

# Marine plastic pollution and extended producer responsibility in the G20

---

SEI report  
August 2025

Julia Jokiaho  
Shogofa Rezaie  
Fedra Vanhuyse



---

**Published by**

Stockholm Environment Institute  
Linnégatan 87D 115 23 Stockholm, Sweden  
Tel: +46 8 30 80 44  
[www.sei.org](http://www.sei.org)

**Author contact**

Julia Jokiahö  
[Julia.Jokiahö@sei.org](mailto:Julia.Jokiahö@sei.org)

**Editing**

Naomi Lubick

**Layout**

Richard Clay

**Media contact**

Ulrika Lamberth  
[ulrika.lamberth@sei.org](mailto:ulrika.lamberth@sei.org)

**Cover photo**

Rubbish washed up on beach © sOulsurfing - Jason Swain / Getty

This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes, without special permission from the copyright holder(s) provided acknowledgement of the source is made. No use of this publication may be made for resale or other commercial purpose, without the written permission of the copyright holder(s).

Copyright © August 2025 Stockholm Environment Institute. This work is licensed under Creative Commons Attribution 4.0 International.

To view a copy of the licence, visit [creativecommons.org/licenses/by/4.0](https://creativecommons.org/licenses/by/4.0)

DOI: <https://doi.org/10.51414/sei2025.036>

**Acknowledgements**

This work was funded by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

**Declaration of generative AI and AI-assisted technologies in the writing process**

During the preparation of this work the authors used ChatGPT from OpenAI to improve the readability and language. After using this tool, the authors and editor reviewed and edited the content and take full responsibility for the content of the publication.

**Stockholm Environment Institute is an international non-profit research institute that tackles climate, environment and sustainable development challenges.**

**We empower partners to meet these challenges through cutting-edge research, knowledge, tools and capacity building. Through SEI's HQ and seven centres around the world, we engage with policy, practice and development action for a sustainable, prosperous future for all.**



Supported by:



Federal Ministry  
for the Environment, Nature Conservation,  
Nuclear Safety and Consumer Protection



INTERNATIONAL  
CLIMATE  
INITIATIVE



Deutsche Gesellschaft  
für Internationale  
Zusammenarbeit (GIZ) GmbH

based on a decision of  
the German Bundestag

---

# Contents

|                                                                           |           |
|---------------------------------------------------------------------------|-----------|
| <b>Summary</b>                                                            | <b>4</b>  |
| <b>1. Introduction</b>                                                    | <b>5</b>  |
| 1.1 Marine plastic pollution as a global challenge                        | 5         |
| 1.2 Reducing marine plastic pollution                                     | 6         |
| 1.3 Extended producer responsibility (EPR)                                | 7         |
| <b>2. Legislative frameworks for EPR in G20 countries</b>                 | <b>8</b>  |
| <b>3. G20 countries' initiatives specific to marine plastic pollution</b> | <b>15</b> |
| <b>4. Recommendations to improve EPR and marine plastic pollution</b>     | <b>16</b> |
| <b>5. Conclusion</b>                                                      | <b>18</b> |
| <b>References</b>                                                         | <b>19</b> |
| <b>Annex 1. Scoping review research method and process</b>                | <b>24</b> |
| Annex references                                                          | 29        |

## Summary

Marine plastic pollution is growing exponentially, presenting a major global challenge. G20 countries, responsible for a significant portion of global plastic production and consumption, are uniquely positioned to drive the transition toward more sustainable plastic management. They have an opportunity to strengthen legislative and market frameworks that address plastic across its entire life cycle, from design to disposal. While progress has been made particularly through the ongoing negotiations for the UNEA Resolution 5/14, “End Plastic Pollution: Towards an International Legally Binding Instrument”, much remains to be done to reduce marine plastic pollution.

Against this backdrop we reviewed literature and policy documents on extended producer responsibility (EPR) and other measures on its potential to reduce marine plastic litter. Our systematic mapping of 100 academic and policy sources focused on the role of EPR in G20 countries, published between 2017 and 2023, looking for recommendations on how EPR policies could be strengthened and extended to further tackle the issue of marine plastic pollution.

Our findings led to several key recommendations for G20 countries and beyond: (1) strengthening legislative frameworks; (2) incentivizing markets to provide economic opportunities for returned plastic products; (3) improvements in the life cycle of plastic, especially in production, consumption and disposal, through integrated waste management systems; and (4) coordination of the EPR strategies on different levels, ranging from globally binding conventions to regional, national and local implementation.

In light of global plastic treaty negotiations and ongoing efforts in the G20, we provide a synopsis of current policy and research, based on our scoping review, and recommendations for policymakers to advance EPR and other complementary measures to prevent further growth of plastic pollution.

# 1. Introduction

Marine plastic pollution is projected to more than double by 2030, with consequences for human health, the global economy, biodiversity and the climate. Here we present the findings of a systematic map of literature on extended producer responsibility (EPR) and marine litter, to inform how policies and systems could be improved for reduced marine plastic pollution.

Our research aims to support the development of a solid policy framework on EPR, through a stocktake of EPR regulations in G20 countries, which together have significant potential to lead global efforts in tackling plastic waste, and through a review of recommendations provided by academia, policymakers and civil society. This report is structured as follows: first, we map out some existing EPR approaches in some G20 countries.<sup>1</sup> Then we present recommendations based on our scoping review of 100 academic and grey literature on how to improve the EPR system, broken down into several categories, such as legislation, technological innovation, the design of a market economy and incentive system, enforcement and data collection, and informal sector workers. We end with some reflections on our findings in the conclusion. In the annex, we provide background information on how we carried out our scoping review using an academic search engine Web of Science (academic literature) and Overton (policy reports).

## 1.1 Marine plastic pollution as a global challenge

Marine litter has been put on the global agenda, given the magnitude and the impacts of waste mismanagement, particularly plastic waste (Haarr et al., 2022; MacLeod et al., 2021). Marine litter can be defined as “any persistent, manufactured or processed solid material discarded, disposed of, or abandoned in the marine and coastal environment” (UNEP, 2021, p. 11). Aside from causing changes to carbon and nutrient cycles; habitat changes within soils, sediments and aquatic ecosystems; co-occurring biological impacts on endangered species; ecotoxicity; and related societal impacts (MacLeod et al., 2021), marine litter severely impacts on livelihoods and causes costs for businesses and governments (Fadeeva & Van Berkel, 2021).

Plastic presents the largest, most harmful and most persistent fraction of marine litter and accounts for at least 85% of total marine waste (UNEP, 2021a). Nearly 8 million tonnes of plastic are estimated to enter the world’s ocean annually; plastic waste originates largely from land-based sources (80%), with plastic packaging presenting the major share of the leakage (Fadeeva & Van Berkel, 2021), mostly in the form of six polymers: polypropylene, polyethylene, polyvinylchloride (PVC), polyurethane, polyethylene terephthalate (PET), and polystyrene. Table 1 provides an overview of the sources of marine litter and how much of it is marine plastic pollution.

---

<sup>1</sup> At the time of the research (2023), the African Union had not yet formally joined the G20. In September 2023, the African Union (AU) was admitted as a permanent member, expanding the group from 19 countries plus the EU to include 55 African states represented by the AU.

Table 1. Sources of marine litter and marine plastic pollution

| Sources of marine litter                                                                                                    | Marine plastic pollution                                                                                                                                        | Types of marine plastic pollution                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Land-based – e.g. discarded directly into rivers, beaches or brought indirectly to the sea with storm water, winds, sewage. | 85% of marine litter is plastic.<br><br>In coastal countries, mismanagement of solid waste has caused between 1.7% and 4.6% of marine plastic pollution.        | Half the litter found on European beaches is single-use plastic.<br><br>Plastic litter dominates marine litter along the Indian coast. In northeastern India, plastic constituted 85% of total litter on 17 beaches surveyed. A similar study conducted in Kanyakumari along the southern coast found that plastics accounted for 65% of the marine litter collected. |
| Sea-based – e.g. from disposal of waste from fishing, shipping, offshore installations.                                     | Total volume of plastic in the ocean: 5.25 trillion particles, weighing 268 940 tonnes (2014).<br><br>Expected to double the total volume in the next 20 years. | 80% of plastics in the ocean are one of six substances: polypropylene, polyethylene, polyvinylchloride (PVC), polyurethane, polyethylene terephthalate (PET), and polystyrene.                                                                                                                                                                                        |

Sources: Addamo et al. (2017), Carney Almroth & Eggert (2019), Collignon et al. (2012), Eriksen et al. (2014), Fadeeva & Van Berkel (2021), Hinojosa & Thiel (2009), Hoornweg & Bhada-Tata (2012), IMO (2019b), Jambeck et al. (2015), Mugilarasan et al. (2021), Perumal et al. (2023), Reisser et al. (2013), Ryan (2013), Schmidt et al. (2017), Sivasdas et al. (2022), UNEP (2017b, 2021a)

The G20 countries generate approximately two-thirds of global plastic waste (Faadeva & Van Berkel, 2021). Higher-income countries typically have higher per capita plastic waste generation, but due to effective collection systems and controlled disposal, they contribute relatively little to environmental plastic leakage. In contrast, emissions are highest in countries with large populations, extensive coastlines, and insufficient waste management infrastructure. Recent modeling and research show that plastic emissions are particularly concentrated in south Asia, southeast Asia and sub-Saharan Africa. Around 69% of global plastic emissions originate from 20 countries, many of which are part of the G20. These findings underscore the important role G20 nations can play in strengthening waste management systems and leading efforts to prevent marine plastic pollution (Cottom et al., 2024).

## 1.2 Reducing marine plastic pollution

Several strategies can reduce marine plastic pollution. Those that are often categorized as strategies to prevent it from occurring (targeting consumers and industry) are also known as upstream measures, versus remediation strategies, aimed at cleaning up marine plastic pollution in different locations (rivers, coastal areas, sea surface, deep sea beds, marine animals and polar ice). Downstream measures target later life cycle stages, including recycling and recovery; remediation includes clean-up, retrieval and destruction.

Table 2 provides an overview of approaches to tackle marine plastic pollution, highlighting upstream and downstream activities. Options to control plastic waste and pollution include mechanical and chemical plastic recycling; incineration of plastic waste; and booms and clean-up boats, trash racks and sea bins to control plastic waste in-stream (Nikiema & Asiedu, 2022). For microplastics, technological solutions include stormwater ponds, wastewater treatment plants, sewage sludge treatment and drinking water treatment (Nikiema & Asiedu, 2022). However, the technology readiness level (TRL) of some solutions is low, for example, for multilayer plastics (Soares et al., 2022), as well as for household plastics.

Table 2. Overview approaches to tackle marine plastic pollution

| Strategies                                                                                                                          | Focus                   |
|-------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| Prevent/reduce generation of waste that contributes to marine litter through product design and efficiency                          | Upstream                |
| Prevent/reduce generation of waste that contributes to marine litter through material choice (e.g. virgin plastic)                  | Upstream                |
| Prevent/reduce litter reaching the marine environment through circular economy strategies                                           | Upstream and downstream |
| Prevent/reduce litter reaching the marine environment through extended producer responsibility (EPR) schemes                        | Upstream and downstream |
| Prevent/reduce litter reaching the marine environment through coordinated waste management                                          | Downstream              |
| Collect litter from the marine environment                                                                                          | Downstream              |
| Remediation of sites (e.g. beaches or open ocean)                                                                                   | Downstream              |
| Plastic biodegradation, involving various enzymes produced by plastic degrading microorganisms, including algae, bacteria and fungi | Downstream              |
| Recycle/upcycle collected litter                                                                                                    | Downstream              |
| Energy recovery                                                                                                                     | Downstream              |
| Final disposal                                                                                                                      | Downstream              |

Source: Inspired by IRP (2021)

### 1.3 Extended producer responsibility (EPR)

Extended Producer Responsibility (EPR) is “a policy approach that makes producers responsible for their products along the entire lifecycle, including at the post-consumer stage. An EPR policy is characterised by the shifting of responsibility (physically and/or economically; fully or partially) upstream to producers, and the provision of incentives to producers to take into account environmental considerations when designing their products” (OECD, 2024, p. 6). Hence, it includes an upstream stage (design and production) and a downstream stage (recovery and collection).

EPR aims at making producers responsible for the environmental impacts of their products throughout the product chain, from design to the post-consumer phase (OECD, 2016). It has two principal environmental goals (UNEP, 2021b): (1) providing incentives for manufacturers to design resource-efficient and low impact products (also referred to as eco-design); (2) ensuring effective end-of-life collection, the environmentally sound treatment of collected products, and improved rates of reuse and recycling.

Since the late 1980s, the concept has been implemented in some countries as a principle of environmental policy (OECD, 2016). For example, Germany implemented the Packaging Ordinance in 1991 to promote separate management and recycling of all types of packaging; Japan implemented an EPR policy on containers and recycling packaging in 1995 (Johannes et al., 2021). However, the level of implementation in EPR policies in countries varies widely. An overview of the status in different countries is provided in Section 2, based on the World Bank (2022) and the World Wildlife Fund (2019), among a few other studies. Overall, the implementation of EPR schemes can be categorized from no EPR policies, voluntary EPR, emerging EPR legislation, and mandatory EPR. EPR systems involve a diverse range of actors, from public to private stakeholders at all stages of the value chain (World Bank, 2022).

The most common EPR policy instruments cover elements of reuse, “take-back” or recycling. Table 3 includes an overview of different mandatory and voluntary EPR schemes; however, in practice, a combination of these instruments can be found.

Table 3. Extended producer responsibility (EPR) schemes

| Mandatory EPR schemes                                                                                                                                                                                                                        | Voluntary EPR schemes                                                                                                                      |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Product take-back requirements</li> <li>• Advance disposal fees</li> <li>• Upstream product taxes</li> <li>• Downstream subsidies for waste management</li> <li>• Deposit refund systems</li> </ul> | <ul style="list-style-type: none"> <li>• Product stewardship initiatives</li> <li>• Corporate social responsibility initiatives</li> </ul> |

Source: Based on OECD (2016)

Product take-back instruments make producers or retailers responsible for managing the end-of-life of a product. It involves the establishment of recycling and collection targets for a product or material. Incentives can be provided for consumers to return a used product at a selling point (OECD, 2016). Economic or market-based incentives can include deposit refund systems, advance disposal fees, and upstream or downstream taxes (OECD, 2016). With deposit refund systems, an initial payment (deposit) is made by a customer at the point of purchase that is then refunded if the product or packaging is physically returned by the customer to the collection scheme (OECD, 2016). Refunds provide consumers with an incentive to return items through appropriate channels for separate collection rather than littering or discarding them in general waste. However, these systems require substantial investment in physical and financial infrastructure and usually incur higher operational costs than other waste collection methods.

## 2. Legislative frameworks for EPR in G20 countries

The G20 members account for two-thirds of global plastic waste (Fadeeva & Van Berkel, 2021); thus it is essential to understand the legislative frameworks in these countries for marine plastic pollution, both on a national and international level, to undertake preventive measures and strengthen their enforcement. We provide an overview of country-specific measures among G20 members, with a focus on EPR regulations (Table 4), followed by an overview of the international regime for the protection of the marine environment (Table 5).

Table 4. Examples of EPR-based regulations in the G20 countries with a focus on packaging waste, until 2023 (before African Union membership to the G20).

| Country          | Selected EPR regulations                                                                                                                                                                                                | Status    | Comments from the literature on the scope and implementation of the EPR regulation in the different G20 countries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Argentina</b> | Pesticide Packaging Take-Back Law (2016)                                                                                                                                                                                | Emerging  | <ul style="list-style-type: none"> <li>Argentina enacted a Pesticide Packaging Take-Back Law in 2016. It aims to achieve higher environmental protection by obligating individuals and companies to assume responsibility for the waste related to pesticide containers.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Australia</b> | Product Stewardship Act (2011)<br>The National Environment Protection (Used Packaging Materials) Measure (2011)<br>Recycling and Waste Reduction Act (2020)<br>Waste Exports ban (2020)<br>National Plastic Plan (2021) | Voluntary | <ul style="list-style-type: none"> <li>In 2011, the Product Stewardship Act (PS Act) established a legal framework for product stewardship, which could be implemented in three ways: voluntary, co-regulated with the respective industry, or mandatory. The regulation of plastics and packaging are regulated under The National Environment Protection (Used Packaging Materials 2011), which establishes a legal framework for a co-regulatory scheme where the government establishes a legal framework while the industry is accountable for meeting the specified targets and requirements.</li> <li>In December 2020, the Recycling and Waste Reduction Bill was adopted by the Australian government to reform the existing regulations under the PS Act. This new legislation aims to create a stronger PS Act and includes a Waste Exports Ban (2020), focusing plastics, paper, glass, and tiers from Australia (with some exceptions).</li> <li>Australia unveiled a National Plastics Plan in 2021, detailing various measures such as upgrading recycling infrastructure, curtailing plastic consumption in government operations, and promoting innovative plastic substitutes, aimed at mitigating plastic waste and pollution. There is a national target to phase out single-use plastic (adopted in 2021), yet as of now, it is voluntary, where seven out of eight states in Australia have committed to banning single-use plastic; however, each jurisdiction is currently banning different plastics.</li> <li>Australia has partly implemented bottle deposit system; its full implementation is planned for 2023.</li> </ul> |
| <b>Brazil</b>    | Sectoral Agreements on Packaging Waste (2010)                                                                                                                                                                           | Voluntary | <ul style="list-style-type: none"> <li>The main principle of the sectoral agreements is to use subsidies to encourage companies to reduce the production of single-use plastic items and to develop and adopt more circular product design and systems.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Canada</b>    | Canada-wide Action Plan for Extended Producer Responsibility (2009)<br>Canada-wide Strategy on Zero Plastic Waste (2018)<br>Single-use Plastics Prohibition Regulation (SUPPR) (2022)                                   | Mandatory | <ul style="list-style-type: none"> <li>National EPR strategy since 2009, which is currently implemented only in a few provinces for packaging. Canadian Council of Ministers of the Environment has also adopted a Canada-wide Strategy for Sustainable Packaging (2009).</li> <li>The Canadian government has committed to move towards zero plastic waste and proposed a harmonized country wide EPR strategy.</li> <li>The regulation includes checkout bags, cutlery, food services ware made from or containing problematic plastics, ring carriers, stir sticks and straws.</li> <li>Bottle deposits and EPR, are currently fragmented across Canada with differing management measures between provinces and municipalities.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>China</b>     | Import Ban on Plastic Packaging Waste (2017)<br>Strengthening Plastic Pollution Control (2020)<br>The Circular Economy Promotion Law of the People's Republic of China (2021)                                           | Emerging  | <ul style="list-style-type: none"> <li>In 2016, China began the promotion of producer responsibility schemes and aims to have regulations and rules ready by 2025.</li> <li>China's development plan for the circular economy (2021-25) targets circular economy through initiatives such as promoting recycling through innovations in key technologies and equipment, remanufacturing, green product design.</li> <li>The National Development and Reform Commission and the Ministry of Ecology and Environment announced a new plan to strengthen plastic pollution control in 2020. The plan will include which plastics will be banned or restricted and in what areas across the country with the overall goal of effectively controlling plastic pollution by 2025. The single-use plastic targeted in the plan includes non-degradable plastic bags, plastic tableware, cotton swabs, plastic products for hotels and express plastic packaging, and the production and sales of daily chemical products containing plastic microbeads.</li> <li>Currently there are no deposit return schemes in place for packaging or plastics.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>France</b>    | Circular Economy Law (2020)                                                                                                                                                                                             | Mandatory | <ul style="list-style-type: none"> <li>Waste prevention and management are regulated under the French environmental code (EFC), modified by the Circular Economy Law (2020), yet France have had EPR measures since 1990 and EPR on packaging since 1992. The new Circular Economy Law includes new obligations of labelling products about their recyclability and reparability, extension of the EPR, and phasing out all single-use plastic by 2040.</li> <li>To date, France has no deposit return scheme for packaging and plastic.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

(Table 4. cont.)

| Country          | Selected EPR regulations                                                                                                                                                          | Status    | Comments from the literature on the scope and implementation of the EPR regulation in the different G20 countries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Germany</b>   | Packaging Ordinance (Verpackungsverordnung) (1991)<br>Packaging Act (2017)<br>German Circular Economy Act (2012)<br>German Ordinance on Single-Use Plastics (2021)                | Mandatory | <ul style="list-style-type: none"> <li>The Packaging Ordinance was first introduced in 1991 and underwent several revisions until it was replaced by the Packaging Act in 2017. The new regulations included certain clarifications of terms, an increased requirement to improve recycling rates, the introduction of a central packaging register (LUCID) to enhance monitoring, incentives to improve the recyclability of packaging, and increased powers granted to municipalities.</li> <li>The German Circular Economy Act (Kreislaufwirtschaftsgesetz) was introduced in 2012 and aims to promote a circular economy in Germany. A previous act (Kreislaufwirtschafts- u. Abfallgesetz) has also been in effect since 1996, with different regulations in some cases, and already contained regulations on take-back obligations. The 2012 law was amended in 2020 to align with the European Union's circular economy goals. The National Circular Economy Strategy was passed in December 2024, after our assessment was completed.</li> <li>The Single-Use Plastics Ordinance, which came into effect July 2021, is a ban on the sale and distribution of certain single-use plastic products, such as plastic cutlery, plates, straws, stirrers and cotton buds. The ban also encompasses a ban on oxo-degradable plastics, ban on expanded polystyrene food containers, and requirement for reporting and labelling.</li> <li>From 1 January 2022, the legal ban on placing lightweight single-use plastic bags on the market came into force.</li> <li>In 2003, the bottle deposit refund schemes was introduced as a mandatory one-way deposit system.</li> </ul> |
| <b>India</b>     | Plastic Waste Management Rules (2016)<br>Solid Waste Management Rules (2016)                                                                                                      | Mandatory | <ul style="list-style-type: none"> <li>The Plastic Waste and Management Rules (2016) apply to all waste generators, local bodies, gram panchayats (village councils), manufacturers, importers and producers, and the rules aim to enhance recycling and to phase out undesirable plastic materials. Since 2016, the rules have been amended to include new regulations. The latest amendment (2022) introduced a minimum level of recycling of plastics packaging, called for a creation of an online portal (for reporting annual return by plastics producers), and the enactment of polluter pays principle with respect to noncompliance with EPR targets.</li> <li>The amendment rules from 2021 prohibited the following single-use plastic: cotton buds with plastic sticks, plastic sticks for balloons, plastic flags, candy sticks, ice cream sticks, polystyrene for decoration, plates, cups, glasses; cutlery such as forks, spoons, knives; straws, trays, wrapping or packing films around sweet boxes, invitation cards, cigarette packets, plastic or PVC banners less than 100 micron, stirrers. In 2002, India banned the production of ultra-thin plastic bags (&lt;20 µm).</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Indonesia</b> | Law on Waste Management (2008)<br>Domestic Waste Management and Similar Waste (2012)<br>National Strategy on Managing and Reducing Waste (2017)<br>Waste Reduction Roadmap (2019) | Emerging  | <ul style="list-style-type: none"> <li>The EPR is drawn up in the Law on Waste Management in Indonesia; however, the implementation of EPR is still in an early phase and the specific type of EPR interventions are still unclear.</li> <li>The Domestic Waste Management and Similar Waste Regulation (2012) specifies the industry obligations towards utilizing recyclable materials and packaging waste regulation. The National Strategy on Managing and Reducing Waste (Jakstranas) (2017), builds on the regulation from 2012 and specifies concrete targets for waste reduction.</li> <li>The Waste Reduction Roadmap (2019) specifies how companies (manufacturers, importers, retailers and the food and beverage service industry), are responsible for reducing the waste stemming from their products including: plastics, paper, aluminium cans and glass. The roadmap also aims to implement a complete ban on single-use plastic, including plastic sachets, plastic straws, plastic bags, single-use food containers and utensils by 2030.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Italy</b>     | Legislative Decree No 22/97 (Ronchi Decree) (1997)                                                                                                                                | Voluntary | <ul style="list-style-type: none"> <li>The Ronchi Decree refers to a consortium system with the overall target of recycling and recovery of packaging across all Italy, including prevention policies through eco-innovation; however, there are large local variations in its implementation.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Japan</b>     | Containers and Packaging Recycling Law (1995)<br>Plastic Circulation Promotion Law (2021)                                                                                         | Mandatory | <ul style="list-style-type: none"> <li>The Containers and Packaging Recycling Law (1995) includes glass bottles, polyethylene terephthalate (PET) bottles, and other plastic and paper packaging.</li> <li>The Plastic Circulation Promotion Law (2021) aims to address the whole life cycle of plastic. The act aims to reduce plastic waste through circular product design systems, where the government has introduced a certification scheme and published a guideline for the design of plastic-containing products. It also targets retailers and service providers to reduce single-use plastic including forks, spoons, knives, stir sticks and straws provided by retailers, restaurants and so forth; hairbrushes, combs, razors, toothbrushes and shower caps provided by accommodations; and hangers and clothing covers provided by laundry services and so forth. Lastly, the new act requires local governments to sort, collect and recycle not only plastic containers and packaging waste but also other plastic products waste.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

(Table 4. cont.)

| Country                  | Selected EPR regulations                                                                                                                                                                  | Status    | Comments from the literature on the scope and implementation of the EPR regulation in the different G20 countries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Mexico</b>            | The Law on the Prevention and Comprehensive Management of Waste (2004)                                                                                                                    | Voluntary | <ul style="list-style-type: none"> <li>The Law on the Prevention and Comprehensive Management of Waste (2004) set forth regulations governing waste management and classification of dangerous residues. The law establishes the polluter pays principle and includes goals for reduction, recycling and reuse. However, while the national level can set standards and goals, the state level sets the policies on non-hazardous waste such as packaging and plastics waste. Currently, there is only one state (of 31 in total) that had planned to implement EPR on subnational level, focusing on waste prevention and circular economy. Subsequently, in 2022, the state of Quintana Roo implemented the law for the Prevention, Integral Management and Circular Economy of Waste.</li> <li>Local governments have put forward regulations to ban single-use plastic (in total 26 states, according to data from 2020). However, all states ban different items.</li> <li>In 2019, representatives from the plastics industry in Mexico signed a national agreement for the New Plastics Economy Global Commitment</li> <li>, committing to reduce single-use plastic and promote recycling.</li> </ul>                                                                                                                                                                                                                                                              |
| <b>Republic of Korea</b> | Promotion of Saving and Recycling Resources (1992)<br>Resource Circulation Act (RCA) (2016)<br>Resource Circulation Master Plan (RCMP) (2018)<br>Plastic Waste Control Plan (PWCP) (2018) | Mandatory | <ul style="list-style-type: none"> <li>The Act on the Promotion of Saving and Recycling Resources (1992) includes materials such as paper packaging, metal cans, glass bottles, and synthetic resin (PET bottles, foamed resins, plastic containers/trays, films/sheets).</li> <li>South Korea adopted the RCA in 2016 with the aim to become more circular. To achieve the vision of a circular economy, the Resource Circulation Master Plan (2018) was adopted. The RCMP is a 10-year plan that encompasses specific strategies, as well as mid-to-long-term policy directives. The same year, the South Korean government adopted its Plastic Waste Control Plan (2018), to facilitate efficient management of plastic waste, using the RCA and PWCP as its framework. The PWCP aims to reduce plastic waste to less than 50% and recycle over 70% of plastic waste by 2030. To achieve these objectives, the plan includes detailed policy directions such as: (1) Phasing out difficult-to-recycle products (e.g. polyvinyl siloxane, colourful drink bottles, and measures against on plastic packaging labelling); (2) Encouraging the design of products that can be easily recycled post-discharge; (3) Strengthening the producer responsibility system to make producers accountable for recycling plastic waste; (4) Expanding the plastic waste recycling infrastructure; (5) Promoting public awareness and participation in recycling programs.</li> </ul> |
| <b>Russia</b>            | Waste of Production and Consumption Regulation (2014)                                                                                                                                     | Mandatory | <ul style="list-style-type: none"> <li>In 2014, the EPR mechanism was introduced into the legislation of the Russian Federation. However, the EPR regulation is currently under revision to increase its effectiveness. Currently, there is no deposit return scheme in place in Russia.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Saudi Arabia</b>      | Waste Management Law (2021)                                                                                                                                                               | Emerging  | <ul style="list-style-type: none"> <li>In 2021, Saudi Arabia published a new waste management law. It provides key requirements for waste minimization, segregation and recycling. The law prescribes the responsibilities of waste-related service providers, allowing for the implementation of EPR principles.</li> <li>Currently considering different options to introduce fees on single-use plastic bags.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>South Africa</b>      | Compulsory Specification for Plastic Carrier Bags and Flat Bags (2003)<br>Waste Act (2008)                                                                                                | Mandatory | <ul style="list-style-type: none"> <li>The Waste Act (2008) established the legal framework for EPR, and the South African government has implemented regulations that require producers and importers of certain products, including packaging, to take responsibility for their products throughout their lifecycle, including post-consumer waste management. The regulations are known as the Section 28 Extended Producer Responsibility (EPR) Regulations for paper and packaging and were introduced in 2020. The EPR Regulations were withdrawn for further consultation after significant feedback from industry stakeholders. A new task team proposed amendments and the revised regulations were published in May 2021. The regulation specifies specific targets set for recycling, for various classes of products.</li> <li>Previous to introducing new regulations in 2020, South Africa had a voluntary EPR scheme, along with material organizations for various plastic types, in place since the early 2000s for example, Collect-a-Can (1993), Glass Recycling Company (2006) and PETCO (2004).</li> <li>Carrier Bags and Flat Bags legislation (2003) specifies that bags require a minimum thickness and allow for limited printing to facilitate recycling.</li> </ul>                                                                                                                                                                             |
| <b>Turkey</b>            | Procedures and Principles Regarding the Charging of Plastic Bags (2017)<br>Packaging Waste Control Regulation (2021)                                                                      | Mandatory | <ul style="list-style-type: none"> <li>The Packaging Waste Control Regulation (2021) replaced the previous regulation (2017) and includes all packages and packaging waste released into the market. The new regulation introduces new obligations for market suppliers and sets out to establish a deposit management system for glass, PET and aluminium beverage packaging.</li> <li>The procedures and principles for plastic bags (2017) came into effect in 2019 and added a fee of 0.25 Turkish liras for plastic bags.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>UK</b>                | Producer Responsibility Obligations Packaging Waste Regulations (1997)                                                                                                                    | Mandatory | <ul style="list-style-type: none"> <li>In 2018, the UK launched the 25-Year Environment Plan that aims to eliminate avoidable plastic waste by 2042. It also announced a new strategy that refers to circularity and puts greater responsibility on businesses for addressing waste challenges.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

(Table 4. cont.)

| Country | Selected EPR regulations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Status    | Comments from the literature on the scope and implementation of the EPR regulation in the different G20 countries                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| US      | State-by-state level or city                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Emerging  | <ul style="list-style-type: none"> <li>EPR legislation for packaging is currently developed in several states and passed only in a few states.</li> <li>Around 10 states have introduced bottle deposit systems.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| EU      | Packaging and Packaging Waste Directive 94/62/EC (1994) [now updated by Regulation (EU) 2025/40, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC; ELI: <a href="http://data.europa.eu/eli/reg/2025/40/oj">http://data.europa.eu/eli/reg/2025/40/oj</a> ]<br><br>Strategy for Plastic in a Circular Economy (2018)<br><br>The Plastic Bags Directive (2015)<br><br>The Waste Framework Directive (2018)<br><br>Single-Use Plastics Directive (2019)<br><br>Circular Economy Action Plan (2020)<br><br>Ecodesign Directive 2009/125/EC, to be replaced by the Ecodesign for Sustainable Products Regulation (2022) | Mandatory | <ul style="list-style-type: none"> <li>The Circular Economy Action Plan was adopted in March 2020 with the purpose of transitioning into a more sustainable and circular economy. In January 2018, the EU implemented the Strategy for Plastic in a Circular Economy, which is an extension of the Circular Economy Action Plan and complements existing efforts to decrease plastic waste. More specifically, it sets out the goal of making all plastic packaging in the EU market recyclable by 2030. The strategy includes several actions including (1) new rules on packaging to improve recyclability and increase demand for recycled plastic; (2) improving the separate collection of plastic waste; (3) launching a pledging campaign targeting industry and public authorities; (4) introducing a directive on single-use plastic products and fishing gear; (5) measures to restrict microplastic use and reduce the unintentional release into the environment; (6) measures on bio-based, biodegradable and compostable plastics; (7) introducing new rules on port reception; (8) scaling up support for innovation; (9) working with international partners to develop global solutions and standards on plastics.</li> <li>A new working plan for Ecodesign and Energy Labelling 2022/C 182/01 (building on The Ecodesign directive (2009/125/EC)) was released in 2022, covering 30 energy-related product groups. Energy performance has to be declared by suppliers in the European Product Registry for Energy Labelling as of 1 January 2019.</li> <li>The Plastic Bags Directive (2015) covers plastic carrier bags with a wall thickness below 50 microns. It requires EU Member States to ensure that the annual consumption of these plastic carrier bags does not exceed 90, respectively 40 bags per person by 31 Dec 2019 and 31 December 2025, and/or that a charge for these bags is levied at the point of sale of goods and products.</li> <li>The Single-Use Plastics Directive (2019) tackles items that include cotton bud sticks; cutlery, plates, straws and stirrers; balloons and sticks for balloons; food containers; cups for beverages and other beverage containers (e.g. plastic bottles); cigarette butts; plastic bags, packets and wrappers; wet wipes and other sanitary items. The directive stipulates that consumer labelling of some plastic products is mandatory from 2021, including information on plastic content, proper disposal methods and environmental risks. It requires that the producers of these goods cover the cost, as required under the EPR specified in the waste category.</li> </ul> |

Sources: Amin et al. (2022), Arp (2021), Australian Marine Conservation Society (2023), Ayçin and Kayapinar Kaya (2021), Baxter et al. (2022), Bilasi (2024), Blank et al. (2021), CCME (2009), Cloché-Dubois et al. (2021), Diggle & Walker (2020), European Commission (2021), Fadeeva & Van Berkel (2021), GOV.CN (2021), Guerrero and Souza (2021), Heidemann et al. (2021), Jamison et al. (2021), Jang et al. (2020), Leal Filho et al. (2019), Lichtenstein (2021), Liubarskaia & Putinceva (2021), Lorang et al. (2022), Ministry of Environment, Forest and Climate Change (2021), MoECC (2021), Nahman (2010), Narula & Sharma (2022), National Development and Reform Commission (2020), OECD (2016), Shin et al. (2020), Sozer (2021), The Minister of Environment and Forestry of the Republic of Indonesia (2020), Vernier (2021), World Bank (2022), WWF (2019), Ying (2021)

Note: The table does not necessarily provide exhaustive documentation of all activities by G20 members, but aims to provide an overview of ongoing efforts, as of mid-2023, before the African Union joined the G20.

Most G20 countries have operationalized elements of EPR, and many countries have applied EPR to packaging (Fadeeva & Van Berkel, 2021). EPR for packaging waste is generally fulfilled collectively through a producer responsibility organization (PRO). Such organizations provide essential coordination, collecting fees from obligated companies to manage waste collection, recycling and compliance reporting. In Europe, 30 countries have mandated EPR systems, with industries establishing PROs to fulfil legal requirements (WWF, 2019). By centralizing waste management tasks, PROs reduce costs and improve efficiency, operating under public agency supervision to ensure transparent fund use.

The structure of PROs varies significantly across regions, with models ranging from non-profit to for-profit organizations, and funding sources spanning from fully industry-supported to a mix of public and private contributions. This diversity implies that successful EPR implementation relies on clear legislation, collaborative stakeholder engagement, and tailored approaches to local waste management needs, alongside efficient organization, financing, administration and control of the system.

Table 4 provides a summary of selected EPR regulations and their current status in G20 countries regarding the management of packaging waste. The table is organized based on the nature of the legal framework, distinguishing between mandatory, voluntary and emerging categories, supplemented with comments on notable developments. In terms of the legal framework, the countries are categorized into three groups following the World Bank's (2022) categorization. The first category is "emerging", which indicates that there is no existing legal regulation, but efforts are under way to develop or implement one. The second category is "voluntary", which implies the absence of a mandatory EPR scheme. Instead, industry-led initiatives with vague or ambiguous objectives are prevalent, and there is no monitoring system in place. Finally, the third category is "mandatory", where a clear and concise framework for EPR exists, along with an effective monitoring system. For a more detailed comparison between mandatory and voluntary schemes, see Table 6. Highlighting the status of EPR schemes is crucial to understanding their effectiveness. Taking plastic packaging as an example, there is a noticeable disparity in collection-for-recycling rates among countries. While multiple factors influence these rates, countries with mandatory EPR schemes generally achieve a higher collection rate for recycling (around 40%) compared to countries with "no EPR" (around 10%) or "limited or voluntary" EPR schemes (around 15%) (Ellen MacArthur Foundation, 2021).

Table 5. International regime for the protection of the marine environment

| Organization                                     | Description initiative                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>European Union (EU)</b>                       | The European Marine Strategy Framework Directive 2008, targeting litter in all EU seas based on source and type                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>G7</b>                                        | G7 Action Plan to Combat Marine Litter 2015, under German G7 presidency ; <u>G7 Ocean Deal</u> 2022, under German G7 presidency                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>G20</b>                                       | G20 Action Plan on Marine Litter 2017 in Hamburg; G20 Osaka Summit 2019 in Japan, G20 Implementation Framework for Actions on Marine Plastic Litter, G20 Resource Efficiency Dialogue in Japan 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>International Maritime Organization (IMO)</b> | UN specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships; in 2001, implemented a strategy to reach zero plastic waste discharges to sea from ships by 2025; GloLitter Partnerships Project which aims to reduce marine litter (IMO, 2019a)                                                                                                                                                                                                                                                                                                                                                                       |
| <b>UN</b>                                        | 2030 Agenda for Sustainable Development:<br><br>Sustainable Development Goal (SDG) 14 (life below water) urges the conservation and sustainable use of the ocean, seas and marine resources for sustainable development, with target 14.1 explicitly addressing marine pollution, including plastic.<br><br>Interlinked SDGs in relation to marine litter prevention: SDG 6 (water), SDG 11 (cities) and SDG 12 (sustainable consumption and production).<br><br>During the Basel Convention Conference of Parties in 2019, an amendment was introduced that incorporated plastic waste into a legally binding framework, aiming to enhance transparency and regulation of global trade in plastic waste. |
| <b>UN Environment Programme (UNEP)</b>           | Resolutions by the UN Environment Assembly (5/14) – with the aim of ending plastic pollution and reaching an international legally binding instrument (UNEP, 2022b)<br><br>Global Partnership on Plastic Pollution and Marine Litter was launched at Rio+20 in 2012 and targets the reduction of land and marine sources and to reduces impacts on habitats (UNEP, 2017a).<br><br>Regional Seas Conventions and Action Plans, providing intergovernmental framework to address degradation of the oceans and seas at regional level (UNEP, 2021d).                                                                                                                                                        |

Sources: based on Axelsson & van Sebille (2017), Fadeeva & Van Berkel (2021), IEEP (2017), IRP (2021), UNEP (n.d.), Xanthos & Walker (2017)

As of 2018, more than 60 countries have implemented bans or levies to curb single-use plastics (sometimes referred to as SUPs), such as plastic bags, styrofoam and other plastic packaging. These measures vary widely, with some countries enacting full or partial bans and others employing levies on suppliers, retailers or consumers. Many policies combine bans and economic instruments, aiming to reduce plastic waste through behavioural change and environmental impact mitigation (UNEP, 2018).

Enforcement of these bans has been partly successful: in the first year of implementation, plastic waste reduced up to 50–90% in 60% of the cases (Nikiema & Asiedu, 2022; UNEP, 2018; Xanthos & Walker, 2017). However, scholars have identified a lack of studies assessing the effectiveness of interventions for single-use plastic (Xanthos & Walker, 2017). Current policy interventions for plastic bags seem insufficient (Fadeeva & Van Berkel, 2021), noting that in the US and Canada for instance, interventions have only been implemented in a few states and cities (Xanthos & Walker, 2017).

Both China and India have introduced bans on plastic bags. In 2002, India banned the production of ultra-thin plastics bags (<20 µm); however, the enforcement of bans remains challenging. In China, a ban on plastic bags (<25 µm) in 2008 resulted in a decrease in plastic bag use between 60% and 80% in Chinese supermarkets; the use of plastic bags remains prevalent among street vendors and smaller stores. The largest quantities of discharged plastics into the world's oceans are estimated for rapidly growing economies, such as China and India, which have extensive coastlines (Xanthos & Walker, 2017).

Table 6. Differences between mandatory and voluntary schemes

| Criteria                            | Mandatory                                                                                                                                                                                                                                                                                                                                 | Voluntary                                                                                                                                                                                                                      |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Financial and sustainability</b> | Clear and concise legal framework that defines the producers and importers who bear responsibility, providing a dependable foundation for the ongoing coverage of operational expenses. The EPR system requires all companies that sell packaged products, typically numbering in the thousands or more, to make financial contributions. | In the absence of a mandatory EPR scheme, each company has the freedom to decide whether, how much, and for how long it wishes to invest in a project. As such, many voluntary initiatives have vague or ambiguous objectives. |
| <b>Competition</b>                  | The EPR system ensures fair competition among companies as all entities that introduce packaged goods to the market are required to contribute to the system.                                                                                                                                                                             | Only a small number of companies take part in voluntary measures, which could potentially place them at a competitive disadvantage.                                                                                            |
| <b>National systems</b>             | Implementation of a nationwide EPR system can be achieved with a legal foundation in place.                                                                                                                                                                                                                                               | Tend to focus on urban areas, neglecting rural areas due to the associated high costs.                                                                                                                                         |
| <b>Monitoring</b>                   | Effective monitoring of compliance with legal requirements depends on the availability of adequate supervision capacities by public authorities.                                                                                                                                                                                          | Apart from self-disclosures and self-declarations, there are no official monitoring systems in place. Overall, the system lacks the authority to enforce targets, attracting free riders.                                      |

Source: Table modified from World Bank (2022)

### 3. G20 countries' initiatives specific to marine plastic pollution

Since the late 20th century, several international initiatives have launched to tackle marine plastic pollution. Such efforts underscore the global dimension of the problem and can also lead to efforts at national and local levels (Axelsson & van Sebille, 2017). The agreements with greatest geographic coverage include the International Convention for the Prevention of Pollution from Ships (MARPOL) and the UN Convention of the Law of the Sea. MARPOL was signed in 1973, with a complete ban on disposal of plastics at sea enacted in 1988. A total of 134 countries agreed to eliminate plastics disposal at sea; however, the problem of marine plastic pollution has worsened since then due to uncontrolled disposal of waste on land (Xanthos & Walker, 2017). Other issues are related to monitoring and the complexity of legalities of international waters; some countries have also created exemptions to existing regulations (Axelsson & van Sebille, 2017).

The 2030 Agenda for Sustainable Development has addressed unsustainable plastic use and marine plastic pollution, which has been targeted in Sustainable Development Goal (SDG) 14 (Life Below Water) and target 14.1, with the aim to prevent and significantly reduce marine pollution, particularly from land-based activities, including marine debris and nutrient pollution, by 2025 (Fadeeva & Van Berkel, 2021). Other initiatives by G20 and G7 countries highlight the urge for action, with G20 countries establishing an Action Plan on Marine Litter in 2017, and G7 members stressing the health of the ocean during the 2015 summits (Axelsson & van Sebille, 2017; Fadeeva & Van Berkel, 2021). Regional efforts include the European Marine Strategy Framework Directive and the UNEP Regional Seas Programme. The importance of circular economy is stressed consistently among many actors and initiatives (Fadeeva & Van Berkel, 2021).

Table 5 highlights some international initiatives and regulative frameworks for the protection of the marine environment. However, while no global legislation is targeted specifically at marine plastic pollution, negotiations are under way. Negotiations began in 2022 during the fifth session of the UN Environment Assembly (UNEA-5.2) and are currently ongoing (UNEP, 2022c).

## 4. Recommendations to improve EPR and marine plastic pollution

Our review highlights that marine plastic pollution and EPR face challenges due to:

- missing product design practices that, for example, eliminate the need for plastic or allow for easy reclamation
- a lack of a functioning solid waste management system and infrastructure, resulting in improper disposal and burdens on landfills and health-related challenges to waste pickers;
- the absence of a financial incentive for plastic producers to repurchase much of the recycled plastic and close the loop on plastic waste;
- lack of affordable alternatives to plastic;
- a gap in enforcement and robust and stringent waste management tools;
- a lack of capacity-building for managing plastic waste, in particular in rural areas; and
- limited understanding of how the informal sector, and its associated activities, contribute to the release of plastic and persistent organic pollutants (POPs).

In addition, other noted challenges include high transportation costs, the lack of waste collection services in rural areas, a limited number of facilities to manage certain types of plastic waste, insufficient pollution control, “free riding” and “orphan” products (i.e. single-use plastic products that are of very low value and very lightweight, making these challenging to collect and recycle). Furthermore, the market-based collection system of recyclables (i.e. secondary plastics) is vulnerable due to difficulties achieving economies of scale and due to higher costs. Most recommendations in the literature (both scientific and policy) we reviewed relate to upstream and downstream activities, enhancing the circular economy and waste management practices, and banning single-use plastic. For an overview of recommendations to strengthen the EPR system, see Table 3 in the annex, which is organized into legislative, technological, market, enforcement and collaboration categories. Less detail is provided on how to improve systems of enforcement, digitalization and how to incorporate informal waste workers. Financing EPR schemes and waste infrastructure is little described in the literature we reviewed, as are the critical success factors of partnerships with the private sector.

Omeyer et al. (2022) suggested more punitive measures for polluters in South Asia. They highlighted that while the Association of Southeast Asian Nations (ASEAN) took a significant step towards collective action by adopting enhanced transboundary cooperation on marine plastic pollution in 2019, this commitment must now be converted into concrete, actionable policies to effectively address the issue. They further called for long-term monitoring protocols aligned with international standards, alongside tools such as “ocean accounting” and the Plastic Pollution Prevention and Collection Technology Inventory. Ocean accounting consolidates data on marine resources, such as tracking pollution sources and economic impacts to improve transparency and accountability. The Plastic Pollution Prevention and Collection

Technology Inventory compiles emerging technologies aimed at reducing plastic waste, including citizen science apps for waste reporting and virtual currencies to reward plastic collection, as well as innovative recycling methods such as enzymatic recycling to enhance plastic breakdown.

Sorensen et al. (2023) recommended clarifying the presence of plastic polymers on the exemption list; regulating marine plastic through classification of types by size and whether they are waste products and toxic pollutants, resulting in proper hazardous treatment, storage and disposal facilities; and publishing criteria for plastic waste in water at a federal or national level, instead of leaving the legislation up to local governments. Similarly, Havas et al. (2022) noted that legislation combined with mandatory EPR for various plastics has been a successful strategy for the EU, but the researchers suggested improving incentives for ecodesign, to stimulate both recycling and reuse and to ensure that EPR targets are met at the lowest possible cost.

Johannes et al. (2021) detailed options for improving EPR and marine plastic pollution as (1) differentiating the responsibility of producers; (2) focusing on rural and remote areas; (3) involving informal sectors; (4) creating joint facilities in recycling parks; (5) expanding waste management collection services; (6) increasing the use of EPR and (7) minimizing free riding. Open access data to ensure transboundary data sharing will help in increasing accountability and transparency in policy choices, as noted also by the World Bank (2022). The organization called for a thorough enforcement of the PRO registration and fee payment, as well as a check on illegal imports. Another suggested improvement pertains to the coupling of behavioural change programs with initiatives around improving information for consumers (SEA Circular, 2021).

Few papers tackle the role of informal waste workers, except for a regional policy guide published by UN Economic and Social Commission for Asia and the Pacific (2019), co-authored with SEI researchers. Recommendations covered three stakeholder groups: informal waste workers, governments and citizens. For informal waste workers, the authors suggested a capacity-building program on how to more effectively collect waste, as well as the need and methods for properly disposing of unwanted waste materials and training related to the efficient collection of waste. Governments should, in turn, develop a clear vision of the role of informal sector workers in the formal waste collection system, design a registration system for informal waste workers, and investigate setting up cooperatives. Finally, for citizens, they advised conducting awareness-raising campaigns on the importance of informal waste workers.

## 5. Conclusion

The findings reported here from our scoping review on EPR and marine plastic pollution in the G20 are aimed to inform policymakers on how to improve EPR. Recommendations gathered from the literature, both scientific and policy-oriented, spanned several categories, such as the legislative framework, technological innovation, the importance of designing a market economy and incentive system, and raising awareness and improving the position of informal waste workers.

Whereas several publications recommended strengthening the legislative framework and incentivizing the market for circularity of plastic, only a few covered the role of informal workers. Yet these workers play a substantial role in the plastic waste management chain. Providing capacity-building programs to these workers, and recognizing their contribution in the management, recovery and recycling of plastic waste, will be essential to reduce marine plastic pollution globally.

Other recommendations included providing affordable alternatives to plastic (bio-based plastic and ecodesign); supporting a more robust market of recyclables, including creating financial incentives for recycling and price differentiation through taxation between virgin and recycled plastics; and enhancing consistency in the application and enforcement of national legislation across rural areas and cities, as well as at the subnational level (e.g. states or provinces).

A single policy or solution, however, will not solve the marine plastic pollution issue. Given the complexity of the problem, different policies will need to be combined, as well as coordinated on different levels, ranging from globally binding conventions to regional, national and local implementation (Mazhandu et al., 2020; Nikiema & Asiedu, 2022; Vince & Hardesty, 2018). Improvements in the various stages of the life cycle of plastic are required, especially in production, consumption and disposal, through integrated waste management systems. In addition to developing affordable, eco-friendly alternatives should be developed. Equally important is a substantial reduction in plastic use, alongside a shift toward minimal-plastic practices, to address the problem at its source.

## References

- Addamo, A. M., Laroche, P., & Hanke, G. (2017). *Top Marine Beach Litter Items in Europe* (EUR 29249 EN). JRC. <https://mcc-jrc-ec-europa-eu.ezp.sub.su.se/documents/201808291247.pdf>
- Amin, S., Strik, D., & van Leeuwen, J. (2022). A multi-method approach to circular strategy design: Assessing extended producer responsibility scenarios through material flow analysis of PET plastic in Jakarta, Indonesia. *Journal of Cleaner Production*, 367, 132884. <https://doi.org/10.1016/j.jclepro.2022.132884>
- Arp, R. (2021). *Extended producer responsibility for plastic packaging in South Africa: A synthesis report on policy recommendations*. WWF.
- Asiandu, A. P., Wahyudi, A., & Sari, S. W. (2022). Aquatic plastics waste biodegradation using plastic degrading microbes. *Journal of Microbiology, Biotechnology and Food Sciences*, 11(5), Article 5. <https://doi.org/10.55251/jmbfs.3724>
- Australian Marine Conservation Society. (2023, January 31). *Which Australian states are banning single-use plastics?* Australian Marine Conservation Society. <https://www.marineconservation.org.au/which-australian-states-are-banning-single-use-plastics/>
- Axelsson, C., & van Seville, E. (2017). Prevention through policy: Urban macroplastic leakages to the marine environment during extreme rainfall events. *Marine Pollution Bulletin*, 124(1), 211–227. <https://doi.org/10.1016/j.marpolbul.2017.07.024>
- Ayçin and Kayapinar Kaya, E. (2021). *Towards the circular economy: Analysis of barriers to implementation of Turkey's zero waste management using the fuzzy DEMATEL method—Ejder Ayçin, Sema Kayapinar Kaya, 2021*. <https://journals-sagepub-com.ezproxy.its.uu.se/doi/full/10.1177/0734242X20988781>
- Back to Blue. (2021). *From intention to action: India's plastics management challenge*. <https://backtoblueinitiative.com/india-country-report/>
- Baxter, L., Lucas, Z., & Walker, T. R. (2022). Evaluating Canada's single-use plastic mitigation policies via brand audit and beach cleanup data to reduce plastic pollution. *Marine Pollution Bulletin*, 176, 113460. <https://doi.org/10.1016/j.marpolbul.2022.113460>
- Bilasi, N. (2024). *Saudi Arabia: Action and Progress on Marine Litter*. Towards Osaka Blue Ocean Vision: G20 Implementation Framework for Action on Marine Plastic Litter. <https://g20mpl.org/partners/saudi-arabia>
- Blank, H., Gregor, N., Hofmann, D., & Wenzler, F. (2021). *Plastics and packaging laws in Germany| CMS Expert Guide*. <https://cms.law/en/int/expert-guides/plastics-and-packaging-laws/germany>
- Carney Almroth, B., & Eggert, H. (2019). Marine plastic pollution: sources, impacts, and policy issues. *Review of Environmental Economics and Policy*, 13(2), 317–326. <https://doi.org/10.1093/reep/rez012>
- CCME. (2009). *Canada-wide Strategy for Sustainable Packaging*.
- Chakraborty, P., Chandra, S., Dimmen, M. V., Hurley, R., Mohanty, S., Bharat, G. K., Steindal, E. H., Olsen, M., & Nizzetto, L. (2022). Interlinkage between persistent organic pollutants and plastic in the waste management system of India: an overview. *Bulletin of Environmental Contamination and Toxicology*, 109(6), 927–936. <https://doi.org/10.1007/s00128-022-03466-x>
- Changing Markets Foundation. (2020). *Talking Trash. The corporate playbook of false solutions to the plastic crisis*. [http://changingmarkets.org/wp-content/uploads/2021/01/TalkingTrash\\_FullVersion.pdf](http://changingmarkets.org/wp-content/uploads/2021/01/TalkingTrash_FullVersion.pdf)
- Cloché-Dubois, C., Plisson, A., Le Bourdon, A., & Peraudeau, C. (2021). *Plastics and packaging laws in France| CMS Expert Guide*. <https://cms.law/en/int/expert-guides/plastics-and-packaging-laws/france>
- Collignon, A., Hecq, J.-H., Glagani, F., Voisin, P., Collard, F., & Goffart, A. (2012). Neustonic microplastic and zooplankton in the North Western Mediterranean Sea. *Marine Pollution Bulletin*, 64(4), 861–864. <https://doi.org/10.1016/j.marpolbul.2012.01.011>
- Cotton, J. W., Cook, E., & Velis, C. A. (2024). A local-to-global emissions inventory of macroplastic pollution. *Nature* 633:101–8. <https://www.nature.com/articles/s41586-024-07758-6>

- Diggle, A., & Walker, T. R. (2020). Implementation of harmonized extended producer responsibility strategies to incentivize recovery of single-use plastic packaging waste in Canada. *Waste Management*, 110, 20–23. <https://doi.org/10.1016/j.wasman.2020.05.013>
- Ellen MacArthur Foundation. (2021). *Extended Producer Responsibility—A necessary part of the solution to packaging waste and pollution*. [www.ellenmacarthurfoundation.org](http://www.ellenmacarthurfoundation.org)
- EPA. (2020). *Best Practices for Solid Waste Management: A Guide for Decision-Makers in Developing Countries* [Document]. EPA. [https://app.overtone.io/document.php?policy\\_document\\_id=epagov-d30a16fea980a122998a8989257c5d9a](https://app.overtone.io/document.php?policy_document_id=epagov-d30a16fea980a122998a8989257c5d9a)
- Eriksen, M., Lebreton, L. C. M., Carson, H. S., Thiel, M., Moore, C. J., Borerro, J. C., Galgani, F., Ryan, P. G., & Reisser, J. (2014). Plastic pollution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. *PLOS ONE*, 9(12), e111913. <https://doi.org/10.1371/journal.pone.0111913>
- ESCAP. (2019). *Closing the Loop: Regional Policy Guide* [Document]. United Nations ESCAP. [https://app.overtone.io/document.php?policy\\_document\\_id=unesap-68905faf3b6b82519f923ab0900c0868](https://app.overtone.io/document.php?policy_document_id=unesap-68905faf3b6b82519f923ab0900c0868)
- European Commission. (2021). *Turning the tide on single-use plastics*. Publications Office of the European Union. <https://data.europa.eu/doi/10.2779/800074>
- Fadeeva, Z., & Van Berkel, R. (2021). Unlocking circular economy for prevention of marine plastic pollution: An exploration of G20 policy and initiatives. *Journal of Environmental Management*, 277, 111457. <https://doi.org/10.1016/j.jenvman.2020.111457>
- GOV.CN. (2021). *China plans to promote circular economy*. The State Council the People's Republic of China. [http://english.www.gov.cn/statecouncil/ministries/202107/07/content\\_WS60e59652c6d0df57f98dc8be.html](http://english.www.gov.cn/statecouncil/ministries/202107/07/content_WS60e59652c6d0df57f98dc8be.html)
- Guerrero and Souza. (2021). *Plastics and packaging laws in Mexico | CMS Expert Guide*. <https://cms.law/en/int/expert-guides/plastics-and-packaging-laws/mexico>
- Gupta, D., & Dash, S. (2023). Challenges of implementing extended producer responsibility for plastic-waste management: Lessons from India. *Social Responsibility Journal*, ahead-of-print(ahead-of-print). <https://doi.org/10.1108/SRJ-08-2022-0326>
- Haarr, M. L., Falk-Andersson, J., & Fabres, J. (2022). Global marine litter research 2015–2020: Geographical and methodological trends. *Science of The Total Environment*, 820, 153162. <https://doi.org/10.1016/j.scitotenv.2022.153162>
- Havas, V., Løkke, S., & Kørnø, L. (2022). Exploring scientific discourse on marine litter in Europe: review of sources, causes and solutions. *Sustainability*, 14(13), Article 13. <https://doi.org/10.3390/su14137987>
- Heidemann et al., (2021). *Plastics and packaging laws in Russia | CMS Expert Guide*. <https://cms.law/en/int/expert-guides/plastics-and-packaging-laws/russia>
- Hinojosa, I. A., & Thiel, M. (2009). Floating marine debris in fjords, gulfs and channels of southern Chile. *Marine Pollution Bulletin*, 58(3), 341–350. <https://doi.org/10.1016/j.marpolbul.2008.10.020>
- Hoornweg, D., & Bhada-Tata, P. (2012). *What a Waste: A Global Review of Solid Waste Management*. World Bank. <https://openknowledge.worldbank.org/handle/10986/17388>
- Hossain, R., Islam, M. T., Shanker, R., Khan, D., Locock, K. E. S., Ghose, A., Schandl, H., Dhodapkar, R., & Sahajwalla, V. (2022). Plastic waste management in India: challenges, opportunities, and roadmap for circular economy. *Sustainability*, 14(8), Article 8. <https://doi.org/10.3390/su14084425>
- IEEP. (2017). *EPR in the EU Plastics Strategy and the Circular Economy: A focus on plastic packaging*. <https://ieep.eu/publications/more-ambitious-extended-producer-responsibility-for-plastics-through-greater-eco-modulation-of-fees/>
- IMO. (2019a). *GloLitter Partnerships Project*. <https://www.imo.org/en/OurWork/PartnershipsProjects/Pages/GloLitter-Partnerships-Project.aspx>
- IMO. (2019b). *Marine litter*. <https://www.imo.org/en/MediaCentre/HotTopics/Pages/marinelitter-default.aspx>

- IRP. (2021). *Policy Options to Eliminate Additional Marine Plastic Litter By 2050 Under the G20 Osaka Blue Ocean Vision: An International Resource Panel Think Piece*. UNEP International Resource Panel. <https://wedocs.unep.org/xmlui/handle/20.500.11822/36440>
- Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, 347(6223), 768–771. <https://doi.org/10.1126/science.1260352>
- Jamison, O., Kahmann, S., & Skorupińska, A. (2021). *Plastics and packaging laws in the European Union | CMS Expert Guide*. <https://cms.law/en/int/expert-guides/plastics-and-packaging-laws/european-union>
- Jang, Y.-C., Lee, G., Kwon, Y., Lim, J., & Jeong, J. (2020). Recycling and management practices of plastic packaging waste towards a circular economy in South Korea. *Resources, Conservation and Recycling*, 158, 104798. <https://doi.org/10.1016/j.resconrec.2020.104798>
- Johannes, H. P., Kojima, M., Iwasaki, F., & Edita, E. P. (2021). Applying the extended producer responsibility towards plastic waste in Asian developing countries for reducing marine plastic debris. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, 39(5), 690–702. <https://doi.org/10.1177/0734242X211013412>
- Leal Filho, W., Saari, U., Fedoruk, M., Iital, A., Moora, H., Klöga, M., & Voronova, V. (2019). An overview of the problems posed by plastic products and the role of extended producer responsibility in Europe. *Journal of Cleaner Production*, 214, 550–558. <https://doi.org/10.1016/j.jclepro.2018.12.256>
- Lichtenstein, F. (2021). *Plastics and packaging laws in China | CMS Expert Guide*. <https://cms.law/en/int/expert-guides/plastics-and-packaging-laws/china>
- Lindhqvist, T. (2000). *Extended Producer Responsibility in Cleaner Production: Policy Principle to Promote Environmental Improvements of Product Systems*. Lund University.
- Liubarskaia, M., & Putinceva, N. (2021). *The Role of Secondary Resource Market in the Development of the Extended Producer Responsibility Mechanism in Russia— IOPscience*. <https://iopscience-iop-org.ezproxy.its.uu.se/article/10.1088/1755-1315/938/1/012014>
- Lorang, S., Yang, Z., Zhang, H., Lü, F., & He, P. (2022). Achievements and policy trends of extended producer responsibility for plastic packaging waste in Europe. *Waste Disposal & Sustainable Energy*, 4(2), 91–103. <https://doi.org/10.1007/s42768-022-00098-z>
- MacLeod, M., Arp, H. P. H., Tekman, M. B., & Jahnke, A. (2021). The global threat from plastic pollution. *Science*, 373(6550), 61–65. <https://doi.org/10.1126/science.abg5433>
- Ministry of Environment, Forest and Climate Change. (2021). *Government notifies the Plastic Waste Management Amendment Rules, 2021, prohibiting identified single use plastic items by 2022*. <https://pib.gov.in/pib.gov.in/Pressreleaseshare.aspx?PRID=1745433>
- MoECC. (2021). *Japan | Towards Osaka Blue Ocean Vision*. <https://g20mpl.org/partners/japan>
- Mugilarasan, M., Karthik, R., Purvaja, R., Robin, R. S., Subbareddy, B., Hariharan, G., Rohan, S., Jinoj, T. P. S., Anandavelu, I., Pugalenth, P., & Ramesh, R. (2021). Spatiotemporal variations in anthropogenic marine litter pollution along the northeast beaches of India. *Environmental Pollution*, 280, 116954. <https://doi.org/10.1016/j.envpol.2021.116954>
- Nahman, A. (2010). Extended producer responsibility for packaging waste in South Africa: Current approaches and lessons learned. *Resources, Conservation and Recycling*, 54(3), 155–162. <https://doi.org/10.1016/j.resconrec.2009.07.006>
- Narula, K., & Sharma, R. (2022). *Understanding the Plastic Waste Management (Amendment) Rules,...* <https://www.investindia.gov.in/team-india-blogs/understanding-plastic-waste-management-amendment-rules-2022>
- National Development and Reform Commission. (2020). *Opinions on further strengthening plastic pollution control*. [https://www.ndrc.gov.cn/xxgk/zcfb/tz/202001/t20200119\\_1219275.html](https://www.ndrc.gov.cn/xxgk/zcfb/tz/202001/t20200119_1219275.html)
- Nikiema, J., & Asiedu, Z. (2022). A review of the cost and effectiveness of solutions to address plastic pollution. *Environmental Science and Pollution Research*, 29(17), 24547–24573. <https://doi.org/10.1007/s11356-021-18038-5>

- Nøklebye, E., Adam, H. N., Roy-Basu, A., Bharat, G. K., & Steindal, E. H. (2023). Plastic bans in India – addressing the socio-economic and environmental complexities. *Environmental Science & Policy*, 139, 219–227. <https://doi.org/10.1016/j.envsci.2022.11.005>
- OECD. (2016). *Extended Producer Responsibility: Updated Guidance for Efficient Waste Management*. OECD. <https://doi.org/10.1787/9789264256385-en>
- OECD. (2022). *Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options*. Organisation for Economic Co-operation and Development. [https://www.oecd-ilibrary.org/environment/global-plastics-outlook\\_de747aef-en](https://www.oecd-ilibrary.org/environment/global-plastics-outlook_de747aef-en)
- OECD. (2024). Extended producer responsibility: basic facts and key principles. OECD Environment Policy Papers, 41. <https://doi.org/10.1787/67587b0b-en>
- Omeyer, L. C. M., Duncan, E. M., Aiemsomboon, K., Beaumont, N., Bureekul, S., Cao, B., Carrasco, L. R., Chavanich, S., Clark, J. R., Cordova, M. R., Couceiro, F., Cragg, S. M., Dickson, N., Failer, P., Ferraro, G., Fletcher, S., Fong, J., Ford, A. T., Gutierrez, T., ... Godley, B. J. (2022). Priorities to inform research on marine plastic pollution in Southeast Asia. *Science of The Total Environment*, 841, 156704. <https://doi.org/10.1016/j.scitotenv.2022.156704>
- Perumal, K., Muthuramalingam, S., & Chellaiyan, S. (2023). Marine litter on the beaches of the Kanyakumari, Southern India: an assessment of their abundance and pollution indices. *Marine Pollution Bulletin*, 186, 114443. <https://doi.org/10.1016/j.marpolbul.2022.114443>
- Reisser, J., Shaw, J., Wilcox, C., Hardesty, B. D., Proietti, M., Thums, M., & Pattiaratchi, C. (2013). Marine plastic pollution in waters around Australia: characteristics, concentrations, and pathways. *PLOS ONE*, 8(11), e80466. <https://doi.org/10.1371/journal.pone.0080466>
- Ryan, P. G. (2013). A simple technique for counting marine debris at sea reveals steep litter gradients between the Straits of Malacca and the Bay of Bengal. *Marine Pollution Bulletin*, 69(1), 128–136. <https://doi.org/10.1016/j.marpolbul.2013.01.016>
- Schmidt, C., Krauth, T., & Wagner, S. (2017). Export of plastic debris by rivers into the sea. *Environmental Science & Technology*, 51(21), 12246–12253. <https://doi.org/10.1021/acs.est.7b02368>
- SEA Circular. (2021). *Perceptions on Plastic Waste: Insights, Interventions and Incentives to Action from Businesses and Consumers in South-East Asia* [Document]. United Nations Environment Programme. [https://app.overton.io/document.php?policy\\_document\\_id=unenvironment-bd99119299553f379a33bdb69406c7c2](https://app.overton.io/document.php?policy_document_id=unenvironment-bd99119299553f379a33bdb69406c7c2)
- Shin, S.-K., Um, N., Kim, Y.-J., Cho, N.-H., & Jeon, T.-W. (2020). New policy framework with plastic waste control plan for effective plastic waste management. *Sustainability*, 12(15), Article 15. <https://doi.org/10.3390/su12156049>
- Sivadas, S. K., Mishra, P., Kaviarasan, T., Sambandam, M., Dhineka, K., Murthy, M. V. R., Nayak, S., Sivyer, D., & Hoehn, D. (2022). Litter and plastic monitoring in the Indian marine environment: a review of current research, policies, waste management, and a roadmap for multidisciplinary action. *Marine Pollution Bulletin*, 176, 113424. <https://doi.org/10.1016/j.marpolbul.2022.113424>
- Soares, C. T. de M., Ek, M., Östmark, E., Gällstedt, M., & Karlsson, S. (2022). Recycling of multi-material multilayer plastic packaging: current trends and future scenarios. *Resources, Conservation and Recycling*, 176, 105905. <https://doi.org/10.1016/j.resconrec.2021.105905>
- Sorensen, R. M., Kanwar, R. S., & Jovanovi, B. (2023). Past, present, and possible future policies on plastic use in the United States, particularly microplastics and nanoplastics: a review. *Integrated Environmental Assessment and Management*, 19(2), 474–488. <https://doi.org/10.1002/ieam.4678>
- Sozer, C. (2021, July 12). Turkey publishes new packaging waste control regulation. *Esin Attorney Partnership*. <https://www.esin.av.tr/2021/07/12/turkey-publishes-new-packaging-waste-control-regulation/>
- The Energy and Resources Institute. (2020). *Strategy for fostering Resource Efficiency and Circular Economy in Goa* [Document]. The Energy and Resources Institute. [https://app.overton.io/document.php?policy\\_document\\_id=teri-d6cff492569a9e21e9e9ab64a65c5ef6](https://app.overton.io/document.php?policy_document_id=teri-d6cff492569a9e21e9e9ab64a65c5ef6)
- The Minister of Environment and Forestry of the Republic of Indonesia. (2020). *Road Map of Waste Reduction by Producer*.

- UN Environment. (2017). *Marine Litter Socio Economic Study*. UNEP. [https://stg-wedocs.unep.org/bitstream/handle/20.500.11822/26014/Marinelitter\\_socioeco\\_study.pdf?sequence=1&isAllowed=y](https://stg-wedocs.unep.org/bitstream/handle/20.500.11822/26014/Marinelitter_socioeco_study.pdf?sequence=1&isAllowed=y)
- UNDP. (2022). *Plastic Waste Management | United Nations Development Programme*. UNDP. <https://www.undp.org/india/projects/plastic-waste-management>
- UNEP. (n.d.). *Plastic Waste Amendments FAQs*. Retrieved 14 May 2023, from <http://www.basel.int/Implementation/Plasticwaste/PlasticWasteAmendments/FAQs/tabid/8427/Default.aspx>
- UNEP. (2017a, August 16). *Global Partnership on Plastic Pollution and Marine Litter*. UNEP - UN Environment Programme. <http://www.unep.org/explore-topics/oceans-seas/what-we-do/addressing-land-based-pollution/global-partnership-plastic>
- UNEP. (2017b, August 18). *Marine litter*. UN Environment Programme. <http://www.unep.org/explore-topics/oceans-seas/what-we-do/working-regional-seas/marine-litter>
- UNEP. (2018). *Single-use plastics: A roadmap for sustainability*. <http://www.unep.org/resources/report/single-use-plastics-roadmap-sustainability>
- UNEP. (2021a). *From Pollution to Solution: A global assessment of marine litter and plastic pollution*. <http://www.unep.org/resources/pollution-solution-global-assessment-marine-litter-and-plastic-pollution>
- UNEP. (2021b). *Tackling Plastic Pollution: Legislative Guide for the Regulation of Single-Use Plastic Products*. <http://www.unep.org/resources/toolkits-manuals-and-guides/tackling-plastic-pollution-legislative-guide-regulation>
- UNEP. (2021c, June 30). *Life Cycle Approach to Plastic Pollution—Life Cycle Initiative*. <https://www.lifecycleinitiative.org/activities/life-cycle-assessment-in-high-impact-sectors/life-cycle-approach-to-plastic-pollution/>, <https://www.lifecycleinitiative.org/activities/life-cycle-assessment-in-high-impact-sectors/life-cycle-approach-to-plastic-pollution/>
- UNEP. (2021d, November 8). *Regional Seas Programme*. UNEP - UN Environment Programme. <http://www.unep.org/explore-topics/oceans-seas/what-we-do/regional-seas-programme>
- UNEP. (2022a). *Review of Current Knowledge and Data on Marine Litter in Asia*. <https://wedocs.unep.org/xmlui/handle/20.500.11822/40132>
- UNEP. (2022b, March). *5/14. End Plastic Pollution: Towards an International Legally Binding Instrument - Resolution adopted by the United Nations Environment Assembly on 2 March 2022 [UNEP/EA.5/Res.14]*. <https://wedocs.unep.org/xmlui/handle/20.500.11822/40597>
- UNEP. (2022c, August 16). *Intergovernmental Negotiating Committee (INC) on Plastic Pollution*. UNEP - UN Environment Programme. <http://www.unep.org/about-un-environment/inc-plastic-pollution>
- Vernier, J. (2021). Extended producer responsibility (EPR) in France. *Field Actions Science Reports. The Journal of Field Actions, Special Issue 23*, Article Special Issue 23.
- Vince, J., & Hardesty, B. D. (2018). Governance solutions to the Tragedy of the Commons that marine plastics have become. *Frontiers in Marine Science*, 5. <https://www.frontiersin.org/articles/10.3389/fmars.2018.00214>
- Watkins, E., Schweitzer, J.-P., Leinala, E., & Börkey, P. (2019). *Policy approaches to incentivise sustainable plastic design*. OECD. <https://doi.org/10.1787/233ac351-en>
- World Bank. (2022). *The Role of Extended Producer Responsibility Schemes for Packaging towards Circular Economies in APEC* [Document]. World Bank. [https://app.overton.io/document.php?policy\\_document\\_id=worldbank-482b0e65cc68e142fa9308904de45034](https://app.overton.io/document.php?policy_document_id=worldbank-482b0e65cc68e142fa9308904de45034)
- WWF. (2019). *Legal Framework Study of Extended Producer Responsibility*. <https://www.greengrowthknowledge.org/research/legal-framework-study-extended-producer-responsibility-epr>
- Xanthos, D., & Walker, T. R. (2017). International policies to reduce plastic marine pollution from single-use plastics (plastic bags and microbeads): A review. *Marine Pollution Bulletin*, 118(1), 17–26. <https://doi.org/10.1016/j.marpolbul.2017.02.048>
- Ying, L. (2021). *China: Action and Progress on Marine Plastic Litter*. Towards Osaka Blue Ocean Vision: G20 Implementation Framework for Action on Marine Plastic Litter. <https://g20mpl.org/partners/china>

## Annex 1. Scoping review research method and process

For this brief, we carried out a scoping review of academic and grey literature published on the topic of extended producer responsibility (EPR) and marine plastic pollution (Munn et al., 2018; Peters et al., 2015; Pham et al., 2014). This process consists of several steps, including (1) setting up the search string and methodology; (2) carrying out the search; (3) screening of titles for relevance; (4) screening of abstracts for relevance; (5) screening of full texts for relevance; and (6) coding of the retained articles.

We used two databases, namely Web of Science, which contains academic publications and Overton, which is a repository of policy reports and grey literature. The search string contained several synonyms to ensure that the corpus contained all relevant articles. For Web of Science, we used several search strings, merging them and removing duplicates to arrive at a final corpus:

Extended AND producer AND responsibility (All Fields) and marine OR ocean OR water (All Fields) and plastic\* (All Fields) and waste OR litter OR pollut\* (All Fields)

Extended AND producer AND responsibility AND marine or ocean AND plastic\* (All Fields) and 2023 or 2022 or 2021 or 2020 or 2019 or 2018 or 2017 (Publication Years) and Environmental Sciences or Humanities Multidisciplinary or Economics or Management or Business or Social Sciences Interdisciplinary or Urban Studies or Regional Urban Planning or International Relations or Law (Web of Science Categories) and All Open Access (Open Access) and PEOPLES R CHINA or USA or ENGLAND or ITALY or GERMANY or CANADA or AUSTRALIA or FRANCE or INDIA or INDONESIA or JAPAN or BRAZIL or SOUTH KOREA or SCOTLAND or RUSSIA or SAUDI ARABIA or TURKEY or MEXICO or SOUTH AFRICA or NORTH IRELAND or INDIAN (Countries/Regions) and English (Languages) and Article or Review Article or Early Access (Document Types)

(ALL=(Extended AND producer AND responsibility AND marine OR ocean AND plastic\* )) AND (PY=(“2023” OR “2022” OR “2021” OR “2020” OR “2019” OR “2018” OR “2017”) AND TASCA=(“ENVIRONMENTAL SCIENCES” OR “HUMANITIES MULTIDISCIPLINARY” OR “ECONOMICS” OR “MANAGEMENT” OR “BUSINESS” OR “SOCIAL SCIENCES INTERDISCIPLINARY” OR “URBAN STUDIES” OR “REGIONAL URBAN PLANNING” OR “INTERNATIONAL RELATIONS” OR “LAW”) AND OAJ=(“ALL OPEN ACCESS”) AND LA=(“ENGLISH”) AND DT=(“ARTICLE” OR “REVIEW” OR “EARLY ACCESS”))

For Overton, we used “(Extended AND producer AND responsibility) AND (marine OR ocean OR water) AND plastic\* AND (waste OR litter OR pollut\*)”.

Table 1 contains our inclusion and exclusion criteria, which guided the screening process. Two of the authors carried out the screening of the titles, abstracts and full text in the Web of Science corpus. When there was uncertainty around the relevance

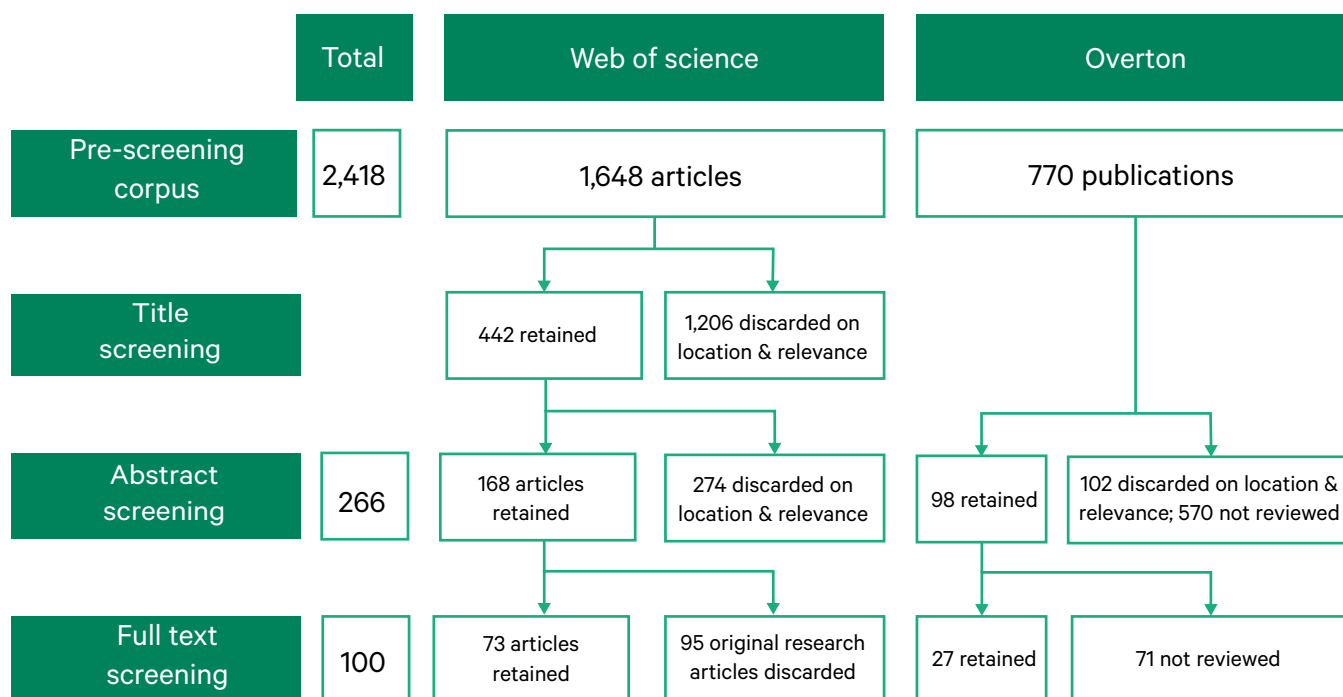
of the article, it was retained for the next level screening. For quality assurance, a third author verified 50% of the title, abstract and full text screening, and 50% of the coding. Given the substantial number of relevant articles retained at the level of abstract screening, we focused on the 73 review articles for the full text screening and coding. For the Overton corpus, the articles were ranked according to relevance. We screened 200 publications at abstract or executive summary, retaining 98 publications. We screened the 27 most relevant articles on full text, resulting in a final corpus for coding 100 publications.

Table 1. Overview inclusion and exclusion criteria

| Category            | Inclusion                                                                                                                                           | Exclusion criteria                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Population</b>   | Search engine policy: Overton<br>Search engine academic: Web of Science<br>Specific information collected from partners                             | Other search engines                                                                                                                                                                                                                                                                                                                                                                 |
|                     | Studies with policy recommendations                                                                                                                 | Studies without policy recommendations (screening for this criterion at full text level)                                                                                                                                                                                                                                                                                             |
|                     | G20 countries                                                                                                                                       | Non G-20 countries                                                                                                                                                                                                                                                                                                                                                                   |
|                     | English                                                                                                                                             | Non-English                                                                                                                                                                                                                                                                                                                                                                          |
|                     | Publications or working papers;<br>For Web of Science: only open access; selected academic disciplines; articles (see detailed search string below) | Other types of publications                                                                                                                                                                                                                                                                                                                                                          |
|                     | 2017 to 2023                                                                                                                                        | Before 2017                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Intervention</b> | Studies on the topic of extended producer responsibility (EPR),<br>marine litter, plastics<br>Extended AND producer AND responsibility              | Anything not related to EPR – like plastic surgery and other waste management interventions. Studies not connected to the topic, such as biology, farming, fisheries, impact on animals or other organisms in the ocean. Papers that do not cover recommendations, or discuss waste management in general without focus on plastic waste<br>Exclude measurement<br>Exclude transport |
| <b>Comparison</b>   | n/a – looking only at EPR and not searching for other regulatory instruments or interventions                                                       | n/a                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Outcomes</b>     | Marine OR ocean OR water<br>AND<br>Plastic*<br>AND<br>Waste OR litter OR pollut*                                                                    |                                                                                                                                                                                                                                                                                                                                                                                      |

Figure 1 provides details on this process and the number of retained articles, using the PRISMA flow chart (Page et al., 2021).

Figure 1. PRISMA Flow chart – systematic map



Source: Authors' own

Our coding framework is provided in Table 2, having selected the coding categories given the challenges found in literature (see e.g. Johannes et al., 2021). For example, challenges have been reported related to technology, legislative frameworks, collaboration and knowledge sharing, and digitalization. In some articles and reports, specific countries were mentioned, whereas others provided more general recommendations. For comprehensiveness, we retained both types of policy recommendations. In our coding of full texts, we first collated the findings per author across the various categories. Then, we summarized these findings across authors per category, for the main section of the brief (see part 2 and 3). See Table 3 for an overview of recommendations to strengthen the EPR system, organized into legislative, technological, market, enforcement and collaboration categories.

Table 2. Coding framework

| Category                                    | Recommendations related to                                               |
|---------------------------------------------|--------------------------------------------------------------------------|
| Legislative framework and regulation        | Banning and prohibiting plastics,                                        |
| Technological innovation and infrastructure | Infrastructure, new technologies, bioplastics, etc.                      |
| The market system and incentives            | Incentives and rewards for actors along the plastic value chain; pricing |
| Collaboration and knowledge sharing         | Awareness raising and education                                          |
| Enforcement and data                        | Data needs, monitoring,                                                  |
| Informal sector workers                     | Wages, recognition, training                                             |

Table 3. Overview of recommendations in the reviewed literature for improving EPR for plastics

| Category                                           | Recommendations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Legislative framework and regulation</b>        | <ul style="list-style-type: none"> <li>• Provide a more precise and concise outlook regarding the plastic waste supply chain's role and responsibilities within the legal framework.</li> <li>• Effectively implement the regulation of the brominated flame retardants under the Stockholm Convention for remediating the initial 12 POPs.</li> <li>• Phase out or ban certain items or materials like single-use plastic products.</li> <li>• Under the polluter pays principle, impose fines for littering, dumping waste and illegal disposal.</li> <li>• Under the user pays principle, impose a tourist tax, which can then contribute to beach cleaning and improving waste infrastructure.</li> <li>• Establish a legally binding global governance arrangement.</li> <li>• Remove plastic microbeads from personal care products.</li> <li>• Encourage the use of degradable/compostable plastics.</li> <li>• Ban or tax plastic products that are harmful to the environment, without compromising public health or food safety and increasing demand for recycled plastics through benefits, sanctions or taxes on virgin plastics.</li> <li>• Implement waste collection systems that lead to reductions in waste production, improve recycling rates following the "pay-as-you-throw" principle, such as door-to-door collection and deposit refund systems.</li> <li>• Introduce mandatory international regulations for shipping routes on shipping spills.</li> <li>• Enforce strict legal obligations to avoid "Special Areas" and Particularly Sensitive Sea Areas (PSSAs), as designated by the IMO.</li> <li>• Limit ship sizes and where they can sail.</li> <li>• Mandate transparency on the ship crew and cargo contents in a public register.</li> <li>• Mandate a code of conduct for safety and its revision.</li> <li>• Place mandatory tracking devices and related technology on containers.</li> <li>• Strict regulations on the use of plastics in consumer packaging.</li> <li>• Apply stricter fines, impose sanctions or penalties for containers for shipping loss and for unreported spills at sea by container ships.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Technological innovation and infrastructure</b> | <ul style="list-style-type: none"> <li>• Identify the hotspot leakage points at the local level and establish easily accessible waste collection points in all local communities and consider increasing collection frequency as needed. When banning or regulating, consider the availability of infrastructure.</li> <li>• In collaboration with the international community, and guided by the recommendations developed under the Basel and Stockholm Conventions, adopt best available technologies, preventing serious contamination and impacts on human health and the environment Basel Convention 1992.</li> <li>• Promote disposal techniques that will destroy POPs irreversibly, to eliminate their persistence and avoid giving rise to toxic byproducts or metabolites.</li> <li>• Recover resources from common food packaging plastics – such as polyethylene (PE), polyethylene terephthalate (PET), polyvinyl chloride (PVC), and polypropylene (PP) – focusing on improved sorting and separation processes. These types are especially prevalent in food packaging and therefore represent significant opportunities for recovery and reprocessing.</li> <li>• Implement unique recycling technology for multilayer plastic polymers – there is, according to scholars, "no mainstream solution for recycling multi-material multilayers plastic packaging in the next 5-10 years" (Soares et al., 2022).</li> <li>• Scale up and commercialize bio-based plastic.</li> <li>• Creating technologies and designs that can deal with waste management.</li> <li>• Improve waste management performance, infrastructure and ability to stop large items of plastic waste from entering the oceans.</li> <li>• Prevent microfibres from clothing and small plastic fragments and beads from entering wastewater by putting filters on washing machines.</li> <li>• Engage in ecodesign – avoiding unnecessary packaging (e.g. double packaging).</li> <li>• Use renewable energy for recycling.</li> <li>• Use bio-based and biodegradable plastics.</li> <li>• Improve the development of appropriate recycling technologies for disposable (single-use) personal protective equipment.</li> <li>• Speed up global technology transfer (reverse innovation from developing to developed countries), especially research on the use of plastics in the field of construction.</li> <li>• Increase the processing capacity of plastic waste in developing countries, which will reduce the cost of handling.</li> <li>• Reduce the impact of plastic in paint by promoting the use of particulate-capturing devices, waste collection systems and recycling facilities during paint disturbance; develop means by which paint particles are isolated from the environment</li> <li>• Improve the management of foamed polystyrene throughout its life cycle.</li> <li>• Redesign multi-component plastic structures to single component plastics (maximizing recyclability).</li> <li>• Develop methods to separate the components from the multilayer structures.</li> </ul> |

| Category                                                                  | Recommendations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>The market system and incentives</b>                                   | <ul style="list-style-type: none"> <li>• Provide incentives for fishers for removing debris from the sea and to coastal villages that have integrated waste management systems to manage the entire waste streams.</li> <li>• Develop a monetized collection model which provides economic benefits to all actors.</li> <li>• Establish a market value for recycled materials by investing in recycling and sorting capacity and creating the necessary infrastructure; as well as create a price difference between virgin and recycled plastic (e.g. tax the use of virgin plastics or differentiate taxes for recycled plastics to create a price incentive).</li> <li>• Reduce cleaning costs and depreciation of environmental health and biodegradation.</li> <li>• Include the end-of-life costs in the upfront price of plastics. For deposit refund systems, increased revenues through material sales in most cases only partially cover the increased costs, meaning that such programs typically require financial support through producer fees or from the public sector. Unredeemed deposits can partially offset the costs of operating the deposit refund systems. However, complementary policies, such as collection targets or a tax tied to collection rates should be considered to incentivize collectors to strive for high return rates and not excessively rely on financing from unclaimed deposits.</li> <li>• Capital is required for successful implementation and support of technology. Products that are unreturned can cause externalities when they are littered or disposed of in general household waste. Public authorities can fully or partially claim revenues from unredeemed deposits and earmark the income to cover costs associated with these externalities, such as financing clean-up of littered items or contributing to the costs of sorting and treating residual waste.</li> <li>• Increase incentives (financial gain or market advantages) to encourage industry to increase recycling activities.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Collaboration and knowledge sharing</b>                                | <ul style="list-style-type: none"> <li>• Raise awareness on the impact of plastics, and in particular microplastics, on the environment.</li> <li>• Engage citizens, businesses and communities to make a transition from plastics and switch to eco-friendly alternatives that are affordable.</li> <li>• Promote voluntary initiatives (e.g. fishing for litter), including company commitments and alliance and group initiatives (see e.g. Changing Markets Foundation, 2020, for a critical review of these initiatives).</li> <li>• Support underwater clean-ups in hotspot areas, such as removing abandoned, lost or otherwise discarded fishing gear from accumulation areas.</li> <li>• Improve collaboration between research and industry startups for the upscaling and commercialization of bio-based plastic.</li> <li>• Provide encouragement and support for low-income countries to adopt environmentally sound technologies from developed countries via the Clean Development Mechanism of the Kyoto Protocol.</li> <li>• Invest in applied research and the construction of new facilities.</li> <li>• Adopt trade policies that could help to mitigate environmental risks, while also creating new economic opportunities, e.g. for investment and job creation.</li> <li>• Build decision-support systems to help communities visualize litter impacts and possible solutions.</li> <li>• Raise awareness of the potential impacts of discarded paint among users.</li> <li>• Conduct leverage points assessments of specific interventions against pollution, to collect social-ecological information on a wide range of issues and sources, including consideration of the systemic depth of the interventions proposed or implemented.</li> <li>• Adopt citizen science through mobile app use to strengthen monitoring capacities.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Enforcement and data (digitalization, traceability and compliance)</b> | <ul style="list-style-type: none"> <li>• Enforce source-specific waste reduction, both at industrial and household levels.</li> <li>• Establish real-time monitoring and open-access platforms for mapping plastic production, demand and waste. Include data on hard-to-recycle materials like black plastic to set accountable EPR targets.</li> <li>• Adopt a labelling system to indicate the number of times a plastic product has been recycled to improve tracking of recycled and virgin plastic consumption.</li> <li>• Adopt an integrated plastic waste management system using Life Cycle Assessment to evaluate environmental impacts across the product lifecycle, informed by consumption data and regulations.</li> <li>• Use consistent monitoring, review and verification mechanisms, in yearly and future projection reports of waste generation amounts, coupled with implementation of the rules and EPR policy to ensure the accountability of waste generators (importers/manufacturers).</li> <li>• Embed the institutional framework for the state and local governments' marine debris actions into their solid waste management strategy and the action plans.</li> <li>• Use enforcement as a tool to ensure stakeholders comply with existing legal provisions. For example, enforcement of ship waste acceptance rules in harbours.</li> <li>• Improve the monitoring of EPR at the level of supermarkets and various brands, where compliance to regulation is not properly implemented (The Energy and Resources Institute, 2020).</li> <li>• Targets are needed to ensure that the system works towards high collection rates.</li> <li>• Develop a traceable "DNA" or marker system for plastics, enabling identification by both type and producer. This would enhance traceability and accountability, supporting enforcement and compliance efforts in addressing marine plastic litter.</li> <li>• Create an international manifest system for tracking the movement of plastic waste in importing countries, to build a traceability system and ensuring appropriate plastics waste treatment.</li> <li>• Implementation of life cycle assessment for each product and process to improve ecodesign (including reuse, repair and recyclability), taking into consideration expected end-of-life of products.</li> <li>• Support research into a combined underwater acoustic and video remote sensing approach to tracking plastic in marine settings.</li> </ul> |

| Category                       | Recommendations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Informal sector workers</b> | <ul style="list-style-type: none"> <li>• Integrate informal recyclers into formal collection and recycling systems to ensure their inclusion in decision-making processes and safeguard their livelihoods. Design policies, such as EPR, with active consultation and participation from informal recyclers to address their needs and perspectives.</li> <li>• Consider socio-economic impacts of regulations, such as single-use plastic bans, to prevent unintended consequences for vulnerable workers and price-sensitive consumers.</li> <li>• Improve the collection system's performance through training of waste workers.</li> <li>• Increase its capacity and enhance waste workers' knowledge.</li> <li>• Give better visibility to waste workers.</li> </ul> |

Sources: Based on Armenise et al. (2021), Ayre (2018), Dey et al. (2021), EPA (2020), Ferronato & Torretta (2019), Filiciotto & Rothenberg (2021), Freeman et al. (2020), Gaylarde et al. (2021), Hale et al. (2020), IEEP (2017), Kumar et al. (2021), Lamba et al. (2022), Landrigan et al. (2020), Laubinger et al. (2022), Lincoln et al. (2022), Madricardo et al. (2020), Martinho et al. (2022), Mazhandu et al. (2020), Napper & Thompson (2020), Nikiema & Asiedu (2022), Pani & Pathak (2021), Prata et al. (2019), Riechers et al. (2021), Saliba et al. (2022), Schmaltz et al. (2020), Schneider et al. (2018), Sharma et al. (2021), Tsuchimoto & Kajikawa (2022), Turner (2020, 2021), Vince & Hardesty (2018), Williams & Rangel-Buitrago (2019, 2022)

\*Note: we acknowledge that new regulations have come into play following on from some of the publications included in our review. Our systematic map covers all recommendations reported in the retained corpus.

## Annex references

- Alfers, L., Chen, M., & Plagerson, S. (2022). Social contracts and informal workers in the Global South. In *Social Contracts and Informal Workers in the Global South*. Edward Elgar Publishing. <https://www.elgaronline.com/display/book/9781839108068/9781839108068.xml>
- Armenise, S., SyieLuing, W., Ramírez-Velásquez, J. M., Launay, F., Wuebben, D., Ngadi, N., Rams, J., & Muñoz, M. (2021). Plastic waste recycling via pyrolysis: A bibliometric survey and literature review. *Journal of Analytical and Applied Pyrolysis*, 158, 105265-. <https://doi.org/10.1016/j.jaap.2021.105265>
- Ayre, D. (2018). Technology advancing polymers and polymer composites towards sustainability: A review. *Current Opinion in Green and Sustainable Chemistry*, 13, 108–112. <https://doi.org/10.1016/j.cogsc.2018.06.018>
- Bhadra, U., & Mishra, P. P. (2021). Extended Producer Responsibility in India: Evidence from Recykal, Hyderabad. *Journal of Urban Management*, 10(4), 430–439. <https://doi.org/10.1016/j.jum.2021.07.003>
- Central Pollution Control Board. (2021). *Annual Report 2019-20 on Implementation of Plastic Waste Management Rules*. <https://cpcb.nic.in/status-of-implementation-of-plastic-waste/>
- Department of Environment, Forest and Climate Change, Government of Uttar Pradesh. (2022). *Uttar Preadesh Roadshow 2021—Pathways For Preventing Riverine & Marine Litter: Enabling A Circular Economy Framework for the State Of Uttar Pradesh*.
- Dey, A., Dhumal, C. V., Sengupta, P., Kumar, A., Pramanik, N. K., & Alam, T. (2021). Challenges and possible solutions to mitigate the problems of single-use plastics used for packaging food items: A review. *Journal of Food Science and Technology*, 58(9), 3251–3269. <https://doi.org/10.1007/s13197-020-04885-6>
- Fadeeva, Z., & Van Berkel, R. (2021). Unlocking circular economy for prevention of marine plastic pollution: An exploration of G20 policy and initiatives. *Journal of Environmental Management*, 277, 111457. <https://doi.org/10.1016/j.jenvman.2020.111457>
- Fadeeva, Z., & Van Berkel, R. (2021). Unlocking circular economy for prevention of marine plastic pollution: An exploration of G20 policy and initiatives. *Journal of Environmental Management*, 277, 111457. <https://doi.org/10.1016/j.jenvman.2020.111457>
- Ferronato, N., & Torretta, V. (2019). Waste mismanagement in developing countries: a review of global issues. *International Journal of Environmental Research and Public Health*, 16(6), 1060. <https://doi.org/10.3390/ijerph16061060>
- Filiciotto, L., & Rothenberg, G. (2021). Biodegradable plastics: standards, policies, and impacts. *ChemSusChem*, 14(1), 56–72. <https://doi.org/10.1002/cssc.202002044>
- Freeman, J., Park, S., & Middleton, C. (2020). Technological literacy and interrupted internet access. *Information, Communication & Society*, 23(13), 1947–1964. <https://doi.org/10.1080/1369118X.2019.1623901>

- Gaylarde, C., Baptista-Neto, J. A., & da Fonseca, E. M. (2021). Plastic microfibre pollution: How important is clothes' laundering? *Heliyon*, 7(5), e07105. <https://doi.org/10.1016/j.heliyon.2021.e07105>
- Gupt, Y., & Sahay, S. (2015). Review of extended producer responsibility: A case study approach. *Waste Management & Research*, 33(7), 595–611. <https://doi.org/10.1177/0734242X15592275>
- Gupta, D., & Dash, S. (2023). Challenges of implementing extended producer responsibility for plastic-waste management: Lessons from India. *Social Responsibility Journal*, ahead-of-print(ahead-of-print). <https://doi.org/10.1108/SRJ-08-2022-0326>
- Hale, R. C., Seeley, M. E., La Guardia, M. J., Mai, L., & Zeng, E. Y. (2020). A global perspective on microplastics. *Journal of Geophysical Research: Oceans*, 125(1), e2018JC014719. <https://doi.org/10.1029/2018JC014719>
- Hossain, R., Islam, M. T., Shanker, R., Khan, D., Locock, K. E. S., Ghose, A., Schandl, H., Dhodapkar, R., & Sahajwalla, V. (2022). Plastic waste management in India: Challenges, opportunities, and roadmap for circular economy. *Sustainability*, 14(8), Article 8. <https://doi.org/10.3390/su14084425>
- IBEF. (2022). *Indian Plastics Industry and Exports*. India Brand Equity Foundation. <https://www.ibef.org/exports/plastic-industry-india>
- Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., Narayan, R., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, 347(6223), 768–771. <https://doi.org/10.1126/science.1260352>
- Johannes, H. P., Kojima, M., Iwasaki, F., & Edita, E. P. (2021). Applying the extended producer responsibility towards plastic waste in Asian developing countries for reducing marine plastic debris. *Waste Management & Research: The Journal for a Sustainable Circular Economy*, 39(5), 690–702. <https://doi.org/10.1177/0734242X211013412>
- Kumar, R., Verma, A., Shome, A., Sinha, R., Sinha, S., Jha, P. K., Kumar, R., Kumar, P., Shubham, Das, S., Sharma, P., & Vara Prasad, P. V. (2021). Impacts of plastic pollution on ecosystem services, sustainable development goals, and need to focus on circular economy and policy interventions. *Sustainability*, 13(17), Article 17. <https://doi.org/10.3390/su13179963>
- Lamba, P., Kaur, D. P., Raj, S., & Sorout, J. (2022). Recycling/reuse of plastic waste as construction material for sustainable development: A review. *Environmental Science and Pollution Research*, 29(57), 86156–86179. <https://doi.org/10.1007/s11356-021-16980-y>
- Landrigan, P. J., Stegeman, J. J., Fleming, L. E., Allemand, D., Anderson, D. M., Backer, L. C., Brucker-Davis, F., Chevalier, N., Corra, L., Czerucka, D., Bottein, M.-Y. D., Demeneix, B., Depledge, M., Deheyn, D. D., Dorman, C. J., Fénichel, P., Fisher, S., Gaill, F., Galgani, F., ... Rampal, P. (2020). Human health and ocean pollution. *Annals of Global Health*, 86(1), 151. <https://doi.org/10.5334/aogh.2831>
- Laubinger, F., Brown, A., Börkey, P., & Dubois, M. (2022). Deposit-refund systems and the interplay with additional mandatory extended producer responsibility policies [Document]. OECD. <https://doi.org/10.1787/a80f4b26-en>
- Lincoln, S., Andrews, B., Birchenough, S. N. R., Chowdhury, P., Engelhard, G. H., Harrod, O., Pinnegar, J. K., & Townhill, B. L. (2022). Marine litter and climate change: Inextricably connected threats to the world's oceans. *Science of The Total Environment*, 837, 155709. <https://doi.org/10.1016/j.scitotenv.2022.155709>
- Madricardo, F., Ghezzi, M., Nesto, N., Mc Kiver, W. J., Faussone, G. C., Fiorin, R., Riccato, F., Mackelworth, P. C., Basta, J., De Pascalis, F., Kruss, A., Petrizzo, A., & Moschino, V. (2020). How to deal with seafloor marine litter: an overview of the state-of-the-art and future perspectives. *Frontiers in Marine Science*, 7. <https://www.frontiersin.org/articles/10.3389/fmars.2020.505134>
- Martinho, S. D., Fernandes, V. C., Figueiredo, S. A., & Delerue-Matos, C. (2022). Microplastic pollution focused on sources, distribution, contaminant interactions, analytical methods, and wastewater removal strategies: A review. *International Journal of Environmental Research and Public Health*, 19(9), Article 9. <https://doi.org/10.3390/ijerph19095610>

- Mazhandu, Z. S., Muzenda, E., Mamvura, T. A., Belaid, M., & Nhubu, T. (2020). Integrated and consolidated review of plastic waste management and bio-based biodegradable plastics: challenges and opportunities. *Sustainability*, 12(20), Article 20. <https://doi.org/10.3390/su12208360>
- Ministry of Environment, Forest and Climate Change. (2020, June 23). *Guideline Document Uniform Framework for Extended Producers Responsibility (Under Plastic Waste Management Rules, 2016)*. <https://moef.gov.in/en/guideline-document-uniform-framework-for-extended-producers-responsibility-under-plastic-waste-management-rules-2016/>
- Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A., & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Medical Research Methodology*, 18(1), 143. <https://doi.org/10.1186/s12874-018-0611-x>
- Napper, I. E., & Thompson, R. C. (2020). plastic debris in the marine environment: history and future challenges. *Global Challenges*, 4(6), 1900081. <https://doi.org/10.1002/gch2.201900081>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
- Pani, S. K., & Pathak, A. A. (2021). Managing plastic packaging waste in emerging economies: The case of EPR in India. *Journal of Environmental Management*, 288, 112405. <https://doi.org/10.1016/j.jenvman.2021.112405>
- Peters, M. D. J., Godfrey, C. M., Khalil, H., McInerney, P., Parker, D., & Soares, C. B. (2015). Guidance for conducting systematic scoping reviews. *International Journal of Evidence-Based Healthcare*, 13(3), 141–146. <https://doi.org/10.1097/XEB.0000000000000050>
- Pham, M. T., Rajić, A., Greig, J. D., Sargeant, J. M., Papadopoulos, A., & McEwen, S. A. (2014). A scoping review of scoping reviews: Advancing the approach and enhancing the consistency. *Research Synthesis Methods*, 5(4), 371–385. <https://doi.org/10.1002/jrsm.1123>
- Prata, J. C., Silva, A. L. P., da Costa, J. P., Mouneyrac, C., Walker, T. R., Duarte, A. C., & Rocha-Santos, T. (2019). Solutions and integrated strategies for the control and mitigation of plastic and microplastic pollution. *International Journal of Environmental Research and Public Health*, 16(13), Article 13. <https://doi.org/10.3390/ijerph16132411>
- Rafey, A., & Siddiqui, F. Z. (2021). A review of plastic waste management in India – challenges and opportunities. *International Journal of Environmental Analytical Chemistry*, 0(0), 1–17. <https://doi.org/10.1080/03067319.2021.1917560>
- Riechers, M., Brunner, B. P., Dajka, J.-C., Duşe, I. A., Lübker, H. M., Manlosa, A. O., Sala, J. E., Schaal, T., & Weidlich, S. (2021). Leverage points for addressing marine and coastal pollution: a review. *Marine Pollution Bulletin*, 167, 112263. <https://doi.org/10.1016/j.marpolbul.2021.112263>
- Ryberg, M. W., Hauschild, M. Z., Wang, F., Averous-Monnery, S., & Laurent, A. (2019). Global environmental losses of plastics across their value chains. *Resources, Conservation and Recycling*, 151, 104459. <https://doi.org/10.1016/j.resconrec.2019.104459>
- Saliba, M., Frantzi, S., & van Beukering, P. (2022). Shipping spills and plastic pollution: a review of maritime governance in the North Sea. *Marine Pollution Bulletin*, 181, 113939. <https://doi.org/10.1016/j.marpolbul.2022.113939>
- Schmaltz, E., Melvin, E. C., Diana, Z., Gunady, E. F., Rittschof, D., Somarelli, J. A., Virdin, J., & Dunphy-Daly, M. M. (2020). Plastic pollution solutions: emerging technologies to prevent and collect marine plastic pollution. *Environment International*, 144, 106067. <https://doi.org/10.1016/j.envint.2020.106067>
- Schneider, F., Parsons, S., Clift, S., Stolte, A., & McManus, M. C. (2018). Collected marine litter—a growing waste challenge. *Marine Pollution Bulletin*, 128, 162–174. <https://doi.org/10.1016/j.marpolbul.2018.01.011>
- Sharma, S., Sharma, V., & Chatterjee, S. (2021). Microplastics in the Mediterranean Sea: Sources, pollution intensity, sea health, and regulatory policies. *Frontiers in Marine Science*, 8. <https://www.frontiersin.org/articles/10.3389/fmars.2021.634934>

- Sivadas, S. K., Mishra, P., Kaviarasan, T., Sambandam, M., Dhineka, K., Murthy, M. V. R., Nayak, S., Sivyer, D., & Hoehn, D. (2022). Litter and plastic monitoring in the Indian marine environment: A review of current research, policies, waste management, and a roadmap for multidisciplinary action. *Marine Pollution Bulletin*, 176, 113424. <https://doi.org/10.1016/j.marpolbul.2022.113424>
- Statista. (2022). *Plastic industry in India—Statistics and facts*. Statista. <https://www.statista.com/topics/6902/plastic-industry-in-india/>
- Tsuchimoto, I., & Kajikawa, Y. (2022). Recycling of plastic waste: a systematic review using bibliometric analysis. *Sustainability*, 14(24), Article 24. <https://doi.org/10.3390/su142416340>
- Turner, A. (2020). Foamed polystyrene in the marine environment: sources, additives, transport, behavior, and impacts. *Environmental Science & Technology*, 54(17), 10411–10420. <https://doi.org/10.1021/acs.est.0c03221>
- Turner, A. (2021). Paint particles in the marine environment: an overlooked component of microplastics. *Water Research X*, 12, 100110. <https://doi.org/10.1016/j.wroa.2021.100110>
- Williams, A. T., & Rangel-Buitrago, N. (2019). Marine litter: solutions for a major environmental problem. *Journal of Coastal Research*, 35(3), 648–663. <https://doi.org/10.2112/JCOASTRES-D-18-00096.1>
- Williams, A. T., & Rangel-Buitrago, N. (2022). The past, present, and future of plastic pollution. *Marine Pollution Bulletin*, 176, 113429. <https://doi.org/10.1016/j.marpolbul.2022.113429>

Stockholm Environment Institute is an international non-profit research institute that tackles climate, environment and sustainable development challenges.

We empower partners to meet these challenges through cutting-edge research, knowledge, tools and capacity building. Through SEI's HQ and seven centres around the world, we engage with policy, practice and development action for a sustainable, prosperous future for all.

---

#### Visit us at

- 1 SEI Headquarters
- 2 SEI York
- 3 SEI US
- 4 SEI Tallinn
- 5 SEI Oxford
- 6 SEI Asia
- 7 SEI Africa
- 8 SEI Latin America

