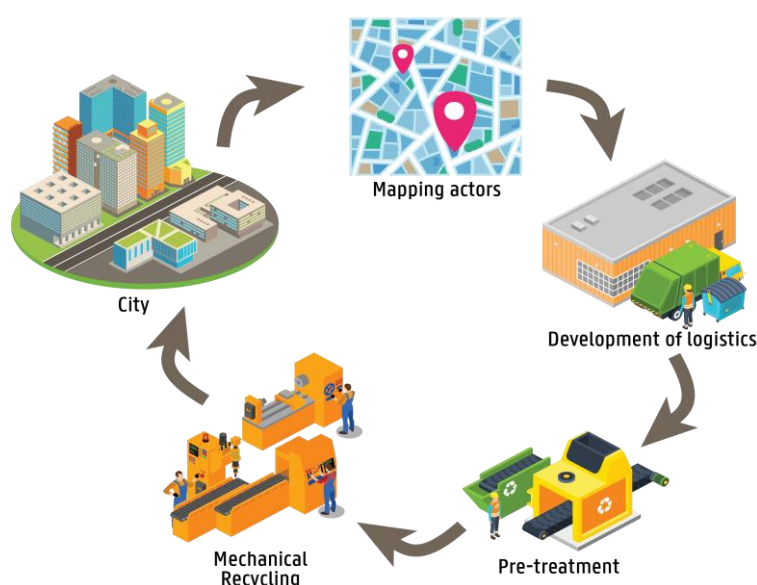# Replicable strategy to produce case-specific solutions for collection, sorting and reprocessing of waste plastic

Produced by the PlastiCity Consortium, January 2021

Executive Summary

Overview

This report outlines a strategy to produce solutions for the collection, sorting and reprocessing of commercial and industrial (C&I)[1] plastic waste in urban environments. The strategy has been developed by the consortium of the Interreg 2 Seas project "PlastiCity" and will be applied in test studies in four European cities over the course of the project.

The aim is to provide guidance for urban and regional policymakers and researchers to, first, understand the current situation regarding the production of C&I plastic waste in their regions. Second, guidance is given on how to engage with the regional actors of the plastic waste value chain and learn about their attitudes. Based on this knowledge, we provide suggestions for potential material testing and test collections of plastic waste, which will result in new logistics scenarios and new circular value chains that could be created. The main objective overall is to develop a circular network with local players throughout the plastic waste value chain that can form a so-called 'plastic hub', which will boost the local circular economy.

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[1] Commercial and industrial waste consists of dry waste generated by businesses, production units, bureaus and offices. It can contain a wide range of materials, from plastics, paper and cardboard to metals, wood, glass and organic materials.

Contents

1   Introduction

Plastic is our daily companion and we cannot imagine our life without it. As it is mostly made from a finite resource, it has value for recycling.

Sadly, plastic waste is polluting our oceans and landscapes, and so we want to transition towards a more sustainable, yet still economically viable, way to deal with our resources. Therefore, it is important to collect, reuse and recycle plastic waste to make sure it does not pollute our environment. A transition towards a more circular economy and increasing plastic waste recycling rates is the key action.

The European Union (EU) set up a European Strategy for Plastics in a Circular Economy in 2018 (European Commission, 2018), and established plastic recycling rate targets of 50% by 2025 and 55% by 2030 to enhance this transition. However, often the main focus lies on post-consumer plastic waste, which is broadly studied. Yet, plastic waste is also generated during the production of post-consumer goods, and also during many other applications and uses that do not end up in the post-consumer bins. This plastic waste is often eligible in terms of quality for mechanical recycling but does not find its way into an appropriate recycling system, and therefore we refer to it as 'lost plastics'.

The reasons for losing these plastics from the desired circular economy can vary, e.g. economic opportunities are not fully known/understood, collection logistics are not fully developed, sorting facilities are not well equipped, or stakeholders are not fully engaged, etc. Moreover, the composition of commercial and industrial (C&I)[2] plastic waste varies depending on the sector producing it and it is often collected by a complex private market – this is in stark contrast to household waste collection, which is often closely supervised by the municipalities/Local Authorities.

1.1   The PlastiCity Vision

The objective of the project is to develop replicable strategies and solutions to increase recycling rates in urban environments, from 20–30% to over 50%. This will be done by unlocking the use of 'lost plastics' as secondary resources from the urban environment, and thereby creating business activity and employment in the circular economy.

PlastiCity wants to find solutions to reuse and recycle plastic with C&I origin in urban environments by:

- developing technical strategies for (reverse) logistics and reprocessing
- inducing behavioural change and increasing the capacity, e.g. increasing knowledge, raising awareness, and encouraging collaboration and the long-term commitment of stakeholders,

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[2] Commercial and industrial waste consists of dry waste generated by businesses, production units, bureaus and offices. It can contain a wide range of materials, from plastics, paper and cardboard to metals, wood, glass and organic materials.

through urban platforms (UPs; an interactive digital environment, which can be linked to a physical recycling hub)

- creating new value chains and designing new products by unlocking the full potential of medium-sized actors (SME's, offices, retail, schools, etc.)
- developing a mobile recycling lab, which will be used to test the composition of post-use plastics and demonstrate the pre-treatment process to stakeholders.

PlastiCity focuses on finding new combinations of technical options and urban collaboration models. The project includes the development and demonstration of innovative sustainable logistics, linked to local 'lumping' strategies at plastic reuse and refinery hubs. We bring data and stakeholders together on UPs in a systematic way. PlastiCity is the first project in the 2 Seas area that is designed specifically to support the implementation of the European Strategy for Plastics in a Circular Economy (European Commission, 2018).

The project runs from 2019 until 2022 and is stimulated by a diverse consortium, with expertise on all parts of the plastic waste value chain in four European regions (Ghent in Belgium, The Hague in the Netherlands, Southend-on-Sea in the United Kingdom and Douai in France). More information on the development of these objectives can be found on the website http://www.PlastiCityProject.eu.

1.2 Structure of this report

This report is structured as shown below.

Section 1. The PlastiCity Vision: We begin by giving a brief introduction to the PlastiCity project.

Section 2. Policy and legislative context: Next, we look at the EU policy and legislation that influences the decision-making processes in the circular economy and plastic recycling.

Section 3. Strategy overview: One of the first steps of the PlastiCity project was mapping the quantities and qualities of waste (e.g. by making use of a mobile recycling lab). This section provides details of our methodology, and offers guidance to policymakers and researchers wishing to replicate the PlastiCity approach. This section is broken down as follows:

- **Subsection 3.1. Top-down analysis of current status:** In this section, we look at the development of a top-down analysis, which will enable the researcher to get an overall picture of the plastic recycling value chain.
- **Subsection 3.2. Identification of actors:** This section introduces the methods for identification of the actors in the plastic waste value chain and provides guidance for a rational selection of focus sectors.

- **Subsection 3.3. Mapping of actors:** Here, examples are given of how the actors can be mapped. We have demonstrated the mapping of actors in each region participating in the PlastiCity project.
- **Subsection 3.4. Surveying attitudes and behaviours of actors:** In this section, we describe how surveying work, based on the 'Theory of Planned Behaviour', can help to identify attitudes and behaviours.
- **Subsection 3.5. Insight into current situation of plastic waste flows in the C&I sector:** Next, we describe our methodology for the reverse material flow analysis and how this data can be verified through large-scale test collection.
- **Subsection 3.6. Lumping strategy:** At the heart of the PlastiCity strategy is 'lumping'. This means establishing which waste can be collected from specific sectors (and how it is source-separated) to achieve large quantities of high-quality waste (a secondary resource).
- **Subsection 3.7. Processing tests:** Here, common practices for plastic waste characterisation and processing tests are described. The knowledge gathered in the previous steps can be used to create new business cases by engaging actors.
- **Subsection 3.8. Engagement of actors:** In this section provides guidance on engaging with actors via workshops and developing business models.
- **Subsection 3.9. Changing the status quo:** Finally, in this section we look at the strategies and solutions that are being developed by the PlastiCity project, which aim to increase the recycling of plastics for high-end applications.

Section 4. Considerations for choosing a hub: In this section, we give advice on how to create a 'plastic hub' in a region and how to find the best location for it.

Section 5. Considerations for logistics: Next, we give guidance on how to develop logistics scenarios.

Section 6. Future work: Finally, this section summarises any future work that is required to complete this strategy.

2   Policy and legislative context

EU policy and legislation is highly influential and, as a consequence, plays an important role in the waste management and recycling practices in EU member states. In this section of the strategy, we look at how EU legislation influences the decision-making processes in the circular economy and plastic recycling industry.

2.1   EU legislation on waste

In the EU, it is estimated that 6 tonnes of waste per person is produced per year (European Commission Waste, 2020).The most significant sources of this waste are agriculture, construction, mining and household waste. Reuse and recycling schemes have improved considerably over the last decade, but large quantities of valuable materials, such as glass, wood, paper and plastic, are still lost as secondary raw materials.

For example, using data taken from the European Commission (European Commission Waste, 2020): In 2010, total waste production in the EU amounted to 2.5 billion tonnes. Of this total, only a limited – albeit increasing – share (36%) was recycled. The rest was either landfilled or used for energy recovery, of which some 600 million tonnes could have been reused or recycled. As a result, the EU increased its attention on waste prevention and management, and as part of the EU Circular Economy Action Plan – Closing the loop (European Environment Agency, 2015), several waste management directives were amended with a strengthened focus on the circular economy. The overarching goals of EU waste and circular economy policies and legislation are to reduce the amount of waste being produced, increase recycling rates and optimise the reuse of valuable materials.

In a circular economy, materials that can be reused as new raw materials are classified as 'secondary raw materials'. The European Commission provides further details on the classification of raw materials (European Commission Raw Materials, 2020), which may be of use when studying the circular economy.

On the same link (European Commission Raw Materials, 2020), the European Commission also discusses how it intends to develop EU-wide standards, so that industries aiming to use secondary raw materials are more certain of their quality: for example, the development of quality standards for secondary raw materials to increase the reuse of waste. The revised legislative proposals on waste establish more harmonised rules to determine whether a secondary raw material may no longer be legally considered 'waste', by clarifying the existing 'end-of-waste' rules.

2.1.1   Waste Framework Directive

The Waste Framework Directive (2008/98/EC) is the basis of EU legislation in the field of waste and it is another useful reference document as it defines the basic concepts related to waste. For example, it not only contains definitions of waste, recycling and recovery, but also explains when waste ceases

to be waste, and how to distinguish between waste and by-products. In addition, the directive establishes some basic principles for waste management.

The waste hierarchy, which is one of the main principles, is shown in Figure 1. It illustrates the preferential order of waste management, with prevention being most desirable, then preparation for reuse, recycling, energy recovery and, finally, disposal to landfill as the least desirable option.

Figure 1: The waste hierarchy
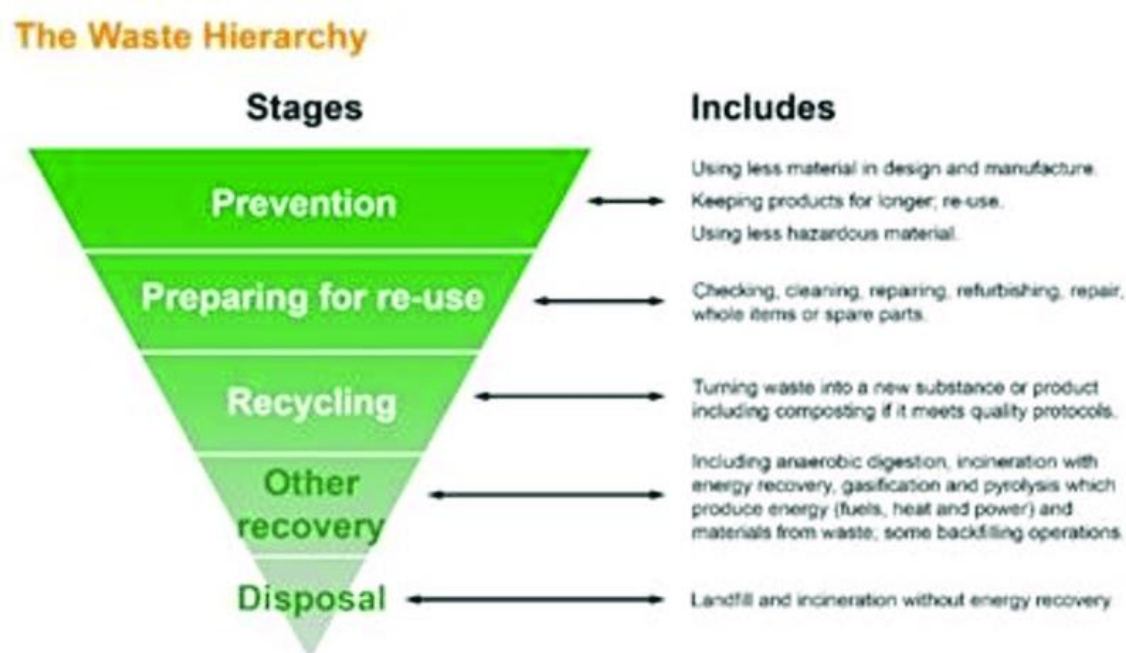
Source: (Atta and Bashir, 2017)

The directive requires that member states take steps to promote the following principles that deliver the best overall environmental outcome (Waste Framework Directive, 2008):

- **The polluter pays:** The costs of waste management are borne by the original waste producer, or by the current or the previous holders of the waste.
- **Protection of health and the environment:** Waste management must be carried out without risk to water, air, soil, flora and fauna, without causing noise or odour nuisance, and without damaging nature and landscape beauty.
- **Extended responsibility for producers:** This means that producers or importers are (partly) responsible for the waste management of the products that they place on the market.

2.1.2 Waste or product

Is post-use plastic a waste or a product? In the European Waste Framework Directive of 1975, (European Environment Agency, 1975) 'waste' is defined as "any substance or object that the holder disposes of, wants to dispose of or must dispose of". In addition to the concept of 'waste', in the guidelines titled "Waste or Product" (Ministry of Infrastructure and Water Management, 2015)two new provisions were introduced in 2008 to distinguish between waste and products (non-waste materials), namely 'by-products' and 'end-of-waste status' for the recovery of waste.

In some member states, the term 'continued use' has also been introduced in the "Waste or Product" guidelines. This concerns material that is released or created during or after the consumption or use phase of a product (including from the service sector, households and offices), such as waste electrical and electronic equipment, empty ink cartridges, and products that are returned to the producer after use.

The assessment of a waste or product must be made on a case-by-case basis, and be grounded on all the facts and circumstances specific to that case. An important role in assessing the facts and circumstances is whether the further use of a material is demonstrably certain, lawful and of sufficient quality.

In practice, it often appears that there is still a lack of clarity about the explanation and application of the term 'waste', and the conditions and criteria for 'by-products' and 'end-of-waste status'. An important reason for this is that there is no explicit explanation of what exactly 'discard' means. In addition, practice shows that initiators do not want the secondary raw materials they produce to be either labelled or legally as waste, due to the administrative burden of waste legislation and the economic risks associated with working with waste. The market, therefore, sees the waste status as an obstacle for circular initiatives and reuse.

2.1.3 EU policy on waste and the circular economy

In 2015, the European Commission adopted an ambitious Action Plan for the Circular Economy (European Commission, 2020), which includes measures to help stimulate Europe's transition towards a circular economy, boost global competitiveness, foster sustainable economic growth and generate new jobs.

The Action Plan for the Circular Economy establishes a concrete and ambitious programme of action, with measures covering the whole lifecycle – from production and consumption to waste management and the market for secondary raw materials – and revised legislative proposals on waste.

The revised legislative framework on waste (European Commission, 2018) entered into force in July 2018. It sets clear targets for the reduction of waste, and establishes an ambitious and credible long-term path for waste management and recycling.

Key elements of the revised waste proposal include (European Commission, 2018):
- A common EU target of recycling 65% of municipal waste by 2035.
- A common EU target of recycling 70% of packaging waste by 2030.
- There are also the following recycling targets for specific packaging materials:
  - Paper and cardboard: 85%
  - Ferrous metals: 80%
  - Aluminium: 60%
  - Glass: 75%
  - Plastic: 55%
  - Wood: 30%.
- A binding target of reducing landfill disposal to a maximum of 10% of municipal waste by 2035.
- The strengthening of separate collection obligations and extension to hazardous household waste (by end 2022), bio-waste (by end 2023) and textiles (by end 2025).
- The establishment of minimum requirements for extended producer responsibility schemes, to improve their governance and cost efficiency.

2.1.4 Packaging and plastics – EU legislation

Packaging is a product used for the containment, protection, loading, delivery and presentation of goods. Packaging waste can be harmful to the environment if not handled appropriately. Plastic waste falls under various European laws and regulations, such as the Waste Framework Directive (2008/98/EC), Packaging and Packaging Waste Directive (94/62/EC), and the Single-use Plastics Directive (2019/904).

2.1.4.1 Waste Framework Directive (2008/98/EC)

The Waste Framework Directive (2008/98/EC) obliges member states to collect plastic waste separately. Member states may deviate from this if, for example, separate collection does not yield the best environmental results, or if it is not technically or economically feasible (European Commission, 2008).

2.1.4.2 Packaging and Packaging Waste Directive (94/62/EC)

The European rules and objectives with regard to packaging and packaging waste are laid down in the Packaging Directive (Directive 94/62/EC) (European Commission, 1994). The directive was revised in 2018 (Directive 2018/852) (European Commission, 2018) to, among other things, limit litter and increasingly regulate plastics.

Under the Packaging Directive, member states must take measures to:

- Prevent the generation of packaging waste and limit the effects of packaging on the environment.
- Sustainably reduce the consumption of lightweight plastic carrier bags.
- Increase the share of reusable packaging and systems to reuse packaging in an environmentally friendly way. This can be done, for example, by using deposit schemes.
- Ensure that systems are in place to allow the take-back and/or collection of used packaging and/or packaging waste.
- Ensure that, by 31 December 2025, at least 65% by weight of all packaging waste is recycled. For 2030, this has been set at 70%.
- Ensure that, by 31 December 2025, the following minimum recycling targets (by weight) are met:
    - 50% for plastic
    - 25% for wood
    - 70% for ferrous metals
    - 50% for aluminium
    - 70% for glass
    - 75% for paper and cardboard.

2.1.4.3 Single-use Plastics Directive (2019/904)

The Single-use Plastics Directive (2019/904) promotes a sustainable and circular approach by regulating certain plastic products. For example, it introduces an EU-wide ban on single-use artificial products, such as cutlery, plates, stirrers and straws.

The Single-use Plastics Directive prescribes that member states must ensure (European Commission, 2019):
- a measurable quantitative reduction in the consumption of, among other things, drinking cups and the packaging of food intended for immediate consumption, by 2026 compared to 2022
- 90% of beverage bottles are recycled by 2029 (77% by 2025)
- beverage bottles consist of at least 30% recycled plastics by 2030
- disposable plastic products (such as wet wipes and tobacco products) are provided with a warning sticker or marking with information about the appropriate waste management options or disposal methods
- measures are taken to encourage responsible consumer behaviour
- consumers are made aware of reusable alternatives and of the impacts on the sewerage system of inappropriate disposal of waste from these single-use artificial products.

2.1.5 The European Plastics Pact

The European Plastics Pact is a voluntary agreement that was initiated in 2019 by the governments of the Netherlands and France. It now includes over 80 other organisations (governments, companies, NGOs and business associations) from across Europe. The Pact brings together governments and businesses within the European Economic Area to work together to form a common vision for the sustainable management of plastics. The central focus of the strategy is a shift towards the reuse and recycling of single-use plastic products and packaging (European Plastics Pact, 2019).

Pact members have committed to a set of ambitious targets for 2025. These include (Ellen Macarthur Foundation, 2017):

- Making all plastic packaging and single-use plastic products reusable where possible and – in all cases – recyclable.
- Reducing the need for virgin plastic products and packaging by at least 20%.
- Increasing the collection, sorting and recycling capacity for all plastics used in packaging and single-use products in participating countries by at least 25%.
- Boosting the use of recycled plastics as much as possible, with an average of at least 30% recycled plastics across single-use plastic products and packaging.

Members of the EU Plastics Pact meet regularly to share best practices and work together to develop solutions for some of the plastic challenges. This voluntary agreement has already had a huge impact.

2.2 National legislation on waste

At PlastiCity we recognise that it is important to understand the local policy and legislative context in our study areas. The following section summarises some of the highlights and variations in the national legislation of our four study regions. This information was gathered from the websites of national and local government, government agencies, the third sector and trade bodies.

2.2.1 The Netherlands

The Waste Framework Directive (2018/851) was revised in 2018 (European Commission, 2018). The revised directive also obligates member states to draw up plans for waste management and prevention, called the National Waste Management Plan (LAP) in the Netherlands. These plans must be revised every six years.

Dutch waste regulations are laid down in Chapter 10 of the Environmental Management Act. Many subjects are further elaborated in General Administrative Measures, provincial environmental ordinances or municipal waste ordinances.

2.2.1.1 *National Waste Management Plan*

In the Netherlands, the National Waste Management Plan (LAP) describes the objectives, principles and organisation of Dutch waste policy (Ministry of Infrastructure and Water Management, 2017).

The third plan (LAP3) entered into force in 2017, with the goal of realising and stimulating a circular economy. LAP3 describes definitions, concepts, national policy and objectives for waste prevention and management, such as collection, recycling, incineration and landfill. It also provides insight into scenarios, monitoring and enforcement. In addition, other topics are also discussed, such as:

- the relationship to the circular economy
- available instruments
- the considerations around whether a material is deemed to be waste or not
- aspects of importance in granting permits
- capacity regulation policy.

The policy framework also describes the actors involved in waste management and provides direction for the granting of permits for waste processing. The LAP3 policy framework consists of the following four parts (Ministry of Infrastructure and Water Management LAP3, 2017):

- Part A – General policy framework
- Part B – Waste management and shipment
- Part C – Actors in the chain
- Part D – Licensing and enforcement

Part E of LAP3 contains 85 sector plans, which state the policy for specific waste materials and flows, such as textiles, plastics and household waste. Each sector plan contains a "minimum waste processing standard"; for example, if recycling is possible, landfilling is no longer allowed. The sector plans are the assessment framework for the granting of permits to waste processing facilities.

The sector plans also deal with legislation and regulations for waste in the fields of separation, collection, transport and mixing, and relevant dumping bans.

2.2.1.2   Packaging

The Packaging and Packaging Waste Directive (European Commission, 1994) aims to reduce and prevent the impact of packaging waste on the environment. The guidelines were revised by the European Commission in 2015 and again in 2018 to, among other things, limit litter, increasingly regulate plastics and promote the transition to a circular economy. The directive has been implemented in the Environmental Management Act (Government of the Netherlands, 2004) and the Packaging Management Decree 2014 (Government of The Netherlands, 2014).

The LAP includes a packaging sector plan. Packaging waste touches on various categories that, in principle, must be kept separate from each other. These include wooden packaging, mixed plastic waste, metals, paper and cardboard, and packaging glass.

Local authorities (provinces and municipalities) must take into account the LAP in the area of waste policy. Within the framework of the LAP, municipalities can develop their own policy for waste prevention and separation of household waste.

2.2.1.3 Packaging Framework Agreement

In the Packaging Framework Agreement 2013–2022, the national government, the Association of Netherlands Municipalities (VNG) and the Packaging Waste Fund (StAv) have made agreements on packaging waste policy. These mainly focus on reuse and the sustainability of the packaging chain. In the Packaging Chain Agreement 2020–2029, further agreements have been made between the VNG and the Packaging Waste Fund Foundation.

2.2.1.4 Plastic waste

The EU Packaging and Packaging Waste Directive (94/62/EC) has been implemented in the Packaging Management Regulations. A draft decision on the extended producer responsibility scheme has also been drawn up to implement the general minimum requirements for such schemes.

In the Netherlands, it has been decided to ban all free plastic carrier bags, with an exception for lightweight plastic carrier bags that are required for reasons of hygiene or that are provided as primary packaging for loose foodstuffs to prevent food waste.

The Single-use Plastics Directive (European Commission, 2019)promotes a sustainable and circular approach by regulating certain plastic products. For example, it introduces an EU-wide ban on single-use artificial products, such as cutlery, plates, stirrers and straws. This directive requires amendments to, among other things, the Environmental Management Act and the Packaging Management Decree 2014, and must be implemented by 3rd July 2021.

The LAP includes a plastics sector plan. It states that, by 2021, 51% of plastic packaging should be recyclable. However, not all plastics fall within the scope of this sector plan; some plastics fall under other sector plans, such as residual household waste or residual waste from companies or packaging.

Because the term 'plastics' encompasses different substances, the plastics sector plan is categorised according to plastics with similar properties. A specified approach and specific minimum standards apply per category. For example, for plastics that melt when heated (thermoplastics), the minimum standard is recycling. In addition, specific attention applies to the potential and/or occasional presence of substances of very high concern (SVHC).

Local authorities must take the LAP into account in the area of waste policy. Within the framework of the LAP, municipalities can develop their own waste prevention and separation policy. Provinces must also take the LAP into account in environmental permits and in the implementation of the Environmental Management Act.

2.2.1.5 The Plastics Pact in the Netherlands

In the Netherlands, at least 66 companies/organisations and 15 local governments have signed the Pact. Signing the Pact is voluntary but not without obligation. Every year the progress of participants is monitored. This is why a start has already been made on setting up the monitoring, reporting and transporting of plastic waste, as well as the circular design of plastic. Progress is monitored by a rotating steering group, consisting of a number of signatories. The European Commission is involved as an observer of the Pact. Together with the European Commission, it is also being examined how the Pact can contribute to a new European plastics policy based on the European Green Deal.

2.2.1.6 Extended producer responsibility scheme

Extended producer responsibility is established per product flow by means of an order in council or ministerial regulations. In line with the waste hierarchy, a minimum target is set per material or product that the producer must achieve within the framework of its extended responsibility. In the future, it will be possible to set additional requirements per product flow via a specific order in council or ministerial regulations.

In order to achieve more unambiguous requirements regarding producer responsibility for the various product flows in the Netherlands, this draft decree implements Article 8 bis of the amended Waste Framework Directive. This decision sets out the minimum requirements for extended producer responsibility schemes, such as:

- the producer must ensure an appropriate intake system for the products covered by the scheme
- the producer must have the financial and organisational resources necessary to fulfil the obligations of the scheme – this also applies to future obligations with regard to products already placed on the market
- the producer is required to submit a one-off report on the way in which the obligations are met and, in addition, send an annual report to the minister about implementation during the previous calendar year
- in order to fulfil its responsibilities, the producer can make agreements with other chain parties, such as sales outlets, recycling companies, collectors, waste processors or municipalities
- it also informs the producer about waste prevention measures, the collection system, facilities for reuse or recovery, and the prevention of litter
- no distinction is made between waste that is released as household waste or as industrial waste.

These unambiguous requirements ensure that the responsibility of the producer is extended to the back of the chain. The aim is to make the producer aware of the entire lifecycle of a product, and to encourage the producer to market products that are durable, reusable, repairable and recyclable.

2.2.2 United Kingdom

Much of the UK's current waste legislation originates from EU legislation. Existing environmental law derived from EU law remained in effect following the withdrawal of the UK from the EU on 31 January 2020.

However, according to the UK government website (https://www.gov.uk/guidance/upholding-environmental-standards-from-1-january-2021) from 1 January 2021 current UK legislation will have the following changes applied:

- removal of references to EU legislation
- transferal of powers from EU institutions to UK institutions
- assurances that the UK meets international agreement obligation.

2.2.2.1 UK Environment Bill

In preparation for this transition, the UK government has introduced a new Draft Environment (Principles and Governance) Bill 2018. According to the Environment Bill Summer Policy Statement update, "The Environment Bill will establish a comprehensive legal framework for environmental improvement. It will chart a clear course for a greener future, creating a new, world-leading Office for Environmental Protection that will hold this government and future governments to account".

The Bill sets out five ambitions, which aim to (UK Government, 2018):

- establish a pioneering new system of green governance
- improve air quality
- restore and enhance nature
- improve waste management and resource efficiency
- improve surface water, ground water and waste water management.

As part of the Bill, the UK government will establish a new statutory body, The Office of Environmental Protection (OEP). The OEP will be responsible for overseeing compliance with environmental law, and providing advice and guidance to the government on future UK environmental policy.

2.2.2.1.1 Plastics in the Environment Bill

The Bill (Bill, 2020) sets out the implementation of extended producer responsibility under the 'polluter pays' principle. This will require the producer to cover the full net costs of the 'disposal' of plastic packaging waste from their products once they have been used for their primary purpose.

Additional measures to tackle plastic pollution include preventing plastic waste from being shipped out of the UK, plans to further reduce supermarket plastic bag sales, banning plastic drinking straws, stirrers and cotton buds, and establishing a sustainable deposit return scheme for drinks containers to push recycling rates up (DEFRA in the media, 2020).

2.2.2.2 England

In England, the Resources and Waste Strategy for England (RWS), published in December 2018 (UK Government, 2018), presents the government's ambition to move towards a more circular economy, and to become a world leader in resource efficiency and the overall reduction of waste sent to landfill. In general, the strategy focuses on the top of the waste hierarchy, i.e. prevention and reuse (see Figure 1 in the EU policy section) and includes the following strategic aims relating to plastics:

1. To work towards all plastic packaging placed on the market being recyclable, reusable or compostable by 2025.

2. To eliminate avoidable plastic waste over the lifetime of the 25-Year Environment Plan.

These aims will be achieved by introducing a number of measures that aim to manage plastics throughout the value chain, as described below (for example but not limited to).

> **The plastic packaging tax** – This applies to plastic packaging produced in, or imported into, the UK that does not contain at least 30% recycled plastic. It will not apply to any plastic packaging that contains more than 30% recycled plastic, or any packaging that is not predominantly plastic by weight. The aim of the tax is to create a greater demand for recycled plastic, which will stimulate collections and the markets for materials. The tax was set out in the 2019 budget and was followed by draft legislation which was published for consultation in 2020.
>
> **Deposit Return Scheme (DRS)** – A scheme whereby consumers pay a deposit for the single-use container (e.g. a plastic bottle) at the point of purchase, which is then refunded to the consumer when they return the container for recycling. The details of the DRS will be subject to extensive multi-stakeholder consultations. The government intends to implement the DRS in England, Wales and Northern Ireland from 2023.
>
> **Extended Producer Responsibility (EPR)** – This ensures that producers pay the 'full net cost of recovery' for the packaging that they produce (e.g. plastic bottles, cans, etc.). This means that producers will be responsible for funding the management of packaging at the end of its life. The government will introduce an EPR system for packaging in 2023.
>
> Source: (UK Government, 2018)

In support of the schemes outlined above, the government will have new powers to set resource-efficient product standards for plastic packaging. This will include a move towards clear and consistent product labelling, which will enable the consumer to make an informed choice about product selection and recycling.

During 2020, the RWS went through a period of multi-stakeholder consultations, the details of which can be found at: https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england. These consultations will allow the government to work with the stakeholders to further define the policies within the RWS to ensure it achieves the optimum environmental benefits.

Prior to the implementation of the RWS, the government has set out its approach to the monitoring and evaluation of the policies set out in the strategy; this is known as the Resources and Waste Strategy: Evaluation Plan (UK Government , 2020).

2.2.2.2.1   25-Year Environment Plan, 2018

In 2018, the UK government published its 25-year Environment Plan, entitled "A Green Future: Our 25-Year Plan to Improve the Environment". The plan has two key ambitions that are relevant to C&I plastics (UK Government, 2018):

> • to make sure that resources are used more efficiently and kept in use for longer, to minimise waste and reduce its environmental impacts by promoting reuse, remanufacturing and recycling

> • to work towards eliminating all avoidable waste by 2050 and all avoidable plastic waste by the end of 2042.

The plan supports the movement away from a linear economy of 'take, make, use, throw' towards a circular economy that keeps materials in use in the system for as long as possible.

2.2.2.3   Wales

In 2010, the Welsh government published Towards Zero Waste 2010–2050, which is the overarching waste strategy for Wales. This cutting-edge strategy was supported by sector plans and documentation, which together with TZW, comprise the statutory waste management plan for Wales. TZW adopted the following principles (Welsh Government, 2015):

- Application of the waste hierarchy
- Polluter-pays principle
- Extended producer responsibility
- Proximity principle[3].

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[3] The EU Waste Framework Directive establishes the principle of 'proximity', which is the requirement for member states to establish an integrated and adequate network of waste disposal installations and installations for the recovery of mixed municipal waste collected from private households, including where such collection

Following TZW, the Welsh Assembly published a consultation in December 2019 called Beyond Recycling: A strategy to make the circular economy in Wales a reality, which – as the title suggests – sets out proposals to move to a circular economy. The aim is to avoid waste by keeping things in use as long as possible. The Welsh government aims to achieve this by following six core themes, which are (Welsh Government, 2020):

1. Improving its recycling record
2. Supporting the prevention of waste and reuse of material
3. Using greener materials
4. Using government powers to develop parts of the strategy into legislation so that it can be enforced
5. Supporting communities and businesses
6. Making waste collections cleaner.

In order to achieve these six core themes, the Welsh government is proposing eight actions, which can be viewed at: https://gov.wales/sites/default/files/consultations/2020-03/consultation-circular-economy-strategy_1.pdf. Action 2 specifically relates to plastics and is summarised below.

Action 2 – Phasing out single-use plastic: Wales aims to be the first country to send zero plastic to landfill. This will be achieved by introducing policy reforms that will include the introduction of Extended Producer Responsibility for packaging, a Deposit Return Scheme for drinks containers and banning/restricting the use of unnecessary, highly littered, single-use plastic.

This ambitious strategy was under consultation from 19 December 2019 to 24 April 2020. A summary of the responses has been published at: Beyond Recycling: Welsh Government Consultation – summary of responses. The Welsh government hopes to publish the strategy during 2021.

2.2.2.4   Scotland

In June 2020, the Scottish government launched Scotland's first Zero Waste Plan (Scottish Government, 2010), which aims to drive change and inspire households, businesses, community groups, local authorities and the wider public sector to change the way they view and deal with waste. The plan set out a number of new measures, including the introduction of an ambitious recycling target of 70% by 2025. The plan also develops new ways of looking at the materials Scotland produces,

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also covers such waste from other producers, taking into account best available techniques (European Commission, 2006).

recognising that everything designed, produced and used is a resource which has a value, and thus supports the circular economy.

In 2016, the Scottish government published Making Things Last: a circular economy strategy for Scotland (Scottish Government, 2016). The aim was to reduce waste and use resources more efficiently, delivering both economic and environmental benefits. The strategy promotes the benefits of a strong circular economy and makes specific reference to the development of circular business models. The strategy also looks at improving the whole recycling supply chain, and – like the PlastiCity project – it recognises that all players need to work together to supply and demand high-quantity and high-quality recycling, identifying and working with key partners to deliver improvements.

The Scottish strategy documents were leading towards the passing of a proposed Circular Economy Bill, but the introduction of this bill has been delayed as a result of the COVID-19 pandemic (Scottish Government, delayed)

2.2.2.5   Northern Ireland (NI)

The revised Northern Ireland Waste Management Strategy (Northern Ireland, 2006) sets the policy framework for waste, and includes sections on resource reuse and recycling – for example:

- the development of a waste prevention programme
- the introduction of a statutory requirement on waste operators to provide specified data on C&I waste
- new and more challenging collection and recycling targets for packaging and waste electrical and electronic equipment
- the development of detailed proposals for an Environmental Better Regulation Bill.

In addition, the Department of Agriculture, Environment and Rural Affairs (DAERA-NI) published the Waste Prevention Programme for Northern Ireland – The Road to Zero Waste (Northern Ireland 2019, 2019), which provides a renewed focus on waste prevention (including reuse), and preparation for reuse and recycling in accordance with the waste hierarchy. In addition to this, the NI government published the Waste Management Plan for Northern Ireland (Ireland, 2019), which sets out its work to create a sustainable and circular economy. In line with the other countries of the UK, the NI strategy sets out to implement extended producer responsibility under the 'polluter pays' principle and a DRS.

2.2.2.6   Packaging producer responsibility reform

The UK government has committed to a UK-wide reform of the extended producer responsibility system for packaging. In February 2019, a joint-government consultation on reforming the UK

packaging producer responsibility system was published and new proposals are now contained in the Environment Bill 2019–20 (DEFRA, 2019).

2.2.2.7   The Plastics Pact in the UK

The UK Plastics Pact is a highly influential collaborative initiative, developed by WRAP that brings together businesses from across the entire plastics value chain with UK governments and NGOs, to tackle plastic waste and develop a circular economy. Approximately 160 UK companies have signed up to the Pact. Details of these companies can be found at: https://www.wrap.org.uk/content/plastics-pact-members.

WRAP has outlined four targets that should be adopted by all parts of the supply chain by 2025 (WRAP, 2018):

1. 100% of all plastic packaging is reusable, recyclable or compostable
2. 70% of all plastic packaging is effectively recycled or composted
3. There is a 30% average recycled content across all plastic packaging
4. Action is taken to eliminate problematic or unnecessary single-use packaging items through re-design, innovation or alternative (reuse) delivery models.

The Plastics Pact "aims to inspire members and supporters to act, and to galvanise wider action by governments, funders, investors, NGOs and businesses who are not members of The UK Plastics Pact" (WRAP, 2018).

2.2.3   France

With a recycling rate close to just 26% in 2016, France is far behind its European neighbours. If "the transition towards a circular economy" remains "the strategic horizon of the sector", the short-term situation is nevertheless paradoxical (Emballages, 2020). Low oil prices make virgin materials very competitive, while the production costs of recycled plastics remain very high because of the necessary investment. Furthermore, the health crisis caused by COVID-19 has boosted the consumption of single-use products, which are often made of plastic. The most recent and relevant laws in France that impact plastics are discussed below.

2.2.3.1   Energy Transition for Green Growth (law of 17 August 2015)

This law sets the objectives of the energy transition, and focuses on reductions of greenhouse gas emissions and energy consumption (i.e. by promoting renewable energies, thermal insulation, energy efficiency, electric vehicles, etc.). It officially introduced the concept of the circular economy.

Several measures concerning plastics are present within this law, with the following schedule:

- From 1 July 2016: single-use plastic bags were removed at shop counters in favour of reusable plastic bags, or paper, cardboard or cloth bags.
- From 1 January 2017: this ban was extended to bags used to pack goods on the shelves (fruit and vegetables, fish, etc.).
- From 1 January 2020: the availability of disposable plastic cups, glasses and plates for the hospitality sector was ended.
- By 2022: the law also calls for the gradual extension of sorting all household waste plastic packaging components ready for recycling.

A specific decree (n°2016-288 of 10 March 2016) reinforces the measures to sort and recover C&I packaging. It states that, from 1 July 2016, companies, businesses, local authorities and administrations are obliged to sort at source and recover five waste streams ("*tri 5 flux*"), including plastics.

Moreover, as part of the Energy Transition Law for Green Growth, the Circular Economy Roadmap ("*Feuille de Route l'Economie Circulaire, FREC*"), published on 23 April 2018, proposes concrete measures to initiate the transition to a circular economy. This roadmap was the working basis for the anti-waste law for a circular economy ("*Loi Anti Gaspillage et Economie Circulaire, AGEC*").

2.2.3.2 AGEC Law of 10 February 2020 (law for the prevention of waste and the promotion of the circular economy)

For the application of the European directive and in response to the mobilisation of public opinion, this is the final chapter aimed at accelerating the change in production and consumption patterns, in order to limit waste and preserve natural resources, biodiversity and the climate.

It is concerned with reducing waste and setting up a circular economy for the next 20-year period. The law is structured around four major aspects: acting against waste, improving production (unsold goods, bulk sales, public purchases), the responsibilities of producers and tackling illegal dumping.

Specifically, with regard to plastics, ambitious objectives have been announced to reduce waste and move away from disposable plastic, including:

- reaching 100% recycled plastic by 2025
- ending the marketing of single-use plastic packaging by 2040, with measures such as prohibiting single-use plastic straws, disposable cutlery, takeaway cup lids, polystyrene containers, balloon stems and confetti, from 1 January 2021
- from 2022, prohibiting the over-packaging of fruit and vegetables weighing less than 1.5 kg
- better collection of plastic waste, thanks in particular to the deployment of sorting bins in supermarkets, which will make it possible to collect packaging material immediately after checkout.

The final key measure concerns consumer information, such as:

- the environmental characteristics of products offered for sale
- from 2022 onwards, companies selling products containing endocrine disrupters must inform consumers of this
- the indication of the Triman logo, accompanied by information on the sorting method, becomes compulsory from 2021 for household products, their packaging or the documents supplied with them.

2.2.3.3   The Plastics Pact in France

The French government has launched a national pact on plastic packaging, named "*Pacte National sur les emballages plastiques*". This is in line with the EU policy on waste and the circular economy (see Section 2.1.3) and France's own national circular economy plan, "*Feuille de Route l'Economie Circulaire*" (see Section 2.2.3.1).

The 13 signatories of the Pact have committed to reducing their impacts on plastic pollution both upstream, through the elimination of problematic and unnecessary plastic packaging and the deployment of reusable packaging, and downstream, by strengthening collection and recycling infrastructure. The Pact thus presents a genuinely transformational approach, making it possible to take into account the entire plastics value chain. Further details can be found at: https://www.ecologie.gouv.fr/sites/default/files/2019.02.21_Pacte_National_emballages_plastiques.pdf.

2.2.4   Flanders (Belgium)

The Flanders region of Belgium has achieved very high levels of recycling through the implementation of a waste strategy that is based on a combination of introducing waste taxes, landfill bans, subsidies and financial incentives for the separate collection of recyclables, and producer responsibility.

There have been landfill bans and restrictions in Flanders since 1998, on both unsorted waste and separately collected waste. The aims of the bans and restrictions are to reduce the amount of waste going to landfill, limit greenhouse gas emissions and reduce ground contamination, while pushing the recycling or composting of wastes.

In recent years, the Flanders region has focused more on waste prevention, reuse and recycling. The main objectives are to significantly reduce incineration and landfilling of waste, and promote the prevention and reuse of waste as priorities in the region's waste management.

The policy in Flanders is shifting from a waste policy (focusing on environmentally sound management of waste) to a sustainable materials management policy (focusing on closing material cycles and bringing about a circular production and consumption model). In this model, prevention relates to both waste prevention and preventing the use of primary materials, and thus increasing circularity. Prevention, reduction and circularity are integrated into several policy documents and programmes as described below.

2.2.4.1 *Framework legislation on the management of material cycles and waste (the Waste and Materials Decree)*

The framework legislation on the management of material cycles and waste (the Waste and Materials Decree) and its implementing regulation VLAREMA came into force on 1 June 2012. The legislation covers the management of waste, with a specific focus on sustainable materials management (SMM), considering the chain of materials used for a service or product as a whole.

The Decree is applicable to materials that have been mined, extracted, grown, processed, produced, divided, commissioned, decommissioned or reused, including waste materials produced during these operations. In essence, the applicable materials include all substances used in the Flanders economy. The concept of lifecycle thinking was introduced into the Decree.

Lifecycle thinking attempts to encompass all consecutive operations throughout a lifecycle or substance flow, ranging from mining and extraction to the moment such operations produce waste material that is unavailable for reuse. As a consequence, materials can progress through the lifecycle multiple times if they are reusable.

The revised hierarchy for material management is as follows (VLAREMA, 2012):

1. waste prevention by more efficient, less environmentally harmful consumption of materials through changes in production and consumption patterns (this occurs before the waste phase)
2. preparation of waste for reuse
3. recycling of waste materials and use of materials in closed material cycles
4. other uses of waste materials, such as energy recovery
5. removal of waste materials, with dumping as a last resort – incineration with low waste recovery is considered waste removal.

The underlying idea is that only the options that produce the best overall result for the environment and human health should be encouraged.

2.2.4.2 *Plastics implementation plan 2020–2025*

The Flemish government approved the plastics implementation plan 2020–2025 of OVAM (Public Waste Agency of Flanders), which is an important step towards the circular economy. The overall aim is to reduce the amount of plastic waste by stimulating its reuse. The plan covers all types of plastics and has the following five specific goals (OVAM, 2020):

1. Less, and more efficient, use of plastics.
2. Creation of a sustainable recycling market for plastics.
3. The usage of plastic recyclate as a developed raw material.
4. Collection of knowledge and data.
5. An exemplary role of the government through circular procurement.

In total, there are 37 actions linked to the goals, which are carried out by OVAM or other stakeholders. These cover preventive actions, and to research and invest in a sustainable recycling market for the use of recyclate as a developed raw material. The plan also consists of the vision and policy framework of the Flemish efforts to sustainably close the plastics value chain and reduce associated climate impacts.

The follow-up of the plan occurs through a consultation platform under the chairmanship of OVAM, and with the co-operation of all partners and stakeholders (private and public), which will also promote knowledge sharing of the plastics problem.

Through this plan, OVAM also meets the last prerequisite to apply for an EU project grant of €9 million, which the Flemish government will use to invest in sustainable solutions for the plastics problem.

2.2.4.3   Co-operation agreement on packaging waste

The co-operation agreement is a legal framework for the prevention and management of all types of packaging waste produced by the three regions in Belgium, i.e. Flanders, Wallonia and the Brussels-Capital Region, whether C&I or household waste.

The agreement sets out three statutory obligations for companies placing products on the Belgian market (IVCCIE, 2008):

- a reporting obligation
- a take-back (i.e. recycling and recovery) obligation
- the obligation to submit a waste prevention plan.

The co-operation agreement outlines a legal framework for accredited compliance organisations, which are responsible for the selective collection of packaging waste arising from businesses and households. It also contains important legal definitions of packaging and related aspects, including regulations on sanctions and checks.

2.2.4.4   Flanders materials programme (VMP)

The government of Flanders worked with OVAM to establish the VMP. This involved engaging with stakeholders from all parts of society to identify solutions for waste, materials management and waste prevention.

The VMP combines three pillars: long-term vision development, policy-relevant research and concrete actions. These are set out in the VMP Plan C, the Policy Research Centre Sustainable Materials Management (SuMMa) and Agenda 2020. Plastic recycling/material management features throughout the VMP, and we would recommend that policymakers/researchers refer to it as an excellent example of a policy promoting and enabling the transition towards sustainable materials

management. The document can be found at: https://eco.nomia.pt/contents/ficheirosinternos/vmp-eng-brochure-150ppi.pdf.

In order to create the foundation for materials to circulate in smart, closed loops by 2020, the VMP focuses on 45 actions divided across 9 circular economy levers. These levers are (OVAM, 2020):

1. Sustainable design
2. Smart collaboration
3. Smart investments
4. Improved regulations
5. Sustainable materials management in construction
6. Sustainable chemistry and plastics in a closed cycle
7. Bio-economy
8. (Critical) Metals in a continuous cycle
9. New materials and material technologies.

2.2.4.4.1 *Plastics in a closed cycle – Flanders' "Plastic Vision"*

One of the developments of the "Plastic Vision" is a quality label that indicates the percentage of recycled materials that a product contains. The aim of this label is to eliminate the bias against recycled plastics, and promote them as viable and sustainable products. Another objective of the vision is to develop indicators to track the progress in closing plastics cycles and compare these with the European best practices. It is thought that by recording plastics that are already being recycled or can be recycled, the VMP will be laying the foundation for an action plan to promote and extend the recycling of plastics (OVAM, 2020).

2.2.4.5 *Extended producer responsibility (EPR) schemes*

The EPR schemes in Flanders place the responsibility for collection and processing during the waste phase onto those who market the product. Manufacturers can meet their obligations through an individual waste prevention and waste management plan, or jointly with a manufacturers' organisation in an environmental policy agreement (MBO [milieubeleidsovereenkomst] or EPR schemes). In Flanders, the promotion and recycling of C&I packaging waste is co-ordinated by a company called VALIPAC.Plastics Pact Flanders/Belgium

OVAM signed the European Plastics Pact on 6 March 2020. It reconfirms the ambition to take the lead in Europe regarding prevention, collection and recycling of plastics. As discussed in Section 2.1.5, the European Plastics Pact is a joint initiative between the Netherlands and France. The goal is to bring together public authorities and frontrunners to speed up the transition to a European circular plastics economy. Besides OVAM, 80 other regions, member states, NGOs and companies signed the pact.

The Pact has four ambitious goals, as follows (European Plastics Pact, 2020):

1. Reuse and recycling: to design all plastic products and packaging in such way that, by 2025, they are reusable or recyclable.
2. Responsible use of plastics: to ensure a more responsible use of plastic packaging and single-use products.
3. Collection, sorting and recycling: to raise the collection, sorting and recycling capacity by 2025, and reach a level that complies with the market demand for recycled plastics.
4. Usage of recycled plastics: to increase the usage of recycled plastics in new products and packaging by 2025.

The Pact supports this work by creating a platform to exchange ideas, show good practices and discuss the challenges to be overcome in order to make this transition.

3 Strategy overview

Sections

3.1. Top-down analysis of current status

3.2. Identification of actors

3.3. Mapping the actors

3.4. Surveying the attitudes and behaviours of actors

3.5. Insight into current situation of plastic waste flows in the C&I sector

3.6. Lumping strategy

3.7. Processing tests

3.8. Engagement of actors

3.9 Changing the status quo

Having an insight into the C&I waste sources and flows in a given area informs the decision-making process. According to the UK government's Waste and Resources Strategy (2018): "Data has the power to transform behaviours. Simply making all those in the production and consumer chain aware of the amount and type of waste they generate can unlock important social and commercial dynamics that lead to waste reduction." If we are to change a system or a process, we first need to understand it from the bottom up (UK Government, 2018).

PlastiCity uses an iterative way of gaining knowledge about an area, with a combination of top-down and bottom-up data analysis on waste quantities/qualities, and gathering the required stakeholders around urban platforms to develop, test and demonstrate new scenarios. As a result, the PlastiCity partners have created this general strategy that is intended to be used in other regions to develop new recycling solutions.

This strategy will focus on presenting our developed methodology, rather than diving deep into technical details. We want to reach out to urban and regional policymakers and researchers, to offer a starting point to gaining a better understanding of the plastic waste streams in their regions and to provide guidelines on how the different parts of the methodology can work together.

The application of the methodology presented in this strategy will need to be adapted to the status quo in new study regions. As an example, if there is already a good knowledge of the actors in the local plastic waste value chain and they are already engaged with the local governments, steps like mapping the actors (see Section 3.3) and surveying the attitudes and behaviours of the actors (see Section 3.4) can be omitted.

3.1 Top-down analysis of current status

This section describes the steps that can be taken to identify the current C&I waste collection practices in an area. It also looks at strategies for the collection of top-down data on waste flows. Top-down data is defined here as the high-level data gathered from articles, reports and databases (e.g. waste data flow, Eurostat, etc.). This can be supported by additional data from municipalities, local authorities and waste management companies. This data should provide a high-level overview of the waste arisings and collections in a given area.

Bottom-up data analysis begins with local information taken from waste characterisation studies (guidance is provided in Section 3.5: Insight into current situation of plastic waste flows in the C&I sector).

3.1.1 Current waste collection practices for C&I waste

It is important to have an overview of the current waste collection practices for C&I waste. If this overview has not already been established, the actors identified in the waste collection and recycling sector can be invited for a workshop or introduction evening within the municipality (county borough) or research organisation (see Section 3.2 for guidance on the identification of actors). Alternatively, they can be contacted individually and interviewed on their current collection practices regarding the sectors in their customer database. Care must be taken to ensure that a competitor's data is not disclosed. It is also recommended to perhaps combine this contact with a behaviour study (see Section 3.4), and to inquire about potential interest in expanding or changing collection methods for a plastic hub or developing new logistics solutions.

3.1.2 Strategy for top-down secondary data collection and analysis

Data on polymer production, use and recycling can be found in European and national statistics databases. This data can be very helpful for identifying potential knowledge gaps. This information can also be compared with any available bottom-up data for the local area. Reporting on only the amount of plastic waste is a starting point, but for recycling purposes, knowledge of flows up to the polymer (production) level is important.

To understand plastic waste production, it is useful to have an overview of the whole plastics chain and not just of the reverse chain.

Material flow analysis (MFA) is a systematic assessment of the flows and stocks of materials within a system defined in space and time. It connects the sources, pathways, and intermediate and final sinks of a material. The results of an MFA can be controlled by a simple material balance comparing all inputs, stocks and outputs of a process. Therefore, following the principles of MFA, we recommend identifying the input and output streams, and mapping the most important players in the plastic value chain. This is best done at the national level first and then the findings later transferred to the local region.

The focus must be kept on the plastic types that represent the greatest proportions of consumption and waste generation. The materials analysis also can be based on the aggregated flows, i.e. considering the quantities of plastics produced. However, if aggregated flows are considered, it will be difficult to identify solutions to recover the value of the plastic waste because each type of plastic will be removed at different stages of the recycling process.

After the definitions of the types of plastics and therefore of the industries to be considered, the next step is identifying the actors in the supply chain. Each tier is responsible for a step of transformation (or processing) of materials in the supply chain. So, for each stage of the supply chain, it is necessary to identify the actors, inputs and outputs, i.e. the supplies and products.

3.1.3   Distinguishing between different sectors

The best strategy to distinguish between different economic sectors in a given municipality/county borough is by following common industrial classifications. We recommend the use of NACE (Statistical Classification of Economic Activities in the European Community) codes for Europe or the equivalent SIC (Standard Industrial Classification of economic activities) for the UK.

For example, by using this classification, the main players in the supply chain can be identified, which – in the case of plastics – are the manufacturers of rubber and plastic products (NACE/SIC 22). Figure 2 shows a generic petrochemistry chain, where the NACE codes are used to identify the different activities throughout the production chain.

Figure 2: Identification of Industries in the petrochemistry chain, according NACE code
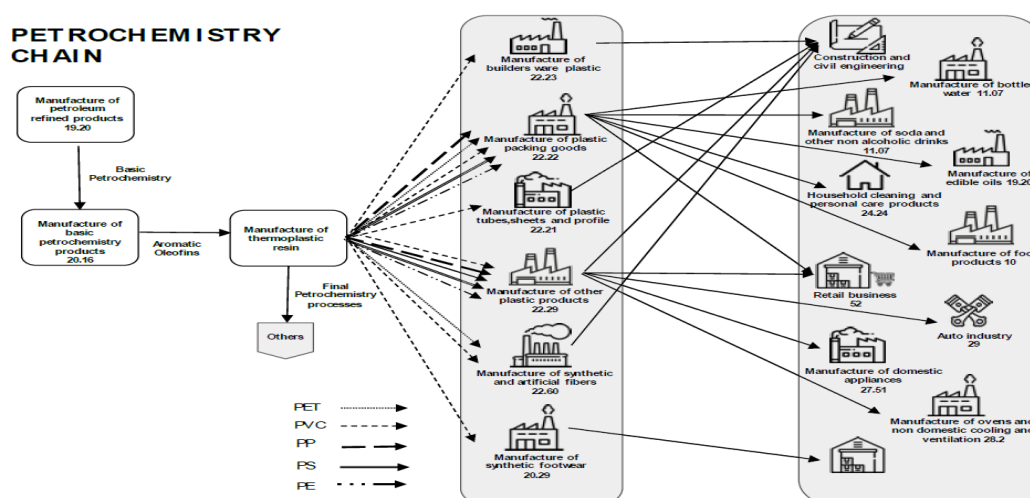
Source: (Luna, 2019)

After characterisation, the manufactured goods of the industries can be studied, e.g. by using the PRODCOM (*PRODuction COMmunautaire*) code for the EU database Eurostat (see Table 1). In Table 1, the plastic products are identified by an 8-digit PRODCOM commodity code:

Table 1: Manufactured goods by Industry of plastic packaging goods

Code	Types of manufactured products
22214120	Plates, sheet, film, foil and strip of cellular polymers of styrene
22214130	Plates, sheets, film, foil and strip of cellular polymers of vinyl chloride
22214150	Plates, sheets, film, foil and strip of cellular polyurethanes
22214170	Plates, sheets, film, foil and strip of regenerated cellular cellulose
22214180	Plates, sheets, film, foil and strip of cellular plastics (excluding of polymers of styrene, of polymers of vinyl chloride, of polyurethanes, of regenerated cellulose)
22214230	Non-cellular plates, sheets, film, foil, strip of condensation or rearrangement polymerisation products, polyesters, reinforced, laminated, supported/similarly comb. with other materials)
22214250	Non-cellular plates, strips..., of phenolic resins
22214275	Non-cellular plates, sheets, film, foil, strip of condensation or rearrangement polymerisation products, amino-resins (high pressure laminates, decorative surface one/both sides)
22214279	Other plates, sheets, films, foil and strip, of polymerisation products
22214280	Other plates..., non-cellular of plastics other than made by polymerisation
22221100	Sacks and bags of polymers of ethylene (including cones)
22221200	Plastic sacks and bags (including cones) (excluding of polymers of ethylene)
22221300	Plastic boxes, cases, crates and similar articles for the conveyance or packing of goods
22221450	Plastic carboys, bottles, flasks and similar articles for the conveyance or packing of goods, of a capacity ≤ 2 litres
22221470	Plastic carboys, bottles, flasks and similar articles for the conveyance or packing of goods, of a capacity > 2 litres
22221910	Spools, cops, bobbins and similar supports, of plastics
22221925	Plastic stoppers, lids, caps, capsules and other closures
22221950	Articles for the conveyance or packaging of goods, of plastics (excluding boxes, cases, crates and similar articles; sacks and bags, including cones; carboys, bottles, flasks and similar articles; spools, spindles, bobbins and similar supports; stoppers, lids, caps and other closures)

Source: (Luna, 2019)

The same exercise should be performed for the reverse chain, to identify activities using NACE codes 38 or 46 and their goods – for instance, 38.11 refers to collection of non-hazardous waste, 38.22 refers to treatment and disposal of hazardous waste, and 46.77 refers to wholesale of waste and scrap.

To estimate the volumes and masses for those players in the plastics chain, national databases on total production and imports/exports should be consulted, besides databases like Eurostat. Using the UK as an example, Eurostat statistics on the production of manufactured plastic packaging goods are shown in Table 2, in terms of volumes sold in 2017.

Table 2: Volumes of plastic packaging goods sold in the UK in 2017

Product Code (Prodcom)	Unit	Volume
22221100	Kg	198122
22221200	kg	92699
22221300	kg	326304
22221450	p/st	19781029
22221470	p/st	2461559
22221910	kg	683
22221925	kg	471645
22221950	kg	122350

Source: (EUROSTAT, 2017)

Identifying the main players can also be done by consulting data on the number of employees in the sector, e.g. to identify the main locations of production. A high number of employees usually also indicates a high level of production. Most European countries provide information about the number of employees, disaggregated at the local authority level. Table 3 illustrates an example of the available data, with the number of employees in activity 22.22 by local authority in the UK.

Table 3: Number of employees in the manufacturing of plastic packaging goods

Local Authority	Number of Employees
Northamptonshire	1.250
Suffolk	1.250
Birmingham	1.000
Cambridgeshire	1.000
Essex	900
Derbyshire	800
Norfolk	800
Nottinghamshire	700

Source: (NOMIS, 2019)

The data in Table 3 was obtained from the NOMIS service by the Office for National Statistics (see https://www.nomisweb.co.uk/). These values can be used as proxy variables to map the main locations of production of plastic packaging goods. They also allow the identification of the main industrial users of plastic (by using the number of employees at major manufacturers) and hubs for consumption of plastic products (by using the number of employees in retail or wholesale). The scale of retail and wholesale also has implications for the organisation of reverse logistics channels, as retailers can centralise collection of post-consumption packaging. By this procedure, the nodes of

origin and destination of plastic products can be traced – if necessary, these flows can be represented geographically.

For estimations of waste generation, data on waste per capita and the number of inhabitants in a region can be used. Finally, the destinations of waste are facilities for energy recovery, incineration, recovery other than for energy (including backfilling), or deposit onto or into land (landfill). Again, using the UK as an example, data related to the location of these facilities and their capacity, as well as recycling rates and other data, is available from UK Statistics (see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/784263/UK_Statistics_on_Waste_statistical_notice_March_2019_rev_FINAL.pdf).

Besides the destinations located within a country, there is also an amount of waste exported to other countries. Some of this data is available on the Eurostat site and in periodically updated plastics market reports. Information about the final destination of waste can be used to approximate C&I waste. Usually, there is a vast amount of data on general waste or household waste generation but little or no distinction in terms of the C&I waste. Using the top-down approach, the amount of C&I waste can be calculated through a balance of flows, as defined by:

> (plastic exported + plastic to landfill + plastic recycled) − consumer waste generated = C&I waste In the UK, based on data for 2016, total C&I waste = (514 + 1378 + 382) − 1533 = 687 tonnes

This gives a ratio of C&I-to-consumer waste of 0.45. By calculating consumer waste volumes at the local authority level, such a ratio can be used to provide a first approximation of C&I waste per local authority. A better approximation can be obtained by correcting this first result with a coefficient that takes into account the population density in the local authority. The coefficient can be calculated as: local authority C&I employees per inhabitant divided by country C&I employees per inhabitant.

To complement this approximation, we recommend local, bottom-up MFA to more accurately fill this knowledge gap and to form a fuller picture of the local plastic flows.

3.2   Identification of actors

The aim of this strategy is to gain a broad understanding of current waste and recycling practices and waste flows in the considered area. Therefore, we recommend finding a representative sample of C&I waste producers and processors, named 'actors', whose data can be extrapolated to represent the whole region.

Actors, in the context of PlastiCity, have been selected as the producers and handlers of C&I plastic waste, the designers of new products, and the decision-makers who drive the value chain. Listed below are the actor categories used by PlastiCity in 2020:

- Owners of plastic waste/end users
- Waste management companies
- Logistics companies
- Sorting companies
- Recycling companies
- Product makers/designers
- Policymakers
- R&D/universities
- NGOs and citizen initiatives.

Figure 3: Demonstration of the actors in the value chain
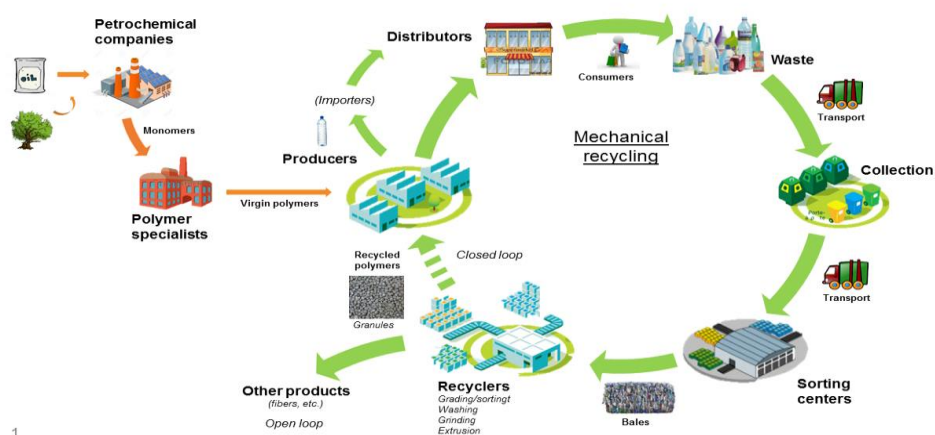
Choosing a list of representative local actors, who might be willing to co-operate in surveying (see Sections 3.4 and 3.5) or testing waste collections (see Sections 3.6 and 3.7) at a later stage, follows several steps.

First of all, a database on the overall number of active actors in the region is needed. We recommend that the database contains the information below, listed in order of importance:

- business name
- full address, geolocation and postcode (or area code/municipality reference)

- NACE code or other identification number of business sector (e.g. in the UK, the SIC) – see Section 3.1.3
- number of employees
- turnover
- business tax records
- anything else that might be used to indicate the scale of the business
- contact name, e.g. business owner.

Geolocations are usually better to work with in GIS environments, so – if they are available – it is advised that these are used instead of addresses. These locations can then be compared with information about the total number of actors per NACE code active in the corresponding city.

It is important that the database comes from a reliable source. Often, local or national government bodies hold information on active businesses in their areas, as the businesses will need to register to pay business rates and comply with other local requirements. Local trade groups or paid-for databases (e.g. ORBIS, NOMIS and Companies House) could also be considered to deliver information, but validation checks are strongly recommended as these datasets can contain duplicate and/or dated entries. In general, a data validation step, and cleaning of duplicates and outliers, is always considered good practice.

> **Recommendations for reliable data sources**
> Through our project work, we can confirm that a combination of data from local and national government bodies delivered the most reliable database. If local or national government data was not available for a project region, paid-for databases were used instead, but careful data cleaning was undertaken and an introduction of an error parameter was applied to match with validated information of the overall numbers of actors in the region. However, this practice is suggested to be the last option when gaining access to a more reliable source has been unsuccessful. Another approach is to compare a combination of different databases to fill any gaps.

Furthermore, data protection rules (e.g. GDPR in the EU) should be taken into account. Any restrictions on using and sharing the data have to be checked, and entries containing personal information might have to be redacted. We recommend considering this from an early stage and, if needed, to set up in advance a data management plan and privacy policy for the future uses of this information. If a reliable database with the previously mentioned data is set up, a visualisation of these actors can be performed (see Section 3.3) and a list of representative actors can be extracted.

Aspects for consideration when selecting a representative sample of actors

The following aspects should be considered when selecting a representative sample of actors for activities such as waste surveying and testing waste collections:

- The representative sample of actors should be selected from the total number of active actors in the region, following standard statistical rules.
- The number of actors per NACE code (or other industrial classification system) category and their company size should be taken into account to get a representative selection of the actor landscape.
- Consideration can be given to the geographical distribution of the actors.
- An additional weighting towards a higher proportion of actors from the most significant NACE codes can be included.
- Actors showing an Interest in further collaborative work in the field of C&I waste handling should be considered as they might be important regional stakeholders, e.g. actors with a high public profile.

This choice of representative actors will form the basis for further analysis and build a picture of the local plastic waste flows (see Section 3.5).

3.3 Mapping the actors

In this section of the report, we discuss the mapping of the actors and use the regions of the partner cities (i.e. Ghent, The Hague, Douai and Southend-on-Sea) as examples. The objective is to visually map all relevant actors and the characterisation of their role in the plastics value chain.

As the availability of datasets containing the type and location of business activities differed per study region, each region was advised to use its most up-to-date local database, including geolocations (see Section 3.2). We would recommend that policymakers may obtain access to these lists through the business rates or Economic Development services.

The actors' addresses and locations were transferred to geolocations and mapped for the four regions using GIS-modelling software, i.e. ArcGIS. Actors were grouped and scaled based on the number of employees, in order to identify clusters of actors and the co-location of large actor groups. Based on GIS maps of the actors, suitable locations can be identified for hubs, logistics routes and new business activity.

Using GIS-modelling software, the actors can be mapped across the plastics value chain. Preferably, this can be done in an interactive online environment, where stakeholders can hover over the map to

see more detailed information on the actors (e.g. name of company, number of employees, actor category).

As examples, the successful mappings of the four project regions are illustrated in Figures 4 to 7.

Figure 4: Mapping of actors in Ghent
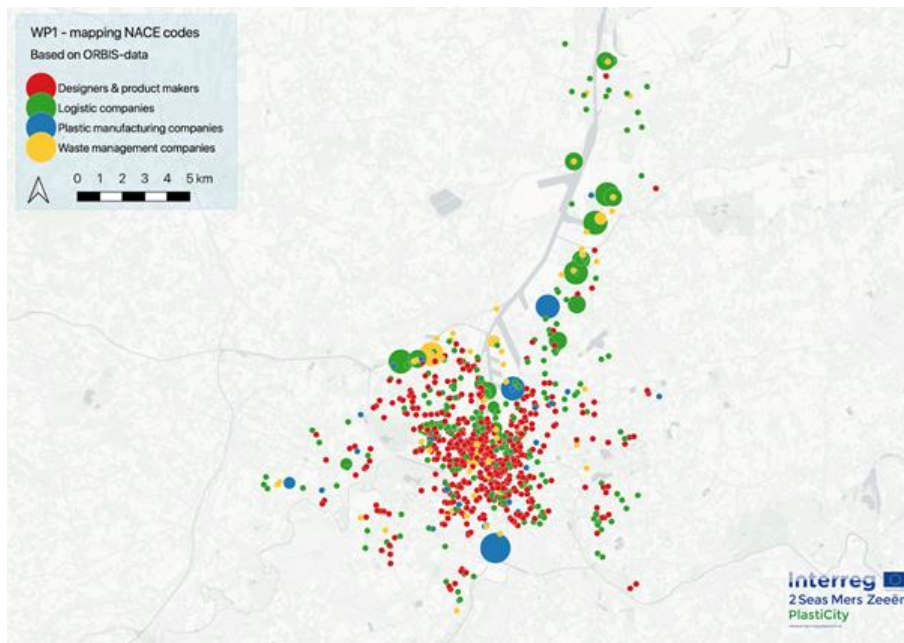
Figure 5: Mapping of actors in Southend-on-Sea
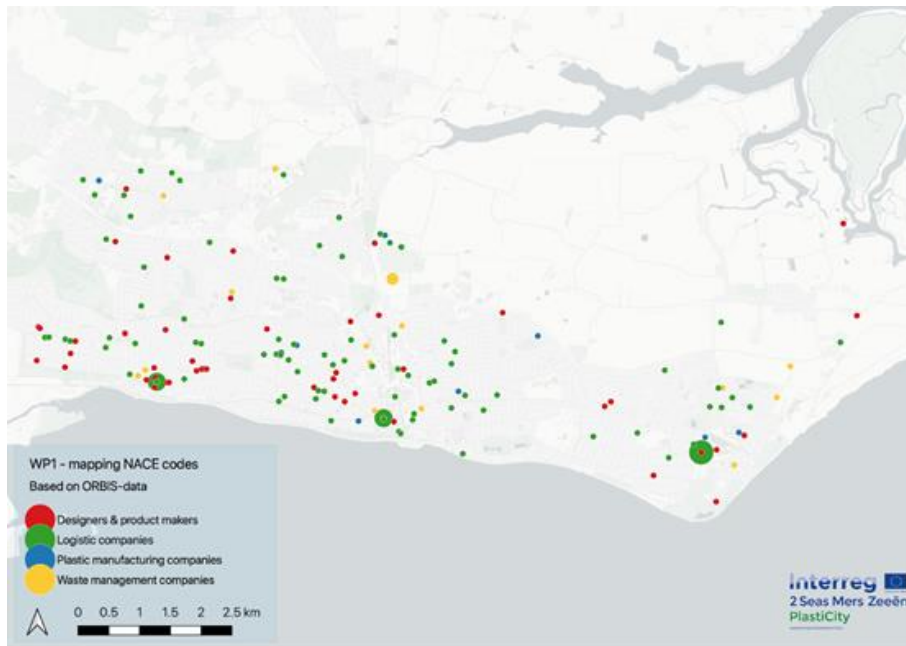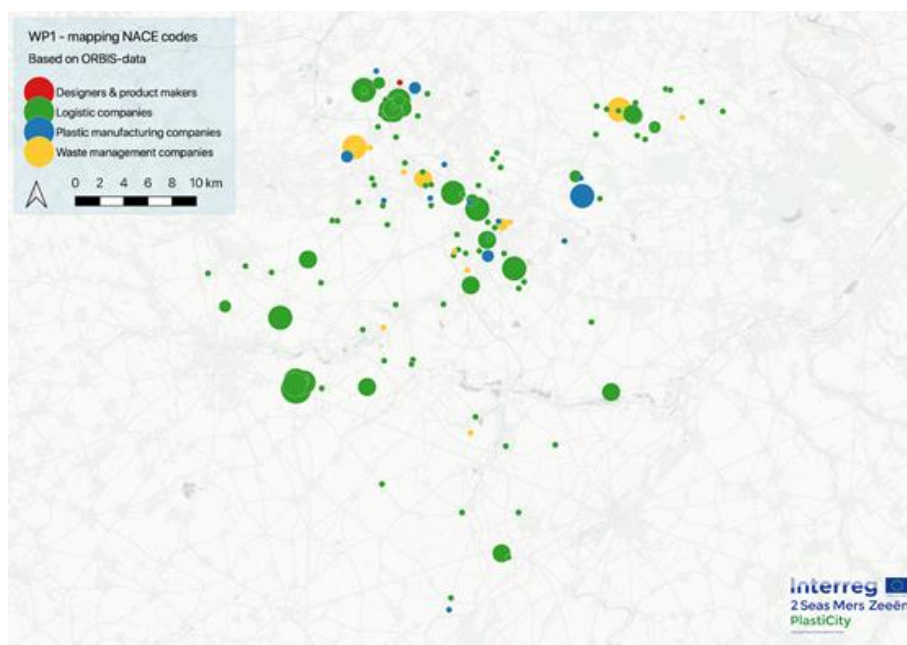

Figure 6: Mapping of actors in The Hague

www.plasticityproject.eu
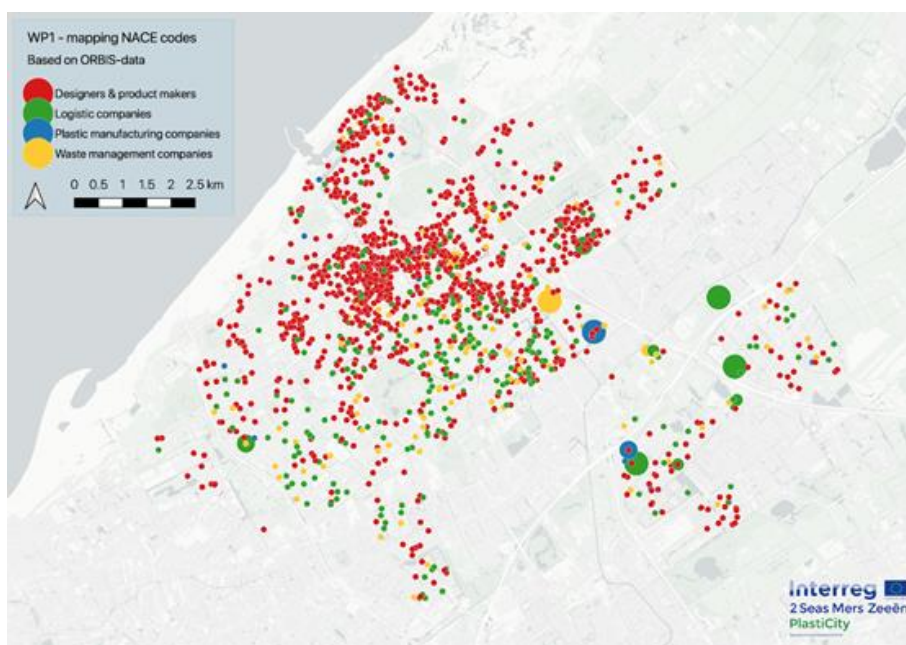
Figure 7: Mapping of actors in Douai

3.4 Surveying the attitudes and behaviours of actors

This section sets out the guidelines for conducting a behaviour study in a municipality or county borough.

In the plastics recycling system, there are many actors along the value chain. In order to make the value chain profitable, and one that will provide value to every actor, we need to find new solutions to fix technical obstacles and possibly form new business models. Therefore, all actors – from waste production and logistics to recyclers and final users – are required to collaborate with each other, generate capacity and get involved in the value co-creation process. Additionally, any other parties, such as policymakers or NGOs, that have the potential to influence this new value chain should also participate in the recycling system to create value (see Figure 3, Section 3.2).

However, while the information exchange between the different actors in the recycling process is very important to reach greater levels of recycling, there is insufficient information on how various socio-economic factors and behavioural elements influence plastic waste recycling. Therefore, it is almost impossible to find answers to why waste is generated and which factors affect the decision-making process for recycling. Furthermore, in order to explore the behaviour of the actors and their inclination to undertake positive behavioural change for better plastic waste recycling, more extensive data has to be collected. This data is also important to understand important leverages or interventions, to generate positive behavioural change in plastic recycling.

Therefore, the purpose of the behavioural surveys is to identify and characterise the behaviour of every actor in the value chain who plays a key role in plastic waste recycling in urban areas. These actors have been identified in Section 3.2 of this strategy.

In other words, the behavioural surveys that we conducted were aimed at mapping the behaviours of actors generating value in the plastics value chain within the four case-study cities of Ghent, Southend-on-Sea, The Hague and Douai. The same methodology can be used by other regions.

3.4.1 Behavioural surveys

After geographically mapping the actors, behavioural surveys are important to determine different actors' capacities, attitudes, motivations and engagement towards waste minimisation, avoidance, collection, sorting and recycling, as well as designing, manufacturing and using new products made with secondary materials.

In order to understand the differences between the actors, we suggest creating separate surveys for each actor type (i.e. waste owners, designers, recycling companies, policymakers, NGOs, waste management companies, logistics companies and plastic makers). The PlastiCity team designed eight different surveys in the native language of the surveyed project region and used an online survey platform, Qualtrics (https://www.qualtrics.com/).

3.4.2 Theory of planned behaviour (TPB)

At PlastiCity, we chose to adopt the theory of planned behaviour (TPB) to structure the behavioural surveys. According to the TPB, attitudes (i.e. overall evaluation of the behaviour), subjective norms and perceived behavioural control (i.e. to what extent a person thinks they can perform the behaviour) predict an individual's intention towards certain actions (White, 2009).

In order to avoid common pitfalls when applying the TPB, we chose to clearly identify particular factors related to intentions and/or behaviours, and aimed to investigate both intentions and behaviours. Furthermore, for better validation of the measure of behaviour, we designed clear and easy-to-understand questions.

Each survey had ten questions to measure different elements of the TPB (see Appendix 1 for the sample survey). The first two questions were asked to understand the attitudes of the respondents towards plastic recycling intentions, and the third and fourth questions were about the influence of subjective norms and perceived behavioural control on plastic recycling intentions, respectively. These four questions were exactly the same (with slight changes in wording) in all eight surveys.

While the fifth question explored respondents' capabilities, the sixth question assessed internal obstacles to plastic recycling. For investigating the respondents' actual intentions and behaviour, the seventh question was divided into two parts. In the first part, individuals were asked whether they

had already undertaken certain actions to recycle more plastic. In the second part, they were asked whether they had intentions to perform different activities to improve their plastic recycling rate in the future.

In order to examine the moderating impact of the external enablers and drivers/obstacles in the relationship between intentions and behaviour, the eighth and ninth questions were added to the surveys. Although the first five questions included very similar items in all eight surveys, some of the items were modified to make them specific for each actor group.

Finally, in order to analyse any correlation between the plastic recycling activities and the number of individuals involved in the recycling process, participants were asked in the final question to state the number of full-time employees who undertake 'green' jobs (i.e. any job that directly deals with information, technologies, or materials that preserve or restore environmental quality) in their company/organisation.

3.4.3   Piloting and finalisation of surveys

Before finalising the surveys and designing the online versions, a pilot survey using the questionnaire for waste owners in paper format was conducted with randomly chosen businesses.

In this way, many different small-scale and large-scale stores and businesses – including coffee shops, restaurants, takeaways, clothing stores, auto-repair shops, hardware stores, pet shops, bookstores, pubs, convenience stores, theatres and grocery stores – were visited and asked to fill out the questionnaire.

A pilot study is a good way to find out whether a questionnaire is well designed, the right length and easy to complete, and also whether the initial findings generate logical results.

In addition to these questions, information about the PlastiCity project and a number of questions to identify the participant's name, location, postcode, size (based on the number of employees) and the nature of the company were also included in the online surveys prepared in Qualtrics.

The survey platform can also be used for advertising, e.g. workshops, project case studies and project newsletters.

3.4.4   Implementation and delivery of online surveys

Even though the availability of free online services makes it easier to conduct surveys, the choice, design and particularly implementation of online surveys are generally poor. One of the main risks in an online survey is low reliability and generalisability. The former happens when there is uncertainty in terms of who responded to the survey and the extent to which responses are meaningful. Generalisability relates to the extent to which the results obtained from a sample can be deemed to accurately represent the entire population.

To address these two significant problems, a good design for online survey implementation introduces mechanisms to restrict access to the survey and decide in advance how many actors will be invited to respond. Thus, a list of potential respondents is drawn up and a link to the survey is sent to each. In cases of concern about data protection, the identity of the respondent can be kept anonymous to data processors by sending each respondent a unique identification code/password to access the survey. This process is structured in multiple phases (see Figure 8).

Figure 8: Survey implementation mechanism
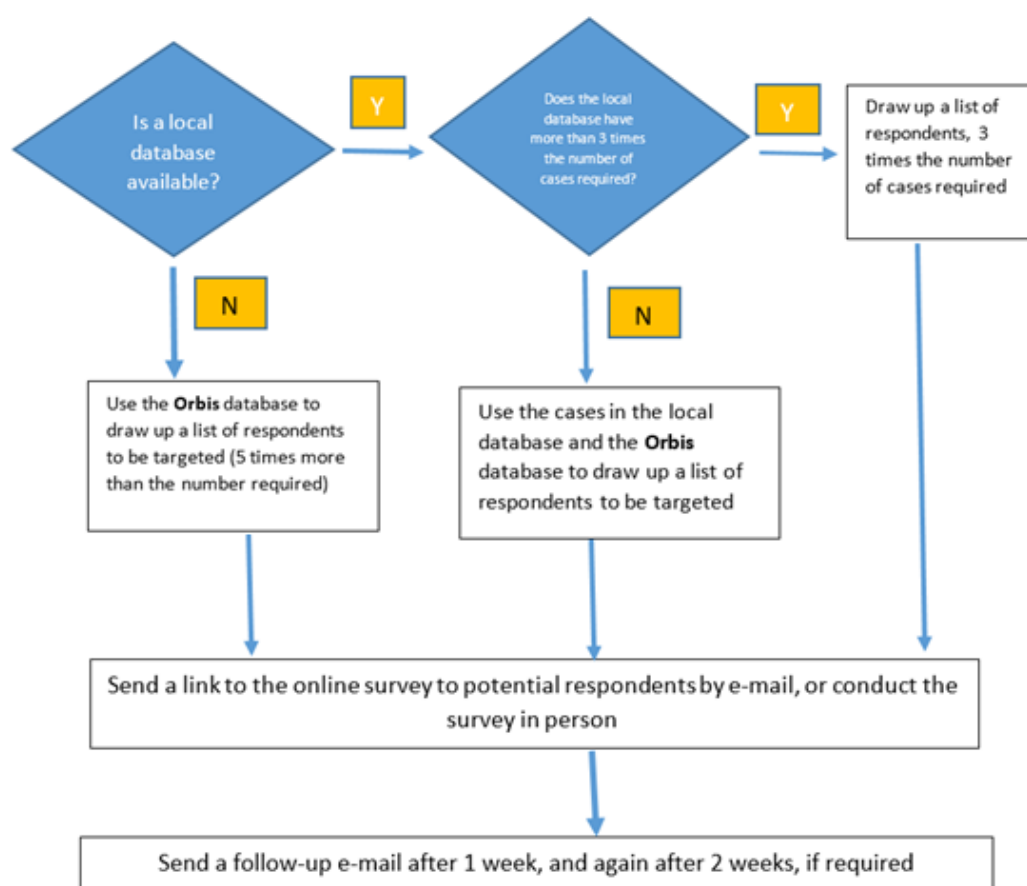
In order to conduct the surveys, the following actions are necessary:

A) Define the population and also the database to be used to capture the population.

B) Calculate the representative sample size that is needed.

C) Calculate the number of invitations needed to achieve the sample size.

D) Draw up the list of addresses to be contacted.

E) Send the link to the survey.

F) Send follow-up e-mails, if required.

3.4.4.1   Population and database

In order to establish a representative sample size, the size of the population to be captured with the survey must be known in advance. In practical terms, 'population' refers to the potential number of respondents to be targeted, for whom information is available and systematised in a list or database. For statistical purposes, it is important that people in such a database can be contacted; thus, a postal address, e-mail or phone number is a minimal requirement. At PlastiCity, we used a separate database for each of the eight types of actors that we focused on. Although it is not always possible in every case (e.g. when the company is very large), we suggest not to ask the same company to respond to more than one survey, even if the company hosts more than one actor (e.g. designer and waste owner).

3.4.4.2   Definitions of the required representative sample size and number of responses needed

Sample sizes are calculated to ensure that confidence levels and error rates are acceptable, i.e. 90% confidence level and no more than 8% error. To calculate the sample size, only the size of the population must be known.

The representative sample size and number of responses needed for statistical analysis may differ. For advanced analysis, the average number of responses needed is usually at least 200.

3.4.4.3   Definition of the number of invitations needed to achieve the required number of responses

Once the number of responses that are needed has been established, it must be decided how to select the survey respondents. Sample size calculations are based on the assumption that such a selection is made randomly by the surveyor. To guarantee random selection, there is the need for a database that captures the population. This database should contain the level of detail needed to ensure that the right people are being targeted. If a database has 20,000 entries and 200 responses are needed, one entry per every 100 must be randomly selected (using an algorithm).

Practical tip: database cleansing. Databases usually have errors. If the database cannot be 'cleansed' in advance but it is known what errors to expect, the number of respondents can be increased, adjusting by the error. If it is not known what percentage of erroneous data is present, a general rule of thumb is to select double the number of entries needed. However, since this

After the answers to the survey have been received, the response rate needs to be calculated – in other words, how many people from the sample selected have responded to the survey. There are several options available to increase the response rate, ranging from offering incentives to repeated e-mails, phone calls or even visits. The procedure with the highest response rate is the direct implementation of a survey by visiting a site, followed by phone surveys, postal mail and e-mail.

For e-mailed surveys with follow-up phone calls, the average rate of response is 25–30%. This means that to obtain the number of responses required, a list must be selected containing four times more entries than the actual number needed. It is not advisable to send mailouts larger than this.

Based on (a) the steps explained above, (b) databases provided by each partner city and (c) a specific NACE classification code attached to each company/organisation in these databases, we calculated the required sample size for each survey in each of the four regions.

3.5   Insight into current situation of plastic waste flows in the C&I sector

A good way to get an overview of the current local plastic waste flows is by surveying and waste sampling. Based on a list of representative actors (see Section 3.2), surveys can be conducted to collect information on each individual actor's plastic flows and their current waste management practices. Combining this with surveying the actor's attitudes and behaviours towards recycling (Section 3.4) can also be considered. We decided to, first, perform a screening survey with all sectors and then use this information to narrow down towards a larger scale collection/survey in the most relevant sectors.

3.5.1   Screening survey on quantity and quality in different sectors

We recommend conducting the survey in interview mode, with an experienced surveyor asking the questions formatted in such a way to allow a natural conversation. This should facilitate obtaining the greatest number of truthful responses, rather than actors simply claiming they perform 'perfect' recycling behaviour. For many companies, talking about waste and recycling is a delicate topic, and therefore it should be made clear at every stage of the interview process that the information given will be handled with care and that the interview is not part of an inspection by the authorities. To avoid actors being reluctant to co-operate, it might be helpful during this task to partner with a consultancy or research institution experienced in surveying.

From our experience, surveying actors on local plastic waste flows has an average response rate of 50%. Therefore, we recommend selecting double the number of actors that is needed for a representative survey sample. We also suggest having a backup list in case a lower response rate is obtained.

> **Suggested topics for MFA**
>
> To understand the plastic waste flows in an area, we suggest including the following survey topics:
> 1. Amounts of general waste and plastic waste, and – if known – which types (including any seasonal fluctuations)
> 2. Previous use(s) of these waste items
> 3. Current collection schemes
> 4. Potential contaminations
> 5. Behaviour towards recycling and separate collection of plastic waste
> 6. End destinations of the waste

The questions should mainly be closed, e.g. multiple choice. However, the use of a limited number of open questions will also facilitate data management and analysis. As mentioned previously, a careful design to follow a logical conversational flow will be helpful and therefore we recommend testing the survey a few times before finalising the design. Examples of survey questions in paper-based and electronic formats can be found in Appendix 2.

3.5.1.1 Paper-based/app-based surveying

The survey can be conducted with the help of data-gathering apps and, for example, tablets or as a paper-based version. Data-gathering apps, e.g. Fulcrum, have the advantage that the time-consuming data transfer of the responses to a paper-based survey into a database is eliminated. Moreover, extra options like GPS trackers or adding photos of local circumstances can be used with an electronic version of the survey. A further advantage of cloud-based services is that the project co-ordinator has access to the real-time data and therefore can quality-check the fieldwork. The collected data should be anonymised and stored, using good data-handling practices (e.g. the allocation of a unique actor reference number).

As the survey work progresses, it is important to keep track of the conducted surveys. Engagement with businesses of the required mix of actor categories (NACE groups) where surveys are still missing should be prioritised. This is so that even if the total target number of surveys is missed, the surveys available are still from a representative mix of different types of businesses.

3.5.1.2 Best times to visit actors/who to address

In our experience, it is helpful to consider the best times to visit the actors, e.g. the busy lunch hours should be avoided at a restaurant. For us, it was quite successful to visit most of the actors without prior arrangements. The biggest actors were best visited via a pre-arranged appointment. As a result, contact was made in advance via e-mail or phone.

To ensure that the most reliable data is obtained, it is important to identify the most appropriate person to talk to. In our case, it was helpful to ask for the technical personnel responsible for the

actor's waste management, the environment managers or the Chief Executive Officers. Some businesses were more receptive to completing the survey due to the potential cost-saving benefits of improved waste management resulting from the project, although others were more interested in the environmental benefits. Surveyors should initially engage with an open mind and actively listen to the responses, highlighting the potential benefits that the project can offer to individual actors.

It was important for us to give a useful introduction about the aims of the survey and information about the project that it was part of. Providing a leaflet with information about the project and contact details of the project team proved useful.

At this stage, we recommend enquiring whether the actor would like to be kept up to date with the project, or receive newsletters and invitations to workshops.

3.5.1.3   Surveyors/briefing

In general, a professional appearance (e.g. uniform, photo IDs/name tags) and any written permission from the authorities that is required to conduct the surveys are recommended. Furthermore, a good pre-survey briefing from experienced surveyors can increase the response rate. Surveyors should have the following skills and experience:

- face-to-face surveying/interviewing

- giving instructions or guidance to a range of people from different backgrounds

- excellent communication skills, and be open-minded and not afraid to approach strangers

- time management and organisational skills

- good IT skills and confidence with using a tablet

- professional manner and appearance

- native speaker of the language used for the survey

- knowledge of waste management and plastic recycling

- motivated and engaged with environmental issues

- local knowledge of the region

- access to transportation (e.g. owning a driving licence).

In the case where surveyors do not have some of the above skills, providing additional training to support them in data gathering should be considered.

It is vital to provide a good briefing to the surveyors, to introduce them to the aims of the project and the survey methodology. Training on typical waste collection systems and plastic recycling may also

be required for surveyors without prior knowledge. We suggest using external support from research or communications specialists if you are not confident you have the skills, experience or time to manage this aspect.

The briefing should cover the following topics:

- background and aims of the project

- survey questions

- typical waste collection arrangements for businesses

- survey methodology and data entry

- (expected) motivations and barriers for businesses of different types and sizes

- role play of the survey process

- progress tracking and the daily target number of surveys

- logistics details (e.g. how to plan the surveying routes)

- health and safety considerations; risk assessments.

3.5.1.4   Route planning for surveying

We recommend using cloud-based mapping services that are accessible to surveyors on the road (e.g. My Maps from Google Maps).

In our experience, it took 45 minutes on average to complete each survey, including planning, travel and data-entry. Using a paper-based survey significantly increased the time taken, due to the extra work needed for digitalisation. Moreover, with progress of the surveying period and tackling specific actor sectors (NACE categories), the time needed for planning increased.

3.5.1.5   Taking samples/sorting analysis

In order not to just rely on the answers to the survey and also to fill in any gaps, we suggest collecting samples and/or asking the actor whether they would be willing to take part in the analysis of waste collection with sorting. Often, an actor does not know what type of plastic waste they have and they only have a limited view on the share of these types of plastics in their overall waste composition. For better knowledge about this, the actor can be asked during the survey if samples of their plastic waste can be taken. These can then be analysed with, for example, handheld or desk-based infrared devices (e.g. FTIR) to discover the types of plastic waste.

The best information on the share of the plastic waste types can be achieved by conducting waste collection at the actor's site and by sorting analysis. By doing so, the weights of each plastic waste

fraction in the overall waste composition will be noted. However, conducting such extensive waste sorting analysis requires further co-operation of the actor and suitable infrastructure to perform this work (e.g. collection vehicle, storage location, waste transport/storage permits, sorting crew).

3.5.1.6   Data analysis/Sankey diagram

After completion of the initial surveying work and waste collection (where undertaken), the waste compositional data should be analysed.

Firstly, all recorded answers should be stored in a spreadsheet or database, and the records should be checked for outliers or potential errors. The results should be normalised to standard units, e.g. kg/week or t/year. Also, the findings should be grouped into actors' categories (NACE). This data can then be used to extrapolate the findings for the entire region, using the database on all regional actors. This overall result can be visualised, e.g. via Sankey diagram or pie chart (see Figures 9 and 10).

Figure 9: Example Sankey diagram, showing the plastic landscape of a region
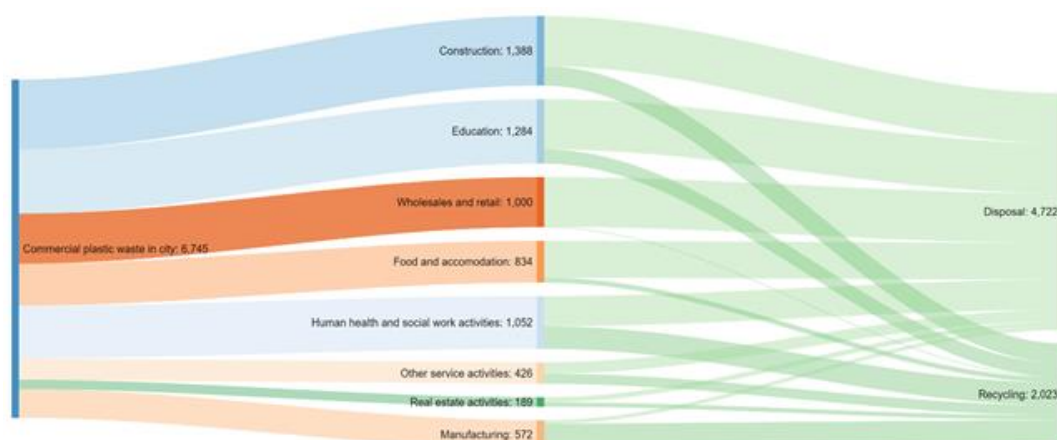
Source: (Resoource Futures, 2020)

Figure 10: Example of important NACE codes and their share of PE flexible waste in Ghent

Total PE flexible waste in Ghent by NACE codes, extrapolation based on survey results

* "Other" includes all NACE codes that summed represent <10%
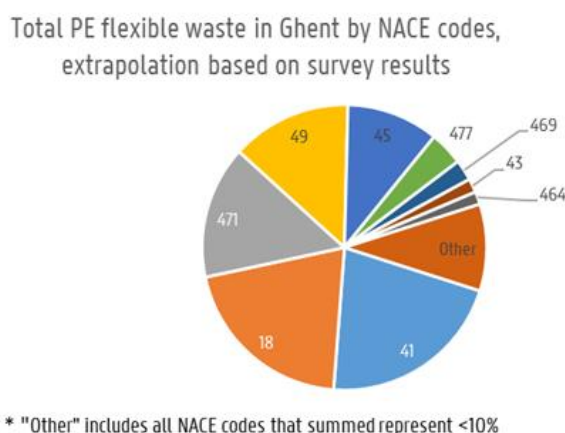
3.5.2   Test collections – larger scale survey

To verify the findings of the (top-down) MFA and the screening survey, it is important to achieve a better standard of representativeness. A good understanding of the local waste streams is the basis for the development of new value chains. We recommend following the scheme presented in Figure 11.

Figure 11: Scheme for characterisation of waste streams

3.5.2.1   Sampling

If separation at source is considered, it has to be developed in close co-operation with local recycling companies. Developing and communicating clear waste sorting rules is important for reducing material contamination.

Tracing the waste is a key innovation and will increase knowledge of the waste composition. Therefore, we recommend implementation of a barcode system, as it is an easy way of tracing the origin of the waste in an anonymised way and the data is easily transferable in a central database for waste analysis. This can create systematic and generic knowledge on the waste quantities and qualities. Furthermore, it can help to detect problem waste streams and keep them apart from high-quality streams.

As an example, the collection tests for retail businesses that took place in Ghent are presented here. In co-operation with local film and rigid plastic recyclers, separation at source into five waste streams was agreed. The source separation was planned to take place using a multiple bag system of five different colours, with a barcode system that traces the following:

- tag (number of the barcode)

- actor's name

- actor's address

- bag type

- date of collection

- weight

- additional comments.

A sorting guide, specifying which plastic fractions should be put in each of the coloured bags, was developed and distributed along with the bags. This sorting guide is shown in Figure 12.

Figure 12: Sorting guide for businesses, following separation at source into five fractions, developed for Ghent

In order to keep the collection test at a feasible level, we recommend not to examine more than two sectors simultaneously. For each sector that is to be studied, a minimum of 15 actors that are willing to co-operate with this test collection need to be found. We recommend collecting over a period of one to two months to reach a minimum of 10–15 m³ per collected waste stream per sector for representative sampling.

3.5.2.2   Characterisation of the waste streams

The collected waste materials are then analysed for composition and potential contamination. If tracing has been completed for each company, e.g. via a barcode system, analysis on a company level can be conducted and a feedback loop implemented to improve sorting at source.

Alternatively, analysis per sector and per stream can be conducted. In this way, a representative sample is taken from the collected waste stream. To our knowledge, there are no clear guidelines for representative sampling of C&I waste, but a common practice is to follow the quartering method. Here, the waste fraction is, firstly, homogenised, e.g. with the help of a small crane. Afterwards, the waste fraction is divided into four sub-fractions and one fraction is chosen at random. For this chosen

sub-fraction, the homogenisation and further subdividing is continued until a sample size is reached that can be analysed. We recommend 100 waste items as a representative sample size. These 100 waste items are analysed following the scheme in Figure 11.

As the focus is on plastic waste, it is recommended to carry out Fourier-transform infrared spectroscopy[4] (FTIR) analysis to determine the major polymer type, coupled with differential scanning calorimetry[5] (DSC) analysis to confirm this and detect potential further polymers. In addition to this, a visual analysis, e.g. with the help of a sorting table, can be performed to get further insight into the sizes of the material, potential miss-throws and further contamination. Washing, de-labelling, de-inking or delamination can be performed to increase the purity of the streams.

This analysis will lead to a better understanding of the waste streams. When detailed information about the material streams from different sectors is known, potential lumping strategies to increase the material volume can be performed (see Figure 13).

3.6   Lumping strategy

At the heart of the PlastiCity strategy is lumping (see Figure 13). This means collecting specific wastes from specific sectors (and separating it at source) to achieve large quantities of good quality waste (a secondary resource). The previously described analysis of plastic waste from C&I sources is the basis for development of potentially viable (e.g. related to logistics) scenarios towards new recycling plants and value chains.

Waste streams that are typically seen as being too small to be worth the effort might become worthwhile if they are aggregated from several actors. However, this requires that actors are chosen with such streams that are not too commingled with other waste, which can be costly to separate out.

For example, plastic waste of one fraction, e.g. transparent film, and from one industry sector can be combined with the same fraction from another industry sector. To ensure a good mixture of the material, another homogenisation step should take place. The combined, or 'lumped', fraction can be processed following the recommendations in Section 3.7, to gain insight on the effect of the mechanical properties of the recycled materials.

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[4]   FTIR   is a technique used to provide quick and definitive identification of compounded plastics, blends, fillers, paints, rubbers, coatings, resins, adhesives and contaminants
 (https://www.thermofisher.com/blog/materials/ftir-a-valuable-tool-in-plastics-analysis/).

[5]   DSC   analysis is a technique used for determination of the thermal characteristics   of polymers and plastics (https://polymerscience.physik.hu-berlin.de/docs/manuals/DSC.pdf).

This exercise should determine which of the local sectors could be easily combined or whether there are sectors with 'problem material' that would be better not mixed with the other sectors. This should then lead to sufficient material with the least possible loss in quality for further recycling.

Figure 13: Lumping strategies example
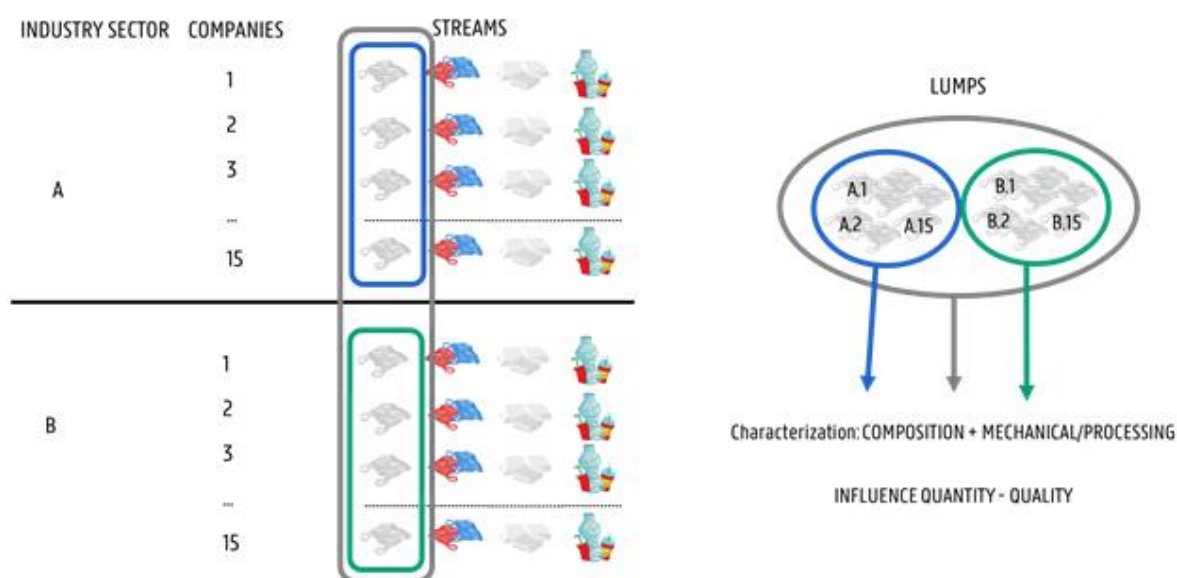
3.7 Processing tests

Based on the elaborated separation at source, the different plastic fractions can be reprocessed, e.g. in an extrusion processes, as shown in Figure 11. Prior to the polymer processing technique, the plastics have to undergo several pre-treatment steps. All collected fractions of the plastic waste must undergo shredding for size reduction. This step is necessary to make the material more manageable in the next steps of the recycling chain. It should be ensured that the waste streams do not contain any contamination (e.g. metals, stones) that could damage the blades of the shredder. Techniques such as a preceding ballistic separation, sink–float and/or removal by magnets can offer solutions. Assuming adequate separation at source and the smart lumping of companies with similar plastic waste, streams of high purity can be recovered. Thus, it is expected that ongoing contamination issues will only occur for the most contaminated streams.

For the two clean film fractions, a densification step should be considered to facilitate the final polymer processing. In this process, the film material is agglomerated by heat treatment. It is also possible to re-granulate it into pellet form. De-inking of the printed films can be considered with a view to (semi-)closed loop recycling towards new film material.

In an ideal scenario, in which the 'clean rigid plastics' fraction consists of only one type of polymer, a single shredding of the material is sufficient. For a more heterogeneous composition, separation techniques such as a simple sink–float or a more complex infrared flake sorting can be opted for.

The remaining plastic fraction might contain valuable plastics that require additional pre-treatments. Initial sorting can consist of separation into flexible and rigid fractions by means of wind shifting. These plastics should undergo a washing treatment, in which they are de-dusted and stripped of (organic) contaminants. Further sorting by polymer type, or even a simple separation into light (density: <1 g/ml) and heavy fractions, can be considered.

3.7.1   Mobile recycling lab

In order to find solutions for plastic collection and recycling, we need to first understand the types and volumes of plastic generated in each of the four regions. At PlastiCity, we developed a mobile recycling lab (MRL) (see Figure 14). The MRL serves for demonstration purposes, showing off the possibilities and opportunities that exist for plastic recycling.

The MRL can identify the particular type of plastic contained in the waste item analysed. By identifying the polymer and testing various materials in the MRL, options can be identified for processing the plastic waste into something new.

The MRL comprises two shipping containers that are each divided into two sections. The first container focuses on pre-treatment of plastic waste and houses washing installations, sink–float tanks, hydrocyclones, a decanter centrifuge, shredders and a dryer. The second container is for characterisation and reprocessing. It houses a state-of-the-art extruder with cooling unit, and a calendar unit and pelletiser to process shredded plastic waste into recyclate. Furthermore, a characterisation laboratory area is also part of the second container. The waste items can be characterised via infrared, melt flow and differential scanning calorimetry. Finally, recyclate properties can be determined via a tensile testing machine.

Figure 14: PlastiCity mobile recycling lab

3.8 Engagement of actors

This part of the strategy deals with the engagement of actors in order to develop business opportunities. First of all, this means that the actors in the (local) plastics chain must be known and business opportunities have been identified. In this project, identification of the business models was achieved by means of workshops.

For bringing about real change in the plastic landscape, the actors involved need to become engaged stakeholders who are willing to actively map business opportunities and invest in the development process. One of the objectives of the PlastiCity project is to identify at least four new value chains, e.g. the creation of new – or the development of existing – products made from recycled plastics that have a viable business case. Creating business opportunities is only possible if actors become stakeholders and are willing to invest in the efforts necessary to achieve the business opportunity. For example, the

www.plasticityproject.eu

partners on the PlastiCity project represent only a selection of the actors in the plastics chain. Although different kinds of partners participate in the PlastiCity project, it is mainly driven from a governmental and research point of view.

This means that, in addition to their own policy targets, governments must also integrate commercial thinking into the project, in order to realise the business cases. It is not sufficient to only research whether a case could be viable. Realising the cases requires the involvement of actors in the plastics chain. After all, realising the identified opportunities requires actors (like developers, users and manufacturers) who are not only willing but also able to capitalise on the opportunities. Design and/or production of plastic (packaging) objects and selling these products is not a task for governments, research institutes, or waste producers and collectors, but a task for businesses!

Therefore, in Section 3.9, it must be remembered that an identified business opportunity requires a commercial approach, a particular mindset and the right actors in order to be realised. This will be discussed further in Section 3.9.

3.8.1   Engagement through workshops

To attract as many actors as possible within all sectors of the plastics chain and to select stakeholders from these actors, we organised workshops on:

- Urban platform (UP) development (x2)
- New value chains
- Design for new products and more use of recycled content in existing products.

Urban platform (UP): In the context of PlastiCity, a UP can be a digital environment and also a physical platform.

In a digital platform, large amounts of data and intelligence about plastic production and recycling activities is collected and combined. In general, this might include data on plastic recycling and flows, business activities, transportation, circularity, innovation, case studies, education and behavioural change. An example of a more general digital UP can be found at: https://www.smartsouthend.org/.

The UP digital environment brings stakeholders and actors together to exchange data, develop ideas, identify new opportunities and guide decision-making in the circular economy for plastics. The UP aims to start a co-creation process (ideas, opportunities and decision-making). The idea is that it provides building blocks towards long-term change in urban environments and follows up the results of past interventions.

In the physical platform, at least 50 users create a community for capacity building and co-creation. This is done by organising workshops, developing new plastic recycling and value chains, and realising new local markets for recycled plastic products. The UPs are in direct contact with the PlastiCity hub

to physically design, produce and prototype the products, and thus increase plastic recycling rates at a local level.

At PlastiCity, the aim of the first workshops was to establish a UP in each of the four partner areas. It also allowed the project team to get to know the actors on a partner level and to screen them to determine whether they could become stakeholders in the project.

As different actors are integral for the generation of capacity and co-creation of value in new chains, it is important to understand how their decision-making can be affected through behavioural change. In this respect, a UP and the data clustered in it is used to facilitate drivers (including education of best practices) and to prevent barriers to plastic recycling, such as the need for infrastructure.

In the recycling system, actors have to identify competitive business cases and perform technical solutions across the value chain. Therefore, in workshops, the potential/real drivers and barriers related to plastic recycling are discussed further.

Depending on the outcomes of the workshops, a specific UP is built to increase capacity, exchange information between actors, recognise better opportunities and lead decision-making.

The aims of subsequent workshops are to establish the UP and select stakeholders who will drive the project forward.

3.8.2 Workshop planning and structure

In this section, we present our planning and structure of the first PlastiCity workshop as an example. However, workshops can have different targets and set-ups. Figure 15 shows the sequential set-up we applied in the PlastiCity project. As shown, it is helpful to break down your goals and present them over the course of your project.

Figure 15: Example of the PlastiCity workshop timeline

goal sept 2020 : establishment of 4 urban platforms & 4 new value chains & demo 4 newly designed products

Handbook finished
Before 30/4/2022

First Workshop
Urban platforms
4 regions
Before 30/4/2020

Second workshop
Urban Platforms
Before 31/12/2021

ZERO WASTE
LABEL
Before 30/4/2022

2020   2021   2022

Workshops with
actors : potential
new value chains
31/10/2021

Workshop with
designers
31/10/21

Life cycle
assessment
Before 30/4/2022

Feasibility study
Business cases
4 regions
Before 31/10/2021

As workshops are a very effective way of gathering information and forming collaborations, they should be planned and shaped based on the specific needs of the project and project area – for example, they can be held as follows:

- with all sectors being represented, to get an overall view of the needs of the value chain
- with only the actors per one sector, focused on a specific problem (i.e. with manufacturers and waste companies in order to discuss separation of plastic and design criteria)
- with the aim to develop a specific business opportunity, with the instigator and stakeholders who are involved in the corresponding plastics chain.

3.8.3   Workshop participants

In order to replicate our strategy, we suggest aiming to have 60 participants in each workshop (as shown in Figure 16).

Figure 16: Number of participants and facilitators in each workshop
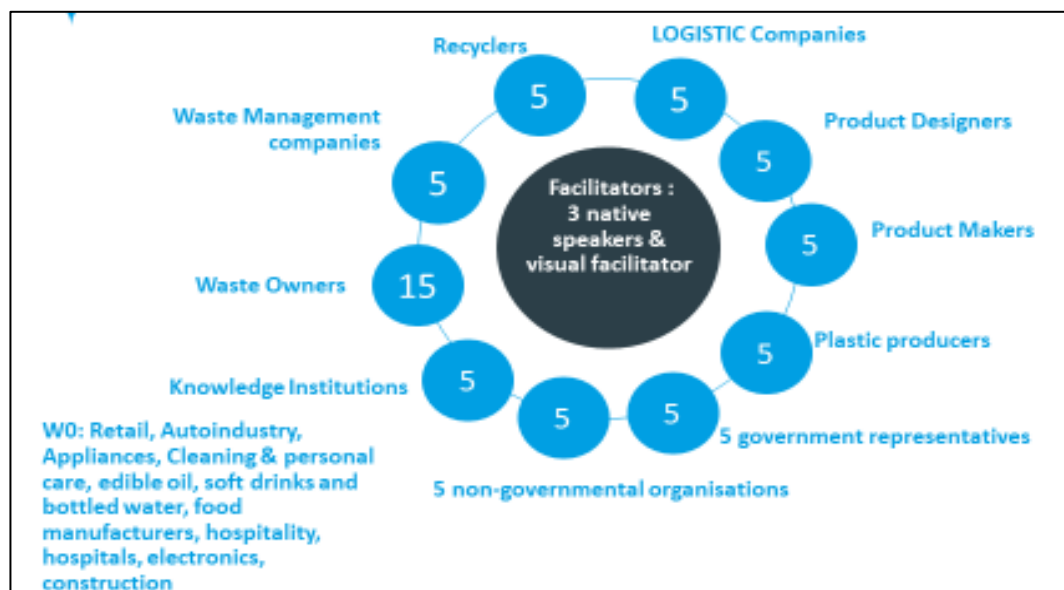
We suggest having at least three waste owners and one of each of the other actors on every table at the workshop. However, numbers may be adjusted according to the availability of the participants. For example, as one of our partner cities, Southend-on-Sea, had only one recycler, there was only one table with a recycler present at the workshop in that city.

Additionally, it is recommended that workshops are conducted in the local language, with at least three native-speaking facilitators. It is also suggested that (depending on budget) a visual facilitator/graphic recorder is present in the afternoon session to create a graphic depiction of the discussions, which can be presented in the wrap-up and uploaded onto, for example, the project's webpage/UP/digital environment.

In terms of workshop duration, we suggest running them over a full day. The rest of this section highlights the schedule and provides an explanation of every activity that we had in our workshops.

Key outputs of the workshops should be:
- the identification of alternative scenarios for more efficient plastic/waste recycling
- to involve stakeholders in the development of the UP/collaborative environment
- to select stakeholders who will drive the project forward by actively mapping business opportunities and investing in the development process
- the identification of new value chains and business cases for plastics in the circular economy
- the design of new products made from recycled plastics.

3.9 Changing the status quo

PlastiCity is developing and demonstrating strategies and solutions to increase the recycling of plastics for high-end applications. PlastiCity contributes to the strategy for smart, sustainable and inclusive growth, and to the achievement of economic, social and territorial cohesion.

In order to achieve an increase in recycling rates, actors need to be involved in the realisation of (new) recycled plastic products on a local/regional level. Therefore, it is essential to identify (new) business opportunities and corresponding business models, and determine how to develop them into business cases/new value chains on a local/regional level.

3.9.1 Business development

In the classic economic approach, a business case – or, even better, a feasible and viable business case – is one in which a return on investment or growth opportunities can be created.

Business (case) development entails all tasks, which serves the purpose of 'developing' the business opportunity and implementing the creation of long-term value for an organisation, customers, markets and relationships.

A tool to be used in the process of business development is the business model. At its core, a business model is a description of how the business makes money. In its simplest form, a business model should contain three parts:

- **How to produce:** design, materials, equipment, manufacturing, labour and so on.
- **How to sell:** marketing, distribution, delivering a service and processing the sale.
- **Costs and return:** all costs, revenue, pricing strategy, payment methods, payment timing and so on.

In classic economics, the primary corporate objective is mainly on profit maximisation or pursuing cost-cutting through greater efficiency in supply chains, factories and operations. This has more or less led to the classic linear economic approach of 'take, make, waste' (see Figure 17).

Figure 17: Example of the linear economic model
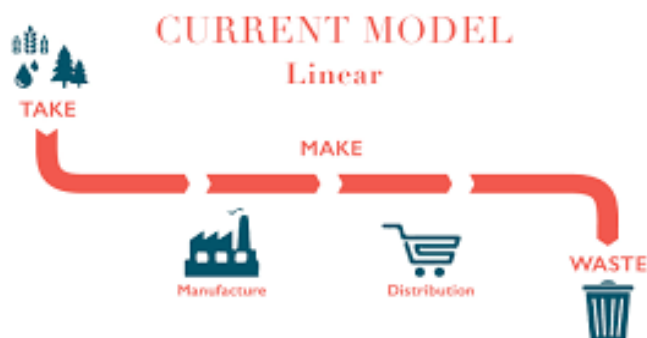
If businesses are aimed at self-preservation, they should take their natural prerequisites into account to ensure they do not endanger their own, or their client's, existence, due to depletion of resources and the effects of climate change. In previous years since the Industrial Revolution, this has not always been the case.

Nowadays, society is more aware of the need to also take natural and social prerequisites into consideration. So, a shift towards a circular economy and entrepreneurship is required, using circular business models.

Circular business models articulate the logic of how an organisation creates, offers and delivers value to a broader range of stakeholders, while minimising ecological and social costs or considering ecological and social aspects as two of the 'stakeholders'.

The circular business models described in the following sections provide opportunities for implementing the idea of circularity at a practical level. Circular entrepreneurship entails new business models. The 'Value Hill' proposes a categorisation of circular business models based on the lifecycle phases of a product: pre-use, in use and post-use. This allows businesses to position themselves on the Value Hill and understand potential circular strategies they can implement, as well as identify missing partners in their circular network (see Figure 18 as an example).

Four business model categories can be distinguished in this approach. They are briefly described in the following sections and contain the key elements of strategies that contribute to a circular business. They all have their own distinct characteristics but no precise boundaries. They can be used singly or in combination.

Figure 18: Example of circular business activities on the Value Hill
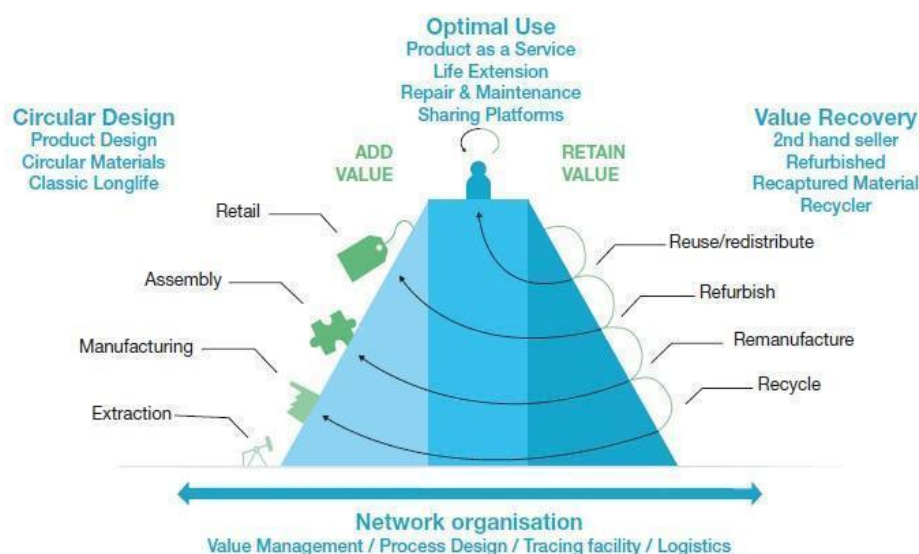
3.9.2 Circular design

In the business model category of circular design, the focus is on the development phase of a product. In these models, products are designed to last longer and to be easier to maintain, repair, upgrade, renew (refurbish), remanufacture or recycle. In addition, new materials are developed or used; for example, bio-based or fully recyclable materials. Examples of business models in this category are given below (Achterberg, Bocken and Hinfelaar, 2016):

- Product design: Development of products designed for easy maintenance, repair and renewal; for example, a modular product.

- Long lifetime: Development of products that last a long time.

- Circular materials: The supply of input materials such as renewable energy, bio-based materials or fully recyclable materials.

- Adequacy: A high price per product can justify lower volumes.

3.9.3 Optimal use

These business models focus on the use phase of a product by optimising use, and thus extending its lifetime and saving raw materials. This makes it possible to maintain ownership of the product (for example, by offering a product as a service instead of selling it) and to take responsibility for the product throughout its lifetime (for example, through maintenance services or other add-ons that extend the service life). These business models involve a switch from selling products to selling contracts.

Examples of business models in this category are as follows (Achterberg, Bocken and Hinfelaar, 2016):

- Product as a service: Delivery of product performance rather than the product itself, through a combination of products and services. Ownership of the product is maintained by the service provider.

- Sell and buy-back: Selling a product on the condition that it is bought back after a certain period, so that it can be reused.

- Sharing platforms (access provider): Increased utilisation of products by enabling the sharing of use, access or ownership.

- Service-life extension: Extension of the useful life of products and components through repair, maintenance or upgrades.

- Support lifecycle: Sale of consumables, spare parts and add-ons to support the lifecycle of products.

3.9.4   Value recovery

These business models focus on the output and added value of a product after the use phase. They generate revenue through the transformation of used products into new products, usable components or raw materials. The development of reverse logistics is essential for this model. Examples of business models in this category are given below (Achterberg, Bocken and Hinfelaar, 2016):

- Second-hand seller: Sale of used products.

- Innovator: Renovation (refurbishment and remanufacturing) of used products with the aim of selling them.

- Reclaimed materials supplier: Sale of reclaimed materials and components instead of virgin or recycled materials.

- Recycling facility: Transformation of waste into raw materials; extra turnover through innovation in recycling technology.

3.9.5   Network organisation

The activities in the categories discussed above cannot individually achieve a circular economy. Collaboration is essential. Network organisation models concern business activities in which collaboration and co-ordination of circular value networks are supported.

At the moment, there are companies such as Recover-E and Dutch aWEARness that have taken on the role of chain director, but there is also a need for joint co-ordination, which requires new ways of organising.

Examples of business models in this category are as follows (Achterberg, Bocken and Hinfelaar, 2016):

- Recovery provider: Sale of take-back systems and collection services to recover usable materials from discarded (by-)products.

- Asset tracking and monitoring: Services for tracking, monitoring and trading of products, parts and materials.

- Contract management: Facilitating the drafting, handling, execution and/or enforcement of contracts.

- Financial services: Services that manage money flows, for example, facilitating chain financing, debtor management, inverse factoring and creditworthiness checks.

- Data services: Services that manage, co-ordinate and facilitate information flows.

3.9.6 Determining potential business opportunities

The main aim of the PlastiCity project is to increase recycling rates of plastics. To do this, we have to make use of more than just one circular business model, i.e. value recovery and more specific reclaiming of materials (the sale of reclaimed materials and components instead of virgin or recycled materials) in combination with recycling facilities (transformation of waste into raw materials).

To determine a potential business opportunity, it is not only the costs and profits that have to be determined but also the principal aspect: plastic products. This must be done with actors willing to be involved in product/business development.

In order to develop a business case based on the circular business model, insight is needed into:

- a potential (new) product
- the whole material chain (from raw material to waste)
- product quality criteria
- actors involved in the chain who want to be stakeholders
- financial (purchase and production costs, market, pricing, etc.), social and environmental impacts
- ideas about the business model(s) to use.

Taking these aspects as a whole determines whether a feasible business case is possible. Gaining insight into these aspects requires involving actors and their agreement to share the risk of developing and realising the potential business opportunity.

> For each partner area at PlastiCity, the overview of the sectors and companies in the plastics chain was made concrete on the basis of an up-to-date list with NACE codes. In this way, the potential functions or roles of companies in the plastics chain were captured.

If a potential new product or business opportunity has been identified and the actors have been mapped, the initiator needs to acquire information about the specific plastics chain (from the resource phase up to the waste phase). The actors in the chain will be familiar with the issues that could be important in realising a circular business model and they will be able to inform the initiator about them. The actors might highlight issues that are unknown to the initiator or share insights that they have encountered in their work on a specific part of the plastics chain. Conversely, it could well be the case that the circular business model presents issues that are unfamiliar to the actors in the supply chain. It could also turn out that the current supply chain is incapable of complying with the requirements of the new business model and therefore that new supply chains must be set up.

In order to gain access to the information, the initiator needs to talk to the actors – not only to retrieve information about how the chain works, its pitfalls and benefits, but also to learn whether there are actors who are willing and able to be engaged in the business development and, if so, in what role.

If this is the case, actors become stakeholders. Especially in the situation when starting up a new development, it is crucial to involve not just the actors who are only interested in playing their part and generating revenue, but also those who are willing to be engaged and become stakeholders.

Filtering out stakeholders from the actors is a delicate process and often goes beyond the present linear economics logic. In the case of a circular business model, it certainly goes beyond the linear business case requirements. Aspects like intrinsic motivation, whether there is a circular business policy in place, the sharing of crucial information, playing a part in the plastics chain, willingness to offer support even though the payback period is long and creating added value other than just increasing the price are equally as important as making a profit.

There is not a list of objective criteria that can be used to select stakeholders from the actors. Nevertheless, as an initiator you need to find out what is important for your business model, and which criteria you want to be met and in which phase of the development process (start-up or maturation phase).

3.9.7 Role of governmental organisations

Governments have a specific role in realising a business case in the plastics chain. In PlastiCity's philosophy, governments are, of course, waste owners

Governments are not directly involved in commercial activities; they are not designers, producers or parties that put a product onto the market. They are, however, involved in the business case in a more indirect way – such as, as (A) initiator, (B) mediator, (C) facilitator, (D) licensing authority and/or (E) (launching) customer.

The main functions or roles of governments are:
A) Initiator
- initiate projects, such as PlastiCity
- develop local or regional policy on circular economy
- develop policy on circular procurement

B) Mediator
- bring together actors and stakeholders
- organise workshops between stakeholders

C) Facilitator
- make locations available
- provide grants aimed at developing, producing or recycling plastic products

D) Licensing authority
- assist in permitting recycling facilities
- designate specific locations in special planning for plastic recycling activities

E) Launching customer
- purchase products
- develop specific criteria for recycled products when purchasing products

If the government uses these roles to stimulate the market and the market parties to help achieve its policy objective, the change in the plastics landscape – from a linear model to a circular model – will certainly be enhanced.

3.9.8 Changed boundaries and project opportunities

PlastiCity uses a certain strategy to accomplish changes in the plastics chain that favours recycling rates and reuse of plastic, and involves multiple actors. In general, the strategy is aimed at gaining a deeper insight into the chain, and the amount and composition of plastic waste from different actors in the chain.

When executing the different steps in the strategy, actors in the chain will react to the activities, i.e. 'wake up', get triggered and respond, and thus create new opportunities. At the same time, external effects can change the landscape during the execution of the project, which for the PlastiCity project were the decrease in oil prices and the outbreak of COVID-19. It is always important to be aware of shifting boundaries, interest and relations, because they also create new opportunities which were not foreseen when drafting the project plan.

When the original landscape changes and new opportunities arise, it could mean that planned actions cannot be executed, and new opportunities and actions present themselves. These new opportunities have the best chance of being successfully executed. Flexibility in planning and implementation of the project is therefore of great importance to realise the goals of the project. Below are some examples to illustrate this.

The outbreak of the COVID-19 pandemic caused a shortage of personal protective equipment
Based on existing contacts with a hospital, it was jointly investigated whether it was possible to produce a face shield from recycled plastic. Although developing a new business case was not yet scheduled in the project, we seized the opportunity right away and looked for suitable production companies. We were able to produce several different sample copies, test them, select a preferred shield and produce it within two weeks, for the same price as a shield made from virgin material.

To develop this business opportunity into a new value case as intended by the PlastiCity project approach, it meant examining the options to redesign the current chain into a local recycling chain and thus create additional environmental benefits.

This example also demonstrates that workshops to organise and design UPs in order to exchange data, develop ideas and identify new opportunities are not essential for the identification and development of business opportunities.

Another opportunity presented itself, which was caused by the delay of the MRL being stranded in one of the pilot cities due to COVID-19.

Revised plans for the MRL during the COVID-19 pandemic

Following the regular strategy, we would first map the plastic waste flow among the different actors who were identified, before collecting samples of the plastic waste streams and examining their characteristics.

Due to the delays, we decided to skip the plastic waste scan, and instead directly collected the plastic waste before executing the analysis afterwards. Furthermore, we developed the option of collecting plastic input quality criteria from plastic designers and producers, and trying to combine this with the quality output criteria from the MRL. This enabled us to get in touch with the designers and plastic makers to start discussions (although not in the regular planning phase yet) on the development of potential products from the recycled plastic.

Because it was also difficult to meet with designers and product makers, partners decided to undertake an inventory on successful recycled plastic products. Based on the outcome, we then further analysed whether these products could be translated into a potential local value chain.

3.9.9   Non-disclosure agreement (NDA)

Finally, in the situation where a potential business opportunity is shown to be feasible or when an initiative is taken up by a company, a certain form of confidentiality and/or careful selection of stakeholder involvement may be necessary. This is to protect the commercial interests involved, and to avoid competition during the initial phase of product development and introduction. Under these circumstances, all parties may prefer to sign an NDA.

4 Considerations for choosing a hub

This section of the strategy will focus on the steps we have taken to plan and develop plastics recycling hubs, and summarise our rationale for selecting the locations. At PlastiCity, a hub is defined as a local network of relevant partners and physical infrastructure, supported by a digital environment/UP, which enhances stakeholder engagement and takes steps to remove barriers. The aim is to increase the quantity/quality of plastics recycling in the region.

Ideally, a hub is a plastics refinery with all the actors in one physical location (pre-treatment, recycling, designers, (reverse) logistics), and with nodes deeper into the city/region for temporary storage and transhipment. However, due to practical implications, these hubs can also be a series of well-linked locations within and outside the cities.

As discussed in Section 3.3 (Mapping the actors) and Section 3.5 (Insight into current situation of plastic waste flows in the C&I sector), the data gathered should provide valuable information for the optimum location of the recycling hub. However, there is also other important information to consider, as summarised in Table 4.

Table 4: Hub considerations

Elements	Considerations
Reasons for the hub	Initially, it must be decided what the reason is for the hub and what it should look like. This is region dependent – e.g. whether it will be a place to give start-ups the opportunity to launch a business case, a digital environment aimed at developing a smart recycling community or a place for testing and product development.
Engage with stakeholders/actors	Stakeholder and actor involvement is important for establishing the need for and design of the hub. If it is a physical hub, stakeholder support is crucial, especially throughout the planning and permitting process. Fine-turning the hub concept and gaining support can be achieved through workshops or consultation events.

Scoping the concept	Document the concept, rationale and scope. Indicate both qualitatively and quantitatively what kinds of activities will take place (e.g. 3D printing, manufacturing, how many companies, how many employees). Is a local chain being set up, or is the plastic mainly being disposed of outside the city? Indicate what the focus is on: testing, education, awareness or profiling. For example, guided tours can be given for school children, entrepreneurs, etc. Is work needed with external partners? If so, who are they and what are their roles in the hub?
Estimated lifetime of the hub	Is the hub intended to be a temporary structure, for a limited period only? If so, consider what will happen to the waste that is left over after the trial and also to the vacant site. Will the waste be carried away via a separate contract, reused or otherwise handled? If it is to be a permanent facility, then consideration will need to be given to the long-term vision, e.g. who will operate it, how will the business grow, how will local and national policy influence the hub, how will it be financed, and what are the permitting and licencing implications?
Location	Deciding where the plastics hub will be located has many considerations and these will be dependent on its purpose. It is important to consider social issues, such as equity in the site choice, the effect on community image, aesthetics, and alternative and future land uses.

If the hub is to be sited in a rented building, then it is important to check the availability of this, and ask a relevant professional to review the terms and conditions of the lease to ensure it is fit for purpose. |
| Planning and permitting | Important planning considerations might include potential groundwater pollution, air quality issues and transportation concerns. Also, are there any other planning restrictions in a particular area – for example, noise restrictions, pollution controls or ecological considerations, i.e. Sites of Special Scientific Interest (SSSIs) and National Nature Reserves (NNRs)? Carefully research local planning rules, as these will help with |

	establishing the suitability of a location and the possible need for an Environmental Impact Assessment (EIA).
Technical and utilities requirements for operation	When planning the technical and utility requirements for running a hub, considerations should include electricity, sewerage and waste water, fresh water, temporary storage, staff facilities (e.g. toilets, rest rooms, desk space), telephone lines and internet connections.
Governance and staffing	Decide who will run the hub: the municipality or (a group of) entrepreneurs/stakeholders? How many members of staff will be required? How will they be trained?
Sustainability	How is the required energy generated: is it sustainable or not? Is the water that is being used from a mains tap or from rainwater, for example? What is the predicted carbon footprint? Is a sustainability assessment required?

5 Considerations for logistics

When developing logistics scenarios, the first step is to gain a deep understanding of the local situation, and its possibilities and constraints. For instance, is it a city centre with access restrictions? Is there a city mobility plan prescribing certain routes for lorries? Does the city have tram rails? Are there canals or shippable rivers in the city? Are there areas with a high concentration of shops and other businesses, such as a high street or shopping malls? If so, local recycling hubs or local collection tours might make sense. Also, what is the current waste collection, sorting and recycling solution? Is waste being pre-sorted and, if not, is there political will to implement this in the future? It is also worth exploring whether there are any pre-existing pilot schemes, such as reverse vending machines for PET bottles at schools, a waste collection tram, or a social inclusion programme where people can collect recyclables and get paid upon delivering them to a recycling centre. In cases where such pilot schemes exist, it is worth investigating them to either understand why they failed and learn from them, or build upon their successes.

When developing scenarios, one should start with a brainstorming session, where all ideas are welcomed. Some of these may turn out to be more realistic than initially assumed. However, it is also necessary to consider the local constraints in terms of space and infrastructure, as well as economical aspects. Unless the recycling operations are going to be cross-funded, whichever scenario is being developed must make economic sense. Therefore, a full cost–benefit analysis, including environmental and social costs and values of economic activities, must be conducted to support the decisions. In projects related to waste recycling, the triple bottom line (TBL) accounting framework is often referred to.

At the strategic level, considerations for waste plastics include the processes of collection, separation, sorting and reprocessing (Bing et al., 2016). In some cases, the separation of waste plastic from other waste is done at the collection point, while in others the waste is sent to a separation centre for this procedure. After separation, the waste is normally sent to a sorting centre, where further sorting of the material by composition is conducted. Next, the sorted waste will be transferred to specialist treatment facilities for recycling. A typical procedure for the logistics flow is shown by (Bing et al., 2016) in Figure 19.

Figure 19: Recycling logistics flow for waste plastics
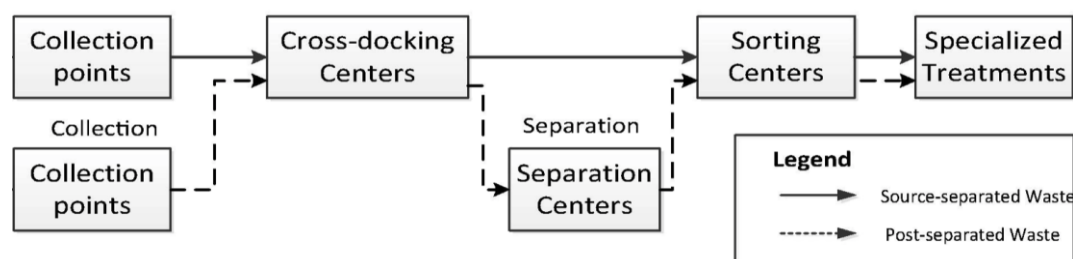
Source: (Bing et al., 2016)

Waste plastics are quite particular in several ways. They are lightweight and yet often take up a large volume. Their value depends on purity (i.e. different materials not being mixed) and cleanliness (i.e. the absence of contamination). On the face of it, it would appear that shredding plastics before transportation would make sense to achieve maximal compacting. However, once plastics are shredded, it is much more difficult to separate different materials, and sorting them requires know-how and expertise. Therefore, best practice is to only compact plastics by pressure before transport and to shred once qualified sorting has taken place.

Pre-sorting at source often makes sense, as it is much easier than post-sorting (sorting after transportation). Pre-sorted materials only need to be checked at the recycling centre, which means a much lower manpower requirement. However, pre-sorting requires that waste producers are instructed accordingly and space is required for different bags/containers for different materials, but this is not always feasible.

Another aspect to bear in mind is that whenever plastics are moved from one container to another, mixing occurs and any contamination might spread. Therefore, when considering multi-modal transport (e.g. combining eCargoBike and boat), it is preferable to transfer the whole container rather than moving the plastics. This has implications on design and infrastructure; for example, a crane might be needed to lift containers.

The capacity and location of facilities further complicates the consideration of logistics. For example, Germany and the UK have their own sorting and reprocessing facilities, while the Netherlands has most of its sorting undertaken at facilities in neighbouring countries. Although data for the capacity of plastics processing facilities is limited, evidence shows that counties with relatively more developed waste recycling systems (e.g. the UK and Germany) might experience an over-capacity problem. As discussed in the 2012 Waste Management World report (https://www.worldbank.org/en/news/feature/2012/06/06/report-shows-alarming-rise-in-amount-costs-of-garbage), "If all of the facilities which have been granted planning consent are built and if waste arisings remain flat, then the UK will have 5 million tonnes more capacity than it requires". To

improve the efficiency of existing processing facilities, co-operation across different countries and the transport of waste plastics from one place to another for processing should be considered. As (United Nations, 2012) reported, a significant volume of emissions can be avoided by shipping waste from one country to another with more advanced processing technology, even after factoring in the logistics emissions.

Finally, a note on social inclusion projects: these work best in public spaces, addressing waste that is left behind. However, in the context of waste collection from companies, members of the public usually would not have access to the waste due to safety and security reasons. Furthermore, licences are required to be authorised to transport commercial (and household) waste in European countries. Therefore, the possibilities for large-scale social inclusion projects and the informal sector are limited.

5.1 Transport modes

In order to find the best potential strategy for plastic waste flows and to make a final decision, it is important for cities to compare different transportation alternatives for waste. In this regard, Table 5 presents a comparison of the economic and environmental vehicle parameters. Note that the highest speeds are somewhat irrelevant (except for the eCargoBike), as speed restrictions are considerably lower than the theoretically possible maximal speed of a lorry.

Table 5: Comparison of different transport modes

	DIESEL	BATTERY ELECTRIC	HYDROGEN-ELECTRIC	E-CARGO BIKE
Examples:	Heil Trucks[1]	BYD Trucks[2]	E-truck Europe[3]	E-Cargo[4]
Primary power unit	Diesel Engine	Battery	Hydrogen Fuel Cell	Battery
Est. Range	1500 km	200km	700km	N.A
Est. Fuel consumption	30L/100km	120kwh/100km	15kwh/100km, 2kg/100km	N.A
Fuel price	130 p/litre (average in 2019, UK)	10p/kwh	10p/kwh, £7/kgH$_2$	N.A
Speed (highest)	300 km/h	105 km/h	105 km/h (assumed)	20 km/h
Refuel/Charging Time	15 mins	9hrs AC (/2.5 hrs DC/1.5hrs DC)	15 mins	2mins (Battery Replaceable)
Loading capacity	20m^3	20m^3	20m^3	0.48m^3
Payload	16000kg	16000kg	16000kg	125 kg
CO2 emission	132g CO2/Km	0	0	0

Sources:
1.https://www.heil.com/products/automated-side-loaders 2.https://en.byd.com/truck/ 3.https://e-truckseurope.com/ 4.https://e-cargobikes.com/ 5.https://www.london.gov.uk/sites/default/files/london_-_a_capital_for_hydrogen_and_fuel_cell_technologies.pdf

6   Future work

The PlastiCity project has developed this conceptual strategy to enable policymakers and businesses to identify and make changes to the plastics value chain. It focuses on gaining a deeper insight into the value chains, and the amounts and composition of plastic waste for different actors in the chain. After all, having an insight into the C&I waste sources and flows in a given area informs the decision-making process.

The initial phase of our project examined the factors that influenced the plastic flows and recycling, with the aim being to understand the status quo. The next stage of the process was to launch the MRL, to research and identify business models, and to develop the recycling hubs in each region. We will measure the success of the project's activities by conducting another waste characterisation study towards the end of the project.

This is a dynamic document that will be continually edited and updated throughout the lifetime of the project.

Ultimately, this report will be used to inform our PlastiCity Handbook.

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8 Appendices

8.1 Appendix 1

Attitude and Behaviour survey for Waste Owners- Survey example

Hello,

This survey is part of the PlastiCity project. This Interreg 2seas project is a joint collaboration of both public and private partners from the UK, North of France, Flanders and The Netherlands.

Plastic is one of the major waste issues at this moment. Plastic waste is found in all parts of nature. Some examples include:

- in the stomachs of fish and birds
- floating in the ocean
- along the roads
- micro-plastics can even be found in the food we eat

The aim of the PlastiCity project is to **develop solutions for recycling and putting lost plastics to good use**. Our aim is to help improve plastic recycling rates to 60% or higher. This will include reusing plastic to make new products. PlastiCity will raise awareness about the risk of poor plastic disposal and plastic recycling.

The aim of this survey is to learn what would motivate people to recycle plastic and what people feel stops them from doing so. Therefore, it would be a great help if you would complete the survey to help us gather this info. Your answers will help us to focus on removing the barriers you experience in recycling plastic and to realise and investigate any opportunities you see to re-use plastic, avoid new plastic production or reduce plastic waste.

Your answers will only be used within the PlastiCity project and may be shared between the partners.

The following survey has 10 questions and takes around 8 minutes to complete.

End of Block: Information Page

Start of Block: Consent Page

This survey must be responded by a person who has knowledge about the organisation's waste management strategies and practices.

Please select the 'Agree' option if you have knowledge about your organisation's strategies and practices related to waste management. Otherwise, please select the 'Do not agree' option.

- Agree
- Do not agree

Thank you for your participation to complete this survey.

 Please click -> to start the survey

First, we would like to ask you a number of questions about your organisation.

 What is the name of your organisation?

_____

X→

In which country is your organisation located?

▼ Belgium ... Other

What is the postal code of your organisation?

_____

X→

In which sector does your organisation operate?

▼ Agriculture, Forestry and Fishing ... Activities of Extraterritorial Organisations and Bodies

How many employees work in your organisation?

- 1-9
- 10-24
- 25-99
- 100-499
- 500 and more

End of Block: Identification Questions

Start of Block: First three questions about recycling

First, we would like to ask you some questions about plastic recycling.

1) To start with, on a scale from 1 (Strongly disagree) to 7 (Strongly agree) how much do you agree or disagree with the following statements?

	Strongly disagree 1	Disagree 2	Somewhat disagree 3	Neither agree nor disagree 4	Somewhat agree 5	Agree 6	Strongly agree 7
Recycling my own plastic waste would give me great satisfaction	●	⬚	⬚	⬚	⬚	⬚	⬚
I feel I should not waste anything if it could be used again	●	⬚	⬚	⬚	⬚	⬚	⬚
I would feel guilty if I did not recycle my plastic waste	●	⬚	⬚	⬚	⬚	⬚	⬚
I believe that recycling plastic creates a better environment for future generations	●	⬚	⬚	⬚	⬚	⬚	⬚
I believe that recycling plastic is important for the health and wellbeing of the communities where I live / work	●	⬚	⬚	⬚	⬚	⬚	⬚

2) Considering the importance given to plastic recycling and environmental issues in your organisation, how much do you agree or disagree with the following statements on a scale from 1 (Strongly disagree) to 7 (Strongly agree)?

	Strongly disagree 1	Disagree 2	Somewhat disagree 3	Neither agree nor disagree 4	Somewhat agree 5	Agree 6	Strongly agree 7

	1	2	3	4	5	6	7
To engage in recycling plastic is an important part of who we are as an organisation	●	☐	☐	☐	☐	☐	☐
Our organisation feels it is their responsibility to facilitate plastic recycling	●	☐	☐	☐	☐	☐	☐
Commitment to environmental protection is part of our organisation's identity	●	☐	☐	☐	☐	☐	☐
Contributing to recycling plastic is morally rewarding for our organisation	●	☐	☐	☐	☐	☐	☐
Recycling plastic is inconvenient for our organisation	●	☐	☐	☐	☐	☐	☐
Recycling plastic will be economically beneficial for our organisation	●	☐	☐	☐	☐	☐	☐

3) Considering the importance given to plastic recycling outside your organisation, how much do you agree or disagree with the following statements on a scale from 1 (Strongly disagree) to 7 (Strongly agree)?

	Strongly disagree 1	Disagree 2	Somewhat disagree 3	Neither agree nor disagree 4	Somewhat agree 5	Agree 6	Strongly agree 7
Most people who are important to our organisation think that we should recycle our plastic waste	●	☐	☐	☐	☐	☐	☐
Most people who are important to our organisation would like to see us facilitating the recycling of our plastic waste by others	●	☐	☐	☐	☐	☐	☐
Please select the Somewhat disagree column	●	☐	☐	☐	☐	☐	☐
Most people who are important to us take actions to support plastic recycling	●	☐	☐	☐	☐	☐	☐
Our neighbouring organisations participate in plastic recycling	●	☐	☐	☐	☐	☐	☐
The community where I live / work is actively engaged in plastic recycling activities	●	☐	☐	☐	☐	☐	☐
Our clients / customers would like to see us participate in plastic recycling	●	☐	☐	☐	☐	☐	☐

Thank you for your answers so far.

Next, we would like to ask you some questions about resources and knowledge your organisation has about plastic recycling.

Please click -> to continue.

4) On a scale from 1 (Strongly disagree) to 7 (Strongly agree) how much do you agree or disagree with the following statements about the resources your organisation has for plastic recycling?

	Strongly disagree 1	Disagree 2	Somewhat disagree 3	Neither agree nor disagree 4	Somewhat agree 5	Agree 6	Strongly agree 7
We have the technological means to easily recycle our plastic waste	●	⯀	⯀	⯀	⯀	⯀	⯀
We have the necessary human resources to easily recycle our plastic waste	●	⯀	⯀	⯀	⯀	⯀	⯀
We do not have management support to recycle our plastic waste	●	⯀	⯀	⯀	⯀	⯀	⯀
We have the financial capacity to implement plastic waste sorting initiatives	●	⯀	⯀	⯀	⯀	⯀	⯀
If our organisation implements actions to facilitate plastic recycling, it will have a high probability of obtaining satisfactory results	●	⯀	⯀	⯀	⯀	⯀	⯀
Our organisation has identified buyers for our plastic waste	●	⯀	⯀	⯀	⯀	⯀	⯀
Our organisation has easy access to recycling facilities	●	⯀	⯀	⯀	⯀	⯀	⯀

5) On a scale from 1 (Strongly disagree) to 7 (Strongly agree) how much do you agree or disagree with the following statements about the knowledge your organisation has about plastic recycling?

	Strongly disagree 1	Disagree 2	Somewhat disagree 3	Neither agree nor disagree 4	Somewhat agree 5	Agree 6	Strongly agree 7
Our organisation knows what items of plastic waste can be recycled	●	⯀	⯀	⯀	⯀	⯀	⯀
Our organisation knows how to sort plastic waste	●	⯀	⯀	⯀	⯀	⯀	⯀

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Our organisation <u>does not</u> know how to improve the recycling quality of our plastic waste	●	⬚	⬚	⬚	⬚	⬚	⬚
Our organisation <u>does not</u> know where to take our plastic waste for recycling	●	⬚	⬚	⬚	⬚	⬚	⬚
Our organisation knows how to benefit from plastic waste	●	⬚	⬚	⬚	⬚	⬚	⬚

Before we move on to the final question, we would like to ask you some questions about the plastic waste management.

Please click -> to continue

6) On a scale from 1 (Strongly disagree) to 7 (Strongly agree) how much do you agree or disagree with the following perceptions about the implementation of plastic recycling actions?

	Strongly disagree 1	Disagree 2	Somewhat disagree 3	Neither agree nor disagree 4	Somewhat agree 5	Agree 6	Strongly agree 7
Recycling plastic waste is too complicated	●	⬚	⬚	⬚	⬚	⬚	⬚
Sorting plastic waste takes up too much room	●	⬚	⬚	⬚	⬚	⬚	⬚
Recycling plastic waste <u>does not</u> require financial resources	●	⬚	⬚	⬚	⬚	⬚	⬚
Sorting plastic waste takes up too much time	●	⬚	⬚	⬚	⬚	⬚	⬚
Sorting plastic waste takes up too much labour	●	⬚	⬚	⬚	⬚	⬚	⬚

7a) Has your organisation already implemented the following actions? If yes, please indicate the level of implementation on a scale from 1 (Very low) to 5 (Very advanced). If no, please select the Not implemented option.

	Very low 1	Low 2	Medium 3	Advanced 4	Very advanced 5	Not implemented
Utilising recyclable plastic packaging	●	⬚	⬚	⬚	⬚	⬚

Asking for products with high recycled plastic content	●	⬚	⬚	⬚	⬚	⬚
Recycling / reusing our plastic waste	●	⬚	⬚	⬚	⬚	⬚
Sorting recyclable materials	●	⬚	⬚	⬚	⬚	⬚
Selling generated plastic waste to other organisations	●	⬚	⬚	⬚	⬚	⬚
Handing over generated plastic waste to a waste management company	●	⬚	⬚	⬚	⬚	⬚
Replacing plastic with other materials	●	⬚	⬚	⬚	⬚	⬚
Using biodegradable plastics	●	⬚	⬚	⬚	⬚	⬚
Reducing the use of "avoidable plastics" (non-recyclable or non-biodegradable)	●	⬚	⬚	⬚	⬚	⬚
Handing over generated plastic waste to a recycling facility	●	⬚	⬚	⬚	⬚	⬚
Reusing plastic products	●	⬚	⬚	⬚	⬚	⬚
Avoiding single-use plastic packaging	●	⬚	⬚	⬚	⬚	⬚
Replacing plastic products with services	●	⬚	⬚	⬚	⬚	⬚

7b) Based on the previous question, will your organisation implement or expand the following actions in the future? (Please select Yes or No)

	Yes	No
Utilising recyclable plastic packaging	●	⬚
Asking for products with high recycled plastic content	●	⬚
Recycling / reusing our plastic waste	●	⬚
Sorting recyclable materials	●	⬚
Selling generated plastic waste to other organisations	●	⬚
Handing over generated plastic waste to a waste management company	●	⬚
Replacing plastic with other materials	●	⬚
Using biodegradable plastics	●	⬚
Reducing the use of "avoidable plastics" (non-recyclable or non-biodegradable)	●	⬚

Handing over generated plastic waste to a recycling facility ○ ☐

Reusing plastic products ○ ☐

Avoiding single-use plastic packaging ○ ☐

Replacing plastic products with services ○ ☐

8) On a scale from 1 (Not at all important) to 7 (Extremely important), what are the main reasons why your organisation would take actions to improve plastic recycling?

	Not at all important 1	Unimportant 2	Somewhat unimportant 3	Neither important nor unimportant 4	Somewhat important 5	Important 6	Extremely Important 7
Financial and fiscal incentives	●	☐	☐	☐	☐	☐	☐
Other forms of public support	●	☐	☐	☐	☐	☐	☐
Existing legislation	●	☐	☐	☐	☐	☐	☐
Anticipation of future changes in legislation	●	☐	☐	☐	☐	☐	☐
Existing professional/product standards	●	☐	☐	☐	☐	☐	☐
Anticipation of future professional /product standards	●	☐	☐	☐	☐	☐	☐
Supply chains pressures (e.g costumers demand for recycled plastic content)	●	☐	☐	☐	☐	☐	☐
Improved profitability of selling plastic waste	●	☐	☐	☐	☐	☐	☐
High profile citizen engagement, advertising and campaigns to promote plastic recycling	●	☐	☐	☐	☐	☐	☐
Creation of a competitive advantage / business opportunity	●	☐	☐	☐	☐	☐	☐
Catching up with main competitors	●	☐	☐	☐	☐	☐	☐

who have already taken action Local community providing appropriate facilities for plastic recycling	●	☐	☐	☐	☐	☐	☐
Waste management companies providing facilities for the segregation and storage of plastic waste	●	☐	☐	☐	☐	☐	☐
Environmental concerns	●	☐	☐	☐	☐	☐	☐

9) Which of the following, on a scale from 1 (Not helpful at all) to 7 (Extremely helpful), would help your organisation to implement actions for plastic recycling?

	Not helpful at all 1	Unhelpful 2	Somewhat unhelpful 3	Neither helpful nor unhelpful 4	Somewhat helpful 5	Helpful 6	Extremely helpful 7
A tool to self-assess how much of our organisations' plastic waste is recycled with respect to others	●	☐	☐	☐	☐	☐	☐
Consultancy on how to improve plastic recycling in our organisation	●	☐	☐	☐	☐	☐	☐
Clear and standardised recycling labels on products and packaging	●	☐	☐	☐	☐	☐	☐
Grants or subsidies	●	☐	☐	☐	☐	☐	☐
Advice on funding possibilities for plastic recycling investments	●	☐	☐	☐	☐	☐	☐
Demonstration of new technologies or processes for plastic recycling	●	☐	☐	☐	☐	☐	☐
Training programs regarding plastic recycling	●	☐	☐	☐	☐	☐	☐
New technologies or processes to facilitate plastic waste sorting	●	☐	☐	☐	☐	☐	☐
New technologies or processes to facilitate plastic waste collection	●	☐	☐	☐	☐	☐	☐

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New technologies or processes to reduce plastic waste storage space	●	⬚	⬚	⬚	⬚	⬚	⬚
Please select the Helpful column	●	⬚	⬚	⬚	⬚	⬚	⬚
Database with case studies that show the benefits of plastic recycling for organisations	●	⬚	⬚	⬚	⬚	⬚	⬚
More cooperation between entrepreneurs for new processes in order to reuse waste	●	⬚	⬚	⬚	⬚	⬚	⬚
Access to networking opportunities to collaborate	●	⬚	⬚	⬚	⬚	⬚	⬚
Increased frequency of plastic waste collection	●	⬚	⬚	⬚	⬚	⬚	⬚
Waste management companies providing better quotes for collection of well-sorted plastic	●	⬚	⬚	⬚	⬚	⬚	⬚
Waste management companies providing guidelines for segregation and storage of plastic waste	●	⬚	⬚	⬚	⬚	⬚	⬚

Thank you for your responses and patience so far.

Next, we would like to ask you one more question to complete the survey.

Please click -> to see the final question of this survey.

End of Block: Break before the last questions

Start of Block: Final question

✳

10) A green job is one that directly deals with information, technologies, or materials that preserves or restores environmental quality. This requires specialised skills, knowledge, training, or experience (e.g. Verifying compliance with environmental legislation, monitoring resource efficiency within the organisation, promoting and selling green products and services).

 Based on the above explanation, how many of your full-time employees, including yourself, work in green jobs some or all of the time in your organisation?

 (Please provide a number)

_____

End of Block: Final question

8.2   Appendix 2

Survey on the status quo of plastics recycling with commercial or industrial origin in the 2Seas region (July - September 2019)

Survey No.:	GE

Name of company:	
Address:	
Contact person:	
E-mail address:	
Phone:	+32
No. Employees:	(in Ghent)
Interest in future cooperation? (e.g. workshops begin 2020) If yes, the specified contact data that you state here might be shared with partners or stakeholders of these events (such as City of Ghent)	☐ YES, please specify way for contact: ☐ NO
NACE Code:	
Sample provided	☐ YES: Sample no.: ☐ NO: ☐ Come back at:
Further comments:	

We are informed that the collected data will be handled within Generic Code of Conduct for the processing of personal data and confidential information at Ghent University. Moreover, we agree that results of the statistical, chemical and physical analysis of (data on) plastic waste will be used confidentially and published on an aggregated level (in such a way that direct identification is excluded).

Plastic waste:

Company name:

What types of Plastic waste do you have?	Used for?	How much?	Seasonal Fluctuations?	Where do they end up?	Why disposed in this system?	Contamination	colour
☐ films/ foils ☐ bottles ☐ rigid (PTT) ☐ other: _____ Name:	☐ Packaging ☐ Primary food cont. ☐ Primary no food c. ☐ secondary ☐ tertiary ☐ end application ☐ other: _____		☐ yes: specification: _____ ☐ no	☐ Residual waste ☐ PMD ☐ Selective system ☐ Return logistics ☐ other: _____	☐ no other system known ☐ no space ☐ obligation to use ☐ economic incentives ☐ company core values ☐ other: _____	☐ organic ☐ labels ☐ printed ☐ odour ☐ other: _____	☐ clear ☐ white ☐ black ☐ multi or
☐ films/ foils ☐ bottles ☐ rigid (PTT) ☐ other: _____	☐ packaging ☐ primary food cont. ☐ primary no food c. ☐ secondary ☐ tertiary ☐ end application ☐ other: _____		☐ yes: specification: _____ ☐ no	☐ Residual waste ☐ PMD ☐ Selective system ☐ Return logistics ☐ other: _____	☐ no other system known ☐ no space ☐ obligation to use ☐ economic incentives ☐ company core values ☐ other: _____	☐ organic ☐ labels ☐ printed ☐ odour ☐ other: _____	☐ clear ☐ white ☐ black ☐ multi or

☐ films/ foils ☐ bottles ☐ rigid (PTT) ☐ other: _____	☐ packaging ☐ primary food cont. ☐ primary no food c. ☐ secondary ☐ tertiary ☐ end application ☐ other: _____		☐ yes: specification: _____ ☐ no	☐ Residual waste ☐ PMD ☐ Selective system ☐ Return logistics ☐ other: _____	☐ no other system known ☐ no space ☐ obligation to use ☐ economic incentives ☐ company core values ☐ other: _____	☐ organic ☐ labels ☐ printed ☐ odour ☐ other: _____	☐ clear ☐ white ☐ black ☐ multi or

Residual waste:

Company name:

	Residual waste	PMD	Selective system: for _____	Return logis: for:_____
How much?	☐ Bags ☐ 30L ☐ 60L ☐ other: _____ ☐ Container ☐ 120L ☐ 240L ☐ 330L ☐ 770L ☐ 1000L ☐ other: _____	☐ Bags ☐ 30L ☐ 60L ☐ other: _____ ☐ Container ☐ 120L ☐ 240L ☐ 330L ☐ 770L ☐ 1000L ☐ other: _____	☐ Bags ☐ 30L ☐ 60L ☐ 300L ☐ 600L ☐ other: _____ ☐ Container ☐ 120L ☐ 240L ☐ 330L ☐ 770L ☐ 1000L ☐ other: _____	☐ Bags ☐ 30L ☐ 300L ☐ 600L _____ ☐ Container ☐ 240L ☐ 330 770L ☐ 1000L ☐ other: _____
Frequency	☐ _____ per week ☐ _____ per month ☐ other:_____	☐ _____ per week ☐ _____ per month ☐ other:_____	☐ _____ per week ☐ _____ per month ☐ other:_____	☐ _____ pe ☐ _____ pe other: _____

Collector	☐ IVAGO bedrijf ☐ IVAGO private ☐ SUEZ ☐ VanHeede ☐ Renewi ☐ other: _____	☐ IVAGO bedrijf ☐ IVAGO private ☐ SUEZ ☐ VanHeede ☐ Renewi ☐ other: _____	☐ IVAGO bedrijf ☐ IVAGO private ☐ SUEZ ☐ VanHeede ☐ Renewi ☐ G.O.P. ☐ other: _____	☐

What environmental practices do you implement? Scale of 1-7 (1 is not implemented and 7 fully implemented)	1	2	3	4	5	6	7	Not relevant/ I don't know	N... to
Implementation of processes to reduce plastic waste									☐
Design of products/services to reduce plastic waste									☐
Logistics to facilitate recycling or reuse of plastic									☐
Choice of products/services with features that help reduce plastic waste (e.g. recycled content, design for recycling, eco-designed, etc.)									☐