Proposal to limit the generation of disposable products and to regulate plastics

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PLASTIC™ OCEANS

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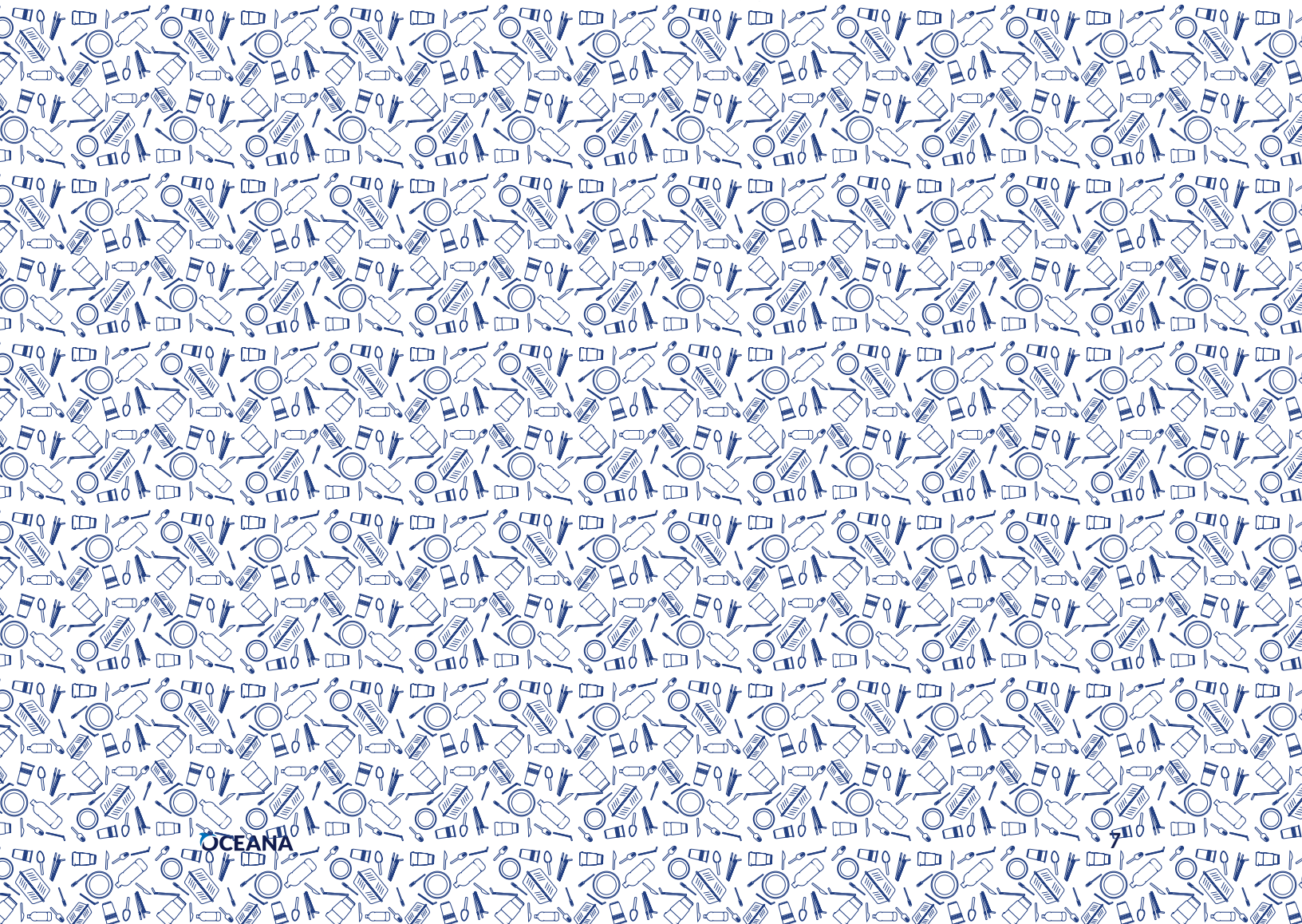
INDEX

I. PROPOSAL TO LIMIT THE PRODUCTION OF DISPOSABLE PRODUCTS AND REGULATE PLASTICS



1. Background information

The sustained increase in the production of waste, particularly plastics, is one of the primary challenges that Chile must face. Chile currently produces more solid municipal waste per capita than Mexico and Brazil, even though both of these countries exceed by far Chile's population and size of the economy[1].

Pollution from plastics is a global environmental problem that is threatening biodiversity. The impact from plastics has been recorded in over 800 marine and coastal species due to plastic ingestion, entanglement, ghost fishing, species dispersion and habitat degradation[2].

Three-quarters of all marine debris is plastic, a persistent and potentially hazardous pollutant, since it may contain toxic chemicals or acquire them from the environment[3]. According to recent estimates, an average of at least eight million tons of plastic enter the sea every year[4].

Waste most commonly found during beach clean-ups are disposable plastics or single use plastics, such as bottles and caps, food packaging, bags, straws and stirrers, and foam take-away containers, an issue that projects onto the water column and seabed[5].

At the global level, of nine billion tons of plastic produced only 9% has been recycled[6]. Recycling municipal plastics is an additional problem. Recycling industrial plastics is more feasible because they are homogeneous, whereas municipal plastic waste is heterogeneous, meaning it has different shapes and types[7].

Even though a large part of plastics is, in theory, recyclable, not all of them are actually recycled. Small or lightweight products will hardly be recycled because their economic value or their volume is limited, but the cost of their collection, sorting and recycling is high[8]. International research estimates that about 30% of plastics will not be recycled and must therefore be replaced by other materials[9]. In short, small or light objects, and especially plastic objects, can only enter the circular economy by preventing their generation and by reusing them.

Plastics can take hundreds of years to degrade under environmental conditions. Expanded polystyrene or styrofoam can even take 1,000 years to degrade in unsuitable conditions[10].

At present, there are alternatives to traditional plastics, such as oxo biodegradables, bioplastics and compostables. However, these are not necessarily degradable in natural environments, but require specific or industrial conditions[11]. It is also important to be clear on the fact that a plastic made from

1 OCDE, Naciones Unidas, CEPAL (2016) Evaluaciones del desempeño ambiental, Chile.

2 Secretariat of the Convention on Biological Diversity (2016) Marine debris: understanding, preventing and mitigating the significant adverse impacts on marine and coastal diversity. CBD Tech. Ser. 83, Secr. CBD, Montreal, QC, Can.

3 Ibid, reference 2.

4 Jambeck JR, R Geyer, C Wilcox, TR Siegler, M Perryman, A Andrady, R Narayan & KL Law (2015) Plastic waste inputs from land into the ocean. Science 347(6223): 768-771.

5 UNEP (2018) Single-Use Plastics: A Roadmap for Sustainability.

6 Geyer R, JR Jambeck & KL Law (2017) Production, use, and fate of all plastics ever made. Science Advances 3: 1700782.

7 Panda AK, RK Singh & DK Mishra (2010) Thermolysis of waste plastics to liquid fuel: A suitable method for plastic waste management and manufacture of value added products. A world prospective. Renewable and Sustainable Energy Reviews 14(1): 233-248.

8 Ellen McArthur Foundation (2016) The new plastics economy: Catalysing action.

9 Ibid, reference 8.

10 Ibid, reference 5.

11 Lambert S & M Wagner (2017) Environmental performance of bio-based and biodegradable plastics: the road ahead. Chemical Society Reviews 46(22): 6855-6871.

renewable resources does not mean it's biodegradable, just as there are plastics made from non-renewable resources that are biodegradable[12]. Even oxo biodegradable plastics do not fully degrade, but only fragment into tiny plastic pieces, increasing the problem of microplastics[13].

Therefore, alternative plastics can suffer the same problems as traditional plastics in terms of the cost of collection, sorting and treatment, and will end up in the sea just like traditional plastics. This makes it necessary to foster the creation of products that are effectively more sustainable than traditional plastics by regulating their requirements. Certification of these new plastics will generate prosperous environments for the innovation of new materials and products.

Another negative consequence from plastics is the exploitation and production of oil, primary raw material of plastic products that has contributed to increase the levels of greenhouse gases, directly influencing climate change[14].

Chile has been enforcing Law 29.920 since 2016, which establishes a framework for waste management, extended producer responsibility and promotes recycling ("Ley REP" in Spanish). Through Supreme Decrees issued by virtue of this Law, goals and other mandatory provisions related to each priority product will be established. There is, however, no certainty that producers should be responsible for the specific good they introduce to the market due to problems with traceability, but they could comply with general waste management goals. This will naturally result in the consequence that no actor will take responsibility for small or lightweight plastics which carry high costs for their collection, sorting and recycling.

Due to the above, the use of a product with these characteristics does not justify its disposable use, meaning plastic should be utilized in cases in which its characteristics justify such use, and its reuse and recycling are effective. Several countries have disposable regulated plastics. In this logic, Law REP establishes the principle of hierarchy in waste management, which sets an order of preference for management that considers prevention as the first choice in waste production.

Because plastic containers and packaging are a priority product for Law REP and will be mainly regulated by this law, this proposal aims to regulate other main disposable plastics such as hot and cold beverage cups, mugs, cutlery (fork, spoon, knife), stirrers, straws, plates, trays or containers for prepared food and their accessory packaging, lids, bottles equal to, or less than 500cc, or others that fulfill the purpose of these individualized products. Thus, the only packaging that this proposal aims to regulate are containers or trays for prepared food and their accessory packaging, and bottles equal to or less than 500cc since these are plastics mainly generated in food vending establishments, which aim to be regulated.

In addition, this proposal was prepared based on Law 21.100 which bans the provision of commercial plastic bags in the entire national territory, with the purpose of having both regulations maintain the same logic. Thus, both regulations control the provision of disposable and plastic elements, which will have to be supervised by municipalities and will include sanctions that will be applied to the establishments by local police courts.

Finally, a series of bills that seek to regulate and deal with the problems associated with single-use plastics have been presented cross-sectionally. Among them are the Bulletin N ° 10.054-12 that regulates plastic bags and films and seeks that these are degradable; Bulletin 11.809-12 that prohibits the manufacture of disposable plastic bottles; Bulletin No. 11.887-12 that prohibits the use of single-use

12 Ibid, reference 11.

13 Ibid, reference 11.

14 The United Nations Framework Convention on Climate Change. Consultative Group of Experts on National Communications from Parties not included in Annex I of the Convention (GCE): Energy sector handbook – burning fuels.

plastics when the sustainable alternatives of these are available; Bulletin No. 11.301-03 requires that information be provided regarding the material of the plastic wrappers of the products; and Bulletin No. 11.802-12 that prohibits the use of plastic containers and packaging, among other initiatives.

2. Proposal

The regulation that is being proposed aims to gradually regulate disposable plastic products and the reusage of the products that will be regulated. Among these are hot and cold beverage cups, mugs, cutlery (fork, spoon, knife), stirrers, straws, plates, packaging or trays for prepared food and their accessory packaging, caps, lids, bottles equal to or less than 500 cc or others that fulfill the purpose of the individualized products.

The regulation is aimed at food vending establishments where people consume food, such as restaurants, cafeterias, social clubs, coffee shops, bakeries, bars and other venues that sell prepared food or beverages.

The following mandatory provisions and regulations will be gradually established in time:

After the first six months of the law's effective date, establishments, including those that sell ready-to-eat takeout and delivery, are banned from providing one of the plastics that is most harmful for the environment: expanded polystyrene, also known as Styrofoam. This ban will star to be enforced on small and medium businesses a year after the law's effective date.

After one year, consumers who eat at the establishments will have to be provided with regulated products made of reusable materials such as ceramic, glass, metal, wood, clay or others that have been designed to be used multiple times.

Reusable plastics will even be allowed; however, because plastics are currently the primary disposable product, a presumption will be established that means venues that use plastics will have to demonstrate that they are being reused.

The only disposable regulated products that establishments will be allowed to provide are wrappers for prepared food and bottle caps, which will have to be made from materials other than plastic or certified plastics. For example, the provision of wrappers for empanadas, tacos or sandwiches will be allowed.

In addition, disposable regulated products for ready-to-eat takeout or delivery will be exempt from this requirement. In other words, when food is consumed outside the establishment, disposable products can be given.

This requirement will start to be enforced for small and medium businesses two years after the law's effective date.

After two years of the law's effective date, food service establishments that sell ready-to-eat takeout and delivery will be banned from providing disposable plastics. This ban will be enforced on small and medium businesses three years after the law's effective date.

Ultimately, once the law fully enters into effect, all establishments will have to provide reusable regulated products; the provision of wrappers for prepared food and disposable bottle caps made from materials that are not plastic or certified plastics will be allowed when the consumption is made inside the establishment. In addition, disposable products can be provided for take-away or delivery food, which must be made of materials other than plastic, or certified disposable plastic.

Disposable plastics will be certified once they comply with the following requirements: must be made of renewable raw materials; they must biodegrade in natural conditions within a time frame of no more than 180 days; and the biodegradation process must not release toxic waste into the environment.

3. Bill

Law that limits the production of disposable products and regulates plastics.

Article 1.- Objective. This law's objective is to protect the environment by limiting the production of regulated products, promote their reuse and the certification of disposable plastics.

Article 2.- Definitions. The following terms are defined for the effects of this law:

a) Regulated products: hot and cold beverage cups, mugs, cutlery (fork, knife, spoon), stirrers, straws, plates, packaging or trays for prepared food and their accessory packaging, caps, lids, bottles equal to or less than 500 cc, or others that fulfill the purpose of the individualized products.

b) Prepared food: culinary preparations made at food service establishments, ready to eat, whether hot or cold. Preparation includes cooking, chopping, slicing, mixing, freezing, heating, pressing, or other form of processing; includes culinary preparations made outside establishments, but sold in them, whose expiration date or duration date does not exceed six days.

c) Establishment: venue where food is sold and consumed, such as restaurants, cafeterias, social clubs, coffee shops, bakeries, bars or other establishments that serve prepared food or sell beverages.

d) Ready to eat takeout or delivery: prepared food that is consumed outside the establishment, whether takeout or delivery.

e) Disposable product: those that have been designed to be used on one occasion. It will be disposable if the establishment that provides them intends a single use for them, even though they can be used multiple times outside said establishment.

f) Plastic: a product whose component, whether total or combined, is a polymer produced from oil or renewable raw materials.

g) Reusable material: a product made of ceramic, glass, metal, wood, clay, plastic or others, that has been designed to be used multiple times.

h) Certified disposable plastic: that which copulatively complies with the following requirements, and is certified (i) comes from renewable raw materials, (ii) biodegrades under natural conditions within a time frame of no more than 180 days, and (iii) the biodegradation process does not release toxic waste into the environment it degrades in.

Article 3.- Consumption inside food venues. Every venue must provide consumers with regulated products made from reusable materials when consumption takes place inside venues; the provision of disposable regulated products, at any capacity, is prohibited.

The following are exempt from this obligation:

a) Disposable wrapping for prepared food made of materials other than plastic or certified disposable plastic.

b) Disposable bottle caps made of materials other than plastic or certified disposable plastic.

c) Disposable regulated products for food-to-go or delivery, meaning, when food is consumed outside venues.

Article 4.- Consumption outside venues. The provision of disposable regulated products is allowed when the consumption of food refers to food-to-go or delivery.

However, the provision, at any capacity, of regulated products made from non-certified disposable plastic is banned.

Article 5.- Certified disposable plastics. Providing regulated products made of disposable plastic will be allowed if they have been certified by a competent authority, and the certification must be displayed on the regulated product.

Establishments that provide regulated products made of certified disposable plastic must display the corresponding certificate on their sides, in accordance to the rules specified in the regulation.

Other plastic products different than the regulated products may also access this certification.

Article 6.- Certification rules for disposable plastics. A regulation will establish the procedure by virtue of which disposable plastics will be certified. The minimum requirements that products must comply with in order to be certified will be the following:

a) Renewable origin: materials that are produced from renewable resources. Second or third generation raw materials or those that do not affect food safety must be preferred.

b) Degrade under natural conditions: materials that achieve their full degradation under environmental conditions, including conditions in the ocean.

c) Absence of toxic waste: materials that upon degradation present amounts of metal that are within the allowed range.

Article 7.- Presumption. It will be legally presumed that plastic regulated products are disposable plastics, and establishments will have to prove that they are being used as reusable materials, or that they are certified disposable plastics.

Article 8.- Inspection. It will be the responsibility of municipalities to oversee compliance with the provisions contained in this law, in accordance to its attributions set in section three of article 5 of the decree with force of law N°1 of 2006, of the Interior Ministry, that establishes the consolidated, coordinated and systematized text of constitutional organic Law N°18.695 on Municipalities.

Article 9.- Violation and fine. Noncompliance with the provisions in articles 3, 4 and 5 will be punished with a fine for municipal benefit of up to five monthly tax units for each regulated product that has been given. The punishments established in this law will be applied by the corresponding local police court, in accordance to the procedure included in law N°18.287, which establishes the procedure before local police courts.

Article 10.- Determination of the fine. the following circumstances will be considered to determine the fine indicated in the preceding article:

c) The number of commercial regulated products provided.

d) Offender's prior conduct.

e) Offender's financial capacity.

Article 11.- Environmental education. The competent authority will promote and implement environmental education programs for citizens, on disposable plastic products that are in circulation and their impact, and it will promote the use of reusable products.

Article 12.- Amend letter c) of article 13 of decree N° 307, of 1978, of the Ministry of Justice, that sets the consolidated, coordinated and systematized text of law N° 15.231, on the organization and attributions of local police courts, in the following manner:

1. In numeral 13, replace the final expression ", and", for a semicolon.

2. In numeral 14, substitute the final period for the expression ", and".

3. Add the following numeral 15:

"15° Law that regulates disposable plastic products and promotes reuse.".

Temporary provisions

First article.- The provisions in this law will enter into effect as of their publication in the Official Journal, except for the following:

1° Six months after this law enters into effect, venues will be banned from providing, at any capacity, regulated products made from expanded polystyrene for consumption inside and outside venues.

2° The provisions in article 3° will be enforced a year after this law is published.

3° The provisions in article 4° will be enforced two years after this law is published.

Second article.- Regarding micro businesses, small businesses and medium businesses established in section two of the Second Article of law N°20.416, the time extension of this law's entry into effect established in numerals 1° to 3° of the previous article, will be one year, two years and three years, respectively.

II. TECHNICAL AND LEGAL BACKGROUND

present in practically every aspect of people's daily life, from water bottles to construction material and medical supplies. Today, the annual production of plastic is over 300 million metric tons, which is expected to increase in the next decades, while the flow of plastics into the ocean is equal to dumping one garbage truck load per minute.

Waste in the sea is a global environmental problem that threatens marine and coastal biodiversity. Plastic accounts for three fourths of this waste, and impacts can already be observed at different levels of the marine ecosystem, affecting over 800 marine and coastal species through the ingestion of plastic, entanglement in plastic, ghost fishing, species dispersion and habitat degradation. According to evidence documented specifically in the Southeast Pacific, at least 97 species interact with plastic waste, including 53 species of marine birds, 20 fish species, 19 marine mammals and five marine turtle species.

In view of these numbers, Oceana Chile has produced a proposal to reduce the use of disposable plastic, on the foundation of technical and legal information detailed below.

The first chapter of this report presents an overview of the beginnings of plastic and its use, in Chile and the world, clarifying what plastic is, its origin, classification and processing methods, followed by a deeper look at the Chilean reality on recycling, and the costs and challenges related with this activity.

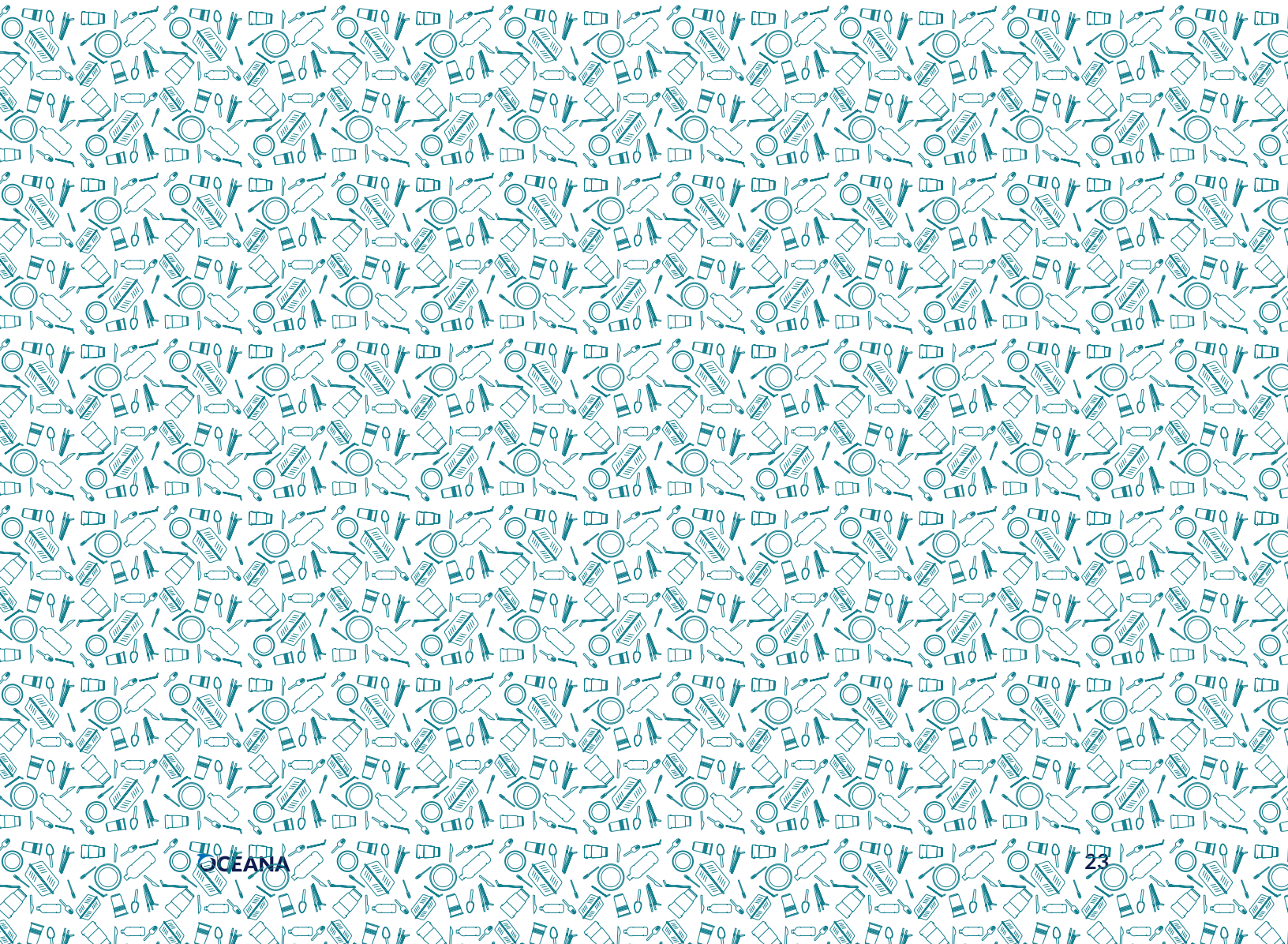
The next chapter describes and analyzes the different legislative and regulatory initiatives developed by several countries, cities and municipalities aiming their efforts to regulate and reduce single use plastics.

The third chapter describes the difficulties of recycling small-sized disposable plastics. In addition, the reason why biodegradable and compostable plastics share the same difficulties as traditional plastics is analyzed. In addition, the report establishes the specific characteristics that must be required from materials that will replace disposable plastics, and the certifications that would ensure compliance with these characteristics.

The last chapter revises some of the alternatives to traditional plastics, such as reusable products and other disposables. In addition, the report provides an analysis of two comparative regulations that focus on the use of reusable products and that limit the use of disposables.

1. Introduction

CHAPTER 1:
THE SITUATION OF PLASTICS IN CHILE AND THE WORLD



To understand the more complex dimension of the perception of plastic in current reality, an overview of the beginnings of this material and its use, in Chile and around the world, is necessary.

Therefore, a revision of the use of plastics around the world will be presented hereafter, establishing how this material has helped to shape and advance societies, and clarifying what plastics are, their origin, classification and processing methods, to later explore Chile's reality, its position in the world of recycling, and the costs and challenges of this practice.

2. Purpose

At the regional and global level, Chile has positioned itself as a pioneer in plastic recycling, creating innovative projects that have provided a concrete solution, transforming disposable material into raw material. However, there are still many products in the current market whose lifespan is brief or whose recycling process is unfeasible.

Considering the above, the purpose of this report is to collect information referring to the use of plastics in products of the national market, and how some of these hinder or make impossible their participation in the circular economy, due to factors as diverse as: complexity or unfeasibility of reuse, recycling and/or recollecting, costs related to this, downcycling and others.

3. Objectives

- Provide a global overview on the origin of plastic, its types and degradation.
- Draw attention to the current situation of plastic waste treatment in Chile.
- Recognize the costs and logistic challenges of a recycling system.

4. On the state of plastic: historical overview

Data provided in January 2016 by the World Economic Forum show that the global production of plastics has increased dramatically in the last 50 years: from 15 million tons in 1964, to 311 million in 2014 and consumption is expected to double in the next 20 years.

At the global level, only 14% of plastic is currently being recycled, a number much lower compared to paper (54%) and steel (70-90%). Of the 14% that is recycled, only 2% of the flow is recycled into products of equal or greater value (upcycling), 6% is recycled into products of less value that are then not further recycled (downcycling) and most of the rest is disposed of in legal and illegal landfills, and the sea. If consumption and behavior don't change, by 2025 the ocean is expected to contain a ton of plastic for every three tons of fish; and by 2050, there will be more tons of plastic than fish.

At present, the economy of plastics is highly fragmented. The lack of standards and coordination throughout the value chain has enabled a proliferation of materials, formats, labeling, and systems for recollection, separation and reprocess, which collectively have created obstacles for the development of efficient markets. Innovation is also fragmented. The development and introduction of new packaging materials and formats around the world is happening at greater speed and is very disconnected from the development of systems and infrastructure for disposal and reuse. At the same time, each year thousands of local and small-scale initiatives are launched, focusing on improving and/or developing technology for recollection and reprocessing (recycling) systems. All of the above, in addition to the lack of regulation for the labeling of containers and packages, creates confusion and infringes upon the

audience's comprehension.

According to numbers provided by Plastics Europe (2018), the global production of plastics has increased by 3.8% in the last 10 years, from 335 to 348 million tons. Of this amount, Latin America accounts for 4% of world production, while Asia accounts for 50.1% of the world production of plastics.

4.1 Use of plastics in the world

*INCLUDES THERMOPLASTICS, POLYURETHANES, THERMOSETS, ELASTOMERS, ADHESIVES, COATINGS AND SEALANTS AND PP-FIBERS. NOT INCLUDED PET-, PA- AND POLYACRYL-FIBERS.

The Science History Institute has been researching different scientific and global innovation processes for years, providing relevant data on plastic and its historical overview. The information of this segment, extracted from their article "The History and Future of Plastics", provides a general overview of plastic and its elaboration, use and disposal.

4.1.1 Materials and development: natural and synthetic polymers

Plastic is a word that originally meant "pliable and easy to shape"; it only recently became a name for a category of materials called polymers. The word polymer means "of many parts," and polymers are made of long chains of molecules. In addition, polymers abound in nature: cellulose, for example, is the material that makes up the cell walls of plants and is a very common natural polymer.

During the last century and a half, humans have learned how to make synthetic polymers, sometimes using natural substances like cellulose, but more often using carbon, whose atoms are provided by petroleum and other fossil fuels.
Synthetic polymers are made up of long chains of atoms, arranged in repeating units, often much longer

than those found in nature. It is the length of these chains, and the patterns in which they are arrayed, that make polymers strong, lightweight, and flexible. In other words, it's what makes them so plastic.

These properties make synthetic polymers exceptionally useful, and since humans learned how to create and manipulate them, polymers have become an essential part of our lives. Especially over the last 50 years plastics have saturated the world and changed the way we live.

4.1.2 History of plastic: synthetic polymers

The first synthetic polymer was invented in 1869 by John Wesley Hyatt, who was inspired by a New York firm's offer of $10,000 for anyone who could provide a substitute for ivory (the growing popularity of billiards had put a strain on the supply of natural ivory, obtained through the slaughter of wild elephants).

By treating cellulose, derived from cotton fiber, with camphor, Hyatt discovered a plastic that could be crafted into a variety of shapes and made to imitate natural substances like horn, linen, and ivory.

This discovery was revolutionary. For the first time human manufacturing was not constrained by the limits of nature, which only supplied wood, metal, stone, bone, tusk, and horn. Now humans could create new materials. This development helped not only people but also the environment. Advertisements praised celluloid as the savior of the elephant and the tortoise. It was thought then that plastics could protect the natural world from the destructive forces of human need; however, the global damage plastic would cause in the future could not yet be discerned.

4.1.3 The advantages of plastic in the past

In 1907 Leo Baekeland invented Bakelite, the first fully synthetic plastic, meaning it contained no molecules found in nature. Baekeland had been searching for a synthetic substitute for shellac, a natural electrical insulator, to meet the needs of the United States.

Bakelite was not only a good insulator; it was also durable, heat resistant, and, unlike celluloid, ideally suited for mechanical mass production. It was marketed as "the material of a thousand uses," because it could be shaped into almost anything, providing endless possibilities.

Hyatt's and Baekeland's successes led major chemical companies to invest in the research and development of new polymers and new plastics. While Hyatt and Baekeland had been searching for materials with specific properties, the new research programs sought new plastics and worried about finding uses for them later.

World War II required great expansion of the plastics industry in the United States. Scarce natural resources made the production of synthetic alternatives a priority, using nylon, for example, invented by Wallace Carothers in 1935 as a synthetic silk, was used for parachutes, ropes, body armor, helmet liners, and more.

In addition, Plexiglas provided an alternative to glass for aircraft windows. A Time magazine article noted that because of the war, "plastics have been turned to new uses and the adaptability of plastics has demonstrated that everything can be rethink" (Nicholson & Leighton, 1942: 306).

During World War II plastic production in the United States increased by 300%. This increase continued after the war ended. After experiencing the Great Depression and then World War II, Americans were ready to spend again, and much of what they bought was made of plastic. According to author

Susan Freinkel, "In product after product, market after market, plastics challenged traditional materials and won, taking the place of steel in cars, paper and glass in packaging, and wood in furniture" (Freinkel, 2011: 4).

Plastics provided an almost utopian vision of a future with abundant material wealth thanks to an inexpensive, safe, sanitary substance that could be shaped by humans to their every whim.

4.1.4 Plastics in ecosystems

The unblemished optimism about plastics didn't last. In the postwar years there was a shift in American perceptions as plastics were no longer seen as positive, and in the 1960s, plastic debris in the ocean was first observed, at a time in which American society became increasingly aware of environmental problems.

Plastic also gradually became a word used to describe that which was cheap, flimsy, or fake. In The Graduate (1968), Dustin Hoffman's character was urged by an older acquaintance to make a career in plastics. Audiences cringed along with Hoffman at what they saw as misplaced enthusiasm for an industry that, rather than being full of possibilities, was a symbol of cheap conformity and superficiality. Plastic's reputation fell further in the 1970s and 1980s as concern over waste increased. Plastic became a special target because, while many plastic products are disposable, plastic lasts forever in the environment. This motivated the industry to work to find a solution to this problem and this is how recycling was offered as a solution.

In the 1980s the plastics industry led an influential drive encouraging municipalities to collect and process recyclable materials as part of their waste-management systems. However, recycling is far from perfect, and most plastics still end up in landfills or in the environment.

The ultimate symbol of the problem of plastic waste is the Great Pacific Garbage Patch, which has often been described as a swirl of plastic garbage the size of Texas floating in the Pacific Ocean.

The reputation of plastics has suffered further due to a growing concern about the potential threat they pose to human health. These concerns focus on the additives (such as the much-discussed bisphenol A [BPA] and a class of chemicals called phthalates) that go into plastics during the manufacturing process, making them more flexible, durable, and transparent.

Despite growing mistrust, there is a category of plastics that have enabled certain aspects of modern life. We're talking about, for example, computers, cell phones, and most of the lifesaving advances of modern medicine. Lightweight and good for insulation, plastics help save fossil fuels used in heating and in transportation.

4.2 Classification of plastics

The American Chemistry Council, an organization that fosters scientific research, provides clear data on types of plastic according to their processing, classified into two distinct groups thermoset and thermoplastics.

4.2.1 Thermoset

A thermoset is a polymer that irreversibly solidifies or "hardens" when heated or cured. Like the relationship between a raw egg and a boiled egg, a boiled egg cannot go back to its original form once it is heated, and a thermoset polymer can't soften once it has "set". Thermosets are valued because of their durability and resistance, and are widely used in cars and construction, including uses such as adhe-

sives, inks and laminates. The most common thermoset is car tires.

A few examples of thermoset plastic and its product uses are the following:

Polyurethane (PUR):

- Mattresses
- Pillows
- Insulation

Unsaturated polyester:

- Bathroom tubs and showers
- Furniture
- Ship hulls

Epoxy:

- Adhesives
- Insulation for electrical devices
- Helicopter and jet engine blades

Phenol formaldehyde (Bakelite):

- OSB
- Plywood
- Household appliances
- Electric boards and switch boards

4.2.2 Thermoplastics

A thermoplastic is a polymer in which molecules remain together joined by weak secondary bonds that soften when exposed to heat and return to their original state when cooled at room temperature. When thermoplastics are softened by heat, they can be molded by extrusion, injection or pressing. Ice cubes are a common household item that exemplify the thermoplastic principle. The ice will melt when it heats up but will easily solidify when it is cooled. Like a polymer, this process can be repeated numerous times.

Thermoplastics offer versatility and wide range of uses. They are commonly utilized for food packaging, because they can quickly and inexpensively be molded into any shape required to fulfill the packaging function. The most common example are soft drink, juice and water bottles, among others.

In 1988, the Society of the Plastics Industry created symbols to identify the resin content of containers and facilitate the recycling of post-consumer plastics.
Its purposes include to:

- Provide a consistent system to facilitate recycling of used plastics;
- Target plastic containers;

- Offer a means of identifying the resin content of bottles and containers commonly found in residential waste; and
- Provide coding for the six most commonly found resin types, and a seventh category created for all other types not found within codes 1 to 6.

Symbol	Type of polymer	Properties	Common Uses
1 PETE	PET Polyethylene Terephthalate	Contact with food, physical resistance, thermal properties, barrier properties, lightweight and chemical resistance.	Bottles for soft drinks, beverages and water; food containers (dressings, jams, jello, cream, pharmaceuticals, etc.)
2 HDPE	HDPE High Density Polyethylene	Stiff, chemically resistant, opaque, easy to dye, manufacture and handle. Softens at 75°C.	Some grocery bags, freezing bags, milk and ice cream containers, juice and shampoo bottles, chemical and detergent containers, buckets, lids, caps.
3 PVC	PVC Plasticized Polyvinyl Chloride	Hard, resistant, can be transparent, can be used with solvents. Softens at 80°C. Flexible, transparent, elastic, can be used with solvents.	Plumbing packaging, piping, bister packs, containers in general, hose, shoe soles, watch bands
4 LDPE	LDPE Low Density Polyethylene	Soft, pliable, translucid, softens at 70°C, easily scratched	Packaging film, garbage bags, lab containers.
5 PP	PP Polypropylene	Hard yet still flexible, softens at 140°C, translucid, supports solvents, versatile	Bags for fried food, straws, gardening equipment, packing tape, containers for veterinary and pharmaceutical use
6 PS-E	PS Polystyrene	Clear, rigid, opaque, easily breaks, softens at 95°C. Affected by grease and solvents	CD boxes, plastic cutlery, crystal imitations, toys, cosmetic packaging
6 PS	PS-E Expanded Polystyrene	Spongy, lightweight, absorbs energy, maintains temperature	Cups for hot beverages, food takeaway containers, dry ice packaging, fragile items packaging
7 OTHER	Others (SAN, ABS, PC, Nylon)	Includes many others, resins and materials. Its properties depend on the combination of plastics.	

SOURCE: SOCIETY OF THE PLASTICS INDUSTRY

4.3 Processing methods

ASIPLA, Chile's trade association for plastic industrials, was established more than fifty years ago. Today the association manages a large part of the information concerning plastic in Chile, including data and statistics on its processing methods.

The plastic processing industry uses different machines, molds, types of raw material, additives and processes to shape different and well-known artifacts, such as containers for different products, filaments or fibers, laminates in different thicknesses (from sheets to film), bottles, etc.

The main processing methods are the following:

1. Extrusion
2. Injection molding
3. Blow molding
4. Rotational molding
5. Compression molding
6. Thermoforming

Today, technology and innovation allow manufacturers to use different combinations of these six processes to make plastic. For example, extrusion-blow molding and extrusion thermoforming processes.

4.3.1 Extrusion

Extrusion consists mainly of:

- Melting solid material and uniformly mixing it.

- Directing the molten material through a hollow cylindrical shaft.

- Forcing out the molten plastic through a forming nozzle that will provide the desired shape or design.

When is the extrusion process used?

- For the continuous production of parts.
- To produce objects of a fixed cross-sectional profile.
- To coat surfaces of other materials in fiber or monofilaments (for knits such as raffia or rugs, etc.)
- To make preforms used in the preprocess of blow molding and thermoforming.

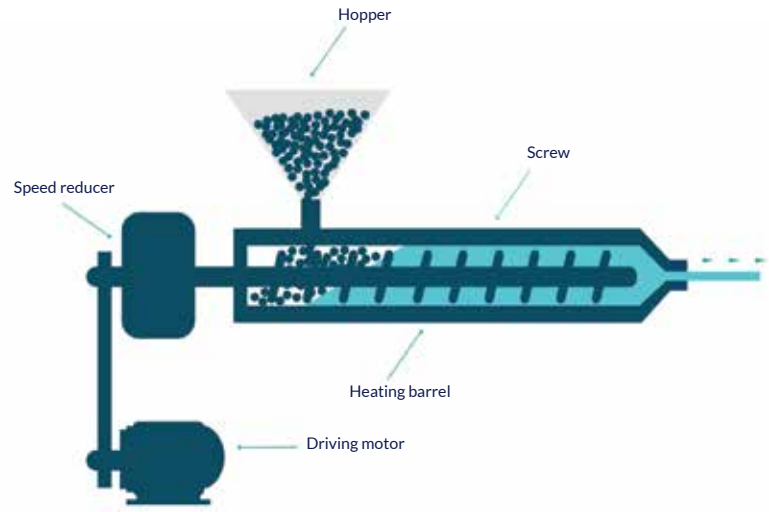


DIAGRAM DEMONSTRATING THE EXTRUSION MOLDING PROCESS.

4.3.2 Injection molding

Injection molding consists mainly of:

- Melting solid material and uniformly mixing it.
- Directing the molten material through a hollow cylindrical shaft.
- Forcing out the molten plastic through one or more injection points into a mold with a certain design.
- Molding and cooling of the part.
- The mold remains closed, cooling, with the right amount of material inside until the temperature of the part is low enough to open the mold and eject the part without it losing its shape or dimensional stability.
- The mold is opened, and the piece or final product is extracted.

When is the injection molding process used?

- Batch production of parts (cycles).
- To increase productivity the mold's cavities are increased.
- This process is used when well finished, high quality pieces require different designs and shapes, but there are certain restrictions for thicknesses vs. deformation. In this case, the thermoforming process is a better choice.
- Very versatile, the same machine can be used for different shapes (only the mold is changed).
- Injection molding depends a lot on the polymer being used; therefore, process conditions such as temperature, duration, and compression are the drivers to make adjustments and achieve injection (important because additives and chemicals help control the operation and increase efficiency).

- A limitation in this process is extracting the parts from the mold; the neck or edge must have a greater surface than the bottom. However, technology has already created collapsible male molds that deform after injection to be able to extract from necks with less surface than the bottom.

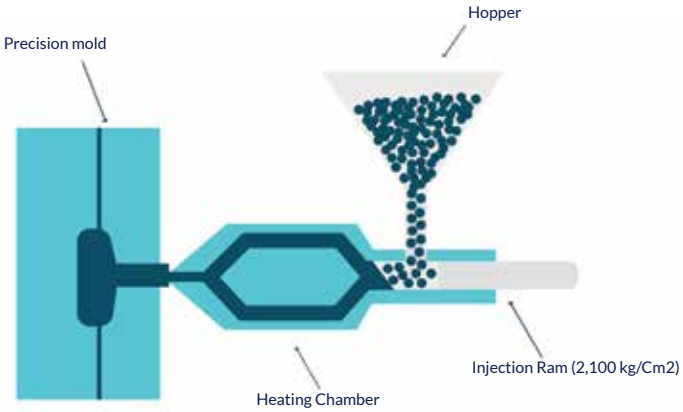


DIAGRAM DEMONSTRATING THE INJECTION MOLDING PROCESS.

4.3.3 Blow molding

Blow molding consists mainly of:

- After making a tubular preform using injection or extrusion molding, this material is heat-softened inside the blow mold.
- The mold provides the finish and the critical point of operational control is the formation of a stable air bubble to blow the preform.
- Air is then blown into the mold so that the preform takes on the mold's shape.
- Cooling and unmolding.

The following is required to blow material:

- An extrusion machine with parts to melt material, shape the preform and guide the nozzle to the mold (a preform can be to laminate and produce plastic film, for example).
- Energy or heat to maintain the preforms molten during the process (heaters).
- A mold with two movable parts and a blowing unit.
- Uniform and continuous air pressure so that the part fully conforms to the mold's shape.
- Cooling in the mold (refrigerated water).
- Machine with mechanical parts that are suited for the processes described above and if necessary, tensioning equipment for plastic film and product receivers.

When is blow molding used?

- For the continuous production of parts that need to be hollow and tube-shaped, where the neck's diameter can be less than the part's body diameter (this can't be achieved by injection).
- To produce objects of variable cross-sectional profiles (does not depend on this dimension).
- To make fuel containers, several drums, personal product containers (cream, soap, shampoo, etc.), chemical product containers (chlorine, detergents), food containers (oil, sauce, etc.), hollow parts such as surf boards, film tubes and plastic sheeting.
- The part's finish is a problem, as well as trimming residual material off the neck.

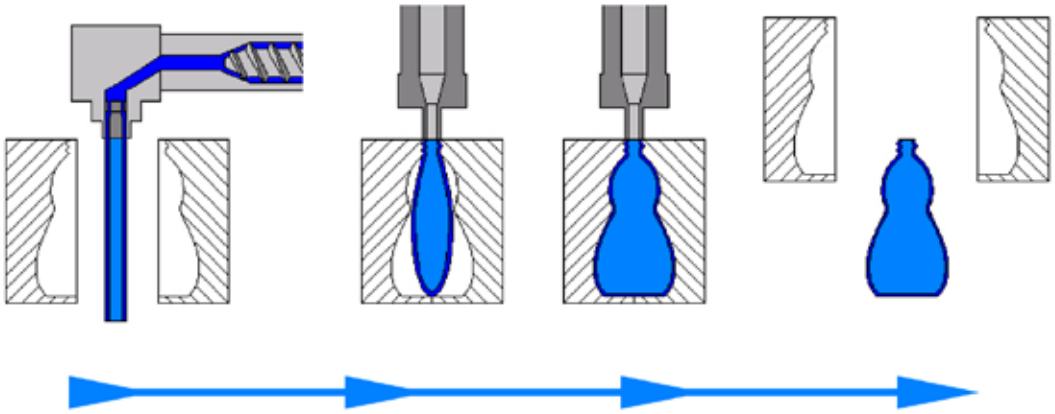


DIAGRAM DEMONSTRATING THE BLOW MOLDING PROCESS.

4.3.4 Rotational molding

Rotational molding consists mainly of:

- Loading the mold. Unlike the other processes, rotational molding does not require melting solid material or liquid paste in a screw barrel; this happens inside the mold.
- Heating, filling with material and cooling the mold in rotation.
- Extraction of the molded part.

When is rotation molding used?

- For batch production of large-sized hollow parts.
- Variable cross-sectional profiles.
- Competes with the blow molding process for large parts and complex shapes.
- Cheaper molds than blow molding, since it does not require the compression stage and tension free parts are obtained, such as tanks and parts that are resistant to high pressure, piping parts for pipelines (gas, diesel), etc.

- The production cycle is low in general because loading the material and unmolding the parts are manual and slow processes, in addition to the time required to fill the mold with powder material.

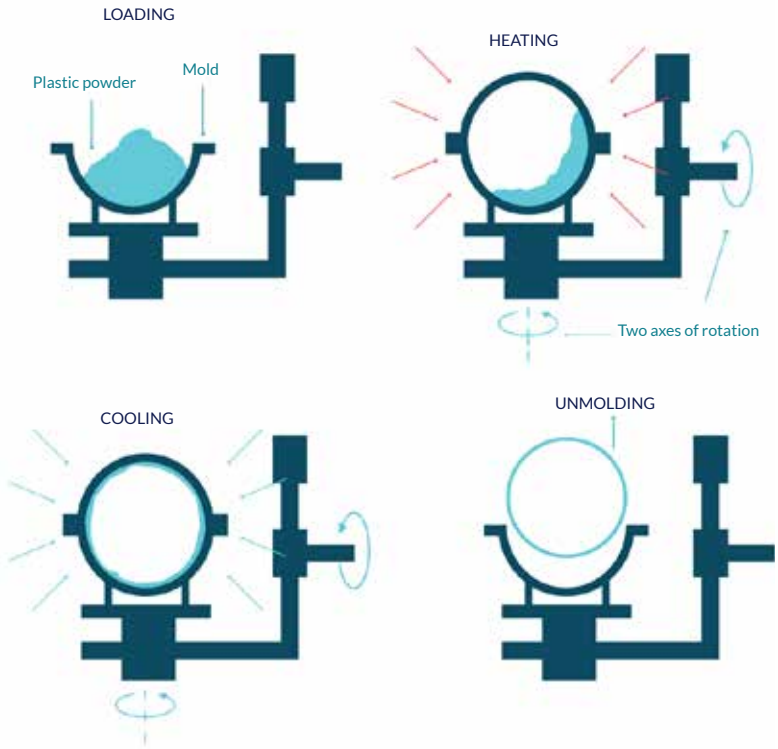


DIAGRAM DEMONSTRATING THE ROTATIONAL MOLDING PROCESS.

4.3.5 Compression molding

Compression molding mainly consists of:

- Load, usually by hand, solid material into the mold; heating it and then cooling it.
- Extraction and cleaning.

When is compression molding used?

- For batch production of small parts, for study purposes or prototypes and pilots.
- Cone section profile, with male and female molds.
- Low cost molds and machinery.
- Low productivity because of slow cycles compared to injection molding.

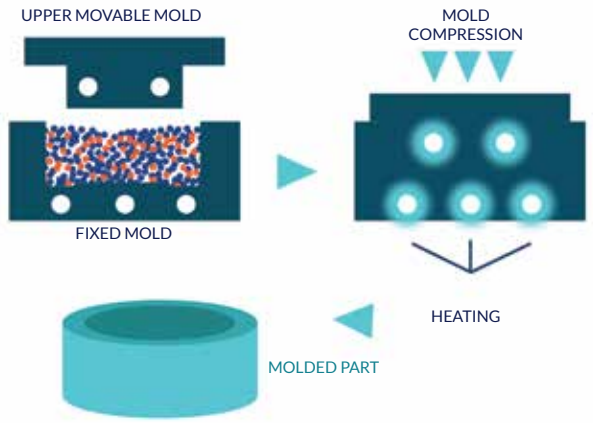


DIAGRAM DEMONSTRATING THE COMPRESSION MOLDING PROCESS.

4.3.6 Thermoforming

Thermoforming mainly consists of:

- Making a film or sheet preform using the extrusion process.
- Heating the sheet.
- Laying the sheet in the design mold in the forming matrix, by pressure or vacuum and then extracting the parts.

When is thermoforming used?

- For the continuous production of thin parts, such as supermarket fruit trays, disposable food service ware and portioned food containers.
- Constant male/female section.
- A disadvantage is the loss of material between molds and sheet edges, which is why manufacturers should invest in a recycling machine (shredder).

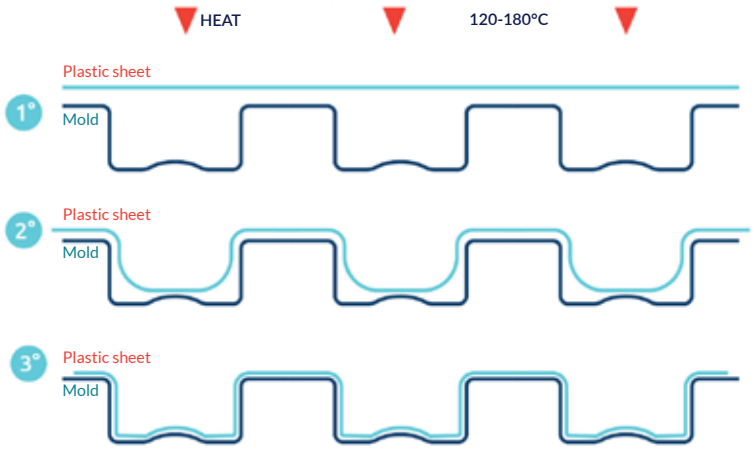


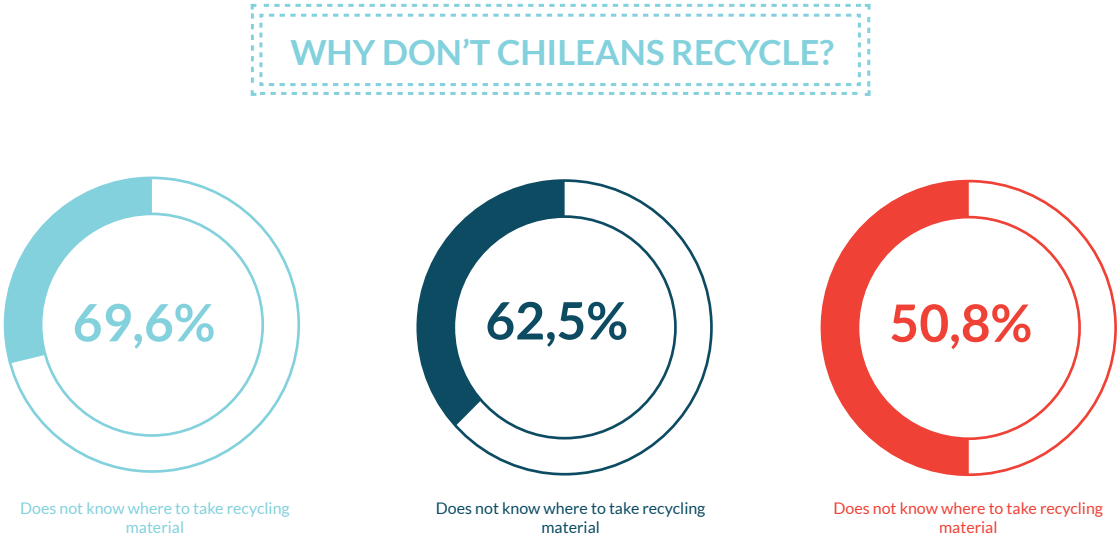
DIAGRAM DEMONSTRATING THE THERMOFORMING PROCESS.

5. The situation in Chile

ASIPLA provides relevant data on the situation in Chile and the population's perception regarding this issue. In research presented in 2019, titled Estudio sobre el reciclaje en Chile (Study of recycling in Chile), estimations indicate that 8.5% of the annual consumption of plastics in Chile is recycled, however, this number includes post industrial waste as well as solid residential waste (post-consumer). If only the solid residential waste was considered, the percentage of recycling is 1.4% of the total annual consumption of plastics in Chile.

According to a study published in 2016 by ASIPLA, in Chile 64% of people declare they recycle, of which 65% do so at least once a week. However, when observing the reasons people give for not recycling, "there's nowhere to recycle" (41%) is well above the top of the list, followed by "lack of habit", "lack of time" and "comfort", with 13% each one. When analyzing the situation of "green" products, people consider that being recyclable (74%) and biodegradable (72%) are their most important attributes.

Following this same line, 74% stated that they would be willing to pay more for a "green" product: in fact, 63% would be willing to pay up to 10% more. When choosing a product featuring these characteristics, the most relevant factor is good quality (62%). Among the reasons given for not buying "green" products are "there's little offer" (34%), "there's little information" (32%) and "poor credibility" (32%). Last, 79% of the people say they would like to have information on the "green" characteristics of the product through the label, but 55% believe businesses male false affirmations regarding the environmental impact of their brands. An overwhelming majority, 99% of the population, said they would like the products that they buy to carry a label stating their environmental impact.



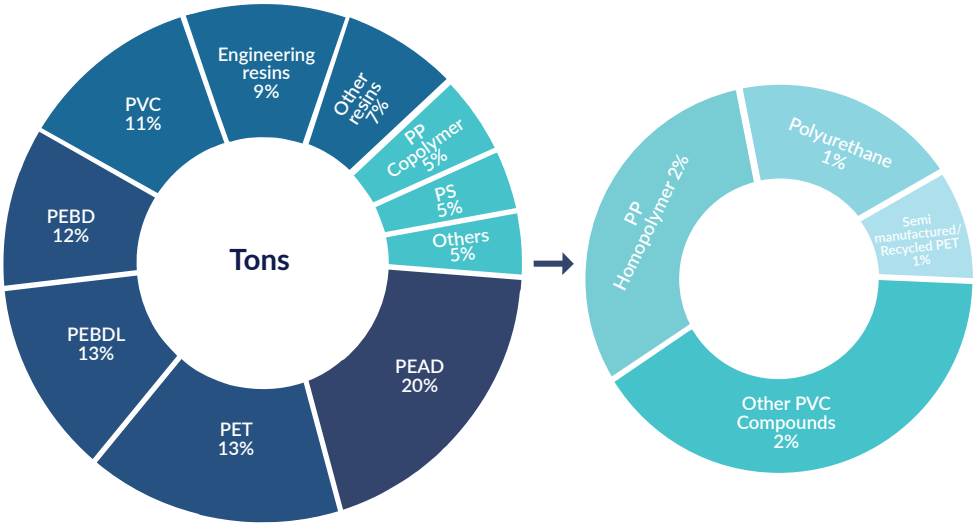
SOURCE: GFK ADIMARK SURVEY AND ELIGE VIDRIO

This demonstrates that a majority of the Chilean population has environmental awareness and is willing to make an effort towards responsible consumption and suitable waste disposal.

5.1 Chile in the global market

Based on the 2019 industry statistics annual report produced by ASIPLA, it can be concluded that in Chile 83,679 tons of plastic parts are processed for recycling each week. According to a previous study, published in 2016 by ASIPLA, the tons of plastics recycled account for the import of over US$1,000 million in raw materials entering the country. High density polyethylene has the largest percentage, 20% of total import, and is mainly used in the container and packaging industry, followed by 13% of PET, used in bottling companies.

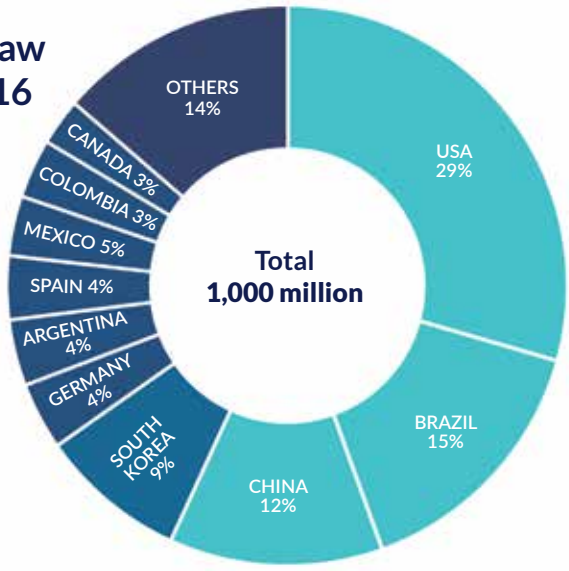
Imported Resins 2016



Total imports **737,000 tons** **CIF US$ 1,000 million**

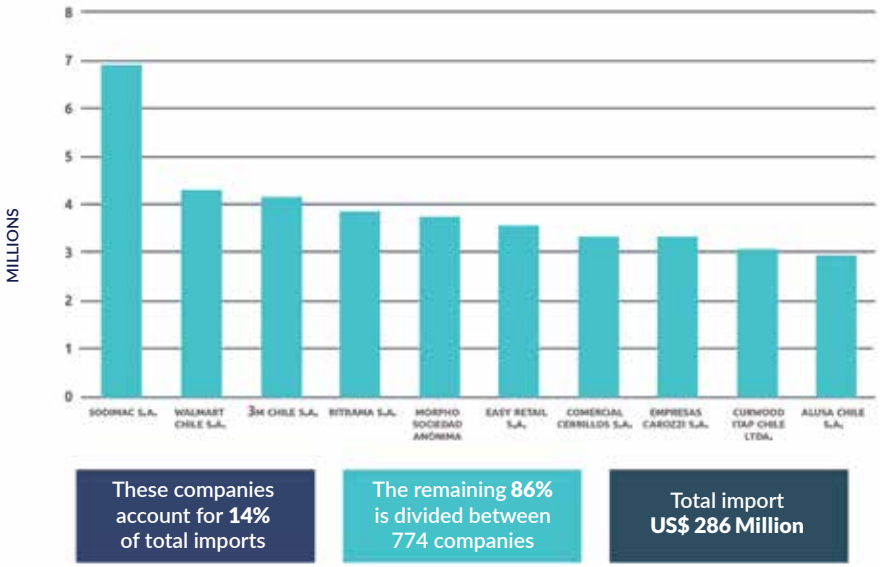
The primary imports of raw material come from the United States, which accounts for 29% of total, followed by Brazil and China, with 15% and 12%, respectively.

Countries of origin of raw material imports in 2016
In CIF US$



In addition, about 300,000 tons of manufactured and semi-manufactured products are imported; Sodimac SA is the primary importer in this field.

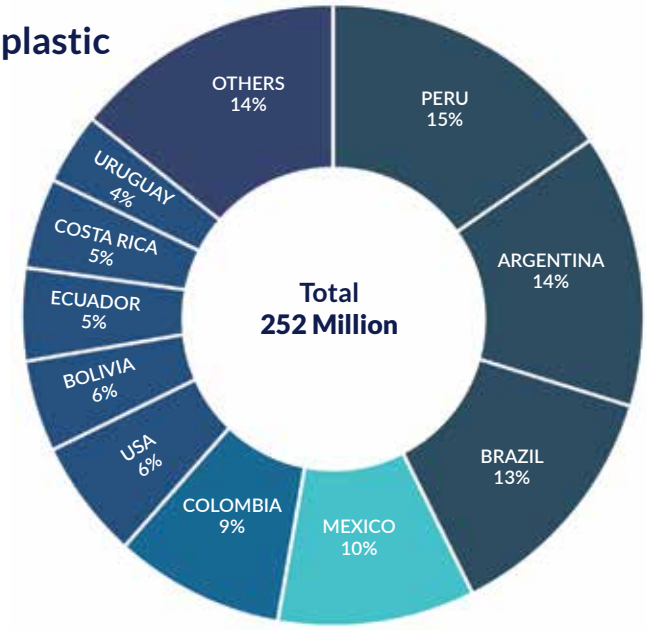
Primary importers of manufactured products
Q4 - 2016



At the global level, imports account for US$ 286,000,000; China is the primary producer with 31% of total purchases, followed by the United States with 12% and Brazil with 8%.

Chile exports 71,000 tons of manufactured parts, which generate an income of US$ 251,000,000 for the country. Perú is the primary destination for these products (15%), followed closely by Argentina (14%) and Brazil (13%).

Destination countries for plastic manufacturing in 2016
In CIF US$



Therefore, it can be concluded that an annual 729,000 tons of plastic parts remain in Chile after their transformation into products. Considering the data regarding the plastics market in Chile, it accounts for 1.5% of the GDP (ASIPLA, 2014).

5.2 Three plastic recycling processes at the global level

In order to establish Chile's comparative position on this issue, it's necessary to identify the three ways in which plastic is recycled in the world:

1. Thermo-mechanical recycling
2. Feedstock recycling of chemical recycling
3. Energy recovery

Plastics Europe (2018) is a reference in this type of research. Below is the leading trade association's accurate and summarized explanation of the three recycling processes:

5.2.1 Thermo-mechanical recycling

Mechanical recycling of plastics is the process through which plastic waste is transformed into secondary raw material or products without significantly changing the chemical structure of the material. In principle, all types of thermoplastics can be mechanically recycled with no significant quality impairment. It is currently almost only form of recycling in Europe, representing more than 99% of total recycled quantities. Waste streams that can easily provide large quantities of clean plastic of a single type are ideal for mechanical recycling and represents a beneficial solution for all from an environmental and economic perspective. The environmental benefits of substituting virgin material for recycled material generally exceed the environmental burden from collection, sorting, transport and recycling operations, while the costs of such operations can be offset by potential revenues from selling recycled products in the market.

5.2.2 Feedstock recycling

Feedstock recycling (or chemical recycling) is a process that changes the chemical structure of plastic waste, converting it into shorter molecules that can be used for new chemical reactions.

For example, processes such as gasification or pyrolysis break down plastic waste to produce synthesis gas as well as other liquid and semi-liquid products. In addition, new depolymerization processes are being developed to convert some types of plastics into monomers to produce virgin plastics.

Feedstock recycling is a complementary technology, that can help to divert from landfills certain plastic waste that cannot be sustainably recycled by mechanical processes. Examples of suitable streams for feedstock recycling include laminate and composite plastics, low quality mixed plastics and plastics that have been contaminated by food waste, dirt, etc.

The most common example of feedstock recycling in Europe is currently the use of plastic waste in blast furnaces, where plastics are gasified into synthesis gas and replace coke, coal or natural gas to act as a reducing agent to convert iron ore and other oxidized metals into pure metals. Other technologies are being studied but not yet available at an industrial scale.

5.2.3 Energy recovery

Some plastics can't be recycled in an eco-efficient manner because of factors such as:

- The amount, cleanliness and composition of the collected waste streams;

- The available technologies for sorting;
- Market requirements on quality and standards for recycled material that may limit the appropriateness of plastics recycling

For these plastics, energy recovery is an option, better than landfilling or even enforced recycling.

The following figure shows recycling and energy recovery in Europe in 2016:

5.3 Plastic recycling in Chile

5.3.1 Residential recycling

The book "Chile recycles. Impacts and challenges of the 'Framework for Waste Management, Extended Producer Responsibility and Promoting Recycling' Law", is a study presented in 2016 that gathers concrete statistics about Chile on recycling and how the high numbers of disposable waste made the OECD cry out in alarm.

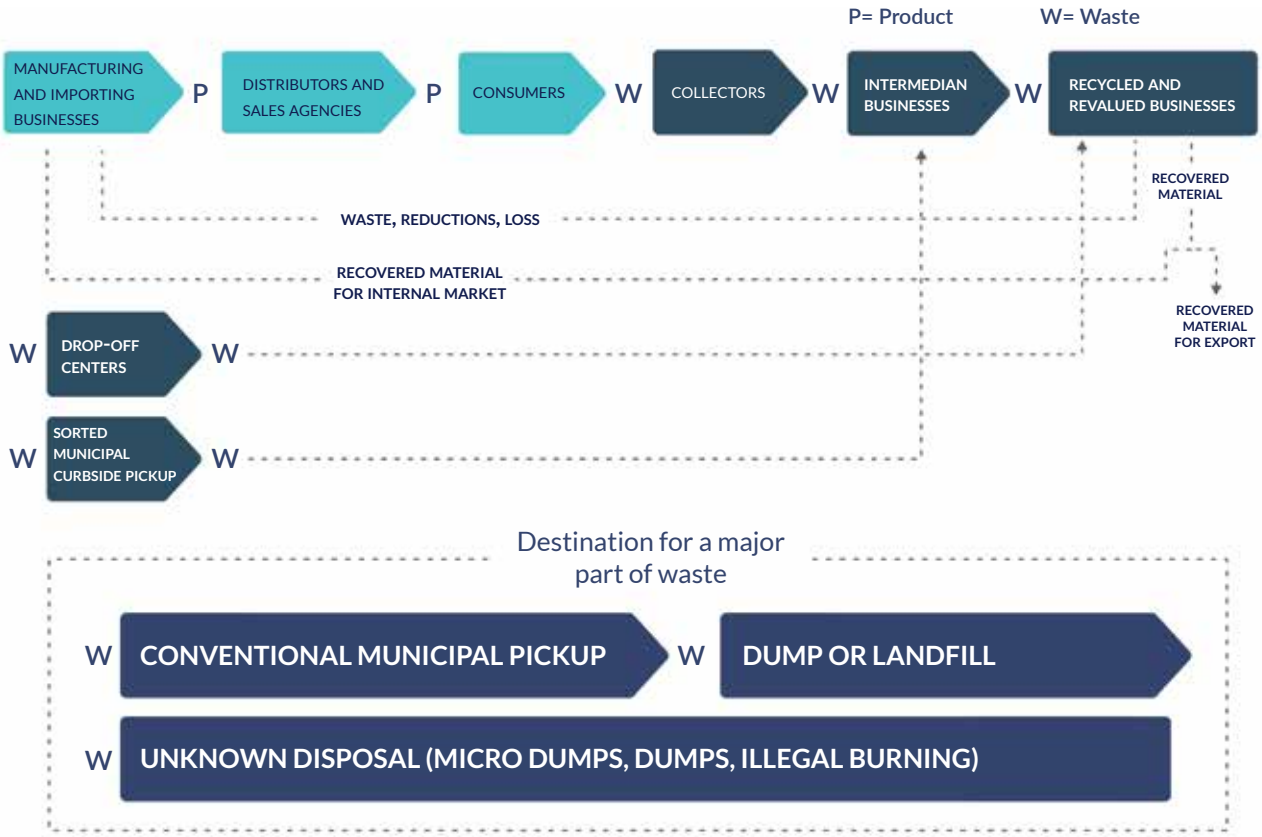
Below are relevant and telling data on the national situation and recycling:

According to data from the first report on solid waste management (2010), 16.9 annual tons of solid waste are produced in Chile, which is habitually called "garbage"[15], from homes, industrial activities and public areas, among others. Each person produces a little over a kilo[16] of waste daily; Chile even has the South American record for e-waste generation, which comes from refrigerators, microwaves, monitors, screens, computers, discarded cellphones: That's 9.9 kilos per person a year! According to the UN (The Global E-Waste Monitor, 2014).

15 It's important to note the difference between waste and garbage. Waste has the potential of being revalued, reused or recycled. Instead, garbage is any object or material that has no value to anyone

16 Nuestra Casa Verde, Ministry of the Environment, http://casaverde.mma.gob.cl

How does waste management work in Chile?



In its 2016 report on Chile's environmental performance (OECD, 2016: 26), OECD warned that Chile produces more solid waste per capita than Brazil and Mexico, countries that exceed ours by far in terms of population and the size of their economies. From an even more graphic point of view, just think that the Municipality of Santiago removed 185,000 tons of waste in 2015, an amount that according to estimations "could have produced two full Santa Lucía hills"[17].

Projections indicate the country will continue to increase waste production as its economy continues to grow, improving the living conditions of the population, expanding consumption and imports, among other factors, as already was the case between the years 2000 and 2009, when waste increased by 42% (CONAMA, 2010: 12).

In addition, of the total of 16.9 million tons of waste, 10 million tons are industrial waste and nearly 7 million tons are municipal waste, which includes that produced by homes, offices, public areas and others.

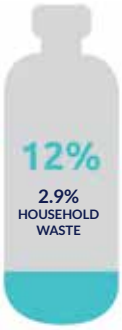
According to consulting reports commissioned by the Ministry of the Environment between 2008 and 2014[18] Chile mostly recycles paper and cardboard (82% of waste), followed by glass (54%), batteries (52%) and discarded lubricating oils (52%). Further down the list are discarded tires (22%)[19]. Estima-

17 "Downtown Santiago produces two Santa Lucía hills of garbage a year. This is how it's fighting the problem", El Definido.cl. http://www.eldefinido.cl/actualidad/pais/6371/Santiago-Centro-produce-dos-cerros-Santa-Lucia-de-basura-al-ano-Asi-es-co-mo-esta-combatiendo-el-problema/dedesechos

18 Presentation of Law N° 20.920, Framework for Waste Management, the Extended Producer Responsibility and Promoting Recycling' from the Ministry of Environment to ASIPLA, July 5, 2016.

19 According to numbers provided by the Ministry of Environment by 2012.

tions made by the Tire Industry Chamber of Chile in 2016 provide even lower numbers for waste tires, at around 5%, electronic devices (19%), plastics (12%) and electrical devices (1.4%). Batteries and light bulbs were not considered.

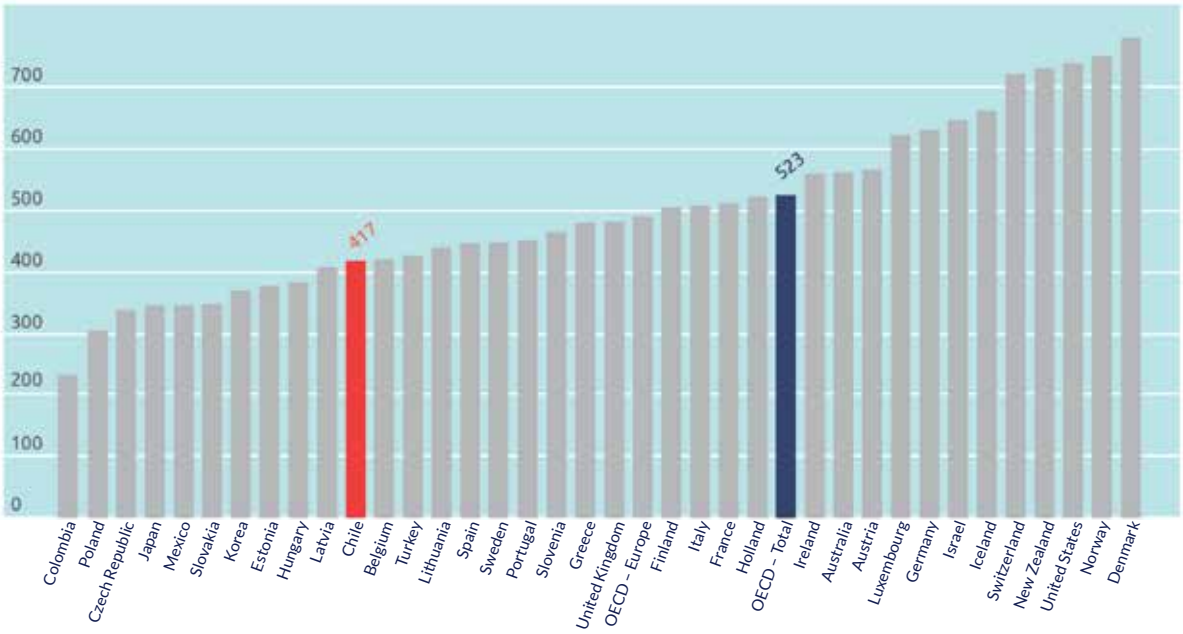


Plastics
**C.G.: 355,934 ton/year

Waste production per person increases as countries become more developed. As seen in graphs provided by OECD, Chile is within the group of countries that produces less waste per capita; but when the graphs are adjusted by GDP per capita, Chile is one of the countries that produces the most waste. Therefore, it can be concluded that Chile has a level of household waste production that is not consistent with its level of development or is well above countries with similar levels of development.

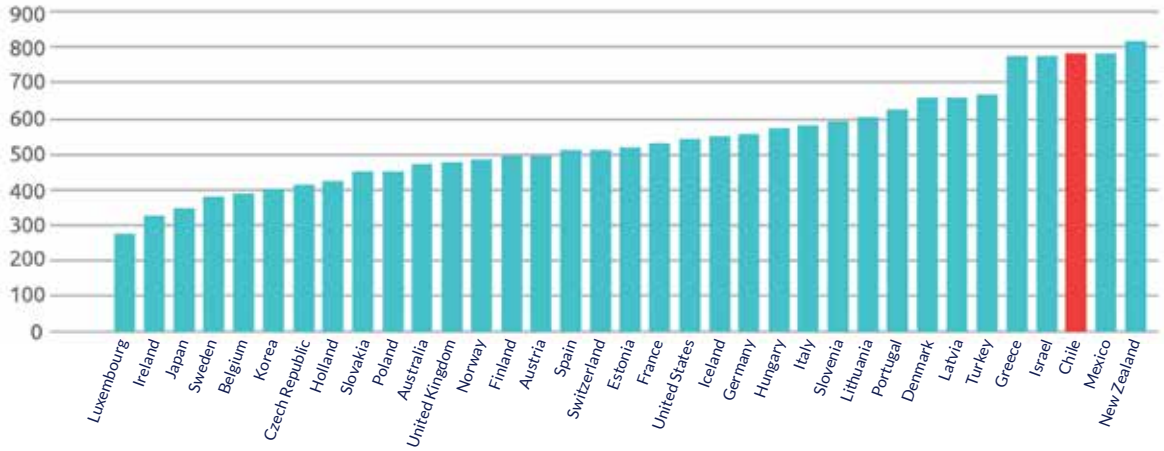
Total municipal waste, Kg
2016 or latest available

SOURCE: OECD: MUNICIPAL WASTE



Municipal Waste (annual kilo per person) adjusted by GDP

SOURCE: OECD: MUNICIPAL WASTE



5.3.2 Industrial recycling

Industrial plastic waste is in a better position than household waste. Regulations and companies' preparedness for the enforcement of the EPR Law have generated the development of ecodesign, not just for parts, but for processes and business models, creating considerable efficiencies.

Companies must understand that adequate treatment of their plastic waste can transform cost centers into profit centers, which is why the opportunity of treating plastic waste as resources not only benefits the environment, but the financial results of businesses as well.

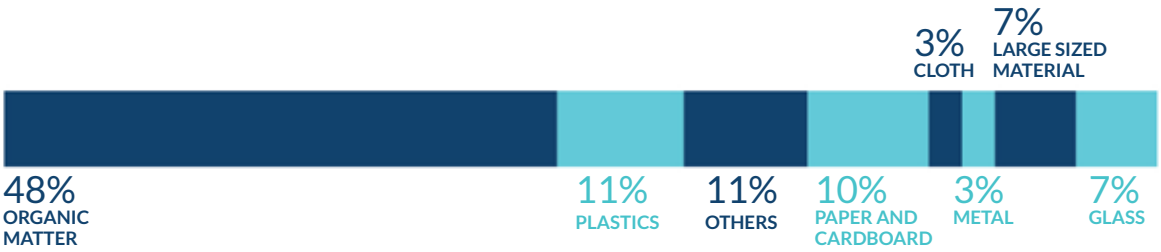
However, it's also necessary to understand that the industry's challenges, in terms of plastic recycling in Chile, are essentially logistic. The national territory's length and its centralization make it difficult to produce volumes of plastic waste interesting enough for recycling companies to install facilities in different areas of the country, which is why they're mostly located in Santiago. Consequently, materials need to be transported very long distances to be recycled, and this involves considerable cost.

In addition, realities of Chile's southern and northern territories are different: in the south, cities are closer together, making it easier to have two or three recycling centers that can take in the waste from nearby cities. In the north, on the contrary, cities are farther apart and have less population, which makes the logistic challenge more difficult.

Continuing with the proposal of Chile Recycles, and contrary to what is seen in businesses that have already taken steps toward recycling, households have barely started this race. The great debt with the country's solid waste recycling is municipal recycling: waste produced in houses, streets, shops, offices, buildings, schools and others.

According to the First Report on Solid Waste Management in Chile published in 2010, 48% of this waste is organic matter, 11% is plastics, 10% paper and cardboard, 7% glass, 7% large material such as furniture, 3% metal, 3% cloth and 11% other type of waste.

COMPOSITION OF MUNICIPAL SOLID WASTE IN CHILE



SOURCE: FIRST REPORT OF MUNICIPAL SOLID WASTE MANAGEMENT IN CHILE.
CONAMA (2010)

The government projects that at least 30%[20] of this waste "is potentially valuable", but our reality is not as promising: only 4% of our municipal waste is recovered or recycled.

Another factor that plays against recycling is the lack of incentives for people to recycle at home. Today, this practice depends on people's willingness, motivation and effort.

Why haven't most municipalities joined the recycling effort? The main reason would be economic. According to Eco-Ingeniería Ltd., a consulting agency for the government that assessed the economic, environmental and social impacts of the implementation of the EPR Law in Chile a few years ago[21], stated that the cost of collection and end disposal systems for municipalities "ranges from 15% to 25% of the institution's total budget", which already is a heavy burden for many of them. Also, according to OECD, over 80% of the population is exempt from paying for garbage collection services, which makes recycling an initiative that municipalities find hard to pay[22].

In addition, there is little incentive for them to reduce the waste that is taken to landfills and dumpsters, "because costs for disposal in these facilities decrease with the volume of waste that is deposited"[23]. Consequently, because there are few municipalities involved in recycling, there is very little infrastructure for this purpose, compared to the growing production of waste in the country.

5.3.3 Primary actors in the recovery of plastic in Chile

As years go by, Chile has been incorporating new plastic recovery and processing facilities. ASIPLA recognizes the following as being the most important: Cambiaso, Ferroplast, Greenplast, Inproplas, Integrity, Recipet, Rplast and Comberplast.

Below is a brief business description of each facility, according to their own statements:

- **Cambiaso Hnos.** Buys discarded polyethylene used in industrial processes in: agriculture, fisheries, mining and others, which are recycled in its facilities and used as raw material for their products.

20 Presidential Statement, Law 20.920.

21 Final report, Assessment of Economic, Environmental and Social Impacts of the Implementation of Extended Producer Responsibility in Chile, packaging industry, Eco Ing, June 19, 2012

22 According to Eco Ing consultancy: "private operators have no incentive to propose different systems; collectors often own the landfills, so they're interested in charging for the end disposal of waste".

23 According to Eco Ing consultancy: "private operators have no incentive to propose different systems; collectors often own the landfills, so they're interested in charging for the end disposal of waste".

- **Ferroplast.** Company dedicated to recycling, grinding and manufacturing PVC composites. In addition, it provides recycling services to third parties for industrial plastic: polyethylene and post-industrial polypropylene

- **Greenplast.** Provides a commercial solution to plastic waste. Mainly recycles articles produced with polypropylene and polyethylene (in all densities), and last, the quality of the material is checked for subsequent sale.

- **Inproplas.** Group of businesses that recycle discarded industrial polyethylene and polypropylene.

- **Integrity.** Recycles disposable plastic soft drink bottles (PET) that are transformed into raw material to manufacture clamshell containers.

- **Recipet.** Receives PET soft drink bottles, including juice/nectar and mineral water. Bottles that contained oil are not accepted (difficult to clean) or any type of chemical/hazardous substance.

- **Rplast.** Business that recycles polypropylene (PP) and high-density polyethylene (HDPE).

- **Comberplast.** Belongs to a holding company in the polymer sector, with presence at the regional level. Leading business in the development of plastic injection and recycling projects in Chile, owns one of the largest recycling facilities in Latin America with state-of-the-art technology and a monthly reprocessing capacity of 600 tons. Supplies parts to important industries in mining, recycling, logistics, appliances, packaging, mass consumption, energy, telecommunications, construction and the agribusiness. The company aims to manufacture products that have a positive impact on the environment. Comberplast S.A. is a leading business in responsible plastic through the development of "circular economy" solutions for its customers. This operation annually recovers over 6,000 tons of waste that is transformed into new useful and quality products. The company is certified to standard ISO 9001:2000, which is why it maintains a Quality Management System thus ensuring full compliance with all pre-established processes and an evaluation process for continuing improvement of its production. This company recycles PP, HDPE, LDPE, ABS, PC, PA, POM, PS, HIPS, PBT, and Poly (p-phenylene oxide) PPO.

Having identified the national primary actors of plastic recovery, it is wise to know how much they are recycling and what difficulties they face according to the material's complexity. Of the eight companies that were reviewed, two focus on PET; five of them focus on high and low-density polyethylene and polypropylene; and only one of them is multimaterial. Also, most of them operate in industrial recycling.

PET, HDPE, LDPE, and PP are recycled in Chile. Of the reprocessed material, 76% is allocated for national production and 24% for exports. Now, what do we save on when we recycle plastic? A ton of recycled plastic saves up to 5,774 kWh of energy, 2,604 liters of crude oil, 98 million BTU's of energy and 22 cubic meters of space in a landfill. Producing plastics from recycled material generates 80% to 90% energy savings compared to what is required to produce plastic from virgin materials (crude oil and gas).

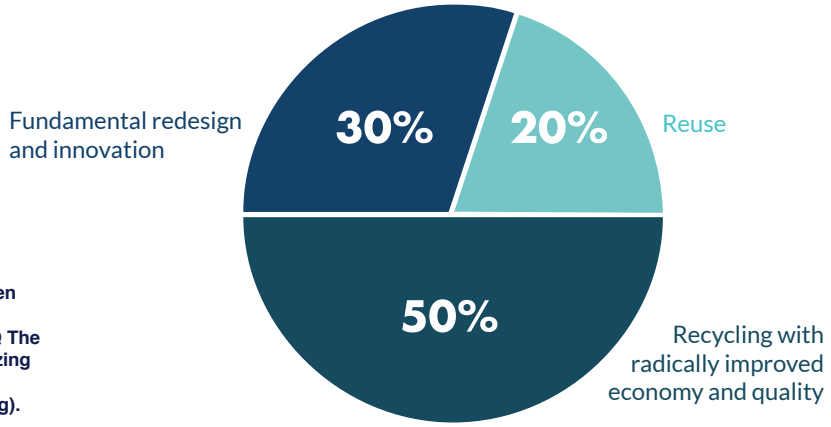
Today, garbage bins, clamshell fruit containers, buckets and boxes, pallets and other products are made from recycled material. However, the task ahead for people in the recycling business is getting hard not only in terms of logistics, but also complex materials. On this occasion, and thanks to research conducted by the Ellen Macarthur Foundation through its New Plastics Economy initiative, this complexity will be divided into three categories:

1. Small plastics

It's very hard for them to enter a value chain: lids, candy wrappers, sachets, cutlery, etc. In general, containers and packaging smaller than 7 cm are very hard to revalue. These products must be replaced by reusable products or enter a redesign program.

According to the report "The New Plastics Economy: Catalysing Action" published by the Ellen MacArthur Foundation, currently 30% of packaging plastics cannot be reused or recycled; reuse is a financially attractive opportunity for at least 20% of this type of plastic, and last, 50% can be financially attractive for recycling provided that their design changes.

Three strategies to transform the global market of plastic packaging



World Economic Forum and Ellen MacArthur Foundation, with the analytical support of SYSTEMIQ The New Plastics Economy - Catalyzing action (2017. www.plasticseconomy.org).

2. Multilayer

This packaging combines more than one type of plastic as layers in its structure, to take advantage of each material's different properties and ensure food safety and duration. Some of these properties include oxygen barrier, UV radiation barrier, humidity barrier, mechanical resistance and puncture resistance.

This allows food to remain in good condition for months, with no refrigeration. In general, multilayers are the most efficient way to conserve food with a carbon footprint that is well below that of other forms of packaging. The problem is when its life cycle expires. The materials used in these products are generally not compatible with each other, so they're almost impossible to recycle. In addition, this type of packaging contains large amounts of organic waste, making a possible recycling process even harder.

In this case the recommendation is to drastically reduce the use of these structures, and to only use them when the product they protect justifies each one of these layers. The clearest example in Chile is the change made by Unilever for its OMO product, going from multilayer packaging to monolayer since the detergent inside did not require the barrier properties provided by the old packaging.

Up to a year ago, the packaging industry was focused on developing monolayer technologies that provided the required barrier features. Today, work is being done to develop compatibilizing additives for the different materials to be able to recycle multilayers. Chile is leading these technologies and successful testing has been done combining polypropylene and polyethylene with polyamide.

3. Uncommon materials or hard to recycle.

PVC and EPS are complex materials to recycle. PVC (polyvinyl chloride), being chlorine based, when it is mechanically recycled or when it is burned to produce energy, it produces gases that oxidize machinery and facilities in a very aggressive manner. This makes the process very expensive, which is why recycling this material is not commercial. In addition, it is very contaminating once it is combined with other polymers. For example, if a load of PET is contaminated with 1% of PVC, the entire load is contaminated and must be discarded.

EPS (expanded polystyrene), better known in Chile as Plumavit (Styrofoam), it's difficult to recycle in large quantities because of its large volume and light weight, which increases its logistic cost. Also, once expanded EPS quickly fragments into smaller pieces that pollute the environment.

5.3.4. Current public policies.

In view of this situation, EPR Law aims to include revaluation of waste as a primary element in solid waste management and introduce a financial instrument into existing regulation on this matter to generate mechanisms to increase current levels of waste recycling that otherwise goes to landfills and illegal dumpsters.

The Law establishes a few environmental management instruments regarding waste, such as EPR (Extended Producer Responsibility), which means that the manufacturer or importer will have to be responsible for the product once its life cycle is over and comply with recycling goals established by the Ministry of Environment. EPR Law states that manufacturers of priority products will have to comply with certain obligations such as registering, organizing and financing waste management, fulfill recollection and revaluation goals through one of the management systems and ensure that the treatment of collected waste is performed by an authorized recycling operator.

In addition, the law establishes the following principles: "Polluters' pay", "Gradualness", Inclusion", "Hierarchy in waste management", "Free competition", "Participatory", "Precautionary", "Preventive", "Responsibility of the waste producer", "Transparency and publicity" and "Traceability".

The Law also provides the Environment Superintendence with competencies to supervise compliance with recollection and revaluation goals of each priority product and related obligations. Sanctions range from written warnings to fines of up to 10,000 annual tax units and will be set according to the economic benefit obtained by the perpetrator, his behavior and his economic capacity, except in cases of collective management systems.

6. Bibliography

Primary sources:
ASIPLA, (2014). Reporte Anual 2013. Plastiguía 2014. Found at http://www.asipla.cl/wp-content/uploads/2014/10/Anuario-Asipla-Ok-baja.pdf

ASIPLA, (2016): Chile se Recicla. Impactos y desafíos de la Ley Marco para la Gestión de Residuos, la Responsabilidad Extendida del Productor y el Fomento al Reciclaje. Santiago de Chile.

ASIPLA, (2016): Estadísticas Industria del Plástico, Informe anual 2016. Santiago de Chile. Found at: http://www.asipla.cl/wp-content/uploads/2017/05/Estad%C3%ADsticas-ASIPLA-2016-Datasur.pdf

Science History Institute: The History and Future of Plastics. Found at: https://www.sciencehistory.org/sites/default/files/history-of-plastics.pdf

World Economic Forum (2016): "The New Plastics Economy Rethinking the future of plastics". Found at: http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf

Secondary sources:
Comisión Nacional de Medioambiente, (2010): Primer Reporte sobre Manejo de Residuos Sólidos en Chile. Gobierno de Chile. Found at: http://www.hidronor.cl/pdf/1_Primer_Reporte_del_Manejo_de_Residuos_S%C3%B3lidos_en_Chile_Conama_2010.pdf

Ellen MacArthur Foundation (2016): The New Plastics Economy. Catalysing Action. Found at: https://newplasticseconomy.org/assets/doc/New-Plastics-Economy_Catalysing-Action_13-1-17.pdf

Internet:

American Chemistery Council (2018). Two Plastic Types, Based on Processing. Found at: https://plastics.americanchemistry.com/Education-Resources/Hands-on-Plastics/

ASIPLA. Transformación. Found at: http://www.asipla.cl/transformacion/

Comisión Nacional del Medio Ambiente (2010): Primer Reporte del Manejo de Residuos Sólidos en Chile. Gobierno de Chile.

CONAMA (2010): Primer Reporte del Manejo de Residuos Sólidos en Chile.

Ferroplast. Found at: http://www.ferroplast.cl

Freinkel, S. (2011): Plastics: A Toxic Love Story.

Greenplast. Found at: http://www.greenplast.cl

How 2 Recycle (2018). A Cleaner World Starts With Us. Found at: http://www.how2recycle.info/

Inproplas. Found at: http://www.inproplas.cl/

Integrity. Found at: http://www.integrity.cl/

Nicholson, J. and Leighton, G. (1942) "Plastics Come of Age," Harper's Magazine.

OECD (2016): Environmental Performance Reviews: Chile 2016.

Plastics Europe (2018): Recycling and energy recovery. Found at: https://www.plasticseurope.org/es/focus-areas/circular-economy/zero-plastics-landfill/recycling-and-energy-recovery

Recipet. Found at: http://www.recipet.cl

Rplast. Found at: http://www.rplast.cl

Superior. Found at: http://www.superior.cl/reciclaje.html

United Nations University-Institute for the Advanced Study of Sustainability (2014): The Global E-Waste Monitor 2014, Quantities, flows and resources.

Harrison JP, BC Boardman, K O'Callaghan, A-M Delort & J Song (2018) Biodegradability standards for carrier bags and plastic films in aquatic environments: a critical review. Royal Society Open Science 5: 171792.

Lambert S & M Wagner (2017) Environmental performance of bio-based and biodegradable plastics: the road ahead. Royal Society of Chemistry 46: 6855-6871.OECD (2016) Environmental Performance Reviews: Chile 2016.

UNEP (2016) Marine plastic debris and microplastics – Global lessons and research to inspire action and guide policy change. United Nations Environment Programme, Nairobi.

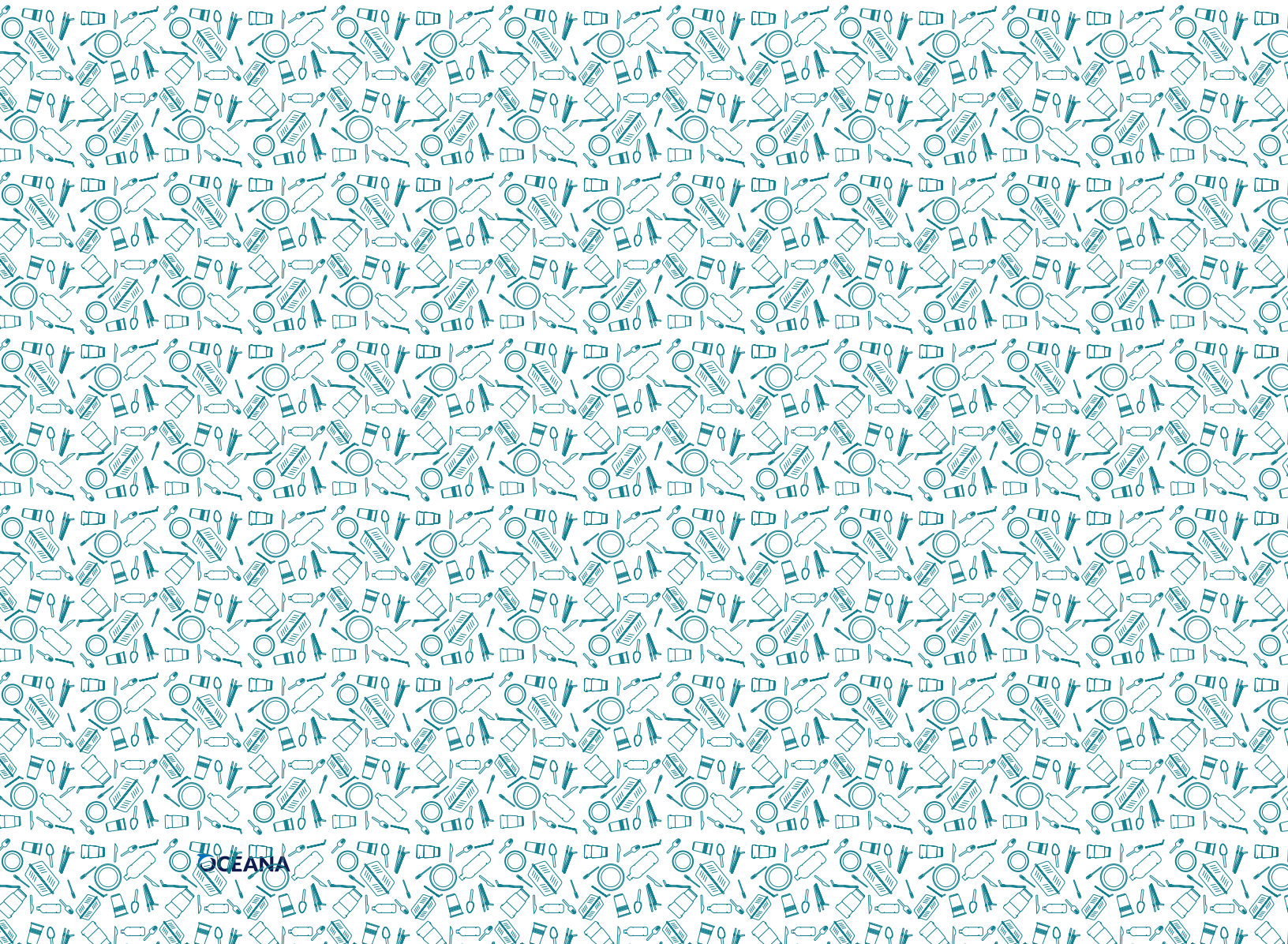
UNEP (2018a) Single-Use Plastics: A Roadmap for Sustainability.

UNEP (2018b) El estado de los plásticos: Perspectiva del día mundial del medio ambiente 2018.

World Economic Forum, Ellen MacArthur Foundation & McKinsey & Company (2016) The New Plastics Economy – Rethinking the future of plastics

CHAPTER 2:

COMPARATIVE STUDY ON SINGLE USE PLASTIC LEGISLATION



1. Introduction

The production and consumption of plastics increased considerably since the second half of the 20th century[24], mainly because it is a light weight, resistant, versatile and inexpensive material, and began to replace a lot of products we originally knew in their "ecological" version, such as glass bottles, paper or cardboard packaging, metal tubes for toothpaste or cloth diapers, among many others[25]. This trend of nearly unrestricted replacement explains why today we are totally dependent on plastic to perform many of our human activities.

A large part of the plastic we use was designed to be discarded after it is used for the first time, which is known as "single use plastic" (hereafter SUP), putting a lot of pressure on the environment and natural resources such as rivers, beaches and the ocean. In fact, according to figures from the United Nations Environment Programme (UNEP), only 9% of 9 billion tons of plastic produced has been recycled and at least 13 million tons of plastic waste end up in the ocean each year[26]. In addition, the exploitation and production of oil, which is the main raw material to produce plastic, contributes to increase the levels of greenhouse gases which directly influence climate change[27].

Regarding the degradation of plastic, these polymers take up to 500 years to degrade in nature, while some plastic bags and Styrofoam products can even take up to 1,000 years to break down if placed under unsuitable conditions[28]. Furthermore, most plastics break down into thousands of pieces called microplastics which infiltrate the trophic chains of fish and marine animals[29].

Also, plastic manufacturing requires chemical additives that remain trapped in its structure and in time, or due to changes in temperature or sun exposure, these additives can be released into the environment or come in contact with food and beverages, which has been linked to high cancer rates[30].

In all, it is estimated that if current consumption patterns and waste management practices continue, then by 2050 there will be about 12 billion tons of plastic litter in landfills and the environment[31], which is clearly unsustainable.

In this context, and for several years, countries, cities and municipalities have aimed their efforts to regulate single use plastic, mainly concerning plastic bags and straws. However, work still needs to be done for legislation to extend its scope to other SUP products that are equally polluting and damaging for the environment such as plastic service ware, cups, plates, wine glasses, and many others.

This report has analyzed 12 comparative legislations to regulate single use plastic products, other than plastic bags, at the subnational, national or supranational level, to identify the regulatory strategies and techniques used to address this issue. The Second Section of this report analyzes regulations, including laws, strategies or bills developed in these 12 locations.

24 UNEP (2018) Single-Use Plastics: A Roadmap for Sustainability

25 Costa Rica 2017-2021 National strategy to replace single use plastic for renewable and compostable alternatives, available at http://estrategia.zonalibredeplastico.org/sobre-la-estrategia

26 UNEP The State of Plastics: World Environment Day Outlook 2018.

27 United Nations Framework Convention on Climate Change. Consultative Group of Experts on National Communications from Parties not included in Annex I of the Convention (GCE): Energy sector handbook – burning fuels.

28 UNEP (2018) Single-Use Plastics: A Roadmap for Sustainability.

29 Ibid. Reference 25

30 Ibid. Reference 29

31 Ibid. Reference 24

Then the Third Section presents compared results of seven structural elements in common: general characteristics, type of instrument, regulated object, regulated individuals and actions, establishing substitutes or replacement alternatives, progressiveness and means to implement regulations such as certification systems, monitoring schemes, supervision and fines or education and environmental awareness. Last, the conclusion includes a few final considerations.

2. Case Studies

This report aims to identify the key elements that are being integrated in legislation seeking to adequately regulate SUPs. Twelve case studies have been analyzed for this purpose at the subnational, national and supranational level, and are presented in this section.

2.1. Subnacional level

2.1.1. Seattle

Regulated SUP	Expanded polystyrene containers, food containers, canisters, plates, serving trays, meat trays, cups, service ware, straws, spoons, forks, knives and utensils
Instrument	Municipal Ordinance

Characteristics

The city of Seattle has been regulating the use of single use plastics since January 2009, when it banned food service businesses from using Styrofoam (expanded polystyrene) containers through Municipal Ordinance N° 122751[32]. In addition, as of January 1, 2010, the city barred these companies from selling or providing food with or in disposable plastic packaging, unless they used compostable or recyclable certified containers[33]. These products include containers, plates, serving trays, meat and vegetable trays, cups for cold and hot beverages, and non-recyclable utensils made of plastic- or plastic-coated paper and are designed for one-time-use, including so-called biodegradable products where any portion is not compostable. Businesses that do not comply with these obligations could face up to a US$250 fine.

Also, the ordinance establishes it will assist the implementation of these measures by creating a group comprised by food service businesses and environmentalists that must develop a report on the availability, cost and performance of recyclable and compostable alternatives to plastic food service ware. This report should include approaches to increase the availability of competitively priced alternatives[34].

32 Seattle City Council Bills and Ordinances, Bill 116250, Ordinance 12275. Available at: http://clerk.seattle.gov/~scripts/nphbrs.exe?s3=&s4=122751&s5=&s1=&s2=&S6=&Sect4=AND&l=0&Sect2=THESON&Sect3=PLURON&Sect5=CBORY&-Sect6=HITOFF&d=ORDF&p=1&u=%2F%7Epublic%2Fcbor1.htm&r=1&f=G

33 According to the Ordinance, "Recyclable" means made solely of materials that are capable of being separated from a waste stream by a food service business and made available for collection and delivery to a processor for reuse or remanufacture into the same or other products (SMC 21.36.086 B number 4). "Compostable" means made solely of organic substances that break down into a stable product due to the action of bacteria in a controlled, aerobic commercial process that results in a material safe and desirable as a soil amendment meeting the compost quality standards found under WAC 173-350-220 for metals, physical parameters, pathogens, manufactured inert material, and other testing parameters established by the local Health Department (SMC 21. 36.086 B number 1).

34 Ibid. Reference 32.

In addition, on July 1, 2018, the city of Seattle banned the use of plastic straws and service ware (spoons, forks, knives) unless they are certified as compostable or recyclable. However, certain exceptions are made for health or safety reasons where plastic straws cannot be replaced by compostable or recyclable alternatives, and other special cases[35].

Considering that the ban involves the replacement of these products for compostable and reusable alternatives, the city of Seattle has made available for the food industry two directories of business that manufacture compostable alternatives, since every replacement product must comply with the compost processing requirements established by the city.

Pros	Cons
Gradual increase of banned SUPs makes it easier for the food industry and regulated individuals to comply with these obligations. In addition, assembling an inter-sector group to search for substitute materials fosters dialogue and local exchange to generate local markets for compostable and/or biodegradable products. The municipality has disseminated this regulation through material that is clear, easy to understand and available in several languages. This makes it easier for food service businesses to implement this regulation, which in a multicultural city like Seattle, many of these businesses are run by people of different nationalities[36]. Seattle aims to save costs by adequately managing waste, which is why it requires food venues to set up clear, well signaled areas for sorting and collecting waste. Provides free and direct assistance to facilitate the implementation of this Ordinance.	The regulation only refers to the food service industry, sale and supply, which even though it is progress it is not enough to eliminate SUP. In this sense, greater ambition is required to also ban SUP production, sale and use for all Seattle industries and individuals. Composting and recycling certified in the city of Seattle; there is no guarantee that these processes are conducted in other cities or in natural and marine environments.

35 Also, within the exemptions are the use of: i) Heavy, long plastic disposable soda spoons when required and used for thick beverages; i) Metallic foil sheets, or foil laminated paper designed to wrap hot food such as hamburgers and burritos; iii) Serving size cups for hot food.
36 Packaging requirements for food services in Seattle. Available at: http://www.seattle.gov/util/forbusinesses/solidwaste/foodyardbusinesses/commercial/foodpackagingrequirements/

2.1.2. Guayaquil

Regulated SUP	Plastic straws, packaging, containers, cutlery, glasses, drink stirrers and mixers, plastic and styrofoam cups and lids, T-shirt type plastic bags[37], even oxo-biodegradable, service ware
Instrument	Municipal Ordinance

Characteristics

On September 25, 2018, the Municipality of Guayaquil issued an Ordinance[38] to regulate the manufacture, sale, distribution and delivery of SUP; specifically, straws, containers, cutlery, glasses, plastic and Styrofoam cups and T-shirt type plastic bags, including oxo-biodegradable. In addition, through this instrument the Municipality aims to foster a reduction in SUP consumption, promoting the development of circular economy to revalue material from waste and/or replacing it with plant-based biodegradable material.

Regarding straws produced with Polypropylene (PP), Polystyrene (PS), Oxo-biodegradable plastic or Fragmentable plastic and its derivatives, their manufacture, sale, distribution and delivery is banned as of March 2019 (article 5). They will have to be replaced by products made from material that is 100% biodegradable or reusable[39], and the biodegradation process cannot exceed 24 months.

The production, sale, distribution and delivery of packaging such as containers, lids, service ware and cutlery, cups, glasses, lids for cups and glasses, stirrers and mixers produced with Flex Foam (Foam or Expanded polystyrene EPS foam, thermoforming, oxo-biodegradable or fragmentable) is banned as of September 2021 (article 7)[40]. They will be replaced by products made with material that is 100% biodegradable, in a biodegradation process of no more than 24 months; made from 70% recycled material, provided that the efficiency and technical feasibility is confirmed; or with reusable material.

This Ordinance bans oxo-biodegradable, fragmentable and/or disposable T-shirt type plastic cases or bags meant to carry products that are not 100% biodegradable or contain recycled material. A progressive replacement system is in place for the percentage of biodegradable or reusable material (article 9), namely:

- By March 2019, all plastic bags must be made of 35% recycled material or be 100% biodegradable.

- By September 2019, all plastic bags must be made of 50% recycled material or be 100% biodegradable.

- By June 2020, they must be 70% recycled material or 100% biodegradable.

37 One time use T-shirt type plastic case or bag to carry products: Bag used to group together a certain number of units of sale to be transported by the end consumer.

38 Ordinance to regulate the manufacture, sale of any type, distribution and delivery of single use plastic products and specifically single use plastic straws, packaging, containers, cutlery, glasses, plastic and Styrofoam cups and T-shirt type plastic bags, including biodegradable, in the Guayaquil canton.

39 The Ordinance's definition for "Reusable packaging" is that which presents the characteristics such as: resistance, high durability, washable, can be used many times and ensures better environmental performance than single use plastic packaging or biodegradable packaging. For the purpose of this Ordinance, regardless of its use, packaging mentioned in Article 4 is not considered reusable packaging. Also, "Reusable case or bag" is defined as being made from different synthetic or natural fibers and possessing the following characteristics: resistance, high durability, washable, can be used many times and ensures better environmental performance than single use plastic bags.

40 Excepting products used as primary packaging containing fresh or frozen meat products, or that require technology such as controlled or modified atmosphere, vacuum packaging, shrink packaging, and others (Article 7 second subparagraph)

In any case, the ordinance considers that if by June 2020 manufacturers were to complain and prove they can't comply with this requirement due to temporary lack of raw materials; the municipality of Guayaquil can grant a temporary waiver (final subsection article 9).

In addition, as of September 2021 the ordinance bans the manufacture, sale, distribution and deliv**ery** of oxo- biodegradable or fragmentable single use containers, including lids, service ware and cutlery, glasses, cups, lids for glasses and cups, stirrers and mixers, and single use food containers made of Polypropylene, PS Polystyrene, Polyethylene terephthalate, and non-recycled PET. The exception are containers that have direct contact with industrialized beverages and food, cleaning supplies and personal hygiene products (article 10), which must follow the same requirements for replacements as flex foam containers.

By March 2019, malls, markets, and supermarkets will have to have fittings to sort SUPs according to source: 1.-Bags or cases, 2.- plastic straws, plastic containers, including their lids, service ware and cutlery, glasses, cups, lids for glasses and cups, stirrers and mixers, SUP food containers. This waste must be sorted by an authorized environmental processor, prior agreement with the mall, supermarket or municipal market, case by case (article 14). It also establishes punishments for non-compliance which range from minor fines, serious fines and temporary and/or definitive shut down (article 19).

Last, the Municipal Ordinance includes a system of environmental and tax exemptions and incentives. Specifically, manufacturers that change their raw material from regulated SUPs to biodegradable and/or recycled material according to the established percentages will be exempt for a ten-year period from paying up to 50% in taxes to the municipality (article 16). In addition, the municipality will create an environmental certification (honor incentive) for private businesses committed to the use of reusable products (article 18).

Pros	Cons
Regulates a broad universe of SUP. Clear definition of biodegradability by providing a maximum deadline of 24 months for decomposition. Determines that the Municipality and private businesses must co-finance communication campaigns to inform and raise awareness on the negative impact of SUP, promoting recycling and the use of biodegradable products (article 13). Bans the purchase of SUP in all public acquisitions, including municipal businesses, corporations and foundations (article 20 and 21).	The advantage of gradually replacing the percentage of recycled material of bags instead of directly eliminating plastic bags is not clear, considering there already exist replacement alternatives that are environmentally friendlier. The fact that a temporary waiver is already being offered in case manufacturers can't comply with the replacement goals could dissuade innovation and research efforts for replacement alternatives This ban makes an exception for SUP produced to be sold or exported outside the Guayaquil border (article 12), which only moves the problem outside municipality limits under circumstances that demonstrate that plastic is a cross-border problem. Only bans the manufacture, sale, distribution and delivery, and not use or consumption of SUP, which could generate a perverse incentive for people to continue to use these products by obtaining them from the neighboring municipality.

2.1.3. Maharashtra

Regulated SUP	Dishes, cups, plates, glasses, fork, bowls, containers, disposable dish/bowls used for packaging food in hotels, spoons, straws, non-woven polypropylene bags, cups/pouches to store liquid, packaging with plastic to wrap or store the products, packaging of food items and food grain material, etc.
Instrument	Law

Characteristics

The State of Maharashtra, through the Maharashtra Plastic and Thermocol Products Notification 2018[41], bans the manufacture, usage, transport, distribution, wholesale and retail sale and storage, of disposable products manufactured from plastic and thermocol (polystyrene) such as single use disposable plates, glasses, cups, forks, bowls, containers, disposable dish/bowl used for packaging food in hotels, spoons, straws, non-woven polypropylene bags, cups/pouches to store liquid, packaging with plastic to wrap or store products, packaging of food items and food grain material, etc. In addition, the law bans the use of plastic or polystyrene for decoration purposes and the usage, sale, storage and manufacture of PET or PETE bottles made of high-quality food grade virgin Bisphenol-A material having liquid holding capacity less than 0.5 liters.

In addition, PET or PETE bottle manufacturers, producers, sellers and traders under "Extended Producers and Sellers/Traders Responsibility" must develop a Buy Back Depository Mechanism for PET/PETE bottles and milk bags by virtue of which manufacturers will charge a refundable amount when a person buys a bottled or bagged product. The payment will be refunded once the bottle or bag has been deposited at the distributor or reverse-vending machine[42].

Indeed, manufacturers of these products will have to print the buyback price on the bottle: 50 paise per milk bag, 1 Rupee (US$ 0.014) for 1-liter bottles and 2 Rupees (US$ 0,029) for bottles ranging from 200mL and 1 liter[43]. They will also have to set up Collection and Recycling units of adequate capacity and number to collect and recycle such bottles and bags. Manufacturers must present proposals on how to implement this scheme; it is their responsibility to set up cooperation mechanisms with recyclers. In terms of consumers, they must return a bag or PET bottle to claim payment; in any case they can be punished if caught in possession of these products. As consumers, they must return a bag or PET bottle to claim the deposit, which in any case can be penalized if they are caught is possession of these products.

Primary soft drink producers of Maharashtra, including Coca-Cola, PepsiCo and Bisleri have currently begun to print the buyback price on PET bottles[44].

The bans apply to all people and public and private institutions located in this State. However, the following products are exempt from these regulations: i) Plastic bags or plastic used for packaging medi-

41 Maharashtra Plastic and Termocol Products (Manufacture, Usage, Sale, Transport, Handling and Storage) Notification 2018. Available at: http://mpcb.gov.in/images/pdf/plastic_27032018.pdf

42 A similar case is Norway and its "Reverse Vending Machines- RVM" system which allows the country to recycle 97% of its plastic bottles. For more information: https://packagingeurope.com/norway-recycling-deposit-tracy-sutton/

43 https://timesofindia.indiatimes.com/india/after-plastic-ban-maharashtra-govt-to-roll-out-buyback-scheme-heres-what-it-means/articleshow/65286357.cms

44 Ibid. Reference 43

cines, ii) compostable plastic bags[45] or material used for plant nurseries, horticulture, agriculture, handling of solid waste, which should be previously certified, iii) to manufacture plastic and plastic bags for export purpose only, iv) plastic cover or plastic to wrap the material at the manufacturing stage or is an integral part of manufacturing, v) Food grade virgin plastic bags not less than 50 micron thick used for packaging of milk. However, the buyback price which should be no less than Rs. 0.50 (US$ 0.0072), should be clearly printed on these bags.

Point 7 of this Notification details the time frame for the implementation of these regulations for the different actors involved:

- For **manufacturers and producers**, the ban to manufacture and sell forbidden SUP began to be enforced from March 23, 2018, with one month from the date of notification to sell banned products out of State or to an authorized recycler or industry.

- The ban for **sellers, retailers and traders** began on March 23, 2018, and provided one month from the date of notification to dispose of the product by selling them out of State to an authorized recycler or industry or handing them over to a local organization for scientific research or recycler.

- For **users**, the use of banned items was enforced on March 23, 2018, and provided one month to sell these products to an authorized recycler or industry or hand them over to a local organization for scientific research purposes or recycling.

- The **local organization** is given one month to arrange the collection, transport and delivery of banned plastic items or plastic waste.

Pros	Cons
The list of SUPs is not limited since the abbreviation "etc." was added at the end, meaning other products may be included in this ban. In fact, an Empowered Committee is established, constituted under the chairmanship of the Ministry of Environment which is in charge of monitoring the implementation of this regulation and regularly reviewing the incorporation of additional items that generate non-biodegradable garbage in this State. Establishes a buyback system for bottles and milk bags that can become an attractive incentive to reuse or recycle these materials. Regulates a broad universe of individuals (manufacturers, producers, sellers, users, local organizations, and others) and actions (manufacture, sale, use). This is consistent with the objective of eliminating SUP.	The ban falls only on plastic bottles with a holding capacity of less than 500mL which is not very ambitious, since 600 or 700mL bottles are still small and therefore, their collection and recycling is cost-inefficient. The implementation period was limited, providing very little time for the industry and users to dispose of or eliminate the available stock of banned SUP. The establishment of these bans through a notification in addition to the limited time provided for its implementation generated a lot of rejection from manufacturers and the industry, who considered it illegal giving rise to several legal actions[46].

45 Compostable Plastic means plastic that undergoes degradation by biological processes during composting to yield CO2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials, excluding environmental petrobased plastic, and does not leave visible, distinguishable or toxic residue. In addition, it shall conform to the Indian Standard: IS 17088:2008 titled as Specifications for Compostable Plastics

46 https://timesofindia.indiatimes.com/city/mumbai/maharashtra-use-of-plastic-can-be-penalized-time-given-for-disposal-hc-told/articleshow/63739097.cms.

2.1.4. Seychelles

Regulated SUP	Plastic utensils such as forks, spoons, knives, plates, cups, containers, trays and polystyrene food take-out containers.
Instrument	Law

Characteristics

The Island of Seychelles, located on the Indian Ocean, has been a trailblazer in SUP regulation. In fact, as a reaction to the environmental crisis set off by bad waste management, the Cabinet approved two groups of regulations that impose, on one hand, restrictions on the import, manufacture, distribution and sale of plastic bags, and the import, manufacture, distribution and sale of food takeaway boxes made of polystyrene and plastic utensils such as forks, spoons, plates, cups, trays (Regulation on utensils, articles 2 and 3). Both legal instruments went into effect on July 1, 2017[47].

However, the regulation includes certain exemptions since it allows the import of utensils and boxes, provided they are biodegradable (article 4). The law defines biodegradable utensils or boxes as those that can be "biologically broken down naturally by bacteria and other living organisms into natural elements in a normal environment leaving no toxicity in the soil" (article 2). In any case, whoever imports these biodegradable products must previously obtain a certificate of conformity issued by the Seychelles Bureau of Standards, the responsible body to undertake the validation of the certificate of conformity with these parameters (article 4).

A violation of these requirements can be punishable with a fine of up to SCR 20,000 (US$ 1,465), imprisonment for no more than a year, or both (article 5). Furthermore, if the guilty party continues to violate these regulations the fine can increase to SCR 2,000 (US $147) for each day that non-compliance continues or up to two years in prison (article 5).

Pros	Cons
Regulates a broad range of SUP. Involves quite strict punishment (fines and even imprisonment) in case of non-compliance with these requirements which increases the coercive nature of this regulation. The regulating body is willing to move forward with the SUP ban, which is reflected in the Regulations that have come into effect on this matter.	Only bans import, manufacture, distribution and sale, but not the use of these materials which begs the question, can people and organizations use SUP anyway and not go against the law? Considering that Seychelles is an island it would be more difficult to generate a perverse incentive as is the case in Guayaquil (obtaining SUP in neighboring areas), however, by not banning the use of these products directly the opportunity remains open. The use of biodegradable alternatives rests on the importance of them without providing incentives to advance in the development and research of substitutes at the local level. The definition of biodegradability is not enough because it does not ensure the breakdown of SUP in a time frame that is sustainable for the environment.

47 Environment Protection (Restriction on importation, distribution and sale of Plastic Utensils and Polystyrene Boxes) Regulations 2017. Available at: https://members.wto.org/crnattachments/2017/TBT/SYC/17_0650_01_e.pdf

2.1.5. Antigua and Barbuda

Regulated SUP	Containers made of expanded polystyrene, plastic utensils (spoons, forks, knives and straws), fruit trays, meat trays, vegetable trays and plastic egg cartons, polystyrene foam coolers.
Instrument	Law

Characteristics

The government of Antigua and Barbuda banned the import and use of polystyrene foam food service products on July 1, 2017 through the External Trade (Import Prohibition) Order of 2017. The implementation of this ban was arranged in three stages, namely[48]:

Stage 1 (July 1, 2017- December 1, 2017)

- Ban on the import and use of clamshell and hinge food service containers, hotdog containers and all other containers made of expanded polystyrene, such as bowls, plates, hot and cold beverage cups, lids and caps.

In addition, the government has encouraged the replacement of plastic PET bowls for ones made from PLA Cornstarch.

Stage 2 (January 1, 2018 – June 30, 2018)

- Ban on the import and use of utensils such as plastic spoons, forks, knives and straws, fruit trays, meat trays, vegetable trays and egg cartons.

Stage 3 (July 1, 2018 – January 1, 2019)

- Ban on the import and use of 'naked' polystyrene foam coolers

The law establishes a list of replacement alternatives approved by the government that includes bagasse (sugar cane pulp), cornstarch (Non–GMO), bamboo, wheat straw, cardboard/paper, Areca palm and potato starch. These products will remain tax free. In any case, importers of these alternative will have to present certificates from manufacturers and accredited labs for verification. In addition, the law provides a 6-month grace period for the disposal of all existing stock of banned products, after which supervisions and confiscation will take place if necessary.

This law applies to all businesses within the food service industry in Antigua and Barbuda, including the catering industry, food vendors, large and small supermarkets and grocery stores. However, airlines, private airline charters and passenger cruise ships are exempted until further notice.

48 http://www.healthwatchantiguaandbarbuda.com/Styrofoam-Ban

Pros	Cons
Provides a reasonable period of time (6 months) for commerce to eliminate inventory stock which facilitates the acceptance and gradual application of this measure. Establishing a list of alternative materials fosters innovation and local economic opportunities for the development of these products. Early involvement of all actors through consultations and workshops generates commitment to the implementation of the law and the development of replacement alternatives. Dissemination mechanisms have been developed for the law's main content at citizens' scale, with simple, visual and comprehensible content for the general public. Establishes a tax exemption system to promote replacement alternatives. Even though the law does not mention it, the government is also developing a composting project that aims to accept alternative products for their breakdown[49].	Airlines and cruises are exempt from these requirements, which can put greater pressure on retailers. Beyond the fact that the list of alternatives refers to compostable material, it remains unclear if differentiated analyses were conducted or not regarding the environmental impact of exploiting these resources in the local setting, which would be able to ensure (or not) their sustainable management.

2.1.6. Galapagos

Regulated SUP	T-shirt type cases, containers, straws, disposable cups, cutlery, packaging, products made of expanded polystyrene: plates, cups, food containers.
Instrument	Municipal Ordinance

Characteristics

On May 21, 2015, the Galapagos Island provincial government approved the Ordinance that aims to promote responsible consumption by regulating the sale and distribution of disposable plastic products and disposable containers made of expanded polystyrene (foam, foamflex, styrofoam) in the Galapagos Islands[50].

In article 5, this Ordinance bans the trade, distribution, sale and delivery of disposable single use plastic T-shirt type cases, and disposable plastic packaging made of expanded polystyrene (known as foam, foamflex or styrofoam) in all commercial, tourism, and/or productive venues of the Province of Galapagos. In any case, it establishes that decentralized governments are charged with issuing ordinances to implement these requirements (article 6), notwithstanding that said regulations must, as a minimum:

a. Promote the use of reusable bags or covers made from compostable materials or alternatives to plastic such as paper, cloth, canvas and others.

b. Reusable cases will have minimum cost, clearly visible and will be paid by the user.

c. Carry out and promote campaigns to raise awareness and provide environmental education on the use and replacement of SUP.

50 http://www.gobiernogalapagos.gob.ec/wp-content/uploads/downloads/2015/02/005-CGREG-11-II-2015-PLASTICOS_1.pdf

d. Promote the productions of reusable products made by local producers, cooperatives, micro-businesses, and others; who must use alternative, sustainable, recycled, compostable and resistant materials that can be used several times.

e. Engage public and private institutions.

f. Promote responsible habits and practices regarding the production and management of solid waste.

g. Create incentives and disincentives to limit and control the use of disposable plastics.

h. Establish mechanisms for control, punishments and fines.

It also states that commercial establishments will not be able to distribute or sell T-shirt type plastic cases, disposable plastic packaging made of expanded polystyrene within a maximum of 4 months from the time the Ordinance is enacted (article 10).

Pros	Cons
Regulates very relevant environmental and ecological sites. The Ordinance establishes that the Government of Galapagos will provide technical and financial support to train and promote the use of alternative, sustainable, recycled, compostable and resistant materials that can be used several times (article 9).	The provincial Ordinance only outlines a general framework and minimum regulation content, delegating the enactment of specific ordinances for its implementation on the Autonomous Decentralized Government of the Province of Galapagos. Therefore, the effective removal of SUP remains subject to the enactment of these ordinances and the content included in them. Only regulates certain actions -trade, distribution, sale and delivery of SUP- conducted by certain individuals -commercial, tourism and/or productive venues of the Province of Galapagos- while making no reference to the use and consumption of SUP of the entire population. The definitions of case and compostable material are ambiguous and insufficient, since they don't indicate a time period for compostability[51].

51 Compostable case: Cases for different uses, made of organic material such as paper, sugarcane Pulp, corn, cotton and others, that break down in a standardized compost pile for a defined amount of time.

2.1.7. Saint Vincent & The Grenadines

Regulated SUP	Food service products made of expanded polystyrene and food packaging
Instrument	Law

Characteristics

These regulations decreed by the Government of Saint Vincent & the Grenadines was enacted on May 1, 2017[52], and refers to the ban on the import, manufacture, use and supply of food service products made of expanded polystyrene. In addition, these regulations aim to promote and encourage the use of biodegradable, recyclable and other environmentally friendly containers or packaging for food in replacement of products made from expanded polystyrene. There is a nine-month deadline to comply with these regulations.

Violation of these regulations may result in a fine of US$ 5,000, imprisonment up to 12 months or both.

Notwithstanding the above, if the Minister considers the import, manufacture, sale or use of any of the banned products is in the public's interest he/she may authorize these actions.

Pros	Cons
The regulation considers that the Division in charge of implementing this law will be responsible for guiding, promoting and incentivizing the use of biodegradable, recyclable and environmentally friendly food containers and packaging as a replacement of products made of expanded polystyrene (article 9).	Only regulates products made of expanded polystyrene. Even though a broad range of actions is regulated -import, manufacture, sale, use and supply of SUP- this only applies to food services.

2.2. National level

2.2.1. Costa Rica

Regulated SUP	Styrofoam packaging; disposable, non-recyclable, non-compostable food packaging cutlery; and plastic straws, spoons, knives and utensils.
Instrument	National Strategy

Characteristics

In 2017, Costa Rica published its "National Strategy to replace single use plastic for renewable and compostable alternatives"[53] (hereafter, "the strategy") to contribute to the solution of a pollution problem generated by these plastics in water basins of the Great Metropolitan Area and Costa Rica's Pacific Coast. This strategy is part of the "2016-2021 National plan for comprehensive waste management" and the "National strategy to sort, recover and revalue waste". It came about as a voluntary and collective action process between the public sector (central government and municipalities), the private sector (industry, trade) and civil society in general. Its impacts include: 1) Reduction of the presence of SUP in Costa Rican rivers and beaches; 2) Reduction of the presence of SUP in waste recovery centers; and 3) Economic growth of the industry for renewable and compostable alternatives.

52 Environmental Health (Expanded Polystyrene ban) regulations. Available at: http://customs.gov.vc/downloads/polystrene-ACT.pdf

53 2017-2021 Costa Rica National strategy for the substitution of single use plastics for renewable and compostable alternatives. Available at http://estrategia.zonalibredeplastico.org/sobre-la-estrategia

To achieve the above, the strategy basically aims to disseminate and monitor voluntary commitments made by institutions, municipalities, businesses and organizations centered on five strategic lines, which in turn define specific goals for 2021, compliance indicators and the definition of base lines for comparison. The five lines are:

1. Municipal incentives to substitute single use plastics for renewable and compostable alternatives. The goal by 2021 is for 80% of cantons[54] to have modified license regulations that include fees to disincentivize the consumption of SUP and foster its replacement for renewable and compostable alternatives.

2. Institutional policies and guidelines for their suppliers to substitute the purchase of single use plastic for renewable and compostable alternatives. The goal for 2021 is for 70% of Costa Rican public institutions to have internal policies in place for suppliers to disincentivize the purchase of SUP and facilitate the acquisition of renewable and compostable alternatives.

3. Promote the replacement of single use plastic for renewable and compostable alternatives among traders, wholesalers and retailers across the country. The goal set for 2021 is for 80% of the members of the Retailers National Chamber of Commerce (Canacodea) to have replaced SUPs with renewable and compostable alternatives.

4. Foster research and development to create and design packaging, bags and containers for solid and liquid products that replace SUP with renewable and compostable alternatives. This work will be developed between specialized labs, private businesses, universities, technical schools and training centers; the goal for 2021 is to have at least 10 new renewable and compostable alternative products in the market.

5. Encourage investment in productive projects that contribute to the replacement of SUP with renewable and compostable alternatives. The goal for 2021 is to have 20 new ventures (or reconversions) that contribute to the substitution of SUP for renewable or compostable alternatives.

In all, this strategy aims to reduce and eliminate the presence of SUP in rivers and oceans through adequate collection, sorting, reuse, reconversion and composting. In relation to sorting, Costa Rica developed an "RCM Sorting System" (renewable, compostable and biodegradable in marine environments) to group products and materials according to their origin and biodegradable and compostable capacity, even in marine environments. Even though this can be applied to all solid products[55] and not just plastics exclusively, it classifies the latter into six categories based on international biodegradation and compostability standards for plastic material, thus providing a clear technical framework to develop specific standards and regulations (Figure 1).

54 A canton is a subnational territorial unit. The Republic of Costa Rica is comprised of seven provinces that are divided into 82 cantons.

55 Non-metallic nor glass, for usage and consumption, of organic plant and animal origin, or inorganic, including its packaging, volume or laminate (film) format, disposable, reusable, recyclable, or not, and must break down by the effect of processes that are not mutually exclusive: biodegradation, photodegradation, chemical degradation, hydrolytic degradation and composting.

Figure 1. International standards for renewable and compostable plastics.

ASTM	Norma Europea EN	ISO
6400	**13432**	**18606**
Standard Specification for Labeling of Plastics Designed to be Aerobically Composted in Municipal or Industrial Facilities.	Requirements for packaging recoverable through composting and biodegradation.	Packaging and the environment Organic recycling.
6868	**14995**	**17088**
Standard specification for labeling of end items that incorporate plastics and polymers as coatings or additives with paper and other substrates designed to be aerobically composted in municipal or industrial facilities.	Plastics - Evaluation of compostability - Test scheme and specifications.	Specifications for compostable plastics.
7081		**14851**
Standard Specification for Non-Floating Biodegradable Plastics in the Marine Environment		Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium.
6691		
Standard test method for determining aerobic biodegradation of plastic materials in the marine environment by a defined microbial consortium or natural sea water inoculum.		
6866	**16785**	
Standard test methods for determining the biobased content of solid, liquid, and gaseous samples using radiocarbon analysis.	Determination of the bio-based content of solid, liquid and gaseous products, raw material, intermediate or finished products.	

SOURCES: ASTM/ EUROPEAN BIOPLASTICS / WWW.ISO.ORG

The RCM acronym refers to: R = renewable origin; C = compostable; and M = biodegradable in marine environments (Figure 2).In addition, "0" means non-compliance with the requirement and "1" means compliance.

Figure 2. RCM categories for single use products.

Material from a **renewable** source comes from animal or plant origin, annual or perennial with annual harvests. It does not come from fossil sources.	A material is **biodegradable** when it breaks down to the basic substances that comprise it, through the action of biological agents and microorganisms. It will be **compostable** if biodegradation happens within **180 days**	A material is **marine compostable** when it biodegrades within 180 days in a marine environment.
R	**C**	**M**
Material from a **renewable** source is not necessarily compostable, and material from a **non-renewable** source could be compostable.	**Compost** is an intermediate material within the biodegradation process of organic matter, which is completed with the production of humus.	Material that is **marine compostable** necessarily must be land **compostable.**
RCM 000 - Non-renewable - Non-compostable	**RCM 100** - Renewable - Non-compostable	**RCM 010** - Non-renewable - Compostable
RCM 011 - Non-renewable - Compostable in marine environment	**RCM 110** - Renewable - Compostable, but not in marine environments	**RCM 111** - Renewable - Compostable in marine environment

Considering that categories RCM 110 and RCM 111 are of renewable origin and compostable, materials classified into these categories will be the most advisable for the manufacture of single use products. Products classified as categories RCM 010 and RCM 011, even though they're synthetic polymers that could comply with composting requirements, because they are made from fossil fuels, they would increase the carbon footprint and therefore their use is not advisable.

Last, Annex 1 of the strategy suggests several actions for municipalities to take, which must be registered at the strategy's website[56], namely:

1. Modify the Municipal License Law to set a fee (or tax) charged to commercial venues that use non-renewable and non-compostable SUP. In addition, it suggests a fee exemption for venues that only use renewable and compostable material according to the RCM categories. The annex also suggests establishing an anticipated reasonable fee (proportional), at least a year, with an information campaign to preparer traders and the public in general.

2. Ban the municipal purchase of single use plastic, only allowing the acquisition of renewable and compostable products according to the RCM categories. This should be accompanied by an information campaign and a period of one year to find alternative materials.

56 www.zonalibredeplastico.org

3. Reduce the fee charged for waste collection services by percentage for licensed vendors that voluntarily adhere to the strategy. Characteristics

Pros	Cons
Covers a broad range of SUP, providing comprehensive and consistent regulation for this material. Establishes clear goals, with set time frames and comparative scenarios to eradicate SUP. The proposal is based on a thorough and well elaborated understanding of "degradation", "biodegradation", "compostability" and "marine compostability". Establishes a certification system (RCM) that facilitates consumers' decisions. It also fosters research and development of new alternatives for replacement, generating new market niches and economic entrepreneurships. Establishes a Participatory Monitoring mechanism for the Strategy's effects (detailed in Technical Annex 2 of the Strategy), involving a wide variety of actors (municipalities, institutions, businesses, civil society organizations) acting as supervising bodies through voluntary monitoring actions that must be registered at the Strategy's website. The Strategy's development included multi-actor and multi-level early involvement, which fostered acceptance and commitment with this initiative.	This is a voluntary and collective system; compliance is non-coercive and therefore, its application depends on political and individual willingness and commitment. Does not establish mechanisms for supervision and punishment; instead, follow-ups are subject to evaluations and periodical monitoring.

2.2.2. Spain

Regulated SUP	Disposable plates, cups, wine glasses, bowls, service ware and straws.
Instrument	Legislative proposal

Characteristics

In January 2018, Spain presented a Bill launched by a group of socialist parliamentarians that aims to drive legislative changes required to ban, by January 1 2020, the sale, import and exploitation of disposable utensils such as plates, cups, wine glasses, bowls, service ware and straws, manufactured in any variety of plastic. The bill establishes that as of the previous date, these products have to be manufactured with at least 50% biodegradable substances sourced from organic matter such as corn starch or potato starch, and by 2025 with at least 60%[57].

57 Legislative proposal presented by Confederal Congressional Group Unidos Podemos -EN Comú Podem-En Marea, regarding the gradual ban on the use of disposable plastic utensils in accordance with environmental objectives. Available at: http://www.congreso.es/public_oficiales/L12/CONG/BOCG/D/BOCG-12-D-282.PDF

Pros	Cons
There is political willingness to regulate a relatively broad range of SUP.	The proposal is quite general and only outlines a framework on which to start a discussion on the regulation of SUP, however, to date the regulation would appear to not consider regulating "use" or consumption, only at the level of manufacture and sale. The process of bills of law in Spain can extend far beyond than desirable because it must comply with requirements such as approval from the State Council and the Council of Ministers that validate its introduction to Congress, initiating its discussion and final approval.

2.2.3. France

Regulated SUP	Bowls, cups, plates, buds, containers, straws, cutlery, lids, food trays, ice cream containers, salad bowls, stirrers
Instrument	Environmental Code and Decree

Characteristics

Within the framework of the Energy Transition for Green Growth Act[58], and by virtue of Book III in article L. 541-10-5 of the Environmental Code[59], France has established that by January 1, 2020, it will put an end to the provision of SUP such as bowls, cups, plates, straws, cutlery, lids, food trays, ice cream containers, salad bowls, boxes and drink stirrers, except for articles that can be composted in domestic composting bins and that fully or partially contain biologically-based materials[60]. The minimum required biological base by 2020 is 50%, and then 60% by 2025[61]. In addition, it establishes a ban on the sale of plastic cotton buds (except Public Health exemptions) by 2020.

As of 2018, France also banned the sale of cosmetic products (cleansing or exfoliating) that contain solid plastic particles, except for natural particles not likely to persist in the environment and spread chemical or biological actives, or to affect animal food chains.

The Environmental Code establishes a ban on the use of plastic bowls to cook, heat and serve food in schools, universities, and nurseries for kids 6 years old and younger; the ban will be enacted on January

58 Law to determine common objectives to drive the energy transition, strengthening energy independence and the economic competitiveness of France, preserving humans, health and the environment, and fighting climate change. Available at: https://www.legifrance.gouv.fr/affichTexte.do;jsessionid=BA558FDF59C1F9DBB36BA1E776370A55.tplgfr28s_1?cidTexte=JORFTEXT000031044385&dateTexte=20181128

59 Design, production and distribution of products that generate waste. Available at: https://www.legifrance.gouv.fr/affichCode.do;jsessionid=BA558FDF59C1F9DBB36BA1E776370A55.tplgfr28s_1?idSectionTA=LEGISCTA000023268652&cidTexte=LEGITEXT000006074220&dateTexte=29990101

60 Article D543-295 of the Environmental Code states that products will be compostable at the domestic level if they comply with the requirements of the French standard approved for specifications on plastic suitable for domestic composting, as well as bowls, cups and plates legally manufactured or sold in a member State of the European Union or Turkey, or legally manufactured in a State that adheres to the Agreement that establishes the European Economic Area and provides equal guarantees. The "biologically-based content" means that the percentage, expressed as a fraction of total carbon, of biologically based material contained in a bowl, cup or plate is determined according to the calculation method specified by the current international standard to determine the biologically-based carbon content of plastics

61 Article D543-296 of the French Environmental Code. Available at: https://bit.ly/2Wn2FpE

1, 2025. In addition, the use of plastic water bottles will be banned in schools as of January 2020 (unless schools don't have a drinking water system or there are restrictions on water assigned for human consumption).

This regulation is part of the Book referring to Prevention and Waste Management of the Environmental Code, which in turn, applies the principle of Producer Extended Responsibility by virtue of which producers, importers and distributors will be required to provide or contribute to prevention and management of waste generated by their products (N.º II Article L541-10).

Pros	Cons
Puts an end to the availability of a broad range of SUP by 2020, which translates into a deep transformation of the consumption pattern of single use plastics. Includes graduality for compliance with its requirements; it provides a period of at least two years for the industry to develop replacement alternatives that comply with the compostability requirements and minimum biological material. Regulates micro plastics present in cosmetic products that could be toxic for human health. This regulation is included in a larger strategy launched by France concerning sustainable waste management.	It is unclear why the increase of minimum biological material is so limited for such an extended period of time. In other words, in five years (from 2020 to 2025) it will increase only by 10%.

2.2.4. Peru

Regulated SUP	Bags, straws, containers, plates, cups and other utensils and service ware.
Instrument	Bill of Law

Characteristics

The Peruvian Congress approved a Bill of Law[62] that regulates single use plastic, other non-reusable plastics and disposable containers or packaging made of expanded polystyrene (tecnopor) for food and beverage for human consumption in the Peruvian territory.

On one hand, the project provides a 36-month time frame for supermarkets, self-services, grocery stores, commerce in general, as well as their contractors or service providers to gradually replace the provision of non-reusable polymer-based bags for reusable bags or others whose break down does not generate pollution from micro plastics or hazardous substances and for them to ensure their revaluation. In addition, the bill states that they must charge for every bag provided and send these funds to the National Environmental Fund for education and environmental awareness purposes (article 2).

On the other hand, the bill bans the purchase, use, introduction or sale of polymer-based bags; polymer-based straws and containers or packaging made of expanded polystyrene for food and beverage for human consumption, in protected natural areas, sites designated as cultural heritage or natural world heritage, museums, coastline beaches and beaches of the Peruvian Amazon, as well as in state

62 http://www.leyes.congreso.gob.pe/Documentos/2016_2021/Dictamenes/Proyectos_de_Ley/02248DC19MAY20180906.pdf

administration organizations (article 3, 3.1 letter a)). It also bans the provision of polymer-based bags or packaging considered unnecessary, specifically that which is part of printed publicity such as newspapers, magazines or other written media formats; invoices for public or private services; and all information addressed to consumers, users or citizens in general (article 3 number 3.1 letter b).

The bill establishes a ban, a year after the law's enactment, on the manufacture, import, distribution, delivery, sale and consumption of: a) polymer-based bags (sized at less than 900 cm2 and those whose thickness is less than 50 micras); b) polymer-based straws (such as "pajitas, pitillos, popotes or cañitas", and others) and c) polymer-based bags that include additives that catalyze the fragmentation of said materials into micro fragments or micro plastic (article 3 numeral 3.2).

A ban is enacted as of July 28, 2021, on the manufacture, import, distribution, provision and consumption of: a) polymer-based plastic bags that are not reusable, that produce pollution from micro plastics or hazardous substances when they decompose, and whose revaluation can't be ensured; b) polymer-based plates, cups and other utensils and service ware for food and beverages for human consumption, that produce pollution from micro plastics or hazardous substances when they decompose, and whose revaluation can't be ensured; and c) the manufacture, import, distribution, provision, sale and use of containers, packaging or cups made of expanded polystyrene (tecnopor) for food and beverages for human consumption (article 3, subsection 3.3).

The bill establishes exemptions regarding bags to contain or transport bulk food of animal origin, due to reasons that include, health, sterility, food safety, cleanliness, and hygiene (article 4, subsections 4.1 and 4.2). Regarding polymer-based straws ("pajitas, pitillos, popotes or cañitas"), these should be used for medical needs in institutions that provide medical services or if required by senior citizens and people with disabilities.

In addition, it mandates the National Institute for Quality (INACAL) to approve the standards and technical regulation to define the quality specifications or requirements to determine the characteristics of reusable bags and bags that do not release micro plastics or hazardous substances when they break down, and to ensure their revaluation.

A Registry of manufacturers, importers and distributors of polymer-based bags and other goods will be established. This registry will be in charge of collecting and systematizing information regarding the placement of these products in the market to build statistical information and will arrange mechanisms to avoid duplicate records in state administration (article 6).

It also establishes requirements regarding education, training, raising citizen awareness and environmental commitment for the Ministry of Environment (MINAM), the Ministry of Education (MINEDU), the Ministry of Production (PRODUCE) and decentralized government (article 7). In addition, article 8 of the Bill lists several institutions that will be responsible for overseeing compliance with the enacted requirements.

Last, PET bottles must be manufactured with at least 20% of recycled material. This will be enforced three years after the law is enacted, and graduality will be established by a regulation.

Pros	Cons
The bill regulates vendors/manufacturers/ traders by punishing the manufacture, import, distribution, provision, sale of SUP as well as users and recipients of these products by regulating consumption. The list of SUP is broad and in a certain sense open to incorporate other products that could become part of its categories: containers, utensils, straws and service ware. Provides special protection for natural areas that have great environmental or cultural value.	Setting up a gradual requirement can be understood for plastic products whose replacement alternatives are still being researched or developed, but not for products for which cost-efficient replacement alternatives currently already exist, for example, for bags and straws. It is unclear why article 3, section 3.3, letters a) and b) do not expressly ban the sale of polymer-based bags, plates, cups and other utensils and service ware, when it does so for products in letter c) referring to containers, packaging and cups made of expanded polystyrene (tecnopor). This legal loophole should be fixed. The biodegradability parameter is not enough to ensure that a bag will decompose within a time frame that is environmentally sustainable. Though the bill assumes actors of the plastic products value chain will participate in education and awareness campaigns, it does not assign them with exclusive responsibility for this. The Extended Producer Responsibility policy approach is not established which makes this bill lack ambition when it comes to assigning responsibilities for environmental costs. Control or supervision of compliance rests on at least four different institutions which in practice may result in overlapping functions, making it inefficient and costly. Provides a very diminished role to the recycling sector (only in complementary provisions).

2.3. Supranational level

2.3.1. European Union

Regulated SUP	Food containers, beverage cups, cotton buds, cutlery, plates, straws, drink stirrers, balloon sticks, drink containers, sanitary napkins, tampons, tampon applicators, wet wipes, balloons, packets and wrappers, tobacco products with filters, oxo degradable plastic products and expanded polystyrene.
Instrument	EU Directive[63].

Characteristics

The European Union approved a Directive to regulate certain single use plastic products[64], aiming to prevent and reduce their impact on the environment, particularly for aquatic life and its environment, and for human health. The Directive also promotes the transition to a circular economy with innovative and sustainable business models, materials and products, contributing to the efficient functioning of the Union market (article 1). This proposal is presented as complementary to the efforts already being made by the EU within the framework of the Plastics Strategy[65], addressing the identified gaps in European actions and legislation, and further reinforcing the EU's systemic and innovative approach to promote bio-based alternatives that will provide new opportunities for businesses and consumer convenience.

The European proposal requires all member States to adopt measures such as:

Consumption reduction

- Ambitious and sustained reduction of at least 25% of food container consumption, with or without lids, beverage cups (products listed in Annex I Part A of the Directive) by 2025. These measures may include ensuring the availability of reusable alternatives to those products at points of sale for final consumers as well as taxes on these products. In any case, all Member States must produce national plans with reduction measures, establishing reduction targets (article 4).

- 50% reduction of post-consumer waste from tobacco filters containing plastic[66] by 2025 and 80% by 2030.

Restrictions on placing on the market

- Broad ban on placing on market of cotton bud sticks, Cutlery (forks, knives, spoons, chopsticks), plates, straw, drink stirrers, sticks to be attached to and to support balloons, oxo degradable plastic products, food and drink containers made of expanded polystyrene (single-use plastic products listed in Part B of Annex I), with certain exceptions (article 5).

- Ensure that beverage containers (or receptacles used to contain liquid, such as bottles) that have caps and lids with a significant part made of plastic may be placed on the market only if the caps and lids remain attached to the container during the product's intended use stage (products listed in Part C of Annex I).

63 On March the EI 27th, 2019 The European Parliament approved the **directive.**
64 Reduction of the impact of certain plastic products on the environment. Available at: https://oeil.secure.europarl.europa.eu/oeil/popups/ficheprocedure.do?reference=2018/0172(COD)&l=en#tab-0

65 EU Strategy for Plastics. Available at: https://multimedia.europarl.europa.eu/en/eu-strategy-for-plastics_9401_pk

66 'Plastic' means a material consisting of a polymer within the meaning of Article 3(5) of Regulation (EC) No 1907/2006, to which additives or other substances may have been added, and which can function as a main structural component of final products, with the exception of natural polymers that have not been chemically modified.

Marking requirements

- Ensure that sanitary pads and tampons and tampon applicators, wet wipes and wrappers or packaging manufactured with flexible material containing food for immediate consumption bear a conspicuous, clearly legible and indelible marking informing consumers of: appropriate waste disposal options for the product and/or waste disposal means to be avoided for that product, the negative environmental impacts of littering or other inappropriate waste disposal of the product, the presence of plastic in the product and the presence of chemical products of interest, such as hazardous metals, phthalates, PFAS, bisphenols, and endocrine disruptors and other substances of very high concern (SVHC) according to Regulation (EC) No 1907/2006 (products listed in Part D of Annex I) (article 7).

Hazardous Products

- Avoid the use of hazardous chemical products in the composition of sanitary pads, tampons and tampon applicators (article 7a).

Extended Producer Responsibility

- Establish Extended Producer Responsibility schemes for the following products listed in Part E of Annex I of the Directive:

    - Food containers, such as boxes, with or without a cover, used to contain food that is intended for immediate consumption from the receptacle, on-the-spot or take-away without any further preparation; for example, food containers used for fast food, except beverage containers, plates and packets and wrappers containing food.
    - Packets and wrappers made from flexible material containing food that is intended for immediate consumption from the packet or wrapper without any further preparation.
    - Beverage containers, meaning receptacles used to contain liquid such as beverage bottles including their caps and lids.
    - Cups for beverages.
    - Tobacco products with filters and filters marketed for use in combination with tobacco products.
    - Wet wipes, pre-wetted for personal care, domestic and industrial purposes.
    - Balloons, except balloons for industrial or other professional uses and applications, that are not distributed to consumers.
    - Fishing gear containing plastic. Member States must ensure the collection of at least 50%[67] of fishing gear containing plastic by 2025 and recycle at least 15% of this gear by that same year.

This means that producers will cover the costs of collection, transport and treatment of waste generated from these products, which will include the costs of garbage cleaning and awareness raising measures (article 8)[68].

67 Calculation based on total weight of fishing gear containing plastic in a given year and expressed as a percentage of the mean weight of fishing gear containing plastic marketed the three previous years.

68 The same applies to fishing gear containing plastic placed on the Union market.

Collection and Recycling

- Adopt measures to collect separately and ensure the recycling of 90% of beverage bottles, including caps by 2025 (products listed in Part F of Annex I) (article 9).

Information mechanisms and responsible consumption

- Develop measures to inform and encourage responsible behavior from consumers (awareness measures) regarding replacement alternatives, re-use systems and waste management options, the impact of littering and other inappropriate forms of waste disposal, and the impact of inadequate waste management on sewer systems. These measures should address plastic fishing gear and SUP such as: food containers, packets and wrappers containing food for immediate consumption, beverage containers, cups for beverages, tobacco products with filters, and filters sold to be used in combination with tobacco products, wet wipes, balloons, sanitary pads, tampons and tampon applicators (products listed in Part G of Annex I) (article 10).

Penalties

It should be noted that the proposal provides Member States with a sanctions regime that is effective, proportionate and dissuasive (article 14), and they must periodically provide information regarding the measures adopted to implement this directive (article 13). In addition, the proposal establishes they will ensure that waste material exported to third countries will not add plastic to marine litter in other places (article 11, second paragraph).

Pros	Cons
This is currently the most comprehensive legislative proposal concerning SUP because its effect will raise the standard for a group of European countries that contribute to the large amount of SUP. In addition, it directly bans certain SUP in a mandatory gradual reduction -yet ambitious- for SUP that currently do not have replacement alternatives. Includes biodegradable and bio-based plastics, as well as plastic/composite material siding. Establishes a broad Extended Producer Responsibility scheme (includes fishing gear). Establishes not only recycling goals, but collection goals too. Establishes strong marking regulations for hazardous substances. Includes raising awareness measures not only in terms of information but also as incentives for consumers' responsible behavior.	Does not regulate light plastic bags, unlike the directive's original proposal. Establishes mandatory gradual reduction on products for which there are supposedly no current cost-efficient replacement alternatives, which is not entirely clear. The definition for single use plastic product is insufficient: "a product that is made wholly or partly from plastic and that is not conceived, designed or placed on the market to accomplish, within its life span, multiple trips or rotations by being returned for refill or reused for the same purpose for which it was conceived". This could be used by companies to sell SUP containers as "reusable" and thus make up for what is understood from this definition. Balloons were eliminated from marking requirements. What is understood as food containers is still limited and because it is not an open definition it makes many of its uses excluded from the mandatory gradual reduction established in article 4.

3. Comparative results

The case studies establish that regulatory techniques, as well as elements included to regulate single use plastics vary from country to country and depend on the social, economic, and environmental contexts where they are immersed.

However, there are common structural elements that, beyond their case by case application, are addressed across all legislations and if appropriately treated will influence how weak or strong the respective single use plastic regulation can be. These elements are presented below:

3.1. General characteristics

Case studies show that approval or discussion of legislation regarding single use plastics, unlike plastic bags, is relatively recent and mostly concentrates in the last three years (2015-2018), except for cases like the city of Seattle that has been continuously and gradually working since 2010 on regulating this material. In addition, efforts are being driven especially at subnational levels by municipalities, cities, cantons or provinces. In fact, 58% of case studies are locations at the subnational level; more than half of these locations have environments that are especially vulnerable to plastic pollution because they're islands or places with great environmental value, as is the case of Antigua and Barbuda, Galapagos or Saint Vicent & Grenadine.

In all, thanks to the collective impulse led by the European Union, countries like France have already committed to ambitious goals at the national level to remove and reduce SUP. In Latin America, efforts made by Peru are noteworthy for initiating the discussion regarding a bill of law that regulates plastic bags and other SUPs. The collective and voluntary actions driven by the central government of Costa Rica are especially significant. Its National Strategy to replace single use plastic for renewable and compostable alternatives reflects serious, quantifiable and transformative efforts addressing this issue.

Other Latin American and Caribbean countries such as Belize, Bermudas and Bahamas are currently working on SUP regulations[69]. In this context, and after the recent approval and enforcement of Law N°21.100, with which Chile bans the provision of commercial plastic bags across the entire national territory, it is important for the country to continue moving forward and escalating efforts to remove all other forms of SUP.

3.2. Type of instruments

Regarding regulatory techniques applied by case study countries, the legislative instrument that is generally used is command and control through the establishment of bans (full or partial) on manufacture, production, import, sale, distribution, use or consumption of SUP. Specifically, 92% of legislations analyzed use this regulatory approach, except for Costa Rica, whose National Strategy is based on a voluntary approach, yet suggests specific actions for municipalities -such as the establishment of tax or tax breaks, or a ban to purchase SUP through public purchases- which ultimately are regulatory instruments of economic nature or based on command and control.

Also noteworthy is the combination of instruments or a combined regulatory approach, applied by legislations of Antigua and Barbuda, Guayaquil and Maharashtra, which include tax, tax breaks or exemptions regarding the manufacture or consumption of SUP or its substitutes. For example, to incentivize the import of replacement alternatives, Antigua and Barbuda have exempted tax on all imports manufactured with raw materials approved by the government such as bagasse, corn starch (NGM), bamboo, wheat, cardboard/paper, areca palm, or potato starch. In addition, Guayaquil exempts manufacturers who change their raw material to biodegradable or recyclable material from paying up to 50% of munic-

69 https://www.unenvironment.org/news-and-stories/story/latin-america-and-caribbean-bids-good-bye-plastic-bags

ipal tax for up to ten years. Last, Maharashtra has established a Buyback Depository Mechanism that involves paying back 50 paise for milk bags, 1 Rs (US$ 0,014) for 1 liter PET bottles and 2 Rs (US$ 0,029) for bottles over 0.5 liters, thus providing direct economic incentives to reuse and recycle this material.

The following table is a summary of the regulatory techniques used by each one of the case studies.

Table 1

Place	Year	Instrument				
		Command and Control	Economic (Tax: T, Exemptions: E)			Voluntary
			Manufacturer	Intermediary	Consumer	
Seattle	2010-2018	x				
Guayaquil	2018	x		E		
Maharashtra	2018	x	T		T	
Seychelles	2017	x				
Antigua y Barbuda	2017	x	E			
Galapagos	2015	x				
Saint Vicent & Grenadine	2017	x				
Costa Rica	2017	x		T/E		x
Spain	2018*	x				
France	2016	x				
Peru	2018	x				
European Union	2018	x				

* STILL IN PROCESS - SOURCE: PREPARED BY AUTHORS

3.3. Regulated objects

Regarding the type and amount of regulated single use plastics, there are two legislative techniques. The first is closed, which implies listing single use plastic products that will be subject to regulation. In fact, this is the case with 83% of legislations that were analyzed (10 out of 12 study cases), except for Maharashtra and Costa Rica.

In spite of this limited nature, there are legislations that choose to list general product categories which can also include a broader universe of subcategories, thus allowing to broaden the universe of regulated SUP. This is the case of categories such as “service ware or cutlery” which involves spoons, forks and knives; “straws” which involves pajitas, popotes, pitillos, cañitas, or “food packets or containers”, among others. Within the closed nature, the example of the European Union is noteworthy because even though it is a comprehensive legislation, it adds a list of products in Annex I that are subject to the mandatory requirements. The reason for this could be that since it is an instrument for command and control in EU countries, it would be more convenient at the political level to advance negotiations for the removal of specific SUPs.

Unlike the above, legislations that are of an open nature, even though they mention types of single use products they do not limit actions or requirements to certain products. This is the case, for example, of Costa Rica, whose strategy aims to substitute single use plastics for compostable and renewable alternatives in general terms, without restricting it to categories or subcategories. It is important to note that, observed from a political point of view, as this is a voluntary and collective strategy, it is easier to

leave the list of regulated SUPs open because it does not directly imply the coercive State ban on any single use plastic, it is more about driving commitments for their voluntary substitution. The Maharashtra case involves a command and control regulation that incorporates a list of SUP that remains open by adding the "etc." abbreviation at the end of the list, allowing for new categories to be included.

Table 2 indicates that over 66% of case studies are regulating, or will regulate, single use plastic products such as: cups, plates, glasses, cutlery, containers, straws, packaging and expanded polystyrene. Of these, the objects that are most regulated are cutlery, plates, tazas, containers and straws, which are addressed in 83% of cases. Far behind are stirrers/mixers, caps, buds and oxo degradable plastic, which are addressed by a little over 30% of case study regulations, and only 25% of the cases analyzed include provisions that would allow regulations for products such as balloons, tampons, wet wipes or tobacco products (imported into the EU), two of which are technically open regulations (Costa Rica, Maharashtra) that allow other products to be included as well.

Table 2

Place	SUP																
	Cups	Plates	Hot beverage cups	Cutlery	Containers	Stirrers/ mixers	Straws	Lids and bottle caps	Cotton bud sticks	Ballon, ballon sticks	Packaging	Tampons and tampon applicators	Wet wipes	Oxo degrad-able	Expanded polystyrene	Tobacco products	Total
Seattle	1	1	1	1	1		1				1				1		8
Guayaquil	1	1	1	1	1	1	1	1			1			1	1		11
Maharashtra	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
Seychelles		1	1	1	1										1		5
Antigua and Barbuda				1	1		1				1				1		5
Galapagos	1	1	1	1	1		1				1				1		8
Saint Vicent & Grenadine															1		1
Costa Rica	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
Spain	1	1	1	1			1										5
France	1	1	1	1	1	1	1	1	1		1						10
Peru	1	1	1	1	1		1										6
European Union	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
Total	9	10	10	11	10	5	10	5	4	3	8	3	3	4	9	3	

SOURCE: PREPARED BY AUTHORS

3.4. Regulated individuals and actions

The analyzed cases reflect that, regardless of the regulatory technique that is being used (command and control, economic, voluntary) over 80% of these legislations tend to regulate the behavior of individuals related to commerce in general or to food services specifically as detailed in Table 3. Notwithstanding, more than 60% of cases are regulations that tend to control the behavior of the general public, as do, for example, Maharashtra, Seychelles, Antigua and Barbuda, Costa Rica, Spain, France, Peru and the European Union. Seattle's Municipal Ordinance differs in that it only aims to regulate food service within the limits of its jurisdiction.

Table 3

Place	Individual		
	Food services	Commercial sector	General Public
Seattle	1		
Guayaquil		1	
Maharashtra	1	1	1
Seychelles	1	1	1
Antigua and Barbuda	1	1	1
Galapagos	1	1	
Saint Vicent & Grenadine	1		
Costa Rica	1	1	1
Spain	1	1	1
France	1	1	1
Peru	1	1	1
European Union	1	1	1
Total	11	10	8

Regarding regulated actions, these generally refer to: i) manufacture or production, ii) import, iii) sale/marketing, iv) distribution or provision and vi) use or consumption, of single use plastics. In this sense, and as shown in Table 4, 83% of case studies concentrate on regulating the sale/marketing or distribution/provision of SUP in the market, reflecting a trend among regulating bodies to especially limit the "availability" (for free or by payment) of these products to the general public. Right behind are regulations that regulate the origin or generation of SUP, where 60% of analyzed cases aim their efforts toward the manufacture or production of the products, as do Guayaquil, Maharashtra, Seychelles, Saint Vicent & Grenada or Peru. Costa Rica and the European Union are also on this list, but the difference is that in both cases the description of regulated actions is quite general since they do not list or determine specific actions, but rather refer to the substitution of SUP for renewable or compostable alternatives in the case of Costa Rica, and to ban "the introduction into the market" of certain SUPs in the case of EU.

Last, noteworthy efforts that aim to regulate the use or consumption of single use plastics, such as Maharashtra, Antigua and Barbuda, Saint Vincent & Grenadine, France or Peru, account for 50% of case studies. Outstanding among these is the ambition of Saint Vincent & Grenadine which aims to ban the use of service ware products made of expanded polystyrene, and the Peruvian bill that seeks to ban under any mode and by 2021, the consumption of plastic bags, plates, cups, other utensils and service ware, and the use of containers and cups for food and beverages for human consumption made of expanded polystyrene.

It's important to note that, in any case, regulations regarding these actions are not restrictive in nature since they provide exemptions based on reasons that involve hygiene, health, food safety, national interest or the protection of commercial relationships. These reasons must be evaluated in light of specific national contexts and conditions.

Table 4

Place	Action					
	Manufacture / Production	Import	Sale / Marketing	Distribution / Provision	Use / Consumption	Total
Seattle			1	1		2
Guayaquil	1		1	1		3
Maharashtra	1	1	1	1	1	5
Seychelles	1	1	1	1		4
Antigua and Barbuda		1			1	2
Galapagos		1	1	1		3
Saint Vicent & Grenadine	1	1	1	1	1	5
Costa Rica	1	1	1	1	1	5
Spain	1	1				3
France			1	1	1	3
Peru	1	1	1	1	1	5
European Union	1	1	1	1		4
Total	8	9	10	10	6	

SOURCE: PREPARED BY AUTHORS

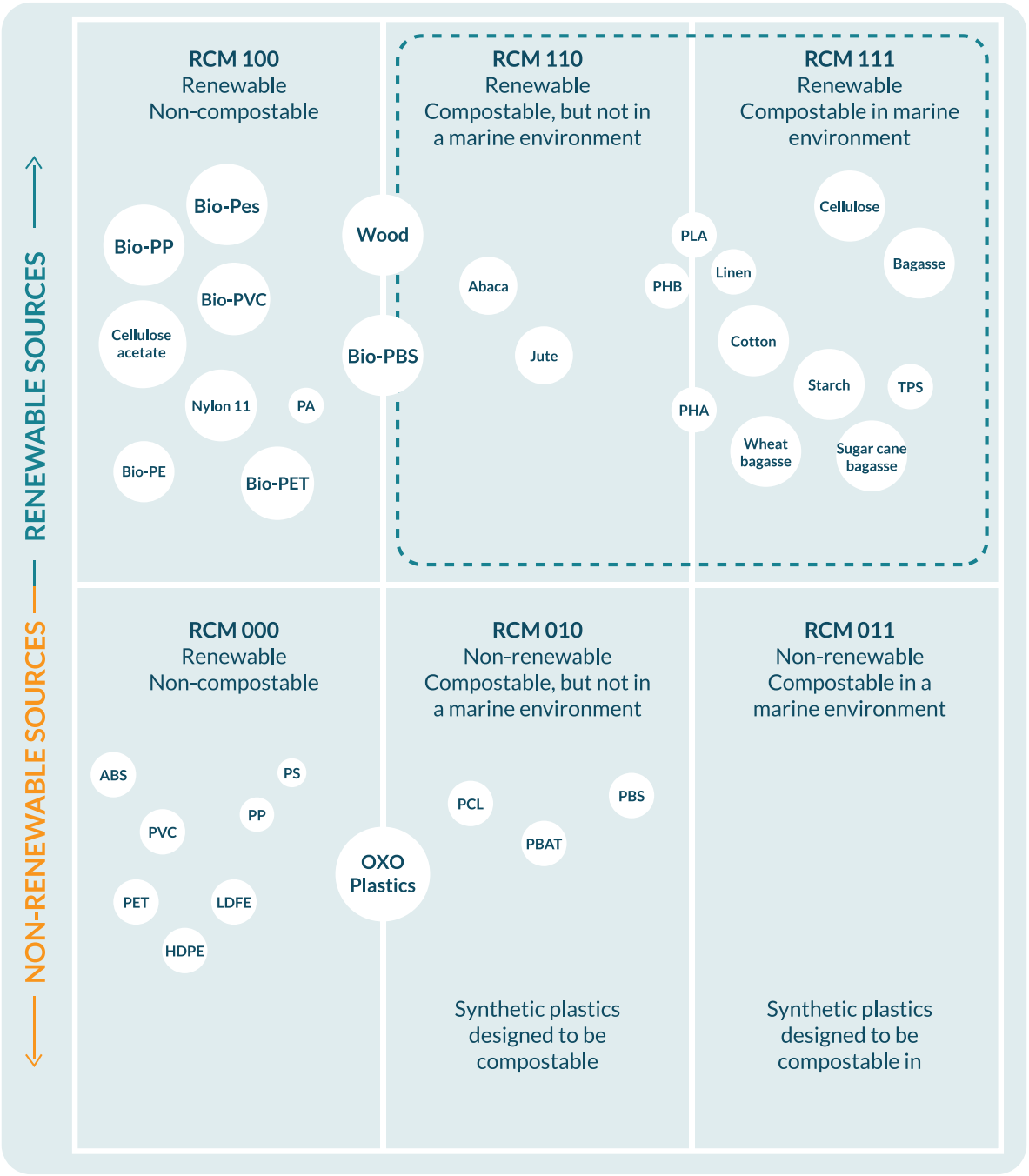
3.5. Substitutes or replacement alternatives

In order to remove and ban single use plastics, it's very important to identify the replacement alternatives that must comply with the required functions but also be environmentally sustainable and compatible with human health. Based on the legislations that have been analyzed, these have generally chosen to establish substitutes through general standards and not a detailed list of alternatives, except for Antigua and Barbuda, which lays out a list of government approved substitutes such as: bagasse (sugar cane pulp), corn starch (NGM), bamboo, wheat straws, cardboard/paper, areca palm and potato starch.

In all, the establishment and selection of those general standards varies from place to place. For example, Seattle mentions substitutes that must be compostable or recyclable, in Maharashtra they must be compostable or made of biological material, in Seychelles they must be biodegradable, in Costa Rica they must be renewable or compostable (including marine compostable), in France compostable or bio-based, in Peru they must be reusable or not produce pollution from microplastics or hazardous substances when they decompose and ensure their revaluation. This is why the suitability of these standards must be evaluated in terms of the definitions and technical parameters included in each one of the regulations and the respective environmental impacts of substitutes, especially their production cycle.

It should be noted that Costa Rica includes in its Strategy a classification of single use plastics and their alternatives that is quite interesting for when the time comes to decide on the most suitable substitutes, as seen in the following Figure.

Figure 8. Clasification of single use plastics and their alternatives according to the Costa Rica Clasification



Bio PE: bio polyethylene; bio PES: bio polyester; Cel-HOAc: cellulose acetate; HPDE: high-density polyethylene; PP: polypropylene; PET: Polyethylene terephthalate; Bio PET: Bio polyethylene terephthalate; Bio PVC: Bio Polyvinyl chloride; PA: polyamide; LDPE: low-density polyethylene; PS: polystyrene; PVC: Polyvinyl chloride; ABS: Acrylonitrile butadiene styrene; PLA: polylactic acid; PHB: polyhydroxybutyrate; PBAT: polybutylene adipate terephthalate; PBS: polybutylene succinate; PCL: polycaprolactone; PA: polyamide; Bio PP: biopolypropylene; TPS: Thermoplastic starch; Bio PBS: biobased polybutylene succinate

3.6. Gradualness

In light of the cases that have been analyzed, we can identify a certain gradualness regarding the time frame provided for the implementation and enforceability of the mandatory requirements. For example, France and the European Union established commitments that will be enforceable as of 2020 and 2025, providing a time frame of about 3 to 7 years to incentivize the development of research and technology to generate replacement alternatives and markets for their cost-efficiency. In addition, Costa Rica sets reachable goals by 2021, which will have to achieve compliance indicators in accordance with pre-established base lines.

Examples such as these can be seen in cities like Seattle, that have been regulating the SUP market since SUP, as previously mentioned; or Antigua and Barbuda which established three temporary phases gradually banning the import and use of new SUP or given a 6-month deadline for the industry to eliminate existing SUP stock.

However, what Maharashtra established differs from this criterion, because even though it has designed a successful regulation from the perspective of banning a wide range of actions, individuals and SUP objects, this requirement is not accompanied by reasonable time frames to facilitate its implementation and compliance. In fact, by providing only one month for the industry and users to eliminate single use plastic outside the territory, regulated entities strongly questioned the regulation and initiated several legal actions to protect their rights.

3.7. Implementation means

Last, a few implementation mechanisms that have been identified in this study should be mentioned. Specifically:

- **Certification systems:** In this sense, the effort being made by Costa Rica should be noted, because it established an "RCM Sorting System" (R: renewable origin, C: compostability, M: biodegradable in marine environment), which groups products and materials according to origin and their biodegradable and compostable capacities. This is a convenient system for a number of reasons, but most of all because it facilitates separate collection and therefore the recycling of different products but also because in addition to marking schemes (like the one driven by UE) they promote conscious and informed options for consumers.

- **Monitoring, supervising and penalizing schemes:** In terms of monitoring, Costa Rica's initiative establishes cross-control programs based on separate and sorted waste collection such as its Participatory Monitoring exercise, which, even though it's voluntary, implies the early involvement of all social actors working toward shared compliance goals, which is more cost-efficient for the State. Regarding penalties, case studies established a wide range, from monetary fines to the definitive or temporary shutdown of commercial venues (Guayaquil), to jail time for a year (Seychelles and Saint Vicent & Grenadine).

- **Environmental education and awareness:** It is universally recognized that the regulation of SUP must be accompanied by environmental education and awareness campaigns that are able to convey the importance and urgency of changing behavior. In fact, consumption of plastics is rooted in the culture of a throw-away society that was born and raised in a discarding format, therefore a change in habits, and the promotion of recycling, reuse and the rejection of unnecessary plastic products will only be possible as long as work is developed closely and early on with the private sector, consumers and the population in general.

4. Conclusions

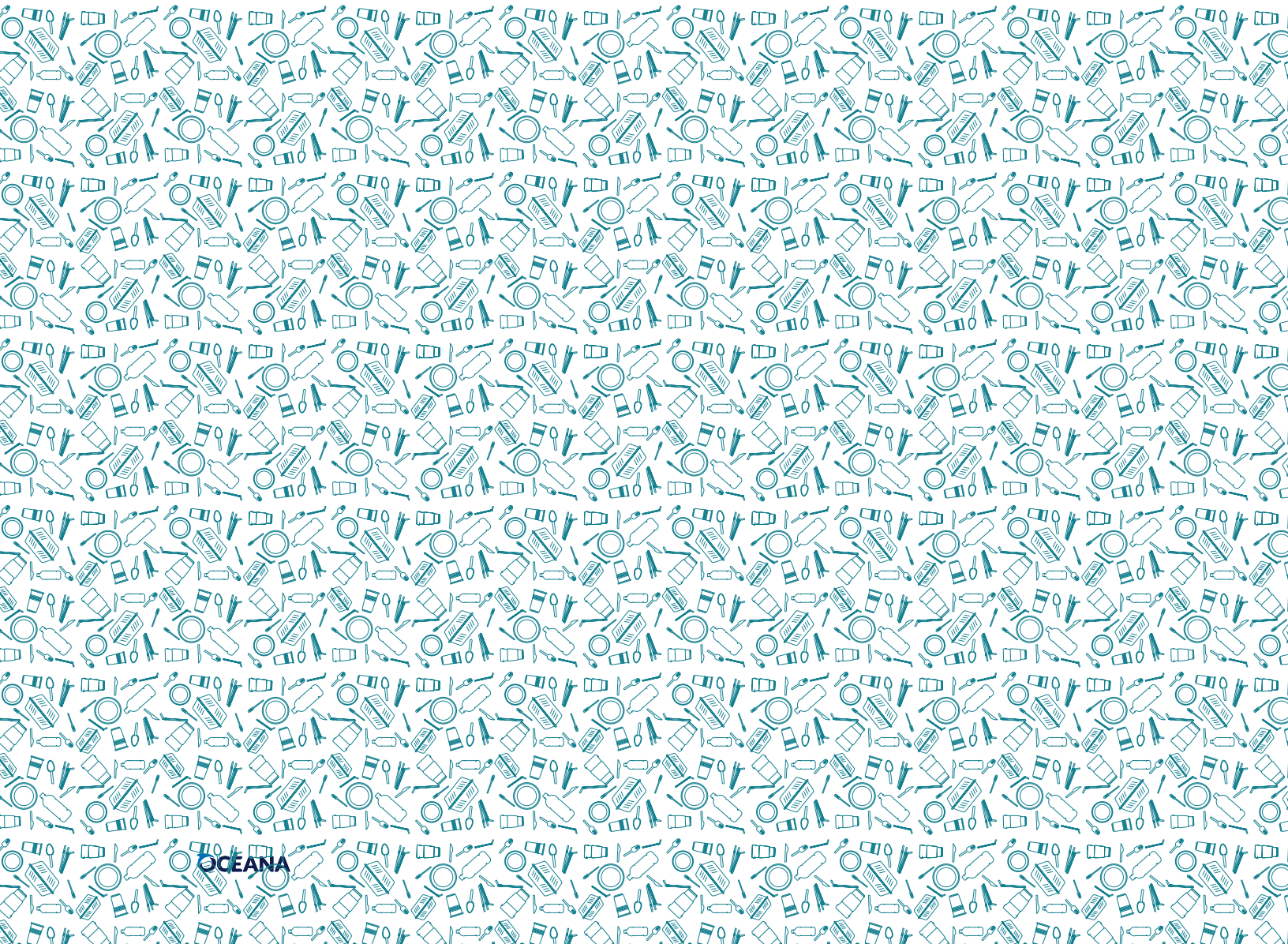
This study analyzed 12 regulations on single use plastics, among which seven common structural elements were identified that are interesting to consider for the design and planning of similar legislations. Specifically, it is striking that a large part of the efforts to regulate SUP (other than plastic bags) are driven at subnational levels. Notwithstanding that, at the national level, cases like Costa Rica or France are interesting examples for other legislations due to the comprehensive and global way they address this matter.

Combined regulatory techniques have shown to be good strategies, because they allow for the direct incorporation of bans on the sale or consumption of SUP, such as gradual reduction requirements and economic incentives in terms of tax or tax exemptions. In this context, the early involvement of regulated individuals in the discussion and planning of legislation will be a key element to increase acceptance and the subsequent implementation of the established requirements. In addition, it will be important to combine bans with strategies aimed at promoting and incentivizing research, development and technological transfers regarding the creation of substitutes or replacement alternatives, promoting the generation of local markets. The definition of substitution standards (compostable or renewable product) should be clearly determined by technical regulations in order to assess the presence or absence of these characteristics and support the supervision efforts of the qualified environmental authority.

Last, changing the consumption model from disposable to reusable is a task that involves everybody, and each actor has a role to play, whether it is the State through regulation, the private sector through innovation or citizens through action[70].

70 Ibid. Reference10.

CHAPTER 3:
ALTERNATIVES TO DISPOSABLE PLASTICS



1. Introduction: problems related to single use plastics.

Since plastics were invented over 100 years ago, they have become an element that is present in practically every aspect of people's daily life, from water bottles to construction materials and medical utensils.

However, due to their bad management, plastics have become a serious environmental problem, generating waste that affects several species through different mechanisms. According to recent estimates, 79% of plastic litter can be found in landfills or as trash in the environment, 12% has been burned and only 9% has been recycled[71]. Even more so, the flow of plastics into the ocean is equal to dumping one garbage truck every minute; plastic pollution in the ocean accounts for 60-80% of marine litter[72].

According to the elements collected during beach cleanups in different countries, disposable or single use plastics are among the most common items found. These are plastic products meant to be thrown away or recycled after a single use, and include food packaging, bottles, straws, plastic cups, and others[73]. Bad management of plastics is mainly due to the fact that we're using material for a purpose that lasts only a few minutes, yet plastic will remain in the environment for centuries.

Once plastics enter the ocean and sink under the column of water, they rest on the seabed or are covered by biological and inorganic matter, and the breakdown rate becomes extremely slow. This happens because the temperature, oxygen level and exposure to UV rays decreases[74], creating litter that could remain floating in the ocean or on the seabed for decades or even centuries, impacting organisms that inhabit these environments.

Regulating single use plastics is therefore necessary. This report analyzes the difficulties related to recycling single use plastics; the problems of biodegradable plastics and compostable plastics; and last, the report presents the characteristics that a material should possess to truly become a better alternative to traditional plastics.

2. Difficulties related to recycling single use plastic.

The amount of single use plastic that is recycled is very low; for example, only 14% of plastic wrappers and packaging is recycled[75]. This is due to several characteristics that make it difficult to recycle and are not necessarily related to the product's material. Among these are the following:

- Materials too contaminated to be recycled.

- Products that contain multiple materials that cannot be easily separated.

- Products too small for easy collection.

- Very small products of low economic value[76].

71 Geyer R, JR Jambeck & KL Law (2017) Production, use, and fate of all plastics ever made. Science Advances 3: 1700782

72 Derraik JGB (2002) The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin 44(9): 842-852.

73 UNEP (2018) Single use plastics: a roadmap for sustainability.

74 UNEP (2016) Marine plastic debris and microplastics – Global lessons and research to inspire action and guide policy change. United Nations Environment Programme, Nairobi. http://wedocs.unep.org/handle/20.500.11822/7720

75 World Economic Forum, Ellen MacArthur Foundation & McKinsey & Company (2016) The New Plastics Economy – Rethinking the future of plastics.

76 Ellen MacArthur Foundation (2017) The New Plastics Economy: Catalyzing action. https://www.ellenmacarthurfoundation.org/assets/downloads/New-Plastics-Economy_Catalysing-Action_13-1-17.pdf

Some of the characteristics of single use plastic can be overcome. For example, plastic material that is contaminated can be replaced by compostable material. Products composed of multiple materials can be redesigned in such a way that they are made up of a single recyclable material.

However, there are two persistent problems related to the small size of these products, which are hard to collect and have low economic value for recycling. Because of this, implementing the measures proposed in the previous paragraph would not make a change because there would still be low economic incentives for the collection and recycling of these products. This is why small plastics can be recycled, but they continue to end up in landfills or as litter in the environment.

3. Compostable plastics and biodegradable plastics do not solve the problem.

In view of the plastic waste problem and the small amount of it that is recycled, several alternatives to replace traditional plastic for biodegradable and compostable plastics have been suggested.

In order to understand the breakdown of plastics, certain concepts must be understood first. Below are definitions included in the report published by the United Nations Environment Programme in 2016 that help to understand plastic degradation[77].

- **Degradation:** the partial or complete breakdown of a polymer due to, for example, UV radiation, an oxygen attack, or biological attack.

- **Biodegradable plastic:** material that can be partially or completely degraded, transforming into water, carbon dioxide or methane, energy and new biomass through the action of microorganisms such as bacteria or fungi. This process requires UV radiation and/or oxygen.

- **Compostable plastic:** material that biodegrades under specific time frames and conditions provided at industrial composting facilities, which include temperatures ranging between 50° and 60°C[78]. Aside this definition, there are international standards that establish the required characteristics for wrappers or packaging to be considered compostable, including:

    - Chemical characteristics: contain at least 50% organic matter and do not exceed a certain concentration of heavy metals.

    - Biodegradation: are at least 90% degradable within six months under controlled composting conditions (58 ± 2°C).

    - Disintegration: they break down into pieces smaller than 2 mm under controlled composting conditions within twelve weeks.

    - Ecotoxicity: they do not leave residuals that could have a negative effect on the final compost[79].

In addition, the term "compostable at home" means materials that can be treated at room temperature, but probably have longer periods of biodegradation and fragmentation than industrially composted material[80].

77 UNEP (2016) Marine plastic debris and microplastics – Global lessons and research to inspire action and guide policy change. United Nations Environment Programme, Nairobi. http://wedocs.unep.org/handle/20.500.11822/7720

78 Lambert S & M Wagner (2017) Environmental performance of bio-based and biodegradable plastics: the road ahead. Royal Society of Chemistry 46: 6855-6871.

79 World Economic Forum, Ellen MacArthur Foundation & McKinsey & Company (2016) The New Plastics Economy – Rethinking the future of plastics.

80 Ibid. Reference 79.

Even though they've been presented as good alternatives, biodegradable plastics and compostable plastics do not necessarily degrade fully under environmental conditions. Many times, they require specific conditions that do not happen in the ocean, which is why they're not a good alternative to traditional plastics[81].

Moreover, it has been suggested that the use of biodegradable and compostable products could increase the problem of garbage by introducing partially decomposed materials into the environment, while at the same time, reduce social responsibility be reinforcing the perception that the use of these materials is good for the environment and minimizes the negative impacts of plastic waste[82].

Furthermore, the same characteristics that make it hard to recycle single use small pieces of plastic (such as size, low economic value and high recollection costs) are also true for biodegradable or compostable materials, and therefore they also depend upon being collected and disposed of at centers with the needed conditions for their complete degradation.

4. Characteristics that the material replacing plastic should have.

For a material to be even more sustainable than traditional plastics and be offered as an alternative to single use plastic, it should fully comply with all the following characteristics:

1. Renewable origin: meaning, it should be produced from renewable resources. Plastic production currently depends most on fossil hydrocarbons, which are a non-renewable resource. However, plastics can be produced from different renewable raw materials:

    I. First generation raw materials: Plant biomass rich in carbohydrates and that can be used as food or animal food, for example, sugar cane, wheat and corn.

    II. Second generation raw materials: Plant biomass that is not appropriate as food or food for animal farming such as, for example, cellulose, discarded vegetable oil, bagasse, corn stubble.

    III. Third generation raw materials: Biomass from algae, which has a greater growth performance than first and second generation[83].

    According to the previous definitions, second or third raw material should always be prioritized, so as to not interfere with food safety. Also, it's important to be clear on the fact that just because a plastic is made from renewable resources does not mean that it's biodegradable, just like there are plastics produced from non-renewable resources that are biodegradable.

2. Degradable in natural environments: As mentioned earlier, compostable plastics, as well as biodegradable plastics, completely decompose only under certain conditions including high temperatures, presence of oxygen and presence of UV rays, which do not occur in the ocean. For a material to be considered as a better alternative to traditional plastic, it needs to achieve full breakdown under environmental conditions, including those present at sea.

3. Degradable in a realistic period of time: Some plastics such as plastic bags and polystyrene foam containers can take up to 1,000 years to break down. Therefore, for a material to be considered

81 Ellen MacArthur Foundation (2017) The New Plastics Economy: Rethinking the future of plastics & catalyzing action. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/NPEC-Hybrid_English_22-11-17_Digital.pdf

82 Harrison JP, BC Boardman, K O'Callaghan, A-M Delort & J Song (2018) Biodegradability standards for carrier bags and plastic films in aquatic environments: a critical review. Royal Society Open Science 5: 171792.

83 Ibid. Reference 79.

better than traditional plastic, it should decompose in a realistic period of time. In order to establish time limits for plastic to decompose, other countries' regulations can be reviewed, such as Costa Rica's, which states no more than 180 days, or Guayaquil, where it is understood that a product is biodegradable if it achieves breakdown within 24 months.

4. No toxic waste: The decomposition of plastic can release toxic substances into the environment due to the nature of these products. Therefore, for a material to be an improvement over traditional plastic, it can't leave behind toxic waste after it decomposes. This point is included within the characteristics that compostable plastic must have according to international standards (ISO 17088, EN 13432, ASTM 6400).

5. Certifications.

At the global level there are a number of standards and institutions in charge of conducting analysis to provide certifications for the biodegradability, ecotoxicity and compostability of several products.
In this regard, Ecolaben was recently inaugurated in Chile; the first biodegradability, ecotoxicity and disintegration laboratory in Latin America. This lab is the result of a project called "Development of biodegradable products optimized for food packaging", and will offer four types of analysis of key materials for the packaging industry that are validated in accordance to international certification standards:

i. Biodegradability: determines the ability of a material to biodegrade and be classified as organically recoverable, under controlled composting conditions.

ii. Disintegration: determines the degree of a material's disintegration, aiming to analyze the physical and visual disappearance of the material in time under controlled conditions.

iii. Ecotoxicity: evaluation of the quality of compost produced during the disintegration stage, in order to observe possible effects on germination and the growth of plants.

iv. Compostability test: includes the three previously mentioned analyses.

Ecolaben creates an opportunity to certify the materials required by the proposal

6. Closure

The problem of pollution from plastic waste is a global one whose solution will require regulations that foster the adoption of sustainable alternatives to traditional plastics.

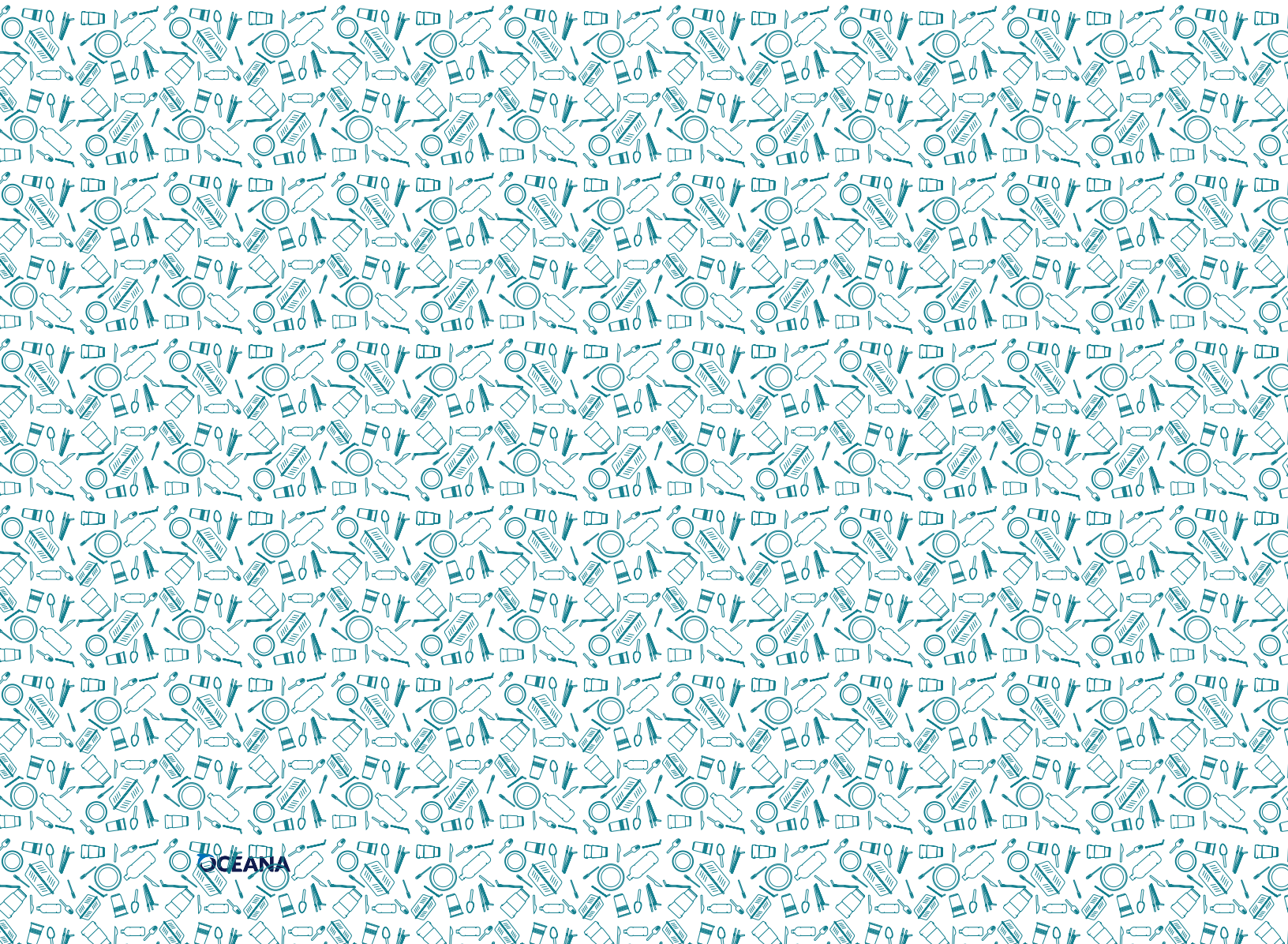
Such measures must be taken considering all the aspects related to pollution from plastics, so that they truly represent an improvement and do not worsen an already existing problem, by allowing the use of materials that really aren't more sustainable than traditional plastic.

Surely, the clearest way to prevent single use plastic to end up in landfills or as garbage in the environment is by applying the principles that govern this material, which are avoid the manufacture of single use plastic, and provide incentives for reuse, especially of other more sustainable materials.

In this sense, financial incentives need to be created to change the habits of consumers and producers in terms of avoiding single use plastic, and for these to naturally produce research and innovation for the development of alternative materials that comply with previously mentioned characteristics.

CHAPTER 4:

REUSABLES AND ALTERNATIVES TO DISPOSABLES



1. Use of reusable products for consumption inside food service establishments.

The proposed regulation aims to limit the production of disposable products and regulate plastics in establishments that sell food.

For consumption inside these establishments, consumers must be provided with regulated products made of reusable materials such as ceramic, glass, metal, wood, clay or others that have been designed to be used multiple times. Plastic will also be allowed, but against it will be the presumption that implies that establishments that use plastics will have to demonstrate that it is being reused. This, because plastic is the primary disposable material.

Thus, for the implementation of this regulation, there already exist several reusable materials that have been historically utilized, and that do not require new developments. This regulation is similar to the one established under Berkeley legislation, detailed in section 4 of this report.

The only disposable regulated product that food service establishments can provide will be wrappers for prepared food made of material other than plastic. For example, establishments are allowed to provide wrappers for empanadas, tacos or sandwiches.

2. Alternatives to disposable plastics for consumption outside food service establishments.

Disposable regulated products for ready-to-eat takeout or delivery will be exempt from the mandatory requirement of providing products made of reusable materials. In other words, when food is consumed outside the food service establishment disposable products can be provided, as long as they are made of materials other than plastic, or are made of certified disposable plastics that comply with the following requirements: made of polymers that come from renewable raw materials; biodegrade under natural conditions, including marine conditions; within a time frame of no more than 180 days; and that the biodegradation process does not release toxic waste into the environment where it degrades.

There are currently in the market several products made of materials such as cardboard, paper, aluminum, bamboo and other alternatives different from plastic. In addition, there are a number of innovations at the local and international levels regarding plastics that comply with all three requirements.

3. Regulations that aim to prevent the production of waste and plastics.

Global concern for pollution from disposable plastics is reflected in several laws that aim to reduce the use of this type of plastic. Like the proposed regulation, most of these laws focus on food service establishments and the laws detailed below specifically refer to the use of reusable products for food consumption in establishments and to limit the use of disposables for takeout.

3.1. California – Berkeley “Berkeley single use foodware and litter reduction ordinance”

The purpose of this ordinance is to reduce the generation of waste related to single use containers and packaging for food and beverages in the city of Berkeley. The proposal requires the use of reusable plates, cups and cutlery when food is consumed in the establishment. Aluminum, wrappers and place mats for trays are allowed.

The ordinance also requires food service establishments to charge customers for cups for consumption outside the establishment and for other takeout utensils in order to incentivize customers to take their own reusable containers and cups.

Last, the ordinance requires all disposable products used for food consumption to be free of certain chemicals that are highly toxic, and for these products to be recyclable or compostable in the city's waste management programs.

It is the responsibility of the city to create and update an accessible list of approved products that can be used for food consumption, so that food vendors can easily identify products that comply with the established requirements.

What does this ordinance entail for Berkeley?

It immediately requires food service establishments to provide items such as straws, cutlery, lids and bags only if they are requested by consumers.

It immediately requires food providers to maintain compost trash bins available for customers.

By January 2020 it requires all disposable products for food consumption to be certified as fully compostable by the Biodegradable Product Institute (BPI).

By January 2020 it requires all food providers to charge USD 0,25 for hot and cold beverage cups for consumption outside food service establishments. This fee will not be applied if customers provide their own cups.

By July 2020 it requires all dine-in foodware to be reusable.

Links of interest:

Ordinance: https://drive.google.com/file/d/1dS6WFLrqEasLTZ7FVbzZBzkJM5d1PEC7/view

News on the ordinance:

https://www.sfchronicle.com/restaurants/article/Berkeley-s-new-regulations-on-disposable-foodware-13557207.php

https://ecologycenter.org/blog/berkeley-on-the-path-to-zero-waste-dining/

3.2. Hobart, Tasmania "Single-use plastics by-law"

This regulation proposal aims to limit the use of disposable plastics in takeout packaging. The regulation states that takeout food sales should not provide packaging that is single-use and/or fully or partially made of plastics. The regulation's arguments specifically state that the use of compostable packaging is no a solution to waste production, since no takeout compostable container fragments quickly in the environment.

On March 4, 2019, the Council voted to approve this proposal to regulate disposable plastics. Additional stages are required for the regulation's approval.

Regulation's applicability:

This regulation applies only to takeout food service establishments, as long as the food was packaged by the vendor or another entity related to the vendor. In addition, this regulation addresses packaging less than A4 size (210 mm by 297 mm) or whose volume is less than one liter.

Similar to the proposed regulation, this regulation does allow packaging certified by the Australasian Bioplastics Association.

This regulation bans the following products:

- Plastic eating utensils
- Sauce sachets, such as ketchup, soy, tartar, etc.
- Plastic containers and lids for dine-out consumption of hot food.
- Plastic straws.
- Noodle boxes lined with plastic.
- Coffee cups lined with plastic.
- Plastic cup lids for dine-out consumption.
- Plastic packaging for sandwiches.

Links of interest:

Link to download the regulation and its fact sheet:

https://www.hobartcity.com.au/Business/Food-businesses/Single-Use-Plastics-By-Law-Information