More environmental benefits with recycling #how?

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More environmental benefits with recycling #how?

Due to low quality and polluted waste streams, plastic packaging and textiles are now mainly 'downcycled', with lower environmental profits and revenues. The recycling process for paper is very successful, because the quality of paper waste is high.

Extending deposit-refund systems to smaller plastic bottles and cans can be socially beneficial. Further research will reveal whether the benefits of expanding into other disposable items outweigh the costs they entail.

Extended producer responsibility (EPR) can increase the quality of waste and promote the demand for recycling through tariffs that address recyclability and environmental benefits.

Banning exports or introducing export duties on plastic packaging waste to countries that dump a large proportion of their own plastic waste, may reduce environmental leakage.

CPB Policy Brief

Annemiek Verrips, Eva van der Wal, Joep Tijm, Esther Mot

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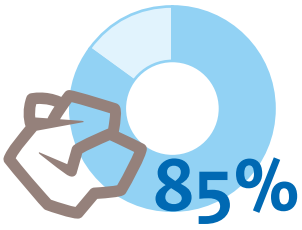
The path to a circulair economy

The Dutch government aims for a fully circular economy by 2050, and secondary raw materials have an important role to play in attaining this target. Large environmental benefits are still to be gained from improved recycling practices

paper excl. wallpaper & toilet paper

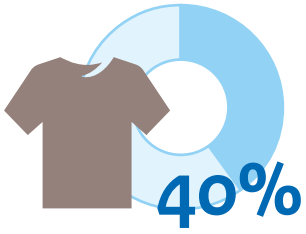
% collected



plastic

textiles clothing and household textiles

% collected



Four policy instruments to make the secondary market work better

EPR

Well-designed extended producer responsibility (EPR). **Producers** who design their products to be easy to recycle or to be more environmentally friendly, **pay lower** collection and recycling tariffs.

effects

+ increased and improved quality supply
+ stimulates innovation

Exports

The Netherlands export a lot of waste, but it is **not always clear** what ultimately happens to it. **Prohibiting or levying a tax** on the exports of plastic packaging waste to countries where waste is commonly dumped can **prevent environmental leakage**.

effects

+ less 'invisible' pollution
+ more supply of waste
- higher costs

Inform

Better information is important to enable people to properly **separate waste** and know the environmental **impact of their choices**. A pizza box, for example, cannot be disposed of with waste paper. A shredded T-shirt can be placed in the clothing container, but a wet one cannot.

effects

+ increased and improved quality supply
+ fewer sorting costs
+ relatively cheap

Deposit-refund

A deposit-refund system on plastic bottles has proven to work. It is expected that the system will be extended to include **small bottles**.
We do recommend researching expansion into **other disposable items**.

effects

+ less litter
+ increased and improved supply
- expensive to implement

Summary

The use of secondary raw materials can generate significant environmental benefits when compared to the use of primary raw materials.

However, markets for secondary raw materials do not function well due to market and governmental failure in the primary and secondary markets. Primary raw materials are too cheap, because there are no pricing policies in place for environmental damage. There are also unexploited economies of scale, market failures in 'green innovation', information problems that result in lower quality of waste supplied , and high transaction costs, particularly when it comes to household waste. In addition, government policies to combat these market failures, sometimes create barriers.

Due to the relatively low quality of the waste, 'downcycling' is now mainly practised to produce low-grade products, the environmental benefits of which are lower than those of recycling the material into a 'similar' product. In the case of plastic packaging, it is the diversity of the material that plays a particularly important role in the resulting low quality of waste. In the case of textiles and paper, the increased pollution of collected waste is becoming a problem. More polluted waste streams are less usable, which puts pressure on both the yield and the environmental benefits.

Export of waste to some countries can lead to environmental leakage. As a result of less restrictive environmental legislation in some countries, the processing of this waste can lead to more damage to the environment and population health elsewhere. Some environmental effects, such as plastic soup, a term used to describe the pollution of the seas by waste plastic, are global in nature.

Extended producer responsibility (EPR) can improve the quality of supply and the demand for secondary raw materials by applying tariff differentiation. This involves producers and importers paying less for products that are more easily recyclable, or that partly consist of recycled material. The design of EPR, the transaction costs, and monitoring costs are key issues. Funds collected with EPR can be used to promote innovation.

Preventing the export of plastic packaging waste to a number of countries by means of an export tax or ban can reduce the environmental damage caused by dumping. Such countries already engage in practices that involve a large proportion of their own plastic waste being landfilled or dumped. There is a very good likelihood that some of the separated plastic waste that we export will also be dumped. The costs, legal complications, and difficulties involved in regulating exports and feasibility because of, for example, the option of transit through another country, are areas of concern.

Deposit-refund systems provide an incentive to combat litter. Plastic litter negatively impacts the environment, especially due to its long lifespan . Deposit-refund systems also provide a more useful input for 'high-quality' recycling than other forms of waste collection. Further research may reveal whether the benefits of extending deposit-refund systems to plastic articles that more frequently end up as litter actually outweigh the costs that are involved.

Informing consumers and businesses as well as practicing waste collection methods that reduce pollution, can improve the quality of the collected waste. Providing information to households on how to separate waste could contribute to reducing the increased pollution of separately collected flows. Pollution

can also be reduced by using other forms of collection. For example, the contamination of textiles collected from underground containers is increasing sharply.

Government policies aimed at volume may have adverse effects on the quality of secondary raw materials. For instance, policies to limit the amount of residual waste can lead to more pollution of source-separated streams (such as paper and textiles), and targets to recycle as much household plastic waste as possible can lead to a more poorly usable material stream.

1 Introduction

Secondary raw materials are those that are extracted from previously applied raw materials. They are collected, sorted and processed into new raw materials or products (through recycling). While the re-use of the products themselves can provide more environmental benefits than recycling, the focus in this study is on recycling.

Recycling reduces the environmental damage caused by the extraction of raw materials and waste and thus represents an integral element of a more circular economy. The Dutch Government is committed to achieving a more circular economy based on the realisation that the current methods of production and consumption are not sustainable. Recycling contributes to the Government's goals to reduce the use of 'primary' raw materials by 50% by 2030 and to 'be fully circular' by 2050.

However, the market for secondary raw materials is not functioning particularly well, especially in the case of household waste. This can be attributed to market failures in both the primary and secondary markets, such as a lack of pricing policies for environmental damage and information problems. There are also unexploited economies of scale, as recycling often takes place on a smaller scale. We further identify a lack of (green) innovation. Additionally, government policy can lead to new barriers (government failure). Due to the limited quality of many secondary raw materials, most of the recycling is actually downcycling into lower quality products with limited environmental benefits and low economic value. These restrictions are greatest for household waste, since industrial waste is more homogeneous in nature and therefore more useful for recycling. Consequentially, the recycling of industrial waste is also less expensive.

Government policy aimed at generating a stable flow of secondary raw materials of sufficient quality and in line with market demand can increase social welfare. While this policy involves costs, social welfare, which includes both financial and economic effects as well as effects on ecology, health and the environment, will improve if the benefits outweigh the costs. In the context of this study, we have considered this in qualitative terms. We have not examined the extent to which policy instruments solve the failures of the market or the government.

We present three cases to cover the development phases for secondary markets, varying from mature (paper), in development (plastic), to the infancy stage (textile).[1] These cases cover the breadth of the

[1] Working visits to Wieland Textiles and Euro Used Clothing have given us more insight into the field of textile recycling. For paper and plastics, we visited Nijssen Recycling. We are also very grateful for the insights we have gained from an expert group.

problem, while enabling us to go into detail at the same time. The materials are widely used, have substantial environmental impacts and consist of renewable and non-renewable raw materials.

Since there are no problems concerning the availability of raw materials for these materials, this problem is not addressed here. Other ways of reducing the environmental impact of the use of raw materials, production and waste (e.g., less use) are only addressed indirectly. Background documents have been made for the cases.

In addition to the well-being related to prosperity here and now, and elsewhere and later, this study examines the global environmental damage associated with the consumption of products in the Netherlands (consumption footprint). A large part of this damage is caused outside the Netherlands, such as local environmental damage associated with the extraction of raw materials. Also, much of the CO2 reductions from recycling do not count towards the achievement of Dutch climate targets, as the reduction takes place abroad. This, however, does not diminish the benefits for the climate.

The structure of this Policy Brief is as follows. Chapter 2 discusses the environmental benefits that recycling can provide, after which Chapter 3 discusses the obstacles secondary raw material markets face as a result of market and government failures in the primary and secondary markets. Problems with the quality of collected waste are discussed in Chapter 4, after which Chapter 5 concludes our study with policy instruments that are suggested as a means to resolving these obstacles.

2 Recycling provides environmental benefits

While high-grade recycling achieves the greatest environmental benefits, many secondary raw material markets are now dominated by downcycling. For instance, about three-quarters of household plastic waste consists of a mix of plastic and foils that are downcycled into low-grade applications with limited environmental benefits (Verrips et al., 2017). Textiles that are no longer wearable largely end up in wiping cloths and insulation materials, and not in new textiles. High-quality recycling means that the material remains in the chain for as long as possible. High-quality recycling often has a maximum number of times of reuse as a result of loss of quality.

Plastic

A rough estimate of the potential environmental benefits of recycling plastic packaging into a *more or less equivalent product* is between approximately 11 and 42 cents per kg.[2] This corresponds to approximately 10 to 40% of the current price of 'fossil' plastic (Tijm and Verrips, 2019). The benefits are primarily attributable to a reduction of CO2 emissions throughout the production chain. In the case of recycling the CO2 emissions are roughly half of those resulting from incineration. Reduction of other emissions makes up the rest of the benefits. This estimate does not include the effects of litter and plastic

[2] The calculation is based on CO_2 prices in 2030 of 40 euros per tonne (WLO low scenario) (CPB, PBL, 2016), 80 euros per tonne (WLO high scenario) and for the bandwidth 153 euros per tonne of CO_2 (middle estimate two-degree scenario (CE Delft, 2017a)).

soup. Except for deposit-refund systems (see Chapter 5), the recycling of plastic used in the Netherlands does not have an effect on the quantity of litter and plastic soup.

Textiles

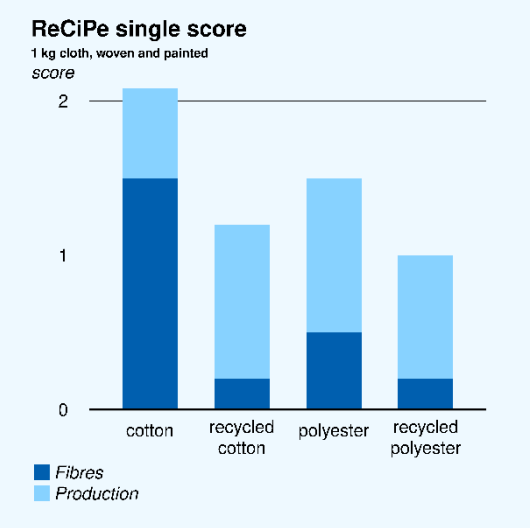
By recycling textile fibres, less water and fewer areas of land are needed and there are environmental benefits as a result of lower CO2 and other emissions. Figure 1 shows the so-called ReCiPe single score (a weighted average of 18 environmental impacts) for primary and secondary cotton and polyester.[3] The environmental impact of recycled cotton fibres is almost half that of virgin fibres. For polyester, the impact is about one third lower. The damage arises predominantly outside the Netherlands, and the extent of the effects on nature, land use and water use depend heavily on where and how the textile is made (CE Delft, 2018).

If 50% of the fibres in a cotton T-shirt were made of secondary material, the environmental benefit compared to 100% primary fibres would be roughly 20 to 60 cents per T-shirt.[4] The environmental costs of an average cotton T-shirt made from primary fibres amount to 0.9 to 2.5 euros. The environmental benefits of recycled material are less significant for polyester clothing, (CE Delft, 2018; Van der Wal and Verrips, 2019). As less than 40% of the textiles in the Netherlands are collected separately, there is still potential for improvement here.

Paper

Because a great deal of waste paper and cardboard is already being used in paper production and the collection rate in the Netherlands is high at 85%, there is relatively little extra environmental benefit to be achieved. The use of waste paper and cardboard in paper production requires less water and land than the use of primary fibres. In addition, CO2 emissions are reduced by an average of 20 to 30% and there are fewer emissions of particulate matter. Regulations and certificates have restricted the use of virgin paper fibres in order to limit the impact on deforestation and the wider ecosystem.

Figure 1 Difference in environmental damage to primary and recycled fibres according to the ReCiPe single score (CE Delft, 2018)



[3] The effects of microplastics from washing polyester garments are not included.
[4] Please, see footnote 2.

A rough indication of the environmental benefit in euros for CO2 alone is, depending on the CO2 price, approximately 1.1 to 4.3 cents per kg of recycled waste paper and cardboard (Sun et al., 2018; CE Delft, 2011; Verrips and Van der Plas, 2019). This is approximately 30 to over 100% of the price of waste paper. Recycling of waste paper and cardboard collected in the Netherlands results in an annual CO2 reduction of approximately 0.6 megatonnes compared with that produced through the use of primary fibres.

3 Market and governmental failures

This chapter deals with market and governmental failures that impair the workings of secondary raw material markets. These market failures can occur both in the primary market as well as in the secondary market. Environmental damage that is not subject to pricing policies can be considered a market failure, one that occurs in both the primary and secondary markets. Pricing policies aimed at pricing environmental damage will foster the secondary market, where environmental damage is generally lower than in the primary market. This also leads to interactions: the prevention of market failures in the secondary market has an effect on the primary market and vice versa. Here, we focus on market and governmental failures that obstruct the secondary market.

Due to a lack of pricing policy related to environmental damage, the price of products based on primary raw materials is too low in relation to the price of secondary raw materials. In most primary and secondary raw material markets, environmental damage is not or only partially subject to a pricing policy (Romijn et al., 2018). In the waste phase too, much environmental damage remains untouched in this respect (litter, plastic soup, emissions), so that the incentive to recycle is too low.

Production costs for the use of secondary raw materials such as textiles are high because economies of scale cannot be sufficiently exploited. This is because the size of the market is limited. For instance, technologies that make it possible to sort or use secondary textile fibres at a lower cost, only operate on a small scale. Economies of scale are necessary to generate supply at a lower cost, but this supply will not take hold with a corresponding demand. Investments that can reduce costs are not profitable. As long as production costs do not decrease, demand will also continue to lag behind. This 'chicken and the egg problem' adds an additional obstacle to achieving economies of scale.

Information problems are another market failure in secondary material markets. Consumers often do not know what secondary raw materials a product may contain, nor what environmental effects these materials may have. Information is sometimes also lacking on exactly how to separate waste, resulting in separate waste streams (such as textiles and paper) becoming polluted (VANG-HHA, 2018). Information on the quality and composition of secondary raw materials (such as textiles) is not always complete and/or accurate, resulting in higher transaction costs (Hogg et al., 2018).

A market for the degree of recyclability of products is lacking, particularly in the market for household waste. The problem is that households have to deal with dozens, if not hundreds, of types of waste. If a household has to make a relatively large effort to collect the waste and sort it into the right bin (e.g., plastics in one bin, textiles in another) and does not receive a positive price for it (such as for metal), there is a strong temptation to sort it with the residual waste or in a bin where it does not belong. The transaction costs in the market for the degree of recyclability are therefore high (Calcott and Walls, 2000). If the transaction costs are high, it is generally not interesting for manufacturers (without a policy) to produce products that are more

recyclable.[5] After all, more recyclable products are usually more expensive in terms of production, and if a household does not actually see this price difference in the waste phase, they will generally not buy the more recyclable yet more expensive product.

Market failures related to (green) innovation slow down the pace of innovation in secondary raw material markets. Innovation has the potential to reduce the costs of the recycling process and improve the quality of the resulting product. For example, innovation in sorting techniques and mechanical recycling of plastics can contribute to more high-quality recycling of plastic waste. An innovation designed to make the provision of proof that secondary fibres do not contain harmful substances, cheaper, could improve textile recycling. However, the pace of green innovation is slower than desired from a societal perspective (Mot et al., 2018).

In addition, government policy creates a number of obstacles. Laws sometimes make recycling unnecessarily difficult without there being any benefits in terms of food safety, for example. Furthermore, legal barriers make it easier to transport waste paper to Asia than within Europe. In addition, government objectives in the area of circular economy can even have adverse effects on the quality of separated waste. In order to achieve the targets of less residual waste and a higher recycling rate, a number of municipalities make residual waste more expensive (with differentiated tariffs) or more difficult to dispose of (limiting collection to sorted streams only, limited collection frequency). These measures generate an incentive to separate the residual waste into separate waste streams. Moreover, collection methods for collecting large quantities of waste are sometimes more sensitive to pollution. Textile waste, for example, is more likely to be polluted in underground containers than in above-ground containers or door-to-door bags as a result of moisture as well as mixing with residual waste.

A number of markets for secondary raw materials are now mainly 'supply-driven', as a result of which the recyclable materials often have a negative value. These market failures play a prominent role here. Separate waste streams may not meet the market's need if there is no demand in the first place, this may occur because the obstacles in place prevent the recycled material from being competitive with newly extracted raw materials. The choice to collect the material stems from policy objectives in the field of waste reduction and recycling. In these types of markets, such as the market for recycled plastic packaging, we see that these market failures occur to a larger extent. The demand for used textiles traditionally consists mainly of wearable textiles. As the share of wearable textiles in waste decreases and the quantity collected increases, this market is also changing into one in which supply is created for which there is little demand. The demand for textiles for recycling is less developed (now mainly focused on downcycling).

In a 'demand-driven' market, such as that of waste paper and cardboard, where recycled products often have a positive value, these problems tend to be less pronounced. Since virgin paper fibres are seven to ten times more expensive than fibres from waste paper and cardboard, which can be used without major loss of quality, there is a strong market demand for waste paper and cardboard. The costs of collecting, sorting and processing waste paper and cardboard are at a level that makes their use in paper production in the Netherlands commercially viable.[6] Consumers have an incentive to collect waste paper and cardboard because, for example, a local association or school makes a profit from it. All this has led to a mature market in which investments have been made in the innovation of process technology in recent decades. There is also a very

[5] An exception to this are products for which the manufacturer can set up a recycling process at a limited cost, or for which (part of) the households are prepared to pay extra as part of an environmental awareness programme. One such example is recyclable carpets.
[6] A guaranteed price from a fund (that the sector itself feeds) ensures purchase of the material, in order to guarantee a stable flow of waste paper and carboard. This fund has only had to pay out one year since 1998.

high demand for plastic waste from the construction industry. These are relatively homogeneous streams with a wide range of applications. Recycling many of these streams is a commercially viable option.

4 Problems with the quality of waste

The market and government failures discussed in Chapter 3 have important implications for the quality of collected waste. As a result, secondary raw material markets do not operate as well as they actually should. This chapter examines the issues concerning the quality and usefulness of the collected waste, as this has important consequences for the secondary market and environmental benefits.

The quality of the collected waste has a major impact on its usefulness as a secondary raw material. First and foremost, this concerns the homogeneity of the waste stream. The usefulness of the waste increases as it consists of purer streams, ideally of one type of material. In the case of plastic packaging, for example, the usability of a large proportion of household packaging waste is significantly reduced by the diversity of this waste, even after sorting (Verrips et al., 2017). In the case of textiles, too, the better sorted they are according to the colour and type of material, the greater their usefulness will be.

The environmental benefits decrease as waste becomes less useful. Less useful waste will end up, to a greater extent, in low-grade applications (downcycling) with generally lower environmental benefits, than if they had been recycled into a similar product or reused.

The contamination of separate waste streams has intensified over the years. This concerns adhering dirt and material that does not belong in the waste stream. More and more collected textiles are not suitable for reuse because they are contaminated. Pollution has increased from 8% in 2014 to 13% in 2018 (VANG-HHA, 2018), a rise that can be explained in part by the fact that many Dutch municipalities have switched to underground containers for collection. However, pollution has also increased in above-ground containers.[7] The pollution of waste paper and cardboard has also increased in recent years, albeit less so than in the case of textiles (VANG-HHA, 2018). A further increase in pollution could also reduce the usability and environmental benefits for waste paper and cardboard. Pollution also plays a role in the case of plastic packaging, in particular because of the growing costs for the processor; however, the usefulness of plastic waste is less sensitive to contamination.

Quantitative government targets for residual waste stimulate the amount of source separated waste but reduce its quality. If it becomes more difficult or expensive to dispose of residual waste, this provides an incentive to deliver waste such as textiles, plastics, paper and organic matter separately. However, this can also provide an incentive to pollute these source-separated streams with residual waste. These spill-over effects are important factors to be considered in the further development of policy and objectives.

The pursuit of the quantity of recycled material in contracts between municipalities, collection companies and sorters is at the expense of the quality of the material and, consequently, of the environmental benefits. The parties have an incentive to maximise the amount of recycled household plastic

[7] In a letter to the Lower House of Parliament (Tweede Kamer) dated 9 October 2019 (Ministry of Transport, Public Works, and Water Management, 2019), the State Secretary for Infrastructure and the Environment referred to the 'Attack Plan for organic waste and textiles' in order to tackle the problem of pollution of these waste streams.

waste. The production process of sorters is designed to maximise the output of sorted plastic waste, even at the expense of its usefulness (Verrips et al., 2017). In addition, useful 'mono streams' of plastic waste are included in the so-called 'mix' of plastics that only allow for downcycling in order to reduce the percentage of plastic waste that has to be incinerated (Thoden van Velzen, 2018). This is at the expense of the environmental benefits. There is a surplus of mixed plastics in the market, resulting in the excess material being partly stored or exported (and possibly still being incinerated).

The export of waste can lead to environmental leakage. Waste streams that cannot be processed profitably in the Netherlands are exported. As a result of less restrictive environmental legislation in some countries, the processing of this waste can lead to more environmental and health damage elsewhere. This is offset by lower processing costs, yet environmental damage is not included in the price.

In the case of the export of plastic waste, environmental leakage leads to an increase in plastic soup, a problem of global proportions. The Netherlands exports a lot of plastic waste outside the EU, some of which will end up in the environment as a result of dumping and therefore in the plastic soup as well. Processing this plastic waste in the Netherlands or Germany, for example, will lead to more private costs but fewer environmental costs, even if we incinerate it locally (with energy recovery).[8]

5 Policy instruments

Various policy instruments can counteract the above-mentioned obstacles in the secondary commodities market. This chapter summarises the main policy instruments and recommendations. Table 5.1 provides an overview of the policy instruments, as well as the market and governmental failures to which they can be applied.

Some market failures will persist, such as the lack of incentives for households to separate waste properly. The proposed policy instruments will aid in counteracting the discussed market and governmental failures, but it is unrealistic to expect them to disappear (altogether). This can be partially attributed to the high transaction costs for household waste. We have not examined the extent to which each policy instrument solves the failures of the market or the public sector.

Pricing policies for environmental damage

Pricing policies for internalising environmental damage are not enough when it comes to other market failures. The pricing of environmental damage makes secondary raw materials relatively less expensive when compared to primary raw materials (Romijn et al., 2018). There are a number of other obstacles in the secondary market. Other policy instruments can counteract these obstacles, and at times address simultaneously the issue of environmental damage not being subject to pricing policies. In practice, pricing is sometimes difficult, especially when are many products are imported (such as in the case of textiles). There are also legal obstacles, including the fact that the Netherlands is not allowed to levy an environmental tax on products from abroad, because this is contrary to the free trade rules of the European Union. If the environmental damage on the primary market were to be taxed, the proposed policy measures in this chapter would not be superfluous or socially unprofitable.[9]

[8] In a letter to the Lower House of Parliament (Tweede Kamer) dated 9 October 2019 (Ministry of Transport, Public Works, and Water Management, 2019), the State Secretary for Infrastructure and the Environment stated that she intended to expand the sorting and recycling capacity in Europe in this context.

[9] Pricing policies for environmental damage in the primary market are the subject of a study by Mot et al. (2019).

Table 5.1 Overview of policy instruments and market and governmental instruments (M represents the main effect, s represents the side effect)

	Market- and governmental alliances							
Policy instruments	Absence of pricing policies for environmental damage		Lack of economies of scale	Information asymmetry			Inno-vation	Govern-ment failure
	Emissions/ damage from raw material extraction and production	Litter/ dumping		Waste separation Households	Non-existent market recycling Producer	Non-existent Market Recycling Consumer		
EPR	s		M	s (a)	M		s (a)	
Stimulating innovation	s		s		s		H	
Deposit refund system	s	M	s	s		M		
Regulation								
- Regulations recyclability	s		s		M			s
- Regulation export	s	M						M
Information and collection								
- Information to households	s	s		M				s
- Collection methods and contracts with municipalities	s							M

(a) This instrument will only intervene in these market failures if part of the collected funds is spent on providing information or stimulating innovation. They can also be regarded as separate instruments, separate from EPR.

Extended producer responsibility (EPR)

EPR can increase economies of scale in the secondary materials market. As the goal is often to achieve a certain recycling rate, EPR (see box 'What is EPR?') leads to a higher supply. This does not provide any guarantees regarding quality. If the contributions that producers and importers pay in a collective EPR system are per weight or per unit and do not depend on, for example, the recyclability of the products collected, producers have little incentive for 'ecodesign' (Massarutto, 2014; Brouillat and Oltra, 2012). In the case of individual collection, companies have better incentives, but transaction costs will be higher. The design is therefore still an important aspect.

What is EPR?

EPR means that the responsibility of producers and importers is extended to the phase after use of the product by the consumer. In practice, EPR leads to the collection and recycling of discarded products. As a consequence, the supply of secondary raw materials in the market increases, resulting in less waste. At the same time, the aim is also to take greater account of the reduction of subsequent costs for re-use, recycling, or waste disposal in the design of products (ecodesign) (OECD, 2001). However, EPR does not automatically promote ecodesign or facilitate that the supply of secondary raw materials is in line with demand. This depends on the manner in which EPR is designed.

EPR can be organised individually by a company or collectively by a sector. In the latter case, one organisation or several competing parties can carry out the tasks (OECD, 2016). In the Netherlands, the collection responsibility associated with EPR is generally organised collectively and outsourced to a third party that is financed by the producers and importers through their contributions. EPR applies to both domestic products and imports and therefore does not discriminate against domestic producers. Many European countries have EPR systems in place.

EPR systems already exist in the Netherlands for plastics and paper. For plastics, EPR applies to packaging, plastics in end-of-life vehicles and plastics in electrical equipment. Separate EPR systems are in place for paper packaging and other types of paper. The government is considering introducing EPR for textiles.

EPR can stimulate demand and improve the quality of supply by means of tariff differentiation. There is currently little demand for textiles made from recycled fibres, but EPR can in fact be used as a means to change that. This could be done, for example, by introducing a more favourable tariff for products containing recycled material, where the required percentage of recycled material increases over time. Based on the environmental benefit of using recycled textile fibres, the contribution for a textile product containing 50% recycled cotton fibres could be about 23% lower. Other criteria for tariff differentiation, such as the recyclability of a product or the absence of toxic substances, may increase the quality of supply.[10] Differentiation does entail administrative costs, so it is important to weigh up the costs and benefits.[11] EPR will therefore not serve as a solution for all raw materials.

[10] Since 2019, the Netherlands has had differentiated rates for plastic packaging: the standard rate is 64 cents per kg, while packaging that is easy to sort and recycle is subject to a rate of 38 cents per kg.
[11] It is likely that these costs will fall sharply as a result of the further development of technologies such as RFID (Radio Frequency Identification), which allows information to be read remotely using a small chip in products (OECD, 2016). Such developments can increase the opportunities for individual EPRs where the incentives are much better.

Stimulating innovation

Innovation is an essential part of improving the quality of secondary raw materials and reducing production costs. For instance, innovations in mechanical recycling and sorting techniques could ensure that a larger proportion of plastic waste can be recycled as useful 'mono streams'. In textile recycling, innovations in the sorting process could contribute to lower costs. Funds collected by means of EPR can be used to promote innovation. Of course, innovation can also be promoted without an EPR system.

Deposit-refund system

A deposit-refund system is a measure that can primarily be used to combat litter. Consumers receive a refund on the small deposit they paid at the time of purchase when they return the product to the shop. This gives them an incentive not to dispose of the product as residual waste or into the environment. Plastic litter causes relatively high levels of environmental damage, because it remains in the environment for a very long time (possibly in the water as part of the plastic soup). As a result, deposit-refund systems are an option for plastic products that more commonly end up as litter. A further benefit is that it generates homogeneous flows, making the collected material easier to recycle.

Extending the deposit system to smaller plastic bottles and cans could be socially profitable (CE Delft, 2017b; CE Delft, 2019). In the Netherlands, deposits on small bottles will be introduced from 2021 onwards in the event that the volume of litter has failed to decrease sufficiently. Cans, which often also contains plastic, is not included in the current plans. Further research will be able to show whether the benefits of expanding into other disposable items outweigh the costs they entail. However, due to the high transaction costs, deposits will only be socially profitable in cases of high environmental damage or low collection costs.

Regulation

For waste where the environmental impact of dumping is high, such as plastic packaging waste, an export tax or ban to a number of countries could be explored.[12] These would be countries where a large proportion of their own plastic waste is landfilled or dumped. There is a very good likelihood that a part of the plastic waste that we export will also be dumped. Although exported waste from the Netherlands has to meet certain criteria, the transaction costs of checking for sustainable processing are high in some distant countries and practice is unruly. The costs in the Netherlands are bound to rise because we were able to export this waste relatively cheaply. However, there are benefits for the environment. The legal consequences and practicability obviously merit attention, as does an increase in processing capacity within the EU.[13]

Lastly, regulation can improve recyclability and reduce environmental damage. For additives or product designs that seriously disrupt the recycling process, a regulation policy would be a logical solution. For example, the use of a number of heavy metals in plastic packaging is prohibited. Regulation, either at the European or national level, could also increase the recyclability of plastic packaging by reducing its diversity in cooperation with the industry. In addition, waste that is more recyclable generates higher revenues, so that overall recycling costs less or generates money. This is important because currently, the costs of recycling household plastic packaging waste outweigh the environmental benefits. Improving the recyclability of packaging can change this (Tijm and Verrips, 2019).

[12] Norway has recently made a proposal in the United Nations to restrict the free trade of plastic waste.
[13] The legal issues concerning the regulation of exports and practicability by, for example, transit through another country, are aspects that have to be addressed.

Information and collection

It is essential to focus more on the quality of the waste collected during collection and in contracts between municipalities, collectors, and sorting companies. Government objectives based on quantity do not directly contribute to this. The incentives for recycling must be designed in such a way that an optimum balance is established between expenses, yields and environmental benefits and not on the largest possible quantity of recycled waste. Underground textile collection containers have lower costs than above-ground collection, because they have a larger capacity and are emptied mechanically, but because of pollution and moisture they have major drawbacks for the quality of the waste.

Information to consumers and businesses can improve the quality of collected waste, especially with regard to textiles and paper. Providing information to households and businesses could reduce the increased pollution of waste. For instance, it would make a difference if people knew that they should not sort pizza boxes containing food detritus into the paper waste bin. In addition, information can also lead to increased collection. For example, many consumers do not know that defective clothing can also be put in the clothes container.

Information can also contribute to an increased demand for products made from recycled materials. Better information can make consumers aware of the environmental impact of the choices they make. The demand for products that (partly) consist of recycled materials can grow as a result, enabling economies of scale to be achieved.

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