PLASTECO
Interreg Europe

European Union
European Regional
Development Fund

JUNE 2020

REPORT

ON TERRITORIAL-SPECIFIC ECONOMIC AND SOCIAL BARRIERS AGAINST MORE SUSTAINABLE PLASTIC CONSUMPTION AND PRODUCTION PATTERNS

Activity 1.1

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PLASTECO - Supporting EU regions to curb plastics waste and littering

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Abstract

This report documents the findings of a survey conducted within the PLASTECO Activity 1.1, titled “Assessment of territorial-specific economic and social barriers against more sustainable plastic consumption and production patterns”. The survey was addressed both to project partners as well as stakeholders participating in territorial plastics value chains in PLASTECO territories. It aimed to document a) the readiness of PLASTECO territories for the transition to a new plastics economy in terms of policies and actions taken; b) the barriers that plastics value chain faces in PLASTECO territories for the transition to a new plastics economy; and c) the public opinion in PLASTECO territories regarding the phasing out of plastics.

The main findings of the survey are:

- Most PLASTECO territories are moving in the right direction, implementing landfill bans and having in place alternative systems for waste management. However, they are still at the beginning of the transition to a new plastics economy, as most of the measures they have in place do not address the complexity of the problem; the rollout and adoption of circular economy models by plastic value chains require more advanced and specific measures that target the whole life-cycle of plastic in the economy.
- The findings regarding the most pronounced barriers are in line with the already well-known barriers documented in the relevant literature. It is risky for many businesses, for example, to transition to circular economy models without financial support mechanisms to aid them; strict or missing industry-standard regulations in combination with technical recycling challenges (e.g. contaminated plastics, poly-streams of incompatible plastics) add to the problem. Also, the correct disposal of post-consumer plastics is low, according to stakeholders.
- Data showed that all partners have ongoing information and awareness campaigns in their territories, addressing plastic waste pollution and sustainable lifestyle changes. Moreover, in all public opinion surveys conducted in PLASTECO territories, regionally or nationally, and reported by project partners, the public is overwhelmingly in favour of stricter bans and changes regarding plastic waste, especially in the issue of single-use plastics, and plastic packaging in particular.

1 The PLASTECO project

1.1 Project overview

Around 25.8 million tonnes of plastic waste are generated in the EU every year, of which less than 30% is collected for recycling. Plastic production and incineration produce 400 million tonnes of CO2 annually; in EU regions, 150.000 to 500.000 tonnes of plastic waste enter the oceans every year, and 75.000 to 300.000 tonnes of microplastics are released into the environment, polluting food, air, and water. In light of these environmental and health threats, the EC has launched in 2018 the European Strategy for Plastics in a Circular Economy, which calls public authorities, the industry, and the public to implement and support measures towards a "new plastics economy". This transition prescribes both the curbing of plastic pollution, as well as boosting EU competiveness through innovation and sustainable growth measures, in the context of a "reduce, reuse and recycle" economy that will eventually eradicate single-use plastic packaging by 2030. In 2020 the European Commission advanced further its agenda for sustainable growth by adopting a new Circular Economy Action Pan as a part of the European Green Deal. EU territorial authorities and agencies are central in managing the threats of widespread plastic pollution, to reduce the impact on their citizens and environment. They need to work and advance their policies, contribute to a comprehensive framework at different government levels, and promote all necessary measures and investments to spur regional growth, jobs and innovation.

The "PLASTECO - Supporting EU regions to curb plastics waste and littering" project seeks to improve regional environmental policies and stimulate eco-innovation and green growth under the "new plastics economy", especially through measures to maximise the efficient use of resources (i.e. minimise single-use plastics). PLASTECO will enable partners and key stakeholders to: a) assess the current situation, potential, and barriers in their regions, b) identify pathways for sustainable growth in plastics value-chains, and c) design and put into effect new policy measures and regulations. In particular, the PLASTECO partners, as the relevant EU public authorities, need and are expected to:

1. Improve the economics and quality of plastics recycling (waste management plans, public procurement, use of economic instruments, Extended Producer Responsibility schemes, uptake of recycled plastics).
2. Curb plastic waste and littering (regional plans against aquatic litter, fines, awareness raising, coastal waste collection, eradication of non-compliant landfills, recycling of agricultural plastics, deposit refund schemes).
3. Drive investments and innovation towards circular solutions (raising landfill and incineration costs, funding, incentives for plastic prevention and recycling).

1.2 Project objectives

The project aims to support the represented territories to exchange experiences and jointly explore solutions on curbing plastic pollution and littering, benefit from the provisions and momentum of the "EU plastics" strategy, and, ultimately, achieve their goals in terms of protecting the environment, increasing resource efficiency and alleviating adverse health effects. PLASTECO sets the following operational objectives:

- Advance territorial waste management planning (separation, collection, and recycling of plastic waste), and accelerate the achievement of targets for plastics recycling.

- Encourage the phasing out of plastics packaging in public procurement, and develop guidelines for relevant green public procurement criteria.
- Facilitate and encourage the emergence, acceptance and uptake of plastic packaging alternative solutions and reverse logistics business models.
- Promote awareness and acceptance of use of recycled plastics in products.
- Improve both monitoring and curbing of aquatic litter.
- Suggest uses of structural funds to increase the capacities of regional value chains as concerns innovative solutions and technologies.

1.3 Expected Results & Outputs

PLASTECO, in line with the "European Strategy for Plastics in a Circular Economy", will support participating territories to take the steps necessary for a transition towards a "new plastics economy". The project is expected to have the following results:

- Increased capacity of 180 staff of public administrations to effectively support new growth trajectories & energy security.
- 19 million euros unlocked to support projects on plastic reuse, eco-innovation, and alternative technologies.
- Increased awareness & consensus building among plastic producers and consumers/the public.

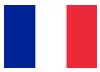
The project's main outputs are:

- 8 action plans to improve the addressed policies, benefiting managing authorities & stakeholders.
- 4 interregional workshops, 2 study visits, and 2 joint policy planning and strategic review procedures, to promote capacity building among partners and stakeholders.
- 3 joint thematic studies on territorial needs and good practices.

1.4 Partnership

PLASTECO brings together 8 institutional, scientific and education partners from 8 EU Member States to improve the implementation of territorial development policies and programmes (i.e. policy instruments) on environmental protection, waste management and circular economy.

No	Country	Partner	Policy Instrument addressed
1		Municipality of Rethymno	Local Waste Management Plan of the Municipality of Rethymno
2		Lombardy Region	Lombardy Regional Operational Programme (ROP) ERDF 2014-2020
3		Styrian Provincial Government	Investments in Growth and Employment Austria 2014-2020 - Operational Programme for the use of the ERDF funds
4		Stara Zagora Regional Economic Development Agency	Operational programme "Environment" 2014–2020

No	Country	Partner	Policy Instrument addressed
5		Cluster of Environmental Technologies Bavaria	Future Guidelines for Augsburg
6		Auvergne-Rhône-Alpes Energy Environment Agency	Regional ERDF programme Rhône Alpes 2014-2020
7		Bucharest-Ilfov Regional Development Agency	Regional Operational Programme
8		Association Baltic Coasts	Operational Programme ''Growth and Employment''

2 Activity A1.1

PLASTECO Activity A1.1 is titled "Assessment of territorial-specific economic and social barriers against more sustainable plastic consumption and production patterns". It aims to:

1) Investigate territorial-specific economic and social barriers that hinder the transition to a new 'plastics economy' in the PLASTECO regions; and
2) Report on key factors that could enable such a transition.

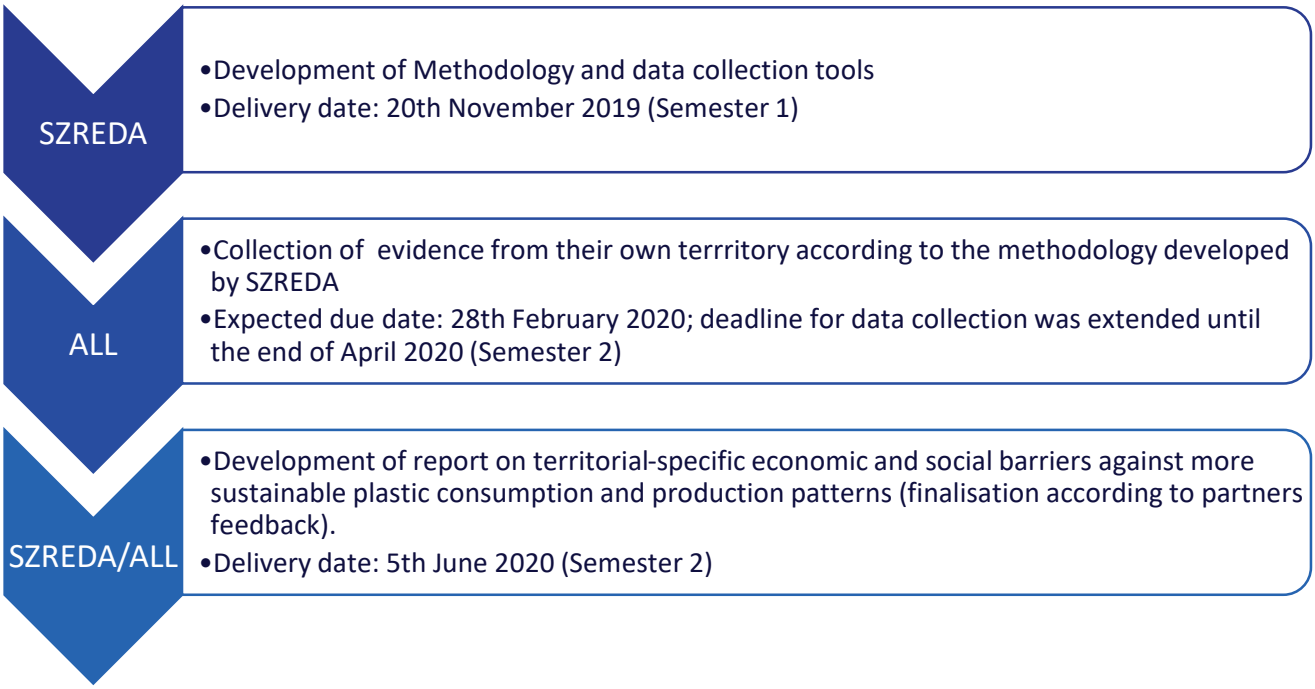
To achieve these objectives, the activity proceeded in two preparatory sequential steps, which culminated in the delivery of this report:

1. The first step was the delivery of a methodology (drafted by SZREDA), which assisted project partners in collecting relevant data. It included data collection forms and tools to facilitate data collection (see ANNEX A & B), and provided the thematic background of the whole activity.
2. Secondly, all partners, following the proposed data collection guidelines of the methodology, proceeded in: a) filling in and returning to SZREDA the questionnaire addressed to them, and b) disseminating the questionnaire addressed to stakeholders to relevant plastics value chain actors in their territory.

To deliver this report, SZREDA compiled and analysed the collected evidence, to a) assess the policy readiness of PLASTECO territories to transition to a new plastics economy, b) identify the most prominent barriers in this transition, and c) document the public opinion in PLASTECO territories regarding the phasing out of plastics.

The timeline that the activity followed is presented in the figure below:

Figure 1: Timeline of PLASTECO activity 1.1



3 Thematic background

3.1 Plastics in the EU context

Plastics are an extensive family of different materials made mostly from petroleum products, with a lifespan ranging from hundreds to thousands of years. Their versatile nature and durability make them indispensable in everyday life, prompting its high demand and use both in the EU28 and globally. They have multiple functions: light and innovative materials in cars or planes save fuel and cut CO2 emissions; high-performance insulation materials help us save on energy bills; in packaging, plastics help ensure food safety and reduce food waste; combined with 3D printing, bio-compatible plastic materials can save human lives by enabling medical innovation.

In the EU, the plastics sector employs 1.5 million people and generated a turnover of EUR 340 billion in 2015. Although plastics production in the EU has been stable in recent years, the EU's share of the global market is falling as production grows in other parts of the world.

Over 300 million tons of plastics are produced annually around the world. This is a significant increase from the 1.7 million tons produced in 1950. Around 25.8 million tonnes of plastic waste are generated in Europe every year. The widespread use of plastic materials causes widespread pollution affecting different components of the eco-system, because less than 30% of such waste is collected for recycling. Of this amount, a significant share leaves the EU to be treated in third countries, where different environmental standards may apply.

The potential for recycling plastic waste remains largely unexploited. Reuse and recycling of end-of-life plastics is very low, particularly in comparison with other materials such as paper, glass or metals. At the same time, landfilling and incineration rates of plastic waste remain high, 31% and 39%, respectively, in the EU28. It is estimated that plastics production and the incineration of plastic waste give rise globally to approximately 400 million tonnes of CO2 a year. Using more recycled plastics can reduce dependence on the extraction of fossil fuels for plastics production and curb CO2 emissions. According to estimates, the potential annual energy savings that could be achieved from recycling all global plastic waste is equivalent to 3.5 billion barrels of oil per year.

In addition, very large quantities of plastic waste leak into the environment from sources both on land and at sea, generating significant economic and environmental damage. In the EU, 150 000 to 500 000 tonnes of plastic waste enter the oceans every year. This represents a small proportion of global marine litter. Yet, plastic waste from European sources ends up in particularly vulnerable marine areas, such as the Mediterranean Sea and parts of the Arctic Ocean.

Regarding the economic losses due to the low uptake of plastics recycling, around 95% of the value of plastic packaging material, i.e. between EUR 70 and 105 billion annually, is lost to the economy after a very short first-use cycle. Demand for recycled plastics today accounts for only around 6 % of plastics demand in Europe. In recent years, the EU plastic recycling sector has suffered from low commodity prices and uncertainties about market outlets. Investments in new plastic recycling capacity have been held back by the sector's prospects of low profitability.

Alternative types of feedstock (e.g. bio-based plastics or plastics produced from carbon dioxide or methane), offering the same functionalities of traditional plastics with potentially lower environmental impacts, are also

being developed, but at the moment represent a very small share of the market. Increasing the uptake of alternatives that according to solid evidence are more sustainable can also help decrease our dependency on fossil fuels.

New sources of plastic leakage are also on the rise, posing additional potential threats to both the environment and human health. Microplastics, tiny fragments of plastic below 5mm in size, accumulate in the sea, where their small size makes it easy for marine life to ingest them. They can also enter the food chain. Recent studies also found microplastics in the air, drinking water and foods like salt or honey, with yet unknown impacts on human health. In total, it is estimated that between 75 000 and 300 000 tonnes of microplastics are released into the environment each year in the EU. While a large amount of microplastics result from the fragmentation of larger pieces of plastic waste, significant quantities also enter the environment directly, making it more challenging to track and prevent them.

In addition, the increasing market shares of plastics with biodegradable properties bring new opportunities as well as risks. In the absence of clear labelling or marking for consumers, and without adequate waste collection and treatment, it could aggravate plastics leakage and create problems for mechanical recycling.

What are "plastics"?

In the same way that we know that there are different types of metals with different properties, plastics are also an extensive family of different materials. Each plastic is designed with specific characteristics that make it ideal for the application to which it is intended, providing us with very resource-efficient solutions. Plastic materials can be produced from different sources. Its raw materials can be of fossil origin (e.g. crude oil, gas) or renewable (e.g. sugar cane, starch, vegetable oils) or even mineral base (salt). Regardless of the nature of their raw materials, certain plastics are also biodegradable. This means that provided they are properly collected and treated together with organic waste, can be decomposed into water and carbon dioxide or methane. Whatever their origin, at the end of their service life, plastic materials are important resources that we can use either in the form of new materials or as an alternative energy source once used in energy recovery facilities.

The plastics' family is composed of a wide variety of materials designed to meet the very different performance requirements of thousands of end products. There are two 'families' of plastics:

- Thermoplastics are a family of plastics that can be melted when heated and hardened when cooled. These characteristics, which lend the material its name, are reversible. That is, it can be reheated, reshaped and frozen repeatedly.
- Thermosets are a family of plastics that undergo a chemical change when heated, creating a three dimensional network. After they are heated and formed these plastics cannot be re-melted and reformed.

3.2 EC initiatives for plastic waste

In December 2015, the Commission adopted an EU Action Plan for a circular economy. There, it identified plastics as a key priority and committed itself to 'prepare a strategy addressing the challenges posed by plastics throughout the value chain and taking into account their entire lifecycle'. In 2017, the Commission confirmed it would focus on plastics production and use and work towards the goal of ensuring that all plastic packaging is recyclable by 2030.

The European Strategy for Plastics in a Circular Economy adopted on January 2018 aims to transform the way plastic products are designed, used, produced and recycled in the EU. Better design of plastic products, higher plastic waste recycling rates, more and better quality recyclates will help boosting the market for recycled plastics. It is expected to deliver greater added value for a more competitive, resilient plastics industry.

The strategy is part of Europe's transition towards a circular economy, and will also contribute to reaching the Sustainable Development Goals, the global climate commitments and the EU's industrial policy objectives. This strategy will help protect our environment, reduce marine litter, greenhouse gas emissions and our dependence on imported fossil fuels. It will support more sustainable and safer consumption and production patterns for plastics.

In addition to this strategy, the European Commission:

- Is promoting an EU-wide pledging campaign for the uptake of recycled plastics and calls on stakeholders to come forward with ambitious voluntary pledges to boost the uptake of recycled plastics.
- Proposed on May 2018 new EU-wide rules to target the 10 single-use plastic products most often found on Europe's beaches and seas, as well as lost and abandoned fishing gear. Together these constitute 70% of all marine litter items.

3.3 A sustainable approach to plastics: the 'new plastics economy'

While delivering many benefits, the current plastics economy has drawbacks that are becoming more apparent by the day. To this end, enhancing system effectiveness to achieve better economic and environmental outcomes while continuing to harness the many benefits of plastic packaging has led to the 'new plastics economy'. This concept encompasses a new vision, aligned with the principles of the circular economy, to capture these opportunities. The new plastics economy aims to spark a wave of innovation and to move the plastics value chain into a positive spiral of value capture, stronger economics, and better environmental outcomes.

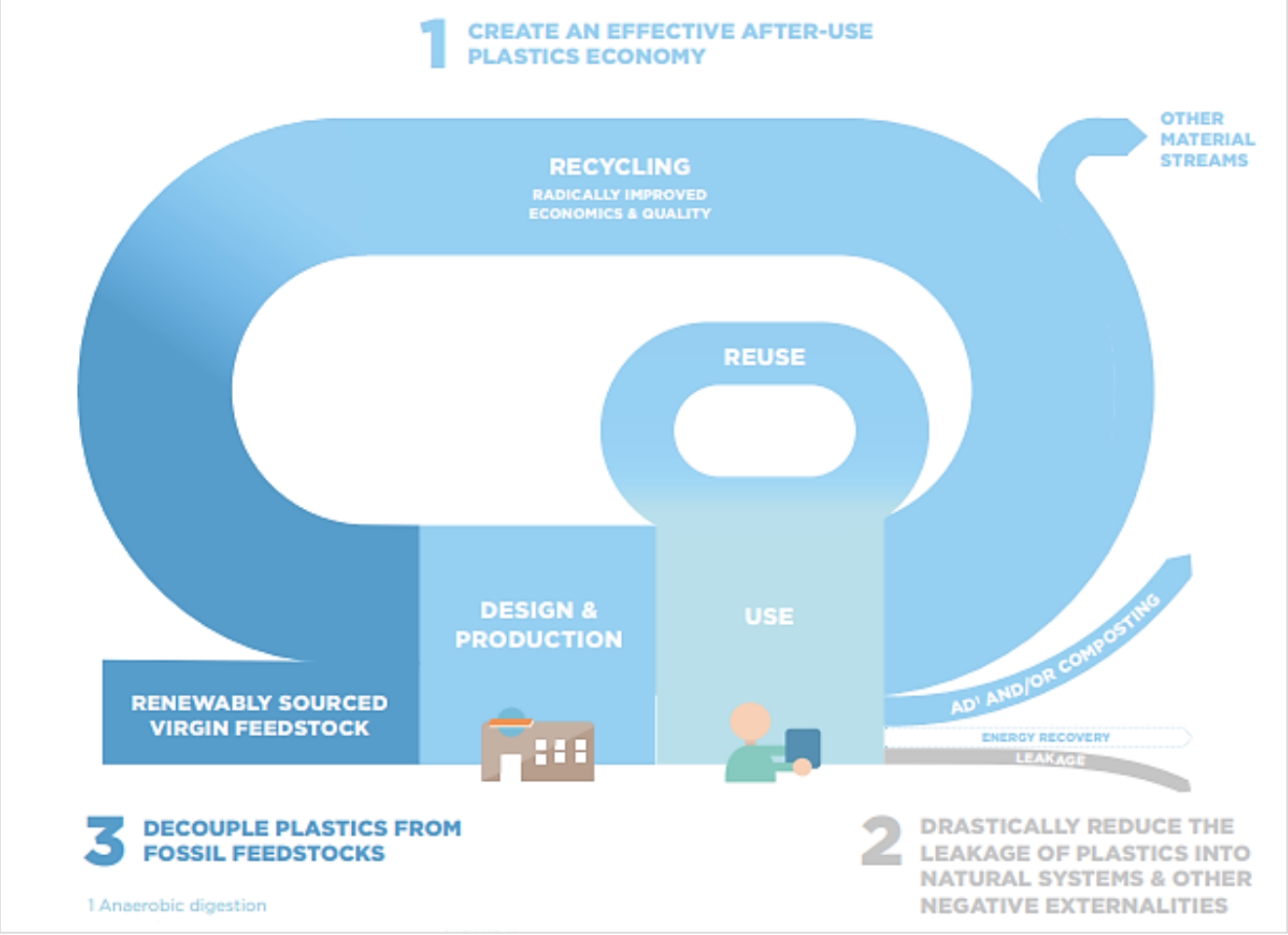
The overarching vision of the new plastics economy is that plastics never become waste; rather, they re-enter the economy as valuable technical or biological nutrients. It sets the ambition to deliver better system-wide economic and environmental outcomes by creating an effective after-use plastics economy (the cornerstone and priority); by drastically reducing the leakage of plastics into natural systems (in particular the ocean); and by decoupling plastics from fossil feedstocks.

The new plastics economy builds on and aligns with the principles of the circular economy, an industrial system that is restorative and regenerative by design, and has three main ambitions (see Figure 2); namely to:

1. Create an effective after-use plastics economy by improving the economics and uptake of recycling, reuse and controlled biodegradation for targeted applications. This is the cornerstone of the new plastics economy and its first priority, and helps realise the two following ambitions.
2. Drastically reduce leakage of plastics into natural systems (in particular the ocean) and other negative externalities.
3. Decouple plastics from fossil feedstocks by — in addition to reducing cycle losses and dematerialising — exploring and adopting renewably sourced feedstocks.

Figure 2: The vision for the new plastics economy.

Source: World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, The New Plastics Economy — Rethinking the future of plastics (2016, http://www.ellenmacarthurfoundation.org/publications).



Moving towards a sustainable plastics economy could deliver considerable benefits. To reap these, it will require action from all players in the plastic value chain, from plastic producers and designers, through brands and retailers, to recyclers. Similarly, civil society, the scientific community, businesses and local authorities will have a decisive role to play in making a difference, working together with regional and national governments.

To this end, the 'European Strategy for Plastics in a Circular Economy' document lays down the following vision for the new plastics economy:

- A smart, innovative and sustainable plastics industry, where design and production fully respects the needs of reuse, repair, and recycling, brings growth and jobs to Europe and helps cut EU's greenhouse gas emissions and dependence on imported fossil fuels.
- Plastics and products containing plastics are designed to allow for greater durability, reuse and high-quality recycling. By 2030, all plastics packaging placed on the EU market is either reusable or can be recycled in a cost-effective manner.
- Changes in production and design enable higher plastics recycling rates for all key applications. By 2030, more than half of plastics waste generated in Europe is recycled.
- Separate collection of plastics waste reaches very high levels. Recycling of plastics packaging waste achieves levels comparable with those of other packaging materials.
- EU plastics recycling capacity is significantly extended and modernised. By 2030, sorting and recycling capacity has increased fourfold since 2015, leading to the creation of 200 000 new jobs, spread all across Europe.
- Thanks to improved separate collection and investment in innovation, skills and capacity upscaling, export of poorly sorted plastics waste has been phased out. Recycled plastics have become an increasingly valuable feedstock for industries, both at home and abroad.
- The plastics value chain is far more integrated, and the chemical industry works closely with plastics recyclers to help them find wider and higher value applications for their output. Substances hampering recycling processes have been replaced or phased out.
- The market for recycled and innovative plastics is successfully established, with clear growth perspectives as more products incorporate some recycled content. Demand for recycled plastics in Europe has grown fourfold, providing a stable flow of revenues for the recycling sector and job security for its growing workforce.
- More plastic recycling helps reduce Europe's dependence on imported fossil fuel and cut CO2 emissions, in line with commitments under the Paris Agreement.
- Innovative materials and alternative feedstocks for plastic production are developed and used where evidence clearly shows that they are more sustainable compared to the non-renewable alternatives. This supports efforts on decarbonisation and creating additional opportunities for growth.
- Europe confirms its leadership in sorting and recycling equipment and technologies. Exports rise in lockstep with global demand for more sustainable ways of processing end of-life plastics.
- Plastic waste generation is decoupled from growth. Citizens are aware of the need to avoid waste, and make choices accordingly. Consumers, as key players, are incentivised, made aware of key benefits and thus enabled to contribute actively to the transition.
- Better design, new business models and innovative products emerge that offer more sustainable consumption patterns.
- Many entrepreneurs see the need for more resolute action on plastics waste prevention as a business opportunity. Increasingly, new companies emerge that provide circular solutions, such as reverse logistics for packaging or alternatives to disposable plastics, and they benefit from the development of digitisation.
- The leakage of plastics into the environment decreases drastically. Effective waste collection systems, combined with a drop in waste generation and with increased consumer awareness, avoid litter and ensure that waste is handled appropriately. Marine litter from sea-based sources such as ships, fishing

and aquaculture are significantly reduced. Cleaner beaches and seas foster activities such as tourism and fisheries, and preserve fragile ecosystems. All major European cities are much cleaner.

- Innovative solutions are developed to prevent microplastics from reaching the seas. Their origin, routes of travel, and effects on human health are better understood, and industry and public authorities are working together to prevent them from ending up in our oceans and our air, drinking water or on our plates.

3.4 Plastics value chain

The EU plastics industry covers a total amount of 60.000 companies, from manufacturers (3,77%) to converters (94,34%) to recyclers (1,89%)[1]. Plastic materials, thermoplastics and polyurethanes, and other plastics such as thermosets, adhesives, coatings, and sealants (excluding fibres) produced in 2016 in EU28 were 60 million tonnes, two million tonnes more than in 2015. Considering only plastics raw materials manufacturers and converters, it had registered a trade balance of close to EUR 15 billion in 2016[2].

The plastic value chain, whose simplified version is shown in Figure 3, involves different players: plastic raw materials **producers** generally apply thermal and catalytic cracking to valorise low-value hydrocarbons into higher value products. Depending on the requirements necessary to produce specific plastic products, **compounders** add chemical substances to enhance polymer properties such as workability, flexibility and strength. Plastic **converters**, mainly in packaging, building and construction, automotive, electrical-electronic applications, assembly plastics resins and other materials to produce semi-finished and finished products. The final part of the plastic value chain, next to distribution and consumption phases, deals with the end-of-life (EoL) scenario, represented by **collection, sorting, recycling and disposal** of plastic waste deriving from community, users and consumers, that produce a high and diversified volume of post-consumer plastic waste.

Figure 3: The plastics value chain - simplified version.

Source: Paletta et al., Barriers and challenges to plastics valorisation in the context of a circular economy: Case studies from Italy, Journal of Cleaner Production 241 (2019).

Plastic material production

Primary plastics production refines crude oil and produces monomers that are chemically bonded into polymers. The different combinations of monomers and their blending with oxygen, chlorine, fluorine and nitrogen generates different types of plastics. Monomer production is the domain of big companies, mainly oil and chemical, which may also carry out polymerisation and blending activities. Polymers and plastics, especially polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polyethylene terephthalate (PET),

[1] https://www.plasticsconverters.eu/

[2] PlasticsEurope, 2017

polystyrene (PS) and polycarbonate (PC) comprise about 80% of the industry's output worldwide[3]. In 2016, Europe produced 60 million tonnes of plastic, corresponding to 19% of world production[4].

Plastic products manufacturing

According to the annual report published by PlasticsEurope (2017), the EU plastic converter demand was 49,9 million tonnes in 2016. The most profitable sectors for plastics conversion are packaging (39,9%) and building & construction (19,7%). Then, considering that 12% of materials in an average car today are plastics[5], 8,9 million tonnes of plastic are used in the automotive sectors, covering the 10% of total demand, followed by electrical-electronic applications (6,2%), household, leisure and sports (4,2%), agriculture (3,3%) and other sectors.

The plastics most in use in Europe are the following:

- PP and polyethylene low-density (PE-LD): PP is a characteristic polymer in automotive components, but it is also used for food packaging, sweet and snack wrappers, microwave, pipes, and bank notes. PE-LD is the favoured material for plastic bags and packaging film.
- Polyethylene high-density (PE-HD): PE-HD is adopted for toys and cleaning bottle manufacturing. Bottle caps also use PE-HD.
- PVC: The highest demand for PVC comes from building & construction sector. PVC is a polymer largely used for many building components from windows and doors profiles to pipes, cables and floor coverings
- Polyurethane (PUR): Polyurethane (PUR), a common thermoset polymer, is used for daily household and non-returnable goods like pillows, mattresses, fridges, eyeglasses etc.
- PET: The packaging sector is the main industrial customers for PET. All bottles containing liquid are made by PET

Recent years have shown an increasing demand for environmentally friendly polymers as well. Environmentally friendly polymers have been studied for years, generating “biodegradable plastics” or “bio-based plastics”. Biodegradable plastics can be degraded by microorganisms able to adopt them as a substrate for their metabolism. Therefore, complex polymeric chain can be decomposed into water and carbon dioxide or methane, respectively with aerobic or anaerobic conditions. Biodegradable plastics can be synthetized either from biogenic or fossil feedstocks. Biobased plastics, different from biodegradable ones, can be only synthetized from biogenic sources, even if the structure is identical.

Bioplastics are used in an increasing number of markets, from packaging catering products, consumer electronics, automotive, agriculture/horticulture and toys to textiles and several other segments. Packaging remains the largest field of application for bioplastics at almost 60%[6]. However, since biopolymers are mostly biodegradable, and some of them also compostable, their application makes sense when a reasonable time frame of degradation is considered. In addition, they have much less stability and durability than petroleum-

[3] Singh and Sharma, 2008

[4] Plastics – the Facts, 2017

[5] Munoz et al., 2006

[6] European bioplastics, 2018

based polymers. They generally present poor mechanical properties regarding the ability to be processed and end-use application, since the fragility and brittleness exhibited can limit their potential for application.

Plastic waste management

Depending on their functionality, performance and properties, different life cycle of plastic products can be considered. Based on these criteria, plastic goods are classified as durable or non-durable. The durable goods cover a useful life of three years or more and generally refer to appliances, furniture, consumer electronics, automobiles, and insulation materials for construction sector. Products with a useful life of less than three years are generally referred to as non-durables. Depending on the chemical composition, involving a specific molecular structure, and additives included, a broad variety of applications can be satisfied. Common applications include packaging, trash bags, cups, eating utensils, sporting and recreational equipment, toys, medical devices, and disposable diapers.

Plastic waste is among the most critical waste categories in the world, owing to its long-term degradation (it follows that the volume of collected waste cannot match, in a single year, the volume of production or consumption). 27,1 million tonnes of plastic waste (post-consumer) was collected, through official schemes, in 2016 in EU28.

In terms of sustainable waste processes, recycling is a sustainable alternative waste disposal strategy other than landfill and incineration. Recycling of waste plastics emerged during the early 1990s. Since 1990, the global rate of recycling has increased by approximately 0,7% per annum to the current rate of 20%[7]. Due to the rapid depletion of natural resources, many organizations have realized that recycling of used products can be a building block to achieve competitive advantage, however, it is still the second option in the actual European waste management system. In fact, only 31,1% of plastics is sent for recycling, the remaining are landfilled (27,3%) and incinerated for energy recovery (41,6%)[8].

Because of its short 'in use' lifetime, high use and consumption, packaging is the largest contributor to plastic waste generation. 16,7 million tonnes of plastic post-consumer packaging waste was generated in EU28 in 2016. The other sectors produce a huge number of plastic products, but the long lifespan causes yearly plastic waste production to be smaller. In the construction sector, plastic products can last between 30 and 40 years before being disposed of. In the automotive sector, the average life span of vehicles is around 13.5 years while the electronic-electric devices have a service life of 3 to 12 years. However, packaging waste, if efficiently collected and separated, turns out to be the most recyclable waste, thanks also to the kind of high-quality polymers, products "eco-design" and recycling process optimisation that is adopted: with 2017 data, 40,9% is recycled, 38,8% is energetically valorised, and only 20,3% is landfilled[9].

[7] Geyer et al., 2017

[8] PlasticsEurope, 2017

[9] PlasticsEurope, 2017

3.5 Barriers & challenges

The use of recycled plastics is marginal compared to virgin plastics across all plastic types due to a range of technological and market factors. Performance tests on recycled plastics are usually lower than in virgin plastics. Moreover, the difficulty in finding high quality recycled plastics in the local market increases the price for the associated transport costs. Even if the practice is getting more traction, recycled plastics are not commonly used in food packaging owing to directives on food safety and hygiene standards.

Another limit on the use of recycled plastics is that plastic processors require large quantities of recycled plastics, manufactured to strictly controlled specifications at a competitive price in comparison to virgin polymers. Therefore, collection, sorting, and general waste management become essential preliminary actions to maximizing the polymers separation, obtaining the maximum level of materials purity. At the same time, the recycling market must increase, making regions self-determined and self-sufficient. To maximize the recycled plastic demand, it is necessary to establish a strong connection between recyclers and converters, optimizing needs on the prescription for various applications.

Some problems are also related to composite plastic materials and non-recyclable polymers. Recycling processes are very often hampered by inseparable polymer composites, an unnecessary use of additives or combining plastics with other materials (paper, metal, fibres) in a way that does not allow for an easy separation. Recycling of plastics does not begin with collection but rather with the eco-design of products, in a life cycle thinking approach. For non-recyclable polymers, even if some thermosetting polymers can be converted relatively easily back to their original monomer, such as PUR, the more common thermosetting resins such as PS and epoxy are not easy to be depolymerised to their original constituents. In Europe, approximately 1 million tonnes of composites are manufactured each year[10]. Eco-design and redesign of products, in a circular economy perspective, becomes important by limiting unrecyclable multi-material products, dangerous substances and coloured and opaque materials. However, the perceived lack of recyclability is now increasingly important and seen as a key barrier to the development or even continued use of composite materials in some markets. Challenges for thermosetting polymers is limiting as much as possible the use of non-recyclable polymers and substituting them with more sustainable materials.

An alternative plastics value chain, where recyclers and converters are strictly inter-linked, could assist in overcoming the above-mentioned barriers; such an approach could be supported by tools such as protocols for recycling standardisation (especially for post-consumer waste) and acquisition agreement, certification, and labelling on the quality of recycles. Thus, this will ensure a well-working after-use plastics economy, where converters could play a key role as well by promoting eco-design and design for recyclability practices through a strong collaboration with stakeholders working on waste management.

[10] PlasticsEurope, 2017

4 Data collection

4.1 Survey design

To collect data, the activity implemented a survey. The survey followed a mixed approach, i.e. both a quantitative and a qualitative one; it was implemented through two questionnaires:

1. Questionnaire A was addressed to PLASTECO project partners (Annex A).
2. Questionnaire B was addressed to stakeholders from the plastics value chain in project partners' territories (Annex B).

Both questionnaires are available online and were filled in in the "EU Survey" platform in the following links:

Questionnaire A: https://ec.europa.eu/eusurvey/runner/PLASTECO11A

Questionnaire B: https://ec.europa.eu/eusurvey/runner/PLASTECO11B

4.2 Survey objectives & scope

The objective of the survey was to identify three elements:

1. The readiness of PLASTECO territories for the transition to a new plastics economy in terms of policies and actions taken;
2. The barriers that plastics value chain faces in PLASTECO territories for the transition to a new plastics economy;
3. The public opinion in PLASTECO territories regarding the phasing out of plastics.

The scope of the survey was already defined in the PLASTECO Application From (in terms of geographical scope and target population) as follows:

- Geographical scope: Territories represented in the project consortium.
- Target population:
    - Project partners.
    - Territorial stakeholders participating to the plastics value chain in PLASTECO territories.

4.3 Questionnaire A

Questionnaire A was addressed to PLASTECO project partners. The questionnaire covered survey objectives 1 and 3, namely:

- Survey objective 1: To identify the readiness of PLASTECO territories for the transition to a new plastics economy;
- Survey objective 3: To identify the public's opinion in PLASTECO territories regarding the phasing out of plastics.

To this end, it includes two main sections:

- Section A: It consisted of three questions:
    - Question 1 was a multiple choice question including 10 options; the options were measures, proposed by EC, that are expected to lead EU regions towards a new plastics economy. Partners were expected to choose whether such measures exist in their territory or not.

- Question 2 required partners to rank a list of 7 options (measures for phasing out plastics), to determine which they considered the most effective in their territory.
- Question 3 required partners to rank a list of 7 options, which are measures to curb plastic waste, to determine which they consider the most effective in their territory.

- Section B: It consists of two questions:
  - Question 4 required that partners document the most important information campaigns existing in their territory regarding plastic waste.
  - Question 5 required that partners find surveys (at least one) conducted in their territory regarding the public's opinion on plastic waste and document their key findings.

4.4 Questionnaire B

Questionnaire B was addressed to territorial stakeholders participating to the plastics value chain in PLASTECO territories. The questionnaire covered the survey objective 2, namely:

- Survey objective 2: To identify the barriers that plastics value chain faces in PLASTECO territories for the transition to a new plastics economy.

To this end, the questionnaire included one section, which listed several potential barriers (legislative, economic, technological, and socio-cultural); respondents were asked to rank each barrier's importance in hindering the transition to a new plastics economy.

4.5 Data collection

- For Questionnaire A:
  - For Section A, project partners used their own organisational resources to assess the readiness of their territory for transitioning to a new plastics economy.
  - To complete the Section B (on public opinion), partners conducted desk research to determine the public's views. Specifically, in addition to own knowledge, they draw relevant information through the following outlets:
    - EU Barometer report: "Attitudes of Europeans towards waste management and resource efficiency" https://ec.europa.eu/commfrontoffice/publicopinion/flash/fl_388_en.pdf
    - Visited Google Scholar (https://scholar.google.com/) and conducted a search with relevant keywords (e.g. 'public opinion / attitudes plastic waste' including also the name of the territory in question).
    - Contacted waste management authorities in their territory to inquire if they have relevant information.
    - Contacted environmental NGOs (e.g. Greenpeace) to inquire if they have conducted relevant surveys.
- For Questionnaire B, project partners distributed the questionnaire to a list of enterprises in the plastics value chain in their territory/country, specifically to the following categories of stakeholders:
  1. Producers of plastics
  2. Plastics converter businesses
  3. Recyclers of plastics

4. Organisations that conduct R&D activities relevant to plastics, such as Universities or laboratories.
5. Collectors and sorters
6. Waste management companies
7. Public authorities relevant with plastic waste management
8. Association of producers/importers and/or EPR organizations

4.6 Key Performance Indicators (KPIs)

Regarding the Questionnaire B, minimum targets for the collection of data from the PLASTECO consortium countries were set by taking into account the number of enterprises active in the countries represented in the PLASTECO project[11] and the dissemination capacity of partners. The aim of these targets aimed to track and monitor the data collection process, to make sure sufficient data were collected. The following table presents the KPIs set for each partner and the target achieved.

Table 1: KPIs for questionnaire B

No	Partner	Country	Minimum target	Target achieved
1)	Municipality of Rethymno	EL	5	9
2)	Lombardy Region	IT	15	19
3)	Styrian Provincial Government	AT	5	5
4)	Stara Zagora Regional Economic Development Agency	BU	8	8
5)	Cluster of Environmental Technologies Bavaria	DE	12	20
6)	Auvergne-Rhône-Alpes Energy Environment Agency	FR	10	26
7)	Bucharest-Ilfov Regional Development Agency	RO	7	13
8)	Association Baltic Coasts	LT	5	4
	TOTAL	**PLASTECO consortium**	**67**	**104**

4.7 Timeline

Data collection lasted from 25/11/2019 until 21/05/2020.

[11] https://ec.europa.eu/eurostat/statistics-explained/images/6/65/Key_indicators%2C_manufacture_of_rubber_and_plastic_products_%28NACE_Division_22%29%2C_2010_A.png

5 Data analysis

5.1 Policy readiness (survey objective 1)

5.1.1 Current situation in PLASTECO territories

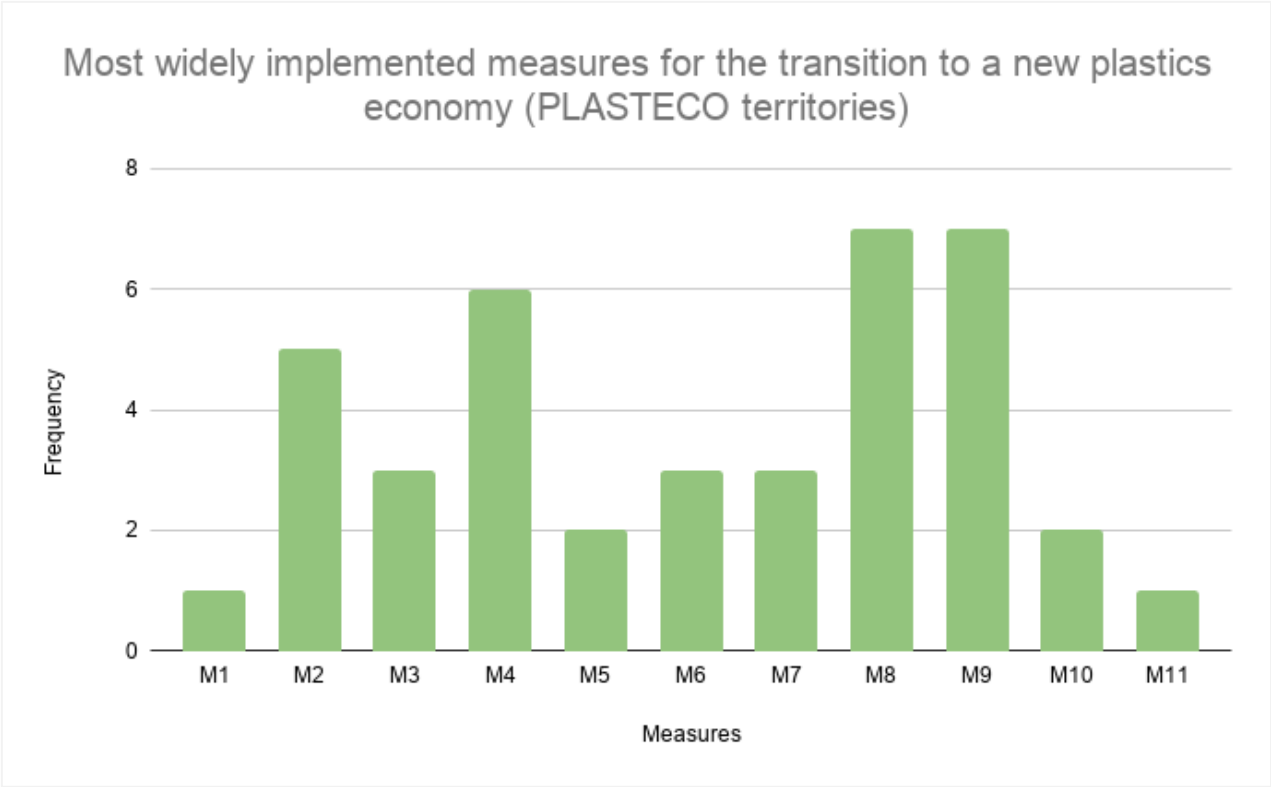
To survey the readiness of PLASTECO territories to transition to a new plastics economy, project partners were asked in Questionnaire A to respond to the following multiple-choice question: "Which of the following measures does your territory have in place?" The available options to choose from where the following eleven measures (M1 to M11):

1. Public procurement guidelines that favour reusable and recycled plastics and/or promote alternatives to single-use plastics (M1).
2. Economic instruments (e.g. taxes) that reward reuse and recycling of plastics over landfilling and incineration (M2).
3. Innovative waste management methods (e.g. automated waste collection, route optimisation) that are used for the separate collection of plastics (M3).
4. EPR (Extended Producer Responsibility) schemes (M4).
5. Deposit refund systems (e.g. for beverage containers) (M5).
6. Voluntary agreements/commitments among public authorities and the plastics value chain stakeholders (M6).
7. Dialogue and cooperation platforms (i.e. institutional, not ad hoc) between public authorities and stakeholders from the plastics value chain (M7).
8. Awareness campaigns and/or clean-up activities regarding plastic littering that have been/are being organised (M8).
9. Illegal and non-compliant landfills that have been eradicated (M9).
10. Standards/protocols for recycled plastics (M10).
11. Other measure(s) (M11).

As it can be observed in the Figure below, the most commonly implemented measures are M8 and M9, followed by M4 and M2 in the third and fourth places respectively:

1. Awareness campaigns and/or clean-up activities regarding plastic littering that have been/are being organised (M8).
2. Illegal and non-compliant landfills that have been eradicated (M9).
3. EPR (Extended Producer Responsibility) schemes (M4).
4. Economic instruments (e.g. taxes) that reward reuse and recycling of plastics over landfilling and incineration (M2).

Figure 4



It is worth noting, also, that the least implemented measures, which, despite their low implementation in PLASTECO territories, are quite important for the transition to a new plastics economy, are M1, M5, and M10:

1. Public procurement guidelines that favour reusable and recycled plastics and/or promote alternatives to single-use plastics (M1).
2. Deposit refund systems (e.g. for beverage containers) (M5).
3. Standards/protocols for recycled plastics (M10).

Nevertheless, apart from M8 and M9, which are almost unequivocally implemented in PLASTECO territories, the implementation of all other measures varies significantly from territory to territory, as it can be seen from the Table below. The territories with the most measures are Lombardy and Styria, while almost all the rest have five to three measures.

Table 2

	RETHYMNO	LOMBARDY	STYRIA	SZREDA	UCB	AURA-EE	ADR-BI	BALTIC
M1		✓						
M2	✓	✓	✓	✓		✓		
M3		✓	✓					✓
M4		✓	✓		✓	✓	✓	✓

	RETHYMNO	LOMBARDY	STYRIA	SZREDA	UCB	AURA-EE	ADR-BI	BALTIC
M5			✓		✓			
M6		✓		✓		✓		
M7		✓	✓	✓				
M8	✓	✓	✓	✓	✓		✓	✓
M9	✓	✓	✓	✓	✓	✓		✓
M10	✓						✓	
M11				✓				

In addition to selecting the measures that are already in place in their territory, project partners were asked to answer **which of the eleven options presented above they consider "will have the most positive impact in the transition towards the new plastics economy**" and to explain their choice. The most common answer (half of all partners) responded prioritising some kind of financial measures, albeit not the same ones. For example, Rethymno explained that financial tools such as municipal tax reduction (e.g. lower taxes in case of increased flow in recycled materials). AURA-EE emphasised landfill taxes and bans since they are simple to implement and quite effective, while Styria prioritised economic tools concerning public procurement, arguing that without such measures secondary raw materials are often not competitively priced compared to primary raw materials (e.g. due to the low price for crude oil as a raw material for primary plastics). Along the same lines, Baltic Coasts underlined that economic instruments could have the most positive impact – considering that Latvia still faces a problem with most plastic waste disposed of in landfills, being impossible to raise only waste disposal fees without alternative solutions related to the promotion of recycling.

Other partners highlighted the importance of innovative waste management solutions. UCB prioritized a smart combination of different measures, where public procurement guidelines are implemented alongside innovative waste management methods, and ADR-BI mentioned that innovative waste management methods are needed to expand and improve the separate collection of plastic waste, to ensure quality inputs to the recycling industry, improving the infrastructure to ensure high-quality separate collection of plastics. Lombardy advocated for a combination of measures as well, mentioning an enhanced EPR policy, with more intense and effective involvement of producers, and the development of innovative waste management methods that are used for the separate collection of plastics (for the sorting and the treatment in particular, to have homogeneous materials collected to recycle all the polymers). SZREDA also advocated for innovative methods of waste management and the complete eradication of illegal and non-compliant landfills.

5.1.2 Most promising measures for phasing out plastic waste

To survey the **most effective measures for phasing out plastic waste** in PLASTECO territories, partners were asked to rank six options in order of importance, from 1 to 8, whereas "1" signifies the most preferred one, and "8" the least preferred. The six options were the following:

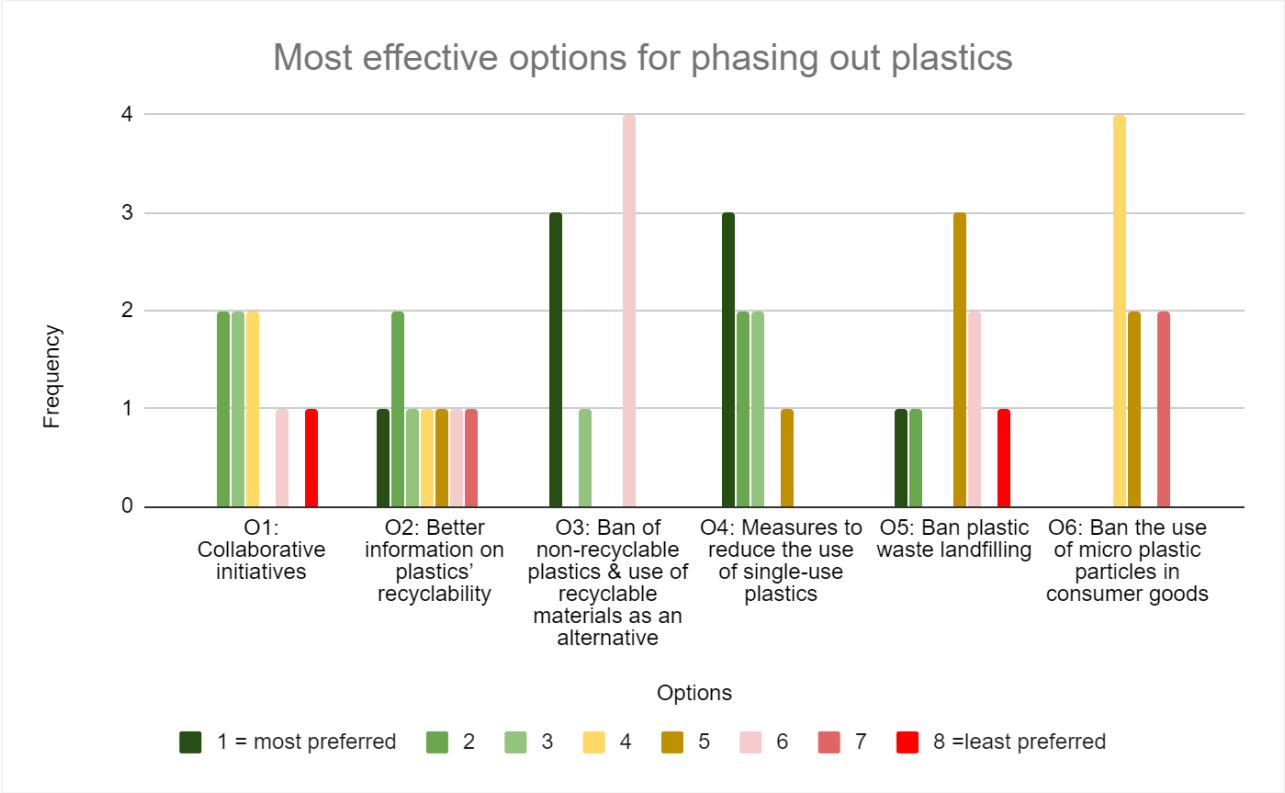
1. More collaborative initiatives between public authorities and the plastics value chain (e.g. voluntary agreements) are needed to limit plastic waste and increase recycling (O1).
2. Better information should be provided to the public about which plastics are recyclable (O2).
3. The production of non-recyclable plastics should be stopped and recyclable materials used as an alternative (O3).
4. Measures should be taken to reduce the use of single-use plastic items, such as shopping bags (O4).
5. Disposing of plastic waste into landfill sites should be prohibited (O5).
6. The use of micro plastic particles in consumer cosmetics and similar products should be forbidden (O6).

Visualisation of the results, depicted in the Figure below, indicates a clear preference primarily for O4 and, following closely, O3:

1. Measures should be taken to reduce the use of single-use plastic items, such as shopping bags (O4).
2. The production of non-recyclable plastics should be stopped and recyclable materials used as an alternative (O3).

It should be noted that O4 is more consistently marked as an effective measure, whereas O3 also concentrates a high percentage of choice '6', denoting that its importance is not self-evident for all territories. Also, both measures lean heavily on the legislative side, which is to be expected since partners are primarily policy organisations. Nevertheless, this is in contrast with stakeholders' evaluation of legislative barriers (see analysis of Questionnaire B), who –in general– did not consider legislative barriers to be the most significant ones for the transition to a new plastics economy.

Figure 5



Partners were also asked to **explain the choices that ranked the highest (i.e. with '1')**. UCB emphasised that different measures to reduce the use of single-use plastic items should be defined on many everyday levels, starting from consumers (e.g. returnable coffee cups; a system already exist in Augsburg, called Recup; this should be strengthened), public bodies (e.g. removing the single-portion bags for milk in meetings), events (e.g. assess the possibility of reusable cups for big events like sports games) and going all the way to the company level (e.g. idea to establish an initiative for companies to reduce plastic waste). SZREDA explained that the impact of consumer psychology is a process that is brought up slowly and should not be prohibitive, making sure that plastic alternatives are also environmentally friendly as a choice, because there are many cases where green solutions are not green at all.

AURA-EE mentioned that O3 and O4 are simple and effective ways to redirect the plastic flow and boost the recycling process, and ADR-BI explained that they chose O4 due to the situation in its area. According to the waste management plans of Ilfov County and Bucharest City, plastic waste from domestic and similar waste represents 15 % in Bucharest, 14, 9% in all the urban areas of the County, and 15,07% in the rural area. As most of these percentages represent single-use plastics, they end up littering the environment because of the unwittingly individual behaviour and also because of the poor waste management system.

Styria emphasised that the production of non-recyclable plastics should be stopped and recyclable materials used as an alternative. The reason is that many materials made of plastics or plastic components are currently not recyclable (e.g. multilayer films, composite materials). Various additives (colours, plasticizers, fillers, etc.) can also make recycling more difficult. It is only improved recyclability or the increased replacement of non-recyclable plastics with recyclable ones that enable wider implementation of plastic recycling.

Along the same lines, Lombardy explained that the main aim is to avoid and phase out materials that are not recyclable and are disposed of into landfills. Boosting the circular economy, supporting the production of recyclable plastics. Baltic Coasts, also, mentioned that stopping the production of non-recyclable plastics would eliminate this type of waste in the future. Finally, Rethymno prioritised the dissemination of information as a key to a successful transition to a new plastics economy, as well-informed and aware publics can facilitate the implementation of the legislation and relevant measures.

5.1.3 Most promising measures for curbing plastic pollution

As with the previous question, to survey the **most effective measures for curbing plastic pollution** in PLASTECO territories, partners were asked to rank seven options in order of importance, from 1 to 8, whereas "1" signifies the most preferred one, and "8" the least preferred. The seven options were the following:

1. Ensuring wider availability of litter bins for plastics by waste management authorities (O1).
2. Better enforcement of existing anti-litter laws against the public (O2).
3. Encouraging alternatives to plastic bags or other plastic packaging (O3).
4. Intensification of communication campaigns on plastic waste addressed to the public (O4).
5. Increasing and encouraging the recycling of waste (O5).
6. Financial participation by producers of plastics in funding the phasing out of plastics (e.g. EPR schemes) (O6).
7. Organisation of clean-up events (O7).

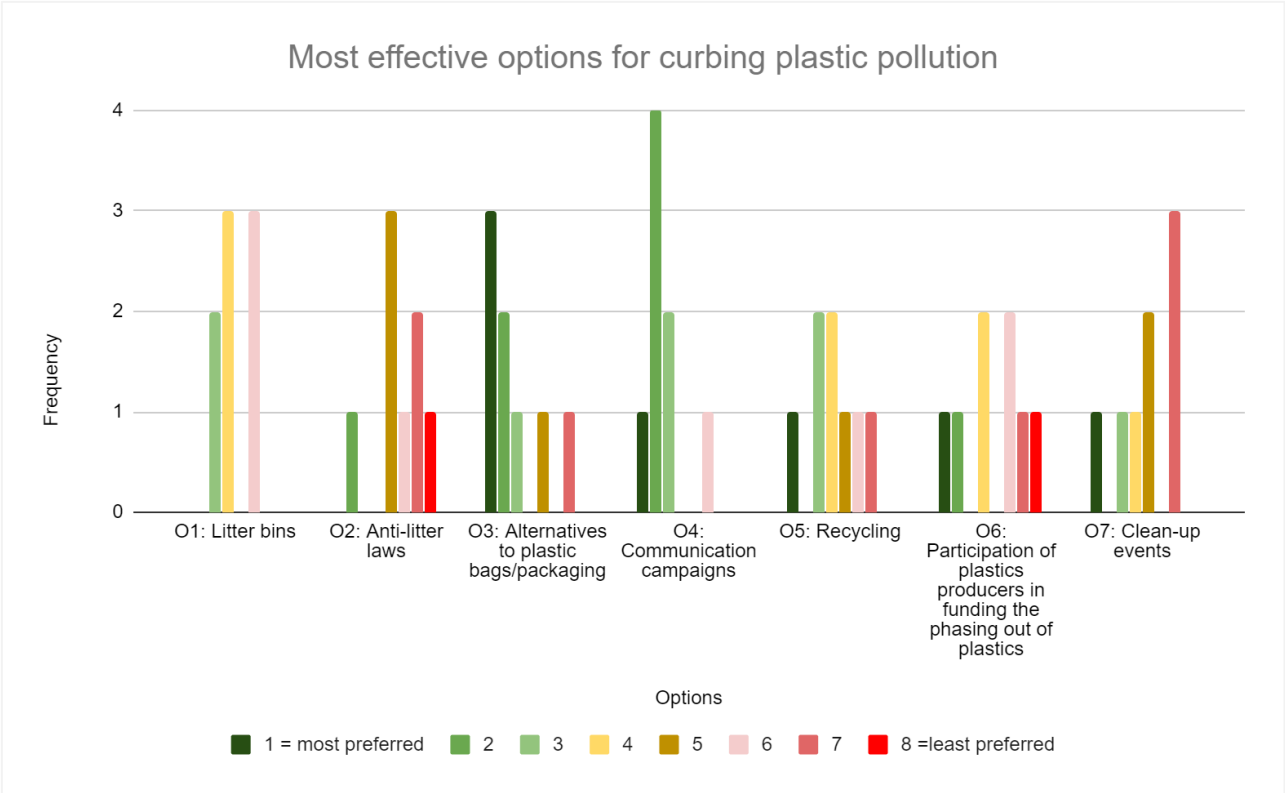
Data analysis, depicted in the Figure below, indicates two options as the most pronounced, namely O3 and O4:

1. Encouraging alternatives to plastic bags or other plastic packaging (O3).
2. Intensification of communication campaigns on plastic waste addressed to the public (O4).

O3 has been the most highly-ranked choice among all available options, while O4 has concentrated the second-highest ranking. The measures that were not considered fundamental for curbing plastic pollution (i.e. concentrated low rankings) are mainly O7 and O2:

1. Organisation of clean-up events (O7).
2. Better enforcement of existing anti-litter laws against the public (O2).

Figure 6



In addition to selecting the most effective options for curbing plastic waste, project partners were asked to **explain the choices that ranked the highest (i.e. with '1')**. Rethymno prioritised awareness campaigns, reasoning that they encourage the use of alternatives to plastic, adding that the reduction of alternatives to plastics needs to be more economically competitive to curb plastic pollution. AURA-EE selected O4, mentioning that awareness campaigns contribute to changing consumers' attitudes and the habit of using single-use plastics. Similarly, UCB selected awareness campaigns as the most effective measure, explaining that innovative and target-group oriented communication campaigns on plastic waste and alternatives to plastic have a visible effect on the environment. The unawareness of many citizens needs to be addressed with campaigns, with targeted actions such as providing information in newspapers on ways of living with less plastic and revealing information on the journey of plastic waste after it is put in a bin.

Styria prioritises the organisation of clean-up events when it comes to the most effective solutions to curb plastic pollution. It reasons that diminishing littering requires the cooperation of the broad population. Large-scale anti-littering campaigns (e.g. the large Styrian spring cleaning with about 55,000 participants last - www.saubere.steiermark.at) attract large parts of the population, especially children and young people, to participate. Awareness is also raised through media reports that reach even more people. At the same time, the cleaning campaigns remove considerable amounts of waste from nature (3 to 4 kg/participant).

Baltic Coasts prioritised the EPR schemes that implement the 'polluter pays' principle, according to which producers/importers/sellers of plastics have to be responsible for the product in its whole life-cycle, including when it becomes waste. This means that they will be financially involved in recycling. Lombardy emphasised the use of non-plastic items, reasoning that using degradable or reusable items can strongly curb plastic pollution and provide a solution to this problem.

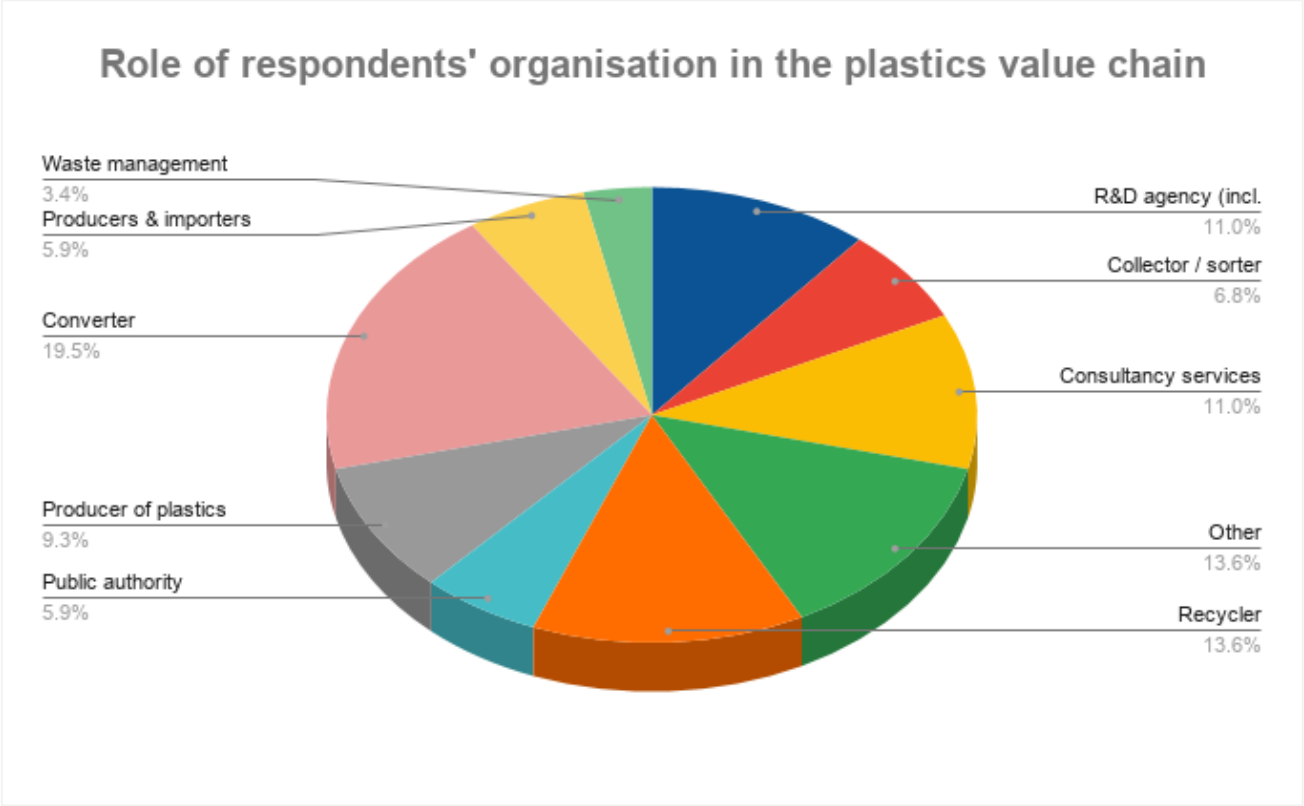
5.2 Barriers (survey objective 2)

This questionnaire was addressed to plastics value chain stakeholders (e.g. producers, converters, recyclers, R&D institutions) in the countries represented by the partnership (Greece, Italy, Austria, Bulgaria, Germany, France, Romania, Latvia). It aimed to identify the barriers (economic, legislative, technological, and socio-cultural) that plastics value chain actors face in their efforts to transition to a new plastics economy.

5.2.1 Types of organisations & territorial distribution

To identify the role of each respondent in the plastics value chain, the questionnaire included the following question: **"What is your company's/organisation's role in the plastics value chain?"**; a multiple-choice answer was available, with the following options: 1) Producer of plastics, 2) Converter, 3) Recycler, 4) R&D agency (incl. University), 5) Consultancy services, and 6) Other. Coding of data showed that four additional categories were needed to complement the ones above: 7) Collector/sorter, 8) Waste management company, 9) Public authority 10) Association of producers/importers and/or EPR organization.

Figure 7



From the Figure above we can draw the following results:

- Converters, the most dominant type of organisation in the plastics value chain across the EU (according to EUPC data) is well represented in the sample, being the biggest sample subgroup (19.5%). However, compared to the over 90% representation of converters in the EU plastic value chain, they are under-represented in this survey.

- Producers of plastics (9.3%) and those that also serve as importers (5.9%) are well represented in the sample, considering that their EU presence ranks between the 5-10% ranges in various countries.
- It is valuable that for the results of the survey that recyclers of plastics are well-represented in the sample, as they are the second most pronounced subcategory of stakeholders in the sample, ranking at 13.6%. This is particularly important, considering that they will play a central role for shift to a new plastics economy; therefore, their adequate presence in the sample provides additional validity to the survey, especially when considering that they have first-hand knowledge of technological barriers.
- The subcategory 'Other' unites under this generic term organisations that have a loose connection to the plastics value chain; it is important to note that most organisations under this term are either economic institutions or producers that manufacture products that are antagonistic to consumer plastics. Their contributions were not disqualified, however, since they did not have an over-representation in the sample and their opinion can complement those other subcategories that are more involved in the plastics economy.

Regarding the territorial distribution of respondents concerning their role in the plastics value chain, data showed that there was not a homogenous distribution of stakeholders in each territory (compared with the Figure above). This is not surprising and it was expected, as the EU plastics value chain itself is not homogenous across the EU. Therefore, it can be inferred –grosso modo– that the territorial divergences in the type of respondents in the questionnaire reflect the composition of the value chain in each territory. As the number of respondents for some partnership countries cannot be deemed entirely representative, and as some countries had higher KPIs to reach (therefore are more prevalent in the sample), nevertheless data coding revealed the following territorial distribution for the sample[12]:

- Most converters come from France (16); Italy has four and Greece two.
- Most producers come also from France (7), with Italy contributing another three and Bulgaria one.
- Most R&D agencies and universities come from Germany (5) and Italy (3); Romania and Greece contribute with two each, and Austria with one.
- Recyclers are distributed among various countries, with Romania and Italy each contributing with four, Germany with three, Greece and France both with two, and Austria with one.
- Collectors and sorters also are distributed among various countries, with Germany and France with three each, and Italy and Austria with one.
- Most consultancy services are in Germany (7), with Romania contributing three, and Greece, Italy, and Romania one each.
- EPR organisations, importers, and public authorities come from all the countries of the partnership.
- All waste management organisations come from Greece (4).
- Bulgaria and Italy have the highest number of organisations under the 'other' category, with five entries each.

[12] The analysis of barriers in the following sections does not include an additional analysis of the choices that each stakeholder type made per barrier, as there were not significant divergences among them overall.

5.2.2 Economic barriers

Stakeholders were presented with ten different statements and were called to rank them as a barrier or not by selecting one of the following answers: a) Not a barrier, b) Slightly Important, c) Moderately Important, d) Important, e) Very Important, f) No opinion / N/A. The ten statements, presented as possible economic barriers, were the following:

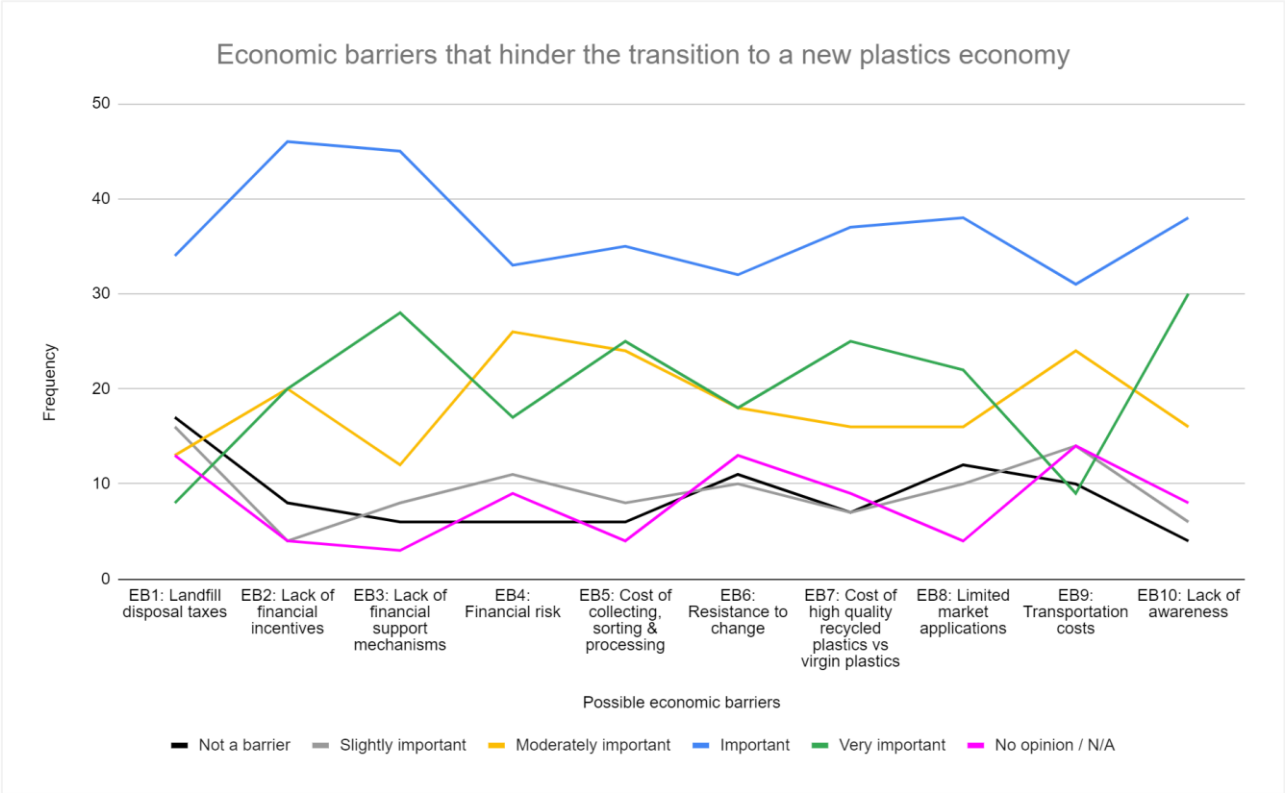
1. Landfill disposal taxes (or similar financial schemes) for plastics are missing and/or are insufficient (EB1).
2. Public financial incentives for plastics recycling and their uptake are missing (EB2).
3. Lack of financial support mechanisms for scaling up circular economy models in the plastics value chain, especially for SMEs (EB3).
4. High financial risk for plastics value chain for moving from linear to circular production processes (EB4).
5. High costs of collecting, sorting, and processing waste plastics (EB5).
6. Resistance to change among product manufacturers (EB6).
7. High quality plastics recycling is more costly to buy than virgin plastics (EB7).
8. Recycled plastics have limited market applications (EB8).
9. Recycled plastics have high transportation costs due to shortages in local markets (EB9).
10. Lack of awareness of end-users on recycled plastics (EB10).

The visualisation of data, depicted in the Figure below, shows that in general, most respondents considered all the possible statements as important barriers for the shift to a new type of circular economy in the plastics value chains. This can be inferred by the high volume of individual responses that the option 'Important' received for all the ten options presented in the questionnaire, exceeding –in terms of frequency– all the other ranking choices by, on average, twenty times. Nevertheless, focusing on the nuances of all the data lines presented in the Figure below, data show that:

- There is a positive correlation among two choices, namely 'Important' and 'Very important' (blue and green line respectively). That is, when there is a spike in one there is a spike in the other (and vice versa when there is a drop). This positive correlation is an indicator that enables to distinguish better which options were more fundamental barriers than others.
- In line with the above, there is a negative correlation trend among the group of 'Important' and 'Very Important' choices, on the one hand, and the 'Not a barrier' choice, on the other hand (black line). That is, when 'Not a barrier' choice raises, the 'Important' and 'Very important' choices tend to fall and vice versa. This is to be expected, as it is logical when an option is considered more strongly a barrier then it is less easily considered to not be a barrier. It is another indicator, however, that reinforces the importance and validity of those options that are indeed concentrated high-frequency scores.
- The ranking options that indicated that a barrier is not a very fundamental one for the transition to the new plastics economy, namely 'Slightly important' and 'Moderately important' more irregular (yellow and grey lines). More specifically, they show a minor correlation with the lines that indicate when an option is considered a more fundamental barrier. Also, these lines were the least selected out of the four that indicate the importance of a barrier. Their irregularity, however, should not be overemphasised, as the yellow line ('Moderately important' choice) presents a

negative correlation trend, at times, with the 'Important' and 'Very important' choices (more visible in EB3, EB4, EB7, EB8, EB9, EB10) and the 'Slightly important' choice presents a similar trend line, albeit not as visible as the other trend lines.

Figure 8



Regarding the findings, it is clear from the Figure above that EB2 and EB3 are the most pronounced barriers under the 'Important' choice (blue line). EB7, EB8, and EB10 follow quite closely as well. The green line, representing the 'Very important' choice, can indicate –in combination with the blue line– more clearly the most pronounced barriers by following its spikes. Therefore, we can conclude that the two most pronounced economic barriers for the transition of plastic value chains to a new plastics economy are the following three, in order of significance:

1. Lack of financial support mechanisms for scaling up circular economy models in the plastics value chain, especially for SMEs (EB3)
2. Lack of awareness of end-users on recycled plastics (EB10).
3. Public financial incentives for plastics recycling and their uptake are missing (EB2).

On the other hand, the least selected options as barriers were EB9 and EB4:

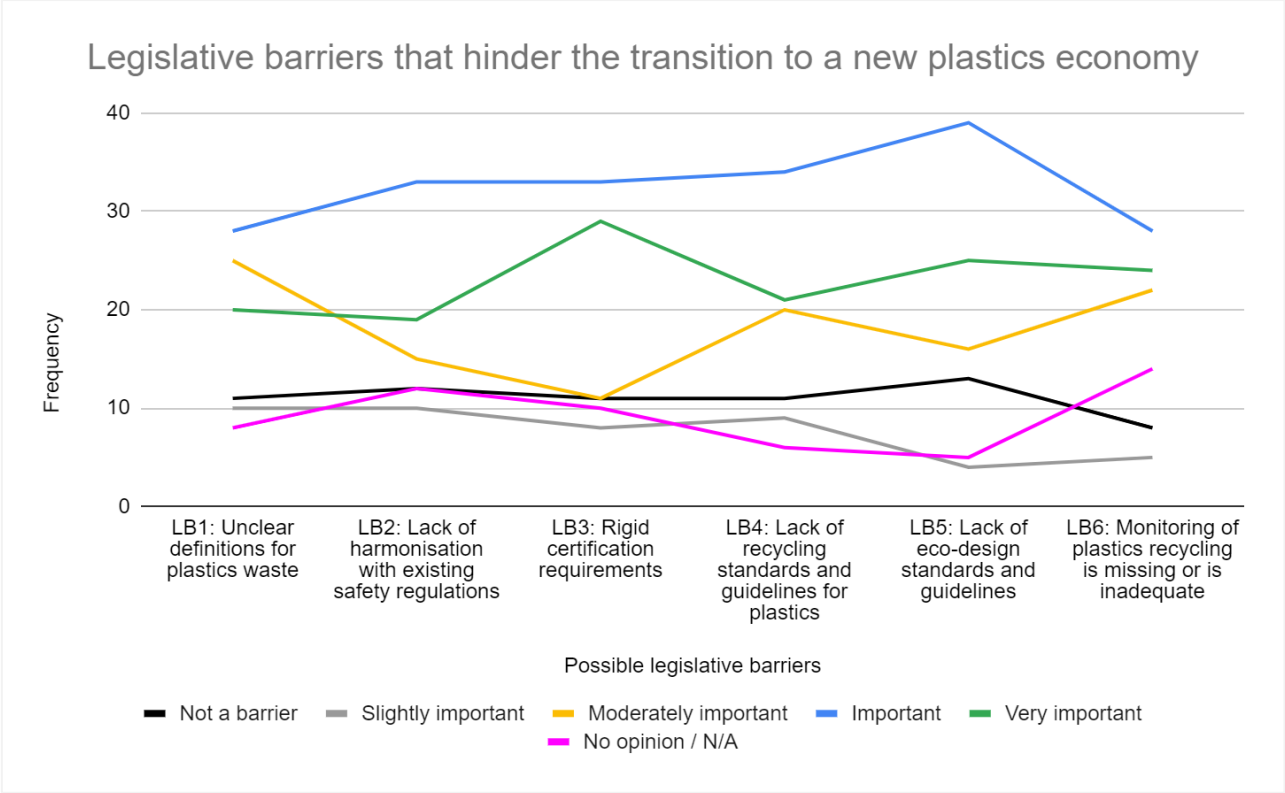
1. Recycled plastics have high transportation costs due to shortages in local markets (EB9).
2. High financial risk for plastics value chain for moving from linear to circular production processes (EB4).

5.2.3 Legislative barriers

Stakeholders were presented with six different statements and were called to rank them as a barrier or not by selecting one of the following answers: a) Not a barrier, b) Slightly Important, c) Moderately Important, d) Important, e) Very Important, f) No opinion / N/A. The six statements, presented as possible legislative barriers, were the following:

1. The definitions for plastics waste (e.g. End-of-Waste criteria) are unclear (LB1).
2. Recycled plastics are not harmonised with existing safety regulations (LB2).
3. Existing safety regulations (e.g. for food packaging or food contact) require rigid certification hindering the use of recycled plastics (LB3).
4. Recycling standards and guidelines for plastics are missing (LB4).
5. Eco-design standards and guidelines are missing (LB5).
6. Monitoring of plastics recycling is missing or is inadequate (LB6).

Figure 9



Data analysis, depicted in the Figure above, shows that in general, most respondents considered only two legislative barriers (LB3 and LB5) to be crucial –when lifted– for the shift to a new type of circular economy in the plastics value chains. This is demonstrated by the consistent answers under the 'Not a barrier' lines (black) which is higher also compared to the one presented in the previous section that referred to the economic barriers. A more in detail look into the Figure above shows that:

- There is not a correlation among two choices, namely 'Important' and 'Very important' (blue and green line respectively). That is, when there is a spike in one there is not a similar spike in the other (and vice versa when there is a drop). This non-correlation is an indicator that legislative

barriers are not considered univocally to be the main barriers for the transition to a new plastics economy by plastics value chain stakeholders.

- There is a negative correlation between the 'Moderately important' and 'Very Important' choices. That is, when one choice raises, the other tends to fall and vice versa. This is to be expected, as it is logical when an option is considered more strongly a barrier ('Very important') then it is less easily considered a moderate barrier. This is an indicator, however, that reinforces the importance and validity of the 'Very important' option when it concentrates high-frequency scores.
- The ranking options that indicated that a barrier is not a very fundamental one for the transition to the new plastics economy, namely 'Slightly important' and 'Moderately important' show positive correlation (yellow and grey lines). This is to be expected. More specifically, the yellow line ('Moderately important' choice) presents a negative correlation trend with the 'Important' and 'Very important' choices and the 'Slightly important' choice presents a similar trend.

Regarding the findings, it is clear from the Figure above that LB3 and secondarily LB5 are the most pronounced barriers. The green line, representing the 'Very important' choice, can indicate –in combination with the blue line– very clearly in this Figure the most pronounced barriers. Therefore, we can conclude that the two most pronounced legislative barriers for the transition of plastic value chains to a new plastics economy are the following, in order of significance:

1. Existing safety regulations (e.g. for food packaging or food contact) require rigid certification hindering the use of recycled plastics (LB3).
2. Eco-design standards and guidelines are missing (LB5).

On the other hand, the least selected options as barriers were LB1, LB2, and LB6:

1. The definitions for plastics waste (e.g. End-of-Waste criteria) are unclear (LB1).
2. Recycled plastics are not harmonised with existing safety regulations (LB2).
3. Monitoring of plastics recycling is missing or is inadequate (LB6).

5.2.4 Technological barriers

Stakeholders were presented with six different statements and were called to rank them as a barrier or not by selecting one of the following answers: a) Not a barrier, b) Slightly Important, c) Moderately Important, d) Important, e) Very Important, f) No opinion / N/A. The six statements, presented as possible technological barriers, were the following:

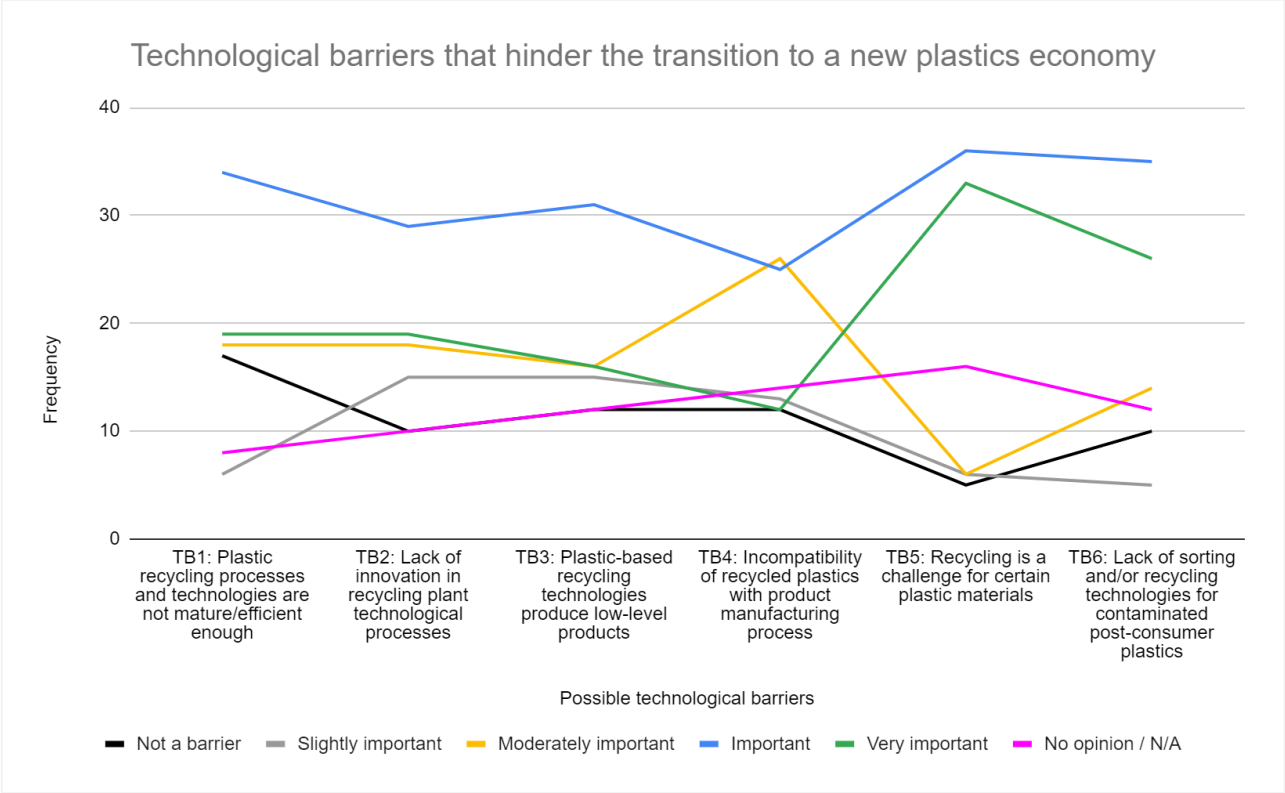
1. Plastic recycling processes and technologies are not mature/efficient enough (TB1).
2. Lack of innovation in recycling plant technological processes (TB2).
3. Current plastic-based recycling technologies produce low-level products (TB3).
4. Incompatibility of recycled plastics with product manufacturing process (TB4).
5. Recycling is a challenge for certain plastic materials (e.g. LD polymer-based films, composite materials, thermoset polymers) (TB5).
6. Lack of sorting and/or recycling technologies for treating contaminated post-consumer plastics (TB6).

The visualisation of data, depicted in the Figure below, shows that in general, most respondents considered all the possible statements as important barriers for the shift to a new type of circular economy in the plastics value chains. This can be inferred by the high volume of individual responses that the option 'Important'

received for all the six options presented in the questionnaire, exceeding –in terms of frequency– all the other ranking choices. Nevertheless, focusing on the nuances of all the data lines presented in the Figure below, data show that:

- As it was also the case with economic and legislative barriers, there is a positive correlation among two choices, namely 'Important' and 'Very important' (blue and green line respectively). This positive correlation is an indicator that enables us to distinguish better which options were more fundamental barriers than others. In this case, the spikes in both lines at TB5 show clearly that it is the most pronounced technological barrier.
- In line with the above, there is a negative correlation trend among the group of 'Important' and 'Very Important' choices, on the one hand, and the 'Moderately important' choice, on the other hand (yellow line). That is, when 'Moderately important' choice raises, the 'Important' and 'Very important' choices tend to fall and vice versa, as it can be observed in TB4, for example. This is to be expected, as it is logical when an option is considered more strongly a barrier then it is less easily considered to be a moderate barrier.

Figure 10



Regarding the findings, the Figure above shows that TB5, TB6, and TB7 are the most pronounced barriers under the 'Important' choice (blue line). The green line, representing the 'Very important' choice, can indicate –in combination with the blue line– more clearly the most pronounced barriers by following its spikes. Therefore, we can conclude that the two most pronounced technological barriers for the transition of plastic value chains to a new plastics economy are the following three, in order of significance:

1. Recycling is a challenge for certain plastic materials (e.g. LD polymer-based films, composite materials, thermoset polymers) (TB5).

2. Lack of sorting and/or recycling technologies for treating contaminated post-consumer plastics (TB6).
3. Plastic recycling processes and technologies are not mature/efficient enough (TB1).

On the other hand, the least selected option as barriers was TB4:

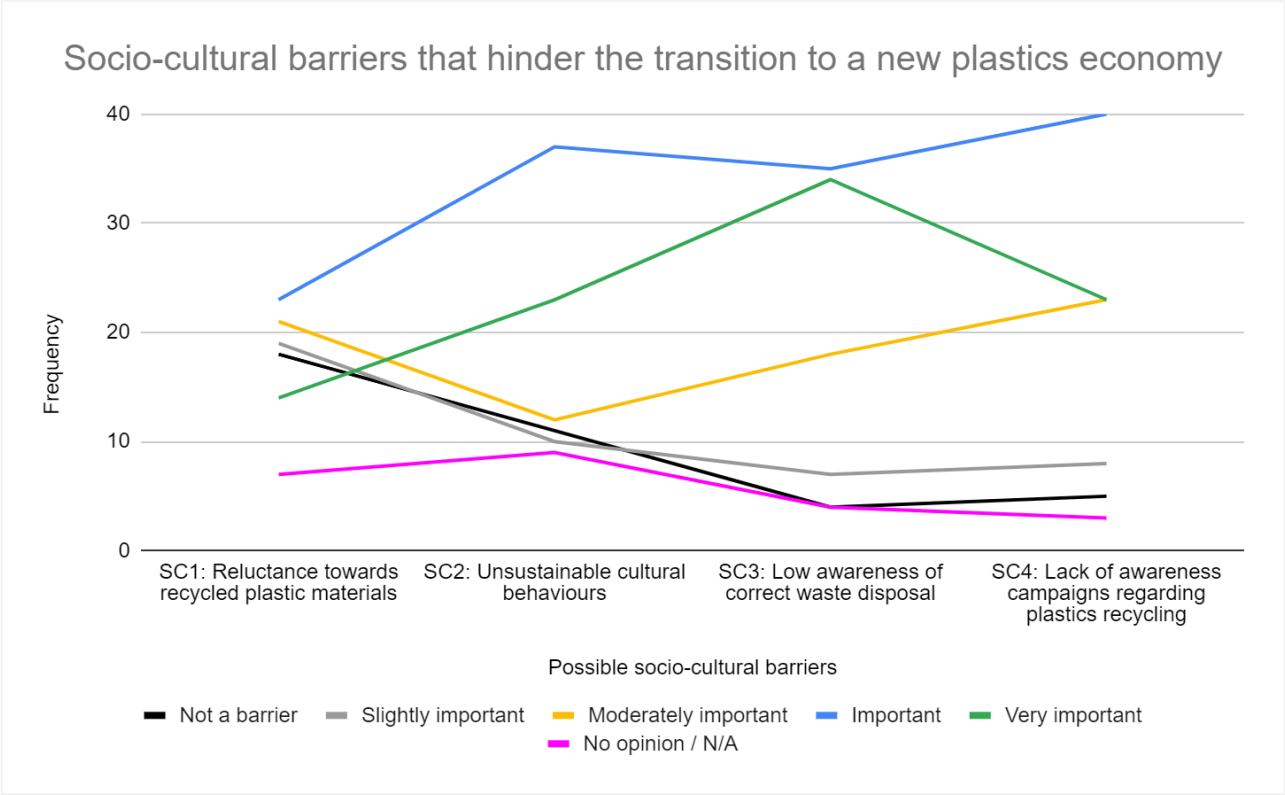
1. Incompatibility of recycled plastics with product manufacturing process (TB4).

5.2.5 Socio-cultural barriers

Stakeholders were presented with four different statements and were called to rank them as a barrier or not by selecting one of the following answers: a) Not a barrier, b) Slightly Important, c) Moderately Important, d) Important, e) Very Important, f) No opinion / N/A. The six statements, presented as possible socio-cultural barriers, were the following:

1. The public is reluctant towards recycled plastic materials (SC1).
2. There are unsustainable cultural behaviours that delay the phasing out of plastics (SC2).
3. The public has low awareness of correct waste disposal (SC3).
4. Lack of awareness campaigns regarding plastics recycling (SC4).

Figure 11



Data analysis, depicted in the Figure above, shows that in general, most respondents considered socio-cultural barriers to be crucial for the shift to a new type of circular economy in the plastics value chains. This is demonstrated by the fact that all options were ranked as important or very important barriers apart from one (SC1). Regarding the findings, it is clear from the Figure above that SC3 and secondarily SC4 and SC2 are the most pronounced barriers. The green line, representing the 'Very important' choice, can indicate –in combination with the blue line– very clearly in this Figure the most pronounced barriers. Therefore, we can

conclude that the three most pronounced socio-cultural barriers for the transition of plastic value chains to a new plastics economy are the following, in order of significance:

1. The public has low awareness of correct waste disposal (SC3).
2. There are unsustainable cultural behaviours that delay the phasing out of plastics (SC2).
3. Lack of awareness campaigns regarding plastics recycling (SC4).

5.3 Public opinion (survey objective 3)

Public awareness is paramount for the successful transition to a new plastics economy. The data that follow in the next two sections show that all partners have ongoing information and awareness campaigns in their territories that address plastic waste, pollution, and sustainable lifestyle changes. Also, it is important to note that all public opinion surveys conducted in PLASTECO territories, regionally or nationally, present a public that is overwhelmingly in favour of stricter bans and changes regarding plastic waste, especially in the issue of plastic packaging.

5.3.1 Information & awareness campaigns

In Questionnaire A, project partners were called to respond to the question: "**Are there information campaigns in your territory regarding plastics recycling/phasing out plastics?**" As it was expected, all partners responded positively. Awareness campaigns and activities as well as clean-up events are taking place throughout the partnership regions and are organised by public authorities as well as civil society actors.

Also, partners were asked to document and provide details for one information campaign in their territory, preferably the one with the most impact. The table below presents their answers:

Table 3

Information campaign with the most impact in each PLASTECO territory	
Rethymno	"I can make it without plastics" was the central message of the targeted information campaign about the reduction of disposable plastic use, coordinated by the Network for Collaboration on the Marine Environment and taking place also in the Rethymno region. The main aim of the campaign was to raise public awareness about the damage caused to the marine environment due to the use of single-use plastics (especially straws and plastic bags). In the context of the campaign, reusable, and environmentally friendly alternatives were proposed and promoted as solutions to the problem. A variety of dissemination activities were conducted and dissemination materials were produced, such as information videos, social media promotion campaigns, cleaning beaches, and information/raise awareness posters. More info: https://diktyogiatithalassa.gr/καμπανια-επικοινωνιασ/
Lombardy	Concrete actions to make the environment greener and more sustainable development are one of the focus of the strategic actions of the Lombardy Region. In this challenge, the Body has chosen to also involve employees with an awareness campaign that aims to trigger positive micro-actions and their dissemination in daily practice. To this end, the break areas and common spaces of Palazzo Lombardia welcome the photographic exhibition widespread entitled 'Contaminations'. The works created by the artist Mandy Barker, a British photographer who has been researching pollution in the seas for decades, aesthetically reinterpreting plastic pollution and lead the viewer to a profound reflection on what it means to consume less and more consciously.

Information campaign with the most impact in each PLASTECO territory	
	Furthermore, drinking water dispensers have been positioned in the break areas of the regional building where each employee can stock up, avoiding the use of disposable plastic bottles. This action is supported by a communication campaign to the public. More info: https://www.regione.lombardia.it/wps/portal/istituzionale/HP/DettaglioRedazionale/istituzione/attivita-istituzionali/red-contaminazioni-plastica-consapevole
Styria	"It's all around!" ("Rund geht's!") is an initiative of the Austrian waste industry to raise awareness that waste is a resource for reuse and recycling. The state of Styria also supports this initiative. As part of the campaign, the diverse possibilities and ways are brought up in front of the curtain of how new and innovative products are created from supposed waste. One of the 9 categories is dedicated to the topic of plastics. An innovative reach out campaign was used in Graz to reach consumers. The main message of the campaign was that waste can be valuable as secondary raw material. Through recycling, plastic can found new life in more than one product. And so the old yogurt cup can, for example, supply the raw material for the high-heeled shoe in a women's shoe. More info: https://www.rundgehts.at https://www.abfallwirtschaft.steiermark.at/cms/beitrag/12584621/152084019/2
SZREDA	"Bottle Caps for Future" is a campaign set up by Lazar Radkov and Martina Iordanova to collect as many bottle caps as possible to buy new incubators and later to donate them in hospitals in small towns all around Bulgaria. "Bottle Caps for Future" is one of the fastest spreading campaigns among Bulgaria and up to now 140 000 tons of plastics caps were collected. The campaign became popular because people are more likely to participate in voluntary activities which result can be seen by everyone and seeing premature babies have a new chance to live is more than satisfying. The campaign takes place every six months and up to now they were four big meetings of collecting bottle caps, but if a citizen is not able to keep the bottle caps at home, there are collecting stations in some cities and towns. More info: https://www.facebook.com/kapachkizabudeshte/
UCB	"Clean is in!" is an anti-littering campaign and a yearly clean-up event organised by the city of Augsburg. The campaign aims to sustainably raise awareness and mobilise the citizens of Augsburg to actively participate in the environmental protection of their public space. Many citizens of Augsburg volunteer for keeping the city clean. The city of Augsburg, with its waste management and city cleaning company and its office for green spaces, ensures cleanliness in public spaces. However, a city can only be kept clean in the long term if all citizens help -primarily by not inadvertently disposing of waste in the landscape. Also, The "Forum Plastikfreies Augsburg" wants to make lifestyle changes for more sustainable consumption patterns. The forum raises awareness among citizens, businesses and farmers in Augsburg for the ecological and health consequences of the waste society. It wants to ensure that plastic waste is avoided and that sustainable and environmentally-friendly solutions for plastic products are found and used. The "Forum plastikfreies Augsburg" organises monthly meetings (so-called "Stammtische") and participants talk

Information campaign with the most impact in each PLASTECO territory	
	about a different topic, such as plastic-free cleaning. There are also lectures and workshops that provide information on how households and companies can become more plastic-free More info: http://sauber-ist-in.augsburg.de/index.php?id=32607 http://plastikfreies-augsburg.de/
AURA-EE	The Metropolitan Authority of Lyon "Greater Lyon" has an ongoing advertising campaign to raise awareness among residents on the change in sorting instructions for packaging. Also, since January 2020, Greater Lyon has extended the sorting instructions, which means that from now on all domestic packaging and papers have to be sorted. To disseminate this sorting practice, Greater Lyon has mobilised several complementary communication tools: • dissemination of information with clear communication media: • an information relay via a blog, which also disseminates the main communication media • appearances on the main regional TV channel in France • a communication on different local newspapers • an explanatory video posted on the website of the metropolis of Lyon • a web page dedicated to FAQs listed on the Facebook page of Greater Lyon, supplemented by a web page with the main questions people ask about sorting waste in general. More info: https://www.grandlyon.com/services/bien-trier-ses-dechets.html https://blogs.grandlyon.com/developpementdurable/2020/01/22/de-nouvelles-consignes-de-tri-prenez-en -knowledge/
ADR-BI	The "After Us is up to Us to clean up" campaign is implemented in partnership by Coca-Cola Company HBC Romania, the City Hall of the 3rd District in Bucharest (Department of Sanitation), and Green Point Management organisation. Throughout this campaign, in February 2019, 30 Big Belly type smart containers (15 for recyclable waste and 15 for other municipal waste) were installed in the central area of the Bucharest (Unirii Square - University Square), as part of the program to encourage selective collection. In less than three months, from the beginning of February until the middle of April 2019, through the Big Belly network, 8.4 tons of recyclable materials were collected in the 15 containers dedicated to the collection of recyclable waste, this volume representing 64% of the total volume of waste collected in the Big Belly containers. Also, almost 80% of the materials disposed of in the recyclable waste containers complied with the norms in force, which shows that such an infrastructure motivates the consumers to get involved in the selective collection initiatives. A platform (https://dupanoi.ro/) brings together all the social responsibility projects carried out by Coca-Cola HBC in Romania. On this platform, a "Recycling map" is also available (www.hartareciclarii.ro), an interactive and educational platform for locating the points of selective collection of recyclable waste in Romania. The Recycling Map Platform is a project of the ViitorPlus Association, developed in partnership with the Coca-Cola HBC Romania company, being included in the education campaign for selective collection "After Us is up to Us to clean up". At the same time, the Recycling Map benefits from the support of the

Information campaign with the most impact in each PLASTECO territory	
	Ministry of the Environment and has an educational component also outside the virtual environment, financed through European funds, within the project "No planet B". More info: https://dupanoi.ro/dupa-noi-strangem-tot-noi/ https://youtu.be/LKQoQIb2gFU)
Baltic Coasts	Information campaigns are provided by EPR schemes every year. Each year they have to organize at least 4 public awareness-raising activities. The two most important ones are: 1. The campaign “My Sea”, launched by the Foundation for Environmental Education (Vides izglītības fonds) in 2012, is a successful example of reducing plastic waste in the coastal area. The campaign was launched to raise public awareness on the problem of marine pollutant waste. The campaign is implemented every year in cooperation with a wide range of partners in Latvia and other countries – public administration institutions, municipalities, NGOs, international institutions, research institutes, and active citizens. The campaign has gained recognition mainly through the annual Green Expedition, an initiative opened to everyone interested, and full of educational activities addressed to a diverse public that takes place along the entire 500-kilometer coastline of the Baltic Sea in Latvia. The public is further informed through the publication of the results of a campaign study on the situation of marine pollutant waste on the Latvian coast. Alongside these activities, the campaign provides data analysis, advocacy, and suggestions for future improvements in reducing marine pollution, following the UN Environmental Programme methodology. The campaign addresses the Latvian public by informing coastal visitors about the sources of marine pollutant waste, especially plastics, and its impact on the fragile Baltic Sea ecosystem. The campaign “My Sea” has been highly acclaimed nationally and internationally, receiving prestigious awards such as the Environmental Science Award (2012), the Latvian Society of Physicians Annual Health Award (2016), the Energy Globe Award Latvia (2017), and the International Baltic Sea Fund Award (2018). 2. The social campaign “Save life. Sort wastes” (“Izglāb dzīvību. Šķiro atkritumus”) took place in 2018 and was organized by the Green belt (Zaļā josta), an association founded in 2002 that offers consultancy services on the collection and recycling of used packaging. Moreover, the company carries out education and awareness-raising activities addressed to the whole society. The campaign aimed at encouraging the public opinion to think about the consequences of human actions regarding waste management and to become more involved in waste sorting. The campaign was carried out through outdoor advertisements, to sensitize the public opinion on the harmful effects of waste on wildlife and to make people more aware of the benefit that recycling brings, both to obtain valuable secondary raw materials, and to save natural and economic resources. In particular, the campaign focused on the duty to protect animals from waste diet and sea animals from entanglement and on the role that the society can play in this respect. The threat of plastic bags has been especially highlighted. In Latvia indeed an estimation of 3,000 tons of plastic bags is used every year (Green belt / Zaļā josta, 2016). More info about the campaign “My Sea”:

Information campaign with the most impact in each PLASTECO territory	
	http://www.manajura.lv/lv/par-kampanu/ https://www.facebook.com/tirajuravieno/ More info about the campaign "Save life. Sort wastes": http://www.zalajosta.lv/lv/zala-josta-riko-socialu-kampanu-izglab-dzivibu-skiro-atkritumus

5.3.2 Findings on public opinion

In the final part of Questionnaire A, project partners were asked to report the key findings of surveys conducted in their territories, or countries if relevant surveys were not available, regarding the public's opinion on plastic waste. The result was a wealth of evidence from various sources ranging from Eurobarometer data to smaller scale surveys and opinion polls organised by public authorities as well as civil society actors such as environmental NGOs. The following table summarises the results of each partner:

Table 4

Summary of key findings on plastic waste in PLASTECO territories	
Rethymno	Greenpeace conducted an online opinion survey about plastic recycling from May to September 2019. It is noticeable that 73% of the participants (6.631 in total) believe that the most important contribution of the citizens is recycling and half of them declare that recyclability or not of a product affects considerably their purchase habits. Besides, the survey results highlighted the problem of lack of knowledge about the operation of the recycling system in Greece, since only a 9.4% of the participants recognise the right meaning of the Green Dot sign in the product packing (which demonstrates that the product's company is involved in an alternative waste management system). The Special Eurobarometer public opinion survey on the environment in the 28 European Union countries was conducted between September and October 2017 with 27.881 face-to-face interviews. Regarding the impact of plastic products in Greece, the vast majority (86%) of Greek respondents agree that they are worried about the impact of everyday products made of plastic on their health. Also, the percentage of worries about the impact on the environment follows the same trend and reaches 94%. Remarkably, Greece reached the second-highest percentage overall (50%) in the "totally agree" answers in the question about the impact of plastic products on health.
Lombardy	The Censis survey, commissioned by Corepla, the National Consortium for the collection, recycling and recovery of plastic packaging, aimed to document the Italians' thoughts on plastic and the perception of the value of recycling. It was carried out on a representative sample of 1000 Italian citizens who were given a structured questionnaire that examines the different sectors in which plastic is applied. According to the data collected: • 96.6% of Italians consider plastic a fundamental material for modern life. However, if we move onto the reference sample and consider graduates, the percentage is almost a percentage point higher, 97.3%, and rises to two points higher in the case of millennials. Only 3.4% of respondents do not consider it a fundamental material. Also, about 46.5% of it considers plastic to be indispensable in the packaging sector, considering this material

Summary of key findings on plastic waste in PLASTECO territories	
	irreplaceable for the wide range of functions that packaging performs: treatment, conservation, protection, storage, and transport of products. • 40.6% of the sample believe that the food sector is the one that expresses the greatest need for it; for 33.8%, instead, household items are the most involved merchandise. Still, according to the perceptions of 29.2% of the sample, the technological sector is the one for which the contribution of plastic was most important; in this sense, the reference is directly to the creation of plastic components, a choice that has made the devices lighter, more colorful and with reduced energy impact. • The abandonment of plastic waste in the environment is perceived by Italians as incorrect conduct from all points of view, as it doubly damages the environment by not allowing the recycling and reuse of the material. • 96.4% of Italians are aware that plastic can be recycled for the creation of new materials and only 3.6% of respondents are unaware that plastic is recyclable. • Compared to the usefulness perceived by Italians of the practice of recycling, 74% of the interviewees consider this practice useful since it allows the reuse of the material and counteracts the pollution consequent to the abandonment of the waste. For 16.3% of the sample, recycling to be adequately exploited as potential should be promoted by all citizens and businesses, while it is completely useless for 9% of the interviewees.
Styria	The federal state of Styria has not conducted any public-opinion surveys on plastic waste in recent years. However, there have been Austria-wide surveys conducted by various organizations. One of these is that of "Global 2000", which was reported on in the regional newspaper "Kleine Zeitung" of 6.6.2019 as follows: • Plastic bags are banned in Austria from January 2020. 59% stated in the survey that they would like further bans. The same number of people spoke out in favour of a ban on microplastics in cosmetics and cleaning agents across the EU. • More than half of Austrians were in favour of higher penalties for companies that dispose of plastic waste in the environment. After all, 54% want manufacturers to have a legal obligation to bring durable, repairable, and reusable products to the market. • 51% voted for the promotion of reusable packaging. In general, the survey shows that many people are fed up with short-lived plastic disposable products and want more sustainable forms of consumption.
UCB	A survey was conducted by the city of Augsburg on different aspects of waste management, including some questions on waste separation, in 2005. Its key findings are: • 95,3% of the people answering the survey separate their waste most of the time. • Almost all (95,3%) vote for an admonition when public places are polluted by "waste / bottles / Packaging waste" by somebody. A penalty was requested by 83,5% of the respondents.

Summary of key findings on plastic waste in PLASTECO territories	
	In addition, a survey on the national level (Germany) on the regulation of plastic consumption in 2019 showed that: • 84% of the respondents requested the prohibition of even more single-use plastic products. • 92% say they wish that the German government supports returnable packaging. • 93% requested clear labeling of products that contain microplastics. • 91% would like to see a producer's obligation on durable, repairable, and recyclable products on the market.
AURA-EE	A national survey, conducted by a specialized organization (IFOP) for WWF France and entitled "French people and the recycling of plastic products and packaging" was conducted with 1,004 people in November 2019. The results of this survey show that: • 85% of French people are in favour of banning single-use plastic products and packaging and • 88% are in favour of banning non-recyclable plastic products and packaging. • A comparable proportion of French people (88%) also wish to set up a deposit system allowing the reuse of bottles and packaging.
ADR-BI	The project "Romania Recycles", initiated by the Green Institute Association, conducted a survey within the framework of promoting the practices of selective collection of recyclable waste. The survey was conducted online during April-May 2017, on 249 respondents. The study is exploratory and has no claim to representativeness. The research data however is illustrative for the general attitude of the urban population regarding the issue of collection selective waste. Some of its key findings are: • Among the aspects that contribute to the reduced level of waste recycling in Romania were mentioned: people that recycle do not have any financial advantage for doing so (32.6% total agreement), the state is less concerned about the recycling problem (87% total agreement), people are too little informed about the importance of recycling (64,6% total agreement), citizens are too little preoccupied about environment matters (61,7% total agreement); • Plastic is selectively collected systematically (57,1%). • The biggest part of household waste collected selectively is plastic (61,2%). • People do not recycle as much mostly because they do not have any collecting point closer to home (72,9%) • Respondents agreed as solutions to stimulate recycling: o Hypermarkets should be required to have selective collection centres - 89,6%. o Each building should have special containers for selective waste collection - 79,6%. o People who do not recycle should pay a special tax on waste - 43,8%. "What Romanians believe about separation and packaging waste recycling?" was a survey realised by IMAS Marketing and Surveys at the request of Eco-Rom Ambalaje The survey was conducted by telephone calls during September 2013 on 1010

Summary of key findings on plastic waste in PLASTECO territories	
	respondents, representative for the population with age over 18 years old across Romania. Its key findings are: • The level of information on separation and recycling is increasing. • The access of the Romanians to the separate collection service is easier. • Romanians want everyone to be educated to separate and the separated collection services to be improved. • The number of people separating waste increased significantly in the last two years. • 60% of the Romanians declare that they select their household waste before disposal.
Baltic Coasts	Several surveys have been conducted during the last years to poll Latvia's public opinion attitude on waste management. For example, the "2014 Public opinion survey on waste sorting" shows the great importance given to waste sorting in Latvia already in 2014. A public opinion survey on waste sorting was conducted in March 2014 by the research center SKDS on behalf of the Eco Baltia group in the form of direct personal investigation. During the study, 1000 permanent residents of Latvia aged 18 to 74 were interviewed. According to the study more than a third (37%) of Latvia's permanent residents sorted waste daily in 2014. The following age ranges were found to be the most active in sorting waste: 45-54 (44%) and 35-44 (42%). Moreover, two thirds (64%) of the population declared that they would be ready to sort waste if separate collection (sorting) containers were available near the place of residence. This shows that the percentage of residents sorting waste would significantly increase if more waste sorting containers were available. According to the survey's 2014 press release, continuous investment is being made in the construction of new sorting points and sites, as waste sorting and recycling is the most cost-effective and sustainable way to reduce landfill. The study found indeed that 59% of the population who declared to not sort waste (i.e. 63%) was discouraged by the lack of available sorting containers. Finally, the reason why waste should be sorted and the benefits that sorting brings were unclear to only 7% of the population in 2014 according to the survey. Another public opinion survey, in 2019, is more recent and focuses on Latvian residents' attitudes on waste management. It was conducted within the framework of the "DDB Brand Capital" survey, conducted by "RAIT Custom Research Baltic" during summer 2019. Almost 2,816 people aged 15 to 74 were interviewed in the Baltic States. During the study, 996 inhabitants were surveyed in Latvia, 1000 in Lithuania, and 820 in Estonia. The number of waste sorters among the population of the Baltic States continues to grow if compared to previous years' results. According to the survey data, 83% of Latvians believe that sorting waste is important. Although this figure has grown by only 2% in four years (81% in 2016), there is a growing number of people who sort waste. In 2016 indeed 50% of the interviewed declared to sort waste, while in 2019 the percentage increases of 10 percentage points registering a 60%.

Summary of key findings on plastic waste in PLASTECO territories

When asked which brand of products they prefer, respondents show to pay more and more attention to various aspects of green-thinking. 40% of Latvians indicates that they would be willing to pay more for goods whose packaging can be recycled or reused, and 62% have expressed the willingness to pay more for a product in which all raw materials are natural. Finally, 53% of Latvia respondents prefer brands that stand for a clean environment.

According to the director of the Latvian Green Dot, Zaļais Punkts, the public has begun to look more critically at whether the words "bio" and "eco" appear only on the product label, or whether it embodies the overall business strategy of a particular company. Thanks to wide information and campaigns ran by companies and organizations, citizens are becoming increasingly aware of what makes a product environmentally friendly. Moreover, there is a growing number of people who pay attention to how much green a product or good is and what will happen to it after being used. At the same time, it is very important to create conditions for entrepreneurs to be more and more motivated to offer sustainable products and recyclable packaging.

Despite the efforts made to reduce the number of different packaging - boxes, bags, dishes, etc. – the consumption is similar in all Baltic countries (close to 70% in Latvia and Lithuania, 72% in Estonia). However, sustainability lies not only in the packaging but also in the company's level of responsibility on resource use and management. Several companies in Latvia received an eco-friendly rating such as the company "Latvian State Forests", the fuel trader “Neste Latvija”, and other brands (Venden -water brand-, Lido -food products brand-, and Everest -water brand-).

6 Summary of findings & discussion

Policy readiness of PLASTECO territories

Most project partners have the following measures and initiatives in place to address and manage plastic waste in their territories[13]:

1. Awareness campaigns and/or clean-up activities.
2. Active EPR (Extended Producer Responsibility) schemes.
3. Economic instruments (e.g. taxes) that reward reuse and recycling of plastics over landfilling and incineration.
4. Eradicated illegal and non-compliant landfills.

These results show that most PLASTECO territories are in the right direction. However, they are still in the beginning of the transition to a new plastics economy, as most of the measures they have in place address the problem in its most fundamental level (avoiding landfilling and having in place alternative systems for waste management), but they do not address it in its entirety. The adoption of circular economy models by plastic value chains requires more advanced and specific measures. Many territories, as data showed, have not implemented some or any of the following measures, which play a significant role in the transition to a new plastics economy:

1. Public procurement guidelines that favour reusable and recycled plastics and/or promote alternatives to single-use plastics.
2. Deposit refund systems (e.g. for beverage containers).
3. Standards/protocols for recycled plastics.

Regarding the most effective measures to phase out plastics, project partners prioritised the following ones:

1. Measures that reduce the use of single-use plastic items, such as shopping bags.
2. The production of non-recyclable plastics should be substituted for recyclable materials and used as an alternative when appropriate.

Regarding the most effective measures to curb plastic pollution, project partners considered the following as the most important:

1. Encouraging alternatives to plastic bags or other plastic packaging.
2. Intensification of communication campaigns on plastic waste addressed to the public.

[13] For 1 and 2, 7 partners out of 8 have these measures in place; for 3 and 4, 6 and 5 partners respectively have these measures in place.

Barriers for the transition to a new plastics economy

Stakeholders from plastics value chains in PLASTECO regions indicated the following barriers as the ones that hinder the most the transition to a new plastics economy:

Table 5

Economic	Legislative
1. Lack of financial support mechanisms for scaling up circular economy models in the plastics value chain, especially for SMEs. 2. Lack of awareness of end-users on recycled plastics. 3. Public financial incentives for plastics recycling and their uptake are missing.	1. Existing safety regulations (e.g. for food packaging or food contact) require rigid certification hindering the use of recycled plastics. 2. Eco-design standards and guidelines are missing.
Technological	**Socio-cultural**
1. Recycling is a challenge for certain plastic materials (e.g. LD polymer-based films, composite materials, thermoset polymers). 2. Lack of sorting and/or recycling technologies for treating contaminated post-consumer plastics. 3. Plastic recycling processes and technologies are not mature / efficient enough.	1. The public has low awareness of correct waste disposal. 2. There are unsustainable cultural behaviours that delay the phasing out of plastics. 3. Lack of awareness campaigns regarding plastics recycling.

The findings from stakeholders are in line with the barriers documented in the relevant literature. It is risky for many businesses, for example, to transition to circular economy models without financial support mechanisms to aid them; strict or missing industry-standard regulations in combination with the challenges in recycling contaminated plastics or from more streams than one add to the problem. Correct disposal of post-consumer plastics is low, according to stakeholders, making the transition to a new plastics economy a multi-factor issue that needs interventions across the whole life-cycle of plastics in value chains.

Public opinion regarding plastic waste in PLASTECO territories

As public awareness is paramount for the successful transition to a new plastics economy, data showed that all partners have ongoing information and awareness campaigns in their territories that address plastic waste, pollution, and sustainable lifestyle changes. It is important to note that all public opinion surveys conducted in PLASTECO territories, regionally or nationally, present a public that is overwhelmingly in favour of stricter bans and changes regarding plastic waste, especially in the issue of plastic packaging.

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ANNEX A: Questionnaire A

This questionnaire is for demonstration purposes only; it was filled-in online, in the EU Survey platform, following this link: (https://ec.europa.eu/eusurvey/runner/PLASTECO11A)

Questionnaire for public authorities

Contact information

Who is filling-in this questionnaire?

Name:
Organisation:
Region:
Country:
E-mail:

Section 1: Measures for new plastics economy

The following measures are proposed by EC[14] to lead EU regions to the new plastics economy; this section aims to assess the level of readiness of your territory according to these EC guidelines.

Q1: What of the following measures does your territory have in place? (Multiple choice question).

☐	Public procurement guidelines that favour reusable and recycled plastics and/or promote alternatives to single-use plastics.
☐	Economic instruments (e.g. taxes) that reward reuse and recycling of plastics over landfilling and incineration.
☐	Innovative waste management methods (e.g. automated waste collection, route optimisation) that are used for the separate collection of plastics.
☐	EPR (Extended Producer Responsibility) schemes.
☐	Deposit refund systems (e.g. for beverage containers).
☐	Voluntary agreements/commitments among public authorities and the plastics value chain stakeholders.
☐	Dialogue and cooperation platforms (i.e. institutional, not ad hoc) between public authorities and stakeholders from the plastics value chain.
☐	Awareness campaigns and/or clean-up activities regarding plastic littering that have been/are being organised.

[14] A European Strategy for Plastics in a Circular Economy, COM/2018/028 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN

☐	Illegal and non-compliant landfills that have been eradicated.
☐	Standards/protocols for recycled plastics.
☐	Other(s): (please specify):

Which of the options above do you consider will have the most positive impact in the transition towards the new plastics economy? Please explain your choice (max 300 characters):

Click here to enter text.

Q2: What is the option you consider the most effective for phasing out plastic waste in your territory?

Please rank the following options in order of importance, from 1 to 8: "1" signifies the most preferred one, and "8" the least preferred.

Click here to enter text.	More collaborative initiatives between public authorities and the plastics value chain (e.g. voluntary agreements) are needed to limit plastic waste and increase recycling.
Click here to enter text.	Better information should be provided to the public about which plastics are recyclable.
Click here to enter text.	The production of non-recyclable plastics should be stopped and recyclable materials used as an alternative.
Click here to enter text.	Measures should be taken to reduce the use of single-use plastic items, such as shopping bags.
Click here to enter text.	Disposing of plastic waste into landfill sites should be prohibited.
Click here to enter text.	The use of micro plastic particles in consumer cosmetics and similar products should be forbidden.
Click here to enter text.	Other(s) (please specify here):

Please explain the choice you ranked with "1" (max 600 characters):

Click here to enter text.

Q3: What is the option you consider the most effective for curbing plastic pollution in your territory?

Please rank the following options in order of importance, from 1 to 8: "1" signifies the most preferred one, and "8" the least preferred.

Click here to enter text.	Ensuring wider availability of litter bins for plastics by waste management authorities.
Click here to enter text.	Better enforcement of existing anti-litter laws against the public.
Click here to enter text.	Encouraging alternatives to plastic bags or other plastic packaging.

Click here to enter text.	Intensification of communication campaigns on plastic waste addressed to the public.
Click here to enter text.	Increasing and encouraging the recycling of waste.
Click here to enter text.	Financial participation by producers of plastics in funding the phasing out of plastics (e.g. EPR schemes).
Click here to enter text.	Organisation of clean-up events.
Click here to enter text.	Other(s) (please specify here):

Please explain the choice you ranked with "1" (max 600 characters):

Click here to enter text.

Section 2: Public's awareness regarding phasing out plastics

This section aims to assess the readiness of the public in your territory to transition to a new plastics economy. To answer the following questions, you should conduct desk research on the views of the public in your territory/country.

Q4: Are there information campaigns in your territory regarding plastics recycling/phasing out plastics?

☐ Yes ☐ No

***If "Yes", please describe one of them (1), preferably the campaign that conducted the most dissemination activities; please provide relevant links:**

Click here to enter text.

Q5: Find surveys (ideally two) conducted in your territory regarding the public's opinion on plastic waste; please provide the links where you found the surveys and summarise their key findings.

Surveys:

Links: Click here to enter text.

Key findings: Click here to enter text.

ANNEX B: Questionnaire B

This questionnaire is for demonstration purposes only; it was filled-in online, in the EU Survey platform, following this link: https://ec.europa.eu/eusurvey/runner/PLASTECO11B

Questionnaire for stakeholders in the plastics value chain

Contact information

Who is filling-in this questionnaire?

Name:

Company / organisation:

Region:

Country:

E-mail:

What is your company's / organisation's role in the plastics value chain?

- ☐ Producer of plastics
- ☐ Converter
- ☐ Recycler
- ☐ R&D agency (incl. University)
- ☐ Consultancy services
- ☐ Other (please specify here):

Barriers for the new plastics economy

Below is a list of factors that could delay the transition of the plastics value chain to a new plastics economy; this section aims to identify the most prominent of them.

The factors have been categorised into four sections, for standardisation reasons: a) Economic, b) Legislative, c) Technological, and d) Socio-cultural.

Please rate how important or not is each factor below according to the following scale of classification:

- *1: "Not a barrier"*
- *2: "Slightly Important"*
- *3: "Moderately Important"*
- *4: "Important"*
- *5: "Very Important"*
- *"No opinion / N/A"*

	Barriers	1	2	3	4	5	N/A
Economic	Landfill disposal taxes (or similar financial schemes) for plastics are missing and/or are insufficient.	☐	☐	☐	☐	☐	☐

	Public financial incentives for plastics recycling and their uptake are missing.	☐	☐	☐	☐	☐	☐
	Lack of financial support mechanisms for scaling up circular economy models in the plastics value chain, especially for SMEs.	☐	☐	☐	☐	☐	☐
	High financial risk for plastics value chain for moving from linear to circular production processes.	☐	☐	☐	☐	☐	☐
	High costs of collecting, sorting and processing waste plastics.	☐	☐	☐	☐	☐	☐
	Resistance to change among product manufacturers.	☐	☐	☐	☐	☐	☐
	High quality plastics recycling is more costly to buy than virgin plastics.	☐	☐	☐	☐	☐	☐
	Recycled plastics have limited market applications.	☐	☐	☐	☐	☐	☐
	Recycled plastics have high transportation costs due to shortages in local markets.	☐	☐	☐	☐	☐	☐
	Lack of awareness of end-users on recycled plastics.	☐	☐	☐	☐	☐	☐
Legislative	The definitions for plastics waste (e.g. End-of-Waste criteria) are unclear.	☐	☐	☐	☐	☐	☐
	Recycled plastics are not harmonised with existing safety regulations.	☐	☐	☐	☐	☐	☐
	Existing safety regulations (e.g. for food packaging or food contact) require rigid certification hindering the use of recycled plastics.	☐	☐	☐	☐	☐	☐
	Recycling standards and guidelines for plastics are missing.	☐	☐	☐	☐	☐	☐
	Eco-design standards and guidelines are missing.	☐	☐	☐	☐	☐	☐

	Monitoring of plastics recycling is missing or is inadequate.	☐	☐	☐	☐	☐	☐
Technological	Plastic recycling processes and technologies are not mature / efficient enough.	☐	☐	☐	☐	☐	☐
	Lack of innovation on recycling plant technological processes.	☐	☐	☐	☐	☐	☐
	Current plastic-based recycling technologies produce low-level products.	☐	☐	☐	☐	☐	☐
	Incompatibility of recycled plastics with product manufacturing process.	☐	☐	☐	☐	☐	☐
	Recycling is a challenge for certain plastic materials (e.g. LD polimer-based films, composite materials, thermoset polymers)	☐	☐	☐	☐	☐	☐
	Lack of sorting and/or recycling technologies for treating contaminated post-consumer plastics.	☐	☐	☐	☐	☐	☐
Socio-cultural	The public is reluctant towards recycled plastic materials.	☐	☐	☐	☐	☐	☐
	There are unsustainable cultural behaviours that delay the phasing out of plastics.	☐	☐	☐	☐	☐	☐
	The public has low awareness on correct waste disposal.	☐	☐	☐	☐	☐	☐
	Lack of awareness campaigns regarding plastics recycling.	☐	☐	☐	☐	☐	☐