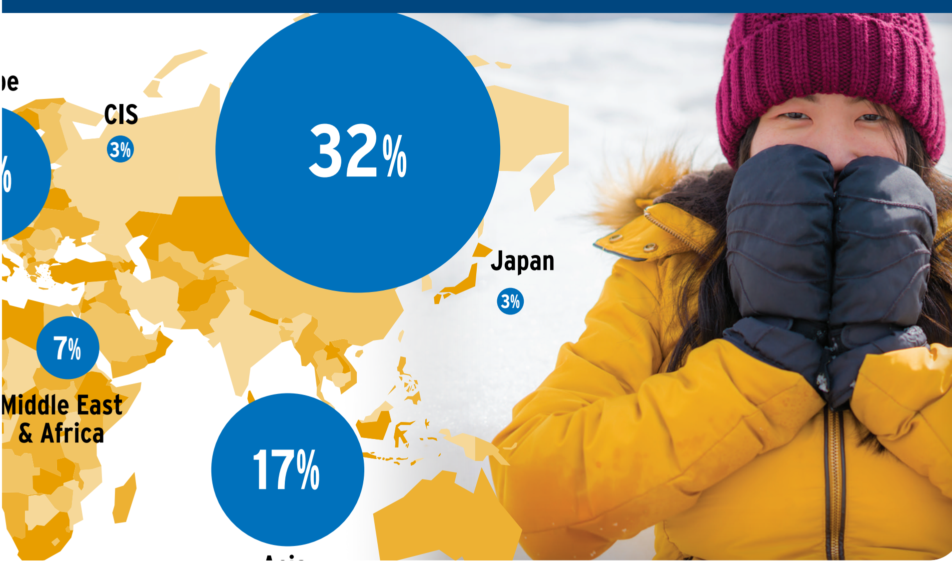
TOXIC PLASTICS: A HEALTH THREAT TO THE CIRCULAR ECONOMY

THE STATE OF THE PLASTICS MARKET WITH LESSONS FROM CHINA, INDONESIA & RUSSIA

February 2022



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for a toxics-free future

TOXIC PLASTICS: A HEALTH THREAT TO THE CIRCULAR ECONOMY
The state of the plastics market with lessons from China, Indonesia & Russia

FEBRUARY 2022

Editor - ***Vito A. Buonsante, Technical and Policy Advisor, IPEN***

This report summarizes the information from the following studies:

- China: *Plastic waste management and burden in China - Country Situation Report*
- Indonesia: *Plastic Waste Management and Burden in Indonesia - Country Situation Report*
- Russia: *Plastic and Plastic Waste in Russia - Country Situation Report*
- BPA: *A call to action: free children from BPA's toxic legacy*
- PFAS: *PFAS in Clothing: Study in Indonesia, China, and Russia Shows Barriers for Non-toxic Circular Economy*
- BFR: *Brominated flame retardants in plastic products from China, Indonesia, and Russia*

IPEN is a network of over 600 non-governmental organizations working in more than 120 countries to reduce and eliminate the harm to human health and the environment from toxic chemicals. IPEN's campaign on Toxic Chemicals in Plastics seeks to eliminate harm from chemicals in plastics when plastics are produced, used, recycled, and discarded.

ipen.org

Arnika is a Czech non-governmental organisation established in 2001. Its mission is to protect nature and a healthy environment for future generations both at home and abroad.

arnika.org/en

Nexus3 or Nexus for Health, Environment, and Development (formerly known as BaliFokus Foundation) is an organization in Indonesia that works to safeguard the public, especially vulnerable populations, from the impact of development to health and the environment, towards a just, toxics-free, and sustainable future..

www.nexus3foundation.org

Toxics Free Corps/Shenzhen Zero Waste focuses on independent testing and corporate advocacy to provide detoxification of public, daily consumer goods, as well as mainstreaming chemical management issues by fostering and developing civil corporation networks, all to achive a "non-toxic national" vision.

www.toxicsfree.org.cn

Eco-Accord Center for Environment and Sustainable Development promotes the transition to sustainable development by searching and implementing new approaches to solving environmental, economic and social problems at the global, national and local levels, as well as educating the general public about environmental protection and sustainable development.

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1. ADVANCING A CLEAN CIRCULAR ECONOMY FOR PLASTICS

REDUCING NON-CIRCULAR PLASTICS AND ADVANCING CIRCULAR PLASTIC COLLECTION IN CHINA, INDONESIA & RUSSIA

1.1 INTRODUCTION

The impact of plastics on human health has so far been largely underestimated. Yet, taking a broader approach, plastics have negative impacts on human health at each step of their lifecycle, arising from both exposure to plastic particles themselves and associated chemicals.[1] Despite the evidence that only a small fraction of plastics is actually recycled, most decision-makers and consumers believe that, in general, plastics are being recycled, and can be recycled, and that plastic waste has a positive economic value. However, only a small percentage of plastics are recycled, and when recycled these plastics can pose hazardous threats and economic burdens on national governments and consumers. Plastic materials include a wide range of toxic chemicals that are added to them to make them useful for specific functions, and when recycled these plastics may end up in toys and other consumer goods that could threaten people's health.[2] The world production of plastics is expected to increase to 1.1 billion tons by 2050,[3] thus making this industry a significant source of chemical pollution to our water, soil, air, food chain, and the wider environment. Countries from emerging economies are of particular importance as their consumption of materials is increasing. Raw materials consumption across BRIICS countries (i.e., Brazil, Russia, India, Indonesia, China, and South Africa) almost tripled between 1995 and 2017 even if per-capita material consumption still remains lower than for OECD countries.[4] Thus, attention

1 D. Azoulay et al. Plastic & Health: The Hidden Costs of a Plastic Planet (2019), CIEL.

2 See Brosché, S., Strakova, J., Bell, L. and Karlsson, T. Widespread chemical contamination of recycled plastic pellets globally. International Pollutants Elimination Network (IPEN), December 2021; Straková J., DiGangi J., Jensen G.K. Toxic Loophole: Recycling Hazardous Waste Into New Products, October 2018.

3 Plastics Europe, EPRO. Plastics - the facts 2018. An analysis of European plastics production, demand and waste data. 2018.

4 OECD, "Towards a more resource-efficient and circular economy - The role of the G20", 2021

Global Plastic Production

Regional Production 2021

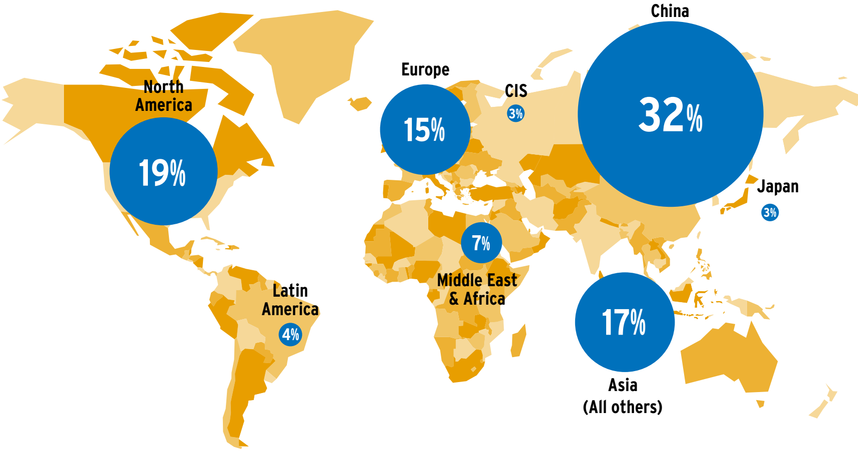

Figure 1. Plastic production by region. Source: https://plasticseurope.org/wp-content/uploads/2021/12/Plastics-the-Facts-2021-web-final.pdf

on the production, use, recycling, and disposal of plastics in these countries is key to progressing towards a circular economy that doesn't deplete resources, but also protects human health and the environment.

When plastics containing hazardous chemicals are collected for recycling, hazardous chemicals can uncontrollably spread to new plastic products and contaminate and compromise the circular plastic economy. In addition, these "toxic" plastics may also be collected and then exported as plastic waste or managed within the country, posing waste management burdens for local or national governments. The impact of hazardous chemicals in plastics on effectiveness and safety of a circular economy is however still largely under-researched. Yet, thousands of chemicals are being used to make plastics products and thousands of them are either toxic or their hazardous properties are unknown.[5] Consequently, the policy framework needs to increase the attention both to the resource efficiency aspect and to the environmental health and safety aspect of the circular economy. A key problem at policy level is the need to define what plastics can be part of the circular economy. If plastics contaminated with

5 Helene Wiesinger, Zhanyun Wang, and Stefanie Hellweg "Deep Dive into Plastic Monomers, Additives, and Processing Aids" Environmental Science & Technology 2021 55 (13), 9339-9351, DOI: 10.1021/acs.est.1c00976

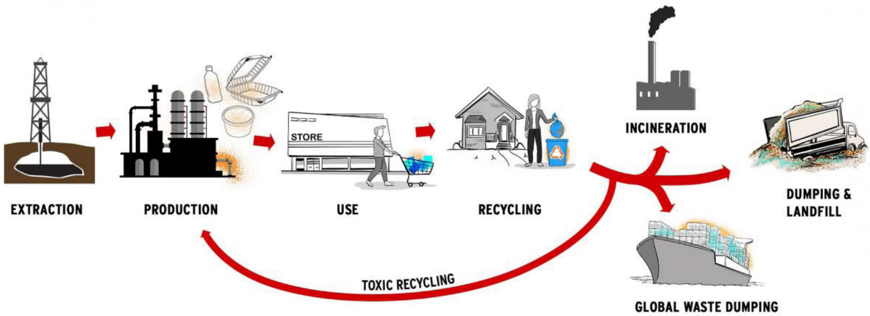

Figure 1: Many challenges have been found when trying to "close the loop", arising at every stage in the life of plastics, from the initial design to the end of life.

toxic chemicals are allowed to be part of the circular economy, this will lead to uncontrolled exposures to toxic chemicals. Therefore, it is necessary to establish criteria to determine which plastics should be considered circular. "Non-circular plastics" (plastics containing hazardous substances and those too difficult to reuse and recycle) should be identified and safely disposed of. This problem is also connected with the lack of knowledge on plastic flows in terms of specific types of plastic.

Plastics contain chemical contaminants from manufacturing along with many additives to make them inflammable (flame retardants), more flexible (plasticizers), grease-resistant (fluorinated chemicals known collectively as PFASs), sterile (biocides), or harder (bisphenols), and other substances to create many other properties. Many of these additives are toxic, leak from products during use, and can be released during recycling and from recycled products.

This report focuses on three emerging economies – China, Indonesia, and Russia – to showcase the structure of their plastics market in terms of import, production, and consumption and to understand how their governance structure allows to manage the end of life of plastics and to protect human health and the environment from the adverse impacts of plastics production, use, and disposal. Three case studies focus on the consumers' market to understand to which extent citizens are being exposed to toxic chemicals in plastics.

1.2 PLASTICS AND THE CIRCULAR ECONOMY: NOT ALL PLASTICS ARE CIRCULAR

The Circular Economy has many definitions.[6] The definition of the Ellen McArthur Foundation provides a good synthesis of all these definitions: "A circular economy is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models." Therefore, policies to achieve a circular economy for plastics should aim at reducing plastics generation and discourage or prohibit designs that do not allow reuse and recycling, including the use of toxic chemicals.

This report will first analyze the size of the plastics market in China, Indonesia, and Russia and subsequently analyze what the governance systems for plastics look like in these countries. Finally, it will showcase three case studies on plastics-containing products commonly found on the market to understand whether the plastics are circular or not and whether they may be harmful for human health and the environment.

6 Ekins, P., Domenech, T., Drummond, P., Bleischwitz, R., Hughes, N. and Lotti, L. (2019), "The Circular Economy: What, Why, How and Where", Background paper for an OECD/EC Workshop on 5 July 2019 within the workshop series "Managing environmental and energy transitions for regions and cities", Paris.

2. THE SIZE OF THE PLASTIC MARKET IN CHINA, INDONESIA, AND RUSSIA

This part focuses on the plastic that is produced, on what is imported, including plastics-containing products, and on what plastic is exported

2.1 CHINA'S PLASTICS MARKET

Production

China's plastic output has increased steadily and reached 95.741 million metric tons in 2019,[7] equaling nearly one third of the global plastic output,[8] making it the largest plastic producer globally. The five most widely used synthetic resins account for seventy percent of China's plastic production,[9] and nearly sixty percent of them are polyethylene (PE) and polypropylene (PP), which are mainly used to make disposable plastic products such as plastic packages and films (China Plastics Industry Yearbook; see Table 1 for details). In addition, the output of polyethylene terephthalate (PET) bottle chips mainly used for manufacturing plastic bottles reached 8.84 million tons.[10]

China's plastic products output has also grown rapidly in the past decade, albeit with a slower rate after a period of rapid growth (2011-2014). In 2019, the output of plastic products reached 81.84million tons.[11] The apparent consumption of plastic products in China is about 70 million tons.[12]

7 National Bureau of Statistics (NBS). The production of plastics in primary forms [EB/OL]. 2019.
8 Plastics Europe, Plastics – the Facts 2020 [EB/OL], 2020.
9 The five major synthetic resins include PE, PVC, PS, PP, and ABS.
10 www.askci.com, China Business Research Institute, the status of the Chinese market for PET bottle chips in 2021 and forecasts for its trends [EB/OL], 2020-12-01. https://www.askci.com/news/chanye/20201201/1624561297407.shtml
11 National Bureau of Statistics (NBS). The output of plastic products [EB/OL]. 2019.
12 China Plastic Processing Industry Association (CPPIA). China Plastics Industry Yearbook. China Light Industry Press [J]. 2019.

TABLE 1 THE PRODUCTION OF 5 MAJOR PLASTIC RESINS IN CHINA, 2012-2019 (IN MILLION TONS)

Year	2015	2016	2017	2018	2019
Total resins	77.182	80.182	82.136	85.58	95.74
PE	13.855	14.355	13.363	14.02	17.449
PP	16.864	18.106	19.035	20.419	23.485
PVC	16.190	16.899	17.745	18.739	20.107
PS	3.053	1.958	2.025	1.757	2.983
ABS	3.089	3.098	3.244	3.258	3.93

Source: China Plastics Industry Yearbooks published from 2016 to 2020 for synthetic resin and categorized data; the National Bureau of Statistics (NBS) for the total output of plastic products.

Import/Export

Although the output of plastic in primary forms has increased year by year, China still relies on imports when it comes to certain synthetic resins. In 2019, China imported 33.668 million tons of synthetic resins and exported 6.543 million tons, with net imports of 27.125 million tons, equaling a 14.1 percent year-on-year increase. The amounts of the five major resins imported and exported were 24.384 and 1.679 million tons respectively, with net imports of 22.704 million tons, which accounted for 83.7 percent of the total net imports of synthetic resins.

TABLE 2. THE IMPORTS AND EXPORTS OF SYNTHETIC RESINS IN CHINA (IN MILLION TONS)

Year	Imports	Exports	Net Imports
2019	33.668	6.543	27.125
2018	29.955	6.191	23.764
2017	31.959	6.18	25.779
2016	31.825	5.74.2	26.083
2015	31.872	4.981	26.891

Source: China Plastics Industry Yearbook 2020

TABLE 3. THE IMPORTS AND EXPORTS OF THE 5 MAJOR RESINS IN CHINA (IN MILLION TONS)

Year	Imports	Exports	Net Imports
2019	24.384	1.679	22.705
2018	21.408	1.683	19.725
2017	18.506	2.012	16.494
2016	16.197	2.058	14.139
2015	16.595	1.666	14.929

Source: China Plastics Industry Yearbook 2020

2.2 INDONESIA'S PLASTICS MARKET

Production

The national demand for plastic raw materials in Indonesia is estimated to be around 7.2 million tons per year. About 2.3 million tons of raw materials in the form of local virgin plastic is supplied by the domestic petrochemical industry. The plastics industry faces various challenges as it develops, including supply and demand for raw materials such as polyethylene and polypropylene (Pardosi & Mulyana, 2019).

According to the Indonesian Aromatic and Plastic Olefin Association (INAPLAS), Indonesia's plastic consumption per capita in 2019 was 23 kg per person per year.[13] If Indonesia's population in 2019 was 270 million people, it is estimated that Indonesia's annual plastic consumption was more than 6.2 million tons. The biggest plastic user in Indonesia is the food and beverage packaging sector, which reaches up to 65% of the total national plastic consumption. The nature of food and beverage packaging products are generally disposable (KLHK, 2020).

Ministry of Industry data show that in 2019 there were 1,581 companies - around 380 large industries and 1,200 small-medium industries - with an investment value of IDR 7.15 trillion engaged in the plastics industry, with a total of 177,300 workers employed.[14,15]

13 Andi M. Arif. Bisnis.com, 30 December 2019. Evaluasi Industri Plastik 2019. Accessed by 7 June 2021 https://ekonomi.bisnis.com/read/20191230/12/1185390/evaluasi-industri-plastik-tahun-2019
14 Dimas Andi and Anna Suci Perwitasari, Kontan.co.id, 04 April 2021. Pemerintah dorong industri manufaktur berbasis ekonomi sirkular. Accessed by 7 June 2021 https://industri.kontan.co.id/news/pemerintah-dorong-industri-manufaktur-berbasis-ekonomi-sirkular
15 ADUPI, Focus Group Discussion Nexus3 with plastic and paper recycling industries, 29 July 2021.

Note: red dot is a special economic zone of with trade facilities. Companies in this special economic zone allowed to import their raw materials but have to export the products and not allowed to sell it to the local or domestic market.

Figure 2. Distribution of plastic industry in Indonesia. Source: KLHK, 2020

There are approximately 892 companies manufacturing plastic packaging.[16] Most plastic manufacturers and recycling industries are concentrated in Java and Sumatra, as shown in Figure 2.

The main output of Indonesia's plastics industry includes the production of polyethylene, HDPE, LLDPE, PP, PVC, PET, rPET, ABS, polyester, acrylic acid, and 2-ethylhexanol. The largest producers in Indonesia include Chandra Asti, Asahimas Chemicals, Sulfindo Adiusaha, and Indorama Petrochemicals Indonesia.

For production volumes of these types of plastic polymers in Indonesia, PE, PP, and PET account for 34%, 31%, and 12% (totaling 77%) respectively. The production of PVC is 11%, PS accounts for 7%, while ABS and PC are 3% and 2% respectively.[17]

16 Ibid
17 Dimas Andi and Anna Suci Perwitasari, Kontan.co.id, 04 April 2021. Pemerintah dorong industri manufaktur berbasis ekonomi sirkular. Accessed by 7 June 2021 https://industri.kontan.co.id/news/pemerintah-dorong-industri-manufaktur-berbasis-ekonomi-sirkular

TABLE 4. INDONESIAN PLASTIC PRODUCTION IN 2020 (TONS PER

Type of Product	Company	Amount	Sub-Total	Remarks
Polyethylene	Chandra Asri Petro-chemicals (CAP)	736 000	736 000	PE, PET, containers
HDPE	Chandra Asri Petro-chemicals (CAP)	336 000	586 000	HDPE
	Lotte Chemical Titan	250 000		
LLDPE	Chandra Asri Petro-chemicals (CAP)	400 000	600 000	LLDPE
	Lotte Chemical Titan	200 000		
Polypropylene (PP)	Chandra Asri Petro-chemicals (CAP)	590 000	935 000	PP
	Pertamina Refinery Unit III Plaju	45 000		
	Masplene/PT Polytama Propindo	300 000		
Polyvinyl Chloride	ASC (AGC Group - PT Asahimas Chemical)	550 000	862 000	PVC
Polyethylene Tere-phthalate (PET)	PT. Indorama Ventures Indonesia (PTIVI), Tang.	95 000	197 000	PET
	PT. Indorama Polypet Indonesia (PTIPPI), Cilegon	102 000		
recycled Polyeth-ylene Terephthal-ate (rPET)	PT Veolia Services Indonesia & PT Tirta Investama (Danone Aqua)	25 000	25 000	rPET
Synthetic Rubber (ABS)	Chandra Asri Petro-chemicals (CAP)	120 000	195 000	Tires, O-ring, etc.
	Other	75 000		
Polyester	PT Indorama Polyester Industries Indonesia Karawang	38 000	38 000	Polyester
Acrylic Acid	Other	140 000	140 000	Plastic diapers, textiles, etc.
2-ethylhexanol	Other	140 000	140 000	Plasticiz-ers
Total			**4 454 000**	

Source: CAP, 2021; Kemenperin, 2020; PTIP, 2020

Tax holidays play an important role in the establishment and increase of plastics production in Indonesia as they create incentives for new job creations in exchange of not paying taxes for a set number of years. For example, Chandra Asri, a major petrochemical industry in Indonesia, received 100% tax holiday for their corporate income tax for the first 20 years on its commercial production, followed by 50% tax reduction for 2 years. Chandra Asri contributed to more than 50% of Indonesia's petrochemical Olefins and Polyolefins importations. In addition, they planned to double their production to 8 million tons a year with products including: PE, PP, and aromatics.[18]

2.3 RUSSIA'S PLASTICS MARKET

In recent years, production of various types of plastics in Russia has significantly increased. Between 2014-2019 the production of plastics increased by 64.2%.[19] Production of ethylene-based plastics increased with an average rate of 7.3%, while production of propylene-based plastics increased by 7.1%. Vinyl chloride-based ones by 8.5%, styrene-based plastics by 0.9%, and polyethylene terephthalate plastics by 2.2% (see Table 5).

18 Press release by Chandra Asri, 2020, accessed by 7 May 2021. http://www.chandra-asri.com/files/attachments/press_releases/2020/CAP%20-%20Siaran%20Pers%20-%20Tax%20Holiday%20Chandra%20Asri%20Perkasa%20(ENG).pdf

19 https://magazine.neftegaz.ru/articles/pererabotka/536762-plastpererabotka-sostoyanie-i-perspektivy/

TABLE 5: PRODUCTION VOLUMES OF MAIN TYPES OF PLASTICS IN RUSSIA, FROM 2017 TO Q1 OF 2020

Plastic types	Production in 2017, million tons	Production in 2018, million tons	Production in 2019, million tons	Q1 of 2019	Q1 of 2020	Change Q1 of 2019 vs Q1 of 2020 (%)
Ethylene-based plastics	2 046	2 196	2 357	569	824	44.7
Increase in production, as a percentage compared to the previous year	5.3	7.4	7.3			
Propylene-based plastics	1 449	1 458	1 750	364	497	36.5
Increase in production, as a percentage compared to the previous year	0.6	0.6	20.0			
Vinyl chloride-based plastics	963	1 020	1 046	269	283	5.0
Increase in production, as a percentage compared to the previous year	16.9	5.9	2.6			
Styrene-based plastics	537	552	550	136	139	1.8
Increase in production, as a percentage compared to the previous year	0.1	2.9	-0.3			
Polyethylene terephthalate plastics	540	550	570			
Increase in production, as a percentage compared to the previous year	1.1	1.9	3.5			

Source: Estimates of the Development Centre of the National Research University of the Higher School of Economics, based on data of Rosstat and the RF Customs Service.[20]

In January-April of 2020, production of plastics increased by a record high 18% compared to the same period of the previous year. The increase was primarily due to the launch of new production facilities in Western Siberia by ZapSibNeftekhim (a subsidiary of PJSC SIBUR).

The COVID-19 pandemic triggered an increase in the production and consumption of disposable medical supplies, including those made of plastics and nonwoven materials for personal protective gear, as well as

20 Volkova A.V. Large-scale polymer market-2020. HSE, the Development Centre, 2020. (Rus.)

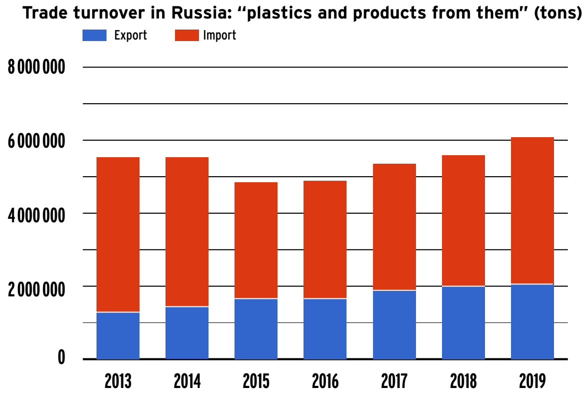

Figure 3. Trade turnover of plastic products in Russia: export and import of plastic and plastic products in the period from 2013 to 2019.

in the demand for other disposable plastic products. Accordingly, these developments caused increased consumption of some kinds of plastic products and also some increase in waste generation. At the same time, starting from April 2020, shutdowns in several industries (such as the automotive, consumer goods, and construction industries) led to a sharp decline in the demand for certain other types of plastics.

According to the forecast of the Russian Ministry of Economic Development, the industrial production index of rubber and plastic products will reach 120.6% in 2022 and 134.1% in 2024 (relative to the level of 2018), i.e., the annual growth in the industry will reach 5% - 5.5%.[21]

Growing production and use of plastics have been accompanied by a relevant increase in related waste generation. According to the Ministry of Industry and Trade, about 3.6-5 million tons of plastic waste[22] is generated in Russia every year, and, according to various estimates, 7-20% of morphological waste undergo some processing, with different processing degrees for different types of plastics.

In 2013-2016, **the foreign trade turnover** of plastics and plastic products in Russia increased in physical terms by 10%. At the same time, after

21 Ministry of Economic Development of the Russian Federation. Scenario conditions, the main parameters of the forecast of socio-economic development of the Russian Federation and projected changes in prices (tariffs) for goods and services of economic actors operating regulated activities in the infrastructure sector for 2020 and for the planning period of 2021 and 2022. http://anspa.ru/upload/file/news-2020/ANSPA%20%20Econometric%20Analysis%202020.pdf (Rus.)

22 https://finance.rambler.ru/economics/42436515/?utm_content=finance_media&utm_medium=read_more&utm_source=copylink (Rus.)

the crisis of 2014, there was a slight decrease in imports, after which the growth continued again (see Figure 3).[23]

Exports

Exports of plastic goods from Russia in the period from 2013 to 2019 amounted to 12,226 thousand tons, with a monetary value of 18.9 billion USD. The export structure was dominated by "polymers of ethylene in primary forms" (17%), "polymers of propylene or other olefins in primary forms" (13 %), "styrene polymers in primary forms" (7%). Leading countries of destination of these export flows include Belarus (24%), Kazakhstan (21%), Ukraine (12%), and China (10%).

Imports

Imports of plastics and plastic products to Russia exceeded exports in the period from 2013 to 2019 and amounted to 25,682 thousand tons with a monetary value of 66 billion USD. Main types of imported plastics included "other products made of plastics and other materials" (12%), and "ethylene polymers in primary forms" (11%). In the structure of imports by countries of origin, Germany was in the lead (18%), followed by China (17%), and Belarus (7.1%).

In 2019, the total share of imported plastics, raw rubber, and rubber reached 5.7% of the total amount of imported goods.[24] At the same time, out of the total amount of exported goods, 1.4% of plastics, raw rubber, and rubber were exported. Exports of plastics and plastic products was 4.62% lower in 2019 than in 2018,[25] when Russian exports of goods from the "plastics and plastic products" group amounted to $3.18 billion, with a total weight of 2,038 thousand tons.[26] Main exported types included "polymers of propylene or other olefins in primary forms" (14%), and "polymers of ethylene in primary forms" (13%). At the same time, the share of imported plastics in 2019 increased by 0.69% compared to 2018.[27]

Over the course of the eight first months of 2020, Russian companies increased their imports of polypropylene (PP) by 19% in comparison to the same period in 2019.[28] The total volume of purchases of polypropylene

23 Source: https://ru-stat.com/date-Y2013-2020/RU/trade/world/0739
24 https://ru-stat.com/analytics/6556
25 https://russian-trade.com/reports-and-reviews/2020-02/vneshnyaya-torgovlya-rossii-v-2019-godu/
26 https://ru-stat.com/date-Y2018-2019/RU/export/world/0739
27 https://russian-trade.com/reports-and-reviews/2020-02/vneshnyaya-torgovlya-rossii-v-2019-godu/
28 http://www.mrcplast.ru/news-news_open-377000.html

reached 143.2 thousand tons. In particular, the main increase in external supplies was associated with propylene homopolymer (PP-homo).[29]

However, the Higher School of Economics (HSE) provides an alternative estimate of plastic exports and imports. According to the HSE, imports of linear polyethylene (LPE) in 2019 decreased down to 180.9 thousand tons due to some increase in national production, which was facilitated by the entry of ZapSibNeftekhim products to the market, as well as by an increase in production volumes by the key Russian LPE producer - Nizhnekamskneftekhim. Overall, by the end of 2019, national facilities produced 254,000 tons of LPE, which was 45% higher than in the previous year. At the same time, production of high-density polyethylene (HDPE) decreased by 10% to 868.5 thousand tons: partly due to reorientation to the production of LET, and partly due to repairs. As the demand on the national market remained high, the volume of imports sharply increased. The largest increase was observed in the import of HDPE for plastic films (by 65%, to 132,000 tons), and the imports of HDPE for other applications also increased (for pipes, extrusion blow moulding, and injection moulding).[30]

Expandable polystyrene imports in 2019 increased by a record high 29%, compensating the decline in 2018, and imports of general-purpose polystyrene also increased significantly (by 23%). External purchases of ABS plastics increased only slightly.

The volume of imports of emulsion PVC (PVC-E) in 2019 reached the level of 80,000 tons - or about 40% of the total imports of vinyl chloride polymers.

Markets of linear polyethylene, PVC-E, and ABS plastics remain the most import-dependent ones, with shares of foreign products close to 70%. In the case of ethylene polymers, the high share of imports is also attributed to an actively growing demand.

By Decree No. 348-r of February 28, 2019, of the Russian Government, an action plan (roadmap) for development of the petrochemical complex in the Russian Federation for the period up to 2025 was approved. The document provides the following data on the state of the petrochemical complex in Russia: the market of petrochemical products in the Russian Federation has long been in short supply for most products. However, in the period from 2009 to 2017, shares of imports in consumption of basic plastics decreased: in 1.8 times for polypropylene, in 2 times for polyvinyl chloride, in 2 times for polystyrene, and in 2.2 times for polyethylene tere-

29 http://www.mrcplast.ru/pages/datascope.html
30 https://dcenter.hse.ru/data/2020/07/07/1595325171/Рынок крупнотоннажных полимеров-2020.pdf

phthalate. In the same period, production volumes of petrochemical products increased: in 2 times for polypropylene, in 1.2 times for polyethylene, in 2.2 times for polyethylene terephthalate, in 2 times for polystyrene, and in 1.7 times for polyvinyl chloride.[31]

31 http://static.government.ru/media/files/6JYMjf310u2AR6d9uK3ALBRA0zBxLc35.pdf

3. PLASTIC WASTE GENERATION, IMPORTS, AND EXPORTS

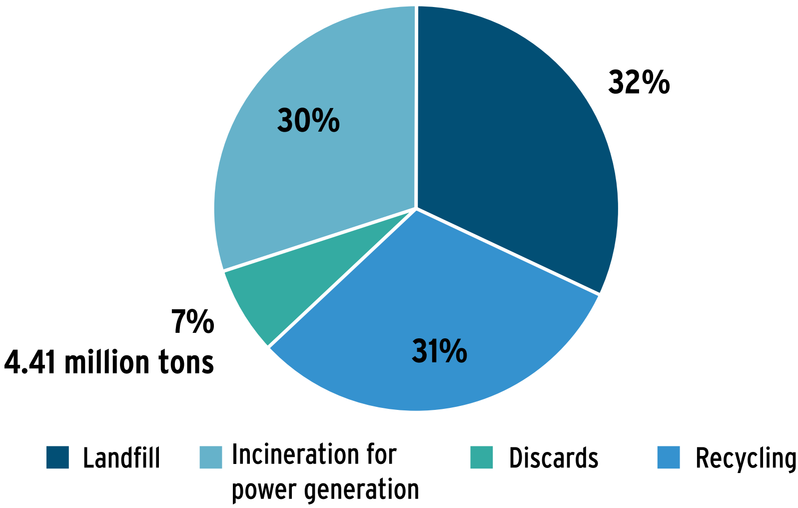

Figure 4. The amount and proportion of waste plastics treated in China in 2019 (2019-2020 Development Report of China Plastic Recycling Industry)

3.1 CHINA'S PLASTIC WASTE DATA

Waste Generation

In 2019, China generated 63 million tons of waste plastics. About 30% of each were landfilled, incinerated, and recycled respectively, with the remaining seven percent (about 4.4 million tons) polluting the environment (see Figure 4).[32] The amount of recycled waste plastics reached 18.9 mil-

32 The Plastic Recycling Association of the China National Resources Recycling Association (CRRA). 2019-2020 Development Report of China Plastic Recycling Industry [R]. Beijing: The Plastic Recycling Association of the CRRA, 2020.

lion tons in 2019, up 600,000 tons since 2018,[33] or about twice as much as in the EU, or seven times as much as in the United States.[34]

Import/Export of Waste

2017 marked the turning point of the imports of waste plastics in China. Before 2017, China once accounted for nearly 60 percent of the global plastic waste trade, as it imported a cumulative total of 170 million tons of waste plastics from 1992 to 2016.[35] With the release of the "Implementation Plan for Banning the Import of Wastes and Promoting the Reforming of the Solid Wastes Import Management System" (GBF [2017] No. 70) (hereinafter referred to as the Ban on Wastes), the imports of waste plastics in China dropped by 21 percent year-over-year to 5.8291 million tons in 2017, to 70000 tons in 2018 and to zero in 2019 (see Table 6). China has since been no longer a major importer of waste plastics.

Although China's plastic waste imports have plummeted, there is a growing market demand for recycled plastics. As global brands promise to reduce the use of virgin plastic while increasing that of recycled plastic as an alternative, the demand for recycled plastic particles is soaring around the world, which has also led to fast-growing imports of such particles in China. In 2019, the amount of recycled plastic particles imported into China was about 3.5 million tons, according to statistics from the Plastic Recycling Association of the CRRA.[36]

33 The Plastic Recycling Association of the CRRA. 2019-2020 Development Report of China Plastic Recycling Industry [R]. Beijing: The Plastic Recycling Association of the CRRA, 2020.

34 Statistics about waste plastics recycling vary slightly from country to country. Such statistics in China only cover the amount of waste plastics recycled through local material-level recycling processes, that is, they exclude the amount of wastes recycled and exported as well as energy recovery by plastics incineration for power generation. The amount of plastics recycled in the EU is the figure in 2018 from Plastics – the Facts 2020. The U.S.-relevant amount is also the figure in 2018 from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data.

35 This figure was calculated by analyzing data from the UN Comtrade Database.

36 The Plastic Recycling Association of the CRRA, loc. cit.

TABLE 6. THE IMPORTS AND EXPORTS OF WASTE PLASTICS IN CHINA (IN MILLION TONS)

Year	Total Imports	Total Exports
2019	Negligible	0.03
2018	0.076	0.03
2017	5.829	0.037
2016	7.3472	0.0301
2015	7.3542	0.0304
2014	8.2542	0.0427
2013	7.8813	0.042
2012	8.8777	0.0329
2011	8.3842	0.0255
2010	8.0097	0.0258

Source: The annual versions of China Customs Statistics Yearbook

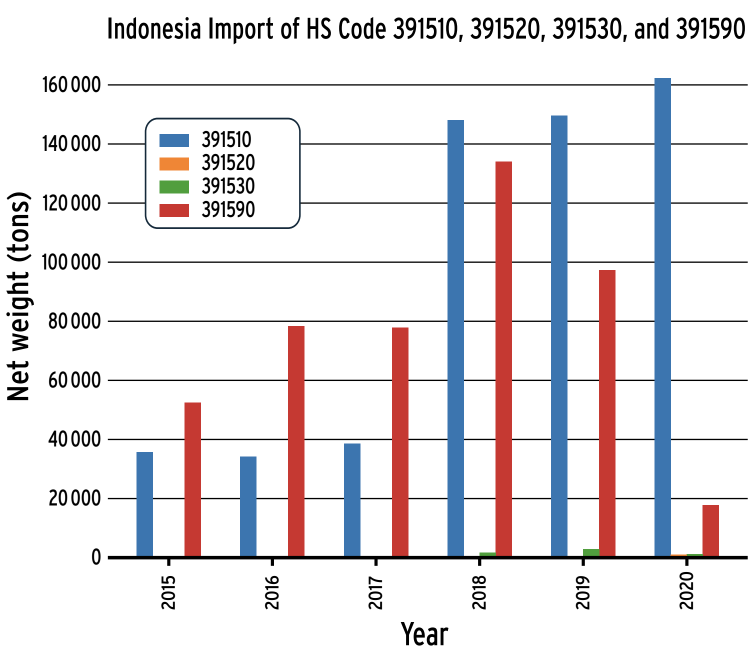

Figure 5. Plastic waste imported by Indonesia 2015-2020.
Source: BPS, 2021

3.2 INDONESIA'S PLASTIC WASTE DATA

There are several reports available about plastic waste generation, leakage and plastic waste management in Indonesia (Muhammad Reza Cordova et al., 2019; Danone & SWI, 2018; KLHK, 2020; MacQuarie, 2020; Shuker & Cadman, 2018; WEF, 2020).

Waste generation in Indonesia differs between big and small cities. However, the World Bank estimates that the total waste generation rates are 3.57 liter/capita/day, equivalent to 0.87 kg/capita/day (Shuker & Cadman, 2018). Meanwhile, plastic waste generated per capita is 0.07 kg of plastic waste/capita/day or about 8% of the total waste generation rate (KLHK, 2020).

A recent National Plastic Action Partnership (NPAP) report revealed that Indonesia's plastic recycling rate in 2020 was approximately 10% of the total plastic waste generation, 6.8 million tons (WEF, 2020). **The study also identified that around 4.2 million tons or 61% of post-consumer plastic wastes were not collected by waste collectors or management systems but leaked to the environment.** The rest ends up in landfills.

The World Bank estimated that approximately three million people are engaged in waste recycling, including informal collection, waste picking, collection, processing, and trade. Most of the items collected by waste pickers are plastic, metals, and cardboard with varying prices per kilogram, depending on the product type, source, and collection level (from the source, from waste pickers, from collector/middleman, etc.), ranging from 0.04 - 1.19 USD (Shuker & Cadman, 2018).

Around 2% of recycling is happening through waste banks (Bank Sampah), a system for the collection and sorting of waste at the community level, and around 8% from sorting of mixed waste.

Estimates show that the informal sector collects for recycling about 1 million tonnes of plastic waste that and around 700 000 tonnes are transformed into recycled plastic; the remaining 300 000 tonnes are eventually disposed of due to yield losses in the sorting and recycling process, such as after contamination with organic material. This puts Indonesia's plastic recycling rate at around 10% of the total 6.8 million tonnes of plastic waste generated (measured as a percentage of plastic waste that is actually recycled into new plastic) (World Economic Forum, 2020). Other estimates by recyclers estimate that recycling of major plastic resins amounts to approximately 1.6 million tonnes (Ministry of Environment and Forestry, Republic of Indonesia) Further improvements will need efforts and funding from various different sources.

Imports

Indonesia's import of plastic waste and scrap (HS Code 3915) spiked in 2018 (with an increase of 141% compared to the previous year) but has declined ever since. As Indonesia reviewed its import policy in 2019, plastic waste imports declined by 27% in 2020 from the year before.

Based on data collected from Indonesia Statistics, the five most significant trade partner countries were the Netherlands, Germany, Slovenia, United States, and Singapore. The trade values, however, fluctuate differently from the imported volume. Before 2018, most imported plastic waste fell under HS Code 391590, containing mixed plastic and other types of plastics that are not polyethylene, polystyrene, or polyvinyl chloride. Starting from 2018, after China stopped most plastics waste imports, the proportion of polyethylene waste scraps (HS code 391510) outnumbered that of other plastics wastes and kept increasing until 2020 (Septiono, Ismawati, & Arisandi, 2021).

After the restriction and reviewed regulations in Indonesia in 2019, these shipments started to decrease overall. Shipments from Australia & Oceania dropped by almost half to 43,000 tons and from North America by 30% to 37,000 tons. However, shipments from the Western European countries rose to 107,000 tons, making the region the most substantial plastic waste exporter to Indonesia. The latest data from 2020 shows that shipments from Western Europe account for 57% of the total amount of imported plastic waste to Indonesia.

In response to China's new policy and the enforcement of the Basel Ban Amendments on plastic waste trade, the Ministry of Trade has issued a new Decree to regulate plastic and paper waste trade through Permendag (*Regulation*) No. 83/2020. Additionally, joint decrees were signed by three ministers and the Chief of the National Police to set the maximum contaminant standard to 2% in six kinds of waste/scrap commodities.

Exports

Indonesia mainly exports plastic waste under HS Code 391590. Unfortunately, there is no further detail on whether they are mixed plastic waste or cleanly separated plastic waste other than PE, PS, or PVC. Considering Indonesia and some ASEAN countries play a role in intermediate re-processing countries for plastic waste trade (Barrowclough, Birkbeck, & Christen, 2020), the end product of those processing operations should either be cleanly separated plastic waste or other plastic products.

Based on the data from Indonesia Statistics, Indonesia used to ship plastic waste mainly to China. In 2020, however, shipment to China dropped by 87% to only 4,774 tons. Instead, the leading export destination of plastic waste from Indonesia in 2020 became the United States, reaching more than 8,000 tons of plastic waste exported, followed by the United Kingdom (5,721 tons), and with China being the third-largest export destination (4,774 tons).

Indonesia's export market is mainly concentrated in the East Asian Region, either China or Hong Kong. Hong Kong was one of the top transit hubs of plastic waste shipments, usually re-exporting from the US, Japan, Germany, and the UK to mainland China.

After the waste import policy restriction in China, however, the destinations of plastic waste export shifted to developing countries like Thailand, Malaysia, and Vietnam (Low, 2019). Indonesia used to export in high volumes to Hong Kong until 2017, but this dropped in the following year. Indonesia's shipment to China also dropped after the implementation of the Blue Sky Policy.

3.3 RUSSIA'S PLASTIC WASTE DATA

Waste generation is rapidly growing. According to the Accounts Chamber, in 2019 in Russia, the volume of solid municipal waste alone reached 65 million tons, or 450 kg per capita. At the same time, more than 90% of waste in Russia is not recycled, but sent to landfills, including unauthorized waste dumps,[37] and more than 27,000 such dumps were identified in 2019.

Due to the growing production and use of plastic, the volume of plastic waste is also increasing (with 3.5-5 million tons being generated annually[38]), and the share of plastics in the total volume of waste is constantly increasing.

Over the past couple of decades, the share of plastic in household waste has roughly doubled, from 3-4% in the 1990s to 5-10% today.[39]

In general, the Russian Federation Ministry of Trade estimates that the level of plastic recycling reaches 7-12.5%.[40] At the same time, various

37 https://riafan.ru/1316254-v-minprirody-otvetili-na-kritiku-musornoi-reformy-so-storony-schetnoi-palaty
38 https://finance.rambler.ru/economics/42436515/?utm_content=finance_media&utm_medium=read_more&utm_source=copylink
39 https://rupec.ru/analytics/36881, https://polymerbranch.com/85ae750ad1dbdc5c2703bcfe97e77152/03f6ce2244bdca9c79843b0785803b2c/magazineclause.pdf
40 https://www.gazeta.ru/business/2019/07/01/12469297.shtml

experts estimate this indicator in the range of 5-25%,[41] which is a very low figure both in terms of protecting the environment and human health.[42] The rest of the generated plastic waste ends up in landfills or is incinerated. Despite the presence of valuable waste fractions in solid municipal waste, at least 2 million tons of plastic materials are irretrievably lost in the process of their disposal annually, which is a problem both from the point of view of environmental protection and from the point of view of obtaining economic benefits.

Nevertheless, some positive trends have been observed over the past few years.

The level of collection of waste that can be recycled is increasing. In 2019, Greenpeace conducted a rating of availability of separate waste collection in some large Russian cities. The results of the study showed that out of the 147 million residents of Russia, at least 27,212,253 people (18.5%) who live in large cities have access to the infrastructure for separate waste collection. This figure has more than doubled since 2018.[43]

Imports

In recent years, both imports and exports of plastic waste has increased.[44] Moreover, the volume of imports in 2019 significantly exceeded both the volume of waste generation and export supplies. The situation is largely due to lack of national raw materials or their low quality in the context of low efficiency of the waste separation system. Russian imports of plastic waste in 2019 reached 45,057 tons, a 123% increase over the past five years (2015-2019) (See Figure 6).

Russian imports of plastic waste by type are shown in Figure 7. Interestingly, the share of cuttings and scrap plastic of vinyl chloride polymers, that practically are not recycled in Russia, reaches 32% of imported waste flows.[45]

Belarus was the leading supplier of imported plastic waste to Russia in 2019 - (36.5% of total imports). The top three exporters also include Japan (11.7%) and Lithuania (8.4%).

41 A number of experts believe that 10-15% of all plastic waste is recycled in Russia (https://takiedela.ru/2019/03/bezyskhodnoe-proizvodstvo/ (https://takiedela.ru/2019/03/bezyskhodnoe-proizvodstvo/) [1] According to Mikhail Katsevman, the President of the Union of Plastics Processors, the level of plastic recycling in Russia (including mechanical processing, thermochemical methods of processing, and incineration of plastic for energy recuperation) reaches 20-25% (https://clck.ru/Qpnjt)

42 https://dcenter.hse.ru/data/2018/07/11/1151608260/Рынок%20утилизации%20отходов%202018.pdf.

43 https://greenpeace.ru/wp-content/uploads/2020/03/Rating-RSO-2018.pdf

44 https://tebiz.ru/mi/rynok-plastikovykh-otkhodov-v-rossii

45 https://dcenter.hse.ru/data/2018/07/11/1151608260/Рынок%20утилизации%20отходов%202018.pdf

Figure 6. Dynamics of Russian imports of plastic waste in 2015-2019, [tons]. Source: The RF Customs Service, Tebiz Group

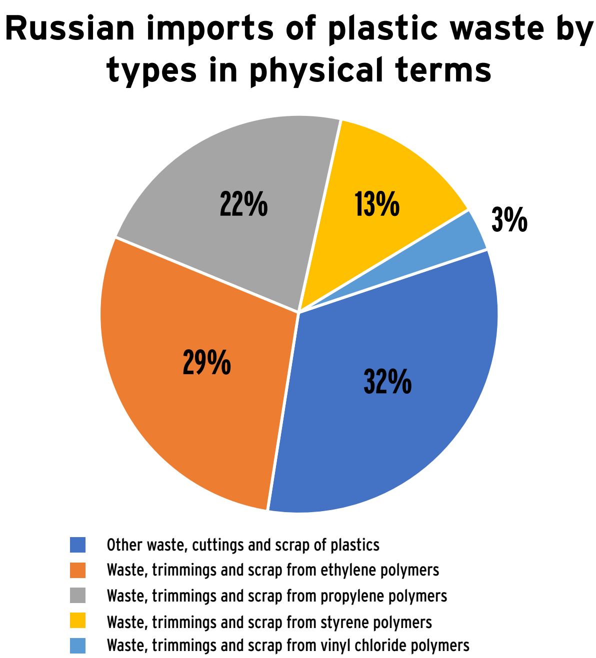

Figure 7. Russian imports of plastic waste by type. Source: The RF Customs Service, Tebiz Group

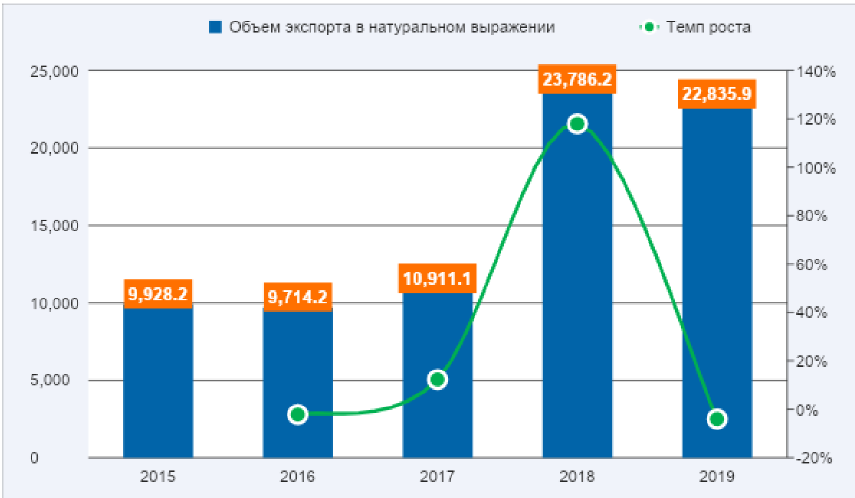

Figure 8. Dynamics of Russian exports of plastic waste in 2015-2019, [tons]. Sources: the Russian Federation Customs Service, Tebiz Group

Russian exports of plastic waste by type in physical terms, 2019

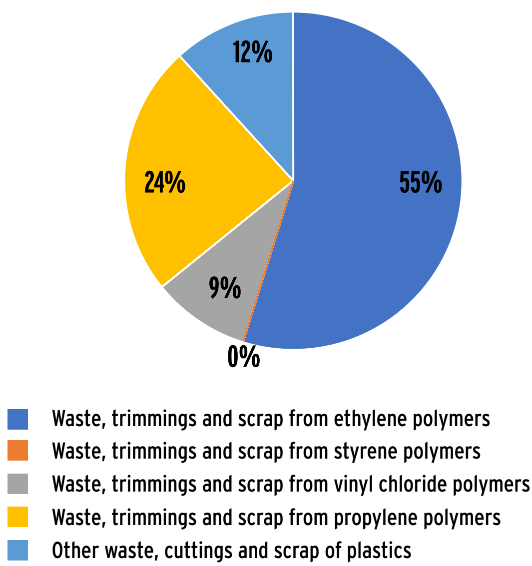

Figure 9. Russian exports of plastic waste by type. Sources: the Russian Federation Customs Service, Tebiz Group

In the fall of 2020, the Russian authorities decided to work out a ban on imports of materials from recycled polymer pellets and other types of recycled materials. The purpose of this measure is to promote utilisation of waste in the country.[46]

Responses to the decision were controversial. According to the Vtorplast company, "the ban on imports of polymer pellets and other recycled products will stimulate the own market." At the same time, a number of plastics processors fear a shortage of raw materials and an increase in prices for them in the absence of imports. In particular, according to the Russian Environmental Operator, the country's plastics processing capacity reaches about 1 million tons per year, but in fact these processing facilities are only half-loaded. According to Ms Natalia Belyaeva, the Deputy Head of the Committee for Waste Recycling and Secondary Resources of "Delovaya Rossiya", in conditions when waste separation in Russia is underdeveloped, it will be difficult to cover such a shortage.

Exports

Between 2015 to 2019, exports of plastic waste from Russia increased by 2.3 times.[47] In 2019, 22,836 tons of plastic waste were exported. In comparison to the previous year, supplies decreased by 4%, demonstrating a slight decrease in interest in Russian plastic waste in other countries (see Figure 8).

The commodity structure of exports is dominated by waste, cuttings, and scraps of ethylene-based polymers (54.7%), and waste, cuttings, and scraps of propylene-based polymers (24.4%) (See Figure 9).

In 2019, the volume of plastic waste exports from Russia reached 4.7 million USD. In comparison to 2018, when exporters shipped 5.8 million USD worth of plastic waste from the Russian Federation, export supplies demonstrated a decline rate of 19%. The leading countries of destination for Russian exports of plastic waste in 2019 included Uzbekistan (42.8%), Belarus (19.5%), and Azerbaijan (14.9%).

46 https://www.rbc.ru/business/08/10/2020/5f7db87d9a7947883db28a02E
47 https://tebiz.ru/mi/rynok-plastikovykh-otkhodov-v-rossii

4. PLASTIC RECYCLING MARKET STRUCTURE

4.1 CHINA'S RECYCLING MARKET PROFILE

In China plastics wastes are classified into industrial, medical, agricultural, and domestic ones. Waste plastics from industrial sources mainly refer to scraps generated by industrial plants and are generally characterized by higher purity and ease of collection; most of them are directly reused within the plant or shipped to plastic recyclers. The main waste treatment methods in China are landfill and incineration. In 2019, for example, Municipal Solid Waste (MSW) landfilled and incinerated in Chinese cities and counties accounted for 52 percent and 44 percent of all such waste respectively. Of the 63 million tons of waste plastics generated in 2019, about 32% were landfilled, 31% were incinerated, and 30% were recycled, with the remaining seven percent (about 4.4 million tons) polluting the environment (see Figure 10).

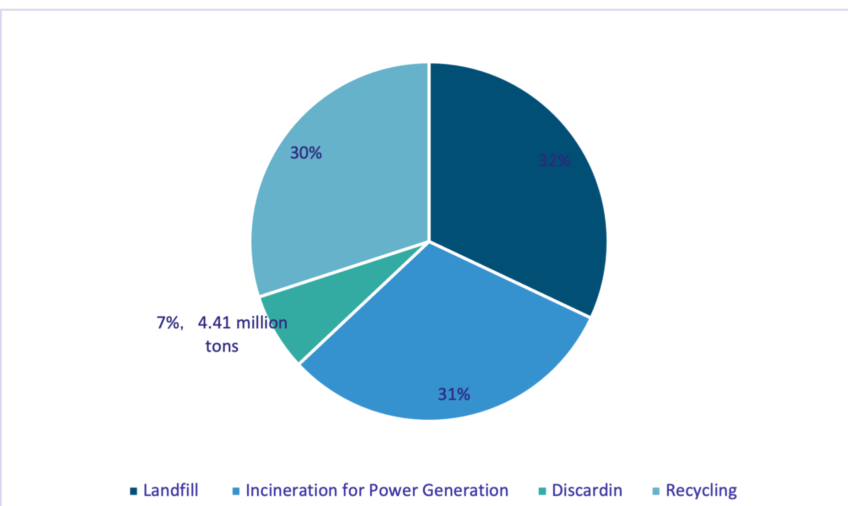

Figure 10. The amount and proportion of waste plastics treated in China in 2019. Source: 2019-2020 Development Report of China Plastic Recycling Industry

The supply chain of the plastic recycling industry currently lacks traceability regulation, standardization and management, and the sources of waste cannot be completely controlled, which also leads to potential safety risks associated with recycled plastics.

The total value of recycled waste plastics has gradually increased since 2015, with a high of over RMB 110 billion, according to data from the Plastic Recycling Association of the CRRA. In 2019, the average price of recycled plastics decreased slightly due to the Sino-US trade war and the decline in international crude oil prices. As a result, the value of recycled waste plastics decreased by about 12.5 percent compared with the level in 2018, but it still exceeded RMB 100 billion.[48]

TABLE 7 THE VALUE OF RECYCLED WASTE PLASTICS IN CHINA

Year	Value of Recycled Waste Plastics (in billion yuan)
2019	100
2018	114.3
2017	108.13
2016	95.78
2015	81

Source: 2019-2020 Development Report of China Plastic Recycling Industry

The renewable resources recovery system is the main path to recycling waste plastics and includes waste plastics recoverers and recyclers. Today, small companies are being replaced by large ones, and the whole industry is growing in size and becoming increasingly standardized. In 2019, there were more than 3,000 companies registered in China which engaged in waste plastic processing, and 300 of them were able to process over 10,000 tons of recycled plastics per year, including 50 companies each with an annual processing capacity of more than 50,000 tons.[49] There are recovery outlets across China able to recover more than six million tons of plastics waste per year. Large plastics recycling marketplaces and processing/distribution centers are mostly in the provinces of Zhejiang, Jiangsu, Shandong, Hebei, and Liaoning, and are evolving into recovery and processing clusters with increasingly centralized transactions.

48 The Plastic Recycling Association of the CRRA. 2019-2020 Development Report of China Plastic Recycling Industry [R]. Beijing: The Plastic Recycling Association of the CRRA, 2020.

49 The Department of Distribution Industry Development, the Ministry of Commerce (MOFCOM). Development Report of China Renewable Resources Recycling Industry 2018 [R]. Beijing: The Department of Distribution Industry Development, the MOFCOM. 2018.

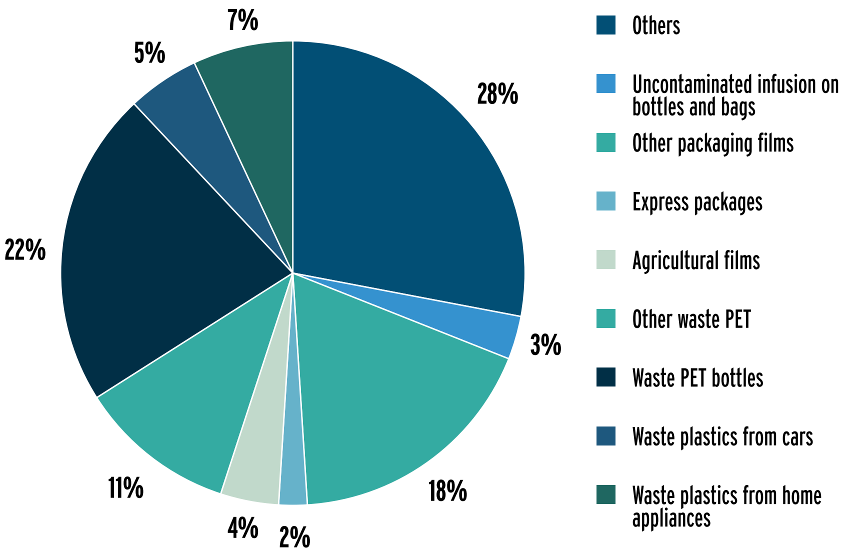

Figure 11. Shares of recovered waste plastics in China. Source: The Plastic Recycling Association of the CRRA

Of all the types of waste plastics in 2019, PET saw the largest recovered amount at 6.3 million tons, including 4.22 million tons of waste PET bottles and 2.08 million tons of the other kinds of waste PET. It was followed by waste plastics from packaging films at 3.4 million tons and those from electric and electronic products at 1.5 million tons (see Figure 11).

PET bottle recovery

The gross amount of PET bottles recovered across China in 2019[50] was 4.22 million tons. The recovery rate of PET bottles varies significantly from method to method. The average PET bottle recovery rate is 75 percent, according to statistics from the Plastic Recycling Association of the CRRA. That compares with over 94 percent estimated in the Report on PET Beverage Package Recycling in China published by the China Beverage Industry Association (CBIA).[51] Despite the lack of an exact recovery rate, it is indisputable that the recovery rate of PET bottles is higher than those of the other types of plastics waste. This is mainly attributable to the

50 It is generally difficult to remove water from PET during recovery. Generally, PET bottles with a water content less than six percent are acceptable in the recovery industry.
51 Weixing, X. The report on PET beverage package recycling in China: The PET bottle recovery rate is over 94 percent [J]. Beverage Industry, 2020, 23 (05): 78-79.

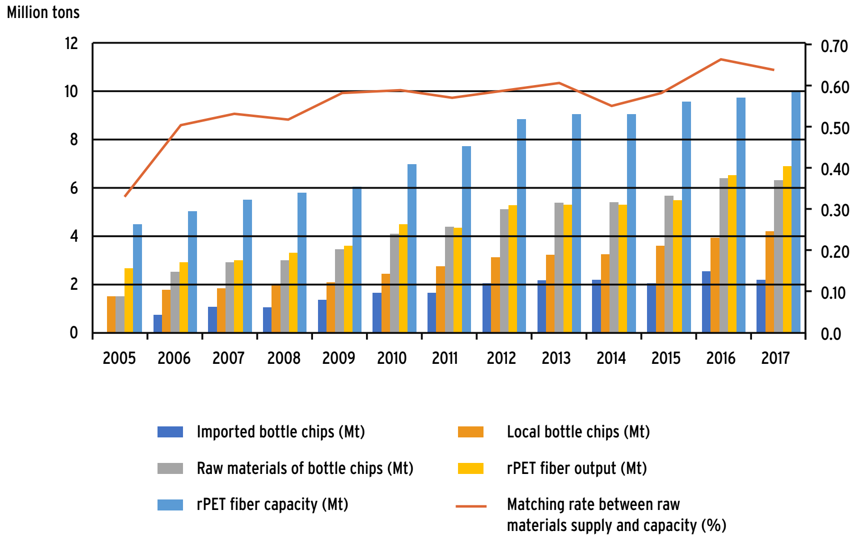

Figure 12. Raw materials supply vs. capacity in China's rPET industry, 2005-201. Source: Ccfei.com, China Chemical Fibers Association (CCFA)

few types of products to be recovered, a relatively sound recovery system and a more mature downstream recycling industry.[52]

In 2017, materials recycled from waste PET bottles were the main raw materials of recycled chemical fibers, as they accounted for about 60 percent of the total production capacity (see Figure 11). China had the world's highest recycled chemical fiber production capacity at over 10 million tons in 2017, when it actually produced six million tons, or about 80 percent of the global annual production.[53]

Electronic waste

Electronic waste, also known as e-waste, refers to discarded electrical and electronic equipment that is no longer in use. Unlike ordinary MSW, electronic waste has complex ingredients and contains large amounts of metals such as gold, silver, copper, mercury, lead and cadmium, polychlorinated biphenyls (PCBs), halogen flame retardants, plastics, and asbestos. If not handled properly, it may cause serious environmental pollution and ecological damage. Plastics are widely used in electrical and electronic

52 The Plastic Recycling Association of the CRRA. 2019-2020 Development Report of China Plastic Recycling Industry [R]. Beijing: The Plastic Recycling Association of the CRRA. 2020.
53 Li, A. Attention: The recycled chemical fiber industry is entering a strategic, new era of high-quality development [N]. China Strategic Emerging Industry. Dec. 12, 2018. http://www.chinasei.com.cn/ad/ad9/201901/t20190114_24394.html

products because of their light weight, stable chemical properties, and ease of forming.

A total of 6.2 million tons of common types of e-waste were recovered across China in 2019, including 1.5 million tons of waste plastics, of which PS, PP, ABS, and others accounted for 55 percent, 25 percent, 12 percent, and 8 percent respectively.[54]

As many as 100 million to 120 million home appliances are scrapped across China annually, and this number is growing by 20 percent per year on average. Plastics waste, in particular, accounts for nearly 40 percent of all materials recovered from scrapped appliances.[55] Using them as resources or reusing them to form a real closed-loop economy will become a trend in the future. Home appliances contain various types of plastics (see Figure 13). Considering plastics recycling in the early design stages of electric and electronic equipment can significantly increase the plastic recovery rate while reducing the difficulty of recycling. This includes carefully using additives and fillers, minimizing the use of dark pigments, and composite or multilayer materials, etc.

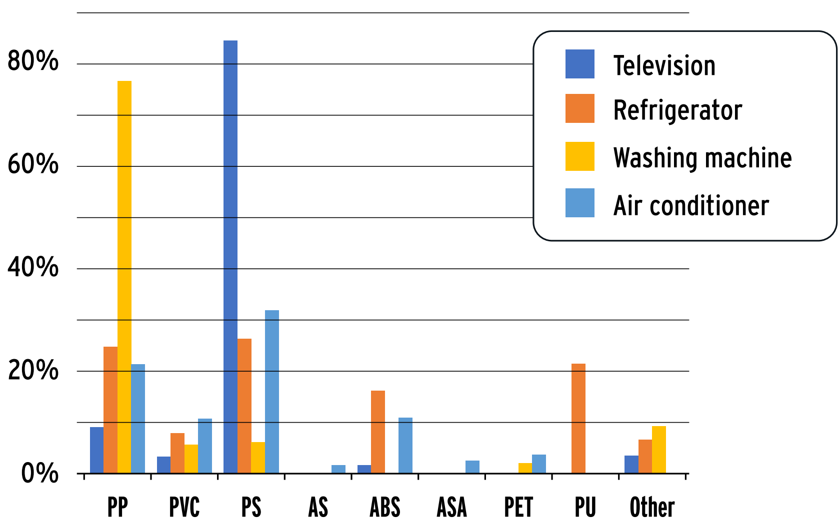

Figure 13. The proportions of plastics used in home appliances[56].

54 The Plastic Recycling Association of the CRRA. 2019-2020 Development Report of China Plastic Recycling Industry [R]. Beijing: The Plastic Recycling Association of the CRRA. 2020.

55 Sen, C. On the applied technology for housing plastics from e-waste [D]. Southwest Jiaotong University, 2014.

56 Ziya, X. On the compatibility between ABS and HIPS in housing plastics from e-waste [D]. Shanghai Polytechnic University, 2018.

China's plastic recycling industry is also facing many problems, even though the increasing attention of the international and domestic communities to pollution from waste plastics has brought more opportunities for plastic recovery, recycling, and regeneration. The local recovery system and waste plastics regulation remain imperfect, making it impossible for large plastic recyclers to obtain sufficient waste plastics. This has resulted in serious overcapacity. An excessive tax burden also reduces corporate profits and hinders the industry's growth. Although a number of environmentally compliant, large plastic recycling enterprises have emerged in the industry, non-compliant small ones have led to unstable quality of recycled plastic products. The overall management in the industry has yet to be refined, and it is necessary to strengthen the standardization and information disclosure of product identification and raw material traceability. Some companies will indicate the proportions of recycled materials when using a mixture of primary and recycled materials to make plastic products. The term "PP-R-30," for example, means that 30 percent recycled PP materials were added. Nonetheless, the plastic products processing industry currently does not force the identification of the proportions of recycled plastics in plastic products, making it difficult for users to obtain detailed information on their types and shares.

4.2 INDONESIA RECYCLING MARKET PROFILE

The Ministry of Industry recorded that the plastic recycling rate in 2019 was around 14%, while the Ministry of Environment and Forestry stated that the overall plastic recycling rate was only 7%. Studies have shown that since 2018, about 30% to 50% of plastic and paper waste imported by companies are mismanaged and dumped in the nearby villages. The local communities separate the high-value plastics and sell them to intermediary collectors. The remaining scraps are then sold to tofu makers, lime kiln plants, or are burned. As a result, high dioxin concentrations can be found in chicken eggs from hens in villages near plastic and paper recycling facilities. The pollution cost has not been determined due to Indonesia's lack of standards and mitigation plans (Petrlik et al., 2020; Petrlik et al., 2019).

In the last 30 years, plastic leakages discharged to the environment from domestic waste generation, industrial activities, institutional settings, and imported wastes have become a public environmental and health burden (Afdal, Werorilangi, Faizal, & Tahir, 2019; Sahwan, Martono, Wahyono, & Wisoyodharmo, 2005; Tahir, Taba, Samawi, & Werorilang, 2019; Uneputty & Evans, 1997; Yudhantari, Hendrawan, & Puspitha, 2019).

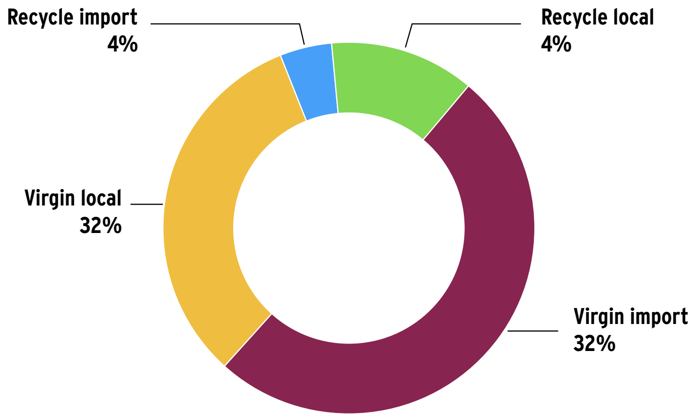

Figure 14. Raw materials for plastic production in Indonesia. Source: Ministry of Industry (2019)

During the pandemic, researchers found medical wastes and large amounts of PPE debris in river outlets into Jakarta Bay (M. R. Cordova, Nurhati, Riani, Nurhasanah, & Iswari, 2020). A study found that the mangrove ecosystem on the small island was being polluted mainly by plastic film (63%) and fibre (31%). Furthermore, the study identified that the sources of about 61% of plastic debris in the mangrove areas are land-based (Suyadi & Manullang, 2020). This land-based plastic pollution is affecting mangrove health (tree density, survival rates, and tree size). The effects of plastic pollution reduce the ecological functions and ecosystem services of the mangrove ecosystem.

Around 72% of plastic pollution originates in rural regions and small- to medium-sized cities. Currently, only 11% of plastic wastes in Indonesia are being recycled. With a waste collection rate of almost 70%, the mis-management of plastic waste is a constant domestic challenge. In 2017, Indonesia pledged up to 1 billion USD annually to clean its seas from plastic debris and other waste over the next eight years (until 2025). This pledge was followed by issuing a Presidential Decree (Number 83, 2018) and a Minister of Environment and Forestry Decree (No. P.75/MenLHK/SetJen/KUM.1/10/2019) concerning the roadmap of waste reduction by producers.

The need for raw materials for the national plastic recycling industry is around 2 million tons, with a domestic supply of approximately 913,000 tons, and the rest being imported. The Minister of Industry stated that the Indonesian plastic recycling industry could produce various value-added products with economic potential reaching more than Rp 10 trillion, or

690 million USD, per year. Meanwhile, the export potential of recycled plastic derivative products can reach 141.9 million USD per year.[57]

The total production capacity of these producers is about 5 million tons per year, and most of these companies produce conventional petroleum-based downstream plastics products. The domestic petrochemical industry supplied 50% of the raw materials for the downstream plastic industry to make a limited type of product.

On the other hand, the demand for domestic petrochemical products is still huge. The volume of polyethylene demand, for example, reaches 2.3 million tons per year. Domestic production can only meet 280,000 tons per year, and the rest, 1.52 million tons, has to be imported from other countries.

Plastic waste recycling and for fuel substitutions

There are four tiers of the concept of plastic recycling (Goodship, 2007), namely:

- Many SMEs recycling plastics in Indonesia are mainly using mechanical processing with materials collected from post-consumers. Only Unilever has piloted a chemical recycling technology to recycle sachet/multi-layer plastic post-consumer packaging.
- Most of the raw materials for plastic bags are recycled plastic. The plastic bag industry absorbs 6.5% of the total national plastic ore/pellets consumption, which reaches 366,000 tons and employs about 30,000 workers.[58] Currently, PET and HDPE are the most common types of plastic that can be recycled. Large plastic producers may be able to also recycle LDPE and PP. Most PVC, polystyrene, and other types of plastic cannot be recycled. In many places, scavengers do not collect Styrofoam because its lack of value and because it cannot be recycled. Several scavenger groups who sort the waste also stated that ABS (acrylonitrile-butadiene-styrene) and polycarbonate (PC) plastics were of no value and could not be recycled.
- Sachets and pouches are made of multiple layers of plastics and aluminum. Due to their complex structure, they are not easily recycled and have no value among scavengers and waste collectors, rendering sachet waste a significant environmental problem in developing coun-

57 Elsa Catriana, Bambang P. Jatmiko. Kompas.com, April 05, 2021. Minister of Industry: The Use of Plastics in Indonesia is at the Bottom of the World. Accessed 7 June 2021 from https://money.kompas.com/read/2021/04/05/172547126/menperin-use-plastik-di-indonesia-berada-di-peringkat-ter Bawah-dunia

58 https://ekonomi.bisnis.com/read/20191230/12/1185390/evaluasi-industri-plastik-tahun-2019

tries. Chemical recycling like solvolysis, introduced by the Fraunhofer Institute and Unilever, has been promoted as the solution to tackle sachet pollution.[59,60] In addition to Unilever, Danone has invested USD 5.25 million for the Close Loop Fund to produce 25,000 tons per year of food-grade recycled PET Plastic (rPET) which has met food safety standards (food grade) and halal certification.[61]

- Recently, multiple layers of plastic packaging have been considered valuable, and instead of being recycled in a chemical recycling plant they have been shredded and compacted in the form of brickets and sold as RDF (Refuse-Derived Fuel). Additionally, flexible plastic packaging has also been traded as fluff or Processed Engineered Fuel (PEF) to feed boilers and coal-fired power plants as a substitute for coal. A guidebook regarding standards of RDF pellets for cement kilns is available and issued by the Centre for Clean Industry, an R&D organization under the Ministry of Industry of Indonesia (ASI, Widowati, Indrawan, Trisnawanditya, & Abdulkadir, 2017).

59 https://www.unilever.com/news/press-releases/2017/Unilever-develops-new-technology-to-tackle-the-global-issue-of-plastic-sachet-waste.html
60 Unilever https://www.unilever.com/news/news-and-features/Feature-article/2018/our-solution-for-recycling-plastic-sachets-takes-another-step-forward.html
61 https://aqua.co.id/corporate/public/en/danone-aqua-and-veolia-indonesia-inaugurate-the-most-modern-and-largest-plastic-recycling-facility-in-indonesia

PET recycling

Indonesia committed to reduce 70% of its plastic marine debris by 2025, from a 2017 baseline. PET plastic, commonly used in bottles, is 100% recyclable and the world's most collected and recycled plastic packaging.

TABLE 8. RAW MATERIALS FOR PLASTIC PRODUCTION IN INDONESIA AND THEIR SOURCES (MOT, 2019)

Source	Volume (tons)
Recyclate, import	320 452
Recyclate, local	913 629
Virgin, import	3 663 577
Virgin, local	2 332 769
TOTAL	**7 230 427**

On the 6th of July 2021, the Indorama Corporation announced a new PET recycling facility being built in Karawang. The plant aims to recycle 1.92 billion post-consumer PET bottles per year from across Indonesia by the end of 2023. Indorama claimed that this new plant will provide 217 'green jobs' and associated indirect employment to the area.[62] Polyethylene terephthalate (PET) is the most widely used packaging material worldwide for bottled water and other non-alcoholic refreshment beverages. However, in recent years, concerns have been rising about the safety of polyethylene terephthalate food packaging due to the possible migration of chemical compounds from polyethylene terephthalate bottles into the water contained in it, which may pose a health risk to the consumers (Coniglio, Fioriglio, & Laganà, 2020). Studies have shown that there is potential migration of several non-intentionally added substances (NIAS) from PET production, PET use under high temperature, or the PET recycling process, such as antimony, phthalates, BPA, DEHP, etc.(Al-Otoum, Al-Ghouti, Costa, & Khraisheh, 2017; Coniglio et al., 2020).

The plastic recycling industry in Indonesia currently consists of around 600 large and 700 small industries, with an investment value of IDR 7.15 trillion (approx. USD500 million) and a production capacity of 2.3 million tons per year.[63]

62 Indorama Venture Press Release, 6 July 2021. https://www.indoramaventures.com/en/updates/press-releases/1787/new-karawang-facility-to-recycle-2-billion-pet-plastic-bottles-annually
63 https://industri.kontan.co.id/news/pemerintah-dorong-industri-manufaktur-berbasis-ekonomi-sirkular

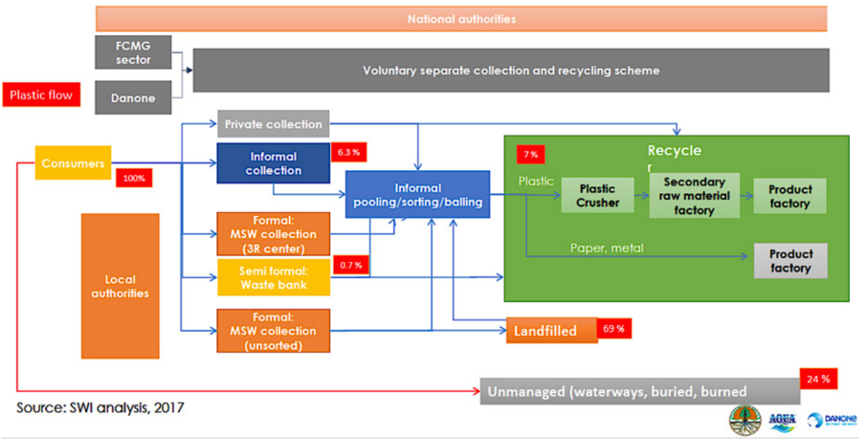

Figure 15. Flow of post-consumer plastic recycling in Indonesia.
Source: Danone-Aqua, 2018

The informal sector (including waste pickers, junk shops and aggregators/"bandar lapak") plays a critical role in plastic waste collection in Indonesia. Nearly all plastic waste collected by the informal sector ends up at a recycling facility.

Figure 15 below was released in 2018 from a study funded by Danone-Aqua, showing the flow of post-consumer plastics in the recycling chain. The study revealed that only 7% of post-consumer plastics, paper and metals went to the recycling plants, 69% to landfills, and 24% remained unmanaged (i.e., leaked to waterways, was buried, or burned) (Danone & SWI, 2018).

This sector collects around 500,000 tons of plastic waste per year (7% of total plastic waste) directly from residential areas and 560,000 tons of plastics (8% of the total) from collected waste that is in transit to landfill, and from the actual landfills (WEF, 2020). Nearly all waste collected by the informal sector ends up at a recycling facility (Danone & SWI, 2018).

According to Indonesia Plastics Recycler Association, due to the Covid-19 pandemic, there has been a 70% drop in the market, with 54% less plastic waste being absorbed into the recycling industry.[64]

The Indonesian Institute of Science (LIPI) conducted a survey in 2018 and revealed that the most common trash found was Styrofoam waste.[65]

64 https://www.indonesiawaterportal.com/news/can-plastic-and-rubber-industry-recover-from-covid-19.html
65 https://www.republika.co.id/berita/q2ect5328/dominasi-sampah-stirofoam-di-laut-indonesia

Further, LIPI released a baseline number of 0.27-0.59 million tons of ocean plastic per year, based on the field results in 18 locations collected using stranded beach data collection over the period a year. This figure was adopted by the National Taskforce on Marine Plastic Debris as a preliminary national baseline in December 2019 (Muhammad Reza Cordova et al., 2019).

Additionally, the LIPI study recommended several actions to be adopted and further implemented by the Indonesian government, as follows:

- Establish a standard method of monitoring marine debris washed up on the beach as an approach in measuring the distribution of marine debris in Indonesian waters;
- Conduct monitoring studies and modeling the distribution of marine debris on a regular basis so that the latest data is always available based on standardized methods; and
- Carry out further studies related to the impact of plastic waste on marine biota and humans.

Indonesian plastic recycling industries are primarily concentrated in Java and Sumatra (see Figure 13 in Distribution and scale of plastic recycling). In 2020, the recycling rate in Indonesia was low, at only 11% (KLHK, 2020; WEF, 2020).

Interviews with several plastic recyclers revealed some challenges faced, among others:

- lack of infrastructures needed to tap plastic wastes from domestic sources;
- poor quality of plastic waste due to poor waste separation;
- lack of incentives from the government to support the recycling industry.

4.3 RUSSIA'S RECYCLING MARKET PROFILE

According to a public opinion survey by the Levada Centre, more than half of Russia's residents are very concerned about the problem of plastic pollution (55%). The idea of legislative restrictions on disposable plastic items is supported by 84% of Russians. The overwhelming majority of the respondents (88%) agreed that manufacturers and retailers use too much plastic when packaging goods (59% of them strongly agree and 29% rather agree than disagree with this point of view). The same share (61%

completely agree and 28% rather agree) support the point of view that the state is not making enough to resolve the problem of plastic pollution.[66]

According to the Ministry of Trade of the Russian Federation, there are about 500 enterprises in the country that process from 350,000 to 450,000 tons of plastic waste per year.[67] Of all types of plastic processing, mechanical recycling is the main one in Russia. The country has facilities for processing of the following types of plastic waste:[68]

- PET bottles (marking 1)
- HDPE packaging - cans, bottles for household chemicals and cosmetics (markings 2 and 5)
- LDPE - different types of films and bags (marking 4)
- Polypropylene (marking 5)

The main input materials for waste processing facilities included clean industrial and commercial waste, as well as solid municipal waste. This is because industrial waste is easier to return into circulation.

However, as indicated above, there are huge potential reserves for greater use of plastic from SMW, that is hampered by an unsettled system of separate waste collection and a lack of waste separation capacity.

Almost all companies involved in processing of plastics in Russia process PET waste into plastic pellets that can be used in the manufacture of products for technical use, i.e., with reduced consumer properties. Currently, the share of secondary raw materials (mainly PET) in the raw material balance of the Russian plastics processing industry is not higher than 2-3%.[69]

The main sectors of application of recycled plastics in Russia include the following ones:[70]

- **Polyethylene (PE) waste.** The secondary polyethylene market in Russia is estimated at the level of 245,000 tons. However, the Strategy for Development of Industry for Processing, Utilisation and Disposal

66 https://greenpeace.ru/news/2019/11/19/84-rossijan-podderzhivajut-zakon-ob-ogranichenii-odnorazovogo-plastika/
67 https://www.gazeta.ru/business/2019/07/01/12469297.shtml. According to Tebiz Group, in 2019, the physical volume of the plastic waste market reached 574,000 tons: https://tebiz.ru/mi/rynok-plastikovykh-otkhodov-v-rossii
68 https://www.raiffeisen-media.ru/business/kak-rabotaet-zavod-po-nbsp-pererabotke-vtorsyrya-v-nbsp-rossii/
69 M. L. Katsevman, “State and development prospects of the plastics processing industry.” Polymer Materials Journal.” 2020 / # 5. pp. 4-11 (Rus.).
70 http://ecotechpro.ru/images/pdf/yan_2017.pdf

of Production and Consumption Waste for the Period up to 2030 estimates the level of polyethylene recyclate to be 20% of the total volume of generation of PE waste. [71]

- **Polypropylene (PP)** is a thermoplastic polymer. According to estimates of the Strategy for Development of Industry for Processing, Utilisation and Disposal of Production and Consumption Waste for the Period up to 2030,[72] the degree of PP processing reaches 17%.
- **PVC waste** is less recyclable. According to the Strategy for Development of Industry for Processing, Utilisation and Disposal of Production and Consumption Waste for the Period up to 2030, the level of PVC processing in Russia reaches about 10%. At the same time, a large amount of PVC waste (mainly waste from cable and furniture factories, substandard plastics) is exported.
- **Plastic from electronic waste.** About 1.4 million tons of e-waste is generated in Russia annually. At the same time, according to expert estimates, less than 20% of the e-waste is processed. The estimates account for so-called "grey" recyclers, who extract only the most valuable components from obsolete equipment and dispose of the rest into landfills. In fact, currently, in Russia, almost no control exists over the quality of recycling of electronic waste by recycling companies, and the scope of e-waste treatment has not been defined at the level of regulations. As a result, electronic waste in Russia is mainly disposed of in landfills and unauthorized waste dumps or is incinerated, even though electronic scrap accounts for about 70% of all the most toxic substances in SMW.[73]
- **Waste synthetic textiles.** The most common synthetic fibres include polyester, polyamide, and acrylic fibres. Synthetic fibres have high chemical resistance, low hydrophilicity, low thermal insulation, relatively low melting points, and high electrostaticity.

The recycling market and incentives to recover plastic waste

In Russia, the Extended Producer Responsibility (EPR) mechanism was introduced by Federal Law # 458-FZ of December 29, 2014, on Amending the Federal Law on Production and Consumption Waste and Certain Legislative Acts of the Russian Federation and Revoking Certain Legislative Acts (Provisions of Legislative Acts) of the Russian Federation.

71 http://static.government.ru/media/files/y8PMkQGZLfbY7jhn6QMruaKoferAowzJ.pdf
72 Ibid.
73 https://news.solidwaste.ru/2020/07/tyomnaya-storona/

Article 24.2 of the Federal Law[74] defines three options for EPR implementation:

- independent compliance with the recycling standards by importers and manufacturers of goods;
- conclusion of contracts with waste processing facilities;
- payment of the environmental charge.

At the same time, the recycling obligation of goods manufacturers or importers is considered fulfilled from the date of submission of their reports on implementation of recycling standards, or on payment of the environmental charge.

For various groups of goods, recycling standards have been set as percentages of the total amount of goods released by manufacturers and importers of goods for internal consumption over the past calendar year. When determining the standards, aspects such as economic conditions, potential hazards of waste to human health and the environment, as well as technological possibility of their utilisation were taken into account.[75]

The government plans to increase recycling rates annually, with the following rates set for the main groups associated with plastic waste for 2018-2020 (see Table 2.2.3#9).

TABLE 9. RECYCLING RATES FOR WASTE FROM USE OF GOODS

Product groups	Recycling rates for waste from use of goods (%)		
	2018	**2019**	**2020**
Group # 21 "Plastic packaging products"	10	15	20
Group # 22 "Plastic construction products"	5	10	15
Group # 23. "Blocks for doors and windows, thresholds for doors, shutters, blinds and similar plastic products"	0	5	10
Group # 24 "Other plastic products"	10	15	20

74 http://www.consultant.ru/document/cons_doc_LAW_19109/5becb664d19d0c893e59dc3501754b0f828ed269/http://docs.cntd.ru/document/901711591
75 http://static.government.ru/media/files/k8qAWg0Iz7AAqAo92iksmtc7AAvsWCSk.pdf

However, over the initial 5 years, the EPR implementation did not lead to significant economic stimulation of development of the waste management industry.[76]

The existing EPR model provides for establishment of the obligation of manufacturers and importers of goods to ensure compliance with the waste recycling standards established by the government of the Russian Federation for disposal of waste from goods released into circulation and packaging of goods that have lost their consumer properties. The list of these goods is set by the government of the Russian Federation.

In Russia, the exact number of EPR subjects is unknown as it is impossible to identify them in the EPR system, since the obligation to recycle waste from use of goods applies to goods and packaging items from the moment of their initial sale, and not from the moment of their production.

One of problems of the existing EPR system in Russia is associated with mixing recycling targets set at the national level and recycling standards, that, in fact, only determine the number of "discounts" for payments of the environmental charge. However, as such, there are no EPR targets at the national level.

76 https://www.alta.ru/tamdoc/20a12888/

5. PUBLIC POLICIES CONCERNING PLASTICS THROUGHOUT THEIR LIFECYCLE

This chapter highlights the regulatory frameworks for the three target countries. It shows that, despite attempts to regulate the use of plastics, the regulation is not systematic, and it does not address the negative impacts of plastic production, use, and disposal throughout its entire lifecycle. In addition, legislation in these countries tends to leave the polluters off the hook, while citizens pay the high cost of the pollution and its impacts.

5.1 CHINA

China's Plastic Pollution Management Policies

China has released and implemented a series of policies and regulations on plastic pollution management in recent years. The most recently enforced ones are represented by the "Opinions on Further Strengthening Plastic Pollution Management officially released in 2020". It is primarily focussed on conducting plastic pollution management by region, and industry. This document marks a new stage of more stringent plastic pollution management across China, and will be followed by supportive, specific policies and programs (see Table 7). Additionally, The National Development and Reform Commission (NDRC), released the 14th Five-Year Plan (2021-2025) for Circular Economy Development which also includes developments on plastic pollution controls, packaging and increasing materials-use efficiency. Under this initiative, China issued, in September 2021, a five-year plan outlining the nation's strategy for tackling plastics pollution.

TABLE 10

Time	Policy	Purpose
June 2008	The Chinese government issued the Circular on Restrictions on the Production and Sale of Plastic Shopping Bags (the Restrictions on Plastics), which requires that free plastic bags be not provided, and that the recycling rate of waste plastics be raised.	As China's very first specific measure introduced to manage the pollution of plastic products, it has led to a reduction in plastic bag consumption by more than one million tons. Nonetheless, it specifies few management targets and lacks a sustainable updating mechanism.
Aug. 2008	The State Council, or China's cabinet, announced the Administrative Regulations on Waste Electrical and Electronic Product Recovery and Treatment, which was put on trial from January 1, 2011, and revised in March, 2019.	The Extended Producer Responsibility (EPR) was first introduced into the fields of appliances and electronics to promote the comprehensive utilization of resources and the growth of a circular economy.
Dec. 2016	The State Council issued the Circular on Releasing the Extended Producer Responsibility Implementation Plan, covering paper-based composite packaging products for appliances, electronics, and beverages.	The EPR was further implemented.
2017-2019	The Implementation Program for Banning Waste Import and Promoting the Reforming of the Solid Waste Import Management System was introduced in 2017.	Given the environmental impact of the imported waste plastics, the Chinese government will no longer allow waste import. After this policy was introduced, the waste plastic import into China sharply dropped to 76,000 tons with 99% year-on-year reduction in 2018.
Feb. 2019	With a typical island ecosystem, the Hainan Province released the Implementation Program of Hainan Province for Comprehensively Banning the Production, Sale and Use of Disposable, Non-degradable Plastic Products, with a list of the banned products. It requires a stop to the production, sale, and use of all the listed products across the province by the end of 2020.	This policy can be regarded as the forerunner of similar policies in China.
May 2019	The pilot Waste-free Cities project was launched across the board.	This pilot project focuses on solid waste management where there have long been management gaps. Waste plastic recycling, in particular, has been covered in numerous cities involved in this project.

Time	Policy	Purpose
June 2019	China's nine ministries such as the MOHURD jointly released the Circular on Implementing Comprehensive Domestic Waste Classification in Cities at the Prefecture and Higher Levels, making it clear that a domestic waste classification and treatment system will be phased in for each of these cities, or nearly all the medium- and large-sized Chinese cities.	With the roll-out of the domestic waste classification system and the separation of kitchen garbage from the recyclable, the local conditions for recovering common things in daily life such as waste plastic will be significantly improved.
Jan. 2020	The National Development and Reform Commission (NDRC) and the MEP jointly and officially released the Opinions on Further Strengthening Plastic Pollution Management.	This document marks a new stage of more stringent plastic pollution management across China, and will be followed by supportive, specific policies and programs.
Apr. 2020	To promote the implementation of the Opinions on Further Strengthening Plastic Pollution Management, the NDRC worked with other relevant authorities to conduct the drafting of the Catalog of Plastic Products of Which the Production, Sale and Use Will Be Banned or Restricted (the Version for Comments) in order to publicly seek advice.	The catalog for Phase I has been worked out. It was also made clear that, as a dynamic updating mechanism, it will offer updates from time to time.
Apr. 2020	The amended Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Wastes was enacted at the Seventeenth Session of the Standing Committee of the Thirteenth National People's Congress. Effective from Sept. 1, 2020, it includes provisions on banning or restricting the production, sale and use of disposable, non-degradable plastic bags.	With the inclusion of plastic pollution management into legal provisions, waste plastic product management is legally supported.
Jul. 2020	China's nine ministries such as the NDRC co-released the Circular on Effectively Promoting Plastic Pollution Management to monitor local governments' efforts in developing local feasibility plans for the implementation of this document.	Local efforts have been made to effectively promote plastic pollution prevention and control since the COVID-19 pandemic broke out, with an aim to meet the targets for 2020 specified in the Opinions on Further Strengthening Plastic Pollution Management.

Time	Policy	Purpose
2019-2020	The following standards relevant to waste plastic recovery and treatment were announced: GB/T 37547-2019 Waste Plastic Classification and Coding GB/T 37821-2019 Technical Specification for Recycling Waste Plastics GB/T 39171-2020 Technical Specification for Recovering Waste Plastics	They aim to regulate plastic recycling.

TABLE 11 NATIONAL STANDARDS AND REQUIREMENTS FOR PLASTIC PRODUCTS

Applicability	Regulations and Standards
Common plastic products	GB/T 37866-2019 Green Product Assessment: Plastic Products
Plastic materials to which foods are exposed	GB 4806.1-2016 General Safety Requirements for Materials to Which Foods Are Exposed and Relevant Products GB 4806.6-2016 Plastic Resins to Which Foods Are Exposed GB 4806.7-2016 Plastic Materials to Which Foods Are Exposed and Their Products GB 4806.11-2016 Rubber Materials to Which Foods Are Exposed and Their Products GB 9685-2016 Standards for the Use of Materials to Which Foods Are Exposed and Additives for Their Products
Infant feeding bottles	GB 28482 Safety Requirements for Infant Pacifiers The Announcement of the Ministry of Health and Five Other Authorities on Prohibiting the Use of Bisphenol A in Infant Feeding Bottles (No. 15 of 2011)
Children's plastic toys	GB 6675.1-2014 Part 1 of Toy Safety: Basic Requirements
Stationery for students	GB 21027-2020 General Safety Requirements for Student Supplies T CSSGA 1001-2017 Book Films and Covers T CSSGA 1002-2017 Erasers

Clothes	GB 18401-2010 National Basic Safety Technical Code for Textile Products GB 31701-2015 Safety Technical Code for Textile Products for Infants and Children GB 30585-2014 Safety Technical Code for Children's Shoes
Plastic furniture	GB 28481-2012 **Limits of Harmful Substances in Plastic Furniture**
Recycled plastic products	GB/T 40006.1-2021 Plastics - Recycled Plastics - Part 1: General Principles GB/T 40006.2-2021 Plastics - Recycled Plastics - Part 2: PE Materials GB/T 40006.3-2021 Plastics - Recycled Plastics - Part 3: PP Materials

International Conventions on Plastic Pollution Management and China's Action

From the Restrictions on Plastics[77] released in 2007 to the ban on waste import in 2017, China has been paying close attention to plastic pollution. In 2017, the State Council launched the EPR implementation plan aiming to promote a transition toward circular economy in four industries including beverage packaging covering all stages of the product lifecycle ranging from product design to recycling.[78] In January 2020, the NDRC and the MEE jointly released the Opinions on Further Strengthening Plastic Pollution Management (hereinafter referred to as the New Restrictions on Plastics),[79] in order to further prohibit or restrict the production, sale and use of certain plastic products, and to regulate the recycling and disposal of plastics waste. Unlike the previous regulations focusing on individual aspects and fields, the policies and measures included in the New Restrictions on Plastics cover nearly all processes and dimensions relevant to plastic products such as manufacturing, distribution, use, recovery, and disposal, reflecting the systematic approach and integrity of product lifecycle management (PLM). This is conducive to establishing a long-term mechanism for managing plastic pollution.

The New Restrictions on Plastics include requirements for strengthening control over toxic and harmful plastic additives for the first time. They stipulate that plastic product manufacturers should work in accordance with the governing laws and regulations to ensure plastic products must

77 The Circular of the General Office of the State Council on Restrictions on the Production and Sale of Plastic Shopping Bags, GBF [2007] No. 72.
78 The Circular of the General Office of the State Council on Releasing the Extended Producer Responsibility Implementation Plan, GBF [2016] No. 99.
79 The Opinions on Further Strengthening Plastic Pollution Management, FGHZ [2020] No. 80.

not use any chemical additives harmful to human health or the environment.

Of the many chemical additives, short-chained chlorinated paraffins (SCCPs), hexabromocyclododecane (HBCD), PBDEs, per- and polyfluoroalkyl substances (PFAS), etc., are internationally recognized POPs. Listed in Annex A or B to the Stockholm Convention on Persistent Organic Pollutants (hereinafter referred to as the Stockholm Convention), they are required to be prohibited, eliminated, or strictly restricted.

Regarding the chemicals listed in Annex A or B to the Stockholm Convention that can be used as plastic additives, as shown in Table 9, China has banned the production, distribution, use, import, and export of tetrabromodiphenyl ether (TeBDE), pentabromodiphenyl ether (PeBDE), hexabromodiphenyl ether (HexaBDE) and heptabromodiphenyl ether (HeptaBDE),[80] and prohibited the production, distribution, use, import, and export of perfluorooctane sulfonate (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF) except for specific exemptions and acceptable purposes (see the relevant annex).[81] Also, the production, use, import, and export of HBCD will be completely banned from December 26, 2021.[82]

SCCPs, PFOS, its salts and PFOSF, HBCD, decabromodiphenyl ether (DecaBDE),[83] as well as PFOA, its salts and relevant compounds[84] have been included into the List of Chemicals Prioritized for Control; SCCPs, PFOS, its salts and PFOSF, and HBCD have been listed into Catalog of Toxic Chemicals Strictly Restricted from Import and Export in China (2020);[85] TeBDE, PeBDE, HexaBDE and HeptaBDE have been included

80 MEP, the Ministry of Foreign Affairs (MFA), NDRC, the Ministry of Science and Technology (MOST), the Ministry of Industry and Information Technology (MIIT), MOHURD, the Ministry of Agriculture (MOA), MOFCOM, the National Health and Family Planning Commission (NHFPC), the Customs, AQSIQ and the State Administration of Work Safety (SAWS): The Circular on the Entry into Force of the Amendments to Annexes A, B and C Intended to Add Nine Types of Persistent Organic Pollutants to the Stockholm Convention on Persistent Organic Pollutants and the Amendment to Annex A Intended to Add Endosulfan (Circular 2014 No. 21), Mar. 25, 2014.

81 MEE, MFA, NDRC, MOST, MIIT, MOHURD, the Ministry of Agriculture and Rural Affairs (MOARA), MOFCOM, the National Health Commission (NHC), the Ministry of Emergency Management (MEM), the Customs and SAMR: The Circular on Prohibiting the Production, Distribution, Use, Import and Export of Persistent Organic Pollutants such as Lindane (Circular 2019 No.10), Mar. 4, 2019.

82 The General Offices of MEE, MIIT, MOHURD and SAMR: The Notice on the Implementation of the Ban on the Production and Use of Hexabromocyclododecane under the Stockholm Convention on Persistent Organic Pollutants (HBGTH [2021] No. 237), Jun. 4, 2021.

83 MEP, MIIT and NHFPC: The Circular on Releasing the Catalog of Chemicals Prioritized for Control (Batch 1) (Circular 2017 No. 83), Dec. 27, 2017.

84 MEE, MIIT and NHC: The Circular on Releasing the Catalog of Chemicals Prioritized for Control (Batch 2) (Circular 2020 No. 47), Oct. 30, 2020.

85 MEE, MOFCOM and the Customs: The Circular on Releasing the Catalog of Strictly Restricted Toxic Chemicals in China (Circular 2019 No. 60), Dec. 30, 2019.

into the Catalog of Products Prohibited from Export (Batch 6) and the Catalog of Products Prohibited from Import (Batch 7).[86]

TABLE 12

<table>
<tr><th>Chemicals</th><th>Effective Date in China</th><th>Implementation Plan</th><th>Elimination Status</th><th>The Catalog of Toxic Chemicals Prioritized for Control</th><th>The Catalog of Strictly Restricted Toxic and Hazardous Chemicals (2020)</th><th>The Catalog of Products Prohibited from Import</th><th>The Catalog of Products Prohibited from Export</th></tr>
<tr><td>PFOS, its salts and PFOSF</td><td>Mar. 26, 2014</td><td rowspan="4">Supplement Plan released on Dec. 17, 2018</td><td>Production, distribution, use, import, and export are banned except acceptable purposes.</td><td>√</td><td>√</td><td>-</td><td>-</td></tr>
<tr><td>HexaBDE and heptaBDE</td><td>Mar. 26, 2014</td><td>Fully eliminated</td><td>-</td><td>-</td><td>√</td><td>√</td></tr>
<tr><td>TeBDE and PeBDE</td><td>Mar. 26, 2014</td><td>Fully eliminated</td><td>-</td><td>-</td><td>√</td><td>√</td></tr>
<tr><td>HBCD</td><td>Dec.26, 2016</td><td>To be fully eliminated by Dec. 26, 2021</td><td>√</td><td>√</td><td>-</td><td>-</td></tr>
<tr><td>BDE-209</td><td rowspan="3">Yet to take effect</td><td rowspan="3">-</td><td>-</td><td>√</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>SCCPs</td><td>-</td><td>√</td><td>√</td><td>-</td><td>-</td></tr>
<tr><td>PFOA, its salts and PFOA-related compounds</td><td>-</td><td>√</td><td>-</td><td>-</td><td>-</td></tr>
</table>

86 MOFCOM, the Customs and MEE: The Catalog of Products Prohibited from Import (Batch 7) and the Catalog of Products Prohibited from Export (Batch 6) (MOFCOM Circular 2020 No. 73), Dec. 30, 2020.

Ministry of Environment and Forestry
Ministry of Public Works
Ministry of Trade
Ministry of Industry

National Law	UU No. 18 / 2008 Law on Solid Waste Management	UU No. 11 / 2020 Law on Job Creation			
Government Regulation	PP No. 81/2012 Government Regulation on Management of Household and Household-like Waste	PP No. 22/2021 Implementation of Environmental Protection and Management	DRAFT Government Regulation on Excise on Plastic	PP No. 27/2020 Management of Specific Wastes	
Presidential Regulation	Perpres No. 97/2017 Presidential Regulation on National Policy and Management Strategy of Household Waste and Household-like Waste	Perpres No. 83/2018 Presidential Regulation on Marine Debris Management	Perpres No. 18/2015 Presidential Regulation on Income Tax Facilities for Investment in Certain Business Fields and/or in Certain Regions	Perpres No. 15/2018 Presidential Regulation on Acceleration of Damage and Pollution Control on Citarum River Basin	Perpres No. 35/2018 Presidential Regulation on Acceleration of Development of Waste-to-Energy Installation Using Environmentally-sound Technology
Presidential Decree	Keppres No. 61/1993 and No. 47/2005 Presidential Decree on Ratification of the Basel Convention on the Control of the Transboundary Movement of Hazardous Waste and Their Disposal				
Ministerial Regulation	Ministry of Trade Regulation No. 83/2020 Third Amendment to the Min. of Trade No. 84/2019 concerning Provisions for Importation of Non-hazardous Waste as Industrial Raw Material	Ministry of Public Works Regulation No. 3/2013 on Implementation of Solid Waste Infrastructure and Facilities	Ministry of Environment and Forestry Regulation No. P.75/2019 on Roadmap to Waste Reduction by Producers	Ministry of Environment and Forestry Regulation No. 13/2012 concerning Bank Sampah	
	Ministry of Trade Regulation No. 48/2015 on General Provisions in the Import Sector	Ministry of Trade Regulation No. 70/2015 on Importer Identification Number	Ministry of Industry Regulation No. 48/2015 on Requirements for Income Tax Facilities Implementation		
Regional/Local Regulation	Regional/Local Regulations on SUPs - PerGub Bali No. 97/2018 - PerGub DKI Jakarta No. 142/2019	- Perwali Denpasar 36/2018 - Perwali Bogor 61/2018 - Perwali Banjarmasin 18/2016	- Perwali Balikpapan 8/2018 - Perwali Padang 36/2018 - Perda Purwakarta 37/2016		

Figure 16. Summary of Indonesia's national waste management regulations (as of July 2021). Source: KLHK-SWI (2019), Nexus3-ICEL-AZWI (2021)

5.2 INDONESIA

Waste management policy and regulations

The Ministry of Environment and Forestry stated that the local government had improved the quality of waste management through the preparation of the Regional Waste Management Strategy Policy (Jakstrada), which is a mandate from Presidential Regulation No. 97, 2017, on National Policy and Management Strategy on Household Waste and Household-like Waste.[87]

87 Perpres No. 97/2017 tentang Kebijakan dan Strategi Nasional Pengelolaan Sampah Rumah Tangga dan Sampah Sejenis Sampah Rumah Tangga https://peraturan.bpk.go.id/Home/Details/73225/perpres-no-97-tahun-2017

This policy provides a direction towards a balanced waste management based on the amount of waste generated in 2025, and the phase-out and prohibition of several types of single-use plastics such as plastic shopping bags, plastic straws, and Styrofoam containers.

By the end of June 2021, two provinces and 58 regencies/cities had issued regional policies related to waste reduction through the prohibition and restriction of single-use plastics. Figure 16 provides a summary of Indonesia's national waste management regulations (as of July 2021). Due to the pandemic, several draft regulations are still in the pipeline and might be released in 2022.

Single-use plastic bans

Since 2016 until now, several provinces and cities/regencies across Indonesia have enacted single-used plastic bans regulation:

At regency and city levels: 54 regencies.[88,89,90,91] At the provincial level: two provinces, Bali and DKI Jakarta.[92,93]

Although there was an increase in single-use plastic usage during the COVID-19 pandemic, in general, the regulations are still enforced by the government and retailers.

In 2019, when the governor of Bali issued the new regulation to prohibit SUPs, several plastic producers and retailers sued the provincial government. After several months of hearings, the Supreme Court verdict ruled out the judicial review request submitted by the Association of Plastic Recyclers (ADUPI). Bali Governor Wayan Koster told all local governments to follow his path and not to be afraid to issue the plastic ban regulation.[94]

In collaboration with the government of Bali, the Alliance for Zero Waste Indonesia and its members, DIGKP, Nexus3, and PPLH Bali cond

88 https://dietkantongplastik.info/download/
89 https://www.liputan6.com/bisnis/read/4454331/41-daerah-sudah-terapkan-larangan-penggunaan-kantong-plastik
90 Ibid.
91 http://lh.surabaya.go.id/fileupload/SURAT%20EDARAN%20WALIKOTA%20PELARANGAN%20KANTONG%20PLASTIK.pdf
92 Peraturan Gubernur DKI Jakarta No. 142 tahun 2019 tentang Kewajiban Penggunaan Kantong Belanja Ramah Lingkungan Pada Pusat Perbelanjaan, Toko Swalayan Dan Pasar Rakyat https://jdih.jakarta.go.id/uploads/default/produkhukum/PERGUB_NO._142_TAHUN_2019.pdf
93 Peraturan Gubernur Bali Nomor 97 Tahun 2018 tentang Pembatasan Timbulan Sampah Plastik Sekali Pakai https://dklh.baliprov.go.id/wp-content/uploads/2020/07/20.-PERGUB-97-TH-2018-compressed.pdf
94 Bali wins plastic-ban battle in Court, steps closer to being plastic-free island. 15 July 2019. Jakarta Post, accessed by 7 May 2021. https://www.thejakartapost.com/news/2019/07/15/bali-wins-plastic-ban-battle-in-court-steps-closer-to-being-plastic-free-island.html

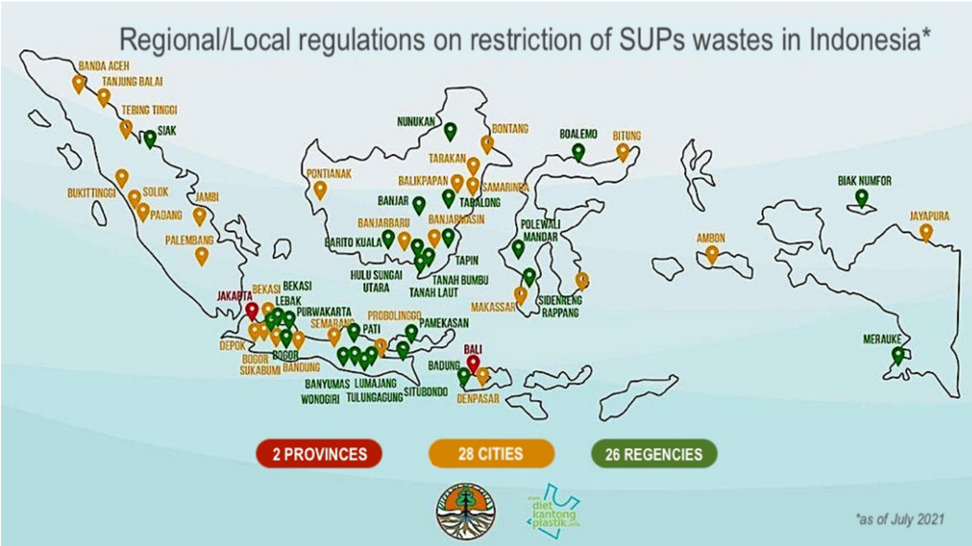

Figure 17. Provinces, cities and regencies with SUPs band regulations (as of July 2021). Source: GIDKP, 2021

ucted a participatory evaluation regarding the effectiveness of the Bali Governor Decree No. 97/2018 in early 2021.[95]

The evaluation results show a significant reduction in the use of single-use plastic bags, straws, and Styrofoam as follows:

- 51-57% reduction of single-use plastic bags;
- 77-81% reduction of single-use Styrofoam for food packaging; and
- 66-70% reduction of single-use plastic straws.

Furthermore, 94% of respondents stated that they use reusable shopping bags, and 86% said that they have no difficulties finding alternatives to plastic bags.

Meanwhile, the evaluation in Jakarta concerning the effectiveness of Jakarta Governor Decree Number 142/2019 also shows significant reductions of single-use plastics as follow:

- 82% reduction of single-use plastic bags;

95 Aliansi Zero Waste Indonesia Instagram account, 5 July 2021. https://www.instagram.com/p/CQ73fmxgfC1/?utm_source=ig_web_copy_link

- 42% reduction of single-use plastic bags at the household level;
- 95% reduction of single-use plastic bags at shopping centers;
- 100% reduction of single-use plastic bags at supermarkets; and
- 50% reduction of single-use plastic bags at traditional markets.

However, in general, the regulations are still being enforced by the government and retailers, but there has been an increase in single-use plastic usage during the Covid-19 pandemic.

Value Added Tax for plastic products

A plastics tax, especially for the food and beverage sector, has been discussed in various forums over the last five years. In addition, Value Added Tax (VAT) has been discussed among the Indonesian recycling sector as a rule that will hinder the effort in promoting the recycling business.

Meanwhile, for plastic products, in early 2020, the Minister of Finance (Menkeu) Sri Mulyani Indrawati said the application of an excise tax on plastics would take place next year. This is the government's strategy to pursue tax revenues in 2022.[96]

In the 2022 State Revenue and Expenditure Budget (APBN), the tax revenue target is within the range of Rp. 1,499.3 trillion to Rp. 1,528.7 trillion. This figure rose from 8.37% to 8.42% from the projected 2021 tax revenue.

The discourse on a plastic excise tax has been around for a long time. At least last year, the government wanted to implement it, but due to considering the impact of the coronavirus pandemic, it was finally postponed. However, at the end of 2020, the Ministry of Finance reported that excise would be imposed on all plastic products. The proposal grew because, previously, it only imposed excise duty on plastic bags with an excise rate of Rp 200 per sheet. This plan is also claimed by the Ministry of Finance that has been approved by Commission XI of the Indonesian House of Representatives.

In terms of plastic excise tariffs, the tax should be applied differently depending on the type of plastic and its impact on the environment. This method is also useful so that the government can assess the effectiveness of an excise on public consumption of various plastic products.

96 https://newssetup.kontan.co.id/news/pemerintah-berencana-terapkan-cukai-plastik-tahun-depan?page=all

5.3 RUSSIA

National Legal Framework

Legal regulation of waste management, including plastic waste,[97] is based on the Federal Law on Production and Consumption Waste.[98] The main directions of the state policy related to waste management include "maximal use of raw materials and material inputs" and "prevention of waste generation" and are included in paragraph 2, Article 3 of Federal Law # FZ 89 on Production and Consumption Waste. The Ministry of Natural Resources and Ecology of the Russian Federation (the Ministry of Natural Resources) is the state authority in charge of implementation of the state policy and legal regulation in the area of waste management. The Ministry of Natural Resources also monitors the situation in management of solid municipal waste, including plastic waste.

Plastic Waste Management in Russia

Paragraph 2 of Article 3 of Federal Law No. 89-FZ on Production and Consumption Waste,[99] prioritises directions of state policy in the area of waste management in the following sequential order:

- maximal utilisation of raw materials and material inputs;
- prevention of waste generation;
- reduction of waste generation and reduction of hazard classes of waste on sources of waste generation;
- waste treatment;
- waste recycling;
- waste neutralisation.

Based on these priority directions, the waste management industry currently consists of the following main sectors:

- waste collection;

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97 Plastic waste is generally understood as used containers and packaging, products or parts of them that have lost their consumer properties, cuttings and unmarketable residues, formed at facilities processing primary plastics, non-marketable "transitional" grades formed at enterprises producing primary polymers; plastic window frames, housings of electronic devices, photographic film, plastic containers and packaging in agricultural waste (films for mulching, containers and packaging from mineral fertilisers and chemicals, geomaterials, etc.) (https://dcenter.hse.ru/data/2018/07/11/1151608260/Рынок утилизации отходов 2018.pdf).

98 http://www.consultant.ru/document/cons_doc_LAW_19109/

99 http://www.consultant.ru/document/cons_doc_LAW_19109/f380561eb65d28708f522e4230771b49d1d5eb4e/

- waste separation (both household and industrial waste);
- sorting of mixed waste and sub-sorting (enrichment) of separately collected waste;
- processing of collected secondary raw materials;
- landfilling;
- waste incineration.

Integrated waste processing plants (the ones operating with waste sorting, processing, incineration, and disposal of non-recyclable waste) are at the initial stages of development, while small and medium-sized businesses are engaged into waste prevention (bulk and bottled goods, sharing services, delivery in reusable containers and packaging, etc.)

The maximal utilisation of raw materials and material inputs is not singled out separately in activity reporting of economic actors and currently cannot be assessed.

The most striking example of a violation of the relative priority order of the state policy directions in the area of waste management is associated with state support for thermal neutralization technologies (the lowest priority method of waste management in accordance with the Federal Law) at the background of no actions to prevent waste generation and to maximise utilisation of raw materials and material inputs. The only example of implementation of the highest priorities of the state policy on waste management is the initiative of the Committee for Culture of the Leningrad Oblast, that issued Order No. 01-04/18-45 of February 27, 2018, on Banning Use of Plastic Dishes, Plastic Bags and Packaging in the Course of Major Cultural Events.

For a long time, in Russia, a unified waste collection and disposal system was maintained, that was created in the period of the former USSR and practically did not change for 40-50 years. Then there were some elements of waste separation (for example, a system for collecting waste paper and scrap metal, mainly by school children, as well as glass containers). In the 1990s, that system was abandoned and in parallel the situation changed significantly: as volumes of garbage increased sharply, waste composition also changed significantly (primarily due to growth of the amounts of plastic and electronic products), while waste disposal methods were outdated and did not meet modern challenges. As a result, landfills for disposal of solid waste were increasingly overflowing with garbage, almost no waste processing was applied, and illegal waste dumps appeared everywhere, causing discontent among residents and leading to significantly increasing environmental pollution. As a result, it was necessary to reform the entire waste management system.

On January 1, 2015, amendments to the Federal Law No. 89-FZ of June 24, 1998, on Production and Consumption Waste entered into force - the amendments were intended to modernise the waste management system, including:

- introduction of priority directions of the state policy in the area of waste management in the Russian Federation;
- transfer of powers in the area of waste management from municipalities to constituents of the Russian Federation;
- introduction of the institute of territorial waste management schemes, regional programs and the institution of a regional operator;
- introduction of an environmental charge/fee or the institution of extended producer responsibility.

According to the reform, regional authorities are to bear the responsibility for the management of solid municipal waste. The regional authorities should independently select operators and are responsible for the entire waste management process – from waste collection to its transportation, processing, and final disposal. All waste will go through waste separation plants, that will separate the maximal amounts of waste suitable for recycling.

However, both experts and the public believe that the reform has not brought the expected results yet, and the situation in the area of waste management continues to remain unfavourable. As noted in the Accounts Chamber report,[100] landfilling still remains the priority method of solid waste management (SWM), while measures to reduce waste generation volumes are not being taken. There is an acute problem of development and introduction of modern waste processing technologies, but there are not enough funds for these activities. In conditions of depleting capacity of landfills and growing unauthorised dumps, waste continues to pose threats to the environment and human health. Attempts to lobby for waste incineration and the desire to equate it with waste recycling also cause public concerns.

In December 2019, amendments to the Federal Law No. 89-FZ of 24.06.1998 on Production and Consumption Waste were adopted, which

100 Report on findings of the expert and analytical event "Analysis of implementation of measures to ensure environmental safety of the Russian Federation, in terms of eliminating accumulated damage sites and development of an integrated system for management of solid municipal waste." https://ach.gov.ru/upload/iblock/41b/41b02dc50697e6fc57ec2f389a8b68f0.pdf (Rus.)

equate waste incineration with recycling (the so-called "energy recuperation"). These amendments open the door to large-scale incineration of residual waste after waste separation at environmentally hazardous facilities for generation of expensive and unnecessary energy. In such conditions, the level of material processing, when new goods are produced from waste, will not rise. Currently, Russian citizens are already protesting against the launch of waste management facilities of any kind in their regions due to distrust in the actions of the authorities. Equating waste incineration with energy recuperation is already leading to an increase in protests due to the residents' fears that an ordinary incinerator with toxic smoke and toxic ash (necessitating new specialised landfills) may appear behind the facade of any "waste recycling" plant.[101]

Nevertheless, the Russian Government continues to strengthen the legislation in the area of waste management. From January 1, 2021, uniform requirements are imposed on the operation of waste processing plants and landfills. These requirements primarily apply to new sites to be built. If such facilities and landfills were designed or built before 2021, then they must meet the uniform requirements by January 1, 2026. The corresponding government decree was signed on October 12, 2020.[102] In particular, the document states that "disposal and incineration of waste shall be possible only in cases if they are unsuitable for processing."[103] It should be noted that clause 13 of the uniform requirements equates production of fuel from waste with waste disposal, which might lead to a situation when secondary raw materials that can be used to produce new goods will be used as fuel. The uniform requirements consider waste to be incinerated as renewable energy sources, while the requirements do not regulate contents of waste made from hydrocarbons in the total waste stream sent for incineration.

Several provisions of the requirements regulate issues of reconstruction and closure of landfills. Such facilities must be reconstructed if a landfill adversely impacts the environment, exceeding permissible levels of environmental impacts as stipulated by relevant documentation. Landfills filled up to their design capacity are subject to closure.

In 2020, the EcoLine Group conducted a study of waste morphology in 50 districts of Moscow, where about 4 million people live. Their research has shown that the share of packaging reaches 80-90% of contents of containers for recyclable items: 55% of these packaging items are made

101 https://www.roi.ru/63007/
102 http://static.government.ru/media/files/Po7Qsq9NzZyImVZv7iCa4nLpX8hLjNn7.pdf
103 http://government.ru/docs/40608/

of plastics, and half of them are non-recyclable for various reasons. Such waste, even if collected separately, is sent to landfills.[104]

TABLE 13. SUMMARY INDICATORS OF THE PLASTIC WASTE MARKET IN RUSSIA IN 2015-2019, [TONS]

Supply and demand balance	2015	2016	2017	2018	2019
Supply	371 657	446 771	468 749	525 103	596 883
Production	2 473	1 314	1 471	1 679	1 826
Import	19 184	20 457	17 278	23 424	45 057
Collection of plastic waste (estimate)	350 000	425 000	450 000	500 000	550 000
Demand	371 657	446 771	468 749	525 103	596 883
Export	9 928	9 714	10 911	23 786	22 836
Market volume	361 729	437 057	457 838	501 317	574 047

Source: the RF Federal Statistics Service, the RF Customs Service, Tebiz Group[105]

Governmental Decree # 1589-r of July 25, 2017, approved a list of types of production and consumption wastes containing useful components that are prohibited for disposal. Some of the items of this list (scrap and waste containing ferrous and non-ferrous metals, lamps and mercury-containing waste) are prohibited for disposal from January 1, 2018, for other disposal is prohibited since January 1, 2019 (paper, cardboard, tires, polyethylene and polypropylene waste, glass containers) and the remaining from January 1, 2021 (electronic devices, including computers and their parts, telephones, voice recorders, etc.; electric appliances, including refrigerators, kettles, electric coffee makers, microwave ovens, air conditioners, etc.; banking equipment, batteries, wires and cables).

Adoption of amendments to Law # 89-FZ on Waste in late 2019 equates waste incineration with waste recycling (so-called “energy recovery”). The risk is that the amendments promote incineration of waste after sorting at environmentally hazardous plants with production of expensive energy and increasing greenhouse gas emissions.

The Strategy for Development of Industry for Processing, Utilisation and Disposal of Production and Consumption Waste for the Period up to 2030 sets an ambitious goal - to increase the share of SMW recycling in

104 https://drive.google.com/file/d/1ZztU_v-Ulhp4RpTYcBfF190eL6CocBey/view
105 https://tebiz.ru/mi/rynok-plastikovykh-otkhodov-v-rossii.

Russia from 8.9% in 2016 to 80% by 2030.[106.] The document spelled out the 3R principle (waste reduction, reuse, and recycling), but at the same time, none of the measures from the strategy's action plan are intended to reduce the volumes of waste generation. The document focuses on dealing with the existing waste: processing of the general SMW stream, landfilling, and incineration in cement kilns.

For most plastics, import restrictions are in place, such as customs duties. Currently, the base rate is set as 6.5%. Zero import duties are set only for emulsion PVC and for foaming and special purpose polystyrene, the need for which cannot be met by national production.

By Decree No. 348-r of February 28, 2019, of the Russian Government, an action plan (roadmap) for development of the petrochemical complex in the Russian Federation for the period up to 2025 was approved.[107] Development of the Russian petrochemical industry is intended to achieve the following main goals:

- stimulating development of non-energy resource exports;
- achieving a new level of competitiveness of the production base of the petrochemical industry (at which national producers would have long-term competitive advantages both in the national and foreign markets, due to development of new efficient capacities);
- addressing the problem of a growing surplus of light hydrocarbon raw materials by processing them at petrochemical facilities;
- meeting the demand of the chemical industry for raw materials;
- minimisation of adverse environmental impacts due to the introduction of the best available technologies.

International obligations

Currently, imports and exports of waste to/from Russia and transit of production and consumption waste are conducted in accordance with:

- The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, ratified by Federal Law # 49-FZ of November 25, 1994;
- Federal Law # 89-FZ of June 24, 1998, on Production and Consumption Waste;

106 http://static.government.ru/media/files/y8PMkQGZLfbY7jhn6QMruaKoferAowzJ.pdf
107 http://static.government.ru/media/files/6JYMjf310u2AR6d9uK3ALBRA0zBxLc35.pdf

- Decree of the Government of the Russian Federation # 442 of 17, 2003, on Transboundary Movement of Waste;
- Sections 1,2 of Annex # 1, section 2.3 of Annex # 2, and Annex # 7 to decision # 30 of the Board of the Eurasian Economic Commission of April 21, 2015 on Measures of Non-tariff Regulation;
- Administrative Regulation of Rosprirodnadzor on provision of state services for the issuance of permits for the transboundary movement of waste, approved by Order # 179 of the Ministry of Natural Resources of Russia of June 29, 2012.

At the 14th Conference of the Parties to the Basel Convention in 2019, amendments to the Annexes # II, VIII, IX of the Basel Convention were adopted. In accordance with Article 18 of the Convention, the Depositary informed all Parties on acceptance of these amendments on 24 September 2019. The Parties were reminded that:

- any Party that does not consider it possible to accept amendments to the annexes to the Convention shall notify the Depositary in writing within six months from the date of notification by the Depositary of its acceptance (paragraph 3 and subparagraph 2 (b) of Article 18);
- upon the expiration of six months from the date of notification by the Depositary, namely on February 24, 2020, the amendments will enter into force for all Parties that have not submitted a notification of non-acceptance of these amendments (paragraph 3 and subparagraph in (c) of Article 18);
- new provisions in Annexes II, VIII, IX to the Basel Convention will come into force on January 1, 2021 (decision of the 14th Conference of the Parties to the Basel Convention).

The Russian Ministry of Natural Resources did not provide any comments, and the amendments on plastic waste entered into force for Russia on January 1, 2021.

The Basel Convention's new non-hazardous plastic waste rules require exporting countries to obtain the prior informed consent of the importer for supply of virtually all non-hazardous plastic waste. So, for example, the import of PVC waste will be possible only with the prior informed consent of the importing country.[108] Moreover, the importing country is obliged not only to agree to import, but also to guarantee the handling of incoming waste in an environmentally sound way.

108 http://www.basel.int/Implementation/Plasticwaste/PlasticWasteAmendments/FAQs/tabid/8427/Default.aspx

Prior informed consent requirements do not apply to:

- Plastic waste, almost exclusively composed of a single, non-halogenated polymer. These polymers include commonly used polyethylene, polypropylene, and polyethylene terephthalate (PET).
- Waste plastics, almost exclusively consisting of a single hardened resin or condensation product. Such resins include urea-formaldehyde resins and epoxy resins.
- Waste plastics, almost exclusively consisting of one of the following fluorinated polymers:
    - Perfluoroethylene/propylene (FEP);
    - Perfluoroalkoxy alkanes:
    - Tetrafluoroethylene/perfluoroalkyl vinyl ether (PFA);
    - Tetrafluoroethylene/perfluoromethylvinyl ether (MFA);
    - Polyvinyl fluoride (PVF);
    - Polyvinylidene fluoride (PVDF).

These types of wastes can be freely exported to different countries, but only on condition of ensuring their environmentally sound processing, which excludes their disposal in landfills or any type of thermal utilization.

6. CASE STUDIES: TOXIC CHEMICALS IN CONSUMER PRODUCTS FOUND ON THE MARKET IN CHINA, INDONESIA, AND RUSSIA

6.1 BISPHENOL A

Bisphenol A (BPA) is a *synthetic chemical* used in a wide range of products such as epoxy paints and glue, lining of food cans, and thermal paper receipts. BPA is also used as a building block in polycarbonate plastics which can be used to make food containers and baby bottles, despite BPA being a *known endocrine-disrupting chemical* (EDC).[109] Several million metric tons of BPA are produced yearly[110] *even though* BPA is associated with several negative effects on the environment and human health.

6.1.1 Environmental and health concerns of Bisphenol A

BPA and its metabolites have been found in urine, blood, saliva, umbilical cord blood, placenta, and amniotic fluid, and samples collected from people around the world indicate that more than 90% of the world's population have BPA in their bodies[111]. Newborn and infant exposure to BPA increases the sensitivity of hormone-sensitive organs to later-life exposures to estrogens[112,113] or chemical carcinogens[114,115].

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109 Gore, A.C., et al., Introduction to endocrine disrupting chemicals (EDCs). A guide for public interest organizations and policy-makers, 2014: p. 21-22.

110 Bisphenol A - Global Market Trajectory & Analytics. 2021: Global Industry Analysts, Inc.

111 Vandenberg, L.N., Exposure to bisphenol A in Canada: invoking the precautionary principle. CMAJ, 2011. 183(11): p. 1265-1270.

112 Wadia, P.R., et al., Perinatal bisphenol A exposure increases estrogen sensitivity of the mammary gland in diverse mouse strains. Environmental health perspectives, 2007. 115(4): p. 592-598.

113 Ho, S.-M., et al., Developmental exposure to estradiol and bisphenol A increases susceptibility to prostate carcinogenesis and epigenetically regulates phosphodiesterase type 4 variant 4. Cancer research, 2006. 66(11): p. 5624-5632.

114 Lamartiniere, C.A., et al., Exposure to the endocrine disruptor bisphenol A alters susceptibility for mammary cancer. Hormone molecular biology and clinical investigation, 2011. 5(2): p. 45-52.

115 Jenkins, S., et al., Oral exposure to bisphenol a increases dimethylbenzanthracene-induced mammary cancer in rats. Environmental health perspectives, 2009. 117(6): p. 910-915.

Moreover, BPA levels found in children are typically higher than in adults. This is due to the higher food consumption per kilo of body weight in early life, dust ingestion associated with hand-to-mouth contact behaviour in children, as well as to a higher use of plastic products. Babies are exposed to BPA when it leaches from feeding bottles and other containers into the beverages and food they consume.

Health and environmental concerns have led many countries to restrict the use of BPA in baby bottles and other items in contact with children's food or placed into the children's mouths (see BPA report, **Table 1**). However, in many countries compliance with the legislation is only sporadically monitored. On top of that, the restriction of BPA has led to its replacement with other bisphenols just as harmful, or potentially worse, although not yet regulated. Those so-called regrettable substitutes of BPA include bisphenol-F and -S, as well as bisphenol-E and -B, which exhibit similar endocrine-disrupting properties and health impacts as BPA[116].

STUDIES ON ANIMALS AS WELL AS EPIDEMIOLOGICAL STUDIES ON HUMAN HEALTH EFFECTS SHOW THAT BPA CAN AFFECT BRAIN DEVELOPMENT LEADING E.G. TO BEHAVIOURAL IMPACTS IN CHILDREN. EXPOSURE CAN ALSO INCREASE ANXIETY, DEPRESSION, HYPERACTIVITY, AND INATTENTION AND NEGATIVELY AFFECT REPRODUCTIVE FUNCTIONS.

In China, BPA is restricted from polycarbonate baby feeding bottles and other infant feeding bottles since 2011. According to GB 9685-2016 "National Food Safety Standard for the Use of Additives for Food Contact Materials and Products", when bisphenol A is used as an additive in adhesives and paint coatings, its specific migration limit (SML) is 0.6 mg/kg, and when bisphenol S is used as an additive in paint coatings, its SML is 0.05 mg/kg.

In Indonesia, the allowable concentration of BPA in food contact materials should not be higher than 600 µg/kg.

In Russia, the use of BPA in baby bottles is unregulated.

116 Vandenberg, L.N., et al., Plastic bodies in a plastic world: multi-disciplinary approaches to study endocrine disrupting chemicals. Journal of Cleaner Production, 2017. 140: p. 373-385.

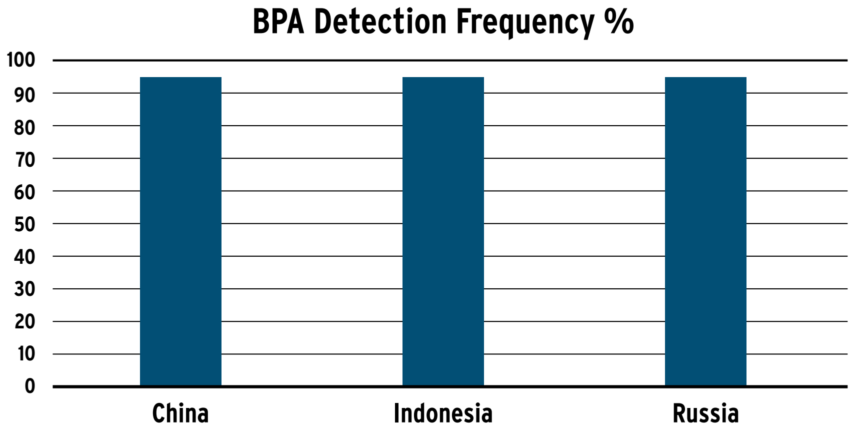

Figure 18: Proportion (%) of BPA-containing samples per country

The study, which included also other countries, covered a total of 92 samples of hard and transparent plastic bottles and cups that were collected during October-November 2020 from China, Indonesia and Russia. For budgetary reasons, a subset of 50 samples was collected for lab analyses.

Samples from China, Indonesia, and Russia (Group 1) were shipped in their original packaging for lab analysis to the University of Chemistry and Technology Prague. Inner separable parts (i.e., straws) and lids of the bottles were removed from the samples as they were expected not to be made from polycarbonate. The samples were filled up with demineralized water up to 90 % of the bottle volume. Inert glass was used to cover the bottles during the analysis. BPA was extracted for 30 minutes in a demineralized boiling water bath (> 90°C) under static conditions (mixing by magnetic stirrer). The extraction from one Indonesian sample (IND-BPA-17) was conducted at ambient laboratory temperature (×23 °C) as this sample was sensitive to deformation at high temperature. The extracts were analysed using flow-injection analysis electrospray ionization high resolution mass spectrometry (FIA-ESI-HRMS) without additional reagents. The analytical results were obtained in ng/L with 5 ng/L Limit of Quantification (LOQ). The ng/L unit expresses the amount of extracted BPA into the boiling water.

Results overview and basic statistics of samples collected in China, Indonesia and Russia (Group 1) are provided in Table 14.

TABLE 14

Country	Samples number (#)	BPA >LOQ (#)	BPA >LOQ (%)	Min (ng/L)	Max (ng/L)	Average (ng/L)	Median (ng/L)
China	20	19	95	19	50 292	5 046	1 055
Indonesia	15	13	87	33	16 521	2 810	820
Russia	15	13	87	32	2 376	412	181

6.1.2 Main findings

- 90% (45/50) of all the samples contained BPA above the Limit of Quantification (LOQ). The samples included different baby feeding bottles and other items in contact with food or children's mouth marked to be made of polycarbonate, polypropylene, a combination of the two materials, or silicone. The proportion (%) of BPA-containing samples per country is provided in the Graph 1 below.
- 8 out of 11 (73 %) "BPA-free" or "0% BPA" labelled products were found to be mislabelled, because they did contain BPA.
- All analysed samples containing BPA above the LOQ are at this point legal since they either do not exceed the threshold concentrations set by the legislation, or do not fall into a product category covered by national/regional legislations, or no legislation concerning BPA exists in that country/region.
- In the first groups of analysed samples, where the extractable BPA content in the plastic itself was measured, the highest BPA concentration was found in a sample from China (50 292 ng/L).

6.1.3 Discussion

Of the 50 tested samples, 45 contained BPA above the level of quantification. Our analysis shows that BPA is present in the products and that it can leach out of them. Consumers are exposed to BPA from food contact materials in addition to other exposure routes, resulting in 90-99% of individuals having BPA in their bodies[117]. Children are particularly sensitive to BPA as their metabolic system is under development. These findings illustrate an urgent need for stronger, global controls on the use of BPA since BPA is a known endocrine disruptor with several negative effects on human health.

117 Vanderberg. loc cit.

Other studies from countries with enforced BPA regulations (Spain, Italy) showed that BPA migration levels were below the allowed regulatory limits (as of 2010, 2011, and 2013)[118,119,120]. Those studies illustrate that regulations are an effective tool to protect people from exposure to BPA and other harmful chemicals. On the other hand, if the threshold amounts are high or the items are distinctively defined by the national legislation, products with BPA continue to flood the markets. Such a situation is illustrated in Indonesia and China, countries with BPA restriction in baby bottles. None of the samples from Indonesia exceeds the, far too high, threshold set by the Food Packaging Regulation and none of the samples from China designed for children (i.e., holding nipple or with child-friendly pictures) is out of the scope of the legislation of the Chinese Ministry of Health as the manufacturer claims the item is meant for older children and adults.

6.1.4 Conclusions and Recommendations

Consumers including children in China, Indonesia, and Russia are likely exposed to the endocrine-disrupting chemical Bisphenol A (BPA) from many widely used products. Consumers in Indonesia are deceived by misleading "BPA free" or "0 % BPA" labelling of baby products. It is important to view these results in relation to the scientific research that has shown that BPA can impact brain development and increase anxiety, depression, hyperactivity, and inattention. It is also crucial to note that concerns have been raised about other bisphenols (mainly BPS and BPF) and that only regulating the use of BPA runs the risk of steering the manufacturers towards those regrettable substitutions instead. Therefore, the governments of China, Indonesia, and Russia should take immediate steps to restrict manufacture, sale, and distribution of BPA and other bisphenols used as replacements (BBB, BPS and BPF) in all products intended for children as well as food contact materials. Where existing regulations exist, control mechanisms for monitoring compliance should be established and existing legislation enforced. Governments should take the following steps to protect consumers' and children's health:

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118 Maiolini, E., et al., Bisphenol A determination in baby bottles by chemiluminescence enzyme-linked immunosorbent assay, lateral flow immunoassay and liquid chromatography tandem mass spectrometry. Analyst, 2014. 139(1): p. 318-324.

119 Maiolini, E., et al., Bisphenol A determination in baby bottles by chemiluminescence enzyme-linked immunosorbent assay, lateral flow immunoassay and liquid chromatography tandem mass spectrometry. Analyst, 2014. 139(1): p. 318-324.

120 Santillana, M.-I., et al., Migration of bisphenol A from polycarbonate baby bottles purchased in the Spanish market by liquid chromatography and fluorescence detection. Food Additives & Contaminants: Part A, 2011. 28(11): p. 1610-1618.

1. To immediately ban the use of BPA and bisphenol-based materials (i.e., polycarbonate plastics, bisphenol-containing polypropylene, or bisphenol-containing silicone) in baby bottles.
2. To rapidly ban the use of BPA and bisphenol-based materials in all children's products and all food contact materials.
3. To establish a control mechanism for monitoring compliance of products on the market to established legislation.
4. To establish legally binding rules for "BPA free" labelling of consumer products.
5. To support substitution of BPA and bisphenol-based materials with safe, already existing alternatives[121] to rapidly transition towards non-toxic, recyclable materials.
6. To require separation of bisphenol-based materials from the waste stream to avoid circulation of bisphenols into new products.

121 Bisphenol substituion, document depository. Available from: https://substitution-bp.ineris.fr/en/documents

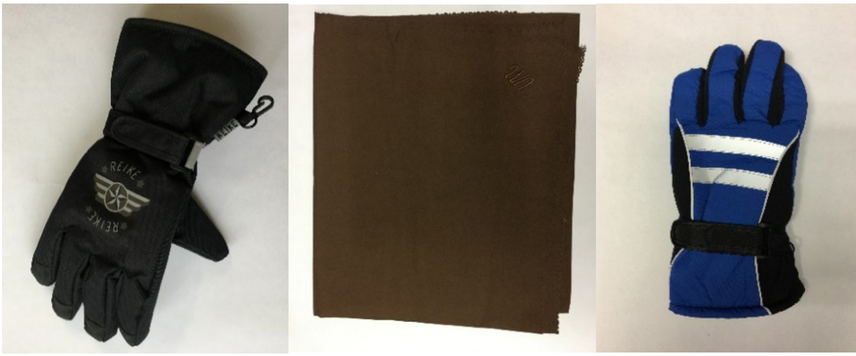

Figure 19. (left to right) **Glove sample from Russia; Hijab sample from Indonesia; Glove sample from China.**

6.2 PFAS IN CLOTHING AND ACCESSORIES

PFAS (per- and polyfluoroalkyl substances) are a large group of more than 4,700 synthetic organic substances[122] used ubiquitously in consumer- and professional products. They are used to make products water-, grease- and stain-resistant and are commonly found in waterproof rain gear and food packaging, as well as in non-stick cookware and firefighting foams. However, most of the PFAS uses are not essential for the functioning of society and/or have safer alternatives that could be used instead[123]. Humans are also continuously exposed to PFAS. Diet and drinking water have been established as the main exposure routes to PFAS; however, exposures from dust, indoor environments, and personal care and consumer products are also important[124]. PFAS have been shown to be associated with a range of negative health impacts, including negative impacts on fertility, foetal development[125], and thyroid hormone function[126,127].

Given that 1) PFAS are continuously emitted to the environment where they persist to a level that has earned them the epitome of 'forever chemicals', 2) biomonitoring studies regularly detect PFAS in humans and 3) PFAS have been associated with a wide range of negative environmental

122 OECD, *Toward a new comprehensive global database of per- and polyfluoroalkyl substances (PFASs): Summary report on updating the OECD 2007 list of per- and polyfluoroalkyl substances (PFASs).* 2018, Environment Directorate.

123 Cousins, I.T., *et al.*, *The concept of essential use for determining when uses of PFASs can be phased out.* Environmental Science: Processes & Impacts, 2019. 21(11): p. 1803-1815.

124 De Silva, A.O., *et al.*, *PFAS Exposure Pathways for Humans and Wildlife: A Synthesis of Current Knowledge and Key Gaps in Understanding.* Environ Toxicol Chem, 2021. 40(3): p. 631-657.

125 Szilagyi, J.T., *et al.*, *Perfluoroalkyl Substances (PFAS) and Their Effects on the Placenta, Pregnancy, and Child Development: a Potential Mechanistic Role for Placental Peroxisome Proliferator-Activated Receptors (PPARs).* Curr Environ Health Rep, 2020. 7(3): p. 222-230.

126 Kim, M.J., *et al.*, *Association between perfluoroalkyl substances exposure and thyroid function in adults: A meta-analysis.* PLoS One, 2018. 13(5): p. e0197244.

127 Caron-Beaudoin, E., *et al.*, *Exposure to perfluoroalkyl substances (PFAS) and associations with thyroid parameters in First Nation children and youth from Quebec.* Environ Int, 2019. 128: p. 13-23.

and health effects, their wide usage creates a challenge in relation to the circular economy. When PFAS-treated products are recycled, PFAS can spread uncontrollably and contaminate new products, extending the toxic legacy of these chemicals and undermining the ability to transition to a clean circular economy.

The use of PFAS in the textile sector accounts for about 50% of the total global use of PFAS[128]. The usage of PFAS in textile and outdoor wear both increases environmental pollution and human exposure as PFAS are emitted to the environment at every stage of the textile product (i.e., during production, use and final disposal). During the production phase, textile factories pollute the surrounding environment through air and wastewater emissions[129] and expose workers to PFAS[130]. PFAS are volatilized, weathered and washed out from the textile products during their use[131]. When PFAS-treated articles are disposed of at their end of life, PFAS migrate from the waste into the landfill leachates[132,133], are emitted with incineration fumes and ashes[134,135], or are recycled into new products[136,137].

6.2.1 Regulatory framework

Two members of the PFAS group have been especially widely used: perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA), both consisting of a chain of eight perfluorinated carbon atoms (C8) and two carbon atoms without fluorine. The Stockholm Convention added PFOS to its global restriction list in 2009 and PFOA to its list for global elimination in 2019.

128 Lassen, C., *et al.*, *Polyfluoroalkyl substances (PFASs) in textiles for children. Survey of chemical substances in consumer products. The Danish Environmental Protection Agency*. 2015, Report. p. 83.
129 Heydebreck, F., *et al.*, *Emissions of Per- and Polyfluoroalkyl Substances in a Textile Manufacturing Plant in China and Their Relevance for Workers' Exposure.* Environ Sci Technol, 2016. 50(19): p. 10386-10396.
130 Lu, C., *et al.*, *Perfluorinated compounds in blood of textile workers and barbers.* Chinese Chemical Letters, 2014. 25(8): p. 1145-1148.
131 van der Veen, I., *et al.*, *The effect of weathering on per- and polyfluoroalkyl substances (PFASs) from durable water repellent (DWR) clothing.* Chemosphere, 2020. 249: p. 126100.
132 Masoner, J.R., *et al.*, *Landfill leachate contributes per-/poly-fluoroalkyl substances (PFAS) and pharmaceuticals to municipal wastewater.* Environmental Science: Water Research & Technology, 2020. 6(5): p. 1300-1311.
133 Solo-Gabriele, H.M., *et al.*, *Waste type, incineration, and aeration are associated with per-and polyfluoroalkyl levels in landfill leachates.* Waste Management, 2020. 107: p. 191-200.
134 Ibid.
135 Stoiber, T., *et al.*, *Disposal of products and materials containing per-and polyfluoroalkyl substances (PFAS): A cyclical problem.* Chemosphere, 2020. 260: p. 127659.
136 OECD, *PFASs and Alternatives in Food Packaging (Paper and Paperboard) Report on the Commercial Availability and Current Uses, in OECD Series on Risk Management*. 2020, Environment,Health and Safety,Environment Directorate. p. 67.
137 Curtzwiler, G.W., *et al.*, *Significance of Perfluoroalkyl Substances (PFAS) in Food Packaging.* Integrated Environmental Assessment and Management, 2021. 17(1): p. 7-12.

The PFOS listing entered into force in Indonesia and China in 2010 and 2014, respectively. PFOS in China is allowed to be used for 7 acceptable purposes until now. The PFOA listing entered into force for most countries, including Indonesia, on 3 December 2020. It has not yet been implemented in China. Neither of the two listings have been approved in Russia.

The Stockholm Convention allowed a five-year exemption for PFOA use in textiles, but only for, *"the protection of workers from dangerous liquids that comprise risks to their health and safety."* In the EU, the global restrictions on PFOS and PFOA were implemented along the provision limiting the use of PFOA and PFOS at 1 microgram per square meter (μg/m^2) on textiles and other coated products [53]. Outside the provisions of the Stockholm Convention, Indonesia and Russia have not adopted any additional regulatory control over PFAS. In China, PFOS, its salts and PFOSF (perfluorooctanesulfonyl fluoride) were listed on the List of Priority Control Chemicals in 2017 and is on the List of Strictly Restricted Toxic and Hazardous Chemicals. PFOA and its salts were listed on the List of Priority Control Chemicals in 2020.

IPEN's partner organizations Nexus 3 (Indonesia), EcoAccord (Russia), and Toxics-Free Corps (China) purchased synthetic winter gloves or other outdoor wear for adults and children expected to be water resistant. In total, 41 items of synthetic textile products were collected during October-November 2020 in China (18 items of winter gloves), Russia (15 items of winter gloves), and Indonesia (2 items of sport gloves and 6 additional samples of outdoor wear). All items were bought in popular clothing stores or e-shops.

For budgetary reasons, 25 out of the 41 collected items were selected for laboratory analysis. The selection covered different countries and different types of products. A summary of the lab-analysed items is given in Table 15.

6.2.2 Results

At least one of the 55 targeted PFAS was detected in 84% (21/25 samples) of the analysed outdoor- and sportswear products. PFAS presence was confirmed in all samples of winter gloves from China, in all samples of sport gloves and outdoor wear (hijab, trouser, t-shirt) from Indonesia, in all samples of adult winter gloves from Russia and in 57% (4/7) of the children winter gloves from Russia. The most abundant PFAS was 8:2 FTOH, found in 84% of all synthetic textile samples.

6.2.3 Discussion

Fluorotelomer alcohols (FTOHs) and polyfluoroalkyl phospfate diesteres (diPAPs) in synthetic outdoor- and sportswear – sources of consumer concerns

8:2 FTOH was quantified in 21 out of 25 samples (84 %) of the analysed outdoor- and sportswear. Fluorotelomer alcohols are starting chemicals and intermediate degradation by-products in production of the majority of commercial PFAS, including fluorotelomer-based polymers. Their presence is an indication of treatment with PFAS compounds even if the identity of the PFAS is not known.

FTOHs have been shown to be released from products similar to those investigated here[138] and there are multiple toxicological concerns regarding FTOHs themselves and their degradation products. Both are associated with hepatotoxicity, mammary gland cancer, negative impacts on the reproductive system, and with developmental disorders[139]. The results in this study are therefore particularly concerning regarding the children's winter gloves from Russia, since children can be exposed to FTOHs in the gloves to a greater extent than adults, due to more hand-to-mouth contact [58].

6.2.5 Nature of the PFAS treatment – potential contradiction to the Stockholm Convention intention

Our findings of the fluorotelomer alcohol 8:2 FTOH suggest that the water repellence of the tested outdoor textiles from China, Indonesia, and Russia was achieved by the application of side-chain fluorotelomer-based polymers (FTPs), consisting of a non-fluorinated backbone with C8 polyfluoroalkyl side chains[140]. FTPs are responsible for the 8:2 FTOH presence in the analysed samples. 8:2 FTOH can further degrade into PFOA. The use of FTPs therefore undermines the intention of the Stockholm Convention to globally stop emissions of PFOA, its salts and PFOA-related compounds via measures to eliminate the production and use of the chemicals under the scope as it results in environmental exposure to PFOA.

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138 Knepper, T., *et al.*, *Understanding the exposure pathways of per-and polyfluoralkyl substances (PFASs) via use of PFASs-containing products–risk estimation for man and environment.* Environmental Protection Agency of Germany (UBA) TEXTE, 2014. 47(2014): p. 1-139.

139 Huang, M., *et al.*, *Toxicokinetics of 8: 2 fluorotelomer alcohol (8: 2-FTOH) in male and female Hsd: Sprague Dawley SD rats after intravenous and gavage administration.* Toxicology reports, 2019. 6: p. 924-932.

140 Buck, R.C., *et al.*, *Perfluoroalkyl and polyfluoroalkyl substances in the environment: terminology, classification, and origins.* Integrated environmental assessment and management, 2011. 7(4): p. 513-541.

6.2.6 PFAS in synthetic outdoor- and sportswear: a barrier to a non-toxic circular economy

Since only a fraction of the post-consumer synthetic outdoor and sportswear is recycled, the type of garments investigated here would mostly end up in landfills or be incinerated[141]. However, there is an increasing demand for recycled textiles overall due to the increased pressure to move towards a more circular economy. When polyester materials are mechanically recycled, the end-of-life products will likely be down-cycled (i.e., converted into products of lower value such as filler materials for furniture and insulation)[142] and contribute to the contamination of the recycling chain with PFAS[143]. As a consequence, their presence in consumer products would be difficult to trace, thus legacy PFAS may find their way into products despite their restricted use. The presence of PFAS[144] in the post-consumer textile waste stocks constitutes a barrier to the recyclability of such products, especially since it is difficult to remove PFAS from the fibres once it has been added[145]. Therefore, recycling PFAS-treated textiles would lead to uncontrolled exposure to these forever chemicals, without any possibility of tracing their presence in other consumer products made of recycled materials.

BASED ON THE FINDINGS AND CONCLUSIONS OF THIS SURVEY, WE CALL ON:

National Governments:

- To enter the PFOS and PFOA listing of the Stockholm Convention into force nationally.
- To implement bans on PFOS and PFOA in national regulations.
- To support the development of a broad and protective restriction on PFAS and thereafter to fully implement it.

Parties to the Stockholm Convention:

- To ratify the amendments' listings of PFOS and PFOA and to support the removal of all exemptions and acceptable purposes.

141 *Plastic in textiles: towards a circular economy for synthetic textiles in Europe*. 2021, European Environment Agency.
142 Le, K., *Textile Recycling Technologies, Colouring and Finishing Methods.* Prepared for Karen Storry, Senior Project Engineer, Solid Waste Services, Metro Vancouver, 2018.
143 Herzke, D., *et al.*, *Perfluoroalkyl and polyfluoroalkyl substances (PFASs) in consumer products in Norway–A pilot study.* Chemosphere, 2012. 88(8): p. 980-987.
144 Östlund, Å., *et al.*, *Textilåtervinning: Tekniska möjligheter och utmaningar*. 2015: Naturvårdsverket.
145 Le, loc. cit.

- To implement bans on PFOS and PFOA in national regulations.
- To support the listing of PFHxS for global elimination without exemptions.
- To work for a class-based approach of listing all PFAS for global elimination under the Stockholm Convention.

Parties to the Basel Convention:

- To define all PFAS-contaminated waste as hazardous waste based on their H11 (delayed or chronic toxicity) characteristics.
- To ratify the Basel Ban amendment, ensuring no export and import of PFAS-contaminated waste to non-OECD countries.
- To acknowledge that polymeric fluorotelomer-based products (i.e., side-chain fluorinated polymers) as well as PFAS-contaminated products are non-recyclable, and hence non-circular, in the technical guidelines on the identification and environmentally sound management (ESM) of plastic wastes and for their disposal.
- To work for a class-based approach when determining maximum limits for PFAS content in waste (the so-called "low POPs content" levels).

SAICM stakeholders:

- To significantly increase efforts towards transitioning to safe, non-PFAS alternatives, including establishing ambitious deadlines for phasing out PFAS as a class for all uses not essential for the functioning of society. To significantly increase availability of information to support this effort, including analytical methods, hazard data for PFAS, and information about non-PFAS alternatives.
- To work towards full transparency of PFAS content in products and support consumers' right to know and be able to choose PFAS-free products. Sufficient information on PFAS in products, waste streams, and recycled materials will improve monitoring of compliance of recycled materials and articles produced within existing legislation.

6.3 TOXIC FLAME RETARDANTS IN PRODUCTS

6.3.1 Background

Brominated flame retardants (BFRs) are man-made chemicals that are regularly added to consumer products to reduce fire-related injury and damage. The massive production and use of BFRs was initiated as a response to frequent fires started by cigarettes in the 1970s. This solution focused on chemical fire retardants, rather than measures to increase fire safety of cigarettes[146,147] and led to the development of related fire safety standards focused on chemical fire retardance[148]. Since the 1970s, brominated flame retardants have been used in consumer products such as electronics, furniture and car upholstery, matrasses, household textiles and building insulation[149,150,151].

6.3.2 The problem with BFRs

BFRs include several different types of chemicals, such as polybrominated diphenyl ethers (PBDEs), hexabromocyclododecanes (HBCDs), and tetrabromobisphenol A (TBBPA), each with their set of hazardous properties. They have typically been used in acrylonitrile butadiene (ABS) plastics, polyurethane (PU) foams and polystyrene (PS) plastics, which are used to make electronic casings, household textiles, furniture upholstering and building insulation. BFRs are known to be released from the products they are used in[152,153]. Moreover, other harmful brominated substances such as brominated dioxins (PBDD/Fs) occur as unintentional by-products of BFR application in the products[154].

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146 Callahan, P.R.S., *Playing with fire A deceptive campaign by industry brought toxic flame retardants into our homes and into our bodies. And the chemicals don't even work as promised.* 2002.

147 D'silva, K., et al., *Brominated organic micropollutants—igniting the flame retardant issue.* Critical Reviews in Environmental Science and Technology, 2004. **34**(2): p. 141-207.

148 Guerra, P., et al., *Introduction to brominated flame retardants: Commercially products, applications, and physicochemical properties*, in *Brominated flame retardants*. 2010, Springer. p. 1-17.

149 UNEP POPRC (2007); *Risk profile on commercial octaBDE (UNEP/POPS/POPRC.3/20/Add.6).*

150 UNEP POPRC (2010); *Risk profile on Hexabromocyclododecane (UNEP/POPS/POPRC.6/13/Add.2).*

151 POP RC (2006). *Risk profile on commercial pentabromodiphenyl ether, UNEP/POPS/POPRC.2/17/Add.1, Stockholm Convention POPs Review Committee.*

152 Rauert, C., et al., *Mass transfer of PBDEs from plastic TV casing to indoor dust via three migration pathways--A test chamber investigation.* Sci Total Environ, 2015. **536**: p. 568-574.

153 Liu, X., et al., *Estimation of human exposure to halogenated flame retardants through dermal adsorption by skin wipe.* Chemosphere, 2017. **168**: p. 272-278.

154 Petrlik, J., Brabcova, K., *Toxic Soup Flooding Through Consumer Products: Brominated dioxins recycled together with flame retardants into toys and other consumer products -now a widespread problem*, in *14th meeting of the Conference of the Parties to the Basel Convention Geneva, 29 April - 10 May 2019*. 2019, Arnika, IPEN: Geneva. p. 4.

Worldwide, TBBA is the flame retardant produced in the largest volumes. TBBA is a known endocrine-disrupting chemical[155,156]. PBDEs and HBCD are persistent organic pollutants ("POP-BFRs"), known to disrupt human endocrine, immune, and reproductive systems. They negatively affect the development of the nervous system and can negatively impact the IQ of children[157,158,159,160]. Humans are exposed to PBDEs through several routes including through food, dust ingestion, and through dermal exposure[161]. PBDEs and HBCD have been found in the Arctic region and oceans since they decompose very slowly under natural conditions and are able to travel far from their place of origin through water and air currents[162].

Since regulatory measures for PBDEs and HBCD have increased, novel BFRs (nBFRs) are increasingly used as substitutes. Studies on the nBFRs have, however, shown that they have properties like those of persistent organic pollutants (i.e., they are extremely slow to degrade, and are found in the Arctic due to their ability to travel long distances)[163,164,165]. Very little information has been made available about their hazard characteristics. Because of these properties, they can be considered regrettable substitutes of PBDE, and include BTBPE (1,2-Bis(2,4,6-tribromophenoxy) ethane) and OBIND (Octabromo-1,3,3,-trimethylphenyl-1-indan).

6.3.3 Recycling of POP-BFRs creates a toxic loophole

Despite existing international controls, many studies have shown the presence of PBDEs and HBCD in new products and household

155 Kodavanti, P.R.S., Loganathan, B.G., , *Polychlorinated biphenyls, polybrominated biphenyls, and brominated flame retardants.*, in *Biomarkers in Toxicology*, R.C. Gupta, Editor. 2019, Academic Press. p. 433-450.

156 Kitamura, S., et al., *Thyroid hormonal activity of the flame retardants tetrabromobisphenol A and tetrachlorobisphenol A.* Biochemical and Biophysical Research Communications, 2002. **293**(1): p. 554-559.

157 UNEP POPRC (2007), loc. cit.

158 UNEP POPRC (2010), loc. cit.

159 Sepúlveda, A., et al., *A review of the environmental fate and effects of hazardous substances released from electrical and electronic equipments during recycling: Examples from China and India.* Environmental Impact Assessment Review, 2010. **30**(1): p. 28-41.

160 UNEP POPRC (2007b); *Risk profile on commercial pentaBDE (UNEP/POPS/POPRC.2/17/Add.1)*

161 Liu, loc. cit.

162 Segev, O., et al., *Environmental impact of flame retardants (persistence and biodegradability).* Int J Environ Res Public Health, 2009. **6**(2): p. 478-91.

163 Gewurtz, S.B., et al., *Wastewater Treatment Lagoons: Local Pathways of Perfluoroalkyl Acids and Brominated Flame Retardants to the Arctic Environment.* Environmental Science & Technology, 2020. **54**(10): p. 6053-6062.

164 de Wit, C.A., et al., *Brominated flame retardants in the Arctic environment — trends and new candidates.* Science of The Total Environment, 2010. **408**(15): p. 2885-2918.

165 Lee, H.-J., et al., *Chapter Six - Persistence and bioaccumulation potential of alternative brominated flame retardants*, in *Comprehensive Analytical Chemistry*, J.-E. Oh, Editor. 2020, Elsevier. p. 191-214.

equipment[166,167], including children's toys[168,169,170,171,172], thermo cups, kitchen utensils[173,174,175], office utensils[176], and carpet padding[177,178]. A study by IPEN and Arnika in 2018 showed that also TBBPA and nBFRs, in addition to POP-BFRs, were present in consumer products, including children's toys, hair accessories, and kitchen utensils[179]. It is noteworthy that the analyzed products did not require fire retardance but still contained BFRs. The studies concluded that toxic flame retardant chemicals were not intentionally added to the specific consumer products purchased in more than 30 countries in Europe, Asia, Africa, Latin and North America, but were passed on during the recycling of e-waste plastics into new products. This practice contradicts the PentaBDE and OctaBDE listing in Annex A of the Stockholm for global elimination[180]. When these substances were listed in 2009, governments agreed to an exemption until 2030 that permits recycling of materials such as foam and plastics that contain these substances. Such practice creates a toxic recycling loophole in the global controls and compromises the circular plastics economy.

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166 Turner, A., et al., *Bromine in plastic consumer products - Evidence for the widespread recycling of electronic waste.* Sci Total Environ, 2017. **601-602**: p. 374-379.

167 Li, Y., et al., *Occurrence, levels and profiles of brominated flame retardants in daily-use consumer products on the Chinese market.* Environmental Science: Processes & Impacts, 2019. **21**(3): p. 446-455.

168 Li, loc. cit.

169 Chen, S.-J., et al., *Brominated flame retardants in children's toys: concentration, composition, and children's exposure and risk assessment.* Environmental science & technology, 2009. **43**(11): p. 4200-4206.

170 Ionas, A.C., et al., *Downsides of the recycling process: harmful organic chemicals in children's toys.* Environ Int, 2014. **65**: p. 54-62.,

171 Guzzonato, A., et al., *Evidence of bad recycling practices: BFRs in children's toys and food-contact articles.* Environ Sci Process Impacts, 2017. **19**(7): p. 956-963.

172 Fatunsin, O.T., et al., *Children's exposure to hazardous brominated flame retardants in plastic toys.* Science of The Total Environment, 2020. **720**: p. 137623.

173 Guzzonato, loc. cit.

174 Samsonek, J., et al., *Occurrence of brominated flame retardants in black thermo cups and selected kitchen utensils purchased on the European market.* Food Addit Contam Part A Chem Anal Control Expo Risk Assess, 2013. **30**(11): p. 1976-86.

175 Puype, F., et al., *Evidence of waste electrical and electronic equipment (WEEE) relevant substances in polymeric food-contact articles sold on the European market.* Food Addit Contam Part A Chem Anal Control Expo Risk Assess, 2015. **32**(3): p. 410-26.

176 Li, loc. cit.

177 DiGangi, J., et al., *A survey of PBDEs in recycled carpet padding.* Dioxin, PCBs, and Wastes Working Group, IPEN, available at http://ipen. org/sites/default/files/documents/A-survey-of-PBDEs-in-recylcled-carpet-padding. pdf, 2011.

178 Abdallah, M.A.-E., et al., *Dermal contact with furniture fabrics is a significant pathway of human exposure to brominated flame retardants.* Environment International, 2018. **118**: p. 26-33.

179 Strakova, J., et al., *Toxic LOOPHOLE: Recycling Hazardous Waste into New Products*. 2018, Arnika IPEN, HEAL, Sweden.

180 Commercial octabromodiphenyl ether (OctaBDE) is listed in the Stockholm Convention as hexabromodiphenyl ether and heptabromodiphenyl ether. Decabromodiphenyl ether (DecaBDE) is listed as the commercial mixture of DecaBDE. HBCD is Hexabromocyclododecane. Listing of POPs in the Stockholm Convention. Available at: http://chm.pops.int/TheConvention/ThePOPs/ListingofPOPs/tabid/2509/Default.aspx.

6.3.4 Regulatory frameworks in China, Indonesia, and Russia

Russia has not yet ratified any of the POP-BFR amendments to the Stockholm Convention, paving the way for continued imports of these substances. Despite relevant amendments being ratified and monitoring projects realized in Indonesia, any ban or restriction related to POP-BFRs has not been implemented into Indonesian legislation. In China, a ban on production, distribution, use, import, and export of penta- and octaBDE was implemented and a ban on HBCD is expected to follow at the end of 2021. HBCD and decaBDE were included into the List of Chemicals Prioritized for Control. HBCD is listed into the Catalog of Toxic Chemicals Strictly Restricted from Import and Export in China and penta- and octaBDE have been included into the Catalog of Products Prohibited from Export and the Catalog of Products Prohibited from Import. In addition to that, China has set a series of standards that tend to control POP-BFRs content in selected products.

6.3.5 Aim of the study

This study aimed to determine whether children's toys, hair accessories, office supplies and kitchen utensils sold on the Chinese, Indonesian, and Russian markets contained BFRs. This would indicate use of recycled, flame-retardant-containing plastics, like what has been seen in previous studies.

All three countries are facing waste management challenges at both the local and national levels. One of many reasons for this is plastic waste imports with unknown chemical content. The data collected in this study will therefore generate information that can contribute to the setting of appropriate standards and to improve the control over circulation of harmful BFRs in plastic consumer products and waste.

6.3.6 Materials and methods

Throughout October-December 2020, 455 samples of consumer products made of black plastics were purchased at markets and stores in China, Indonesia, and Russia. Black plastic items were selected since electronic casings are typically black, generating black plastics when recycled. Products that are not required to meet any fire standards were deliberately chosen, so that it could be assumed that any BFRs present were not added to the product but rather followed as a consequence of recycling of plastics containing BFRs. Children's toys, hair accessories, kitchen utensils, and office supplies were of primary interest, because they are used by children and women in reproductive age, who are especially sensitive to BFR exposures[181,182,183]. Toys are often in contact with children's mouths, kitchen utensils are in contact with food, and hair accessories and office supplies are in contact with the skin of women in reproductive age (see Figure 20 for photographs of examples of the analyzed products). One item constituted one sample.

X-ray fluorescence, a technique frequently used to determine PBDEs in plastics[184,185], was used to do a preliminary screening of the plastics using a handheld NITON XL 3t 800 XRF analyser (using the plastic consumer goods program). Samples that contained 213 ppm or more of bromine and 64 ppm or more of antimony were chosen for further analysis. This screening criteria was applied since bromine is a key component of BFRs and antimony trioxide is a common BFR synergist[186]. Samples were also chosen to cover different countries and sample categories (toys, office supplies, hair accessories, kitchen utensils, and other items). Out of the 455 samples, 73 was selected for lab analysis: 30 samples from Russia, 20 samples from China and 23 samples from Indonesia (Table 16).

TABLE 16: LAB-ANALYSED SAMPLES PER COUNTRY AND SAMPLE CATEGORY

	Children toys	Office supplies	Hair acces-sories	Kitchen utensils	Other items	Samples per country
China	5	2	6	2	5	20
Indonesia	10	4	2	1	6	23
Russia	24	0	2	3	1	30
Total number per sample category	39	6	10	6	12	73

181 Ionas, loc. cit.
182 Oulhote, Y., et al., *Exposure to polybrominated diphenyl ethers (PBDEs) and hypothyroidism in Canadian women.* The Journal of Clinical Endocrinology & Metabolism, 2016. **101**(2): p. 590-598.
183 Bannan, D., et al., *Brominated Flame Retardants in Children's Room: Concentration, Composition, and Health Risk Assessment.* International Journal of Environmental Research and Public Health, 2021. **18**(12): p. 6421.
184 Gallen, C., et al., *Towards development of a rapid and effective non-destructive testing strategy to identify brominated flame retardants in the plastics of consumer products.* Sci Total Environ, 2014. **491-492**: p. 255-65.
185 Petreas, M., et al., *Rapid methodology to screen flame retardants in upholstered furniture for compliance with new California labeling law (SB 1019).* Chemosphere, 2016. **152**: p. 353-9.
186 Schlummer, M., et al., *Characterisation of polymer fractions from waste electrical and electronic equipment (WEEE) and implications for waste management.* Chemosphere, 2007. **67**(9): p. 1866-76.

The samples were analyzed for the presence of 16 different PBDE congeners,[187] based on the components of different commercial BFR mixtures. These included the congeners in the commercial pentaBDE mixture (BDE 28, 47, 49, 66, 85, 99, 100), the octaBDE mixture (BDE 153, 154, 183, 196, 197, 203,206, 207), and the commercial decaBDE mixture (BDE 209). The presence of three isomers[188] of HBCD (α-, β-, γ-HBCD) and TBBPA was analyzed. Also, the presence of six nBFRs: (1,2-bis(2,4,6-tribromophenoxy) ethane (BTBPE), decabromodiphenyl ethane (DBDPE), hexabromobenzene (HBB), octabromo-1,3,3-trimethylpheny-1-indan (OBIND), 2,3,4,5,6-pentabromoethylbenzene (PBEB), and pentabromotoluene (PBT). All analyses were performed by the laboratory at the University of Chemistry and Technology Prague, the Czech Republic.

6.3.7 Results and discussion

Laboratory analysis of the 73 samples revealed that all analyzed samples contained POP-BFRs (see Annex 2 for detailed results). All samples contained octaBDE at concentrations ranging from 0.008 to 261.7 ppm and 72 samples contained decaBDE at concentrations ranging from 0.088 to 442.6 ppm. HBCD and pentaBDE were only detected at very low concentrations, which is expected since these flame retardants are primarily used in polystyrene insulation and foam products and not electronic casings. None of the samples were required to meet any fire safety standards. In addition, the measured levels of BFRs do not provide a fire-retardant function. Therefore, it is likely that the BFR content comes from recycled e-waste plastics. Summary of the POP-BFRs results per country are provided in Table 2.

The composition of BFRs differ between individual samples, without any specific composition or concentration patterns (see Table 3). This suggests that materials from heterogeneous sources have been used to produce the recycled plastics that have likely been used to make these products.

This study shows that consumer products containing POP-BFRs, likely made from recycled plastics, are available on the market in China, Indonesia, and Russia. None of these countries have regulations limiting BFR content in products or waste. However, entry of BFR-containing products on the markets should be prohibited.

All three countries are both producers and potential recipients of e-waste containing POP-BFRs. To stop imports of waste with POP-BFRs, strict

187 Congeners are chemical substances related to each other by origin, structure, and function
188 Isomers are compounds with the same formula but a different arrangement of the atoms in the molecule.

limits for POPs content in waste[189] need to be established. The 2017 Conference of Parties to the Basel and Stockholm Conventions suggested using either a 50 ppm or 1,000 ppm limit for POPs waste containing PBDEs[190] (the so-called "low POPs content" level). With the weaker limit of 1,000 ppm, all wastes containing less than 1,000 ppm of PBDEs will be considered "clean" and allowed for export for recycling or disposal. This weak "low POPs content" level raises concerns since PBDEs are very similar in structure and toxicological profiles to the highly toxic polychlorinated biphenyls (PCBs)[191,192]. The POPs content level for PCBs in waste under the Conventions is 50 ppm and it would therefore be consistent for PBDEs also have a 50 ppm limit[193]. Of the analyzed products in this study, 62 out of 73 (85 %) would be categorized as POPs waste using a 50ppm limit. Moreover, a weak "low POPs content" level above 50 ppm would lead to decreasing demand for superior waste disposal technologies with the ability to fully destroy BFRs in the waste while not emitting any unintentionally produced POPs (U-POPs). Truly environmentally sound BFR destruction technologies exclude incineration processes. Although Russia and China have the technical capability and pilot plants, they have not yet invested sufficiently to establish commercial non-combustion plants for POP destruction.

Recommendations for Parties to the Basel and Stockholm Conventions and for National Governments:

- **Apply a class-based approach for restricting all brominated flame retardants**

  To achieve a non-toxic circular economy, it is crucial to apply a class-based approach that prevents use of regrettable substitutes to POP-BFRs that are potentially just as harmful, although not yet regulated. A class-based approach to phase out all BFRs is the only adequate

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189 The Stockholm Convention requires that POPs wastes be treated so that POP content is destroyed or irreversibly transformed to that they no longer exhibit POPs characteristics. The Convention sets low POPs content limits (LPCL) above which treatment is required. POPs waste is prohibited to be recycled and cannot be transported across the international borders of the countries – see Article 6 of the Stockholm Convention.

190 Revised draft general technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants (General technical guidelines), version of March 2018 available at: http://www.basel.int/Implementation/POPsWastes/TechnicalGuidelines/TechnicalGuidelines(versionMarch2018)/tabid/6303/Default.aspx

191 Walter, K.M., et al., *Association of polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) with hyperthyroidism in domestic felines, sentinels for thyroid hormone disruption.* BMC veterinary research, 2017. **13**(1): p. 1-12.

192 Manchester-Neesvig, J.B., et al., *Comparison of polybrominated diphenyl ethers (PBDEs) and polychlorinated biphenyls (PCBs) in Lake Michigan salmonids.* Environmental science & technology, 2001. **35**(6): p. 1072-1077.

193 *Basel Convention (2017). General technical guidelines for the environmentally sound management of wastes consisting of, containing or contaminated with persistent organic pollutants. Technical Guidelines. Geneva.*

response to prevent further harm to human health and the environment.

- **Set environment and health protective limits for POPs wastes under the Basel Convention**

  Parties to the Stockholm and Basel Conventions should adopt the scientifically and environmentally sound limits of 50 ppm for PBDEs and 100 ppm for HBCD in waste. Only a strict "low POPs content" level will ensure separation of PBDE- and HBCD-treated products from the recycling stream when they become waste. Waste containing these substances in concentrations over the "low POPs content" level must be managed in an environmentally sound manner in line with the Conventions, i.e., POPs in waste must be destroyed or irreversibly transformed. This hazardous waste should not be allowed for export to countries that lack appropriate, truly environmentally sound, POPs destruction technologies.

- **Establish appropriate separation techniques for POP-BFRs**

  Until products are produced without these toxic substances, separation techniques should be used to remove items containing PBDEs and other toxic substances before recycling. In the informal plastic recycling sector in India, a simple sink and float method is used for separation of BFR-treated plastics[194]. In Europe, X-ray fluorescence (XRF) and X-ray transmission (XRT), are used to measure total bromine concentrations, and are operated on an industrial scale[195]. Such methods can be used globally, including controls of imported waste at the state borders.

194 UNEP (2017). *Guidance on BAT and BEP for the recycling and disposal of wastes containing PBDEs.*
195 Ibid.

- **Stop e-waste exports to developing and transition countries under Basel Convention provisions**

  E-waste must be clearly defined as hazardous, which will trigger export prohibitions from OECD to non-OECD countries under the Basel Convention Ban Amendment. In addition, The Basel Convention e-waste guidelines must be modified to prevent the export of e-waste to any country that lacks regulatory infrastructure and technical and economic capacities for hazardous waste management.

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