommendations

Trade policies should be better aligned with global efforts to reduce plastic pollution. Enhanced international cooperation on trade dimensions could support and complement wider international environmental efforts to tackle plastic pollution.

This report recommends governments and stakeholders take cooperative action to:

- Reduce trade in **avoidable, unnecessary, problematic and environmentally harmful plastics**.
- End trade in **hazardous, mixed and contaminated plastic waste** while monitoring and facilitating responsible trade in high-value, recyclable plastic waste destined for certified environmentally sound recycling facilities.
- Promote trade in environmentally sustainable **non-plastic substitutes**; goods and services that promote reuse and refill systems; certified 'plastic free' and recycled plastic products; and goods and services for environmentally sound and locally appropriate waste management and recycling.

To enable progress, trade policy recommendations for governments and stakeholders in this report include:

- Address data gaps on **trade flows** relevant to plastic pollution and improve **transparency, reporting and notifications** on plastics-related trade measures.
- Boost **trade-related technical assistance and capacity-building for developing countries** on trade policy design and implementation relating to plastic pollution.
- Support the development and implementation of **international standards** and sustainability criteria for production and trade of plastics, reuse and refill systems, environmental labelling, recycling, and substitute materials.
- Increase transparency of government **subsidies to fossil-fuel feedstocks and virgin plastic production** and adopt commitments to end future subsidies.

In pursuit of these recommendations, the report suggests governments should act through five pathways:

- International environmental processes, including the Basel and Stockholm Conventions, and the UN Environment Assembly (UNEA), including through discussions of a new global agreement on plastic pollution, called for by over 100 countries.
- At the **World Trade Organization**, including through its Informal Dialogue on Plastic pollution and Environmentally Sustainable Plastics Trade, seeking synergies with the WTO's 'Joint Statement Initiative' on Trade and Environmental Sustainability, and the work of WTO's regular committees.
- In other **international fora**, such as the World Customs Organization (WCO), United Nations Conference on Trade and Development (UNCTAD), Interpol, and the OECD.
- **Through regional cooperation** to advance common

approaches to trade policies aligned with plastic pollution reduction goals

– **Nationally** to harness trade measures to reduce plastic pollution and safeguard plastic pollution reduction policies in bilateral trade negotiations.

This executive summary draws together key findings and recommendations from the report. It reviews the need for a system change approach to addressing plastic pollution and transforming the plastics sector (section 1), why trade matters to plastic pollution (section 2), why trade *policies* matter to plastic pollution and how stronger international cooperation on trade could help (section 3). It concludes with recommendations on policy priorities and pathways (section 4).

1. Setting the scene

1.1. Plastics, the pollution crisis and the need for a system change approach

At the heart of the plastic pollution problem is the massive 20-fold growth in plastic production over the past 50 years. Recent projections foresee a quadrupling of annual plastic production by 2050.[i] The growing production and consumption of plastics is also due to their versatility – they can serve a vast array of useful purposes – and their low cost.

The diversity of plastic polymers and products, and the many combinations of plastics and other materials, means that the types and scale of pollution associated with their production, use and disposal varies as does the range of possible options for reuse, recyclability, and waste management. Since the 1950s, only 9 per cent of plastic waste produced globally has been recycled; today, most plastic waste is either landfilled, incinerated or discarded in the natural environment.[ii]

As the world's production of plastics has soared, so too has the scale and urgency of the plastic pollution crisis. In recent years, impact of marine litter and and microplastic pollution on the world's marine ecosystems has captured the attention of citizens, governments and the media around the world, spurring numerous calls for stronger international action. For millions of people around the world who depend on oceans for their livelihoods, plastic pollution has a direct economic and social impact. At the same time, there are rising concerns about the environmental, economic, health and human rights impacts of plastic pollution on land and in the air across the life cycle of plastics. Around the world, stakeholders concerned about environmental justice and human rights highlight challenges of exposure to toxic chemicals in communities that live alongside production plants, incineration facilities, and plastic landfills. Amidst efforts to reduce the climate crisis, scrutiny of the carbon footprint of the expanding plastics sector is also growing, especially in light of forecasts that the plastics sector could account for almost 20 per cent of the world's carbon budget by 2040.[iii]

To address this problem, governments and stakeholder partnerships around the world are pursuing a range of policies and initiatives to prevent and clean up the leakage of plastic into the environment; phase out unnecessary, avoidable and problematic use of plastics; incentivize the use of alternative plastics where these can reduce environmental harm; and promote substitutes (from 'reduce and refill retail models' to non-plastic packaging). A growing number of businesses and consumer partnerships are also taking voluntary action to reduce their plastic footprint. Among a broad diversity of these stakeholders, the vision of a more circular plastics economy, which moves from a take-make-waste model to a reduce-reuse-recycle approach resonates widely as a framework for action.

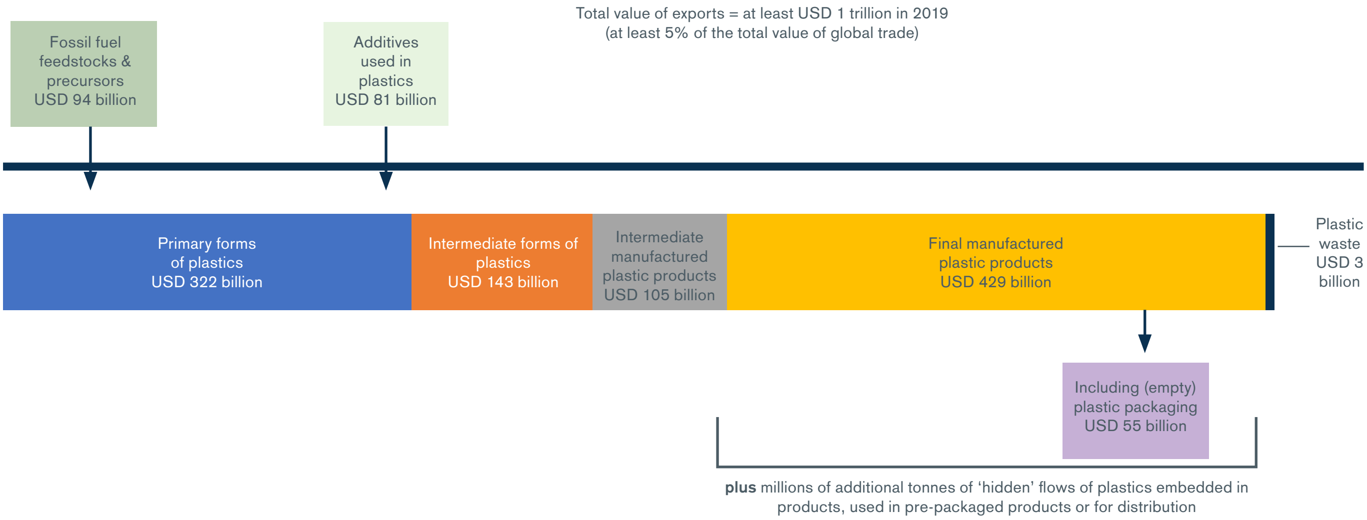
Importantly, there is also rising attention to supply-side factors driving the expansion of the plastics sector and plastic pollution; a key problem being the low price of subsidized fossil fuel-based feedstocks – mainly ethylene and propylene – which the petrochemicals industry uses to produce virgin primary plastics. So long as conventional virgin plastic polymers are cheap, market incentives to reduce production of single-use plastics, move to refill systems, recycle plastic, switch to using recycled material, and shift to substitutes, will be limited.

Whether focus is on ocean plastic pollution or the contribution of the plastics sector to climate crisis, there is a need to tackle the plastic pollution problem both downstream and upstream. Indeed, the latest scientific research emphasises that reducing plastic pollution will require a 'system change' approach, where four strategies are pursued in parallel: 1) reduce, 2) substitute, 3) recycle, and 4) dispose.

1.2. Tackling plastic pollution demands attention to the sector's political economy

Any effort to reduce plastic pollution must acknowledge the reality that enormous economic and commercial interests are driving the USD 569 billion plastics economy.[iv] Primary production of plastics is dominated by 20 major petrochemical companies, underpinned by private and state-owned oil and gas companies, which are some of the world's most politically influential. The plastics industry is financed by an array of international investors and the largest users of plastics are some of the world's largest brands and retail companies, with extensive global supply chains, employing millions of people around the world.[v] The plastics sector as a whole is estimated to employ over 180 million workers globally, with the majority in the developing world, and an uncounted number of informal sector workers involved in waste picking and sorting.[vi] Entire communities, cities or regions may depend economically on activities from plastics production and manufacturing to waste picking.

Figure i. Trade across the life cycle of plastics (USD billions, 2019)



Source: Authors' compilation using 2019 UN Comtrade data, building on analysis by Barrowclough et. al. (2020) *op cit,* p. 17.

In this context, efforts to reduce plastic pollution that do not grapple with the political economy of the plastics sector (i.e., combining voluntary actions with regulations and policies to provide market incentives for innovation), inculding support for the transition of impacted workers, are doomed to fail. Transforming the global plastics economy will require not only international environmental cooperation but also integration with economic policy approaches in regard to taxation, government subsidies, finance, trade, and investment policies. It will also require action from companies at the international and regional level that are supply chain leaders.

2. Why trade matters to plastic pollution

Trade plays a central role in the global plastics economy. **In 2019, the value of global trade in plastics was more than 1 trillion dollars (or 5 per cent of global trade)**. International trade occurs across the life cycle of plastics – from trade in feedstocks and plastic polymers to single-use plastic products and plastic waste (see Figure i).

Notably, these figures omit the vast volumes of 'hidden' trade in plastics that are not captured by international trade statistics. This hidden trade includes cross-border flows of plastic packaging associated with specific products (pre-packaged food and beverages); packaging used in the distribution and transportation of products, including business to business (B2B) packaging; or plastic embedded in countless products that are widely traded and consumed across the world – from cars to household appliances, and construction materials.

Although the volume of such 'hidden plastics' traded internationally is massive, these are not captured in official trade statistics. In a first effort to quantify such hidden flows, this report estimates that trade in hidden plastics added at least a further 70 million metric tonnes (MT) to plastic trade flows in 2018.[vii] Hidden trade flows of plastic packaging, for instance, exceeded the trade flows of empty plastic packaging that are traceable using official trade statistics.

At key points along the plastics value chain, trade represents a significant share of overall global production. In 2019, for instance, exports of primary plastics represented an estimated 56 per cent of the world's primary plastics production.

By volume, over 250 million MT of plastic at different points in the plastic life cycle – from primary plastics and final consumer products to plastic waste – crossed international borders in 2019.

Plastic trade flows are relevant to plastic pollution for two core reasons:

1. **Trade flows of plastic waste to countries with inadequate waste management capacity exacerbate leakage of plastics into the environment;**

2. **Trade in plastic products, as well as products containing plastics and pre-packaged in plastics, adds to the waste management burden of importing countries.**

3. Why trade policies matter to plastic pollution and why stronger international cooperation is needed

For good and ill, trade policies play an important role in shaping international trade in plastics. Many countries use trade-related measures and policies, both at and behind the border, to support the expansion of plastic production and exports. This includes, for example, the provision of government subsidies to plastic producers, including through export credit agencies, as well as the negotiation of trade agreements that reduce barriers to trade for plastics. Powerful exporters of plastic products and waste use bilateral trade negotiations, for instance, to ensure access to markets for plastic wastes and products. This report identifies examples of how such actions can frustrate or present barriers to progress on national efforts to reduce plastic pollution.

At the same time, many countries are using trade and trade-related policies to help reduce plastic pollution. From 2009-2020, for instance, governments notified the WTO of over 140 environment-related trade measures taken to bolster national efforts to tackle plastic pollution, most of which have been taken by developing countries.[viii] These included import tariffs and restrictions on certain types of plastic waste and plastic products, as well as import bans.[ix]

In addition, numerous domestic measures taken to reduce plastic pollution and promote a more circular plastics economy have international trade dimensions. These include: environmental standards and labelling requirements for plastic products and production processes; government procurement policies; regulations to improve supply chain transparency; environmental taxes and charges on plastic production, consumption and waste; and extended producer responsibility (EPR) schemes (including deposit-refunds and product take-back schemes).

Current efforts to use trade policy and measures to support efforts to address plastic pollution are disjointed, ad hoc, uncoordinated, and lacking transparency – all of which undermine their effectiveness. Key shortfalls and gaps in international coordination, transparency and coherence on trade-related aspects of plastic pollution are summarised in Box i. The patchwork of existing national actions does, however, provide an important foundation for international cooperation in favour of greater coherence and enhanced impact.

Existing efforts at international cooperation on plastic pollution and trade

Reducing plastic pollution demands government action at the national level through ambitious environmental goals, well-designed and enforced environmental laws and regulations, as well as effective and adequately resourced institutions. In the absence of sufficient capacity-building and technical support, many governments struggle to implement and enforce national policies to reduce plastic pollution or related international commitments.

At the same time, plastic pollution is a complex, cross-sectoral and transboundary challenge that no single country can address alone. The transboundary nature of the plastic pollution crisis means that international coordination and cooperation are vital. Although calls for stronger international cooperation have yielded important

Box i. Shortfalls in international cooperation on trade and plastics pollution

- **Data gaps** – no common platform exists for publicly accessible data, monitoring and analysis of trends in global plastic production, trade flows and supply chains, or on their implications for trade policy design.
- **Policy incoherence** – trade policy frameworks are not well aligned with domestic plastic pollution reduction measures.
- **Poor coordination** – national approaches to trade and plastic pollution are developed in an uncoordinated, piecemeal and disjointed manner. Companies and exporters – including those working to reduce their plastics footprint – face increasingly complex and diverging regulatory frameworks across global supply chains.
- **Weak transparency of relevant trade policie**s – there is poor transparency of the growing array of domestic plastics-related trade policies, environmental measures and private sustainability standards.
- **Neglected development dimensions** – inadequate attention is paid to the trade-related challenges and opportunities for developing countries in regard to reducing single-use plastics, establishing reuse and refill systems, improved plastics design and manufacturing, managing trade in plastic waste, and building waste management capacity.
- **Insufficient cooperation among international organizations** – insufficient cooperation among international organizations and processes working on the trade-related aspects of plastic pollution and the potential for trade policy to support efforts to tackle plastic pollution.
- **Inadequate research and policy analysis** – beyond trade in plastic waste, there are few studies of the intersection of trade in plastics and plastic pollution, and considerable gaps in evidence and analysis of policy solutions. More broadly, there has been almost no scholarly attention to how trade policy can support international efforts to reduce pollution across the life cycle of plastics.

government and stakeholder initiatives, the proliferation of fragemented, voluntary approaches is not delivering the rapid, comprehensive solutions required to tackle growing plastic pollution.

International cooperation on plastic pollution currently suffers from important blindspots. Most international efforts focus on the end-of-life of plastics, with far less attention to the drivers of expanding plastic production and pollution; pollution across the life cycle of plastics; and the upstream policy measures needed to reduce production of avoidable, unnecessary and problematic plastics.

Over the past few years, the UN Environment Assembly has unanimously adopted several resolutions urging action to bolster international cooperation on marine plastic pollution. In 2021, more than 100 UN members have joined a call for the start of negotiations on a new global agreement on plastic pollution.[x]

While the ambition and purpose of the proposed treaty (i.e., focused on marine litter only or on wider challenges of plastics pollution) remain matters for negotiation, the call for action does signal a recognition that tackling the plastic pollution crisis with the urgency required will demand more effective global environmental governance. This must be guided by environmental expertise, to define and implement clear goals, targets and timeframes for cooperative, mutually-reinforcing actions, and to connect the vast array of currently disjointed domestic and international efforts. Further, there is a growing emphasis among stakeholders on the need for a life cycle approach to the challenges of plastic pollution and the development of clear shared global goals.[xi] Notably, recent proposals for a global plastic pollution treaty recognise the relevance of international trade as well as the interface between trade policy and efforts to reduce plastic pollution.[xii] Looking ahead, a global plastic pollution treaty offers the potential for a multi-layered framework that would include targets and provisions for more environmentally sustainable trade across the plastics life cycle and priorities for trade-related cooperation.

Status quo on trade-related cooperation

In recent years, growing scrutiny of trade in plastic waste has put the issue of 'trade and plastic pollution' on the map. At the heart of concern has been the realisation that plastic waste exports often comprise low-value, mixed, contaminated and hazardous plastic waste, with the result that the vast majority of exported plastic waste is not managed in an environmentally sound manner in the destination country, far less recycled.[xiii]

At present, the key international instrument that addresses the trade-related aspects of plastic pollution is the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes, which was amended in 2019 to more specifically respond to challenges related to trade in plastic waste. Among other measures, the 'plastic waste amendments' introduce export restrictions on contaminated and unrecyclable plastic waste.[xiv] Existing efforts are having mixed results. Restrictions on the import of plastic waste by China and a number of developing countries, has put important pressure on exporting countries to reduce and better manage plastic waste at home, but have also led to a dispersal of waste exports to a broader range of countries, many of which lack environmentally sound waste management capacity. Efforts to implement the new international commitments under the Basel Convention are at an early stage and will take considerable investment to implement. Although some countries are not implementing export bans, illegal trade in plastic waste is also growing.[xv]

Another international effort relevant to trade is the Stockholm Convention, which bans or restricts the production, use and trade of certain Persistent Organic Pollutants (POPs), including a number of additives, such as flame retardants and plasticizers, used in plastics.[xvi]

While important, these existing trade-related efforts do not address all aspects of plastic trade that are important to reducing plastic pollution, nor do they address trade-related challenges and opportunities across the life cycle of plastics for reducing plastic pollution.

In the meantime, interest in how trade policy could support and complement international efforts to reduce plastic pollution and support a more circular plastics economy is growing.

In 2020, a group of WTO Members launched the Informal Dialogue on Plastic Pollution and Environmentally Sustainable Plastics Trade at the WTO. Now cosponsored by 19 WTO Members from developed and developing countries, including China – a key player in global plastics production and trade – as well as Australia, Canada, New Zealand, Switzerland, the UK and the Russian Federation, along with a diverse set of developing countries, including Barbados, Costa Rica, Ecuador, Fiji, the Gambia, Jamaica, Kazakhstan, Morocco and Thailand.[xvii] Their dialogue process has already attracted participation from key countries with the power to make a tangible contribution to reducing plastic pollution by cooperating on some carefully chosen trade policy aspects.

More broadly, a group of 55+ WTO Members has cosponsored the Trade and Environmental Sustainability Structured Discsusions (TESSD), again engaging both developing and developed countries as cosponsors.[xviii] The interest of a number of WTO members in reviving efforts to promote trade in environmental goods and services, and promoting a more circular economy, also provides opportunities for advancing trade cooperation on plastic pollution.

Notably, there is also growing recognition of the need for stronger collaboration and coordination across the range of international organisations and processes that address plastic pollution, and also among ministries at the national level, including environment and trade ministries.

Figure ii. Possible outcomes from trade policy cooperation across the plastic life cycle, by lever

Upstream

Reduce

Reduce trade in avoidable, unnecessary and problematic plastics

Reduce virgin plastic production and trade

End trade in plastic waste that is recyclable and destined for certified environmentally sound recycling facilities.

Substitute

Promote non-plastic substitutes and non-plastic retail and delivery models

Recycle

Promote trade in better designed recyclable and recycled plastics and products

Promote trade in goods and services that increase capacity for waste collection, recycling and product testing equipment.

Facilitate markets for environmentally sound recycling

Dispose

Promote trade in environmentally sound, locally appropriate, waste collection and management services,

Promote trade in goods and services for waste collection, recycling and environmentally sound waste management

Inform and support an enabling trade policy environment

Downstream

4. Recommendations on policy priorities and pathways

This report reviews a broad array of options for harnessing trade policy to support and complement international efforts to tackle plastic pollution, focusing on four levers critical to progress: reduce, substitute, recycle and dispose (see Fig. ii).

4.1. Recommendations on policy priorities

Our recommendations on policy priorities emerged from consultations with experts from government, international organizations, stakeholder groups and the research community. These priorities include specific interventions along the life cycle of plastics and can be achieved over varying time frames: short-term (1-3 years); medium-term (3-5 years) and long-term (5 years +) (See Figure iii). The priorities are clustered in two broad categories according to whether they would have direct or indirect impacts on reducing plastic pollution (see Figure iii):

Incubate and catalyse action (direct impacts)

The four key priorities to incubate and catalyse action proposed in this report are as follows:

1. Reduce trade in avoidable, unnecessary, problematic and other environmentally harmful plastics, including through coordinated restrictions, phase-outs or bans of trade in single-use plastics and packaging most associated with plastic pollution; hazardous plastics; and products associated with microplastic pollution. These efforts can start with those that are already restricted or banned domestically.

2. End trade in hazardous, mixed and contaminated plastic waste (i.e., including by promoting implementation of the Basel Convention's 'plastic waste' amendments), while monitoring and facilitating responsible trade in high-value recyclable plastic waste destined for certified, environmentally sound recycling facilities.

3. Promote trade in goods and services that can reduce plastic pollution, including environmentally sustainable substitutes, including non-plastic substitutes (e.g., both raw materials and manufactured products from natural fibres), reuse and refill systems, certified 'plastic free' products and recycled plastics, as well as technologies for environmentally sound waste collection, recycling and waste management that are appropriate to local circumstances and support local employment.

4. Increase transparency of government subsidies to fossil-fuel feedstocks and virgin plastics production, adopt commitments to end future subsidies, and explore transboundary cooperation on taxation of virgin primary plastics.

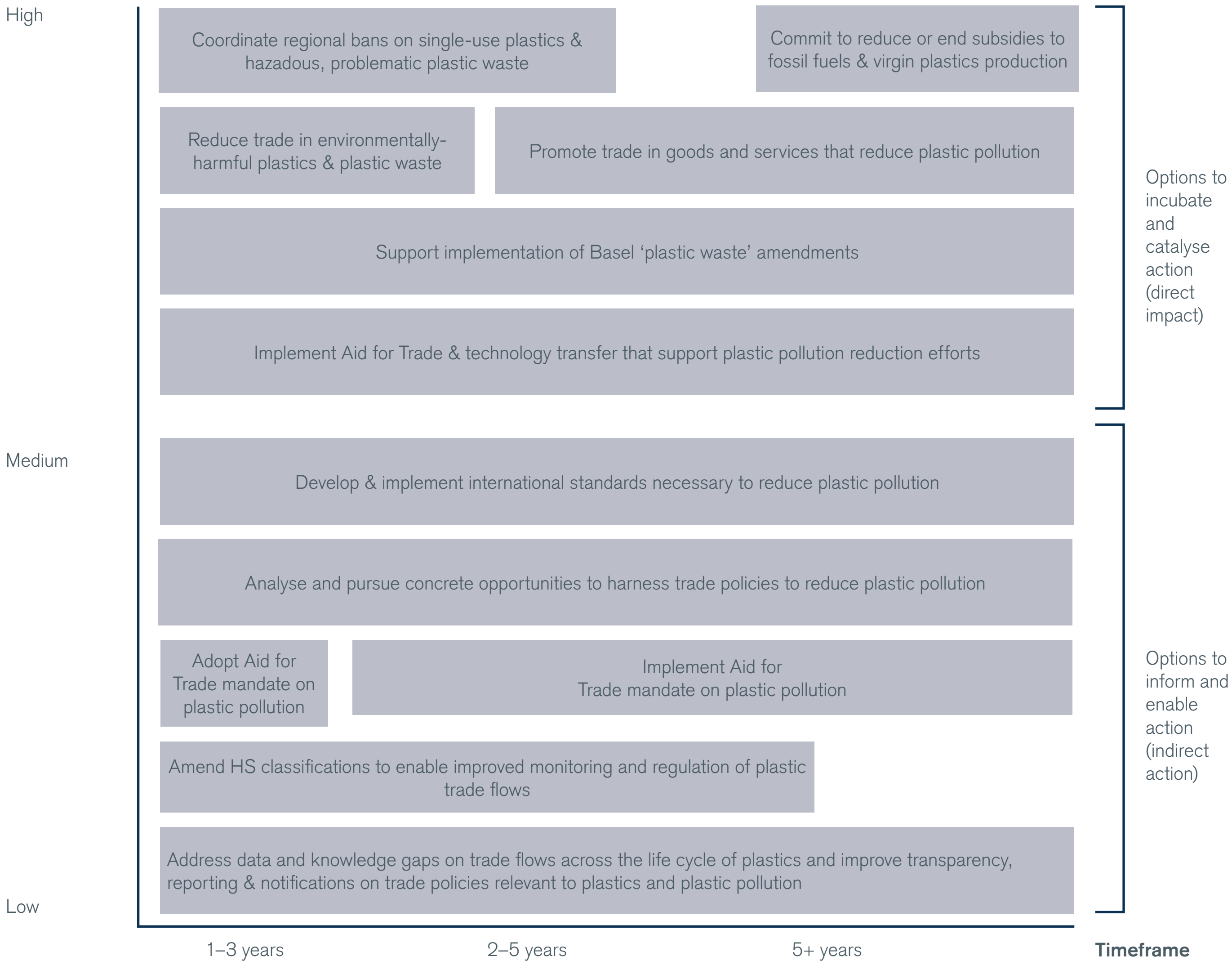
5. Coordinate policies relevant to more sustainable plastics trade, such as through transnational approaches to extended producer responsibility (EPR); improved transparency and cooperation of sustainability criteria and environmental standards for plastics, and of policies and regulations for environmentally sustainable packaging.

Inform, enable and support action (indirect impacts)

These important priorities to facilitate effective policy action on trade-related issues could be advanced in a relatively short period (1-3 years) and then sustained, and comprise five enabling actions:

1. Address gaps in data on trade flows across the plastics life cycle and information-sharing relevant to plastic pollution, mapped against data and metrics of plastic production, consumption, and environmentally sound waste management capacity, and improve transparency, reporting and notifications on plastics pollution-related

Figure iii. Impacts and timeframe for selected trade policy recommendations



trade measures.

2. Invest in detailed analysis and information-sharing on trade policy options that can support reductions in plastic pollution, including through identification of opportunities for global and regional cooperation, as well as on how and where trade rules and policies can impede plastic pollution reduction efforts.

3. Conduct sustainability impact assessments of proposed and existing bilateral and regional trade agreements to review the environmental impacts of plastics trade on both exporting and importing countries. In addition, compile national and regional case studies on the environmental impacts of trade in plastics.

4. Boost trade-related technical assistance and capacity-building for developing countries on the design and implementation of trade policies related to plastic pollution and a more environmentally sustainable, circular plastics economy (e.g., Green Aid for Trade).

5. Support development and implementation of international standards and sustainability criteria for the production and trade of plastics, reuse and refill systems, environmental labelling, recycling, and substitutes. This should include international standards for disclosure of information on the material content of plastic products that cross borders, as well as for the design of packaging to reduce the volume and variety of plastic packaging used in international trade.

4.2. Recommendations on pathways

Strategic trade-related cooperation on these priorities could be advanced through a range of international processes and organizations in both the environmental and economic arena. There is no single inter-governmental venue or process for advancing these priorities.

This report identifies five pathways through which trade-

Figure iv. Priorities at the WTO

Incubate and catalyse action (direct impact)
Promote policy coherence through pledges to restrict or ban trade in hazardous, avoidable, unnecessary, problematic, and environmentally harmful products that are already restricted or banned domestically (including but not limited to single-use plastics).
Adopt voluntary pledges, targets and coordinated approaches to reduce trade in hazardous, avoidable, unnecessary, problematic and environmentally harmful plastic products and to reduce production and trade in virgin plastics (including pellet loss along international supply chains).
Pledge to reduce unnecessary, avoidable and problematic plastic packaging associated with international trade and to better coordinate on policies for more environmentally sustainable packaging, including consideration of challenges arising for developing country exporters.
Promote trade in environmental goods and services that can help reduce plastics pollution, focusing on non-plastic substitutes and environmentally sound, locally appropriate waste management systems, recycling technologies, and certain recycled plastics.
Support efforts to implement the Basel Convention's provisions to regulate trade in hazardous, contaminated and mixed wastes in a transparent and effective manner, and facilitate trade in recyclable plastic wastes destined for certified, environmentally-sound recycling facilities.
Inform, enable and support action (indirect impact)
Adopt and implement an Aid for Trade mandate to support developing countries to use trade policies and measures to reduce plastic pollution; promote trade in non-plastic substitutes and the use of reuse and refill systems; upgrade to meet sustainability standards relevant to reducing plastic pollution; support capacityy building for customs authorities to monitor plastics trade and implement relevant regulations at the border; and engage in negotiations to expand their access to waste management and recycling technologies.
Enhance transparency, information-sharing and coordination on trade measures, taxes, and technical regulations related to plastic waste and products in order to highlight best practices and enhance effectiveness in achieving plastic pollution goals. Working with other international organizations and stakeholders, establish a monitoring mechanism on trade flows and environment-related trade measures relevant to plastics pollution.
Identify key areas where improved international trade statistics and classifications are needed to enable monitoring and regulate international trade across the life cycle of plastics, especially trade flows most relevant to plastic pollution, calling for action where relevant to amend the World Customs Organizations (WCO) Harmonised Commodity Description and Coding Systems (HS).
Identify key areas where internationally-agreed standards are needed to underpin more environmentally sustainable plastics trade, as well as challenges for developing countries, calling for work on these topics in relevant international fora, such as the UN Environment Assembly and the ISO.
Encourage dialogue and information exchange on: i) environmentally harmful subsidies to the plastics sector; ii) trade-related strategies for a shift toward a more circular economy (e.g., coordination of EPR systems and efforts to promote reuse and refill systems); iii) technology-related barriers to developing country efforts to reduce plastics pollution; iv) strategies to support transparency of environmental considerations across global plastics supply chains, including disclosure of plastic footprints and leakage.

related cooperation on these options could be advanced:

– Trade-related action through **international environmental processes**, such as the implementation of plastic waste amendments to the Basel Convention and further upgrading of its rules on plastic waste; adding relevant plastics-related hazardous chemicals to the list of those for which trade is banned or restricted under the Stockholm Convention; setting shared goals and targets for plastic pollution reduction through UNEP and its UN Environment Assembly, including potentially through a proposed global plastic pollution treaty, that can provide a policy framework for action on trade. This would include outlining priorities and targets that can guide efforts to harness trade policy to support reduced plastic pollution.

– Support action on plastic pollution at the **World Trade Organization** through the Informal Dialogue on Plastic Pollution, seeking synergies with the WTO Trade and Environmental Sustainability Structured Discussions, including through the conclusion of Ministerial Statements and workplans for ways forward at the WTO's Ministerial Conference at the end of 2021. Complement this work with discussion in relevant WTO regular committees. Drawing from the policy options reviewed in this paper, recommendations on politically feasible, impactful and relevant options are presented in Figure iv.

– Support complementary action in related **international fora** such as:

  - World Customs Organization (WCO): Amend the Harmonized System of international trade classifications to enable more granular tracking of trade flows in plastics, focusing on the round of negotiations starting in 2021, and support enhanced work on plastics as part of WCO's Green Customs initiative.

  - United Nations Conference on Trade and Development (UNCTAD): Develop and maintain an online database on trade in plastics; strengthen work to support the technical capacity of developing countries to implement trade policies that reduce plastic pollution, support ocean economies and promote circular economies; support analysis of options for more sustainable manufacturing and design of plastics in developing countries; and promote opportunities for developing countries in establishing reuse models and non-plastics substitutes, including through enhanced South-South cooperation on liberalisation and by supporting developing country engagement in related efforts at the WTO.

  - Interpol: Support efforts to monitor and end illegal trade in plastic waste.

- OECD: Encourage research on national experiences and possible options for using trade policy and measures to support plastic pollution goals; contribute OECD data and analysis to efforts to understand plastic value chains; and monitor and analyse subsidies to the plastics sector.

– Support **regional coordination and cooperation**, including by:

- Supporting regional approaches and exchange of best practices on trade policy frameworks for plastic pollution, such as through the Pacific Islands Forum, the Caribbean Community, and the East African Community. Regional approaches could also be pursued within the context of regional trade arrangements, such as the African Continental Free Trade Agreement, and to guard against bilateral and regional trade negotiations with powerful plastic exporters being used to weaken commitments and efforts to reduce plastic pollution.

- Harnessing voluntary settings, such as the Asia-Pacific Economic Co-operation (APEC), to test and incubate options for regional cooperation on trade-related aspects of plastic pollution.

– **National action** to harness trade measures to reduce plastic pollution, including through implementation of the Basel Convention plastic waste amendments, and safeguard plastic pollution policies in bilateral and regional trade arrangements.

Finally, we emphasise the importance of cooperation across international processes and forums. On plastic production use and waste, sustainability standards and monitoring, for instance, enhanced cooperation among key international processes working on different aspects of the issue will greatly enhance impact.

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Restrictions to Transboundary Movements of Plastics and WTO Law: A Policy Brief

By

Dr. Ilaria Espa[1] and Brigitta Imeli[2]

Introduction

This policy brief aims to inform discussions on restrictions on transboundary movements of certain plastic products and plastic waste. It outlines the limits set by WTO law to impose import and export restrictions on plastic products and plastic waste. It focuses on WTO rules that discipline the use of quantitative restrictions and technical specifications, due the recent proliferation of such instruments, and reflects on the policy space left to WTO members to impose such trade-restrictive measures on plastics.

It begins by introducing the current policy context – notably the growing use of trade restrictions related to the transboundary movement of plastic waste, and the interest among some WTO Members in seeking ways to limit the trade of plastic products and inputs that are prohibited or restricted on the domestic market. There is, for example, interest in proposals to reduce the flow in international trade of unnecessary and problematic single use plastics, such as by establishing voluntary targets to reduce the proportion of plastic packaging used and embedded in international trade.

Governments seek to promote policy coherence between domestic policies related to the consumption and production of plastic and their external trade policies. To inform these discussions, this note aims to provide guidance on the directly relevant rules of international trade law and the way they affect the options that countries could consider.

In section two it introduces the concept of "quantitative restrictions". These highly trade-restrictive measures are in principle prohibited, but justification is available in certain cases. The WTO Agreements strive at a balance between trade and non-trade interests, respectively Members' rights to invoke an exception and their duty to respect the treaty rights of other Members. In this spirit Article XX GATT permits Members to pursue important state interests, including the protection of human health and the environment. At the same time it sets stringent requirements on the consistent and even-handed design and application of challenged measures.

Section three deals with regulations that set out requirements on certain product features, such as composition or performance, and labelling. These internal measures are required to follow the principles of non-discrimination, but deviations may be

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justified. Further, if qualified as a technical regulations, these rules must conform to the principles of least-trade-restrictiveness, and be based on international standards where available and appropriate.

To provide context, section four gives a brief overview of WTO case law on trade restrictions that governments have taken on public interest or environmental grounds in other areas, and highlights how these might be relevant in the context of plastics trade. Lastly, to illustrate the application of WTO rules, this paper outlines legal considerations related to two measures: the import restriction applied by China to waste plastics, adopted in 2018, and the prohibition on the placing on the market of certain single-use plastic products and products made from oxo-degradable plastics in the EU, foreseeably in effect by 2021.

1. Policy context

Growing interest in trade-related dimensions and policy options with regard to plastic pollution: International trade plays a central role in the global plastics economy. Transboundary movements of virgin plastics and multiple plastic end-products account in some cases up to 60% of global production. Rising concern about the environmental and economic challenges caused by poorly regulated plastic waste trade spurred the adoption of the 2019 Plastic Amendments to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes (Basel Convention). At the same time, governments across the globe are implementing trade-related measures with the aim to reduce plastic pollution by restricting imports and/or exports of certain plastic products, including plastic waste.

Against this backdrop the multilateral trading system has a vital role to play in supporting greater understanding, dialogue and action on the trade-related aspects of tackling plastics pollution. Attempts undertaken within the WTO shall support and complement existing intergovernmental efforts to reduce plastic pollution, including the UN Environment Assembly and the Basel Convention.

Growing interest in proposal for a WTO Plastics Initiative and in ways in which governments could cooperation at the WTO and use trade policy to promote transformation of the sector and reduce plastic pollution: The 2020 WTO Ministerial Conference is a critical opportunity for WTO Members to signal high-level political commitment to a multilateral trading system that better supports environmental sustainability. As part of such attempt, a group of like-minded Members should launch a WTO initiative on plastic pollution as a platform for efforts to promote coherence between domestic restrictions on certain plastic products that might affect international trade, and the relevant WTO obligations such as transparency, non-discrimination and least-trade-restrictiveness. The experience and infrastructure of WTO Committees – especially the Committee on Technical Barriers to Trade and the Committee on Trade and Environment – could advance a dialogue on plastics-related sustainability standards and technical assistance to developing country Members.

The initiative may also serves to facilitate the reduction of trade barriers for goods and services that help eliminating plastic pollution, and could include voluntary commitments and targets to reduce trade in certain plastic products.[3]

- A brief review of prior GATT/WTO discussion on trade restrictions of domestically prohibited goods.
- A brief review (perhaps some boxes) on existing WTO experiences of export and import restrictions on public interest/environmental grounds, and also to provide examples of precedents for governments using export or import restrictions on certain pesticides (and recently on health - although these are not considered a good example).

2. WTO rules governing the use of quantitative restrictions on imports or exports of plastics

2.1. Defining quantitative restrictions

Quantitative restrictions (QRs) are measures that limit the quantity of a product that can be imported to or exported from a WTO Member. Thus, QRs applied at the border. Other than internal measures, falling within the scope of Article III:4 GATT, they do not affect domestic products.[4] Formal QRs may take the form of:

- Prohibitions on the importation or exportation of a product. A prohibition may be absolute or conditional (that is, applicable if the product does not fulfill certain requirements).
- Import or export quotas, which define the quantity of a product that can be imported or exported. They may take the form of global quota, a global quota allocated between countries, or a bilateral quota.

Measures other than "formal" QRs may still have the effect of reducing the volume of imports or exports and may hence be considered quantitative restrictions. For instance, administrative measures such as import or export licensing procedures may still end up having restrictive or distortive effects on imports or exports, for instance when they exhibit discretionary features. This is important to the extent that non-automatic licensing schemes are usually implemented to administer import or export quotas.

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[3] On the policy context see C. Deere Birkbeck, 'Strengthening international cooperation to tackle plastic pollution: Options for the WTO', Global Governance Centre Brief 20/1, Global Governance Centre, The Graduate Institute, 2020, available at < https://www.plasticpolitics.solutions/research-1/2020/1/9/policy-brief-strengthening-international-cooperation-to-tackle-plastic-pollution-options-for-the-wto>.

[4] In some cases it might be difficult to distinguish border measures from internal measures. The *application* of import licensing requirements might affect the internal sale of products. However, this does not lead to the conclusion that the border measure itself, necessary for the distribution of import licenses, would fall within the scope of Article III:4 GATT (Appellate Body Report, *European Communities – Regime for the Importation, Sale and Distribution of Bananas*, WT/DS27/AB/R, adopted 25 September 1997, para. 211).

2.2. Applicable rules and exceptions

General prohibition

Article XI:1 General Agreement on Tariffs and Trade (GATT) sets out a general prohibition on quantitative restrictions on imports and exports. Art. XI:1 GATT has a comprehensive scope. It applies to any measures irrespective of their legal status, and covers any acts – be they *de jure* or *de facto* – to the extent that they exhibit an actual or potential limiting effect on the quantity or amount of a product being imported or exported.[5] Based on the broad interpretation of Art. XI:1 GATT given by WTO case law, virtually any QRs imposed in the plastic sector could run afoul of this provision.

Art. XI:1 GATT does not apply to measures that deal with the quality, rather than the quantity of imports; the import-restrictive elements of such measures are to be considered under the WTO Agreement on Technical Barriers to Trade (TBT Agreement) discussed *infra*.[6] However, a set of measures "containing both prohibitive and permissive aspects, namely a ban and exceptions" may be challenged as a whole under Art. XI if the acts, taken together, work as a QR.[7] For example, the import restrictions on plastic waste recently enacted by China consist of a ban on post-consumer and industrial plastic waste, and a technical regulation that requires any imports of plastic waste (destined for recycling) to meet a 0.5 percent maximum level of contamination by non-recyclable materials. As such ambitious requirements may de facto create restrictions on the quantity of imports, the acts could be as argued to be inconsistent with Art. XI GATT.[8]

General exceptions

With a view to balance Members' right to protect important societal values, and the rights of other Members under basic trade disciplines, Art. XX GATT allows Members to deviate from any GATT provisions (that is, including Art. XI:1) to the extent that they

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[5] Appellate Body Reports, *China – Measures Related to the Exportation of Various Raw Materials* (hereafter *China – Raw Materials*), WT/DS394/AB/R / WT/DS395/AB/R / WT/DS398/AB/R, adopted 22 February 2012, paras 319-320. Accordingly, Art. XI:1 GATT covers minimum import or export price requirements, discretionary non-automatic licensing systems, and any other measures that have "the very *potential*" to have a limiting effect on trade.

[6] See WTO Doc. G/L/59/Rev. 1, Decision on Notification Procedures for Quantitative Restrictions, 3 July 2012, para. 9.

[7] Panel Reports, *European Communities – Measures Prohibiting the Importation and Marketing of Seal Products*, WT/DS400/R and Add.1 / WT/DS401/R and Add.1, adopted 18 June 2014, as modified by Appellate Body Reports WT/DS400/AB/R / WT/DS401/AB/R, paras.7.660-7.663.

[8] For example, plastic material entering recycling facilities in the US may contain up to 15 – 25 weight percent contamination. Against this background, the Chinese requirements have been considered "almost impossible to meet": Heinrich Böll Foundation and Break Free From Plastic, *Plastic Atlas 2019*, 2nd edn, December 2019, p. 38. For an overview of the Chinese and other restrictive measures that have been recently proliferating in the plastic sector, see I. Espa and B. Imeli, 'Exploring the Implications of the Basel Convention's Plastic Amendment under WTO Law: A case Study on the Chinese Import Restrictions on Plastic Waste', forthcoming.

impose measures that i) can be provisionally justified under one of the paragraphs of Art. XX GATT and ii) meet the requirements of the chapeau.

Provisional justification under Art. XX (b) GATT

Art. XX (b) GATT concerns otherwise GATT-inconsistent measures allegedly adopted to protect human, animal or plant life or health. Provisional justification presupposes that the measure:

- is designed to "protect human, animal or plant life or health", that is, it at least contributes to these goals (which have been interpreted as to include environmental policy measures aimed at protecting public health), and
- is "necessary" to achieve the goal to the level of ambition as defined by the enacting Member, meaning that there is no other measure less trade-restrictive reasonably available that would contribute to the policy aim to the same extent.

A number of recently introduced import and export restrictions on plastic waste[9] may be provisionally justified under Art. XX (b) GATT to the extent that they were adopted within the context of the Basel Convention and its recently adopted Plastic Amendment.[10] This is because, on the one hand, the adoption of the Plastic Amendment by the nearly universal membership of the Basel Convention arguably denotes the recognition of (marine) plastic pollution as a global environmental and human health concern while, on the other hand, it increases the likelihood that QRs concerning "covered wastes" under the Amendment may be considered necessary.[11] Importantly, Art. XX (b) GATT does not require that the restrictions also affect domestic waste plastics. The restrictions must, however, meet the requirements imposed by the chapeau (see *infra*).

Provisional justification under Art. XX (g) GATT

Art. XX (g) GATT concerns otherwise GATT-inconsistent measures allegedly adopted for the "conservation of exhaustible natural resources". "Exhaustible natural resources" have been interpreted as to include the preservation of the environment[12] and living as well as non-living resources.[13] Provisional justification presupposes that the measure:

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[9] See, among others, China's ban on plastic waste imports, which was recognized by the Organisation for Economic Co-operation and Development (OECD) to be consistent with China's rights and obligations as a party of the Basel Convention: OECD Environment Policy Paper No. 12, Improving Plastics Management: Trends, policy responses, and the role of international co-operation and trade, September 2018, p.10. On the export side, see, e.g. the prohibitions imposed by the EU on plastic waste for disposal to non-EU countries and on hazardous plastic waste (as defined under the Basel Convention) for recovery to countries that are not part of the OECD: G/TBT/N/CHN/1211 and G/TBT/N/CHN/1212, notified on 18 July 2017; G/TBT/N/CHN/1233, notified on 15 November 2017; and Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste.

[10] See UNEP/CHW.14/28, Report of the Conference of the Parties to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal on the work of its fourteenth meeting, 11 May 2019.

[11] For more details, see I. Espa and B. Imeli, *supra* n. 2.

[12] Appellate Body Reports, *China –Raw Materials*, para. 355.

[13] Appellate Body Report, *United States – Import Prohibition of Certain Shrimp and Shrimp Products*, WT/DS58/AB/R, adopted 6 November 1998, paras 142-143.

- "relates to" its stated aim, meaning that a real and close relationship between the trade-restrictive act and its objective exists.
- be "made effective in conjunction with restrictions on domestic production or consumption": this is a requirement of even-handedness in the imposition of restrictions on imported and domestic products, which however does not mandate the equal treatment of imported and domestic products.

QRs on consumer goods – like a ban or a quota on single-use plastics items[14]– could seek justification under this paragraph as they could be seen as a so-collad restriction on domestic consumption. The Appellate Body clarified that in case "[…] no restrictions on domestically-produced like products are imposed at all, and all limitations are placed upon imported products alone, the measure cannot be accepted as primarily or even substantially designed for implementing conservationist goals. The measure would simply be naked discrimination for protecting locally-produced goods." [15] Accordingly, a measure that equally applies to competing plastic products irrespective of their origin would arguably fulfil this requirement to the greatest extent.

Requirements of the chapeau

Measures provisionally justified under one of the paragraphs of Art. XX GATT must subsequently meet the requirements of the chapeau. The chapeau focuses on the way provisionally justified measures are applied with a view to exclude the misuse or abuse of the exceptions for protectionist purposes. To this end, it prohibits

- "arbitrary or unjustifiable discrimination" that occurs "between countries where the same conditions prevail": this condition i) proscribes discrimination that is not rationally connected to the pursuit of the policy objective and ii) requires Members to consider differences in conditions between countries, rather than to apply a measure in a rigid and inflexible manner. With regard to import restrictions other than a ban, market access requirements set out in terms of performance rather than in terms of specific procedures (for instance, by mandating a certain level of recycled material content / biodegradability of plastic products, or a maximum level of impurities in plastic waste) are examples that could facilitate a measure's compliance with the chapeau requirements.
- "disguised restrictions on international trade": this last condition must be interpreted in conjunction with the previous criteria of arbitrary or unjustifiable discrimination, and is aimed at overall avoiding situations of disguised protectionism. In line with this, any restrictions on the international trade in plastics, including possible exceptions, must clearly be driven by the measure's stated goal. In the past, one manner to demonstrate that a measure was not a *disguised* restriction was to refer to Members' to undertake good faith efforts to *negotiate* (with no obligation to reach) an across-the-board solution before

[14] See, e.g. the EU's ban on certain single-use plastic items: Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment.
[15] Appellate Body Report, *United States – Standards for Reformulated and Conventional Gasoline*, WT/DS2/AB/R, adopted 20 May 1996, p. 21.

resorting to a unilateral measure. Thus, before enacting trade restrictions on plastic products, it may be useful that Members reach out in a bilateral, plurilateral or multilateral agreement to other affected Members so as to better reflect their major considerations. A WTO initiative on plastic pollution is such opportunity, while as regards plastic waste, the Basel Convention is a relevant multilateral agreement. Measures based on such agreements could be considered a justifiable response to the risks posed by plastic waste covered by the Convention.

Administration of Quantitative Restrictions

To the extent that otherwise GATT-inconsistent QRs are justified under Art. XX GATT, Art. XIII:1 GATT requires that they be administered in a non-discriminatory manner. This means that a quantitative restriction on the exportation or importation of a product shall apply to all Members likewise.

To this end, Art. XIII:2 GATT requires that QRs on imports other than quotas shall aim at a distribution of trade that resembles the shares which the supplying countries might be expected to obtain in the absence of the restriction. Accordingly, in case a global quota is allocated among supplying countries (rather than on a first-come, first-served basis), it shall be distributed among all Members with a substantial interest in supplying the product concerned. The Member applying the measure shall thus seek an agreement with such supplying countries. In case no agreement can be reached, the quota is to be allocated on the basis of the suppliers' share of trade during a "previous representative period" (basically a three-year period prior to the imposition of the quota). Accordingly, the allocation of a global quota for plastic products, including plastic waste, shall be distributed among all Members with a substantial interest in supplying the product, or resemble the shares of supplying countries during the last three-year period before the measure is put in place.

3. WTO rules governing technical regulations affecting imports of plastics

3.1. Defining technical regulations

Technical regulations set out mandatory requirements on certain product features – like the physical characteristics or performance of a product, or the way it is labelled or packaged before it is put on sale.[16] Regulations that require a certain content of recycled

[16] Substantially the same rules apply to "standards"; the difference between a governmental standard and a technical regulation lies in compliance. While conformity with technical regulations is by nature mandatory, compliance with standards is voluntary. A different set of rules governs sanitary and phytosanitary measures, applied to protect human, animal or plant life or health within a Member's territory from risks arising from e.g. additives, contaminants and toxins. Such measures must be based on a risk assessment, addressing the specific risks within that Member, supported by scientific evidence. General studies that show the adverse impact of plastics on animal and plant life may not suffice (Appellate Body Report, *EC Measures Concerning Meat and Meat Products (Hormones)*, WT/DS26/AB/R, WT/DS48/AB/R, adopted 13 February 1998, para. 200). Given these stringent requirements, a measure

plastic in PET bottles,[17] define maximum acceptable levels of contamination for plastic materials destined for recycling,[18] or specify mandatory marking requirements affecting (single-use) plastic products[19] are technical regulations. Whether a measure qualifies as technical regulation has important implications with regard to the applicable obligations. Internal regulations that fall outside of the TBT Agreement's scope of application are only subject to GATT rules – with no disciplines on the trade-restrictiveness of origin-neutral measures.[20]

3.2. Main obligations with regard to technical regulations

Technical regulations are subject to the following basic rules, which are laid down in the WTO Agreement on Technical Barriers to Trade (TBT Agreement) and the GATT:

- *Non-discriminatory treatment*: Art. 2.1 TBT Agreement and Arts I:1 and III:4 GATT prohibit discriminatory treatment that i) impedes the competitive opportunities of imported products as compared to domestic goods (so-called national treatment obligation) or ii) discriminates between imports (so-called most-favoured nation treatment obligation). In line with this, technical specifications shall be applied irrespective of the origin of plastic products, including plastic waste. These obligations apply only to so called "like" products, meaning products that compete in the regulating Member's market place,. In assessing likeness, the products' physical characteristics and consumer preferences (attached to production methods or environmental impact) play a role.[21] In line with this products that serve the same end use, but are made from different materials – affecting their biodegradability, for example – may be accorded different treatment without violating the non-discrimination obligations. Such assessment shall be made on a case-by-case basis.
- *Regulation is not more trade-restrictive than necessary*: In line with Art. 2.2 TBT Agreement, technical regulations' with a limiting effect on trade shall not go beyond what is "necessary" to achieve the legitimate objective pursued (i.e.

adopted both for the purposes of environmental protection and the protection of human and animal life or health, may be easier defended under the TBT Agreement.

[17] These include, for instance, the requirement that PET bottles contain at least 25 % recycled plastic (calculated as an average for all PET bottles placed on the market in an EU Member State): Art. 6 Directive (EU) 2019/904 of the European Parliament and of the Council of 5 June 2019 on the reduction of the impact of certain plastic products on the environment (hereinafter Directive (EU) 2019/904).

[18] For example, the Chinese technical regulation that allows for a 0.5 percent maximum level of contamination by non-recyclable materials in imports of plastic waste destined for recycling. This requirement does not apply to domestic waste.

[19] Directive (EU) 2019/904, for instance, imposes a marking requirement that calls for information on the presence of plastics in certain products and the resulting negative impact of inappropriate waste disposal on the environment (see Art. 7).

[20] Internal regulations are measures that affect products' sale, offering for sale or use, independently of whether they are enforced at the border or e.g. at the place of distribution.

[21] Appellate Body Report, *European Communities – Measures Affecting Asbestos and Asbestos-Containing Products*, WT/DS135/AB/R, adopted 5 April 2001, paras 141 and 147; These considerations equally apply under all three provisions (Appellate Body Report, *United States – Measures Concerning the Importation, Marketing and Sale of Tuna and Tuna Products – Recourse to Article 21.5 of the DSU by Mexico*, WT/DS381/AB/RW and Add.1, adopted 3 December 2015, para. 7.73).

protection of human health or the environment at a level set by the regulating Member).

- *Regulation is based on international standards where available*: According to Art. 2.4 TBT Agreement, when a relevant international standard (which was adopted by a body that is open to all Members) exists, Members shall use them, or their relevant parts, as a basis for technical regulations, unless ineffective or inappropriate to accomplish the legitimate objective pursued. Standards developed by the International Organization for Standardization (ISO), e.g. 'ISO 15270:2008' on the recovery and recycling of plastics waste or 'ISO 18830:2016' on testing plastic products' biodegradability, might qualify as such.[22]
- *Requirements are specified in terms of performance*: Art. 2.8 TBT prefers Members to adopt, wherever appropriate, product requirements in terms of performance since these are typically less prescriptive (see for instance the measures described in fn. 13 and 14).

3.3. Available exceptions

A violation of Arts. I:1 or III:4 GATT may be justified under Art. XX GATT; the explanations made in relation to QRs and Art. XX GATT apply in the same way. Similar considerations can heal a potential conflict with Article 2.1 TBT Agreement. For example, technical regulations that only affect *imports* of plastic waste, and thus violate the national treatment obligation, may be justified – especially if enacted in line with the Basel Convention.

4. WTO rules in work: An overview of case law and illustrative examples of adopted measures

4.1 An overview of relevant case law

A number of past WTO cases illustrate Members' policy space for adopting trade-related measures that protect the environment and public health. Article XX General Agreement on Tariffs and Trade (GATT) on General Exceptions lists specific grounds of justification for measures otherwise inconsistent with the Agreement's provisions. Two exceptions are of particular relevance in the context of trade restrictions on plastics: Article XX(b) GATT allows for measures that are necessary for the protection of human, animal or plant life or health, while policies relating to the conservation of exhaustible natural may be justified under Article XX(g).

[22] The TBT Agreement does not list the bodies that qualify to promulgate international standards. The ISO, in essence a federation of the national standards bodies of 164 countries, plays an important role in developing voluntary standards that meet the TBT Agreement's requirements on "international standard" and thus supports the programs of government authorities. Nevertheless, whether a particular ISO standard qualifies as an "international standard" shall be assessed on a case-by-case basis, considering effective participation in the respective standard's development. For a detailed overview see Janelle M. Diller, 'Private Standardization in Public International Law Making' 33 *Michigan Journal of International Law* 3 (2012) pp. 481-536. For an overview of relevant ISO standards see < https://www.iso.org/news/ref2292.html>.

Measure at issue	Findings of the Appellate Body	Key takeaway
DS2: US – Gasoline, Appellate Body report adopted in 1996		
The "Gasoline rule" under the US Clean Air Act set out requirements on the cleanliness of gasoline. In large metropolitan areas with heavy pollution it only allowed for the sale of "refined gasoline" with certain requirements attached to the 1990 baseline, while in the rest of the country, only gasoline no dirtier than that sold in the base year of 1990 could be sold. Domestic refineries in operation for at least six months in 1990 could establish an individual baseline, while foreign refineries importing to the US were not allowed to rely on individual baselines. Instead, they had to comply with a statutory baseline established by the Environmental Protection Agency.	The measure was found to violate the national treatment obligation (Article III:4 GATT), but was provisionally justified under Article XX(g) GATT. It primarily aimed at the conservation of exhaustible natural resources (clean air), and restrictions applied to both domestic and imported products. However, the lack of even-handedness in the baseline establishment rules prevented the measure's justification under the chapeau of Article XX GATT.	The case affirms Members' right to adopt the highest possible standard to protect the environment so long they fulfill their obligations and respect the rights of other Members under the WTO Agreements. It also clarifies that "in conjunction with" does not refer to identical restrictions on domestic products. Merely required are even-handed restrictions on domestic production *or* consumption. In line with this import restrictions on plastic products, especially plastic waste, may be justified without imposing the same restrictions on domestic products.
DS58: US –Shrimp, Appellate Body Report adopted in 1998		
The US legislation under scrutiny prohibited i.e. the capture or killing of endangered turtle species that occur in US waters. To implement this objective the act required US shrimp trawlers to use a certain type of "turtle excluder device" (TED) in their nets when fishing in areas with a significant likelihood of encountering sea turtles. The measure also prohibited imports of shrimp harvested with commercial fishing technology, unless the harvesting nation was certified to have a regulatory	The measure was found to violate the prohibition of quantitative restrictions (Article XI:1 GATT), but to be provisionally justified under Article XX(g) GATT. It related to the conservation of exhaustible natural resources (turtles as species susceptible of depletion), and the restrictions imposed on domestic products were even-handed. However, the measure failed the chapeau test as it unjustifiably (not as a necessary result of the policy goal) discriminated between countries where the same	The case reiterates that Members are free to adopt their own policies aimed at protecting the environment, within the limits of the WTO Agreements. Further, it highlights the importance of laying down requirements in terms of performance as opposed to defining a single way of compliance – for example by defining targets of biodegradability or recycled content in end-products. The case also brings to the fore the importance of seeking (but not necessarily

programme and an incidental take-rate comparable to that of the US, or that the particular fishing environment of the harvesting nation did not pose a threat to sea turtles. However, the application of the measure required other Members to adopt a regulatory program that is not merely comparable, but rather essentially the same, as the one applied to US shrimp trawlers.	conditions prevail: i) it required, in effect, all other exporting Members to adopt essentially the same policy as in force in the US, and ii) failed to engage exporting Members in serious, across-the-board negotiations with the objective of concluding bilateral or multilateral agreements for the protection and sea turtles, before enforcing unilateral import prohibitions. This inflexibility and the lack of transparency and procedural fairness in its application was also found to constitute arbitrary discrimination. Subsequently the US revised and successfully justified its legislation under Article XX(g) GATT. The adapted measure required other Members' programmes simply to be "comparable in effectiveness", as opposed to "essentially the same", and the US made serious, good faith efforts to negotiate an international agreement.	to achieve) international cooperation before resorting to unilateral action. Such endeavors, for example in the form of plurilateral cooperation in the WTO, would strengthen the grounds to justify trade-restrictive measures on plastics.
DS135: EC–Asbestos, Appellate Body Report adopted in 2001		
The French decree at issue prohibited the manufacture, processing, sale, import, placing on the domestic market and transfer of all varieties of asbestos fibres, regardless of whether incorporated into materials or end-products. Certain limited and temporary exceptions were available from the ban. All measures applied regardless of the products' origin. Canada claimed that the measure discriminates against imported asbestos (products) as it treats certain domestic substitutes, such as	The measure was found to be consistent with the EC's obligations under the WTO Agreements. Especially with regard to the products' different health effects, their likeness was denied. Therefore no violation of the national treatment obligation occurred. Further, the ban was justified pursuant to Article XX(b) GATT. It was found to be necessary to achieve the level of health protection chosen by France; no less trade-restrictive measures	The case highlights Members' right to autonomously define the level of health protection they aim at. At the same time it subjects import restrictions with permissive elements, specified in terms of product characteristics, to the rules of the TBT Agreement. Therefore, also origin-neutral restrictions must comply with the requirement of "least trade-restrictiveness", meaning that such restrictions must be "necessary" to achieve the

PVA, cellulose and glass fibres, more favourably.	were available to this end. Further, it satisfied the conditions of the chapeau.	legitimate policy goal they aim at. The likeness analysis indicates that products posing a serious risk to public health (and arguably the environment) may be accorded different treatment without violating the non-discrimination obligations. This might have implications on the legal treatment of end-products from easily biodegradable and from "conventional"/oxo-degradable plastics.
DS332: Brazil – Retreaded Tyres, Appellate Body report adopted in 2007		
At issue was a Brazilian import prohibition on used and retreaded tyres (a shorter life-span than new tyres, leading to waste accumulation and serving as vectors for diseases), as well as an exemption from the import ban for MERCOSUR countries. The ban was part of a comprehensive strategy including a collection and disposal scheme, which makes it mandatory for domestic manufacturers and importers of new tyres to provide for the safe disposal of waste tyres in specified proportions, and encouraging domestic retreaders to retread more domestic used tyres by exempting domestic retreaders from disposal obligations as long as they process tyres consumed within Brazil. Notwithstanding the import ban on used tyres, a number of Brazilian factories obtained court injunctions allowing them to import used tyres to subsequently retread them.	The ban was found to be inconsistent with the prohibition of quantitative restrictions (Article XI:1 GATT). However, it was provisionally justified under Article XX(b) GATT: As the key element of a *comprehensive strategy* to deal with waste tyres, it contributed to the retreading of domestic used tyres, and thus brought about a material contribution to the reduction of waste tyres. This conclusion was reached without (undoubtedly useful) estimates on the measure's quantitative contribution/time horizon regarding the reduction of waste tyres. Establishing its necessity, the Appellate Body noted that material recycling is costly and might require advanced technologies and know-how that are not readily available on a large scale. Therefore, it was not an available alternative to the ban.	The decision highlights that a provisional justification under Article XX(b) GATT is available without quantifying (as opposed to a qualitative assessment of) the measure's contribution to public health protection. Required is a material contribution – a genuine relationship between ends and means – to the stated objective. This contribution is not required to be immediately observable, but may manifest only after a certain period of time. For example, import restrictions on plastic waste may first lead to a shortage of feedstock for the domestic recycling industry – an interstage of developing domestic waste collection and sorting (given the appropriate economic incentives) that will bring about the positive environmental and public health effects the measure aims at. Further, the case acknowledges that less

These decisions have been challenged as well.	The import prohibition could not be justified because the MERCOSUR exemption and the imports of used tyres under court injunctions resulted in arbitrary or unjustifiable discrimination.	trade-restrictive measures that pose an undue burden on the importing Member, taking into account its level of development, may not be considered as available alternatives.

4.2 Illustrative examples of adopted measures

In recent years a number of Members adopted comprehensive legislative frameworks to address the adverse environmental and public health impacts of plastic waste. To illustrate the application of WTO rules, this paper addresses two measures: the import restriction applied by China to waste plastics, and the prohibition on the placing on the market of certain single-use plastic products and products made from oxo-degradable plastics in the EU, foreseeably in effect by 2021.

Description of the measures	Key WTO law considerations
Chinese import restrictions on plastic waste	
In 2018 China prohibited the importation of post-consumer and industrial plastic waste and scrap. Exempted are products that comply with a 0.5 percent maximum level of contamination by non-recyclable materials (as compared to the previous 1.5 percent requirement). The measures largely halted the inflow of plastic waste. The trade restrictions are part of a comprehensive policy framework that includes the establishment of municipal waste sorting and disposal systems in major cities by 2020, and the promotion of waste-to-energy projects in rural areas, accompanied by public education. Further steps include a cradle-to-grave waste management system to monitor the generation, transport, processing, and disposal of solid wastes. These measures are apt to induce sustainable changes in the practices of the domestic recycling industry, and result in a better waste management and a higher domestic recycling rate in China.	The measure qualifies as a quantitative restriction, prohibited by Article XI:1 GATT. However, it may be justified under Article XX(g) GATT. It can be expected to bring about a material contribution to the conservation of natural resources (e.g. marine species), and is part of a comprehensive policy framework that includes restrictions on domestic production and consumption. A justification under Article XX(b) GATT also appears available. The ambitious measures contribute to the protection of public health, by largely halting (low-quality) plastic waste imports. Less trade-restrictive alternatives – such as lower contamination thresholds or enhanced material recycling – may not provide the same level of protection or would pose an undue burden on China. Further, the measure is acknowledged to be consistent with China's rights and obligations as a Party to the Basel Convention. This supports the conclusion that the restrictions are "necessary". The measure also appears to comply with the requirements of the chapeau. The different treatment of imports rationally relates to the protection of the environment and public health, therefore no unjustifiable

	discrimination appears. At last, measures taken in line with the Basel Convention – a multilateral outcome that reflects the response of the international community to a genuine environmental problem – most likely comply with the requirement of non-arbitrariness under the chapeau of Article XX GATT.
EU prohibition on the placing on the market of certain single-use plastic products	
The EU strategy will prohibit the placing on the market of certain single-use plastic products (see Article 5 and Annex B Directive (EU) 2019/904). The marketing prohibition, also affecting imports, is expected to come into force in 2021. The marketing prohibition of single-use plastic items targets products that appear particularly relevant for the prevention of marine plastic litter in the EU; the covered products are estimated to represent 86 % of the single-use plastics found on beaches. The definitions of "plastic" and "single-use plastic products" exempts i) natural polymers that have not been chemically modified and ii) products that are conceived, designed and placed on the market to accomplish within their life span multiple trips or rotations by being refilled or re-used for the same purpose for which they are conceived. Directive (EU) 2019/904 emphasizes that the restrictions shall remain proportionate and non-discriminatory. The measure is part of the European Strategy for Plastics in a Circular Economy, comprising the extension of domestic recycling capacity, requirements on the recyclability and recycled content of certain plastic products, and the phase out of exports of recyclables.	The definitions of "plastics" and "single-use plastic products" trigger the applicability of the TBT Agreement. A potential conflict arises with Article 2.2 TBT Agreement that requires technical regulations to be no more trade-restrictive than necessary to achieve a legitimate objective, such as environment protection. But the origin-neutral marketing prohibition is likely to be found "necessary". While its trade-restrictiveness may not be contested, the marketing prohibition can be expected to reduce marine plastic pollution more effectively than less incisive measures. In this context Directive (EU) 2019/904 highlights that existing measures, such as the recycling target for plastic packaging waste and targets requiring all plastic packaging to be reusable or easy to recycle by 2030, appear as insufficient to address the immediate concern of marine plastic litter. However, the deviation from Article XI:1 GATT may be justified under Article XX(g) GATT. The prohibition can be expected to deliver a material contribution to the conservation of the marine ecosystem, by reducing marine litter. Further, the measure is drafted in an origin-neutral manner that supports its consistency with the chapeau of Article XX GATT.
EU prohibition on the placing on the market of products made from oxo-degradable plastic	
The EU strategy will as well prohibit the placing on the market of products made from oxo-degradable plastics (see Article 5 Directive (EU) 2019/904). The marketing prohibition, also affecting imports, is expected to come into force in 2021.	While single-use plastic products prima facie differ from products conceived for multiple trips (for example in their end-use and physical characteristics), this conclusion might differ when comparing products made from oxo-degradable plastics with products made from other types of plastic.

Oxo-degradable plastic materials include additives which, through oxidation, lead to their fragmentation into micro-fragments or to their chemical decomposition. On account of their insufficient biodegradability, oxo-degradable plastics contribute to microplastic pollution in the environment. Moreover, they negatively affect the recycling of conventional plastic and fail to deliver a proven environmental benefit.	Given their different biodegradability – affecting the marine environment – the physical characteristics of oxo-degradable plastic products differ from those made from other plastics. However, this is only one factor in assessing products' likeness. Taking into account the end use, tariff classification and consumer preferences of these products, a holistic analysis would presumably lead to the conclusion that the products compete in the market place. Therefore, a claim of discriminatory treatment under Article III:4 GATT cannot be excluded. However, the potential deviation from Article III:4 GATT may be justified under Article XX(g) GATT. The prohibition can be expected to deliver a material contribution to the conservation of the marine ecosystem (and human health) by preventing microplastic pollution. Further, the measure is drafted in an origin-neutral manner. Any discrimination (that might arise from different production structures in the EU and importing Members) may be seen as a necessary result of the efforts to achieve the legitimate policy goal of environment protection.

5. Conclusions

Import or export restrictions on plastic products and plastic waste are, in most cases, in an initial conflict with the applicable WTO rules. Art. XI:1 GATT prohibits any measures with a limiting effect on the imports or exports of plastic, while Article 2.1 TBT Agreement and Articles I:1 and III:4 GATT require that trade-restrictive technical specifications are applied irrespective of the origin of the affected products.

Nevertheless, Members may take measures that deviate from WTO rules inasmuch as they are apt to protect public health and/or the environment. Important prerequisites to this end are that the implied trade-restrictions or discrimination serve the measures' regulatory goal, and, whenever possible, follow upon negotiations with affected Members.

Accordingly, QRs and technical regulations on plastic products shall be applied in an origin-neutral way, and also affect domestic products. For example, Directive (EU) 2019/904 fulfils this requirement as the labeling requirement affects any products covered by the directive, irrespective of their origin. Trade restrictions on plastic waste, even if applied only to foreign products, may nevertheless seek justification unless they are applied in an arbitrary fashion.

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Standards and the International Standardization Landscape: Relevance to Plastics and Plastic Pollution

Research Paper
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1. STANDARDS AND THE INTERNATIONAL STANDARDIZATION LANDSCAPE

1.1. Introduction

In recent years, there has been a growing interest in the role standards can perform in tackling plastics pollution. The field of standards and standardization is, however, a complex area inhabited by a multitude of organizations and technical committees populated by anonymous experts. Together, they deal with topics that are often outside the understanding of non-experts, policymakers, or the public.

This paper aims to help policy makers, academia and the interested public obtain a better understanding of the structure and functioning of the international standardization system. It offers an overview of some of the main standardization organizations and current plastics standards, identifies some of the gaps in the landscape of these standards, and highlights the potential role, as well as the limitations, of standards in combatting plastics pollution. The paper also provides recommendations for enhancing the impact and effectiveness of standardization, and highlights the role standards and other instruments could perform in support of a possible future global treaty on plastic pollution.

Part 1 of the paper introduces the concept, main players, and the functions of standards. It gives an overview of the structure of and trends in today's standardization system and some of the main standards development organizations relevant for the field of plastics and plastics pollution. Part 2 provides an introduction to the standards of some technical committees of the main standards organizations working in the field of plastics, with specific relevance to the environment and plastics pollution. Part 3 presents a preliminary mapping of the standards across the main phases of the plastics value chain to identify the current focus and gaps in the coverage of these standards. Part 4 provides proposals on how the contribution of standards and standardization could be enhanced to address key negative externalities generated by the plastics industry and on how standards organizations should re-orient their work to meet these and other environmental challenges. Finally, Part 5 develops a model of how standards, together with other instruments, could help set and verify targets and monitor progress in addressing plastics pollution under a global plastic treaty.

KEY MESSAGES

- A broad range of standards related to plastics have been developed by different standards organizations. Currently, however, these standards do not form a comprehensive and complete set of instruments that can be applied consistently across international markets to combat plastic pollution – from the design phase to end-of-life – or as indicators for measuring progress on addressing plastic pollution.
- Standards are for the most part voluntary instruments that have been developed by industry players and are intended for their use. There is a need for more involvement by governments to define priorities for standard-setting (such as supporting efforts to phase out certain types of plastics, and to promote greater reusability of plastic products, recycling, use of recycled plastics, and non-plastic substitutes) and to provide clear roadmaps for future work. Without such roadmaps, and a complementary regulatory and policy framework, standards on their own cannot provide a solution to the challenge of the plastics pollution.
- Standards could play an important role in supporting a proposed global treaty on plastic pollution, including by establishing targets and tools for monitoring their implementation. For this purpose, standards organizations will need to apply a holistic and comprehensive approach that addresses the whole plastics value chain and all sources of environmental leakage. Further, they should increase their cooperation and look at ways to reduce the current fragmentation between different standards.

1.2. Multiple players in standardization

Standards are developed by many players. Players can be single companies or groups of companies organized as consortia that develop standards for their internal purposes or to capture markets with their products based on a shared design.

At the other end of the spectrum are specialized standards development organizations that bring together multiple stakeholders from industry, business, academia, regulators, consumers, among others. Many of these organizations have a national basis and are constituted as national standards bodies. Regional and international organizations have national bodies as their members. These members operate through national delegations that represent national positions in regional or international standards organizations.

Since the 1980s, another form of standardization organization emerged. Organizations of this type are characterized by the fact that, while being headquartered in one country (perhaps with regional branch offices), they try to attract participation and members (individuals, companies, or a mix of institutions) from around the world.

These organizations have another important characteristic: they typically have a very limited and specific focus, such as a specific field in information and telecommunication technology (ICT) or single agricultural commodities such as cotton, coffee or a specific area such as forest management, often with the objective to improve ecological, social or economic sustainability of production and supply chains and to benefit small producers.

Most standards organizations aim to attract representatives of relevant stakeholder groups in the development of their standards. Most standards organizations pursue the development of standards using documented procedural rules, which generally aim for openness, transparency, inclusiveness and consensus in order to be compliant with widely recognized principles for the development of standards, such as those defined by the International Organization for Standardization (ISO) and the World Trade Organization (WTO). The rules defined by ISO and the WTO are widely used by many standards organizations and in public discourses about standards.

Definitions and legal status of a standard

This section introduces two frequently used definitions of the term "standard" from ISO and the WTO with the goal of arriving at a working definition of the term "standard" that contains elements of both definitions.

ISO and its partner organization, the International Electrotechnical Commission, IEC define "standard" as follows:

> *"Document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.*
>
> *Note: Standards should be based on the consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits."*[1]

The WTO, in its Agreement on Technical Barriers to Trade (TBT Agreement), defines standard as follows:

> *"Document approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method."*[2]

Both definitions agree that standards are documents approved by a recognized body and provide rules, guidelines or characteristics. In the ISO definition, standards generally relates to "activities or their results," whereas, in the WTO definition, because of the specific focus of the TBT Agreement, standards are limited to products and their related processes and production methods. The scope of the ISO definition is wider. It includes services and any other topic, such as ethical aspects of business, which are not covered by the WTO-definition.

There are also several other important differences between these two definitions: While the ISO definition emphasizes consensus as the basis for standards, the WTO definition does not specify a need for consensus.[3] Furthermore, the ISO definition leaves the legal status of a standard open: A standard can have a voluntary or a mandatory status; whereas the WTO-definition defines a standard as voluntary (as opposed to a technical regulation, which is mandatory).

Working definition of "standard"

Based on these two definitions, the following working definition and understanding is proposed for the purposes of this paper.

Standards are typically voluntary instruments that address products, processes, systems, and services developed by consensus between different stakeholders.The purpose of standards is to provide for common and repeated use, rules, guidelines or characteristics for activities or their results. Standards should be based on the consolidated results of science, technology, and experience, and aimed at promotion of optimum community benefits. The legal status of standards as voluntary instruments can change, e.g., through their incorporation into law or private contracts.

Functions of standards

In addition to the "rules, guidelines or characteristics for activities or their results" mentioned above, the function of standards are typically seen in:

- defining terminology (providing a "common language");
- providing taxonomies and classification systems;
- setting basic requirements for products and services ("fitness for use");

[1] ISO and IEC (2004), ISO/IEC Guide 2:2004 Standardization and related activities – General vocabulary. ISO and IEC, Geneva, partially available at: https://www.iso.org/obp/ui/#iso:std:iso-iec:guide:2:ed-8:v1:en and https://www.iso.org/obp/ui#search (accessed on 03-05-2021)
[2] WTO (1994), Agreement on Technical Barriers to Trade, Annex 1: Terms and their Definitions for the Purpose of this Agreement, available at: https://www.wto.org/english/docs_e/legal_e/17-tbt_e.htm (accessed on 03-05-2021)

[3] However, one of the six Principles for the Development of International Standards, Guides and Recommendations, which the TBT Committee issued in the year 2000 at the second triennial review of the TBT Agreement requires "Impartiality and Consensus." It should be noted that the six principles formulate requirements for standards that claim to be "international standards" but do not address all types of standards. The six principles can be foundhere:https://www.wto.org/english/tratop_e/tbt_e/principles_standards_tbt_e.htm

- defining test methods to assure requirements are met and test results can be trusted globally;
- assuring compatibility and interchangeability (contributing to network effects);
- reducing the varieties of products and materials;
- assuring health, safety and environmental protection; and
- supporting organizations and other entities in their management practices.

An increasingly important function of standards is innovation. Standards can be carriers for spreading new and collectively reviewed knowledge in the economy and society. They can also provide shared reference frameworks for collaboration between economic, trade, scientific, public, and private entities.

Procedures for the standards development process

All standards development organizations have procedures for the development of their standards. Among the topics defined in such procedures are requirements for approving the initiation of a standardization project and the voting stages until publication. In line with requirements in Annex 3 of the WTO TBT Agreement, many standards development organizations foresee at least one stage of public review with a period of at least 60 days of a draft standard before its final acceptance. This public review period is provided to allow potentially affected parties to express their views on the upcoming standard to avoid, or limit, whenever possible, negative effects on trade or other areas.[4]

Standards and regulations

In line with the WTO's definition, standards are voluntary instruments, but their use can be made mandatory through a regulation. There can be different cases. If a regulation mandates the use of a particular standard (e.g. by referring to the standard in the text of the regulation), this is referred to as an 'exclusive reference' to a standard. Alternatively, an 'indicative reference' occurs where the use of a standard is one way (among others) of meeting the requirements of a regulation.[5] In this second case, the status of the standard remains voluntary. This approach provides the possibility to apply other standards, or entirely other approaches, under the condition that they can demonstrate that they meet the legally binding requirements of the regulation. The indicative reference is typically applied in the European Union, where compliance with respective standards is one way for users to demonstrate that they meet legal requirements without insistence that only specific standards can be used for this purpose.

1.3. An overview of standards organizations

There are different ways of classifying standards organizations. In the following, a distinction is made between

- national standards organizations;
- regional standards organizations;
- international standards organizations; and
- other standards organizations

National, regional, and international standards organizations are sometimes collectively referred to as the "formal" standardization system because these organizations typically have a long history and a well-established role.

National standards bodies

As indicated in the name, national standards bodies (NSBs) or national standards organizations are a focal point for standardization activities in a country and represent national interests in regional and international standards bodies. They are multi-stakeholder and multi-sector organizations. Examples are organizations such as the British Standards Institution (BSI), Standards Australia (SA), the Standardization Administration of the People's Republic of China (SAC), or the South African Bureau of Standards (SABS). Currently, over seventy percent of national standards bodies are governmental or other public organizations,[6] while the remaining are private bodies. As NSBs perform an official function in and for their countries, they have some form of official recognition by their government, even if they are private bodies, either through a standardization law, a formal contract or an agreement with the government in their country. In developing countries, NSBs are often governmental entities, whereas in Europe and the United States they are private.[7]

There is significant variation between different countries in terms of the organization and function of their NSBs. In some countries, most standards development and standardization activities are centrally organized and operated by the NSB. In other countries, the role of the NSB is more that of an administrator and the coordinator, while the development of standards is done by specialized technical or professional organizations. In the United States, the role of the American National Standards Institute (ANSI), for instance, is limited mainly to: a) administering standards activities of several hundreds of autonomous standards development organizations in the United States, all of which develop and publish their own standards; and b) representing the United States in international and regional standards bodies. Among this multitude of standards development organizations, some NSBs have a widely recognized international status and influence, such as ASTM International.[8]

[4] WTO (1994), *Agreement on Technical Barriers to Trade, Annex 3: Code of Good Practice for the Preparation, Adoption and Application of Standards, Clause L., available at:* https://www.wto.org/english/docs_e/legal_e/17-tbt_e.htm (accessed on 03-05-2021)

[5] ISO and IEC (2004), ISO/IEC Guide 2:2004, cl. 11.3.1 and 11.3.2; see also Inklaar, Alex (2009), *Technical regulations. Recommendations for their elaboration and enforcement*. Physikalisch-Technische Bundesanstalt (PTB) and International Trade Centre (ITC), available at: https://www.ptb.de/cms/fileadmin/internet/fachabteilungen/abteilung_9/9.3_internationale_zusammenarbeit/publikationen/201_Guide_Technical_Regulations/PTB_Q5_Guide1_Technical_Regulations_EN.pdf (accessed on 03-05-2021)

[6] ISO (2019), *Good Standardization Practices*. ISO, Geneva, p. 99, available at: https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100440.pdf. Although these numbers are based on a survey which was conducted in 2009, the ISO Central Secretariat confirmed in a recent email that they are still representative of ISO's current membership (email of 30-03-2021)

[7] ISO and UNIDO (2013), *Fast forward. National Standards Bodies in Developing Countries*. 2nd edition. ISO: Geneva, p. 61, available at: https://www.iso.org/publication/PUB100038.html (accessed on 03-05-2021)

[8] ASTM International was formerly called the "American Society for Testing and Materials".

Regional standards organizations

There are many regional or sub-regional standards organizations that include the NSBs of the region as their members. Some of the regional or sub-regional organizations primarily perform the role of a platform for policy dialogues and exchanges related to standardization, conformity assessment and trade issues. However, some of these regional bodies have developed regional standards to facilitate trade and cooperation in the region. The region most advanced in this regard is Europe, (i.e. European Union (EU), member countries of the European Free Trade Agreement (EFTA) as well as those associated to the EU like Turkey). The two European standards organizations, namely, the European Committee for Standardization (CEN), and the European Committee for Electrotechnical Standardization (CENELEC),[9] have published over 25,000 standards and other documents such as Technical Specifications or Guides, and the European Telecommunication Standards Institute (ETSI) has published over 51,000 standards.[10]

International standards organizations

The most widely recognized international standards organizations are the following:

- International Organization for Standardization (ISO)
- International Electrotechnical Commission (IEC), and
- International Telecommunication Union (ITU).

At the end of 2020, the ISO had published over 23,500 standards[11] and the IEC around 13,000.[12]

The members of international standards organizations are NSBs or bodies dealing nationally with electrotechnology/electronics or telecommunication. There is also a close cooperation between ISO and CEN (both addressing all subject fields except for electronics and electrotechnology), and IEC and CENELEC (both covering electronics and electrotechnology) through agreements related to information exchange, as well as the joint development of standards intended to become identical international and European standards.[13]

Some intergovernmental organizations also develop standards on certain subject fields. Examples are UN agencies such as the Food and Agricultural Organization of the United Nations (FAO) (where ministries of agriculture represent national members), the World Health Organization (WHO) (where health ministries represent national members), the Economic Commission for Europe (UNECE), and others such as the Organization for Economic Cooperation and Development (OECD).

Other standards organizations

As mentioned in section 1.2, there are hundreds of organizations that develop standards for specific and often highly focused subject fields. Most of these organizations emerged through industry or civil society initiatives, and as a response to frustrations with the slow speed and administrative complexity of the formal standards organizations.

In the Information and Communication Technology (ICT) sector companies are often organized as standards consortia. Other forms of cooperation are groups of individuals who develop standards in organizations such as the Internet Engineering Task Force (IETF) or the World Wide Web Consortium (W3C).

Another very lively field is that of sustainability standards addressing environmental aspects of agriculture, aquaculture, forestry, as well as social and labour conditions under the umbrella of fair trade. Standards on these matters are often collectively referred to as Voluntary Sustainability Standards (VSS). Alongside a vast diversity of sector- and product-specific standards organizations, such as Social Accountability International (SAI), Fairtrade International, the Better Cotton Initiative (BCI), the ISEAL Alliance provides guidance on principles for the development, assurance and impact evaluation of VSS. Other fields of standards include sustainability reporting, which extends financially focused accounting towards non-financial areas represented by organizations such as the Global Reporting Initiative (GRI) or the Sustainability Accounting Standards Board (SASB), and standards like the Greenhouse Gas Protocol, developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD).

A number of non-governmental standards initatives have a global reach and produce globally recognized and widely used standards. Over time, cooperation has also increased between these and the formal standards organizations, where the latter have incorporated subjects dominant to VSS organizations or ICT consortia, and established collaborative relationships with them.

Adoption of standards

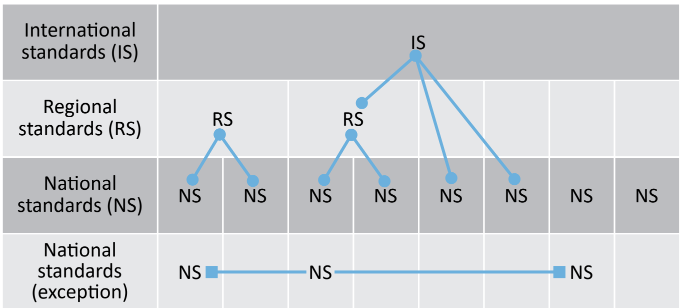
In many cases, NSBs adopt standards that have been developed by international or regional standards organizations as their own national standards. Adoption of such standards reduces the time and resources required for their development, and contributes to consistency between the standards used in different countries and regions. To ensure that a standard meets the requirements of a country or region, it is important that a NSB has participated in and influenced the development of the international or regional standard. Figure 1 shows the different options for adoption: the direct adoption of an international standard (IS) as a national standard (NS); the adoption of an international standard as a regional standard (RS) and then as a national standard; or the adaption of a regional standard as a national standard. As an exception, the NSB of one country can adopt the national standard of another country. In line with the rules for adoption developed by ISO and IEC, if necessary, an adoption can imply technical or editorial modifications to

[9] The number is calculated by combining the numbers for the individual types of publications of CEN and CENELEC. See: https://www.cencenelec.eu/stats/CEN_CENELEC_in_figures_quarter.htm
[10] See the homepage of ETSI at: www.etsi.eu (accessed on 03-05-2021)
[11] See: ISO, *ISO in figures 2020*, available at: https://www.iso.org/files/live/sites/isoorg/files/about%20ISO/iso_in_figures/docs/ISO-in-Figures_2020.pdf
[12] See IEC technical committees and subcommittees, available at: https://www.iec.ch/technical-committees-and-subcommittees#tclist (accessed on 03-05-2021)
[13] On 31 December 2020, the percentage of ISO and IEC standards adopted as standards of CEN and CENELEC amounted to around 45%, see: CEN/CENELEC Annual Report 2020, p. 5, available at: https://www.cencenelec.eu/news/publications/Publications/CEN%20CENELEC%20Annual%20report%202020%20access.pdf (accessed on 03-05-2021)

the original standard, as long as these modifications are clearly identified.[14]

Adoptions typically include the translation of a standard into the language(s) used in the country of the adopting NSB.

Figure 1: Principles of the adoption of international or regional standards as national standards



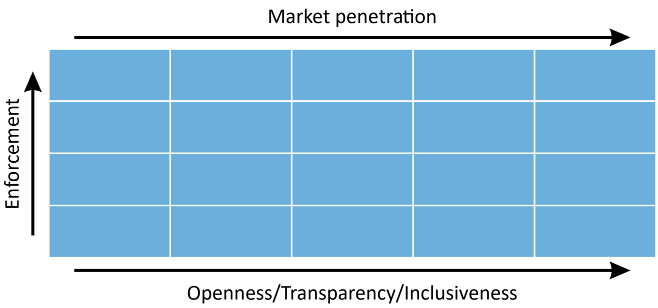
Source: Author's diagram

1.4. Standards mapping

To compare different standards, one can map them over several common dimensions such as:[15]

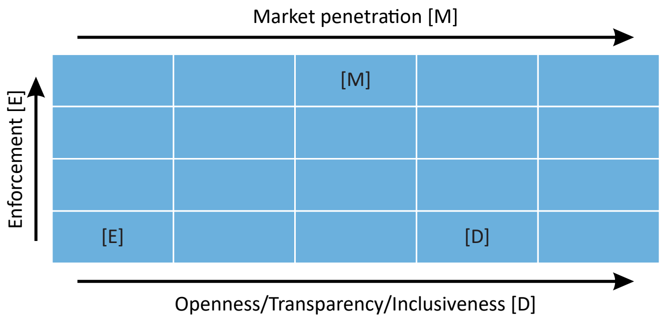
- **Degree of enforcement of the standard:** Has the standard been made mandatory through legislation? Is it imposed by a lead firm in a supply or value chain, making compliance by a firm with the standard a pre-condition for the participation in the value chain?
- **Degree of market penetration:** What is the spread of the standard in (a) market(s)? Has it reached a market-dominating position?
- **Degree of openness/transparency/inclusiveness of the process through which a standard was developed** and, consequently, **the level of consensus** it represents: to what extent did the development process follow the standard principles of openness, transparency, and inclusiveness of relevant stakeholders?

Figure 2: Standards matrix to map aspects of the development, use and impact of standards over three dimensions



Source: Author's diagram

Figure 3: Example of the use of the standards matrix



Source: Author's diagram

Figure 3 presents a case with low (formal or market-driven) enforcement [E], high degree of openness [D], transparency and inclusivity in its development, and medium penetration in certain markets [M].

1.5. The quality infrastructure

Standardization is part of a wider system, often referred to as the quality infrastructure (QI).[16] QI is composed of the following components:

- metrology,
- standardization,
- accreditation,
- conformity assessment (including testing, inspection and certification), and
- market surveillance.

The QI system provides the administrative, managerial and technical infrastructure of measurement (metrology), the development of technical requirements (standards) for products and services, and the verification of these requirements (through testing, inspection and certification) by ensuring that the entities that undertake the verification have themselves the required qualification (competence and facilities) to provide this function (accreditation). Market surveillance aims at verifying those products that have been already placed on the market meet safety and other requirements.

QI is often organized at a national level (NQI), but is based on internationally accepted principles, which assures mutual recognition of requirements and conformity assessment results to facilitate trade and avoid multiple testing at national borders. It is key to the implementation of technical regulations related to product safety, health and environmental aspects of products, their inspection and production methods. QI thus performs an important public policy function with regard to assuring safety of products, their reliability, and health impacts.

[14] ISO/IEC Guide 21-1:2005, *Regional or national adoption of International Standards and other International Deliverables – Part 1: Adoption of International Standards*. ISO and IEC. Geneva 2005, pp. 3-6, available at: https://webstore.iec.ch/publication/11933

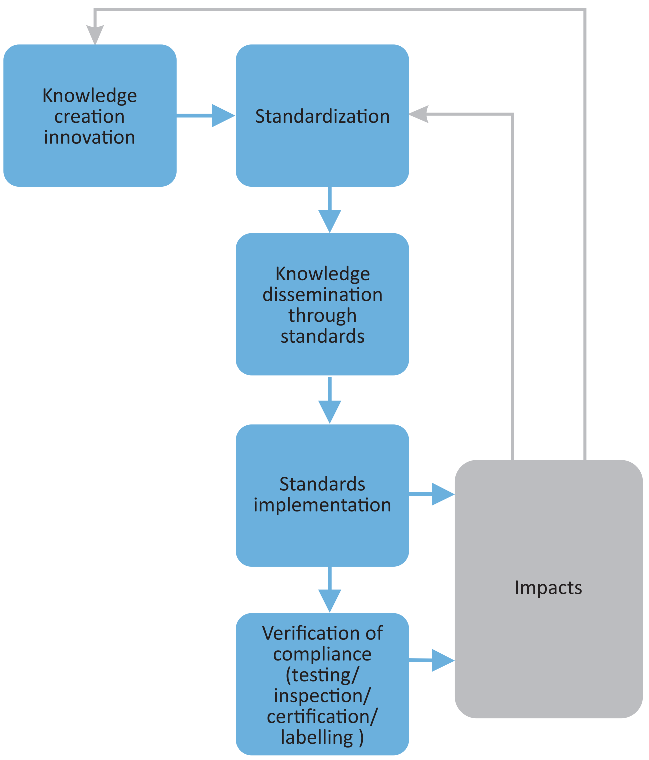
[15] The concept of the three dimensions for the mapping of standards has been developed in and has been adapted from: Thorstensen, Vera, Reinhard Weissinger, Xinhua Sun (2015), *Private Standards—Implications for Trade, Development, and Governance*. E15 Task Force on Regulatory Systems Coherence, available at : https://e15initiative.org/wp-content/uploads/2015/09/E15-Regulatory-Coherence-Thorstensen-Weissinger-Sun-Final.pdf (accessed on 03-05-2021)

[16] See e.g. Kellermann, Martin (2019), Ensuring Quality to gain access to Global Markets. A Reform Toolkit. The World Bank and Physikalisch-Technische Bundesanstalt (PTB). Washington, available at: http://pubdocs.worldbank.org/en/249621553265195570/Full-QI-Toolkit-Report.pdf (accessed on 03-05-2021)

1.6. Standards as a source of innovation through the dissemination of knowledge

Standards can function as an instrument to disseminate new knowledge from research and innovation into economies and societies. As shown in Figure 4, newly created knowledge and innovation is an input into the standardization process. This multi-stakeholder process generates operational knowledge in the form of standards that act as a carrier for knowledge dissemination and generates impacts through their implementation. The implementation of standards may be verified through testing for compliance by independent parties, which may issue certifications and labels that signal to users the compliance of a product, process or service with standards. The use of standards results in experiences, which are channeled back into research initiatives and new standardization projects that may result in the revision, improvement and update of standards.

Figure 4: Generation of impacts through standardization and conformity assessment



Source: Author's diagram

2. STANDARDS AND STANDARDIZATION INITIATIVES RELATED TO PLASTICS

This part of the paper gives an overview of the main standards organizations that develop standards in the field of plastics and environment — ISO, CEN and ASTM International.

2.1. ISO/TC 61 – Plastics

In ISO, technical committee (TC) 61 works on plastics and develops standards related to "nomenclature, methods of test, and specifications applicable to materials and products in the field of plastics including processing (of products) by assembly in particular, but not limited to, polymeric adhesives, sealing, joining, welding." Presently, it comprises of 70 member countries, and addresses the following subject areas through 11 subcommittees (SCs).[17]

ISO/TC 61 was established in 1947 and has so far published more than 700 standards, with around 120 standardization projects currently under development. ISO/TC 61 has eleven subcommittees (SCs) (see Table 1). Most standards produced by TC 61 deal with different types of plastics, their properties and test methods, to determine whether they meet certain requirements. The subcommittee dealing with environmental aspects of plastics is SC 14.

Table 1: Subcommittees under ISO/TC 61 Plastics

Subcommittee reference	Subcommittee title
ISO/TC 61/SC 1	Terminology
ISO/TC 61/SC 2	Mechanical behavior
ISO/TC 61/SC 4	Burning behavior
ISO/TC 61/SC 5	Physical-chemical properties
ISO/TC 61/SC 6	Aging, chemical and environmental resistance
ISO/TC 61/SC 9	Thermoplastic materials
ISO/TC 61/SC 10	Cellular plastics
ISO/TC 61/SC 11	Products
ISO/TC 61/SC 12	Thermosetting materials
ISO/TC 61/SC 13	Composites and reinforcement fibres
ISO/TC 61/SC 14	Environmental aspects

ISO/TC 61/SC 14 – Plastics/Environmental aspects

The SC 14 on Environmental aspects was created under ISO/TC 61 in 2017 and has so far published 31 standards and other types of documents, with 15 documents under development. As stated in the scope of SC 14, the subcommittee deals with "all standardization activities in the field of plastics relating to environmental and sustainability aspects. The focus is on, but not limited to – bio-based plastics, biodegradability, environmental footprint including carbon footprint, resource efficiency including circular economy, characterization of plastics leaked into the environment including microplastics, and waste management including organic, mechanical and chemical recycling."[18]

ISO/TC 61/SC 14 works with five working groups (WGs) (see Table 2).[19] Some of the standards or other documents developed by SC 14 of particular relevance to this paper are introduced below:[21]

[17] See: https://www.iso.org/committee/49256.html (accessed on 03-05-2021)
[18] Recommendation of ISO/TC 61/SC 14 to ISO/TC 61 in document: ISO/TC 61/SC 14 N58, *Report of the plenary meeting on 27-09-2018 in Saitama, Japan* p. 10, dated 04-10-2018

[19] See: https://www.iso.org/committee/6578018.html (accessed on 03-05-2021)

Table 2: Working groups under ISO/TC 61/SC 14 Plastics/ Environmental aspects[20]

Working Group reference	Working Group (WG) title
ISO/TC 61/SC 14/WG 1	Terminology, classification and general guidance
ISO/TC 61/SC 14/WG 2	Biodegradability
ISO/TC 61/SC 14/WG 3	Biobased plastics
ISO/TC 61/SC 14/WG 4	Characterization of plastics leaked into the environment (including microplastics)
ISO/TC 61/SC 14/WG 5	Mechanical and chemical recycling

a. ISO/TR 21960:2020 Plastics – Environmental aspects – State of knowledge and methodologies

This technical report "summarizes current scientific literature on the occurrence of macroplastics and microplastics, in particular in the marine environment, its detection and determination. It gives an overview of current testing methods, including sampling from various environmental matrix, sample preparation and analysis. Further, chemical and physical testing methods for the identification and quantification of plastics are described".

b. ISO/TR 23891:2020 Plastics – Recycling and Recovery – Necessity of standards

This technical report "has been developed to assist all plastics industry stakeholders in the development of new and improved standards for plastic recycling. It gives a short general introduction to plastic recycling, describes the process from feedstock to plastics, different types of recycling technologies, and highlights common problems in relation to recycling of plastic materials and products. Both fossil and non-fossil feedstock are discussed. In Clause 6, existing standards are mapped. In Clause 8, challenges in the transition to a sustainable plastic system are discussed. The necessity of standards is identified in Clause 9."

c. ISO 17422:2018 Plastics – Environmental aspects – General guidelines for their inclusion in standards

This standard "provides a structure for inclusion of environmental aspects in standards for plastic products. It proposes an approach that is directed at minimizing any adverse environmental impact, without detracting from the primary purpose of ensuring adequate fitness for use of the products under consideration.

The guidance provided by this document is intended primarily for use by standards writers. Over and above its primary purpose, this document provides guidance of value to those involved in design work and other activities where environmental aspects of plastics are being considered."

d. ISO 15270:2008 Plastics — Guidelines for the recovery and recycling of plastics waste

This standard "provides guidance for the development of standards and specifications covering plastics waste recovery, including recycling. The standard establishes different options for the recovery of plastics waste arising from pre-consumer and post-consumer sources. It also establishes the quality requirements in all steps of the recovery process, and provides general recommendations for inclusion in material standards, test standards and product specifications. Consequently, the process stages, requirements, recommendations and terminology presented in the standard are intended to be of general applicability".

e. ISO 17088:2012 Specifications for compostable plastics

This standard "specifies procedures and requirements for the identification and labelling of plastics, and products made from plastics, that are suitable for recovery through aerobic composting. The following four aspects are addressed:

i. biodegradation;
ii. disintegration during composting;
iii. negative effects on the composting process and facility; and
iv. negative effects on the quality of the resulting compost, including presence of high levels of regulated metals and other harmful components."

This specification intends to establish the requirements for the labelling of plastic products and materials, including packaging made from plastics, as "compostable" or "compostable in municipal and industrial composting facilities" or "biodegradable during composting….The labelling will, in addition, have to conform to all international, regional, national or local regulations…"

f. ISO 22766:2020 Plastics — Determination of the degree of disintegration of plastic materials in marine habitats under real field conditions

This standard "specifies test methods for the determination of the degree of disintegration of plastic materials exposed to marine habitats under real field conditions.

The marine areas under investigation are the sandy sublittoral and the sandy eulittoral zone where plastic materials can either be placed intentionally (e.g. biodegradable fishing nets) or end up as litter due to irresponsible human behaviour. This depends on their physical characteristics, form and size of the materials, and on water currents and tidal movements."

The standard "specifies the general requirements of the apparatus, and the procedures for using the test methods described."

g. ISO 22526-series:2020 Plastics – Carbon and environmental footprint of biobased plastics

This series of standards "specifies general principles and system boundaries for the carbon and environmental footprint of bio-based plastic products…." The standards are "applicable to plastic products and plastic materials, polymer resins which are based from bio-based fossil-based constituents".

[20] A list of all the current standards and standardization projects of ISO/TC 61/SC 14 can be found here: https://www.iso.org/committee/6578018/x/catalogue/p/1/u/1/w/0/d/0

[21] The information in this overview about ISO standards and other types of deliverables is taken from the introduction or the scope statement of the respective documents. Access to this information is publicly available through the ISO Online Browsing Platform at www.iso.org/obp.

2.2. ISO/TC 122/SC 4 – Packaging/packaging and the environment

Another ISO committee that is relevant in this context is ISO/TC 122 Packaging, and in particular its subcommittee 4, Packaging and the environment.

This subcommittee has published a series of standards (ISO 18601 to ISO 18606) about optimizing the packaging system based on environmental considerations, on the reuse of packaging as well as on material, energy and organic recycling of packaging.[22]

2.3. OTHER RELEVANT ISO STANDARDS AND INITIATIVES

ISO has published many standards on sustainability and the environment.[23] This includes basic standards on environmental management of organizations (the ISO 14000-series), standards on life cycle assessment (ISO 14040 and 14044), standards on greenhouse gas quantification (ISO 14064, 14065, 14067 and others) as well as standards related to climate change adaptation (the ISO 14090-series of standards). A recent initiative in ISO is the new technical committee ISO/TC 323 Circular economy established in 2018, which is in the process of developing standards on "frameworks, guidance, supporting tools and requirements for the implementation of activities of all involved organizations, to maximize the contribution to Sustainable Development".[24]

2.4. CEN/TC 249 – Plastics

In the European Standards Organization CEN, its technical committee CEN/TC 249 deals with various aspects of plastics in the following working groups (WGs) (see Table 3):[25]

Table 3: Working Groups under CEN/TC 249 Plastics

Working Group reference	Working Group (WG) title
CEN/TC 249/WG 2	Plastics warning devises for underground cables and pipelines
CEN/TC 249/WG 4	Decorative laminated sheets based on thermosetting resins
CEN/TC 249/WG 5	Thermoplastic profiles for building applications
CEN/TC 249/WG 7	Thermoplastic films for use in agriculture
CEN/TC 249/WG 9	Bio-based and biodegradable plastics
CEN/TC 249/WG 11	Plastics recycling
CEN/TC 249/WG 13	Wood Plastics Composites (WPC)
CEN/TC 249/WG 16	Welding of thermoplastics
CEN/TC 249/WG 19	Light exposure
CEN/TC 249/WG 21	Profiles for windows and doors
CEN/TC 249/WG 22	Wallcovering panels for building applications
CEN/TC 249/WG 24	Environmental aspects
CEN/TC 249/WG 25	Static thermoplastic tanks for above ground storage of fuel

[22] A list of the published standards and ongoing standardization projects of SC 4 can be found here: https://www.iso.org/committee/52082/x/catalogue/p/1/u/1/w/0/d/0

[23] At the end of 2020, 809 ISO standards and ongoing 169 standardization projects, i.e. a total of 978, have been classified into the category of "sustainability and environment". This amounts to around 3,5 percent of the total standards and projects (see: ISO in figures 2020, available at: https://www.iso.org/files/live/sites/isoorg/files/about%20ISO/iso_in_figures/docs/ISO-in-Figures_2020.pdf) (accessed on 14-07-2021)

[24] See:https://www.iso.org/committee/7203984.html

[25] See:https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:6230&cs=17FC5DE6E1DFEDC2859B4C30DAA179DD1 (accessed on 03-05-2021)

A close cooperation exists between ISO/TC 61 and CEN/TC 249. In many cases, standards are developed in either ISO or CEN and processed in parallel in the other organization, so that the resulting standard is identical in both ISO and CEN. Over 70% of CEN/TC 249 standards are identical with standards developed by ISO/TC 61.[26]

Of particular interest may be CEN/TC 249 Working Group 9 (WG 9) *Bio-based and biodegradable plastics*, Working Group 11 (WG 11) *Plastics recycling* and *Working* Group 24 (WG 24) *Environmental aspects*.

- WG 9 deals with the "definition of terms, vocabulary and identification means regarding degradable plastics and degradability of plastics. Standardization of test methods for the characterization of the degradability of plastics in various environments. Standardization of specifications for degradable plastics".27

- WG 11 deals with various aspects of the recycling of plastics, including sampling procedures for recyclates of different plastic substances, testing methods for recycled plastics to be used in contact with food, plastic waste characterization, and traceability of recycled plastics to calculate the amount of recycled content in plastics.28

- WG 24 deals with "strategic aspects and coordination of all standardization activities in the field of plastics relating to environmental aspects. The focus is on, but not limited to bio-based plastics, biodegradability, carbon and environmental footprint, circular economy and resource efficiency, microplastics and plastics in the environment, recycling, and waste management."[29]

More information, including the standards of CEN/TC 249 and projects, can be found on the website of this committee.

2.5. CEN/TC 411 – Bio-based products

CEN/TC 411 deals with "(i) the development of standards for bio-based products covering horizontal aspects. This includes consistent terminology, sampling, certification tools, bio-based content, application of and correlation towards life cycle analysis, sustainability criteria for biomass used and for final products, and aspects where further harmonization is needed on horizontal level; (ii) Development of standards for bio-solvents, covering product functionality, biodegradability and, if necessary, product specific aspects not covered under (1)."[31]

More information, including on the standards of CEN/TC 411 and projects, can be found on the website of this committee.[32]

[26] Calculated based on the list of published standards of CEN/TC 249 by the author.

[27] See:https://standards.cen.eu/dyn/www/f?p=CENWEB:7:0::::FSP_ORG_ID:19347&cs=1358B3F9360198EAFC7AB2F5834F01314 (accessed on 03-05-2021)

[28] The scope of this WG has been formulated by the author using the abstracts of the publication of the WG, which are available at: https://standards.cen.eu/dyn/www/f?p=204:32:0::::FSP_ORG_ID,FSP_LANG_ID:410327,25&cs=19A7CEAB402ADB700B3007331762CDAA4 (accessed on 03-05-2021)

2.6. ASTM D20 – Plastics

ASTM International (formerly, American Society for Testing and Materials) has a plastics committee, ASTM D20, which was formed in 1937. It has so far published over 475 standards developed by 23 subcommittees.

ASTM D20 develops standards for "test methods, specifications, recommended practices, nomenclature, definitions, and the stimulation of research relating to plastics, their raw materials, components, and compounding ingredients, and to finished products made from plastics such as sheets, rods, tubes, pipes, cellular materials, and molded or fabricated articles".[33] The ASTM standards "have and continue to play a preeminent role in all aspects important to the effective utilization of plastics, including specimen preparation, material specifications and methodologies for mechanical, thermal, optical and analytical testing."[34] ASTM D20 also organizes the cooperation between US interests in plastics and ISO/TC 61.

ASTM D20 has two subcommittees that are relevant in this context: ASTM D20.95 Recycled plastics, and ASTM D20.96 Environmentally degradable plastics and bio-based plastics. More information, including a list of the standards under the two subcommittees and their projects, can be found on the ASTM website.[35]

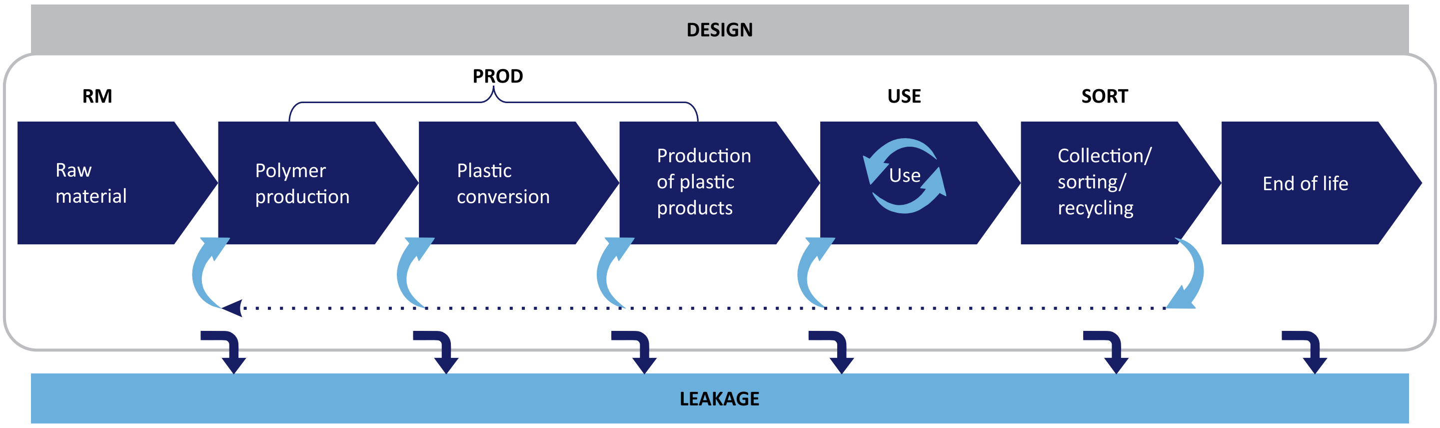
3. PRELIMINARY ANALYSIS OF STANDARDS IN THE CONTEXT OF THE PLASTICS VALUE CHAIN

This part of the paper provides a preliminary analysis of standards in the context of the plastics value chain. The plastics value chain (shown in Figure 5) has four main phases, i.e. raw materials acquisition (= RM), production (= PROD), the use phase (= USE), and collection, sorting and recycling (= SORT) prior to the end-of-life (= EOL) phase. Across these phases, there is a design function, which determines technological, material, product, production and other choices along the value chain.

For the phases to be optimally aligned, the choice of materials and the design of products need to consider functionality and needs across all phases of the value chain, including functionality required after the use phase (i.e. collection, sorting, re-use and recycling) at the beginning of the value chain. This enables efficient and resource-saving choices that facilitate reuse of products, recycling and reuse of materials in production to be achieved. A major challenge that must be addressed is plastics leakage and pollution that occurs throughout the value chain.

Table 4 contains an overview of the main contents of the standards of ISO, CEN and ASTM that were introduced in Part 2 of this paper, mapped to the plastics value chain. A large group of standards addresses different plastics materials and test methods to determine characteristics, the content and the behaviour of plastics (e.g. degradation and disintegration under certain conditions such as exposure to water, seawater as well as in marine environments, which are aspects of leakage into the environment). A specific set of standards, those developed by CEN/TC 411, addresses bioplastics and their behaviour under test conditions aimed at determining biodegradability or compostability. The standards of CEN/TC 249 focus on the behaviour of recycled plastics.

Figure 5: Main stages of the plastics value chain



Source: Adapted from UNEP, Technical University of Denmark (2018), p. 1036

[29] See:https://standards.cen.eu/dyn/www/f?p=CENWEB:7:0::::FSP_ORG_ID:2350485&cs=16A8354F6010EB1B18D1718E860995F0E (accessed on 03-05-2021)
[30] See:https://standards.cen.eu/dyn/www/f?p=204:32:0::::FSP_ORG_ID,FSP_LANG_ID:6230,25&cs=11E174A67F5E5FCE25A38D455165ED0CA
[31] See:https://standards.cen.eu/dyn/www/f?p=204:7:0::::FSP_ORG_ID:874780&cs=112703B035FC937E906D8EFA5DA87FAB8 (accessed on 03-05-2021)
[32] See:https://standards.cen.eu/dyn/www/f?p=204:32:0::::FSP_ORG_ID,FSP_LANG_ID:874780,25&cs=1D63BAA7EABE56EB230DDAA05D6F2CE70
[33] See:https://www.astm.org/COMMIT/SCOPES/D20.htm (accessed on 03-05-2021)
[34] See:https://www.astm.org/COMMITTEE/D20.htm (accessed on 03-05-2021)
[35] ASTM D20.95: https://www.astm.org/COMMIT/SUBCOMMIT/D2095.htm
[36] UNEP, Technical University of Denmark (2018), *Mapping of global plastics value chain and plastics losses to the environment. With a particular focus on marine environment, available at:* https://wedocs.unep.org/handle/20.500.11822/26745, p. 10 (accessed on 03-05-2021)

Table 4. Analysis of main content elements of selected standards of ISO, CEN and ASTM International

	ISO		CEN		ASTM International		Total
Content	**TC 61/SC 14**	**TC 122/SC 4**	**TC 249 (WGs 9, 11, 24)**	**TC 411**	**D20.95**	**D20.96**	
General	6	1	2	1			**10**
Terminology		1	3	1			**5**
Design							**7**
a. Life Cycle Analysis				2			2
b. Carbon & environmental footprint				2			5
Raw materials	3						-
Production							**4**
a. Polymer production			1				1
b. Plastic conversion							
c. Plastic products							3
Materials	3						**66**
a. General							
b. Biomaterials			1	14		1	21
c. Contamination	5		1		5		6
d. Degradation			1			5	6
e. Biodegradation			1			7	8
f. Recycled plastics	8		11		4		15
g. Packaging		10					10
Testing/analysis			6	5		10	**44**
a. General							21
b. Content identification	3		6	6	3		18
c. Separation					3		3
d. Biodegradability	2						2
Labeling						2	**13**
a. General							2
b. Coding		1			1		2
c. Communication		1	2	3			6
d. Declaration	1	1	1				3
Use							**1**
a. General							
b. Reuse		1					1
Environmental conditions							**26**
a. General	9		1			7	17
b. Marine environment	7					2	9
Sort							**18**
a. Waste recovery	1		2				3
b. Collection							
c. Sorting							
d. Recycling	2	5					7
e. Composting	5		1			2	8
End of Life (EoL)				1			**1**
Leakage	18		1			11	**30**

Note: This table analyses selected standards listed in the Annex based on the 'content' elements in the left column. If a standard covers such a content element, the value 1 was assigned. Typically a single standard covers more than one of these elements so that the number for an individual standard can vary between 1 and 4. As a consequence, the numbers in the table exceed the number of the analyzed standards. The numbers in the column 'total' show how often a content element is addressed across the different standards developed by working groups and committees of the three organizations. The rows marked in blue aggregate the elements for the main phases of the value chain introduced in this part of the paper.

Recent studies on pollution across the plastics value chain[37] have shown that the USE-stage is the major contributor to marine plastic pollution, for both macro- and micro-plastics, especially due to "mismanaged municipal solid waste in low-income and lower-middle income countries."[38] For microplastics, the major sources were "abrasion of tyre rubbers, abrasion of road markings and plastics contributing to city dust generation."[38]

Other aspects that are often discussed related to plastics, such as quality categories of recycled plastics for reuse in production, reuse of plastic products, and collection and sorting of plastics, are so far only marginally addressed by any of the standards (e.g. there is one standard about reuse of plastics packaging by ISO/TC 122/SC 4). Another under-represented area is the design of plastic materials and products to facilitate recycling, or providing recommendations for a limited number of additives and avoidance of hazardous substances. To date, the main uses of standards are to determine material content in plastics, bio- or recycled plastics, their behaviour and environmental effects under certain conditions. However, existing standards have so far not systematically addressed key aspects of the plastics value chain. As noted in Part 5 below, a global treaty on plastic pollution could be instrumental to achieve a more complete coverage of the value chain by standards and their use – together with other instruments – in combatting plastics pollution.

4. ENHANCING THE CONTRIBUTION OF STANDARDS AND STANDARDIZATION

The first section of this part of the paper proposes some strategic actions standards organizations could take. The second section, offers specific suggestions for enhancing the contribution of standards to address plastics pollution.

4.1. Proposed strategic actions by standards organizations

As shown in Figure 4, standards can be effective instruments to disseminate new knowledge and innovation in the society and the economy. As the negative side effects of wide scale and increasing use of plastics become increasingly known, standards organizations, and preferably a coalition of them, could help address this challenge in the following three ways:

Apply a value chain and circular economy-based framework as the foundation for standards development

While standards are often highly specific in their focus and developed to address a particular problem (e.g. compostability, test methods for the strength of a certain material), standards organizations should consider the results from large-scale studies about the use of plastics and plastics pollution (e.g. by the World Economic Forum, the Ellen MacArthur Foundation, United Nations Environment Programme, and The Pew Charitable Trusts and SystemIQ).[39]

Standards organizations should base the development of standards on a holistic and systems view of the plastics value chain (Figure 5). This will require overcoming the traditional working style of starting with a focus on highly specific topics, an approach often founded in traditional organizational structures that tend to perpetuate work in silos. The principal orientation should be to contribute towards re-shaping linear value chains into circular value chains by identifying options for reuse, remanufacturing, lifetime extension, recycling, and re-introduction into production. Principles of the circular economy as a holistic framework that aims at retaining goods and materials in use for as long and with a value as high as possible, and comprehensive value chain frameworks, should become the basic paradigm for the development of all standards, not only for standards on plastics. This requires that traditional criteria such as quality, functionality, performance, health and safety of products and materials be systematically extended to encompass ecological footprint and circularity criteria.

Certainly, such a change would not be immediate and would require significant adaptations in the orientation of standards organizations, as well as the experts who are engaged in the development of the standards. However, only such a re-orientation can fully leverage the potential of standardization in support of a fundamental transition towards a circular economy and a sustainable development path.

On plastics specifically, standards should help support sustainable product design choices, reduce the volume of plastics, spur the more efficient use and multiple re-use of plastics, incentivize the design of new types of plastics and plastic products that are more environmentally friendly (biodegradability) and/or achieve significantly higher recycling rates so that plastics can re-enter the production cycle.

A value chain and circular economy framework would also help address and overcome the gaps and deficits in the current set of standards identified in Part 3.

Mutual mapping of standards to determine essential equivalencies

Standards developed by different standards organizations should be mapped against each other to identify common

[37] UNEP, Technical University of Denmark (2018), p. 15; Wilts, Henning, Jennifer Schinkel, Lina Feder (2020), *Prevention of plastic waste in production and consumption by multi-actor partnerships*. PREVENT Waste Alliance and Wuppertal Institute. Bonn; Ryberg, Morten W. et al (2019), *Global environmental losses of plastics across their value chains*, in: Resources, Conservation & Recycling 151 (2019) 104459, available at: https://doi.org/10.1016/j.resconrec.2019.104459 (accessed on 03-05-2021)

[38] Ryberg, Morten W. et al (2019), ibid., p. 1

[39] The following publications are particularly relevant (all accessed on 2021-05-03): World Economic Forum (2016), *The new plastics economy – Rethinking the future of plastics*, available at: http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf; Ellen MacArthur Foundation (EMF) (2017), *The new plastics economy – Catalysing action*, available at: https://www.ellenmacarthurfoundation.org/publications/new-plastics-economy-catalysing-action; EMF (2019), *Reuse – Rethinking packaging,* available at: https://www.ellenmacarthurfoundation.org/publications/reuse; EMF (2020), *Upstream Innovation. A guide to packaging solutions*, available at: https://www.ellenmacarthurfoundation.org/news/new-upstream-innovation-guide-offers-practical-solutions-to-the-plastic-pollution-crisis; The Pew Charitable Trusts and SystemIQ (2020), *Breaking the Plastic Wave. A comprehensive assessment of pathways towards stopping ocean plastic pollution*, available at: https://www.pewtrusts.org/-/media/assets/2020/07/breakingtheplasticwave_report.pdf

functionalities and requirements. The overview of standards in the plastics sector provided in the Annex reveals a multiplicity of standards, which makes it difficult for standards users to grasp the differences between them. If standards that have been developed by European standards organizations and standards developed by bodies with a stronghold in the United States are essentially equivalent in key requirements, they should be identified as such. This would reduce confusion about diverging standards used in different parts of the world if only limited technical differences exist.

Increase cooperation between standards organizations

In the light of the urgency of addressing plastic pollution, leading standards organizations should increase their cooperation and coordination, including through joint development of standards and joint processes for review of existing standards. Even if there are some differences due to history and regional specifics, reaching an alignment between different standards on essential requirements would provide clearer orientation to markets.

Improve the measurement of the impacts of standards

Standards organizations generally lack systematic knowledge about the impacts of their standards on society, the economy and the environment. Such impacts can be attributed in full or partially to the implementation of standards by companies, public authorities or other users. Statements or claims about the impacts of standards are often either derived from high-level macroeconomic theories or assumptions based on proxy indicators such as figures from the sales of standards, numbers of national adoptions of standards or references to standards in regulations. Although work has been done by some scholars and standards organizations, in particular ISO and the ISEAL Alliance[40] on a methodology for determining impacts, data from systematic and regular evaluation and measurement of the impacts of standards is largely missing. Standards organizations should cooperate in the development of such a methodology for the measurement of standards impacts with a view to implementing it on a significant scale.

4.2. Specific proposals: enhancing the contribution of standards to plastic pollution reduction efforts

The proposals below do not claim to be exhaustive in any form but, if implemented by industry players, would mark a major step forward.

Variety reduction of plastic materials

There are many kinds of plastics, typically mixed with various types of additives and there often exists a high degree of uncertainty about the specific composition of plastic materials or products. The reduction in the variety of plastic materials and of functionally equivalent product types will significantly contribute to simplification, which in turn will increase efficiency in the subsequent life cycle stages such as collection, sorting, reuse and recycling. A key priority is to address challenges upstream in the plastics value chain through design choices with the aim to achieve variety reduction both at the level of materials and of functional equivalent products. This would require a higher degree of standardization both for materials as well as for products, resulting in less material and product variety.

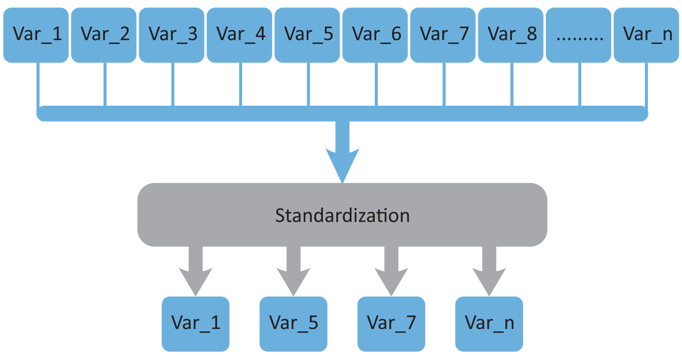
Information about the material composition of plastics should be generated at the beginning of the supply chain and – through a standardized digital materials passport associated with the materials and products using them – be passed through all subsequent life cycle stages. Information about the composition of plastic materials registered in a *standardized digital materials passport* would also ensure transparency about the contents of specific plastic materials and its products.

The basic approach suggested here is to apply an essential function of standardization, which is variety reduction, to plastics production. As shown in Figure 6, variety reduction means that through standardization a number of varieties - among a range of theoretically possible varieties (Var_1 to Var_n) - is given preference in terms of:

- Plastic materials selection
- Plastic products selection

This would make it possible to reduce variability at all later stages, and provide the required transparency for collection, sorting, reprocessing, reuse and recycling. It would also make it more attractive to reuse recycled plastics as its quality could be better assured due to availability of information about the materials used in the preceding loop.

Figure 6: The principle of variety reduction of materials and products



Source: Author's diagram

[40] See ISO (2013), *Economic benefits of standards - ISO Methodology 2.0*, available at: https://www.iso.org/publication/PUB100344.html and ISEAL Alliance (2014), *Assessing the Impacts of Social and Environmental Standards Systems. ISEAL Code of Good Practice. Version 2.0*, available at: https://www.isealalliance.org/sites/default/files/resource/2019-06/ISEAL_Impacts_Code_Version_2.0.pdf (both accessed on 26-07-2021)

Consistent global plastics terminology

Much work has been done on defining key concepts related to plastics, but there is still lack a consistent global terminology and definitions. For example, there is much confusion about concepts such as biodegradability, compostability and bio-based plastics.

Variety reduction in plastic products based on functional equivalence

Consideration should be given to reducing product varieties, such as of plastic bottles and cups, as well as plastic parts in cars, planes or other complex products and replacing them with standardized parts. Such usage of common product types or parts could help all manufacturers meet regular performance requirements. A reduction would also facilitate collection, sorting, reuse and recycling of plastic products by allowing simplified sorting, collection schemes and the required infrastructure. Sustainability, durability, longevity and reusability should be emphasized in the process of variety reduction.

Global taxonomy for quality categories of recycled plastics

Use of recycled plastics is often hampered by uncertainty about the quality and performance of recycled plastics. There is a need for the definition of quality categories and related testing methods to determine the quality of recycled plastics, ensure reliable information about recycled plastics and facilitate their reuse. The reduction of material and product varieties, as suggested above, would significantly reduce the complexity in arriving at the definition of quality categories.

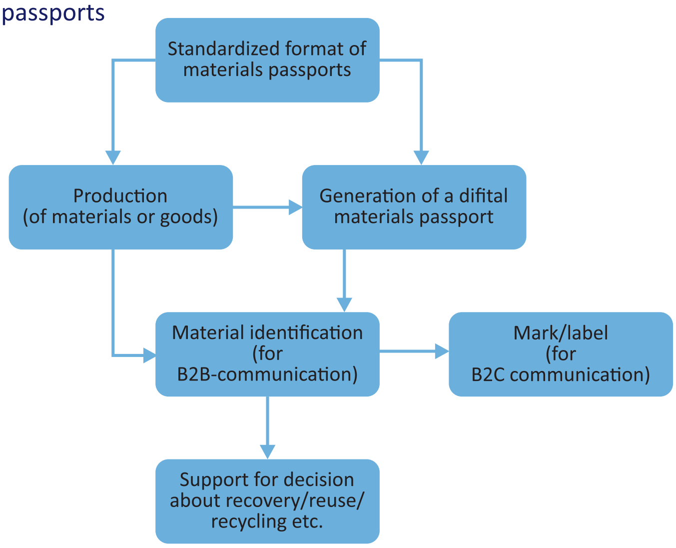
Standardized digital materials passports for plastic products (material transparency)

To provide transparency of the material composition of plastic materials and products, a standardized digital materials passport[41] should be introduced that contains information about all substances, including additives that are part of the composition of plastic products. Standards should define the structure, data format and content of such passports, which should be used by all plastic materials and product manufacturers. Currently, the specific substances mixed in plastics are often unknown, thus making it difficult to determine whether they are hazardous or not, as well as their degree of recyclability. A requirement for a materials passport for plastics would provide transparency along the value chain, including the end-of-use stage of plastic. Such transparency could contribute to the reduction and elimination of hazardous additives in plastic as it would allow scrutiny into the substances used. Materials passports (different from marks and labels) would mainly respond to the need for business-to-business sharing of information and decision-making along the supply chain and product life cycle.

Simple and clear labelling schemes

[41] The concept of materials passports is used, for instance, in the building sector, see: https://www.bamb2020.eu/topics/materials-passports/ (accessed on 03-05-2021)

Figure 7: Generation and use of standardized digital materials passports



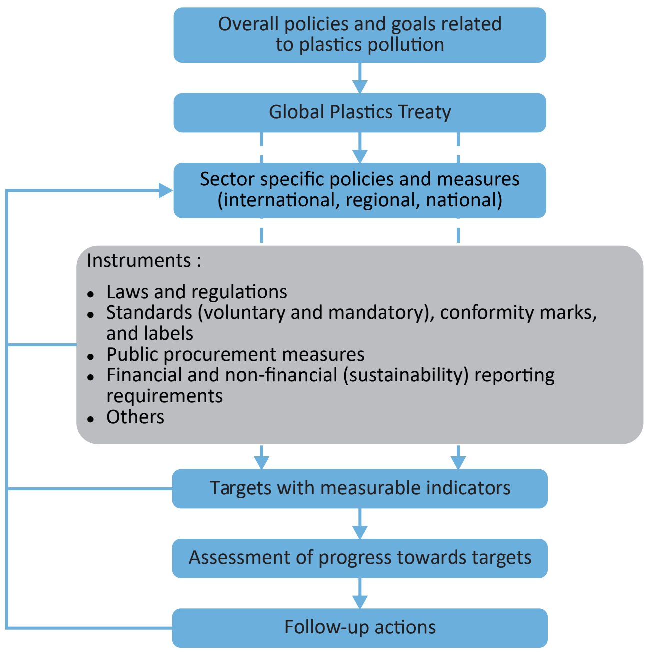
Source: Author's diagram

Simple and clear labelling schemes that express sustainability aspects, including recyclability and content of recycled materials are important for consumers to take informed purchasing decisions. Different from the materials passports, labelling schemes or marks should mainly address the need for business-to-consumer communication and provide consumers with sustainability information, information about recycled content and recyclability of the product.

5. STANDARDS AND OTHER INSTRUMENTS IN SUPPORT OF A GLOBAL TREATY ON PLASTIC POLLUTION

There is growing interest among a broad range of governments in developing a new global treaty to provide a legal framework

Figure 8: Standards and other instruments addressing plastics pollution



Source: Author's diagram

for international efforts to combat plastic pollution. Figure 8 outlines a generic process of how standards, together with other instruments, can be applied in the context of such a global treaty. A global treaty on plastic pollution could also provide the framework to fill gaps in the current set of standards to cover the whole plastics value chain and could trigger more comprehensive implementation of the standards, including monitoring of their effectiveness together with other measures.

To be achieved, the goals of a global treaty need to be translated into sector specific policies and measures at international, regional and national levels, and supported by regulations, standards and other instruments, such as financial, public procurement policies as well as reporting requirements for business and other legal entities. Standards can be used on their own or in support of the other instruments, such as laws and regulations, financial instruments, public procurement measures as well as reporting requirements.[41] The impacts of these instruments and measures will need to be assessed against specific targets in line with the overall goals of the treaty and legal frameworks. The assessment of progress and follow-up actions may require an adaptation of sector-specific policies and measures.

By defining and maintaining a toolbox of recognized and equally functional standards that can be used to achieve targets, the proposed global treaty could leave the choice of specific standards to the implementers. Such an approach would avoid giving preference to certain standards in the treaty itself.

6. FINAL REMARKS

Standards are voluntary agreements developed by groups of multi-stakeholder experts, who cooperate in committees run by standards organizations. The existence of a standard does not assure its use or its large-scale and consistent implementation in markets and industries. First, different standards organizations sometimes develop similar standards, which may compete in the market resulting in the uptake of different standards in different markets and, potentially market fragmentation. Second, to ensure successfull implementation, standards require additional conditions such as an infrastructure and institutional frameworks, including appropriate policies, regulations and consumer awareness. The quality infrastructure, in the form of testing, inspection and certification, plays an especially vital role.

Further, the proposals in this paper for standards that can support a reduction in upstream variety of plastics (both in terms of materials used and product types) and downstream efficiency, can only be implemented through the broad cooperation of a range of industry players and stakeholders upstream and downstream. Such cooperation will require not only voluntary commitments, but also the formulation of regulatory measures and coherent policy objectives by governments, as well as major efforts in end user and consumer education.

Notably, some of these measures would require adaptations in existing regulations and a significant push to ensure that manufacturers engage in such common frameworks. Measures would also have to include incentive and pricing schemes that promote sustainable production and consumption, extension of product lifetimes and support for secondary raw materials markets. Monitoring systems that detect and help address practices contrary to these objectives would be essential. In addition, developed countries will needed need to take action to reduce their own contributions to plastic pollution and to provide technical and financial support to developing countries to tackle the global plastics pollution challenge.

Without pressure from governments, academia, consumer groups and the society, it is unrealistic to expect convergence on such measures and new frameworks, including in regard to new voluntary standards and technical regulations. A global treaty on plastic pollution could play an important role in spurring such cooperation.

[42] Recent developments in the field of financial and non-financial, i.e. sustainability, reporting regarding climate risks, stricter and unified disclosure requirements about impacts on natural and social capital and generally on environmental, social and governance (ESG) topics may evolve into one of a set of powerful instruments driving down environmental impacts of companies and may also result in stronger measures against plastics pollution. In this context see e.g. the contribution by the former CEO of the Global Reporting Initiative (GRI), Mohin, Tim (2021), 'World Changing Ideas. 5 things you need to know about the future of ESG reporting,' in *Fast Company,* 2021-04-21, available at: https://www.fastcompany.com/90627951/5-things-you-need-to-know-about-the-future-of-esg-reporting?partner=rss&utm_source=rss&utm_medium=feed&utm_campaign=rss%20fastcompany&utm_content=rss%3Fcid%3Dsearch&s=09 (accessed on 03-05-2021)

ANNEX – LIST OF RELEVANT STANDARDS OF ISO, CEN AND ASTM INTERNATIONAL (Date: April 2021)

ISO/TC 61/SC 14	Plastics/Environmental aspects
ISO 10210:2012	Plastics — Methods for the preparation of samples for biodegradation testing of plastic materials
ISO 13975 :2019	Plastics — Determination of the ultimate anaerobic biodegradation of plastic materials in controlled slurry digestion systems — Method by measurement of biogas production
ISO 14851:2019	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by measuring the oxygen demand in a closed respirometer
ISO 14852:2018	Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium — Method by analysis of evolved carbon dioxide
ISO 14853:2016	Plastics — Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system — Method by measurement of biogas production
ISO 14855-1:2012	Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions — Method by analysis of evolved carbon dioxide — Part 1: General method
ISO 14855-2:2018	Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions — Method by analysis of evolved carbon dioxide — Part 2: Gravimetric measurement of carbon dioxide evolved in a laboratory-scale test
ISO 15270:2008	Plastics — Guidelines for the recovery and recycling of plastics waste
ISO 15985:2014	Plastics — Determination of the ultimate anaerobic biodegradation under high-solids anaerobic-digestion conditions — Method by analysis of released biogas
ISO 16620-1:2015	Plastics Biobased content — Part 1: General principles
ISO 16620-2:2019	Plastics — Biobased content — Part 2: Determination of biobased carbon content
ISO 16620-3:2015	Plastics Bio-based content — Part 3: Determination of biobased synthetic polymer content
ISO 16620-4:2016	Plastics — Bio-based content — Part 4: Determination of biobased mass content
ISO 16620-4:2016	Plastics — Bio-based content — Part 5: Declaration of bio-based carbon content, bio-based synthetic polymer content and bio-based mass content
ISO 16929:2021	Plastics — Determination of the degree of disintegration of plastic materials under defined composting conditions in a pilot-scale test
ISO 17088:2012	Specifications for compostable plastics
ISO 17422:2018	Plastics — Environmental aspects — General guidelines for their inclusion in standards
ISO 17556:2019	Plastics — Determination of the ultimate aerobic biodegradability of plastic materials in soil by measuring the oxygen demand in a respirometer or the amount of carbon dioxide evolved
ISO 18830:2016	Plastics — Determination of aerobic biodegradation of non-floating plastic materials in a seawater/sandy sediment interface — Method by measuring the oxygen demand in closed respirometer
ISO 19679:2020	Plastics — Determination of aerobic biodegradation of non-floating plastic materials in a seawater/sediment interface — Method by analysis of evolved carbon dioxide
ISO 20200:2015	Plastics — Determination of the degree of disintegration of plastic materials under simulated composting conditions in a laboratory-scale test
ISO/TR 21960:2020	Plastics — Environmental aspects — State of knowledge and methodologies
ISO 22403:2020	Plastics — Assessment of the intrinsic biodegradability of materials exposed to marine inocula under mesophilic aerobic laboratory conditions — Test methods and requirements
ISO 22404:2019	Plastics — Determination of the aerobic biodegradation of non-floating materials exposed to marine sediment — Method by analysis of evolved carbon dioxide
ISO 22526-1:2020	Plastics — Carbon and environmental footprint of bio-based plastics — Part 1: General principles
ISO 22404:2019	Carbon and environmental footprint of bio-based plastics — Part 2: Material carbon footprint, amount (mass) of CO2 removed from the air and incorporated into polymer molecule
ISO 22526-3:2020	Carbon and environmental footprint of bio-based plastics — Part 3: Process carbon footprint, requirements and guidelines for quantification
ISO 22766:2020	Determination of the degree of disintegration of plastic materials in marine habitats under real field conditions
ISO/TR 23891:2020	Plastics — Recycling and recovery — Necessity of standards
ISO 23977-1:2020	Determination of the aerobic biodegradation of plastic materials exposed to seawater — Part 1: Method by analysis of evolved carbon dioxide
ISO 23977-2:2020	Determination of the aerobic biodegradation of plastic materials exposed to seawater — Part 2: Method by measuring the oxygen demand in closed respirometer

ISO/TC 122/SC 4	Packaging/Packaging and the environment
ISO/TR 16218:2013	Packaging and the environment — Processes for chemical recovery
ISO/TR 17098:2013	Packaging material recycling — Report on substances and materials which may impede recycling
ISO/TR 18568:2021	Packaging and the environment — Marking for material identification
ISO 18601:2013	Packaging and the environment — General requirements for the use of ISO standards in the field of packaging and the environment
ISO 18602:2013	Packaging and the environment — Optimization of the packaging system
ISO 18603:2013	Packaging and the environment — Reuse
ISO 18604:2013	Packaging and the environment — Material recycling
ISO 18605:2013	Packaging and the environment — Energy recovery
ISO 18606:2013	Packaging and the environment — Organic recycling
ISO 21067-2:2015	Packaging — Vocabulary — Part 2: Packaging and the environment terms

CEN/TC 249/WG 9	Plastics/Bio-based and biodegradable plastics
CEN/TR 15351:2006	Guide for vocabulary in the field of degradable and biodegradable polymers and plastic items
EN 14987:2006	Evaluation of disposability in waste water treatment plants - Test scheme for final acceptance and specifications
EN 14995:2006	Evaluation of compostability - Test scheme and specifications
EN 17228:2019	Bio-based polymers, plastics, and plastics products - Terminology, characteristics and communication
ISO 13975 :2019	Determination of the ultimate biodegradation of plastics materials in an aqueous system under anoxic (denitrifying) conditions - Method by measurement of pressure increase

CEN/TC 249/WG 11	Plastics/Plastics recycling
CEN/TR 15353:2007	Plastics - Recycled plastics - Guidelines for the development of standards for recycled plastics
CEN/TS 16010:2020	Plastics - Recycled plastics - Sampling procedures for testing plastics waste and recyclates
CEN/TS 16011:2013	Plastics - Recycled plastics - Sample preparation
CEN/TS 16861:2015	Plastics - Recycled plastics - Determination of selected marker compounds in food grade recycled polyethylene terephthalate (PET)
EN 15342:2007	Plastics - Recycled Plastics - Characterization of polystyrene (PS) recyclates
EN 15343:2007	Plastics - Recycled Plastics - Plastics recycling traceability and assessment of conformity and recycled content
EN 15344:2007	Plastics - Recycled Plastics - Characterisation of Polyethylene (PE) recyclates
EN 15345:2007	Plastics - Recycled Plastics - Characterisation of Polypropylene (PP) recyclates
EN 15346:2007	Plastics - Recycled plastics - Characterization of poly(vinyl chloride) (PVC) recyclates
EN 15347:2007	Plastics - Recycled Plastics - Characterisation of plastics wastes
EN 15348:2014	Plastics - Recycled plastics - Characterization of poly(ethylene terephthalate) (PET) recyclates

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EN 15347:2007	Plastics - Recycled Plastics - Characterisation of plastics wastes
EN 15348:2014	Plastics - Recycled plastics - Characterization of poly(ethylene terephthalate) (PET) recyclates

ASTM D20.96	Plastics/Environmentally degradable plastics and bio-based plastics
D3826-18	Standard practice for determining degradation end point in degradable polyethylene and polypropylene using a tensile test
D5071-06(2013)	Standard practice for exposure of photodegradable plastics in a xenon arc apparatus
D5208-14	Standard practice for fluorescent UltraViolet (UV) exposure of photodegradable plastics
D5272-08(2013)	Standard practice for outdoor exposure testing of photodegradable plastics
D5338-15(2021)	Standard test method for determining aerobic biodegradation of plastic materials under controlled composting conditions, incorporating thermophilic temperatures
D5511-18	Standard test method for determining anaerobic biodegradation of plastic materials under high-solids anaerobic-digestion conditions
D5526-18	Standard test method for determining anaerobic biodegradation of plastic materials under accelerated landfill conditions
D5988-18	Standard test method for determining aerobic biodegradation of plastic materials in soil
D6400-19	Standard specification for labeling of plastics designed to be aerobically composted in municipal or industrial facilities
D6691-17	Standard test method for determining aerobic biodegradation of plastic materials in the marine environment by a defined microbial consortium or natural sea water inoculum
D6866-21	Standard test methods for determining the bio-based content of solid, liquid, and gaseous samples using radiocarbon analysis
D6868-21	Standard specification for labeling of end items that incorporate plastics and polymers as coatings or additives with paper and other substrates designed to be aerobically composted in municipal or industrial facilities
D6954-18	Standard guide for exposing and testing plastics that degrade in the environment by a combination of oxidation and biodegradation
D7444-18a	Standard practice for heat and humidity aging of oxidatively degradable plastics
D7473/D7473M-21	Standard test method for weight attrition of non-floating plastic materials by open system aquarium incubations
D7475-20	Standard test method for determining the aerobic degradation and anaerobic biodegradation of plastic materials under accelerated bioreactor landfill conditions
D7991-15	Standard test method for determining aerobic biodegradation of plastics buried in sandy marine sediment under controlled laboratory conditions

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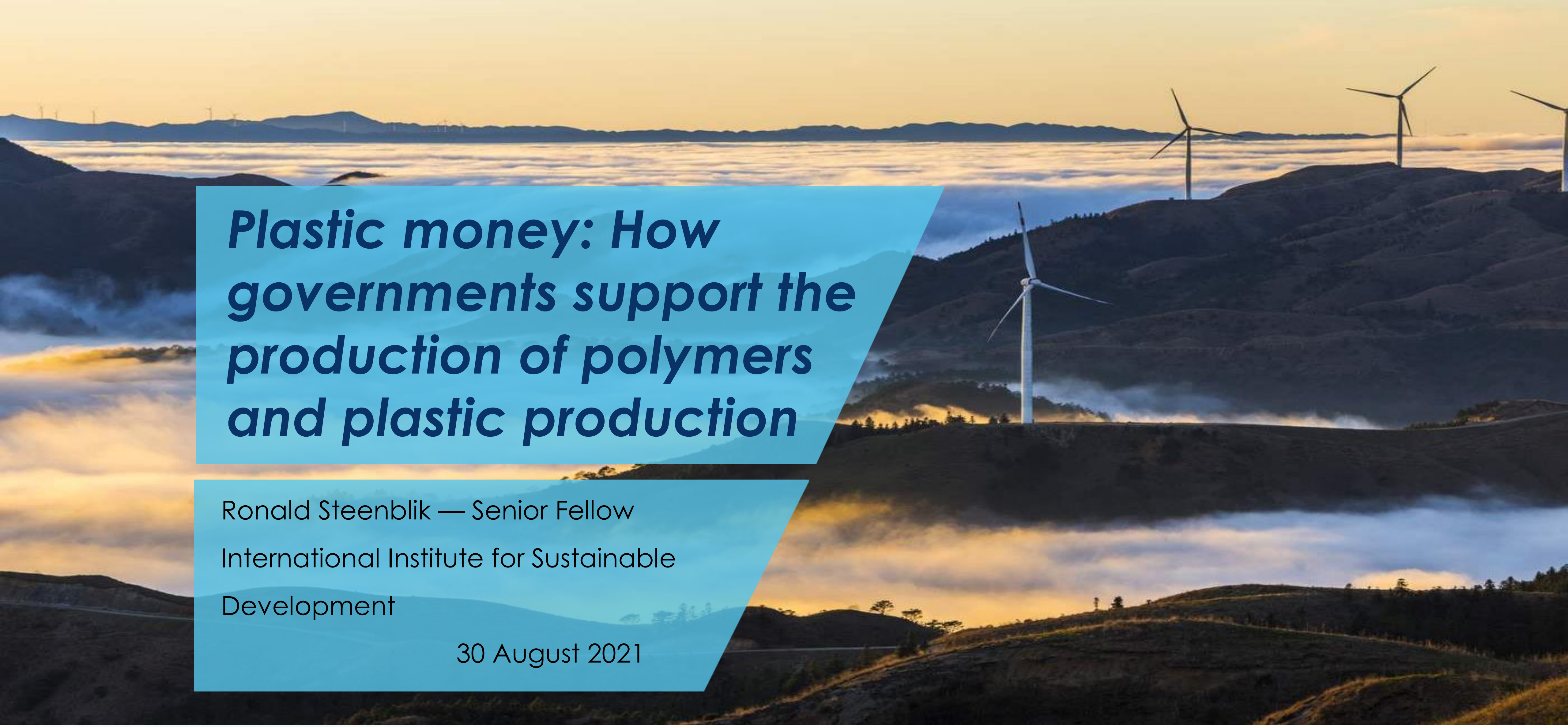


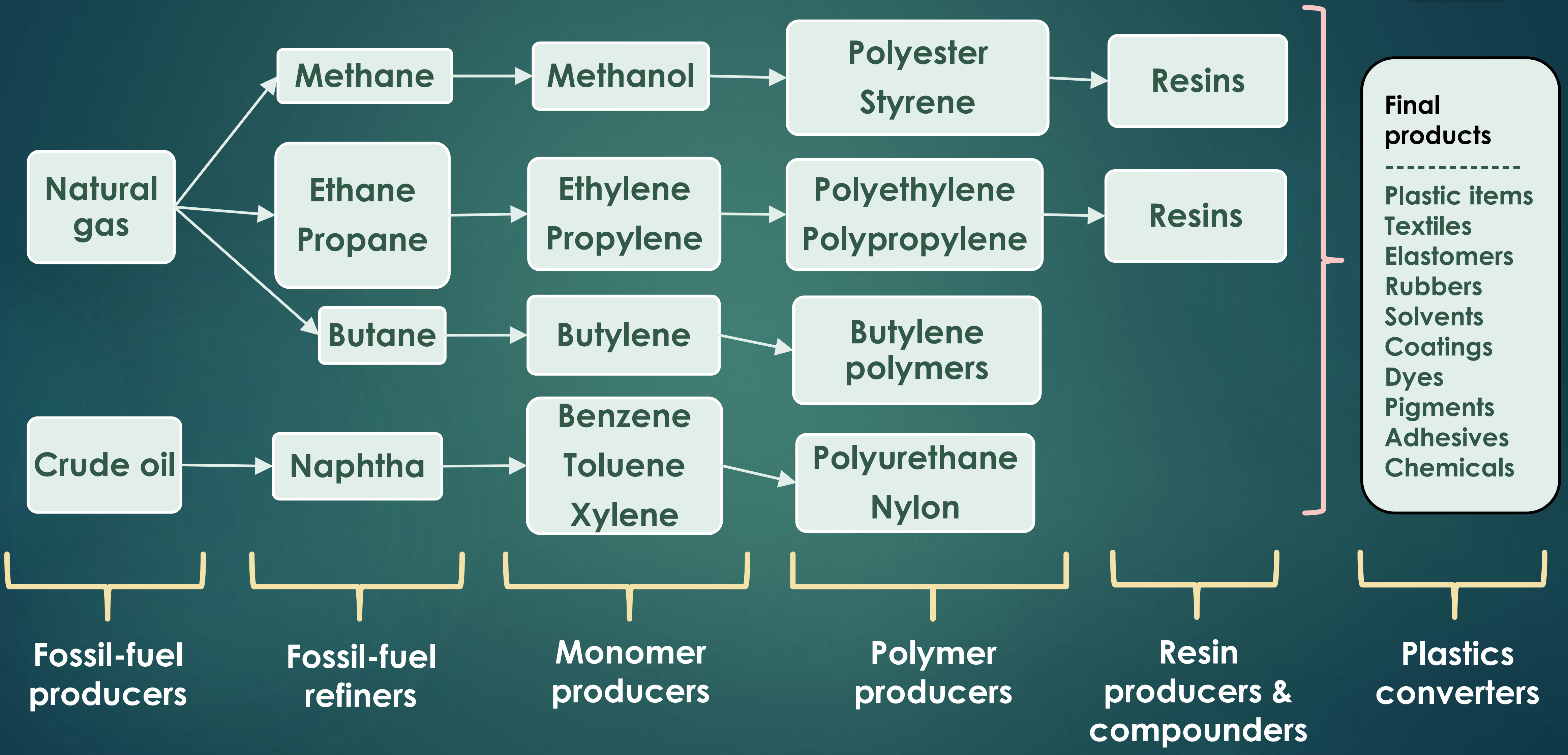
Plastic money: How governments support the production of polymers and plastic production

Ronald Steenblik — Senior Fellow

International Institute for Sustainable Development

30 August 2021

Stages of plastics production



Low-priced crude oil and natural gas may be subsidizing some petrochemical production

Country	Primary plastic production, 2015 (kilotonnes)	Petroleum consumption subsidies, 2019 (US$ billion)	Natural gas consumption subsidies, 2019 (US$ billion)
China	63 771	12.4	--
United States	36 004	--	--
Korea	14 411	--	--
Saudi Arabia	14 342	18.2	4.7
India	9 867	21.0	0.9
Japan	8 766	--	--
Germany	8 654	--	--
Chinese Taipei	7 775	--	--
Thailand	7 669	--	--
Brazil	6 150	--	--
Iran	6 038	18.0	16.3
Belgium	5 381	--	--
Russia	5 250	--	10.4

Sources: • **plastic production:** Euromap; • **consumer price subsidies:** International Energy Agency.

Incentives for producers of polymers appear to be significant in some countries

- Central-government subsidies to the primary plastic producers have not yet been assembled
- The BASF Group in its Annual Report (2020) mentions having received "government grants and government assistance" from several countries, amounting to €27 million (USD 30 million) in 2019, and €43 million (USD 50 million) in 2018.
- Many are provided by subnational governments. The web site Subsidy Tracker (https://www.goodjobsfirst.org/subsidy-tracker) documents many in the United States.

Much to be done to identify subsidies to producers of plastic products

- There are at least 10s of thousands of companies that process and fabricate products made of plastics around the world.
- Many of these plants benefit from general government support for manufacturers.
- In addition, governments also often provide targetted support to encourage plants to be established in particular locations.
- A quick search of the EU’s database on approved regional aid packages shows that plastic product manufacturers in the EU received at least € 130 million during 2006 and the 2012-14 period.

A research agenda for improving subsidy information relating to plastics

- Identify which petrochemical refiners are benefitting from low feedstock costs.
- Drill into databases on sub-national support to facilities producing polymers or plastics.
- Expand information on government and multilateral credit benefitting facilities producing polymers or plastics; estimate the subsidy-equivalent value of such credit, where possible.
- Attribute subsidies to relevant polymers.