Recycled content in plastic material with focus on PET, HDPE, LDPE, PP

State of play

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Global Project
"Support of the Export Initiative for Green Technologies" (BMU)
Köthener Str. 2
10963 Berlin / Germany
T +49 30 338 424 646
E markus.luecke@giz.de

Collaborative Action for Single-Use Plastic Prevention
in Southeast Asia (CAP-SEA)
193/63 Lake Rajada Office Complex, 16th Fl.
New Ratchadapisek Road, Klongtoey
Bangkok 10110 / Thailand
T +66 65 2400266
E christoffer.brick@giz.de

More information
https://www.giz.de/en/worldwide/78869.html
www.exportinitiative-umweltschutz.de

Authors:
Clara Löw
Andreas Manhart
Siddharth Prakash

Layout:
kippconcept gmbh, Bonn

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In cooperation with Öko-Institut e.V.

Contact
info@oeko.de
www.oeko.de

Head Office Freiburg
P. O. Box 17 71
79017 Freiburg

Street address
Merzhauser Straße 173
79100 Freiburg
Phone +49 761 45295-0

Office Berlin
Borkumstraße 2
13189 Berlin
Phone +49 30 405085-0

Office Darmstadt
Rheinstraße 95
64295 Darmstadt
Phone +49 6151 8191-0

Table of Contents

List of Abbreviations

B-2-C	business-to-consumer
BMU	German Federal Ministry for the Environment
CAP SEA	Collaborative Actions for Single Use Plastic prevention in South East Asia
CEN	European Standardisation Body
EPU	Economic Planning Unit (Malaysia)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
HD	High density
HDPE	High density polyethylene
IN	Indonesia
LD	Low density
LDPE	Low density polyethylene
MOEF	Ministry of Environment and Forestry (Indonesia)
MY	Malaysia
PCD	pollution control department (Thailand)
PE	Polyethylene
PP	polypropylene
PPWD	Packaging and Packaging Waste Directive
rPET	Recycled polyethylenetherephthalat
SUP	single-use plastic
TH	Thailand

About the Export Initiative for Green Technologies

The GIZ global project **"Support of the Export Initiative for Green Technologies"** contributes to solving key environmental problems on behalf of the German Federal Ministry for the Environment (BMU). The **BMU Export Initiative** aims to export know-how available in Germany and support sustainable development worldwide. It includes topics such as poor waste management, air and water pollution or supporting infrastructures for sustainable urban development. Partner countries are Egypt, Jordan, India, Thailand, Malaysia, Indonesia and Ukraine. Project measures focus on building up technical and institutional know-how as well as laying the groundwork for the introduction and use of environmental and climate protection technologies "Made in Germany".

The project component CAP SEA, which stands for Collaborative Action for Single-Use Plastic Prevention in Southeast Asia, focusses on the prevention of single-use plastic (SUP) and reusable packaging systems in Thailand, Malaysia, and Indonesia.
For more information on CAP SEA project activities, please download the factsheet **here**.

Executive Summary

- PET is currently the polymer with the highest recycled content shares in packaging. In Europe, 70 % of rPET go to the packaging sector incl. food-grade applications and PET-beverage bottles, which contain, on average, 24 % of rPET. Some sellers of beverages (e.g. Eiszeitquell and Vilsa) even use bottles of a 100 % rPET content.

- In Europe, LDPE has relatively high shares of recycled content in carrier and rubbish bags (90 % and 70 % respectively) and building foils (~55 %).

- From a sector perspective, potentials for high shares of recycled content in products can be identified as follows:
  - *Increase where high potential* → (non-food) packaging sector (PET and LDPE)
  - *Expand an existing system* → agricultural foils (LDPE)
  - *Catch up where only few material requirements* → construction (doors, traffic barriers, …) and furniture (chairs, …) (e.g. HDPE)

- A major barrier for continuously low use of recycled material is a financial one: The price for recycled material is too high compared to virgin material. The price for recycled material is influenced by a combination of costs for alternative waste management options, the virgin polymer price, the demand for recycled material and the cost of supplying secondary raw material, i.e. operational costs for recycling. Subsidies for primary plastics, e.g. through tax exemption for the material use of fossil fuels, may also have an influence in some countries.

- Other challenges of a non-financial nature that recyclers have to face lie in the sorting of composite material. Manufacturers of plastic products have to adhere to product quality standards while at the same time environmental and health safety standards have to be met. In some cases, product quality standards do not allow the use of recycled material, but research is providing more and more insights into the behaviour of contaminants. In addition, further differentiation between different applications for secondary plastics could be helpful as there are applications where some substances do not cause any damage or product quality loss.

- Under the existing conditions – at least in Europe – it is unlikely that the recycled content can be significantly increased without any regulatory approaches or at least any soft law approach (commitment to voluntary targets to avoid stricter regulation), as there is not sufficient economic incentive for the use of secondary plastic. Thus, the two main options are either to make virgin plastic less attractive (taxes, fees …) or to promote the use of recycled material via mandatory targets (or the combination of both).

- Voluntary industry commitments for recycled content targets worldwide are summarised e.g. in the Ellen MacArthur Foundation's so-called "Global Commitment"(Ellen MacArthur Foundation 2019), while another strategy to promote the voluntary use of recycled content is certification, labelling and green public procurement. In the context of labelling, it needs to be noted that the generation of new additional product labels is a critical strategy as large numbers of environmental labels tend to confuse consumers and may throw open the doors to unsubstantiated product claims (greenwashing). Thus, it is recommended using existing type-I ecolabels which are reliable and independent, when it comes to voluntary product-based certification schemes.

In compiling this paper, some important concrete aspects have emerged that should be considered when implementing recycled content targets. They are listed here as "key implementation aspects" in the last chapter and include these five elements:

- Focus on the domestic recycling sector, hence, the mistake of using well-sorted imported plastic for recycling should not be made. Inputs for plastic recycling should be domestically sourced.
- Need of a third-party control system as the recycled content cannot be physically or chemically determined at the level of the final product or packaging to supported market surveillance and enforcement.
- Introduction of binding targets or minimum requirements because of higher costs of most recycled plastic types (compared to virgin plastics) the recycled content of products won't widely increase without any regulation, though, soft law approaches are possible (see chapter 6.3).
- Differentiation of targets for different polymers and applications because materials are used in different functions with different requirements related to hygiene or sensitivity.
- Facilitate the achievement for industry by setting sector-specific targets or targets on average figures but not for individual producers.

1 Background & introduction

In an ideal circular economy, no primary resources shall enter production processes, but only recycled material. The transition towards circular economy includes the optimisation of manufacturing processes in terms of decrease of primary resource consumption shares but increase of secondary raw material shares. Introducing voluntary or mandatory targets for recycled content in specific plastic products for local (plastic) manufacturing industries and procurement policies is a first step towards an implementation. Thereby, the market for recycled raw materials and subsequently collection and recycling of plastic waste will be stimulated.

This report presents an overview over

- some general aspects of recycling,
- the technical state of the art with respect to recycled plastic content in products,
- limiting factors, and
- options for action to boost secondary plastic use in the production process.

It summarises key implementation aspects at the end.

Efforts to increase the recycled content in locally manufactured plastic products is a major element of the German government-funded[1] project "Collaborative Actions for Single Use Plastic prevention in South East Asia" or short "CAP SEA". The project is one component of a global export initiative to reduce plastic waste, and focusses on single-use plastic (SUP) prevention and preparation for reuse options. It is conducted in Thailand (TH), Indonesia (IN) and Malaysia (MY) and seated in the Pollution Control Department (PCD, TH), collaborating with Ministry of Environment and Forestry (MOEF, IN) and Economic Planning Unit (EPU, MY). It started in 8/2019 and will run until 2/2023.

One of the outcomes shall be a "systematically strengthened market for the recycling of raw materials" by means of informed decision-making on circular economy plastic policies. This report has been prepared to support the partner institutions in the target countries to take informed decisions on recycled content.

1 Funded under the German Federal Ministry for the Environment, Natural Conservation and Nuclear Safety within the so called "Export Initiative"

2 General points on recycling

First of all, the following subchapters serve to frame the topic and build a common ground as "recycling" can be differently understood depending on the perspective:

2.1 Closed-loop vs. open-loop recycling

If every material, every product and its components can be recycled several times without losing material quality, this is called "closed-loop recycling". The circular economy is built upon this principle, i.e. using the material that we used to call "waste" to produce as many times as possible, and that we will generate as little waste as possible. It is understood that this is not yet a reality and if recycling takes place at all, waste material, more frequently, continues to be recycled in an "open-loop recycling". Other terms are downcycling or cascade recycling. These terms refer to the recycling of waste in cases where the recycled material is of lower quality and functionality than the original material. Both is possible: Downcycling triggered by market demands but also due to material composition (e.g. laminates) and / or contamination.

A prominent example for the first reason of downcycling (demand on another market) is the recycling of plastic bottles which are being processed into fleece fabric for jackets. In such fleece fabrics, rPET is easy to use. Hence, considerable amounts of rPET are being used for this application. However, the material cannot be recycled after the end of life of the fleece fabrics. At the same time, bottle-to-bottle recycling of PET allows a closed-loop recycling, but the demand for fleece fabrics is also high. Therefore, not all of the collected and recycled PET is used for the bottle-to-bottle approach.

A prominent example for the second reason of downcycling are material composition and contamination, for examples production of paving stones from former plastic as a strategy to reduce plastic pollution in Cameroon[2], or producing flowerpots or park benches. In this form of open-loop recycling, the recycling sector has found a way to deal with multilayer packaging and collection of mixed plastics whose exact material composition is unknown. Contamination of the material either takes place during production for its primary application or during poor end-of-life management (e.g. unsegregated collection) conditions. In general, such contamination limits the types of application for which the recycled material can be used. In the construction sector in general, it is not necessary to pay so much attention to harmful trace substances. Such downcycling takes place where no single-origin waste stream is distinguishable.

However, in both cases, the material cannot be recycled again – or at least not to a high degree which is comparable to virgin material – and will most likely have to "leave the loop", ending up as non-recyclable waste. This means that while open-loop recycling can prolong the lifetime of a material, closed-loop recycling can finally support zero-waste strategies and will lead to less resource depletion in the long run.

2 Pavement production from Plastic Project from Coeur d'Afrique foundation in Cameroon: https://af.reuters.com/article/cameroonNews/idAFL5N1KG4GK

2.2 Mechanical vs. chemical recycling

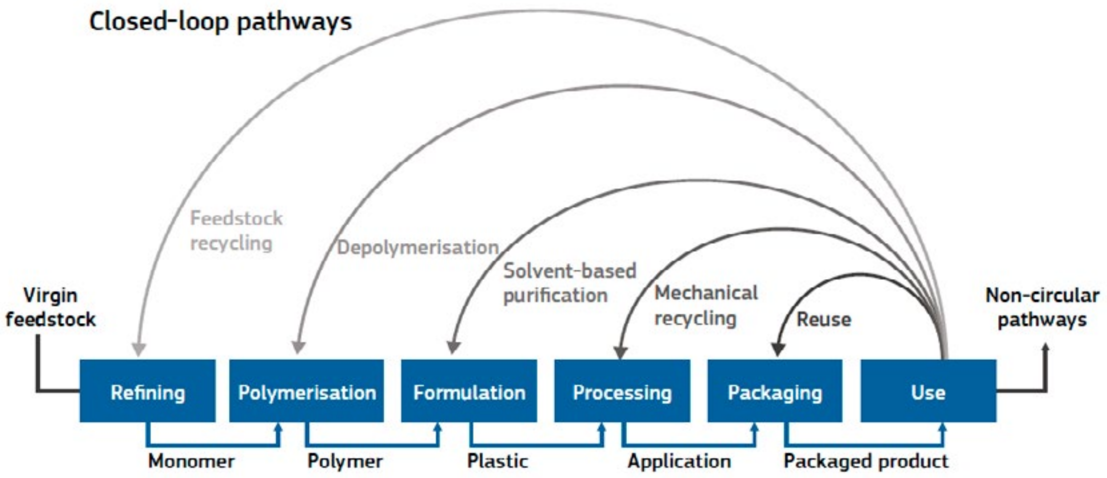
Even in closed-loop recycling, the loops can be narrower or wider depending on the production stage where the output of the recycling can be used.

The following figure (Figure 2-1, next page) presents different loops for plastic in a circular economy. Having in mind the distinction between open and closed loops, the loops indicated in the figure only relate to closed-loop pathways but not to the cascade use of recycled material.

Operations that recover plastic via mechanical processes are called "mechanical recycling", which is by far the most common plastic recycling pathway. Another option is chemical recycling which is mostly still in its infancy (not yet established on an industrial scale).

Mechanical recycling processes include grinding, washing, separating, drying, re-granulating and compounding. In mechanical recycling, plastic waste (commonly pre-sorted by material type) is milled and washed, passes a separation process, and is dried. The "product" which is the result of such mechanical recycling operations is the so-called recyclate. The plastic flakes are then either used directly to produce new plastic materials or they are processed into granulates beforehand. A precondition is that the plastic can be re-melted and reprocessed, which is possible for "thermoplastics", one of three types of plastic material types[3] which hold the highest share of the overall amount of plastic produced; the polymers in the scope of this study are such thermoplastics (European Bioplastics 2020).

Figure 2-1: Different loops for plastics in a Circular Economy



Source: (European Commission 2019b)

3 The two others are thermosetting plastic (for example used for heat-resistant insulation, light switch …) and elastomers (rubber or flexible machine components.).

Chemical recycling processes are the followings: Solvent based purification, depolymerization and feedstock recycling, the three wider cycles being presented in the figure above. Feedstock recycling leads to an organic hydrocarbon mix output which can be refined again through cracking and chemical reactions in order to obtain the monomer. A depolymerization aims at recovering the monomers which can be re-polymerized. A solvent-based purification will separate different polymers from a specific plastic type.

The amount of energy consumed accumulates over the different steps from virgin feedstock to the packaging or product. Hence, the further back in the production chain a recycling process (cyclic arrows in the upper part of the figure) should convert the material, the higher the energy consumption for the process. As a general rule of thumb, it is important to note that the narrower a loop, the more favorable in terms of energy consumption for recycling. It needs to be carefully examined whether the energy used for chemical recycling processes is worth in order to close a loop or avoid downcycling; e.g. the production of chemically recycled nylon fibers under the tradename Econyl® present an example for a depolymerization process on industrial scale (see the presentation of this company under chapter 4). Considering the issues around energy balance, mechanical closed-loop recycling should generally be preferred over chemical recycling approaches.

2.3 Pre- vs. post-consumer plastics

Input fractions to the recycling process can be pre-consumer waste (production waste) and post-consumer waste (waste after product use). There are discussions ongoing whether in the context of recycled content targets, only post-consumer material should be accounted for. Efficient use of material in a pre-consumer stage is mostly already well established due to efficiency improvements for economic reasons. Furthermore, the material composition of production waste is usually very well known, which further facilitates recycling. The accounting of such pre-consumer volumes in the context of recycled content would not lead to the intended effects of stimulating recycling markets and reducing plastic waste littering.

2.4 Recycled content in the context of plastic reduction

In a recent study, a group of researchers modelled the fate of plastic consumption from now on until 2040. In different scenarios, they developed the reduction potential of several strategies to avoid plastic pollution. The recycling scenario (green in Figure 2-2, next page),[4] assesses the potential of “ambitious scale-up of collection, sorting and recycling infrastructure coupled with design for recycling”. The researchers found that these measures could reduce plastic leakage by 38±7 % in 2040 as compared to the business-as-usual scenario which is 65±15 % above the 2016 levels. In the so-called System Change Scenario, plastic leakage reduction potentials are summed up, e.g. a 20 % contribution to total reduction is assumed for the recycling-related activities (Figure 22, next page). The figure sums up “the shares of treatment options for the plastic that enters the system over time” (PEW und Systemiq 2020; Lau et al. 2020).

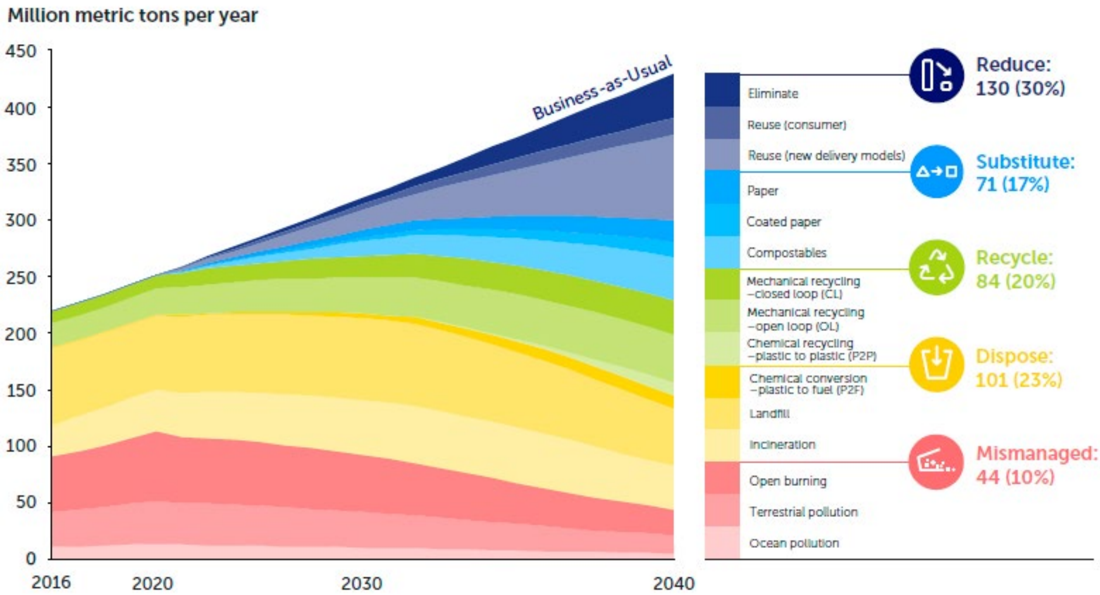
This means that a strong stimulation of collection and recycling of plastic waste is considered as key strategy to manage the growing global crises around plastic pollution. At the same time, there is a widespread recognition that recycling markets are currently below their potential and that concerted stimulation is needed. Targets for increasing the recycled content in products is seen as a major lever for such stimulation.

2.5 Polymers and their recyclability potential

“Polymers” is the term used in material sciences to describe plastic. It is related from the fact that plastic is made up of long chains (“poly” = many) of the so-called monomers that are chemically bound to each other. Several substances can be used as monomers, provided that their chemical structure is equipped with at least two possibilities for chemical reaction with another molecule of the same substance to form the chain. Depending on the “nature” of the side chains or reactive locations in the molecule, it is possible to obtain an … -A-B-A-B-A … structure of two different monomers, which is called co-polymer.

4 The recycling scenario takes into account maximum foreseeable collection rates by archetype, a breakdown by urban and rural areas (affordability and performance limit), separation at source (convenience limit), food quality requirements (performance limit), technological improvements (technological limit), incentives for recycling / recycled content (performance limit), design for recycling (performance and convenience limit) and the scale-up of chemical conversion technologies.

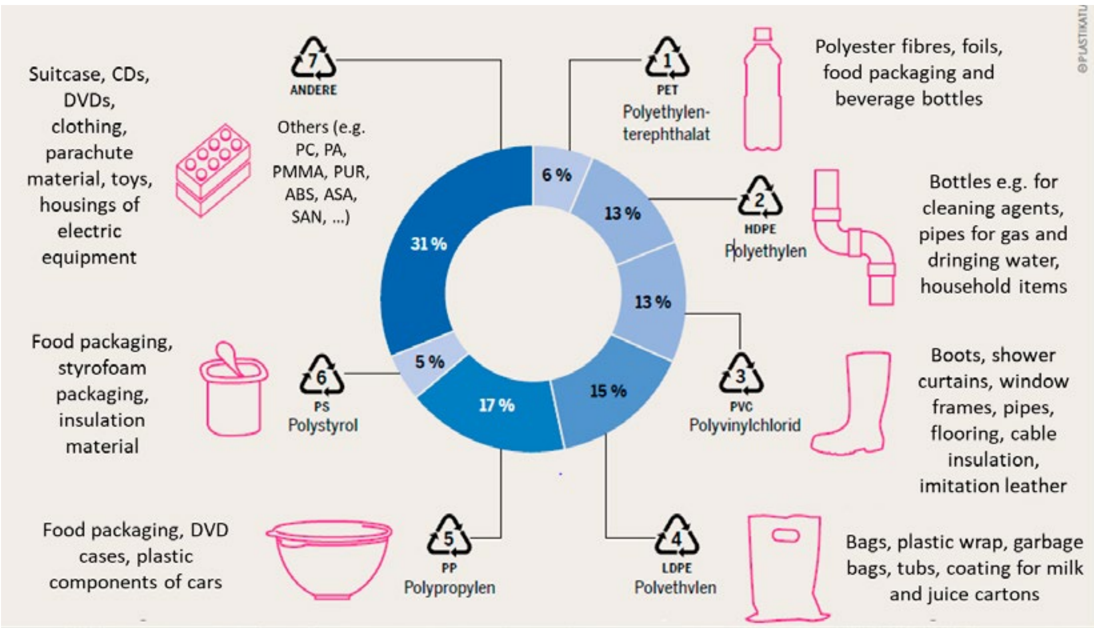
Figure 2-2: A forecast: Plastic fate and reduction potentials of several measures



Note: The numbers include macro-plastic and microplastic.

Source: (PEW und Systemiq 2020)

Figure 2-3: Shares of different polymer types in Germany, 2017

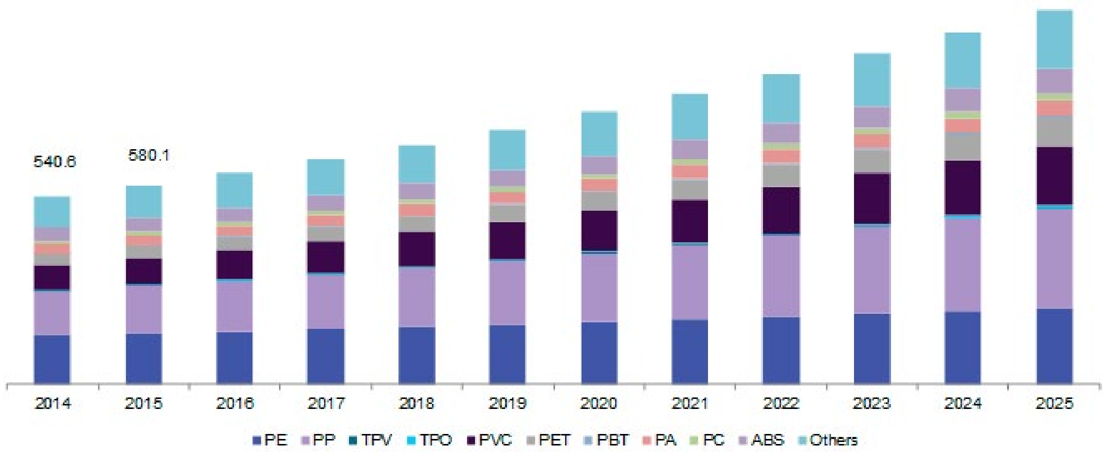


Source: (Heinrich-Boell-Stiftung; BUND 2019); originally in German, own translation

This study shall focus on polymers that are highly used in consumer goods and which are simple from a chemical point of view: HDPE and LDPE are both versions of the polymer polyethylene (PE) with HD and LD coding for high and low density. The density characterises the stability and thus the different application areas (see the second column of Table 2-1, next page). The two other types of polymers are polypropylene (PP) and polyethylene terephthalate (PET). PE and PP are mono-polymers while PET is a co-polymer with the two sub-units of ethylene and terephthalic acid. Other polymers relevant for consumer goods are e.g. PVC, PS and ABS. Figure 2-3 shows the abundance of the polymers in the German market.

The four polymers in the scope of this study, HDPE, LDPE, PET and PP account for a good 50 % of the German market which is exemplary for the total European market where shares are in a comparable range (Wang et al. 2019). The forecast of the Malaysian plastic compounding market (Figure 2-4) shows a comparable share for the polymers in scope.

Figure 2-4: Forecast: Malaysia plastic compounding market by product, 2014 - 2025 (Million US$)



Abbreviations specific for this graph: Thermoplastic Vulcanizates (TPV); Thermoplastic Polyolefin (TPO); Polybutylene Terephthalate (PBT); Polyamides (PA); Polycarbonates (PC); Acrylonitrile Butadiene Styrene (ABS); other abbreviations are used in the report and can thus be found in the abbreviation list.

Source: https://www.grandviewresearch.com/industry-analysis/malaysia-plastic-compounding-market (27.08.2020)

As can be seen from Table 21: Whether a polymer is easily recyclable or not is not a question of mono- or co-polymer. The sorting of plastics is mainly done manually, which leads to acceptable results in terms of single-origin polymer streams for HDPE, LDPE, PP and PET. Mechanical recycling is a well-established technology for the material recovery of plastic materials such as polypropylene (PP), polyethylene (PE) or polyethylene terephthalate (PET).

Table 2-1: Types of polymers, input material for recycling, recyclability and grade of recycled material

Polymer	Input for recycling	Recycling possible?	Where can recycled material be used?
HDPE[5]	• Canisters/barrels • Waste cuttings • Natural foil, • Household bottles & cases • Trash bins	100% recyclable if single-origin HDPE is used	• Packaging
LDPE	• Transport packaging • Shrink hoods • Brickyard plastic films • Tyre films • Pellet bags • Agricultural film (e.g., silage cover films, stretch films) • Strips and hoses for irrigation • Protective foil for varnishing, canvas covers • Waste cuttings • Granulate bags • Coiled nodules	100% recyclable if single-origin LDPE is used	• Garbage and carrier bags • agricultural foils.
PP	• Big bags • Woven and unwovan fabric • PP/PET strapping bands • Multiwall sheets • PP/PS Plant trays & flower pots • PP buckets • Cases & hard plastics • Packing belts • PP/PS Cups & Packaging	Recyclable; recycled PP has only been available in significant quantities for a few years	• Automotive industry • Flower pots • Parc benches
PET[6]6	• PET bottles • Blisters • Foil • Flakes • Packing belts	100% recyclable if single-origin PET is used	• Packaging, incl. food packaging, or bottles for cleaning agents and cosmetics • New PET bottles • Foils • Textile fibres

Sources: http://www.pieringer.info/en/plastic.html (14.08.2020);
https://www.s-d-kunststoffrecycling.de/en/products/ldpe-industrial-films (14.08.2020)

5 https://www.agvu.de/de/141-141/ (13.08.2020)
6 https://www.agvu.de/de/polyethylenterephthalat-pet-144/ (13.08.2020)

2.6 Standards for recycling and recyclates

In Europe, the standardisation of recycled plastics has been driven to a large extent by the Packaging and Packaging Waste Directive (PPWD). Its Annex II[7] contains "essential requirements" for packaging for which European Member States have to ensure compliance. Annex II of the PPWD can be found in the Annex to this report. These requirements have been "translated" into norms by the European standardisation body (CEN)[8], defining e.g. minimum quality criteria for recycled plastic and criteria for recycling.[9]

The aim is to ensure the proper functioning of the internal market for recycling and to ensure compliance with environmental requirements for the recycling process, while ensuring a level playing field for recyclers, so that no material of lower quality produced with less ambitious environmental standards can be sold at lower prices (Kojima 2010).

To give another impression of standardisation systems, the following table provides exemplary Japanese industrial standards which have been elaborated on a detailed product level and which are available for various applications.

Table 2-2: Exemplary Japanese Industrial Standards for Recycled Plastic Products

JIS Code	Type of JIS
JIS A5731	Recycled plastics inspection chambers and covers for rainwater
JIS A5741	Products of wood-plastic recycled composite
JIS A5742	Products of wood-plastic recycled composite – assembled decks
JIS K6930	Reclaimed granulate moulding materials of agricultural polyvinyl chloride film
JIS K6931	Reclaimed plastics bars, rods, plates, and piles
JIS K6932	Recycled plastics stakes
JIS A9401	Recycled plastics medial strip block
JIS A9402	Recycled plastics buffer for parking
JIS K9797	Un-plasticised poly(vinyl chloride)(PVC-U) three-layer pipes with recycled solid core
JIS K9798	Un-plasticised poly(vinyl chloride)(PVC-U) three-layer pipes with recycled foamed core

JIS = Japanese Industrial Standard.c

Source: (Kojima 2019)

7 Named "Essential requirements on the composition and the reusable and recoverable, including recyclable, nature of packaging"

8 EN 134 xx are packaging norms; EN 1534x are plastic material norms

9 https://docs.european-bioplastics.org/publications/bp/EUBP_BP_Mechanical_recycling.pdf (2020)

As an example for national standardisation in South East Asian countries, a case study of Malaysia on establishing industry standards for recycled waste was found. The author Ahmad Fariz Mohamed concludes that the "demand for a greater market of recyclable material […] requires standards to ensure good quality. […] To ensure that the country's waste recycling industry can penetrate the international market, there is a need to synchronize Malaysian standards with other countries' standards for easy use or for compliance of recyclable materials and intermediate products to be exported or imported. […] However, the concern for the protection of sovereignty especially for the local industry against the need for regional and global compliance or safety must also be seriously addressed" (in Kojima 2010). Malaysia has already implemented the MS ISO 15270:2008 for "Plastics – Guidelines for the recovery and recycling of plastic waste".

In the recycling field, several types of standards are relevant depending on what exactly is the subject of standardisation and for whom it is important. From an environmental perspective, minimum standards for recycling plants serve to minimise pollution. Those who want or need to use recycled material want to be sure that they will receive material of a certain quality on the market. Recyclers are interested in generating the maximum output in their plant, so they want the material to be easy to recycle and not too expensive to sort. The three types of standards in the context of recycling are compared to each other in the following figure. Examples for quality standards for recycled material are given in chapter 6.1, page 25.

Figure 2-5: Different types of standards in the context of recycling and their goals

Recycling process standards	• Addressing the problem of low-quality recycling, thereby aiming at avoiding environmental pollution from unsound recycling activities
Quality standards for recycled material	• Serving product safety and reliability for manufacturers of plastic products • Ensuring a level playing field for recyclers
Recyclability standards	• Ensuring that a product can be technically recycled in a given (national or regional) recycling market (comparable to design for recycling criteria, not focus of this study)*

(*) Note that such standards cannot ensure that a product will in fact be recycled at its end of life as this also depends on the type of waste collection and the general economic framework conditions for recycling

Source: Own compilation.

3 Status Quo: Recycled content in Europe

Typical shares of recycled content

The top 3 industry sectors using recycled material in their polymer applications in Germany are the agricultural sector (~35 % recycled content) followed by construction (~22 %) and the packaging sector (~9 %), see Table 4-1 (next page). In agriculture, plastic is used especially in the form of films, e.g. silage cover films, foil tunnels or coverage of the ground. Other applications are greenhouses, pipes in plastic irrigation systems and boxes for vegetable collection (Plastics Europe 2020). According to the Plastic Recyclers Europe Association, (Figure 3-1, next page), the recycled content in LDPE agricultural films is around 20 %, either the European average is lower than the share in Germany, or the German figures include agricultural applications other than foils, e.g. HDPE in boxes or water tanks.

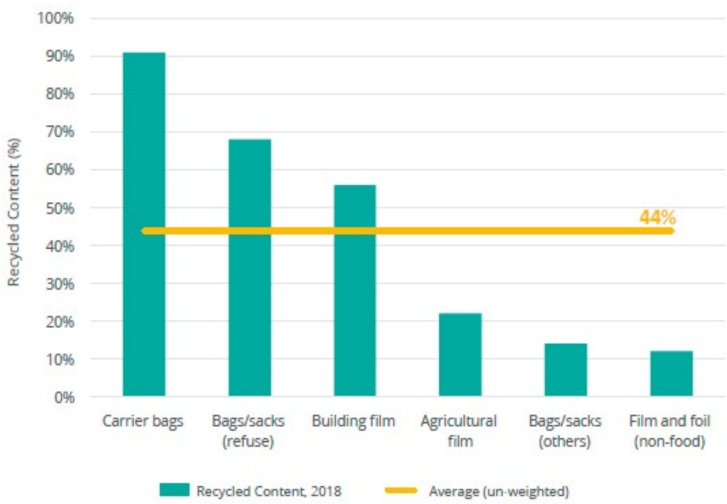
There is a difference in the sectors in terms of who is involved in the product cycles. While agriculture and construction mainly are business-to-business collaborations including high tonnages of the same type of plastic material, the packaging sector, furniture, electronics and household segments are involving individuals and private households (business-to-consumer, B2C), and a broader variety of polymers. However, the material recycled and used as secondary raw material in B2C segments is most probably not originating from packaging waste and plastic waste from municipal solid waste collection, but rather from sources with larger volumes and comparably uniform material composition (e.g. carrier bags from waste of agricultural foils).

Table 3-1: Shares of recycled content in polymers by relevant industries in Germany (2017 data)

Segment	Share of recycled content in polymers per sector [%]
Agriculture	34,9
Construction	21,5
Packaging	9,1
Automotive sector	4,8
Furniture	4,0
Electronics	3,2
Household, sports, toys…	2,0
Medicine	0,1
Other	12,6

Source: (Conversio Market & Strategy GmbH 2017)

Figure 3-1: Recycled Content in LDPE applications in the EU (2018 data)



Note: "Refuse" is meant in the sense of rubbish.

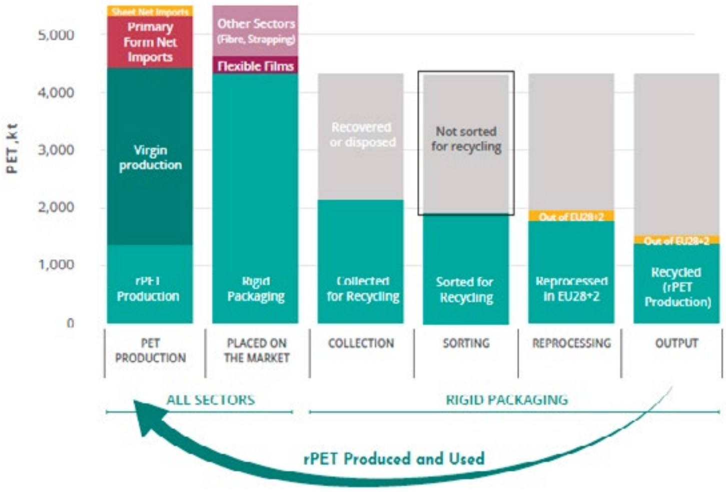
Source: (Plastics Recyclers Europe 2020)

PET material flow

Figure 3-2 summarises the overall PET mass balance of 2018 for Europe. In the production of PET, ~20 % of the input is recycled PET (rPET), around 80 % of the PET is put on the market as packaging material. Around 40 % of the tonnage put on the market is collected separately, and nearly every PET item collected is sorted into the single-origin PET flow. PET is unique as a single-origin material flow by using post-private-consumer material.

As can be seen from Table 3-2, shares of around 30 % of the total tonnage of recycled PET are used in sheets and blow moulding each. Together with another 10 % of rPET in strapping material, a total of ~70 % of rPET is used in the packaging sector, including food-grade material for packaging and bottles. Around 25 % of rPET is used in polyester fibres which gives an indication of the magnitude of downcycling PET bottles to fleece fibres (see chapter 2.1).

Figure 3-2: Overall PET Mass Balance, 2018



Source: (Plastics Recyclers Europe; EFBW; petcore Europe 2020)

Table 3-2: Distribution of application of recycled PET in several end markets (EU 28+2) in 2018

Sheet	Food-contact material Non-food contact material	14 % 16 %
Blow-moulding	Food-contact bottles Other	18 % 10 %
Fibre		24 %
Strapping		10 %
Other		8 %

Source: (Plastics Recyclers Europe; EFBW; petcore Europe 2020)

4 Potential for improvements in recycled content from a product / sector perspective

Environmental impacts of postconsumer recycled plastic are studied in life-cycle assessment studies such as Bataineh (2015), which come to the conclusion that PET and HDPE recycling yields some important environmental benefits over single-use virgin PET and HDPE, e.g. a saving of non-renewable energy of 40–85 % and a saving of greenhouse gas emissions of 25–75 % can be achieved. Thus, the use of recycled plastics not only saves resources and avoids waste generation but has further positive effects on climate change mitigation.

Generally speaking, society seems open for a recycled content in plastic products, e.g. in 2018, in the UK 93 % of consumers were of the opinion that plastic bottles should contain a recycled content, and 55 % of people were of the opinion that the bulk of a bottle's raw material should be made from recycled plastics (Packaging Europe 2018).

On the German market, already today, a wide range of different segments uses recycled plastic material (see Table 4-1). With ~30 %, ~25 % and ~11 % respectively, the sectors packaging, construction and the automotive sector account for the largest share of the total amount of plastics used or processed. The consumption of polymer material in agriculture is "only" 4 %, however, the recycled content is highest in these plastics (~35 %) followed by the construction sector where polymers typically have a recycled content of ~21 %. Please note that the figures relate to German material consumption and recycled content shares.

Table 41 Volume of processed plastic materials (virgin and recycled) by relevant industries Germany, 2017

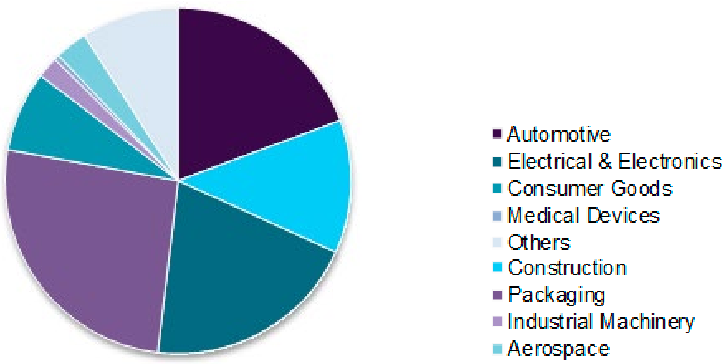
Segment	Share of segment in total polymer processing [%]	Share of recycled content in polymers per sector [%]
Packaging	30,5	9,1
Construction	24,5	21,5
Automotive sector	11,2	4,8
Electronics	6,3	3,2
Household, sports, …	3,4	2,0
Furniture	3,2	4,0
Agriculture	4,0	34,9
Medicine	1,8	0,1
Other	15,1	12,6

Note: Numbers have been already shown in chapter 2.

Source: (Conversio Market & Strategy GmbH 2017)

Looking at the following figures of the Malaysian plastic consumption in the different sectors, it is clear that shares of segments in the total polymer processing are comparable to German shares in the sense that automotive, construction, packaging and electronics account for 70–75 % of the total polymer consumption. Malaysia may act as an example for the ASEAN region here.

Figure 4-1: Malaysia plastic compounding market share per end use, 2015 [%]



Source: https://www.grandviewresearch.com/industry-analysis/malaysia-plastic-compounding-market

The following list compiles the products with significant room for improvement in terms of higher shares of recycled content:

- Products with high potential include construction items such as road barriers, pipes or consumer goods, e.g. furniture, water tanks, or clothing.
- In some applications such as plastic foils and bags based on mono-polymer[10] foils, recycled content is already state of the art, but could be raised to 100%.
- Even though PET rank among the biggest markets for recycled PET, there is room for improvement as virgin polymer is the double amount of recycled polymer in PET production (see Figure 32).

10 The recycling of plastic film consisting of several layers of different polymers (LDPE, HDPE and PP) is one of the most difficult types of recycling because the individual layers, which make up 95 % of the total film, are difficult to separate using standard methods. Although cleaning and separation of the polyolefins (LDPE, HDPE and PP) from the rest is easy using flotation or hydrocycloning methods, separation of LDPE, HDPE and PP from each other is difficult, since their respective densities are very similar, and their variable shape do not allow the use of automated, sensor-based methods (such as use of near-infrared detection). https://cordis.europa.eu/article/id/88019-high-quality-plastic-recyclation-products-for-reuse

Product examples with recycled content

- Indorama, a Thai based multinational petrochemical company with strong activities in **PET** and fiber production, currently produces 6 million t of PET per year. The company aims at increasing its use of post-consumer PET from currently 100,000 t/a to 750,000 t/a by 2025 (EllenMcArthur Foundation 2019).

- In Germany, PET beverage bottles already reached a recycled content of max. 28 % in 2018, while in 2019, the European Union established a mandatory minimum target of 25 % for beverage bottles and 30 % for all PET bottles. PET bottles with higher shares of rPET are available, however, due to the higher rPET shares, the bottles cannot be transparent anymore (Brigitte Osterath 2018). This means the material for the bottles is no longer transparent but (unintentionally coloured because the material properties of PET with a high recycled content change the opacity properties of the raw material for the bottles. The pioneers, e.g. sellers of beverages called "Eiszeitquell" (Eiszeitquell 2020) and "Vilsa" (Vilsa 2020) use 100 % recycled material for their bottles which are blue.

- The sports article producer Puma announced to launch a **sportswear** collection made from 100 % recycled material (mainly PET) in 2020. A prototype of a shoe has already been developed and produced in a limited edition. It is noteworthy that the company does not provide any information on the recycled content with respect to their other articles.

- Some few producers such as the Werner & Mertz Group already changed the lion's share of their product segment to 100 % post-consumer recycled content for their **single-use plastic packaging**, targeting 100 % for their whole product range by 2025 (EllenMcArthur Foundation 2019).

- Under the trade name „Econyl", the Italian company Aquafil sells **nylon yarn** produced from recovered nylon from fishernets and other nylon waste from landfills, e.g. carpets. Aquafil supplies recycled Nylon 6 to more than 1000 companies. The yarn is already used in fashion, e.g. by Prada (Prada Group 2020), outdoor equipment, e.g by Vaude (Vaude 2020), and interior design, e.g. flooring material by Vorwerk (Econyl 2020). The recycling process at Aquafil is based on dissolving the material (which also serves as a sorting method), depolymerization and regeneration of Nylon 6. Aquafil thus is the only company which applies this chemical recycling path (according to own statements). In an interview with Oeko-Institut, Aquafil emphasizes that there is a difference between fishing nets and fishfarming nets: Nets for fishfarms are in the water for a long time and therefore have to be treated with biotoxic substances to prevent alga from sticking to the nets, etc. These nets are considered hazardous waste and cannot be recycled by Aquafil. Fishing nets are not treated with such substances.

- The plastic pipe manufacturers which are members of the German trade association of the **plastic pipe** industry actively support the collection and reuse of plastic pipe waste. […] Plastic pipe systems that are deconstructed after their service life and construction site waste are collected, sorted, cleaned and ground. The ground material obtained is a mixed material, however, the fractions can be separated according to plastic types such as polyethylene, polypropylene or PVC […]. The recycling concept, which is primarily aimed at implementing the association-specific "voluntary commitment", currently aims at the collection, processing and recycling of PVC, PE and PP pipe waste. Recycling concepts are being developed for mineral fibre-reinforced products as well as for PE-X and multi-layer composite pipes (KRV 2020).

- **Clothing** made from recycled fibers of pre- and post-consumer textiles waste is one of the clothing and textiles products industries' big trends in relation to circular economy. There are several labels and initiatives working on higher shares of recycled content in clothing and other textile products in Europe, as can be seen on the following websites, e.g. "Recycled and Upcycled Clothing Brands To Know in 2020" (Omisakin 2020), "9 Great Brands That Make Clothing from Recycled Plastic" (Riva Ras 2019), and others. The European Commission has made textiles one of the priority product groups of its Circular Economy Action Plan, addressing the topic of recycled content in textiles products through the European Clothing Action Plan (European Commission 2020).

- Replas is an Australian manufacturer of **furniture**, **bollards**, **decking**, **fencing** and **signage** made from recycled plastic collected and treated in Australia (RePlas 2020).

5 Limiting factors

Nevertheless, there are a number of concerns and limitations associated with the use of recycled plastics: The use of recycled materials in products can have an impact on product quality and safety, the further recyclability of the material, the environment and health Barriers include concerns about availability raw material and around well segregated waste streams. Limitations are shortly illustrated in the following chapters

5.1 Environmental and health concerns with respect to recycled plastic

Unwanted side-effects in terms of potential environmental emissions and human exposition of chemicals occur depending on the behaviour of additives and non-polymer impurities in the recycling process (S. Margherita di Pula 2015). Environmental impacts may occur when the material is heated up during recycling. It is likely that volatile organic compounds will be released, and additives can form toxic side products. Thus, it is necessary to install dust and emission abatement technologies, otherwise the release of such emissions could be a problem. Adverse health effects can be caused, for example, by substances that could not be destroyed in the recycling process, remain in the material and, depending on the use of the recycled material, are unintentionally introduced into new products that should not contain such substances for hygienic or sensitive reasons, e.g. in the apparel industry, food-grade packaging and medical devices. UV stabilisers are one example of the substances described that many plastics contain to hinder the paling of the colour caused by UV radiation from sunlight. However, some UV stabilisers should not be reintroduced into new products due to hazardous properties.

It is currently the subject of scientific research to investigate the behaviour of various plastic additives in recycling: Which substances decompose and what effects do they have on the secondary material? Which substances “survive” recycling and are to be expected in the secondary material? Do potentially harmful compounds form during the recycling process that the input material for plastics recycling originally did not contain? And for which products is this of interest and for which not?

Since it is claimed that enough is not yet known about the behaviour of additives and potential contamination in recycling, decision-makers tend to rule out any potential risk by requiring primary raw materials with better-known compositions. The research in this area, e.g. Geueke et al. (2018) on chemical safety aspects for food packaging, should further be observed if the prevailing opinion on contaminants should change, so that any concerns which may arise can be addressed wherever possible.

One option for which the results on the behaviour of certain substances in recycling are not required is to use recycled material where the impurities do not play a major role., This is the case for example in durable products e.g. road barriers, outdoor furniture, pipes etc. Several sectors, by differentiating between applications for secondary plastics, could be motivated towards using higher shares of secondary raw material without worrying about product quality loss or impurities.

5.2 Barriers for plastic product manufacturers

Concerns around product quality and safety

Manufacturers of plastic products face the hurdles resulting from the potential impacts of recycled material: They have to guarantee product quality in terms of safety and durability and also in relation to the product as a possible source of pollution for the environment and a possible risk to health.

Material and product quality and safety of the material are influenced by polymer cross contamination and degradation (S. Margherita di Pula 2015). Polymer cross contamination may be an effect of inadequate sorting, e.g. of PE and PP plastics. Degradation of the material may be affected by molecular weight, molecular weight distribution, crystallinity and chain flexibility of the polymer which will change during recycling because plastic waste materials undergo mechanical (i.e. shear forces) and thermal (i.e. high temperature) processes (Hahladakis et al. (2019).

The use of low-quality recycled PE may have impacts on the stability of products – in particular when a high share of LDPE is introduced into a product that requires a certain form stability. Final products such as plastic chairs and buckets would either have to be designed to contain more material to compensate for its weaker physical properties, or it has to be accepted that product stability is lower compared to products manufactured with high-quality polymers (new or from high-quality recycling).

Sometimes, mandatory quality standards for products and packaging are formulated in a way that secondary plastics are excluded from certain applications, as for example in Thailand which still does not allow the use of recycle materials in food-grade applications. This effectively blocks the bottle-to-bottle recycling in the PET waste stream, which is already well developed in many world regions and which is rated as unproblematic from the perspective of consumer safety.

Concerns about raw material availability of recycled plastic

From a corporate strategy perspective, concerns over long-term supply of secondary plastics play a role in a number of ways: Producers do not have confidence in the recycling market and in recyclers to deliver the necessary quantities in the long term. It is not only the quantities, but also colours, purity levels and physical parameters and of cause a constant price for recycled material that matters. Companies, especially brand manufacturers have internal product standards of comparability with very detailed requirements as regards the colour of products, for example. Therefore, they raise the question whether recyclers can constantly supply high amounts of recycled material with the same specification parameter and at stable, affordable costs. Printer manufacturers for example often only use recycled content in those parts of printers that are not visible to the user.

5.3 Barriers for the recycling industry

Segregated waste streams

As already stated earlier in this report, single-use origin polymer streams are easily recyclable. However, single-origin material is not easy to obtain for recyclers. In ASEAN countries, the majority of waste is collected and recorded as non-segregated waste which implies that it is soiled with food residues, diapers, mixed household waste etc.

The problem of non-segregated waste streams exists on several level:

- On the material level:
  - Multi-material waste, e.g. composite material from carton and plastic foils or paper labels on plastic foil cannot be attributed to a single-origin stream (Hautmann 2018).
  - Bio-based plastics are often misplaced in the mixed petrochemical-based plastic waste stream and can compromise the recyclability of the petrochemical-based plastic waste stream (Hahladakis und Iacovidou 2019).
- On the collection level:
  - Recyclers are not able to treat non-segregated waste except for the share of plastic waste which can manually be identified and sorted (PET bottles, HDPE products and larger foils).
- On the system level:
  - Even though a product could technically be recycled in a closed loop, depending on the end-of-life handling of the user, the product might end up in mixed waste which is not separated to a hundred percent but mostly incinerated. See the following example: Earlier, recycled Econyl® Nylon 6 yarn of Aquafil was presented. Technically, this yarn can be recycled over and over again. Nylon fishing nets are suitable for separate collection and can easily be delivered separately since large quantities are involved. However, if swimwear or new carpets are made from the recycled nylon material which is used today, it is likely that they will not be sorted and returned to the recycling company. This occurs when the loop opens, although, from a material perspective, a closed loop would be possible.

Financial concerns

The economic efficiency of the recycling process includes the availability of material and the total cost of the techniques and processes used to obtain the recycled material (sorting, cleaning, etc.) as compared with the profit that can be made from the secondary material. From an environmental point of view, a company must consider aspects such as dust generation, noise pollution from grinding, energy consumption, toxicity of the solvents used, etc. Meeting these challenges requires a high level of commitment, especially when further hurdles come along.

It is a simple calculation: recyclers will only start to find strategies to remove the existing barriers when they get higher prices for their secondary products, i.e. when it is financially worthwhile. An exemplary case of how such a problem can be tackled can be found in chapter 6.3.

5.4 Limitation due to price formation and demand

As stated above, the price of virgin plastic as compared to the price of the secondary raw material plays the most important role especially for both the recycling and the manufacturing industry. A OECD publication (2018) confirms that, "although demand for recycled plastic is influential in the short term, it is the price of oil and primary plastic that drives prices for recycled plastics".

Factors of recycled plastics price formation according to OECD (2018) are:

- Alternative waste management options (led by policy decisions, e.g. the taxation on disposal or EPR, but also costs such as operational, treatment and disposal costs)
- Virgin polymer price (which is a combination of the oil price, grid energy price, cost of additives, supply and demand, cotton price (for polymer fibers only))
- Demand for recycled material (see below)
- Cost of supplying secondary sourced resins (again led by policies, global supply chain networks, technology capability, operational costs)

In Germany, another factor is influencing the price for recycled plastics: Subsidies for primary plastics, in the German case through tax exemption for the material use of fossil fuels compared to energy use. Runkel and Mahler (2017) write that „the non-energy [that means the material use] of fossil fuels such as crude oil, natural gas and coal is not taxed in Germany. As a consequence, the use of fossil fuels and derived products such as plastics as raw materials is favoured by taxation and thus receives a cost advantage over ecological or recycled raw materials." This policy approach may not be an exemption globally and requires further analysis for the target countries in Southeast Asia.

Factors influencing the demand for recycled content can be seen in Table 5-1.

Table 5-1: Summary of main factors influencing the demand for recycled content

Consumer demand	Clothing
	Replacement of metal and ceramic products such as construction materials, automotive parts
	Competing products (wood, paper, reusable items)
Environmental policy	Producer responsibility legislation
	Corporate social responsibility agendas
	Public sector procurement policies favouring recycled content
Enabling technology	Extrusion and foaming – enabling higher content of recycled material
	Product specification
Seasonal festivals and celebrations	Christmas
	Chinese New Year

Source: (OECD 2018)

6 Options for action

An important stakeholder in this field in Germany, an industry working group called AGVU, named several preconditions for promoting a plastics economy based on recycled material which includes the consistent sorting, design for recycling and other product design criteria, guidelines for public procurement and (economic) advantages for recyclable packaging. (AGVU 2020)

Some of those points were also highlighted by the German Federal Environment Agency in a position paper published in 2016, e.g. the focus on the design phase through the means of design criteria for recycling and eco-design, public procurement, and on the importance of a functioning sorting and high-quality treatment. Others are the removal of legal barriers, or improving consumer education on sorting (UBA 2016).

On the sector side, it was shown that there is room for improvement for some products and product groups. As opposed to that, barriers and preconditions were described which explain why higher shares of recycled content are not yet common.

It becomes clear from several positionings of stakeholders, e.g. recyclers (AGVU 2020), non-governmental organisations (Heinrich-Boell-Stiftung; BUND 2019), but also plastic producers, that under the existing conditions – at least in Europe – recycled content cannot be increased without any regulatory approaches, soft policies and voluntary commitment. This is mainly attributable to the current lack of economic incentives for the use of secondary plastic. Thus, the two main options are either to make virgin plastic less attractive or to promote the use of recycled material. The following sections can help to show how this can be done.

6.1 Voluntary industry initiatives

Voluntary pledges and targets

Stimulated by Ellen McArthur Foundation's activities, over 400 organizations have signed commit-ments to contribute towards reducing plastic waste generation. In this context, various multinational companies in the consumer-packaged-food and -retail sector have committed themselves to an average global share of 25 % in the post-consumer-recycled content in plastic packaging by 2025 (e.g. Tetra Pak: 2 %; Nestlé: 15 % Walmart: 17 %; Carrefour, PepsiCo, Unilever: 25 %; Marks and Spencer: 30 %). According to EMF, some signatories have much higher 2025 targets, such as: Werner & Mertz, POSITIV.A, and IWC Schaffhausen (Watchmakers) (100 %); The Bio-D Company Ltd (75 %); Diageo and L'Occitane en provence (40 %); and L'Oreal, M&S, Paccor, and Sealed Air (30 %). "Borealis and Indorama, both resin producers, are industry leaders for committing themselves to shift their existing business model which is based on extracted and virgin materials, to one based on the circulation of materials, by starting to set specific targets with regard to the recycled content." (Ellen MacArthur Foundation 2019)

Standards and reliable environmental labels, such as type-I ecolabels

Options of voluntary initiatives other than voluntary agreements for goals relating to the use of recycled content are certification schemes and reliable environmental labels, such as type-I ecolabels.[11] Based on a catalogue of criteria including e.g. the quality and the share of secondary material used, such labels and certificates can be awarded to businesses:

- EuCertPlast is a Europe-wide certification programme for the recycling of plastic waste. A EuCertPlast certification validates the conformity of the operational standards of plastic recycling processes and their quality level with the regulations. Furthermore, it provides waste management companies with the confirmation that all recyclable plastic waste is recycled in an environmentally-friendly way and according to the respective legal requirements of the respective EU country. Such a certificate can help plastic producers in informing the consumer on the safety of the secondary raw materials (EUCertPlast 2020).

- DIN CERTCO offers a label for recycled content including industrial, pre-consumer waste. The certification mainly works on traceability and offers a method for calculating the recycled content in order to create a basis for the comparability of different products (TÜV Rheinland 2020).

- The Recycled Content Traceability Certification verifies the traceability of recycled material within all steps of the value chain while ensuring the origin of the material pre- and post-consumer in product claims. The Audit Scheme is based on the international standard on chain of custody (ISO 22095), as well as the European standard on plastics traceability (EN 15343:2007), (Recyclass 2020).

- With the German ecolabelling scheme, Blue Angel, (Jury Umweltzeichen 2019) more than 170 different products from recycled polymers have already been awarded, for example covering foils, waste bags, office supplies, waste bins, outdoor furniture, shipping packaging, building fences and other products.

- The Thai Green Label has established criteria to certify (a) plastic products (made from at least 50% plastic) and (b) plastic packaging. Both criteria sets have a strong focus on the recycled content. The required minimum shares range between 20% for big bags and 90% for textiles, carpets and fibers (TEI 2012; 2015). In 2017, three companies (Unipro Manufacturing Co. Ltd.; Thai Polyester Company, PTT Public Company Ltd.) used the label to market some of their products (polyester insulation, yarn, plastic packaging) (TEI 2017).

- Others are the Global Recycled Standard (GRS) or the Recycled Claim Standard (RCS). Both are awarded by an NGO called “textile exchange”.[12]

However, the surveying of Consumers International and UNEP found out that labels and certificates do not always help consumers to make better informed purchasing decisions (UNEP 2020). Furthermore, a report on the consumer perception of the “recycled content”, UNEP claims that too little was known on the waste sector in the US in 2016 to differentiate correctly between “pre-“ and “post-consumer”.

11 https://www.globalecolabelling.net/what-is-eco-labelling/

12 http://textileexchange.org/ (28.09.2020)

6.2 Regulatory approaches and policy options

Chapter 5.4 explicitly points out that policies and legal bindings have an effect on the parameters that are hindering the transformation of the recycling and manufacturing industry.

A minimum recycled content in defined product groups and applications is likely to have a substantial leverage effect in terms of increasing the demand for secondary raw materials. Related requirements are believed to be strong pull factors for local and national plastic collection and recycling industries. A minimum recycled content can either be implemented on a voluntary basis or be based on legally binding requirements.

However, due to the higher costs of most recycled plastic types (compared to virgin plastics), it is unlikely that the recycled content of products will widely increase over a large range of product groups without any **binding targets or minimum requirements**. Therefore, substantial success is believed to be widely tied to regulatory initiatives in this field. Minimum quotas for individual product groups or companies and sectors offer a comparably great potential to open business opportunities for waste plastic collection and high-quality recycling.

However, binding minimum quotas need to be supported by market surveillance and enforcement. As the recycled content cannot be physically or chemically determined at the level of the final product or packaging, independent certifications are needed for the plastic supply chains. Related verification processes and certificates have been developed by a number of companies such as SCS Global Services and TÜV-Rheinland.[13]

The new EU Single-Use Plastics Directive requires a binding minimum target of 25 % recycled plastic for beverage bottles from PET by 2025, and for all kind of beverage bottles 30 % by 2030. The minimum requirements are deemed to be met if the average market of an EU Member State meets the requirement. No individual producer is obliged to meet the requirement on its own, hence, pioneers with high shares of recycled content can support companies with recycled content shares below the criterion. The packaging regulation in Germany specifies that, from 2019 onwards, 58,5 % of all polymers must be mechanically recycled. From 2022 onwards, the rate shall increase to 63 %; with a sub-target of 50 % for all collected light packaging material.

On the international level, further financial instruments – **fees and taxation** – for the increase of recycled plastic in packaging are being discussed, tried and tested.

- The UK for example announced plans to introduce a plastics tax by 2022, addressing the manufacture and import of plastic packaging containing less than 30 per cent recycled plastic (Dickinson 3 Jan 2019)
- From January 1, 2021, the European Union will impose a levy of 80 cents per kilogram of non-recycled plastic packaging waste from EU countries (part of the EU Corona Package) (European Council 2020)
- The Work Group on Plastics and the Work Group on the Urban Waste National plan in Portugal are currently reviewing landfill and energy recovery waste taxes; the recommendations put forth include a reduced levy / zero levy for the plastic bags that incorporate at least 70 % of recycled plastic content (Ellen MacArthur Foundation 2019)
- The German Federal Environment Agency proposed a financial incentive through a CO_2 price for primary fossil fuels to strengthen recycling and the recycled content of plastic material, however, this has not entered into force yet (UBA 2016)

13 TÜV Rheinland (2020); SCS Global Services (2020).

6.3 Exemplary case for a combination of policy decision making and voluntary industry commitment

The wider EU Plastics Strategy (European Commission 2018) aims at voluntary industry initiatives to make sure that at least 10 million tons of recycled plastics will find their way into products on the EU market by 2025 (in contrast to only 3.9 million t in 2016). In this context, the European Commission asked for quantified industry pledges to see whether this goal can be achieved without mandatory legislative measures.

In 2019, related industry pledges on this strategy state that the recycling industry is able and willing to supply at least 11 million tons of recycled plastics on the EU market by 2025. On the demand side of various plastic-using industries and supply chains, pledges currently sum up to 6.4 million t (European Commission 2019a). The pledges are monitored on the European Circular Economy Stakeholder Platform[14]; in addition, the European Commission recently launched the Circular Plastic Alliance[15] to help bridge the gap between the supply and demand for recycled plastics.

This political focus put by the European Commission can already be interpreted as a signal of willingness to put forward binding targets in the event that voluntary initiatives will fail in this regard. This approach is commonly referred to as "soft law" in Europe.

14 https://circulareconomy.europa.eu/platform/en/commitments/pledges (last accessed 22.09.2020)
15 https://ec.europa.eu/growth/industry/policy/circular-plastics-alliance_en (last accessed 22.09.2020)

7 Key implementation aspects

- Aiming for higher shares of recycled material in products increases the demand for recycled materials and subsequently has the effect of stimulating and improving sorting and recycling. The recycler has an economic advantage if he can use well-sorted plastic. In order not to lose sight of the goal **of strengthening the domestic sorting and recycling sector**, the mistake of using well-sorted imported plastic for recycling should not be made. Inputs for plastic recycling should be domestically sourced.

- Recycled content in a product is not visible at first glance, which makes it difficult to enforce mandatory recycled fractions. **Third party control systems** and certificates are needed to control obligations on recycled content.

- As the example of the **soft law policy approach** in the EU shows, it is an option to collaborate with industry: Indicating a policy direction, for example by a binding target for the recycled content in the first place, and further striving for voluntary commitments and pledges with regard to voluntary implementation may be suitable approaches to persuade the industry of the policy objective adopted.

- A unified target is not possible for all product groups. As regards secondary plastics applications, **differentiation** into types of applications is possible and needed where substances do not cause any damage or product quality loss, and for those types where purity and stability play an important role.

- Minimum requirements for recycled content may be introduced on a **sector-specific** basis or **on the basis of average figures**, meaning that targets do not apply for individual producers. The EU targets for recycled content in PET (until 2025) and all beverage bottles (until 2030) only apply to the average of one EU member state's market but not for individual companies is an example.

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Annex

European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste

ANNEX II

ESSENTAIL REQUIREMENTS ON THE COMPOSITION AND THE REUSABLE AND RECOVERABLE, INCLUDING RECYCLABLE, NATURE OF PACKAGING

1. Requirements specific to the manufacturing and composition of packaging – Packaging shall be manufactured in such a way that the packaging volume and weight be limited to the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and for the consumer.
   – Packaging shall be designed, produced and commercialized in such a way as to permit its reuse or recovery, including recycling, and to minimize its impact on the environment when packaging waste or residues from packaging waste management operations are disposed of.
   – Packaging shall be manufactured in such a way that the presence of noxious and other hazardous substances and materials as constituents of the packaging material or of any of the packaging components is minimized with regard to their presence in emissions, ash or leachate when packaging or residues from management operations or packaging waste are incinerated or landfilled.

2. Requirements specific to the reusable nature of packaging – The following requirements must be simultaneously satisfied:
   – the physical properties and characteristics of the packaging shall enable a number of trips or rotations in normally predictable conditions of use,
   – possibility of processing the used packaging in order to meet health and safety requirements for the workforce,
   – fulfil the requirements specific to recoverable packaging when the packaging is no longer reused and thus becomes waste.

3. Requirements specific to the recoverable nature of packaging
   (a) Packaging recoverable in the form of material recycling – Packaging must be manufactured in such a way as to enable the recycling of a certain percentage by weight of the materials used into the manufacture of marketable products, in compliance with current standards in the Community. The establishment of this percentage may vary, depending on the type of material of which the packaging is composed.
   (b) Packaging recoverable in the form of energy recovery – Packaging waste processed for the purpose of energy recovery shall have a minimum inferior calorific value to allow optimization of energy recovery.
   (c) Packaging recoverable in the form of composting – Packaging waste processed for the purpose of composting shall be of such a biodegradable nature that it should not hinder the separate collection and the composting process or activity into which it is introduced.
   (d) Biodegradable packaging – Biodegradable packaging waste shall be of such a nature that it is capable of undergoing physical, chemical, thermal or biological decomposition such that most of the finished compost ultimately decomposes into carbon dioxide, biomass and water.

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn

Friedrich-Ebert-Allee 32 + 36
53113 Bonn, Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1 – 5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

I www.giz.de