Resource-effective and circular plastics flows – The role of Plastic in a circular society

A sector report from the IVA project Resource Effectiveness and the Circular Economy (ReCE)

THEME:
CLIMATE-RESOURCES

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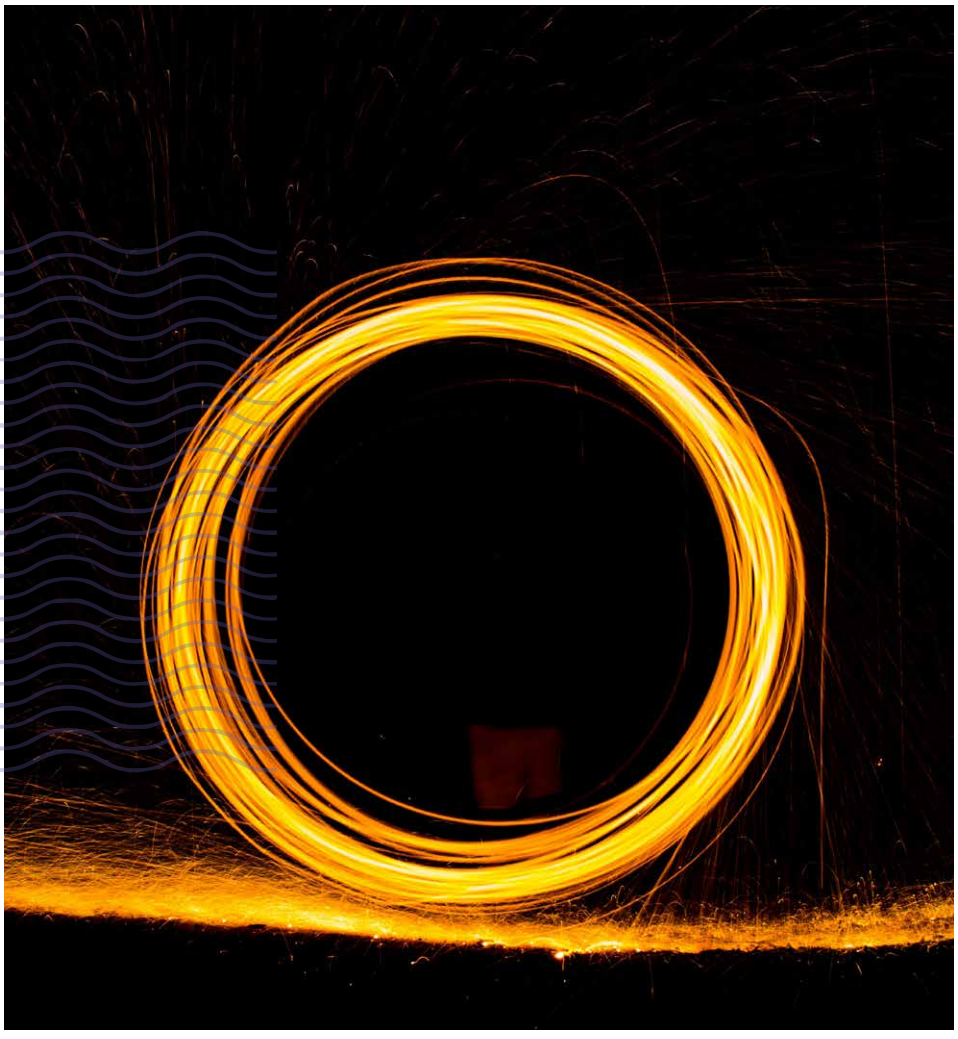
Contents



Foreword: Resource Effectiveness and the Circular Economy

»The purpose of the project is to strengthen Sweden's competitiveness in a future with finite resources in line with the UN's Sustainable Development Goals.«

The Royal Swedish Academy of Engineering Sciences' project *Resource Effectiveness and the Circular Economy* has assembled more than 50 companies, organisations and public authorities around the **vision** of Sweden being the leading nation as a resource-effective, circular society. The **purpose** is to strengthen Sweden's competitiveness in a future with finite resources in line with the UN's Sustainable Development Goals.

The project's **goals** are: to create a platform for resource effectiveness and circularity; to draw conclusions on Sweden's resource options in public policy, research and industry based on initiatives that are under way, and to create collaboration and forward motion.

Resource Effectiveness and the Circular Economy builds on the IVA project *Resource Efficient Business Models – Greater Competitiveness* from 2014–2016. That project presented the significant potential that exists to make society considerably more resource efficient and to generate new commercial opportunities and business models. It defined five material flows (biomass from wood, steel, concrete, food and textiles) to show where flows are "leaking" and thus where commercial opportunities exist through more effective resource management.

This project continues the work of the previous one, using the same sector breakdown and exploring the commercial opportunities that were identified. It is divided into five subprojects: mobility, facilities, food, textiles and plastics. This report will present analysis and observations from the Mobility subproject. The most important conclusions from all of the subprojects will be compiled and presented as the project's recommendations for a broader societal transformation in a joint synthesis report.

The five subprojects have gathered representatives from the entire value chain to participate in individual work groups. They come from the private and public sectors and from the research community. IVA's work is based on a scientific approach and draws from relevant research, but also involves critical analysis of other issues of relevance. Source references are included where appropriate. The project's results come out of an intense programme of workshops and work group meetings involving a large number of people.

The reason for this initiative from IVA is that resource effectiveness and circularity are both crucial for a future with greater global prosperity. One particularly important aspect is ensuring that we successfully improve efficiency in material management and advance material development. To support this, we also need to design new business models and identify commercial opportunities that will stay relevant many years into the future, meet the UN's Sustainable Development Goals and allow us to remain within the planetary boundaries.

We need sustainable systems that can deliver resources to meet the real needs of society. To achieve this we need a long-term system perspective and an overall understanding of, and system of managing, society's resource flows. We need to take a holistic approach in which all aspects in the production chain are included – from material extraction and raw materials, the design phase, manufacturing, business models and financing, through the user phase to the recycler and back to a new producer. This requires cooperation between all actors, as well as clear rules to create the right incentives and market conditions. We also need to accelerate, and better understand the benefits of, digitalisation, innovation and new business models that focus on resource effectiveness.

A lot is already happening – both internationally and around Sweden – with numerous initiatives and projects examining how resource effectiveness and circularity can be introduced in various sectors. But there is no unifying arena to show the need for a systemic change and where differ-

ent perspectives can come together. IVA believes that a platform for cooperation between the private sector, the research community, the political sphere and the public sector is essential in order to achieve a resource-effective and circular society. Actors within such a platform are also the project's overall **target group**.

Resource Effectiveness and the Circular Economy was launched at the beginning of 2018 and will continue until mid-2020.

The project's definition of resource effectiveness and the circular economy

Resource effectiveness[1] and circular economy[2] are two distinct concepts under the same umbrella. A measure that supports the circular economy often also supports resource effectiveness. In this project we regard resource use within the planetary boundaries as the overarching goal. In order to manage any conflicting objectives in future development it is important for there to be clarity and an understanding of systems.

The primary focus of this report is more effective management of the value of society's and nature's resources beyond, for example, mere volumes or mass. Unless otherwise stated, this also includes the concept of a circular economy. In cases where conflicting objectives between the concepts are identified, they are described.

Geissdoerfer et al, for example, define circular economy below mainly in terms of the circulation of materials:

> *A regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling.*[3]

The project's premise is that resource effectiveness takes priority over the circulation of materials. We believe that it is important to include the user phase in the definition – not just the production phase; to include business models and services – not just physical products:

> *A performance economy goes a step further by selling goods (or molecules) as services through rent, lease and share business models. ... In addition to design and reuse, the performance economy focuses on solutions instead of products, and makes its profits from sufficiency, such as waste prevention.*[4]

The project believes that this perspective is missing in some circular economy definitions, even if it is sometimes considered an implicit aspect. One example is the average car which is parked 95 percent of the time. We do not improve the efficient use of resources by merely recirculating the materials the car is made from – no matter how good we get at it. The effective use of resources ("resource effectiveness" = using resources as efficiently as possible while also avoiding negative environmental impact) must be improved.

1 *Europa 2020 – A strategy for smart, sustainable and inclusive growth COM (2010)*, and *A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy COM (2011)*. There is unfortunately no actual definition of resource effectiveness.

2 Kirchherr, J., Reike, D., Hekkert, M., 2017, "Conceptualizing the circular economy: An analysis of 114 de nitions", in *Resources, Conservation and Recycling* 127, pp. 221–232.

3 Geissdoerfer, M., Savaget, P., Bocken, N. and Hultink, E., 2017, "The circular economy – A new sustainability paradigm?" in *Journal of Cleaner Production* 143 (1), p. 759.

4 Stahel, W., "The circular economy", 23 Mars 2016, in Nature 531, pp. 435-438 (https://www.nature.com/news/the-circular-economy-1.19594; accessed 10 December 2019).

As Florian Lüdeke-Freund et al. wrote in their article entitled "A review and typology of circular economy business model patterns":

> *The circular economy may not be a final goal, but rather part of an ongoing process to achieve greater resource efficiency and effectiveness.*[5]

This is a theory the project is happy to endorse.

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5 Lüdeke Freund, F., Gold, S. and Bocken, N., 2018, "A Review and Typology of Circular Economy Business Model Patterns", in *Journal of Industrial Ecology*, Volume 23, Issue1, February 2019, pp. 36-61.

The subproject's summarised observations

»The recycled plastics market has significant potential to be developed and contribute to resource effectiveness in society.«

The project would like to present the following observations as important points relating to the project's visions and goals, which are based on plastics having a role to play in a resource-efficient society. They are aimed at the actors that impact and are impacted by development in the Swedish plastics flows. They are not ranked in any particular order and a number of synergies exist between the points.

1. A developed market for recycled plastics

To achieve more resource-efficient and circular plastics flows, the market for recycled plastics needs to be developed to promote capacity development and efficiency in the collection and recycling of plastics, as well as resource-efficient development and design of products. The project has identified a need for a digital marketplace for recycled raw materials, market actors that promote commerce in collected and recycled plastics, testbeds that help build confidence in the use of recycled plastics, advanced producer responsibility and product declarations. Read more about this under *Action plans* further on in this report.

2. Recycled plastics' supply and demand

The undertakings implemented so far linked to the EU strategy for plastic in a circular economy indicate a clear market failure. Actors in plastics recycling (supply) have demonstrated a higher level of ambition than users (demand). This type of failure is not uncommon in a time of market transition, but they can jeopardise market development and also reveal the need for policy adjustments. Thus we need to focus on the demand side by, among other things, building confidence in the use of recycled plastics.

3. System knowledge and statistics

There are significant gaps in the statistics on Swedish and Northern European plastics flows and this is making it far more difficult to develop resource-efficient strategies in the political and commercial spheres. Without robust knowledge on the various flows, there is a clear risk that decisions regarding technology development, investments and collaborative projects will be less effective, as will the political framework for plastics. The information needs vary. Private sector actors, for example, require detailed information about the quality of the flows. Industry actors also have a responsibility to contribute to the statistics and Statistics Sweden (SCB) needs to collect and process information. Only through this type of cooperation can the situation be interpreted and development monitored to design the right strategies and control mechanisms.

4. Traceability

In addition to knowledge on flows and their volumes, information is also needed on the content of the plastics and

products. Action plans that have been produced in this project rely heavily on advanced traceability with respect to the content and how the plastics were used in the past. Without this, information about resource efficiency is limited by plastics flows going to energy recovery unnecessarily or by lost value at the recycling stage. The same situation applies to plastics reuse – also an area where more information may be required. Traceability is needed at a more general level as well in order to measure and verify how recycled plastic raw materials are incorporated into new products. A lack of traceability can negatively affect confidence in labelling of recycled raw materials. A digital system is needed due to the large volumes and variations in the plastics flows, and this should as far as possible be an international system.

5. Life cycle assessment (LCA)

Plastics are a product category and they are used as individual materials or combined with other materials in a wide range of products. The plastics that are used and how the products are designed affect both plastic recyclability and product functionality. There is therefore significant potential to promote resource efficiency at the development and design stages. It is not clear, however, how different process, design and material choices affect efficiency. Life cycle assessment (LCA) is therefore needed to guide actors towards and promote resource efficiency, and to reduce environmental impact. The project has identified a need to use LCA to a greater extent, including in plastic raw material production, and thus to have better information on which to base development and design decisions as well as policy development. LCA methods may also need to be developed so that simpler comparisons can be made by both public and private sector actors more quickly and at a lower cost.

6. Chemical recycling

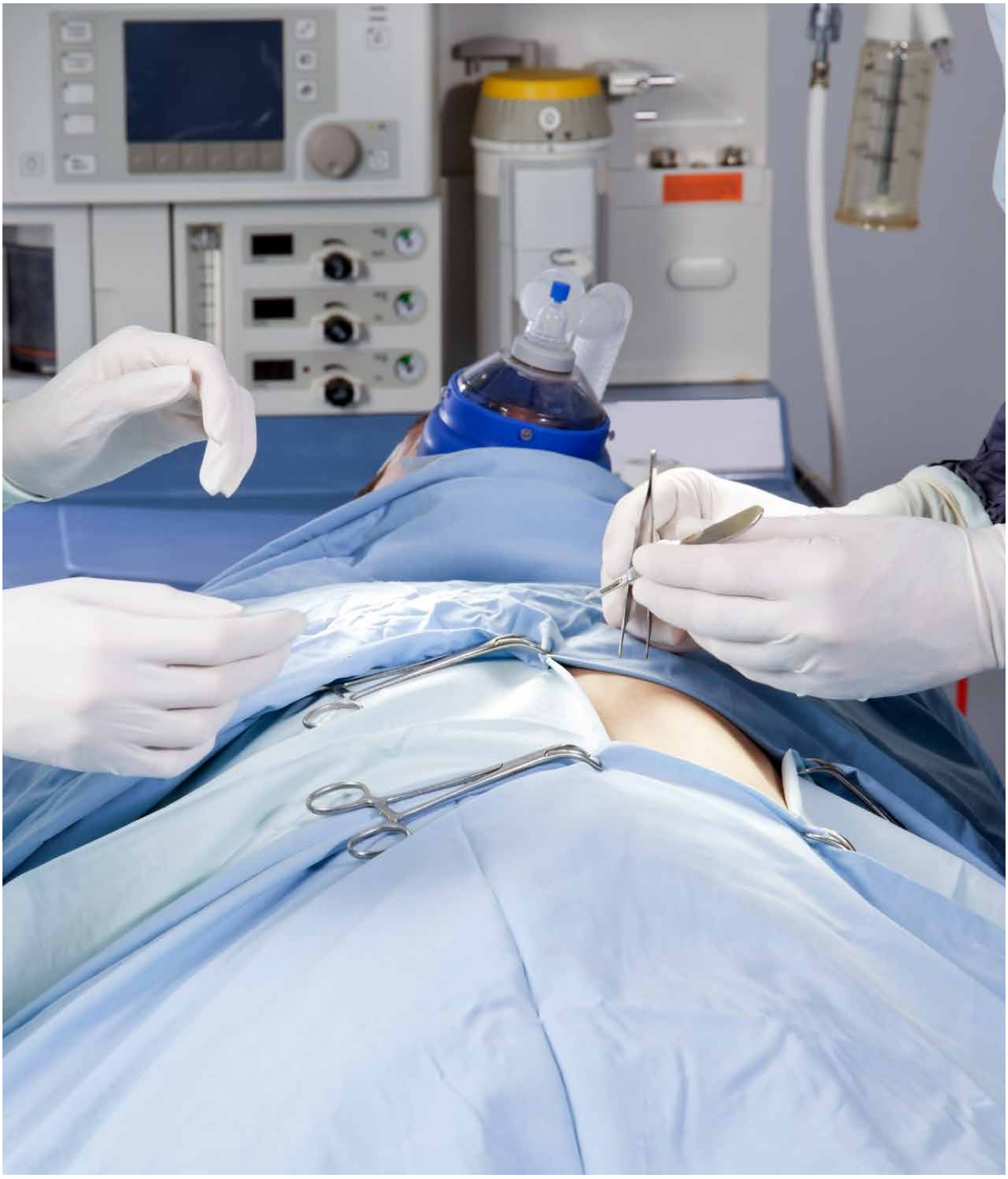
There is a gradual but significant change taking place in the system for recycling plastics based on the development and potential of chemical recycling. This process provides a technical opportunity to handle many of the plastic products that cannot currently be mechanically recycled. This development will impact Swedish actors and a study is therefore needed of the opportunities and obstacles relating to chemical recycling in Sweden. The study should look at how chemical recycling will contribute to resource efficiency and circularity, as well as aspects such as cost and possible financing, technology choices, environmental relevance through LCA, and the need for cooperation among actors.

7. Politics and plastic

Up to now no Government ministry or agency has produced a Swedish plastics strategy with goals, technology and R&D proposals that include resource efficiency aspect. The focus is on reducing the use of plastics rather than steering the system towards higher efficiency. This is a problem because both aspects need to be evaluated in terms of how they help improve resource efficiency in society. The lack of a political agenda is currently limiting development because the actors involved have no clear strategy to work according to. The project believes that the Government should highlight the clear responsibility of the public sector with respect to plastics and form a commission to develop a Swedish plastic strategy that includes resource efficiency and circularity goals. An important aspect of efforts to establish responsibility is to define how plastics contribute to society because the political framework as well as many of the inquiries and studies in this area are largely focusing on plastic as waste.

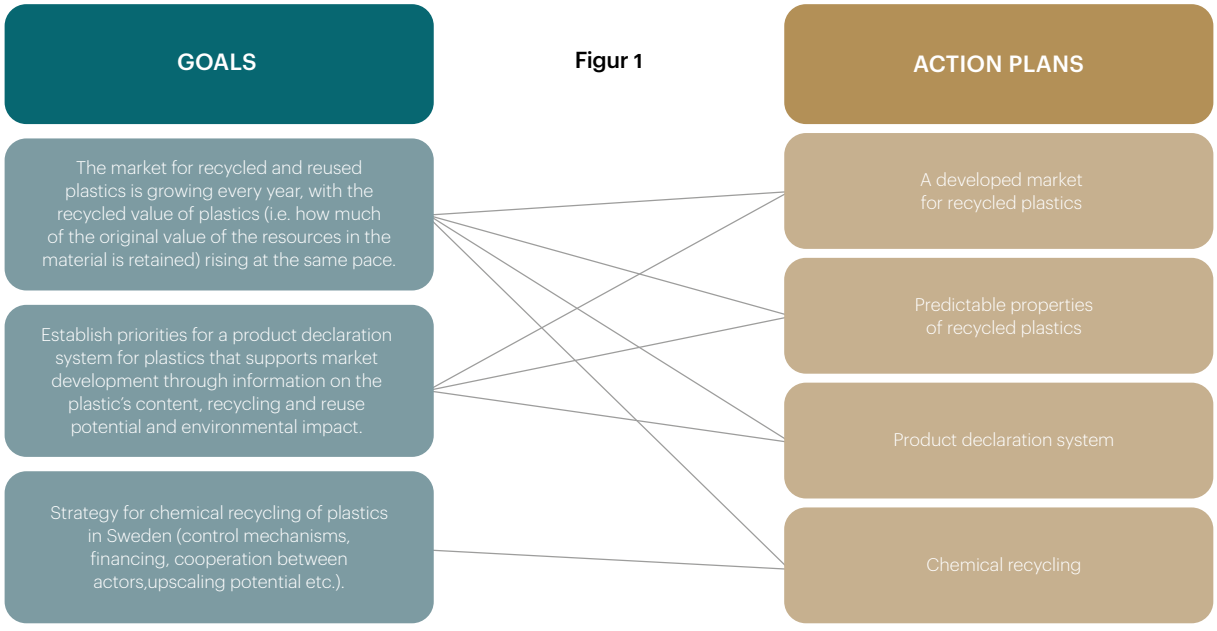
8. Industry cooperation

There is currently no platform that gathers the various industries within the Swedish plastics flow. There is no coordination in research, market development and cooperation at the level that is needed to manage resource efficiency and circularity. Development of a Swedish plastics strategy is needed as a basis for the private sector to coordinate development towards achieving the goals established in the political sphere. This dialogue should include multiple industries such as the chemicals industry, manufacturing industry (e.g. textiles, automotive, building materials and white goods) as well as waste collection and recycling.



The project’s vision and own goals

The project’s vision: »The value created by sustainable plastics in a resource-effective and circular society: A roadmap for Sweden.«



Figur 1

The project's visions and goals are based on the premise that plastics have a role to play in a resource-efficient society. From this starting point a number of areas for development have been prioritised to achieve better use of plastics through resource efficiency and circularity.

The development areas identified are:

- **Market development** within recycled plastics to create incentives for investment in systems for collecting, sorting and recycling materials in the plastic value chains.[6]
- **Capacity development** in systems to achieve better functionality and profitability in materials recycling.
- **Knowledge development** in the value chains to describe the opportunities, challenges and environmental performance of plastics, and to compare this to other potential materialsl.

In developing these areas as well as in policy development Sweden should be seen as part of an international system. Sweden imports and exports large quantities of plastic raw materials, plastics and plastic products, and exports collected plastic for material recycling. Development therefore needs to take place in cooperation with the EU and other international actors.

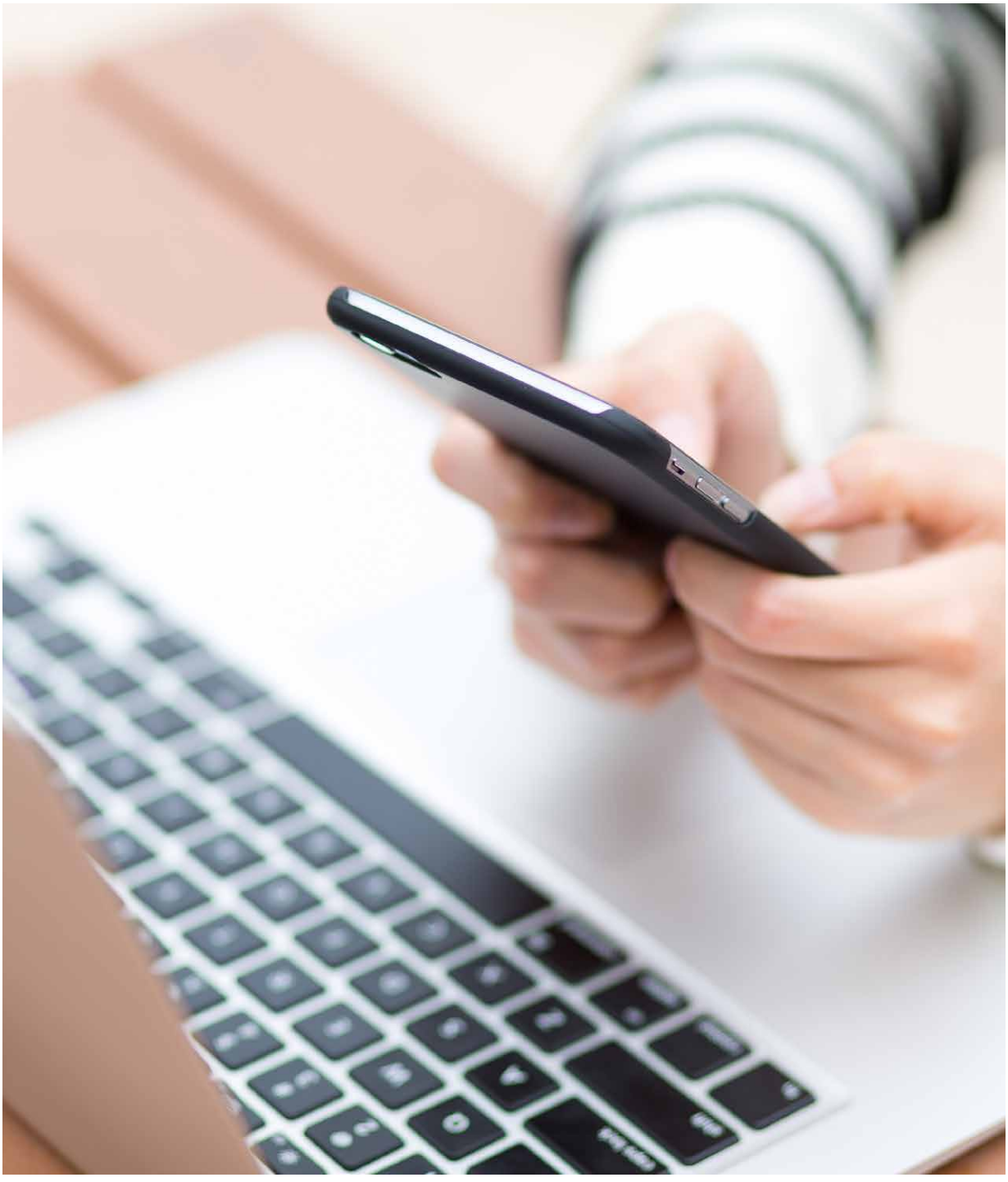
Together, the development areas above show the project's emphasis on the development and design of markets for re-

6 The report uses the term *value chains* to describe the relevant actors in plastics flows – from production of plastics to collection and recycling.

cycled plastic materials. This is a top priority as there is significant untapped potential here to improve efficiency and effectiveness. This is reflected in the goals (Figure 2) that the project has produced.

The project has not established a target level for annual market development as there has been much too much uncertainty to be so specific about objectives. However, the examples of goals in Table 1 further on in this report provide an indication of the pace of transformation that will be needed. A key aspect of the goal is that development should not only be measured in terms of volumes (m3) and weight (kg) of recycled plastics, but also how much of the original value of the plastics is retained. If development is only measured in terms of the first two aspects, this may impede market development because the value of the recycled material is an important factor for investments to be made to expand the capacity of the recycling system.

The project has not defined a goal for reducing actual plastics use overall because the focus has been on increasing societal benefits in *using plastics as a resource* as they have an important role in society today (see Boundaries, Chapter 2.6).



Background

»Plastic supports numerous functions in society that can increase resource efficiency in other resource flows.«

Plastic in society

Plastics have an important role in today's society. Why are plastics used for so many different purposes? And why have plastics often been criticised in recent years? The answer to the question of why plastic has been given such an important role relates to the great flexibility of the material: plastic is mouldable, lightweight and can be adapted for different purposes by using different types of plastic and additives. With respect to the criticism, oil was cheap and environmental problems were not given as much attention in the 1950s and 60s when plastics started to have an increasing role in society.

The question is: Can we imagine a society without plastic? And in the context of this project: Is a society without plastics more resource-efficient or sustainable?

To answer these questions we need to look at the functionality and value creation of plastics in society and not just at plastics production and the potential pollution they cause. There are situations where plastic is the best material to choose. There are also occasions when this is not the case. Plastic is after all a generic term for a multitude of materials used in many different industries and applications.

Plastic supports numerous functions in society that can increase resource efficiency in other resource flows. Plastic as a means of protecting food is a classic example. Without plastic the amount of waste in the food chain would increase significantly, and the environmental impact of efficiently produced plastic film is often far lower than the environmental impact of some types of food. Plastics also offer hygiene solutions in clinical environments; they are mouldable and lightweight making them valuable in, for example, the automotive industry, renewable electricity production (such as wind and solar energy), and electronics and white goods.

We therefore believe that plastics, when designed and used correctly, have a role in a resource-efficient and sustainable society. But there is still a lot to do. Improvement is needed in the production of both plastics and plastic products, and the way in which they are used, collected and recycled. The public sector, the plastics industry, manufacturing industry, the recycling industry and the public all therefore need to make a positive shift in a number of areas.

In this report we describe how the value chains of plastic flows can do this in cooperation with other actors through a number of initiatives that have been prioritised in the project.[7] The means to do this are provided by action plans focusing on how we can:

- develop the market and business models for recycling plastics,[8]
- increase the capacity of the recycling system; and
- develop new recycling technologies.

7 In addition to these initiatives there are other important issues that are not among the project work group's focus areas. This is partly due to the need to focus on a manageable number of challenges and partly that other completed and ongoing projects have addressed these other issues.

8 In this report recycling means material recycling, which should not be confused with energy recovery.

While this project is focusing on the overall resource and market system, there are numerous other projects addressing more specific technical issues, such as recycling specific plastic products.

Plastic in the public debate

Plastic as a category of materials has received negative attention in recent years in the public debate, largely based on the problems that have existed and still exist with respect to health risks, pollution and, in recent years, microplastics in the ocean.[9] Altogether this has led to a shift away from single-use plastics and towards reducing the use of plastics through a "plastic diet". More specific examples include additives in plastic that have been identified as hormone-disrupting, reducing the use of plastic bags and an EU ban on certain single-use plastic items.

These issues are increasingly addressed by actors in the plastics flow value chains. But these actors cannot presume that they themselves will set the agenda for development in the industry. The plastics industry, similar to other industries, increasingly needs to act based on society's view of the opportunities and risks.

It is important for the dialogue about plastics to be nuanced and include both opportunities and problems. As described above, plastics today make a large number of functions in society possible. It is hard to imagine a society without plastic and, although plastics can be replaced in various areas, there is no guarantee that such a path is more resource-efficient or circular.

It is important, therefore, to actively and transparently spread knowledge about plastics in society. Similarly, municipalities, businesses and other organisations that are developing strategies for sustainable plastics use need to be aware of the functionality and benefits that plastics offer society. These strategies should be based on analysis of where in the plastics system the opportunities and problems exist and how they can be managed. In certain cases, reduced plastics use can increase sustainability in society, and in other cases plastics make other materials more sustainable.

Goals for resource-effective and circular plastics

The way in which flow systems for plastics are developed is determined to a large extent by international and national goals and agreements. Goals are established by policy-makers, actors in the value chains and actors in society.[10]

Below are examples of relevant goals for the project (Table 1). It should be noted that this is not a complete list. It does not, for example, include general environmental and climate policy goals. We should also point out that there are several ongoing political and industry initiatives that will result in new goals.

The goals established by policy-makers and in industry in resource-efficient and circular plastics flows can be divided into four categories:

1. Recycling of plastics
2. Reuse of recycled plastics

9 The focus in the public debate is therefore different from in industry which incorporates a strong focus on the climate issue. However, climate issues as they relate to plastics in particular have received more attention in general in the media and in the political debate.

10 One example of the latter is the *European Technology Platform for Sustainable Chemistry* (SusChem, 2018), which has produced a research and innovation agenda in cooperation with industry, academia and the European Commission.

Table 1: Examples of goals for resource-effective and circular plastics.

GOALS	ACTOR(S)	DEADLINE	INTRODUCED
POLITICAL			
50 percent of plastic packaging in the EU is recycled or reused	European Commission	2025	2018
Recycling of plastic packaging, not PET bottles	The Government	<2020 (30 %); >2020 (50 %)	2014
THE VALUE CHAIN			
50 percent reuse or recycling of plastic waste	The European Plastics Industry Circular Economy Voluntary Commitments	2040	2018
All packaging is to be recyclable (100%)	Grocery retail in Sweden	2022	2018
All plastic from grocers/ supermarkets to be fossil-free or recyclable	Grocery retail in Sweden	2030	2018

3. Manufacturing of recyclable plastic products[11]
4. Reduced use of resources as a general principle (e.g. certain single-use plastics)

The three first goals are relevant and interdependent – and all contribute to market and capacity development. The fourth goal is linked to a need on a broad front to reduce general over-consumption of resources in Sweden and in many other countries. It is worth noting that there is no general goal for *reuse* (i.e. not recycling) of plastics as a resource. This is, however, included in general goals for reusing products, where plastics can be one of the resources included (Table 1).[12]

In addition to this there is also a clear trend among individual companies that are setting goals for their use of recycled plastics and recyclable plastics. This is happening both in the international arena and in Sweden. Multinational corporations such as Procter & Gamble, Unilever, Walmart and Ikea are among those that have set goals. The size of these actors also means that they can drive development through their volumes and the signals they send to the value chains and private sector in general. Other large corporations such as Electrolux and Volvo Cars, and a number of smaller ones, have also established goals for resource-effective plastics use.

11 There is, however, no definition of what is recyclable, such as the extent to which the plastic content of a product is able to be recycled.

12 Goals and commitments are also being developed in this area, for example within the framework of *New Plastics Economy Initiative* (https://www.newplasticseconomy.org; accessed 27 September 2019).

Gap between supply and demand

Despite the goals that exist today in this area, there is a gap between supply and demand for recycled plastics. The EU Strategy for Plastics in a Circular Economy calls for voluntary pledges to increase the use of recycled plastics, aimed at driving market development.[13] The goal was set at 10 million tonnes of recycled plastic in products in the European market by 2025. On the supply side, the recycling sector has made pledges which, if they are kept, will exceed this goal. On the demand side, however, the pledges are at 6.4 million tonnes (March 2019).[14] On the other hand, there is a clear gap for individual plastics users with a progressive agenda to increase their use of recycled plastics in specific categories that are currently difficult to source in sufficient volumes of the right type and quality. Development is needed in manufacturing industry, where recycled plastics are seen as an obvious and available material. To bridge the gap the European Commission has launched the Circular Plastics Alliance.[15] This project has developed action plans aimed at supporting this endeavour (see Chapters 4–7).

The Sustainable Development Goals and Swedish environmental goals

By increasing resource efficiency and effectiveness it is possible to increase recycling and reduce the extraction of virgin natural resources, transport and pollution. Through increased efficiency, climate emissions associated with plastics production and combustion of fossil-based raw materials can also be reduced.

To understand how resource-efficient and circular plastics flows can support Agenda 2030 and the Sustainable Development Goals, it is important to look at the targets, as the 169 targets clearly explain the ambitions in the 17 main goals. The work done during the course of this project and the recommendations made relate primarily to the following targets that have a focus on resource effectiveness and extraction of natural resources:

- **Goal 8:** Decent work and economic growth
  - *Target 8.4:* Improve progressively global resource efficiency in consumption and production

- **Goal 9:** Industry, Innovation and Infrastructure
  - *Target 9.4:* Upgrade infrastructure and retrofit industries to make them sustainable

- **Goal 12:** Responsible consumption and production
  - *Target 12.2:* Sustainable management and efficient use of natural resources

The focus of the project also relates to goals 7: Affordable and clean energy, 11: Sustainable cities and Communities, 13: Climate action, 14: Life below water, and 15: Life on land (ecosystems and biodiversity).

The Swedish environmental objectives are also relevant, and in particular:

- the generational goal, which includes resource-efficient cycles and sustainable management of natural resources and patterns of consumption;
- reduced climate impact;
- a sound built environment; and
- a non-toxic environment.

13 European Commission, 2018, "A European Strategy for Plastics in a Circular Economy", COM(2018) 28 final (https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1516265440535&uri=COM:2018:28:FIN; accessed 27 September 2019).

14 European Commission 2019, "Assessment report of the voluntary pledges under Annex III of the European Strategy for Plastics in a Circular Economy", SWD(2019) 92 final (https://ec.europa.eu/docsroom/documents/34267; accessed 27 September 2019).

15 See *Circular Plastics Alliance* (https://ec.europa.eu/growth/industry/policy/circular-plastics-alliance_en; accessed 27 September 2019).

Boundaries

There are aspects that we have not included in the project because they are outside the project's main focus area, which is the role of plastic in society from a resource efficiency and effectiveness perspective.

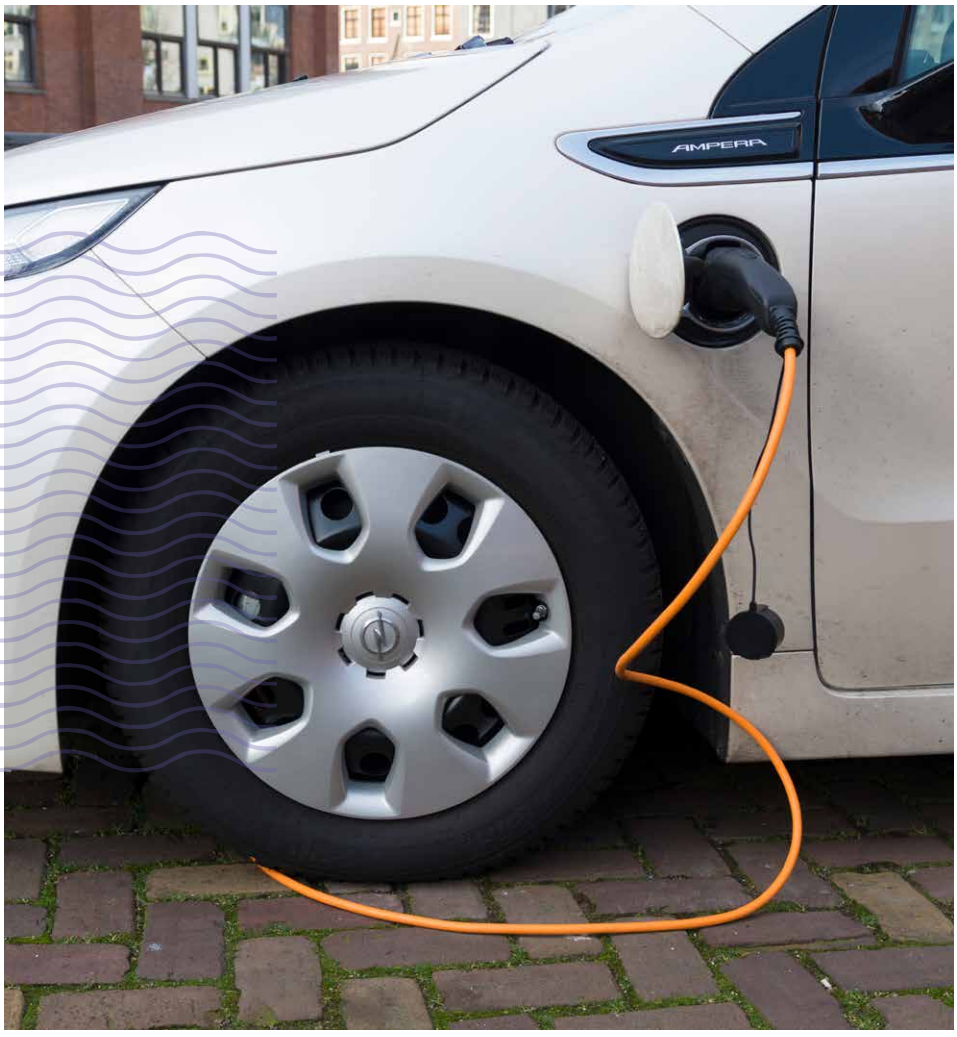
There is increased interest in alternative raw materials (apart from recycled plastic) in plastic production, including bio-based raw materials from the forest and agriculture, technology that turns carbon dioxide or carbon monoxide into plastic, and microbial plastic production. Bio-based raw materials to produce plastics have not been included. Many initiatives to replace fossil raw materials are under way, but there are also problems in that this raw material is not necessarily more resource-efficient or effective than fossil raw materials due, among other things, to the issue of water and land use. This can be compared to the criticism aimed at certain biofuels that are produced in a way that creates land use, climate and societal problems.[16] There are similar concerns around the production of plastic from carbon dioxide or carbon monoxide. The project has not differentiated between the various origins of the plastic, but rather focused on the fact that the plastic, regardless of origin, must be recycled or reused in a way that is resource-efficient and effective.

Nor has the project focused on plastics in the oceans and other pollution. Although these are important issues, there are other projects and public inquires[17] working on them.

Finally, biodegradable plastics have not been identified as resource-efficient/effective or circular as this could lead to that these plastics not being recycled, which is why this aspect is also not included in the project's analysis.

16 A study by the Danish Environmental Protection Agency shows the complexity of choosing raw materials and functionality based on a life cycle perspective for grocery carrier bags (Danish Environmental Protection Agency, 2018, "Life Cycle Assessment of grocery carrier bags", in *Environmental Project* no. 1985 (https://www2.mst.dk/udgiv/publications/2018/02/978-87-93614-73-4.pdf; accessed: 28 November 2019).

17 Government of Sweden, 2018, Det går om vi vill – förslag till en hållbar plastanvändning, SOU 2018:84 (https://www.regeringen.se/rattsliga-dokument/statens-offentliga-utredningar/2018/12/sou-201884/; accessed 27 September 2019).



Resource-efficient plastics flows

»Plastic is a category of materials containing many types of plastic with different origins, a range of properties and various application areas.«

The design of plastics, plastic products, plastics flows and plastics markets is crucial for the level of resource efficient and circularity that can be achieved in the flows and how fast the transformation can take place. In this chapter we therefore discuss the design of plastics and plastics products as well as the flow systems for plastics. The plastic market is mainly addressed in the action plan for "An advanced plastic market" (Chapter 4).

IMPORTANT DESIGN CRITERIA FOR RESOURCE-EFFECTIVE PLASTICS AND PLASTIC PRODUCTS

- Resource-effective raw materials
- Additives
- Number of types of plastic in a product
- Avoid "fusing" different materials together in the same product
- Labelling
- Product life
- Traceability

Plastics and plastic products

Plastic as a material category includes many different sorts of plastic with different origins and a diverse range of properties and application areas.

A variety of raw materials are used in the production of plastics. Today the raw materials are mainly oil-based and therefore of fossil origin. There is, however, a clear trend towards increasing the use of bio-based raw materials and – though mechanical or chemical recycling – also plastic as a raw material for new plastic. Plastics therefore need to be regarded both as a material and a raw material, particularly in the context of a resource-efficient and circular economy.

Plastics also have varying properties – some are stiff, others elastic; many have a long life, while others can be easily broken down. Plastics flows also include many sorts of so-called volume plastics for the largest volumes. Polyethylene (PE) and polypropylene (PP) account for 50 percent of all plastics used in the EU. If we include polyvinyl chloride (PVC), polyurethane (PUR), polyethylene terephthalate (PET) and polystyrene (PS), these six types account for a combined 80 percent of all plastics used.[18] The remaining 20 percent consists of plastics with special properties that can handle high temperatures, are very strong, can conduct electrical current or are water soluble. The most common types of plastics in this category are polyamide (PA), poly (methyl methacrylate) (PMMA) and polycarbonates (PC). Different plastics vary in how well-suited they are for packaging, building materials, electronics, vehicles and in application areas.

There are many examples of how plastics contribute to various product groups and functions. In packaging, plastic has a hygiene value and protective function to reduce

18 PlasticsEurope, 2018, "Plastics – the Facts 2018" (https://www.plasticseurope.org/application/files/6315/4510/9658/Plastics_the_facts_2018_AF_web.pdf; accessed 30 September 2019).

food waste. In the textile industry recycled plastics can be used in polyester. The automotive, electronics and white goods industries use plastic that is mouldable, durable and lightweight. In construction, plastics are used to keep out moisture, in insulation and in pipe systems. In agriculture plastics are used in cultivation and silage baling.

The properties of plastics are also adapted with the help of various additives, such as stabilisers, softening agents, fillers and reinforcement (plastic composites/composite materials). They are added to make the plastic stronger, less brittle, more scratch resistant, shiny or fireproof. This adaptation can, however, reduce mechanical recyclability depending on the extent to which the additions are traceable and can be separated. One example is the increased use of fibre-reinforced plastic in, for example, the automotive industry, which makes it significantly more difficult to mechanically recycle thermoplastics that otherwise have good recycling properties. Polymers in plastics should be chosen to provide good properties in both material use and recycling. Additives can also create concerns about the potential environmental and health risks of the plastics. Traceability and product declarations are therefore needed. Meanwhile, composite plastics and composite materials as well as manufacturing processes are being developed that can reduce the amount of plastic used while retaining the same functionality (e.g. strength). The way plastics are designed can in many ways affect the extent to which they are resource effective (Figure 3). How the issues above impact sustainability and resource efficiency needs to be evaluated through life cycle assessment.

Life cycle assessment

Life cycle assessment (LCA) can be useful to inform the choice of the best design for resource efficiency because it can identify both problems and opportunities from a broad environmental perspective. One important aspect of LCA is that it applies system boundaries to the area to be assessed. In resource efficiency, effectiveness and circularity, system boundaries can be very broad, particularly as assessment should consider the cradle-to-cradle aspect. LCA can be used to shed light on specific issues such as the impact of virgin material extraction or the climate. These assessments may require a significant amount of work, particularly if it includes multiple criteria such as material recycling potential and health issues. This can create obstacles in the form of administrative time and cost burdens, but to achieve progressive development of resource efficiency it is difficult to see how this type of analysis can be avoided. It is important to make the right decision from a system perspective, taking into consideration more than individual sustainability aspects. It is therefore important to emphasise the need for LCA to provide information about environmental impacts in the development of plastics and plastics value chains. The project has identified a number of areas where LCA is needed to inform decisions on strategies and investments relating, among other things, to design and chemical recycling.

Design guidelines for recycling

To some extent, the development of more resource-efficient plastics flows can be facilitated through guidelines on product design to make the material more easily recyclable and to generate higher valued once recycled. A good example of this is the manual that FTI (nationwide packaging recycling system) has produced at the request of Swedish Plastic Recycling. It provides guidelines and explanations on choices of plastic, colour, printing and glue etc. to promote greater recycling potential in packaging.[19]

19 Förpacknings- och tidningsinsamlingen (FTI), *Manual för plastförpackningar*. Can be found at https://www.ftiab.se/1860.html; accessed 20 October 2019). FTI also offers training based on the manual.

Recycling, industrial symbiosis and reuse

Mechanical and chemical recycling

Plastics can be recycled *mechanically* or *chemically*. Today most recycling is handled through mechanical recycling where collected plastic is sorted, broken down, washed and then reused to produce plastic pellets that can be melted down and used as raw material for new plastic products. The ability to use mechanical recycling is limited by the choice of plastic (including polymers), the properties of the collected plastic, the number of re-melting cycles and the sorting and recycling technology. Plastics may also be contaminated by dyes, odours or chemicals.

Increasing the degree of mechanical recycling is largely dependent on better collection and sorting to create homogenous flows of plastics with similar properties and with a known origin. The Swedish Plastic Recycling plant in Motala currently has sufficient sorting capacity to sort plastic packaging from Swedish households. However, there is not as much capacity for other plastic flows, such as plastic from commercial waste. Capacity has, however, been freed up since the plant in Motala was put into operation. However, of the total volume of plastic that is put out into the market in Sweden only 10–20 percent is recycled as new raw material.[20] Much of the packaging volumes today do not get the chance to be sorted and recycled because they end up in different waste fractions. This is due to poor household and commercial sorting of waste as well as technical limitations. In other words, after sorting, a large percentage of the plastic packaging collected today goes to energy recovery because it is not suitable for recycling or because there is no market for the recycled plastic (see also below). This should not, however, be used as an argument for *not* sorting and sending plastics to recycling. These growing volumes are an incentive for entrepreneurs who can invest and take advantage of and use the material. They should also be an incentive for research and development to address current technical shortcomings and to improve recycling capacity.

The low percentage of collected plastic that is turned into new raw material can be explained, among other things, by contamination such as labels, glue, unknown additives and contact with toxic substances. Much of this volume can be managed at a *chemical recycling plant* (also called plastic refinery; see also Chapter 7). This type of plant now exists in Europe. This method breaks down the plastics at the molecular level to produce chemicals that can be used as raw material to produce new plastics of virgin quality or other products. This allows contaminated plastics and old plastic products with unknown content to be processed. Chemical recycling can also be used when the properties of mechanically recycled plastics start to be degraded.

The choice between these two methods should be based on overall resource efficiency and effectiveness perspectives. This is determined by the function of the plastic product and how it contributes – or fails to contribute – to resource efficiency and effectiveness throughout its life cycle, or the resource efficiency of the recycling technology. Due to low chemical recycling capacity and higher energy demand, the project believes that ensuring that products can be mechanically recycled is an important design principle. This does not mean that more complex plastic products that can support increased resource efficiency and effectiveness through their functions should not be developed, but this should be weighed against the ability to recycle them chemically today. Here too, life cycle assessment is needed to study the differences between mechanical and chemical recycling, the functionality of plastic products through their life cycle and plastic production using virgin raw materials.

20 Information from FTI. Other studies exist that suggest lower volumes, for example Ljungkvist Nordin, H., Westöö, A-K., Boberg, N., Fråne, A., Guban, P., Sörme, L. and Ahlm, M., 2019, "Kartläggning av plastflöden i Sverige: Råvara, produkter, avfall och nedskräpning", Svenska MiljöEmissionsData, SMED Report No. 1 2019 (https://smed.se/avfall/4520; accessed 28 November 2019). It is, on the other hand, difficult to make comparisons between reports and estimations that are based on different data and possibly also use different system boundaries.

Developing the capacity and possibility of chemical recycling also involves technology development, lowering the energy consumption and investments in additional facilities, as well as life cycle assessment to determine if and when the chemical method is preferable to mechanical recycling. It is also important to ensure that chemical recycling does not result in less interest in designing plastics and products that are recyclable or easier to recycle wherever possible.

Industrial symbiosis

Industrial symbiosis[21] is a process where different industries benefit each other through their residual flows in the form of, for example, material resources, heat, steam or waste. This often takes place in a limited geographical area like an industrial park, but it may also be in a larger, national or supranational context. There are examples of manufacturers (converters) who purchase production waste from other manufacturers. Industrial symbiosis is believed to have the potential to improve resource effectiveness in Sweden although the project believes that only a minor portion of this potential is being used today. The partnerships between actors highlighted by the project to increase industrial symbiosis in resource efficiency and effectiveness are in the recycling and chemicals industries.

Reuse

If products can be reused, this is generally the best option from resource efficiency and effectiveness perspectives. However, the project believes the potential for this is limited except for specific products. The reason is that traceability and purity requirements create clear obstacles. Examples of this are plastics used in contexts such as food and healthcare – areas that have high standards relating to the plastics' hygiene properties and how they are used. At the same time there is potential for new business models to be created to increase reuse through services or leasing, for example in the case of electronics.

SYNERGIES BETWEEN PLASTIC AND TEXTILE INDUSTRIES

There is great potential for synergies between the plastic and textile industries. Synthetic fibres, the ones used the most in our clothes and fabrics, account for more than 60 percent of fibre used in the textile industry globally. Cooperation is therefore needed to close the circle for both textiles and plastics. The recycled material from plastic products could be a source of raw material for textiles, and worn out fabric items that are collected and recycled could be a resource for the plastics industry. The two industries both have similar challenges to solve, such as standards for polyester and other plastic materials, in order to promote recycling. Textiles and recycled plastics can become composites and new materials in other industries, such as the automotive and aviation industries. For industrial symbiosis to be effective, a common system and marketplaces are needed where companies can continually purchase volumes of collected and recycled resources. There is also a common interest in chemical recycling (see Chapter 9).

Return systems

In addition to the above, there are also systems for returning plastic products (including the return for money back sys-

21 There are many and varied definitions of industrial symbiosis. The following has been used by this project: Cooperation to use resources – residual flows, not resources that reduce the primary production – from one actor as raw material and energy to other actors. The concept is often limited to symbiosis between companies, although not by this project. In addition, the project considers symbiosis to include a financial (monetary) gain for actors involved. This means that the resource has a higher value for the recipient actor.

tem "Pant") and these can make significant contributions to resource-efficient and effective systems by isolating flows for mechanical recycling or reuse. There is potential to further develop of the return/money back system through, for example, ongoing standardisation work. There are several good examples to learn from – both in plastics and other areas. One such example is Svenska Retursystem,[22] which operates as part of the food flow and provides crates and pallets for food transport and handling. Gains within the returns system can boost product reuse and also ensure quality and traceability in the flows that go to recycling. The latter provides increased value in the recycled material and thus lower loss of energy recovery potential. This can be illustrated by the collection system for PET bottles as well as other plastic packaging in closed systems so that the plastic can be recycled for use in the food sector.

Plastics flows in society

A key starting point to facilitate the work on resource efficiency, effectiveness and circularity – both strategic and applied – is an understanding of the various flow systems for plastics. Without information on the volumes and value of the flows, design strategies, roles of actors, plastic imports and exports and how they can be reused or recycled, there are serious gaps in the information on which to based decisions on strategies and development. Consequently, a key question here with respect to development of plastics flows is: Which information and analysis are available and what is the quality of data on the flows?

There is consensus that there is a serious lack of knowledge about the flow systems today. A recent study to increase knowledge about today's flows based on available statistics and information was therefore very welcome (Figure 5). However, the report has identified significant gaps in the statistics in various areas. The lack of statistics is a problem as there is insufficient information about important flows, some of which are relatively pure fractions that also have a high potential for resource-efficient and effective management (such as certain industrial plastics). Data on plastic pollution in existing flows is important in order to evaluate recycling and market potential.

For positive development to take place, the flow systems need to be monitored continuously to see where development towards increased material recycling is accelerating and which sectors may need support. The actors in the value chain have a significant responsibility to contribute to the statistics – not least because this data is needed for market analysis and investment strategies, as well as for analysis to guide policy-making and inform the public debate about plastics. If the industry itself is not contributing to a greater understanding of the systems, there is little justification for criticism regarding resulting problems within the political framework.

Another issue relating to knowledge about flow systems is traceability, which has been highlighted as a key aspect in the project's action plans. The importance of traceability is also evident in the vision of Swedish Plastic Recycling of 100 percent traceability in material recycling or energy recovery from plastic packaging. Analysis of collected plastics is also crucial, especially where traceability is more difficult to guarantee, which can be the case with, for example, long-life products (over 50 years).

Analysis will also be needed to understand the likely future development of plastics flows. This is particularly important bearing in mind that new technologies for plastic recycling are being developed. Policies in China and other East Asian countries to reduce their imports of collected plastics have quickly resulted in a dramatic change in the global plastics flows. Consequently, there is now an increased focus on managing these plastics in Sweden and within the EU. Similar disruptive factors – to which the introduction of chemical recycling is of relevance – need to be included in long-term public and private sector resource efficiency and effectiveness strategies if these strategies are to be robust.

22 Svenska Retursystem (http://www.retursystem.se; accessed 27 September 2019).

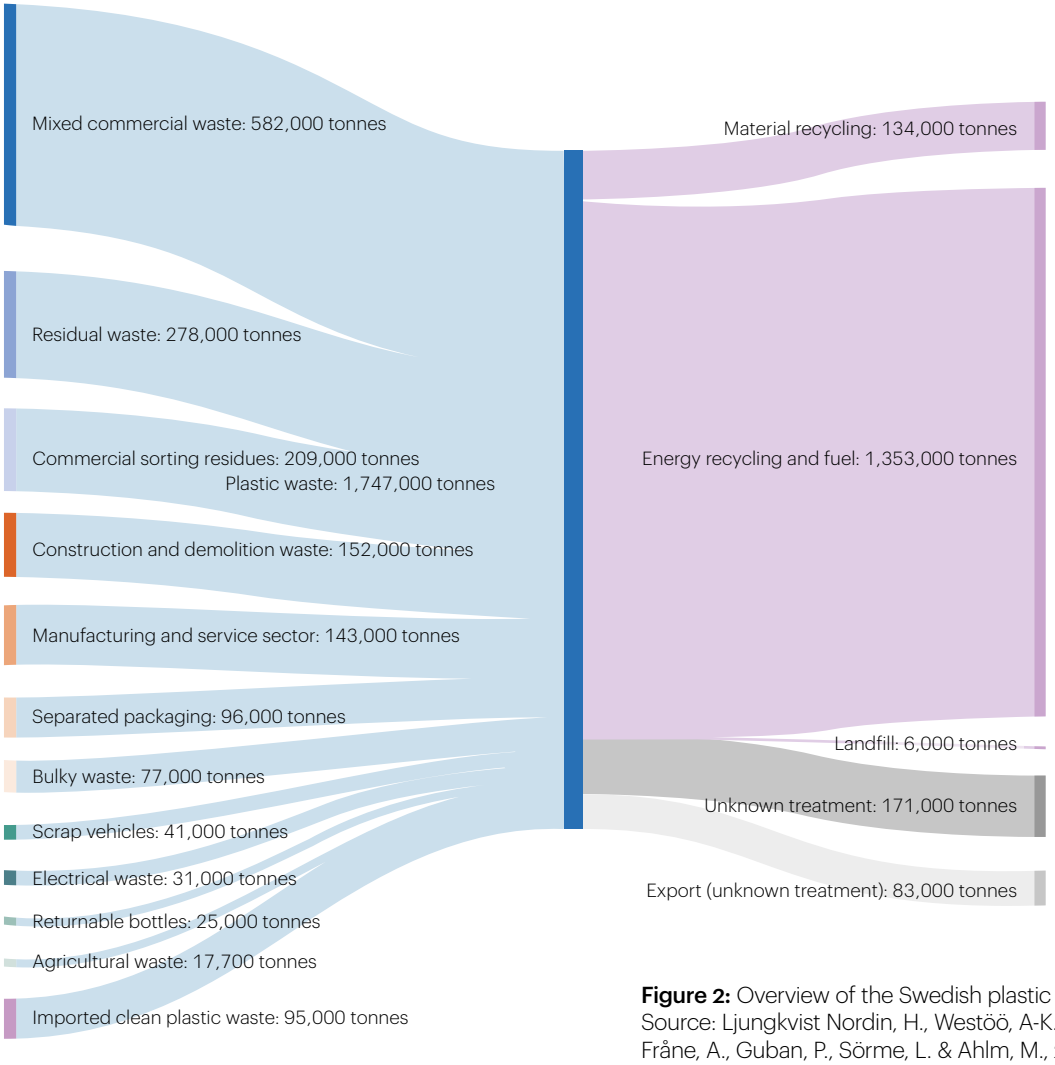


Figure 2: Overview of the Swedish plastic flow. Source: Ljungkvist Nordin, H., Westöö, A-K., Boberg, N., Fråne, A., Guban, P., Sörme, L. & Ahlm, M., 2019.

Packaging and other plastic products

Plastic packaging is currently subject to producer responsibility. Packaging producers are responsible for ensuring that packaging waste is collected and the materials in it recovered when the packaging becomes waste. Collection at recycling stations and in buildings is handled by the FTI nationwide packaging recycling system which is owned by several materials companies,[23] including Swedish Plastic Recycling. FTI coordinates the management

23 Plastkretsen, Pressretur, Returkartong, Svenska MetallKretsen and Svensk Glasåtervinning.

and operation of the collection system on behalf of materials companies. Comparisons need to be made between the collection and recycling of materials in packaging and other plastics flows, with an understanding that the producer responsibility creates certain specific conditions. In addition to packaging, there is also a national producer responsibility for things like vehicles and electronics, as well as voluntary producer responsibility for agricultural plastic.[24] The project has produced an action plan that includes increased producer responsibility for other plastic products as well (Chapter 4).

Mass balance and volumes

The development of markets for recycled plastics is dependent on a high level of confidence in the recycled content of plastic products. Today there is often a mix of recycled plastic raw material and virgin materials with variation in the percentage of the recycled content (which is called *mass balance*). Also, customers that purchase a product labelled as containing recycled plastic may be buying an item with anything from zero percent recycled to a higher average recycled content than stated. Traceability regarding recycled material content is therefore needed to avoid distrust which can result in reduced use. Similar problems have arisen in the labelling of other products.[25] Bearing in mind that plastics are exported and imported, it would be beneficial to establish an international system to manage this imbalance. There are initiatives under way in this area that could serve as starting point for dialogue in Sweden and the EU on how to drive a system of this type forward.[26]

The present volume of all plastics recycled in the Nordic region is not sufficient to meet the plastic raw materials needs of, for example, Borealis and Inovyn, two of the main plastics producers in Sweden. There is therefore a reason for and interest in capacity growth to deliver greater volumes of recycled plastic raw materials. Here, the question of the chicken or the egg – or the market and the capacity – comes up. These are interdependent and both need to be developed in unison to reduce the investment risk associated with capacity development in both recycling and use of recycled plastic raw materials. Considerable coordination is also needed between actors in these value chains. Sweden, which has actors in the chemicals, manufacturing and recycling industries as well as ongoing research, has every opportunity to handle this. The industry actors themselves should be responsible for making this happen, but policy-makers should also share the responsibility as there is no clear road map at this time for resource-efficient and effective plastics in Sweden.

24 Swedish Environmental Protection Agency, *Producentansvar* (https://www.naturvardsverket.se/Amnen/Producentansvar/; accessed 27 September 2019).

25 One example is the debate about around "green electricity", where there is no guarantee given to individual customers that the electricity they are consuming is coming from renewable sources. On the other hand, demand for the labelled product is created of there is a shortage or anticipated shortage of it. In other words, demand for the labelled product can in itself result in new investment.

26 For more information on mass balance, see Ellen MacArthur Foundation, 2019, "Enabling a Circular Economy for Chemicals with the Mass Balance Approach. A White Paper from Co.Project Mass Balance" (https://www.ellenmacarthurfoundation.org/assets/downloads/Mass-Balance-White-Paper.pdf; accessed 27 September 2019).

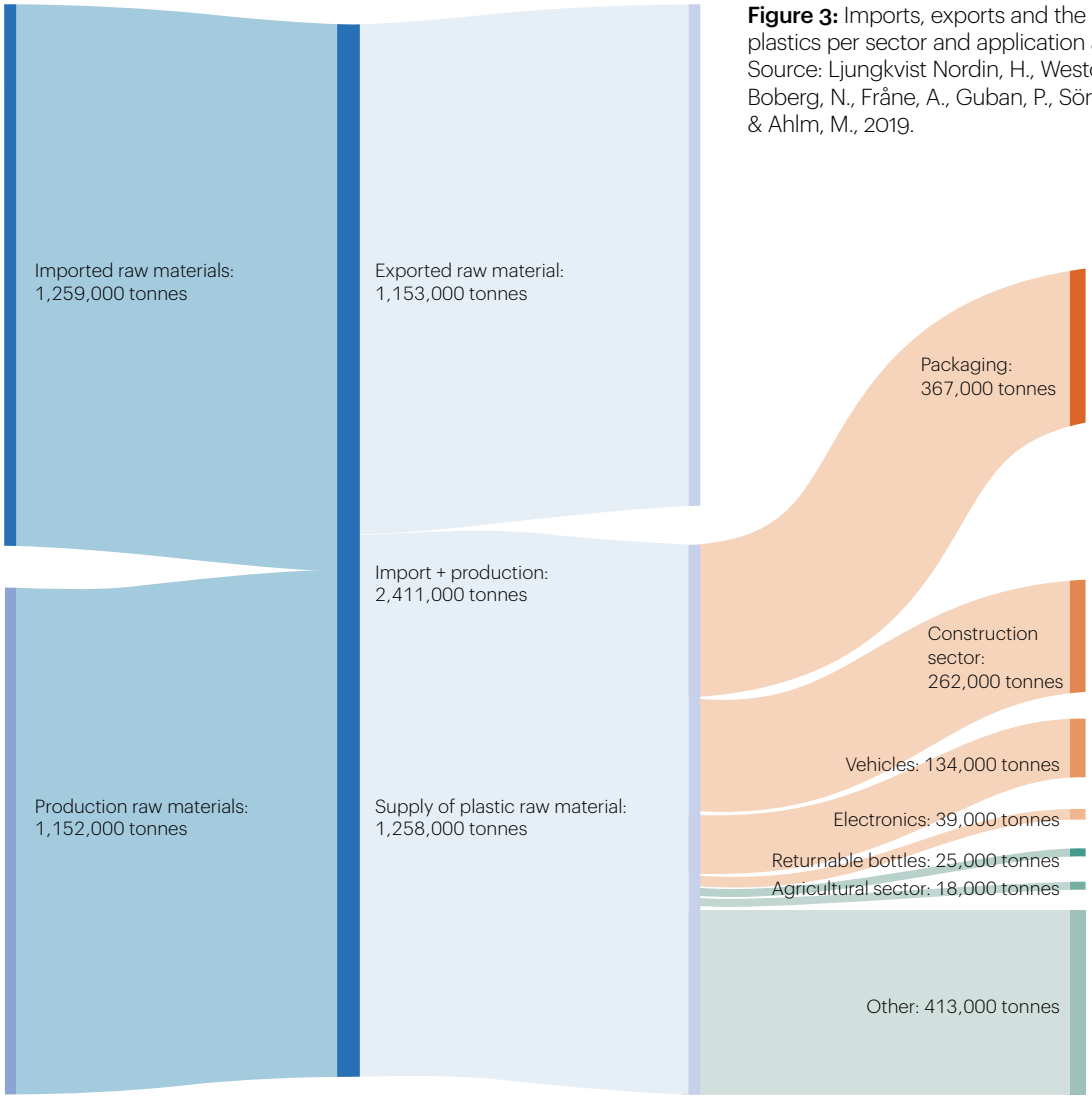


Figure 3: Imports, exports and the use of plastics per sector and application area. Source: Ljungkvist Nordin, H., Westöö, A-K., Boberg, N., Fråne, A., Guban, P., Sörme, L. & Ahlm, M., 2019.

Imports and exports

Sweden's considerable plastics imports and exports (Figure 6) should be taken into consideration when developing the plastics flow system and policies. This includes considering which aspects of the development of resource-efficient and effective plastics flows policy-makers and industry actors in Sweden and the EU have the mandate and the ability to impact. There are international regulations and standards for plastic products, as well as design criteria that may vary from country to country. An example of the latter is Swedish automotive production,

which is governed to some extent by international safety and material use regulations, limiting the ability of Swedish producers to change the standards for components. Also, imported products have plastic components that are produced outside Sweden and where the materials may have been produced in a way that Swedish actors cannot control. When producing strategies and control mechanisms to develop the plastics market, this must be taken into account to avoid an unwarranted negative impact on the competitiveness of Swedish actors or the sub-optimisation of cross-border collaboration for resource-efficiency and effectiveness.

Action plan 1 – A developed market for recycled plastics

»Development of the plastic market creates many opportunities for new business models and the need for cooperation.«

The market for both virgin and recycled plastics is currently going through a significant transition driven, among other things, by a focus in society on the climate, bioeconomics, resource efficiency and circularity, as well as environmental considerations, such as plastic pollution and microplastics in the oceans. The effect is that new plastics and products are being developed that are more well-suited to this transition and in line with the control mechanisms, policies and goals that have been developed.

Roughly speaking, this can be interpreted – within the scope of this project – as involving three main measures/shifts:

- Increased *recycling* of plastics,
- Increased use of *recycled* plastics
- Increased use of *recyclable* plastics and production of *recyclable* products.

These measures need to be implemented in parallel so that market supply and demand can be developed at the same time and thereby avoid market failure (see Chapter 2). The plastic market needs to be developed to find development and investment incentives that promote increased capacity to meet the objectives established for the transition of the plastics system. **Without this it will not be possible to reach the ambitious resource effectiveness and circularity goals for plastics.**

Based on these proposed measures, two action plans have been produced by the project and together they address the need for a developed plastics market. These are *"A better collection system and recycling capacity"* and *"Producer responsibility"*. Together they underscore the importance of collection, sorting and capacity to manage collected volumes with suitable technologies, as well as producer responsibility as a facilitator and catalyst to increase collection and sorting.

Commercial opportunities and incentives

All market transitions involve new commercial opportunities at the same time as they can present risks for present business models. This is especially true in the plastics market. When large global actors present goals for using recycled and recyclable plastics there is little doubt that the transition will be driven by enterprise and not policy-makers alone. The drivers of measures and strategies to increase resource efficiency include fluctuating oil prices, corporate environmental policies, brand issues as well as drivers from the financial sector.

The price of oil has historically been an important factor in investment in plastics recycling capacity as the majority of plastics are produced from fossil crude oil. It is interesting to note that oil price fluctuations have to a certain degree stabilised the price of recycled plastic (Figure 7). This – along with environmental incentives – is one of the main reasons that Electrolux has increased the amount of recycled plastics in its products. It is hard to predict what future trends will look like with increased demand and more capacity in recycled plastics in relation to the price of oil. Price development will be affected by supply and demand trends, and the price of recycled plastics has increased recently. The price is also heavily dependent on the fraction and the quality (purity, traceability etc.) that can be guaranteed, which is currently difficult to do for the large volumes of recycled plastics. The result is lower prices, which increases the need for traceability, analysis, and sorting technologies to increase interest in expanded recycling capacity and a developed market.

As described above, obstacles often arise when supply and demand need be developed at the same time and in line with the political framework. IKEM's economic analysis clearly identifies obstacles at the national level because its survey shows that 80 percent of respondents think that obtaining recycled raw materials of sufficiently high quality

is the main obstacle for increasing circular solutions.[27] The same survey shows that the most important (86 percent) policy measure is reforming the waste sector to increase the supply of recycled raw materials. On the other hand, only 9 percent think that there is a lack of interest from customers. This is a clear example of a market failure and could warrant changes in the political framework in the form of new or adjusted policy instruments.

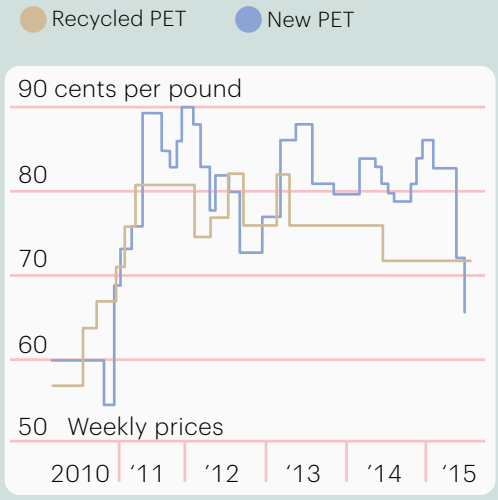
One trend that will have a significant impact on the plastics market is that plastics producers, recyclers and waste-generating actors are seeing commercial opportunities in consolidation between their various operations through acquisitions and various forms of partnerships. This trend among plastics producers and recyclers is driven by a need to ensure a supply of recycled plastics at the desired volume and quality. Consolidation among recyclers and waste-generating actors is driven by environmental incentives and motivation among the latter group to improve how their plastics waste is processed. This trend can be seen as a sign of a probable further transition involving greater cooperation along resource-efficient, effective and circular value chains.

The action plan contains four specific measures identified as priorities to take advantage of opportunities and manage obstacles, and thereby make important progress in market and capacity development:

1. A digital marketplace for recycled raw materials
2. Brokers brokering plastics deals between different actors in the plastics value chain
3. Further development of testbeds that help companies use recycled as well as recyclable plastics
4. Expanded producer responsibility for more products.

All of these measures need to benefit actors who are at the forefront of development and using new technologies and business models in order to identify opportunities that exist and contribute to important, clear progress in capacity and market development.

Figure 4: Price development for virgin and recycled PET.



Polyethylene terephtalate, or PET
Source: Plastics News

The benefit of this action plan is that it creates the necessary conditions for a significantly improved market for resource-efficient and effective plastics. To effectively promote this market development, the demand side is important and actions must generate value for brands. Most of the costs will, however, be related to technology and product development. As these processes are in different parts of the value chains, cooperation is needed between actors and with the financial sector to reduce economic risks and promote development.

27 IKEM, 2018, "Konjunkturbrev", September 2018 (https://www.ikem.se/globalassets/huvudsajt/dokumentfiler/konjunkturbrev---ikem/ikem-konjunkturbrev-sep-2018.pdf; accessed 30 September 2019).

Figure 5: Actors and value chain in action plan 1.

Actors and the value chain

Developing the market based on the measures specified in this action plan will naturally involve multiple actors as well as the whole value chain. The roles in the various part of the value chain have been defined by the project (Figure 5).

1. Plastic product producers manufacture plastic products and choose the materials to use, and can therefore choose recycled. This requires knowledge on which options exist for including recycled and recyclable materials. The producers need to ensure that materials are labelled and have a key role through recycled plastic specifications.
2. Product developers make design decisions that impact the ability to sort and recycle, including through possible expanded producer responsibility and by labelling with product contents and recycling information. There may be requirements here regarding recycled or recyclable materials.
3. Those selling plastic products should be required to provide information to consumers about how to sort

the products and provide credible information on which raw materials the plastic contains (recycled, bio-based, fossil; see *mass balance* in Chapter 3.3).
4. Based on this information, consumers/users can make active choices when purchasing and when using collection systems.
5. The collection systems need to be developed. This could be done by changing policy instruments governing waste, allowing more actors to enter the market for collection and processing of plastic that is not covered by the producer responsibility. This would promote availability and capacity in the collection and recycling system.
6. Technology development and investments in sorting are needed, as well as market development and an understanding of market demand.
7. Mechanical recycling could be used more broadly if information, labelling and producer responsibility were expanded. A dialogue is needed among producers to determine how the recycling stage can deliver the plastics that are needed.

Who is doing what and when?

The measure considered the most important is creating a *digital marketplace* for recycled raw materials.[28] This marketplace should be established in Sweden in the short term, but from a longer-term perspective at the EU level to create a larger market. The purpose of making it easier for customers and suppliers of collected and recycled plastics to find each other is also to give buyers of recycled materials a better chance of finding the right quality and sufficient volumes. One source of inspiration could be the *Finnish Industrial Symbiosis System (FISS)*, which gathers information and presents good examples of which resources can be used for industrial symbiosis in Finland.[29] This system could be developed into a broader tool to coordinate resource-efficient, effective and circular resource systems by defining flows and opportunities to use resources more efficiently and effectively. A state research institute, such as RISE, could act as an independent coordinator for this system. This would create synergies with RISE's test platform which is already serving an advisory function in resource-efficient and effective plastic development (see below). A dual responsibility would promote awareness and use of both functions. The recycling industry is an obvious partner given the knowledge the companies have of the resource systems. This responsibility should also include coordinating the delivery of statistics to SCB. As market development is considered a top priority by this project, we would like to suggest implementing this measure as soon as possible. In order for the digital marketplace for recycled plastics to function, standards are needed that make it possible for buyers and sellers to establish specifications for certain materials and applications. These are under development. Traceability and verification are also needed to avoid abuse of the market.

The project believes that having more actors on the supply side of collected plastics would help the market development process. These are identified as *brokers* or *agents* and could stimulate and develop the market. This could involve recycled raw materials being sold as an alternative to virgin materials, and familiarity with the market made up of both buyers and sellers of recycled materials. These actors could promote coordination among the various actors working with recycled raw materials based on their knowledge of resource flows and content. This could involve existing collection and recycling companies taking a bigger role in the plastics issue, or new actors entering the market. Collected plastics that are currently exported to other countries for recycling are the reason this commercial opportunity is being diminished. The project therefore recommends a preliminary study on how and which actors could act at a national level to increase domestic recycling.

28 Similar initiatives exist, such as Atomler (www.atomler.com; accessed 27 September 2019).

29 FISS – Finnish Industrial Symbiosis System (https://www.industrialsymbiosis.fi/home-en-gb/; accessed 30 September 2019).

A *testbed* for mechanical plastic recycling exists today and is being coordinated and run by RISE.[30] The testbed has expertise and tools to help companies and public sector actors. Companies can, for example, get help to promote more recyclable plastics in products and using more recycled plastics in production. The project believes that the testbed should be permanent, further developed and include a clear focus on market issues alongside technical ones. The testbed could be used more and by more companies. The effectiveness of this measure depends on interest in the value chain in using the testbed for product development and on cooperation between the different parts of the value chain. This initiative in the action plan is considered is highly implementable now.

While *producer responsibility* for plastics exists for packaging, cars and electronics etc., it is lacking for building materials, household plastic items (plastic containers, toys, etc.) and textiles. There is consensus that responsibility for packaging has been efficient and has the added benefit of creating a market-driven system. The issue of expanded producer responsibility is being discussed in general within various industries and also at the EU level. The project therefore sees an opportunity to build on the existing system, and the ongoing dialogue and interest in including the above-mention types of products. This measure is useful in developing both collection and sorting – the latter through increased awareness of and labelling of content.

Innovation needs

The need for innovation

Innovation to develop the action plan is mainly needed in terms of a digital marketplace and new business models for brokers/agents. This requires the collection of facts about plastic flows in order to identify where it will be possible to reduce current losses through a developed market. At this time we do not know enough about this aspect of the flows, but a recent mapping of the Swedish plastics flow will facilitate this type of dialogue and analysis.[31] In addition, development is needed to expand producer responsibility to include more products. It is possible to learn a lot from the existing system for packaging materials as the project believes this system is working well.

Innovation drivers

Important drivers include the political climate with a strong focus on resource efficiency and circularity, both in Sweden and at the EU/international level, and market demand, where there is a common view that product owners should eventually be prevented from selling products that are not adapted for more resource-efficient and effective plastics flows. The product owners' brand focus is therefore a key driver.

Commitments/mandate/recipients

The actor considered as having the greatest capacity and mandate to take this action plan to the next stage and turn it into a coordinated and applied agenda is an actor within the private and public sector recycling sector. Important partners in this are the owners of the big brands that need recycled plastics. Examples of these are Ikea, whose objective is to only use recycled and/or renewable plastics from 2030, and Electrolux, which wants to replace 20,000 tonnes of new plastic with recycled polypropylene plastic by 2020, i.e. 25 percent of all the polypropylene plastic the company uses. By acting within their value chain and through purchasing nationally and internationally, the brand owners can contribute to the system transition.

30 RISE, *Materialåtervinning av plast* (https://www.swerea.se/test-demo/materialatervinning-av-plast; accessed 27 September 2019).

31 Ljungkvist Nordin, H., Westöö, A-K., Boberg, N., Fråne, A., Guban, P., Sörme, L. and Ahlm, M., 2019, "Kartläggning av plastflöden i Sverige: Råvara, produkter, avfall och nedskräpning", Svenska MiljöEmissionsData, SMED Report No. 1 2019 (https://smed.se/avfall/4520; accessed 28 November 2019).

Action plan 2 – Predictable properties of recycled plastics

»Recycled plastics need to be seen as a resource with material properties equivalent to virgin plastics.«

It is essential that recycled plastics are not only discussed in an environmental context, but also as a resource with material properties similar to virgin plastics or other materials. This does not mean that plastics from recovered materials necessarily need to have exactly the same properties as virgin materials – even if this is possible with chemical recycling – but that product developers recognise that recycled plastics can provide the same functions as virgin plastics. This may require changes to some specification requirements, which may create a barrier because it is, of course, easier for product developers to retain past specification requirements than include new materials. Standards play a role here because they reduce the risks and thereby make it easier for companies to make the transition.

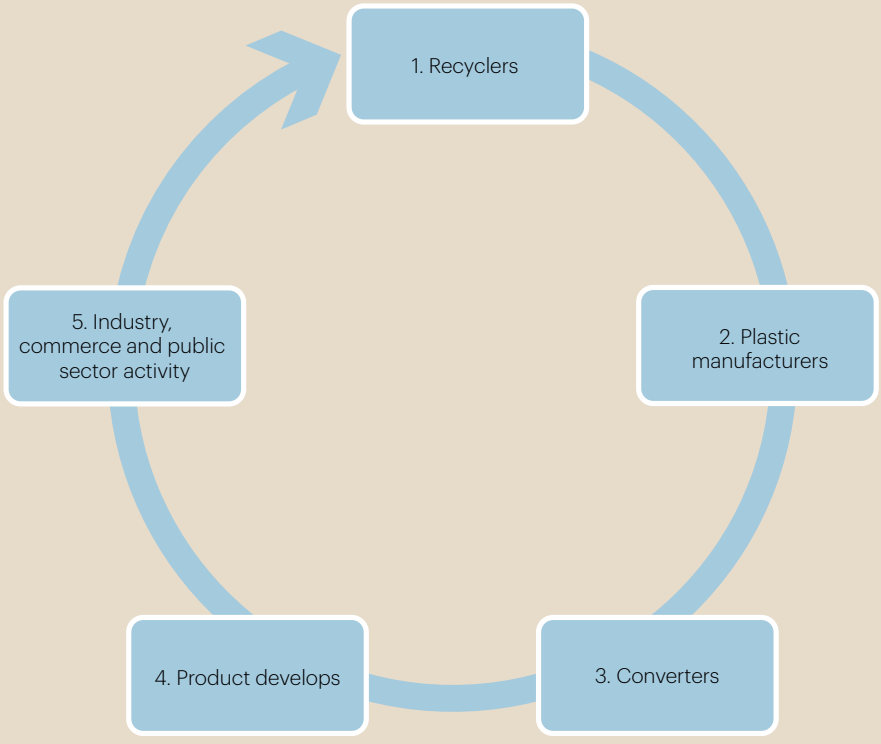
Commercial opportunities and incentives

One essential condition for the broader use of mechanically recycled plastics is that their properties are predictable. Even if predictability can be achieved today for certain recycled volumes, product developers need the same assurances for larger recycled volumes and for a wider range of plastics. Isolated flows are a possibility as they can provide predictability. Focusing too much on specific flows may, on the other hand, result in potential flows being missed or plastics that are more difficult to recycled being overlooked.

Development in the value chain can take place in three different ways. The *first* way is for technical specifications in the manufacturing industry to be adapted to the quality of recycled plastics that can be delivered. The *second* is to attempt to define a number of plastic qualities within recycled volumes that have predictable properties. The *third* way is to approve guarantees that analysis of finished products (of recycled raw material) is reliable, which in turn could be done in cooperation with recycling companies and/or in the above-mentioned testbed (see Chapter 4).

One of the main advantages is that companies can reduce their risk exposure to international markets for virgin raw materials – an aspect that provides gains throughout value chains and not just for plastic raw material producers. The costs for the necessary capacity development and analysis capacity are primarily incurred in earlier parts of the value chains. There may be a need for cost and risk sharing along the value chains, and the financial sector has a role to play here. In addition to design and specifications, cooperation is also a key factor.

Figure 6: Actors and value chain in action plan 2.



Actors and value chains

1. Recyclers need to ensure there is a sufficient volume so that product developers and manufacturing companies will feel confident when introducing a flow of recycled plastics.
2. This is a basis upon which plastic raw material producers can develop recycled plastics with uniform quality and constant volumes. A key aspect of this action plan is specifically analysis of the recycled raw material to determine whether its properties can actually be guaranteed.
3. Converters need to work in cooperation with product developers to overcome unnecessary obstacles for the use of recycled plastic.
4. Product developers need clear strategies for including more and larger volumes of recycled plastics, and to facilitate recycling of the products they develop.
5. The manufacturing industry, retail and grocery retail as well as public sector actors are important through their role in specifying product requirements.

Who is doing what and when?

Mixed fractions of recycled plastics need to be tested to ensure they have the required functionality and to facilitate standardisation.[32] This could be done initially for larger fractions that are more easily separated/traceable fractions or products to develop the system.[33] Testing of recycled plastics is needed as functionality studies are primarily carried out on virgin plastics. Testing could be done through partnerships between companies, academia and, for example, RISE. This would allow specific opportunities and barriers to be managed and show the potential and types of partnerships, as well as to use the lessons learned in a broader development process. Initially, analysis is needed of which flows could be valuable as more dedicated flows,[34] and which synergy effects may exist between different product types.

This development process must be coordinated within the value chain, and dialogue and cooperation are therefore needed, including regarding functions that companies such as product developers may not normally be involved in. To develop standards, targets need to be set at the company level to include recycled plastics. Volvo Cars is one company that has done this. This allows designers to rethink and develop specifications that could, in the case of larger international organisations, also raise awareness outside Sweden. To ensure commitment, support and an understanding at the leadership level of the value that this creates are therefore needed.

Product developers and designers are particularly important actors to set standards and create demand. In line with what is described above, this should be done in cooperation with recyclers, plastic raw material producers, subcontractors and converters to ensure the volumes and specifications are in place.

Development would be much easier to achieve if recycled plastics were included in standards and/or labelling (see Chapter 4) at the international level – both in terms of recyclability to ensure volumes and technical functions (physical properties). This is needed, among other things, to facilitate sorting in the recycling system and to create a common agenda for the development of recycled plastics as a raw material. Traceability also needs to be developed through digitalisation to simplify the transfer of information, which is also linked to the action plan for product declarations.

Dialogue is needed with purchasers who make large investments to show, among other things, the technical and financial potential of increasing the amount of recycled plastic introduced. There are many producers that have introduced products and solutions for public funding focusing on the use of recycled plastics. The investment volume here means that this could create incentives for new and existing suppliers to follow in the same tracks.

With respect to schedules, there are no real obstacles; dialogue could begin immediately for gradual implementation. There is also an ongoing standardisation process within the framework of ISO run by the Swedish institute for Standards (SIS).[35] When this is done the hope is that it will solve the raw material quality assurance challenge, or result in labelling indicating assured quality.

32 There are actors doing this today, for example Polykemi (https://www.polykemi.se/produkter/laboratorium/; accessed 30 September 2019).

33 Examples of this are the system for agricultural plastic through Kretslopp & Recycling Sverige AB (http://krsab.nu/) and Svensk Ensilageplast Retur, Svepretur (https://svepretur.se/; accessed 8 November 2019). Other examples are collection of non-contaminated medical packaging by county authorities, or collection of stretch film for pallets by large retail chains.

34 One approach could be to identify and analyse what was done by PlasticsEurope 2018.

35 SIS, *Plast* (https://www.sis.se/standardutveckling/tksidor/tk100199/sistk156/; accessed 30 September 2019).

Innovative environments

The need for innovation

New testing requirements for recycled raw materials and the plastic subsequently produced are needed to guarantee that the properties of recycled plastic are sufficient. More research is needed for more difficult flows, such as mixed flows. Tests need to be carried out efficiently to continuously monitor the quality as the raw material is more diversified than is the case in production with virgin raw materials. Better information is also needed on how recycled plastics can provide different qualities that will be in demand today and tomorrow. Design is therefore a priority to develop replacements for certain products, such as composite plastics, that are difficult to recycle, and to develop colorants that can be washed out and thereby increase the potential for efficient mechanical recycling.

Innovations are also needed at the market level to accelerate development. The project believes that recyclers would benefit from organising themselves into larger clusters and thereby be able to develop larger volumes and better quality.

Innovation drivers

The market is at this time not the main driver of interest and development in this area. It is instead thought to be driven by public opinion. This is a strong driver at the same time as public understanding and expectations do not necessar-

ily reflect actual opportunities. There is growing awareness within the value chains of resource efficiency and circularity and they are moving towards a business-critical position where proactive agendas with subsequent measures will be required. This is reinforced by the financial sector's growing focus on sustainability.

The main factor holding back the pace of innovation is an underdeveloped market, where directives, control mechanisms and sufficient prioritisation of measures for higher resource efficiency and effectiveness in the financial sector are not at the requisite level. Research funding is also needed so that processes and a platform can be developed to provide knowledge on how to achieve the requisite quality in recycled plastics, and how tests can be more effective and yield results that provide assurance for product developers.

Commitments/mandate/recipients

The actor considered as having the highest level of authority and ability to take this action plan to the next stage and turn it into a coordinated and applied agenda is IKEM representing the innovation and chemicals industries in Sweden, preferably in cooperation with one or more large plastic users in manufacturing industry, retail and grocery retail, as well as public sector organisations to help drive early development and present good examples as described above. Converters, such as Trioplast and Tetra Pak, will also need to be included in the dialogue to identify how they can incorporate the recycled plastic in their operations. It is particularly important to include compounders who can tailor the properties of recycled plastics by mixing different fractions.

Action plan 3 – Product declaration system

»Due to the numerous different types of plastic and plastic products, traceability is needed to facilitate sorting and recycling.«

Improved labelling of plastic products could increase the efficiency of sorting and help with the predictability of properties in mechanically recycled plastics (see Chapter 5). This could be done on a far broader scale than the system for labelling plastic content that applies today. This also needs to happen at the EU level or at the international level in order to be effective and have a broad impact. A full-scale production declaration system would be a significant administrative burden, especially taking into consideration other declarations that are required in the chemicals industry.[36] The project therefore proposes a somewhat simplified system.

Commercial opportunities and incentives

A standard for materials instead of a full content declaration would reduce the administrative burden while also achieving many of the positive aspects. A system could be introduced that classifies different plastics based on aspects like recyclability and which additives and contaminants are approved in a material recycling system. Refined material labelling based on a more detailed classification of types of materials, such as an ISO standard, could enable the materials in products, packaging and wrapping on the market to be recyclable. This does, however, highlight the need for various plastics that do not have the same classification to be able to be separated or for products to be designed with plastics with the same classification.

The system will make it easier for producers, product developers, purchasers etc. to ensure that the materials in products, packaging and wrapping on the market are recyclable, and will guide and improve the efficiency of recycling. The system needs to be designed to make it easy for converters and producers to apply it and for actors further along the resource chain (e.g. recycling companies) to identify products and their content. To market the new classification system, industry organisations from the entire value chain need to inform their members about it.

The construction sector could serve as an example here. Building product declarations exist today but these need to be standardised and digitalised so that relevant material data is available to collectors and recyclers. The reason for this is that data and criteria need to be more readily available in order for it to be possible to identify and purchase the best products. Digitalisation would also be helpful when structures are demolished for better data on materials included.

An important driver of this action plan is that the recycled materials increase in value and thereby stimulate market and capacity development for recycled materials. This also reduces exposure to the virgin material market and by more sustainable production being more attractive among investors and lenders. To promote credibility, the project has identified the need for a supervisory body or other type of third-party scrutiny, e.g. by a certification company, to verify compliance with the system.

36 For example, the REACH directive (Registration, Evaluation, Authorisation and Restriction of Chemicals).

Figure 7: Actors and value chain in action plan 3.

Actors and the value chain

1. The plastics producers need to declare the content of their plastics.
2. Manufacturing companies, including converters, need to declare which plastic or plastics are used in their products and pass on this information through labelling and links to information or standards (depending on which systems are to be applied). This includes requiring documentation to be in place.
3. Retailers should require labelling and recyclable plastics and also use the existing collection systems.
4. Collection actors need to ensure that the system can handle the needs that exist for labelling to be effective.
5. The recycling industry needs to invest in capacity and development to manage efficient recycling based on labelling.

Innovative environments

The need for innovation

Ideas on standardised classification and labelling (digital labelling) of plastics based on recyclability need to be developed further. This includes addressing how the system can work for products that include different classifications. This could be done within the framework of a R&D project linked to the standardisation process, in which the entire value chain is represented. Here, relevant industry organisations could play a role to ensure inclusion and information for the entire value chain. The objective of this R&D project would be to produce the framework for classification and the labelling processes/technology. An R&D project is also needed to test classification/labelling in a number of pilot projects to identity opportunities and barriers and how these can be managed.

It is important to identify initiatives that have already started within ISO for plastic recycling for an effective process of feedback and knowledge transfer. The project believes that this should be started immediately and coordinated with ongoing initiatives to achieve a common system as far as possible within the EU and internationally.[37] To manage the classification process, a digitalised system is needed that can transfer information between different actors in the value chain. The project would like to see this in place by 2021.

Based on the materials and how they are to be grouped to facilitate effective recycling, the plastics industry should be involved and define the boundaries. With respect to labelling, actors that understand digitalisation should be represented, as well as those that will manage the plastics downstream from the plastic producers. It must therefore be easy for those sorting plastics to understand how it should be done.

It is difficult to identify individual entrepreneurial opportunities here. The project instead believes that the whole value chain, as well academic actors, in cooperation with standardisation bodies should be responsible for producing and implementing this.

Innovation drivers

The standard will enable simpler specifications to be in place in connection with purchasing and will make it possible for plastic to be mechanically or chemically recycled, depending on which type of plastic is needed to best suit the application area, which is a common goal in product development. This will in turn encourage producers to use the types of plastics from which materials can be recovered. Sorting plastics when they have served their purpose will be easier with clear labelling.

Commitments/mandate/recipients

The actor group considered as having the greatest capacity and mandate to take the results from ongoing initiatives to the next stage and turn them into a coordinated and applied agenda consists of industrial stakeholders within purchasing and production of both products and packaging. This is because they can drive and coordinate the agreements that are needed for a common system. There is no obvious individual actor here; instead a new coordinating body is needed for the plastic flow as the recipient. Alternatively, this could be coordinated by relevant industry organisations such as IKEM and TEKO which can also act through their respective organisations at the EU level.

Classifications should be developed in consultation between the plastics producers and the recycling industry, with SIS acting as a facilitator.

37 See for example, the European Chemicals Agency, *New database on Candidate List substances in articles by 2021. ECHA/NR/18/44* (https://echa.europa.eu/-/new-database-on-candidate-list-substances-in-articles-by-2021; accessed 28 September 2019).

Borealis's unique testing centre for high-voltage cables in Stenungsund.

Action plan 4 – Chemical recycling

»Chemical recycling provides new opportunities for plastics recycling and this will affect the development of the plastics flows.«

Plastics and textiles that are difficult or impossible to recycle mechanically can increasingly be recycled chemically. This technology is expected to play a growing role in a circular economy where other types of recycling or reuse are not possible.[38] The alternative is often otherwise energy recovery.

While chemical recycling has a role to play in a circular economy, the method is not necessarily more resource-efficient. One main reason for this is that current chemical recycling processes used at a plastic refinery are in general energy-intensive due to the high temperatures required (usually around +200–500°C). The environmental impact from chemical recycling is also heavily dependent on the environmental performance of the electricity and heat supply. While technical development could improve the process, life cycle assessment needs to be carried out to compare different processes and methods for virgin plastic production, mechanical recycling, chemical recycling and energy recovery from a broad resource effectiveness perspective. This type of analysis could also identify priorities for technology development to optimise the processes to reduce environmental impact.

Chemical recycling can also be used to produce fuel from recycled plastic, although this is not a resource efficiency measure and is in strong contrast to measures promoting circularity. Life cycle assessments show that chemical recycling can provide benefits, but they also clearly indicate that waste-to-fuel does not provide anything close to the benefits achieved when the technology is used for waste-to-resource. The political framework should also be designed so as not to incentivise the fuel production through chemical recycling.

Commercial opportunities and incentives

Development is rapid in both technology and markets for chemically recycled plastic and this type of plastic is already offered in the market. New plants are being constructed and goals for further investments are being set up internationally. Interest groups are also forming in Brussels. One reason for this is that it will not be possible to reach the established international goals for recycled plastic use without expanding the potential of chemical recycling. The technology also makes it possible to handle more complex plastic products that, through their functionality in the user phase, may promote resource effectiveness but which may be less suited to mechanical recycling due to their complexity. The potential and the role of different types of technology within chemical recycling and its role in a resource-effective and circular economy need to be studied so that the right decisions are taken from a system development perspective.

One fundamental question is whether Sweden and Swedish actors want to be dependent on other countries to export plastics collected here for recycling and to import chemically recycled plastic. The project does not see this as a potential problem, but given the increased interest among industry and political actors in resource effectiveness and circularity, the question needs to be answered. This is relevant because chemical recycling has a role within the framework of the next generation circular processing industry.

It is unclear whether a full-scale chemical recycling plant in Sweden is needed, as estimates show that only a limited number of facilities will be required within the EU to meet the demand. The number depends on different chemical

38 Chemical recycling is not primarily a process used to handle chemicals that harm the environment, even if it is critical to reduce or eliminate certain toxic chemicals.

recycling technologies and how they can handle different flows of plastics, textiles and other suitable materials. A study should be conducted to determine if the technology options and plastics exist for plants that are suitable for Swedish actors and circumstances. One option is to coordinate this at the Nordic level.

In addition to the above, there are other general issues to address when developing chemical recycling:

- Borealis is the largest plastics producer in Sweden. It primarily produces one type of plastic (polyethylene, PE). The choice of chemical recycling technology is thus determined by which technology is best suited to PE. The company is participating in technology development projects and is also looking into the possibility of investing in a large-scale plant. To create a better understanding of how chemical recycling can impact plastic manufacturing and political goals for resource effectiveness, the opportunities and potential for a Nordic plant should be studied.

- This also links to whether commercial opportunities would instead largely revolve around technology know-how[39] and recycling systems. This would build on a long tradition of Swedish innovation and know-how in the area of plastics. On the other hand, the chemicals industry has traditionally been tied to technology licensing. The opinion within the project is that, while Sweden is behind in development, research is being done in the area and this could create opportunities to export technology.

- A third option is to collect plastics at recycling and CHP plants, subject the materials to pre-pyrolysis treatment (to partially break them down) and sell them to the EU as raw materials. Pre-pyrolysis would facilitate recycling in the EU by taking care of part of the chemical recycling process. This is relevant in particular if pre-pyrolysis can be done within a system of industrial symbiosis, with the help of a surplus of renewable energy or combined with other environmental and sustainable benefits.

A body of knowledge is therefore needed that can support a dialogue on whether Sweden should implement a chemical recycling initiative, and if so, how. There are several technologies like pyrolysis, gasification and depolymerisation that break down materials in different ways and are appropriate in varying degrees for different materials. There is also a need for mass calculations to see on what scale collection, recycling and demand for recycled plastic raw material can be matched. Decisions on the type of plant should be preceded by a study of which technology is most suitable in Sweden, given the access to recyclable materials as well as demand for chemically recycled raw materials.

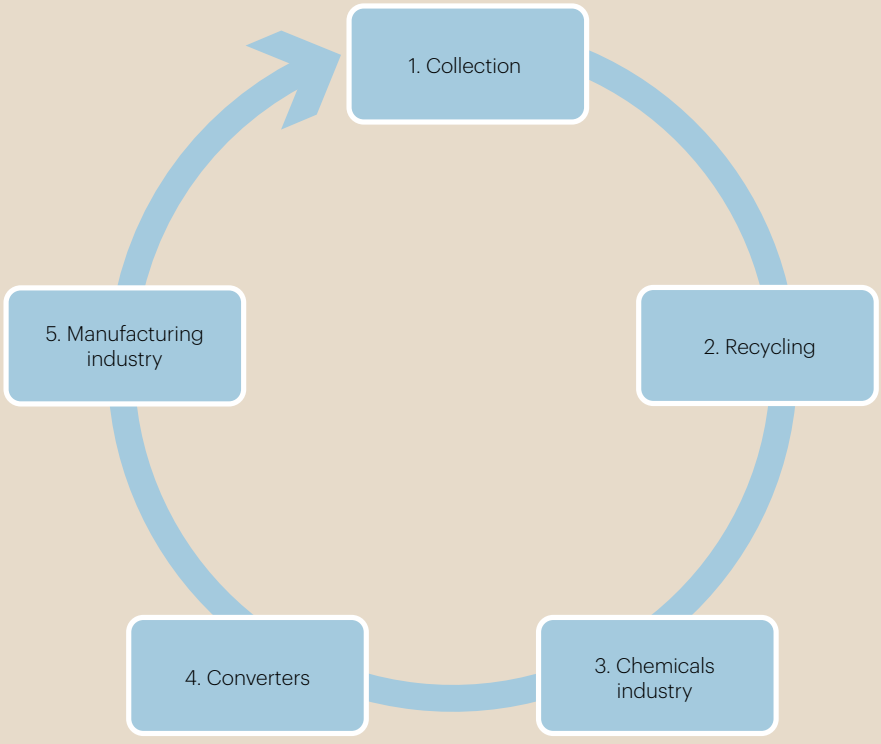
The benefits of the action plan presented for chemical recycling are increased potential for recycling and circularity, and the fact that plastic raw material producers can reduce the amount of virgin materials they use while also reducing their exposure to risks in the virgin materials markets. Plastic product producers that have made good progress in development can build brands and take a bigger market share by including chemically recycled materials.

Value chains and actors

1. Collection should be done by a larger number of actors, such as FTI, Avfall Sverige, waste companies, recycling companies, county authorities and municipal waste companies. It should be done within the framework of producer responsibility systems and include materials rejected from sorting facilities.

39 Research in chemical recycling is, for example, being conducted at Chalmers University of Technology within the Vinnväst initiative *Klimatledande Processindustri* at Johanneberg Science Park and within the Mistra-funded programme *Sustainable Plastics and Transition Pathways* (STEPS).

Figure 8: Actors and value chain in action plan 4.



2. Recycling and collection processes need to be coordinated to efficiently separate and combine flows that cannot or should be recycled mechanically, or be reused. Taking into account the scale that is probably going to be required for a chemical recycling plant or collaboration on pre-pyrolysis, cooperation will be needed between private sector and municipal entrepreneurs, producer responsibility systems, waste and recycling companies and the chemicals industry.
3. The chemicals industry, represented by plastic raw material manufacturers, has a clear role to play in supporting development and establishing goals and standards for chemically recycled raw materials. Without this, there will not be the demand needed in the market.
4. Converters should take part in collaboration to see how they can develop their production processes in the future and which role chemically recycled plastics can play in production.
5. Manufacturing industry as part of business-to-business has a similar role to play as converters by creating demand.

As shown above, there are numerous actors that can deliver recycled plastic for pre-treatment and chemical recycling. These key actors should have a dialogue on volumes and sorting of recycled plastics to plan technology choices, investment and operation. The customers are an important part of a dialogue on demand for the recycled material, regardless of whether it is used for plastic raw material manufacturing or other chemical manufacturing. How much the actors and their customers are willing to pay is another aspect to consider with respect to chemically recycled plastic.

A full-scale chemical recycling plant would involve significant investment costs. The benefits of the investment would be shared by several actors in the value chain and the project recommends joint ventures to make investment happen. This is also recommended by the financial sector which sees a need for a clear recipient and investor to indicate a long-term commercial venture and returns. There are examples of joint ventures and how cooperation can result in larger investments in innovative processes, in part justified by environmental aspects. As this involves substantial investment, the Government also has an important role to play by investing and providing loans.

Outside the value chain described above, the textile industry is a key actor category within chemical recycling. This industry currently has no way of recycling polyester or other textiles such as blended fabrics. It is unclear at this time how new textiles will be developed and produced. This may depend on how chemical recycling develops and what the chemicals market looks like in the future. It is therefore difficult to predict exactly what proportion of materials will be able to be chemically recycled. On the other hand, chemical recycling is expected to play a very important role and is necessary for investments in spinning mills (see the Textiles subproject report).

Innovative environments

The need for innovation

Knowledge is needed on how chemical recycling can handle varied material flows, as different technologies vary in how well suited they are to handle different plastics and other materials in processes (textiles, packaging, refrigerators, water pipes, auto fluff etc.). Gasification, for example, has relatively substantial capacity to handle different flows. This is important in the ability to guarantee sufficient volumes of collected plastics to process at plants. One process may be developed that is superior to others, or different plants around the EU may process different types of flows.

Flexibility to process different flows is also a key development consideration. It is also important to focus on reducing energy consumption. The latter is important in order for chemical recycling to be a feasible option for organisations that have established a carbon budget, as well as for social and political acceptance of the technology.

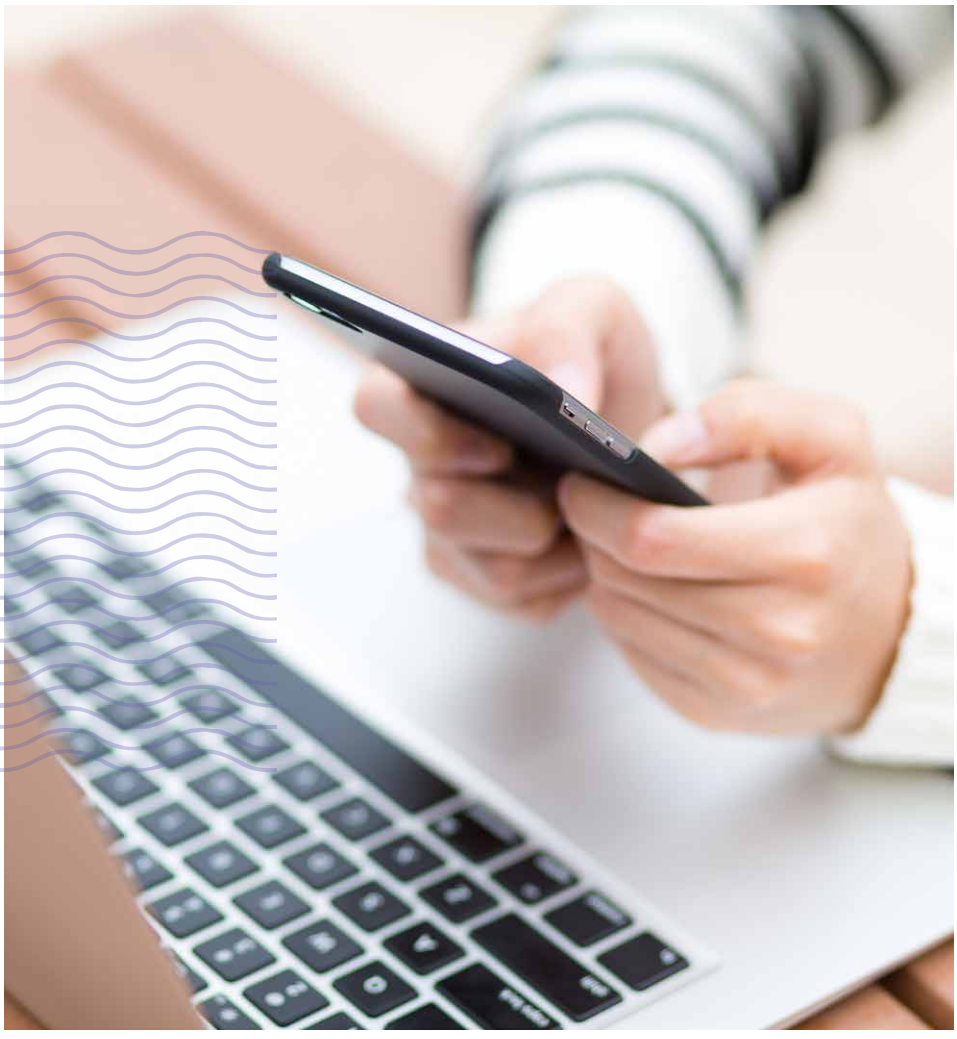
Innovation drivers

The main drivers are the values and lost benefits from the volume of plastics and textiles that cannot currently be recycled mechanically, which represents a considerable portion of the plastics flow. One measure could be to develop control mechanisms to require a significant increase in plastic recycling, e.g. in line with discussions on a ban on incineration of recyclable materials. Legislation on chemicals could emphasise the need to also break down plastics intended for mechanical recycling. It could also be a case of "starting again" with mechanically recycled plastics that are beginning to be degraded.

There may be broad interest in participating in innovation, in line with the broader cooperation that is needed for a chemical recycling plant to come to fruition.

Commitments/mandate/recipients

The actors considered as having the greatest capacity and mandate to take this action plan to the next stage and turn it into a coordinated and applied agenda are IKEM and the Swedish plastic raw materials producers. There should be coordination among the West Sweden chemical cluster and Hållbar Kemi (Sustainable Chemicals) 2030.



The financial sector

»The financial sector needs to pay attention to how development is affecting the profitability of new and old business models.«

The financial sector wants to see long-term and profitable circular projects in various industries. Financial investors require profitable business cases and well-planned and structured projects with a long-term technology perspective. The financial sector also likes to see long-term and reliable strategies. Today, however, there are no clear goals, indicators or benchmarking of resource effectiveness initiatives that could make it easier for the financial sector to evaluate business models.

A taxonomy for each industry is currently being discussed as part of EU directives. An EU taxonomy is a voluntary system aimed at producing metrics for the use of, for example, green bonds. Investments should be made in actors that are trying to make their operations greener.

In the area of plastics, the action plans emphasise a need for analysis, technical development, investment, new business models and innovation. In all of these aspects the role of the financial sector may vary depending on laws and regulations, interest, as well as which role individual actors have within the sector – lending, venture capital investments, pension funds, insurance etc.

Irrespective of which action plan or role within the sector is in focus, clarity is needed on how changes in technology, markets and political frameworks will affect profitability when the measures identified are implemented. This information needs to come from the value chains themselves, as the project's financial reference group has pointed out that the financial sector has little capacity to analyse resource efficiency, effectiveness and circularity. In other words, it is not likely that the financial sector will identify and proactively propose investments to existing and new customers in ventures involved in developing the plastics system.

The project has therefore tried to determine which information is the most important to present in order to demonstrate profitability from small to disruptive changes. This is discussed, among other places, in Chapter 2 on the goals that have been established by policy-makers, Chapter 3 on the plastics return systems and Chapter 4 on the plastics market.

Political and commercial goals and interests indicate that there will be comprehensive and rapid growth of recycled plastics at a level that exceeds today's recycling capacity. New investments are needed to reach the goals that have been set. In order for the financial sector to find these investments attractive, they need to be explained in terms of profitability in relation to supply, demand and technology development, as well as in relation to political interest in developing control mechanisms in this area.

Many of the measures described should be implemented by more than one actor. This is why cooperation is crucial.

This may, to some extent, make it harder to secure commitments from financial actors as they often require a single actor who is the clear investor and therefore recipient of their services. Similar solutions to those described for chemical recycling – joint ventures – can also be relevant to other measures.

Cooperation in development is also relevant to manage investment risk created by asymmetry in supply and demand, as well as the risks taken by individual actors in the value chains when they implement changes. Examples of this are investments in developing new plastics, plastics with improved properties as well as increased inclusion of recycled or renewable raw materials. This is associated with risk if demand for recycling or among product developers proves to be low. Managing risk diversification with help of the financial sector may be an important factor for progress to be made. This may also be relevant for development of the political framework. Development of new materials and processes can be cost intensive and make the raw material more expensive. At the same time the life cycle cost and negative life cycle impacts of products could be reduced. In other words, material development provides value both in later parts of the value chain and for society in general, while the costs are carried by an individual actor.

A potential obstacle to development is the financial sector being slow to keep up with the new business models, with the resulting risk that companies are valued based on their old business models. This could create barriers as the value of a company could go down if, for example, its balance sheet is impacted due to a switch to a model of selling services rather than products. Dialogue is needed based on knowledge and data from the value chain on how the market will be changed and how profitability will be affected from different perspectives.

The conclusion is that the plastic sector is undergoing disruptive development which, combined with a general trend in industry towards a bio-based and circular economy, means that the financial sector will need to adapt and go through a significant change itself.

The project's action plans describe smaller or larger roles for the financial sector to play. The sector cannot, on the other hand, expect the actors in the plastics sector, who have the best knowledge of the system and how it is developing, to also understand the financial sector's instruments and potential role. The financial actors need to recognise how development will impact new or existing customers and businesses. Given the development taking place, a cautious or reactive position is risky.

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