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Abstract

Material flow analysis plastics in Germany 2019



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Target, definition, structure and basis of the project

Targets and areas of investigation of the study

The collection, documentation and publication of production and processing data, also including the recovery, are an important instrument for obtaining a continuous picture of the development of the plastics segment in Germany. This applies not only to the public sector and business companies but also to private consumers. Because of the importance in both the public sector and the economic sector, and because of the demand for such information, this study was carried out for the year 2017.

The study delivers a comprehensive material flow analysis for plastics in Germany and covers the fields of

- Production, processing and consumption,
- Waste generation and recovery
- Plastics recycle and its areas of application

Broad consensus and support of the plastics industry

The study was carried out on behalf of the **BKV** in cooperation with and support from the sponsoring associations of this project – **PlasticsEurope Deutschland, AGPU, BDE, bvse, IK, KRV, VCI, VDNA Kunststoff- und Gummimaschinen, the GKV with its trade associations AVK, FSK, TecPart and pro-K, and the IG BCE.**

The survey was made from March to July 2020.

Methodology

Methodology for the study with the participation of plastics producers, processors and recyclers

- **Plastics producers**

Full survey with around 50 plastics producers (30 companies) based on a written/telephone survey using a pre-defined questionnaire.

- **Plastics processors/plastics recyclers**

For the plastics processors and recyclers, a pro rata survey (primarily online) was carried out. For this, the relevant contacts, e-mail addresses and telephone numbers were obtained from more than 2,000 companies and more than 2,600 invitations (in some cases several contacts per company, e.g. at several company sites) were sent out as part of the study. Some 330 companies took part in the survey.

- **Experts exploration**

In addition, around 50 supplementary discussions were held with experts from various organizations.

- **Further information sources**

- Evaluation of production statistics
- Import/export statistics, e.g. Eurostat, Destatis
- Association statistics, GVM data (market research institute focused on packaging), etc.
- Internet research

An overview of the main results Material flow picture of plastics in Germany 2019: At a glance

Plastics 2019 – A brief overview (1/2)



Total plastics production (plastic materials as virgin material and recyclate as well as other plastics, e.g. for adhesives, paints, surface coatings, fibers etc.) amounted to 20.2 m t in 2019.



Plastics production from virgin material in 2019 was around 18.2 m t. The production of relevance for plastic materials was 10.3 m t and thus approx. 6.6% above the level of 2017. For the supply of raw materials for the production of plastic products, around 2.0 m t of recyclate was additionally available.



The plastics processing sector reported a volume of 14.2 m t for 2019, including the use of recycled materials. Slightly increased processing volumes (compared to 2017) in the construction, agricultural and medical sectors were offset by slightly declining volumes in the packaging, automotive, electrical/electronics, household goods, sport/gaming/leisure and furniture sectors, among others. In total, the amount of plastics used in processing was about 0.9% below the level of 2017. The total amount of recycled material used in 2019 was more than 1.9 m t and increased by 10.2% compared to 2017.



Plastics consumption by end-consumers rose in the last two years, reaching a total of around 12.1 m t in 2019. A comparison with the quantities processed in Germany shows an export surplus of around 15% for plastics products and products with a substantial plastic content (e.g. automotive).

An overview of the main results Material flow picture of plastics in Germany 2019: At a glance

Plastics 2019 – A brief overview (1/2)



In total, more than 99% of plastics waste was recovered, of which approx. 47% by material recycling (predominantly mechanical recycling) and somewhat less than 53% by energy recovery.

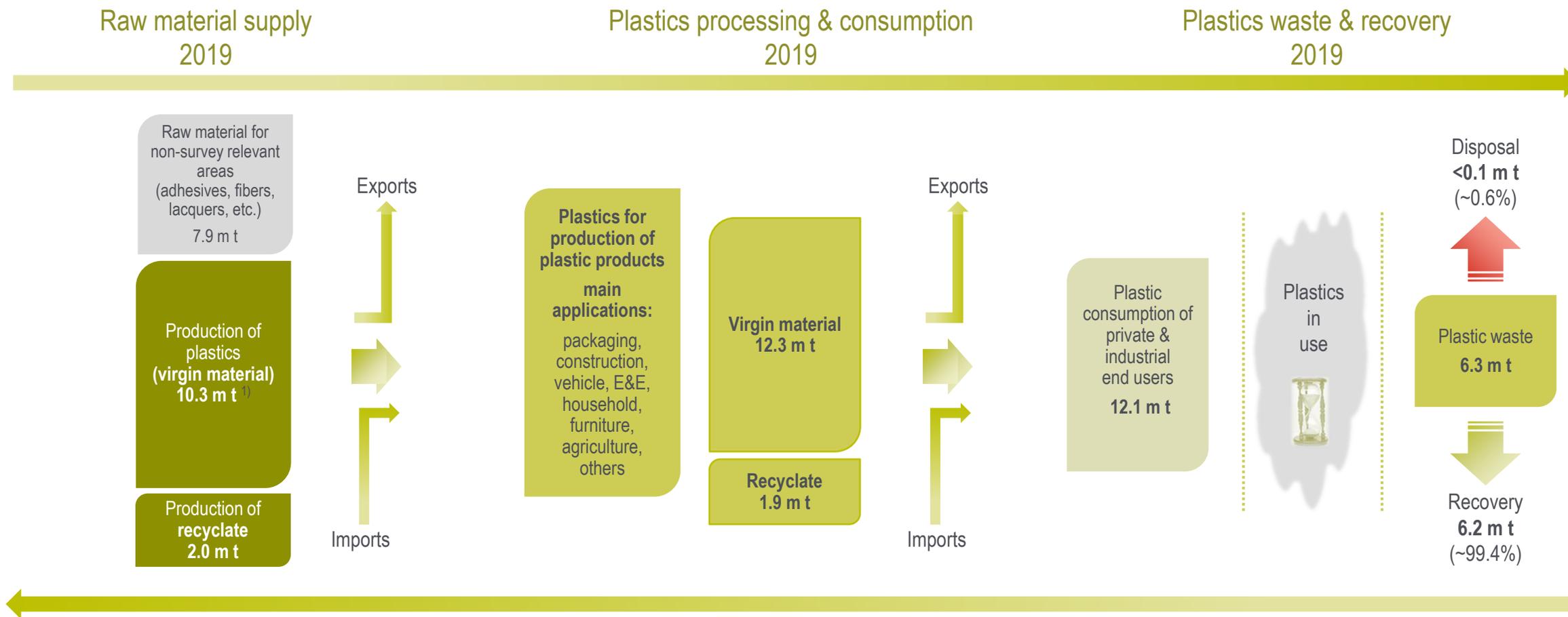


Plastics recycling and the use of plastics recyclate have become established as an important part of the plastics industry and raw material supply. In 2019, around 2.9 m t of the plastic waste produced in Germany was materially recycled. This means that, compared with 2017, an overall increase of 3.2% in the amount of materials recycled was achieved. The increasing recycling from post-consumer waste made a major contribution to this. Almost 2.0 m t of recycled material were recovered from the total waste volume and used for the manufacture of plastic products in Germany. The recycled plastic obtained from post-industrial and post-consumer waste is used in particular in the construction sector and for the production of packaging, but also in the agricultural sector, in the automotive sector or for electrical/electronic applications. The share of plastics recyclate in the total amount processed is 13.7%; the share of recycled plastics from post-consumer waste is approx. 7.2% or an amount of 1.0 m t. Overall, the quantity of recycled material used rose by around 10% compared with the previous survey (2017).



The amount of plastic waste recovered for energy increased slightly compared to 2017. The volume amounted to approx. 3.3 m t, after 3.2 m t in 2017. In the field of energy recovery, the share of substitute fuels also increased slightly (just under 19% of total plastic waste and 21% for post-consumer waste).

An overview of the main results Material flow picture of plastics in Germany 2019: At a glance



¹⁾ Kunststoffarten: PE-LD/LLD, PE-HD/MD, PP, PVC, PS, PS-E, PA, PET, ABS, ASA, SAN, PMMA, other thermosets, other plastics, including PU

Key results at a glance

Comparison of consumption and waste quantities

Comparison of plastics consumption and waste quantities in Germany using key examples (1/2)

The private and commercial consumption of plastics as the main component (e.g. packaging) or partial component of a system (e.g. automotive) was approx. 12.1 m t in 2019. Because the service life of the products differs enormously, varying from just a few days (e.g. packaging) to 80 years and more (e.g. plastic pipes in the construction sector), not all the products appear again as waste in the same year.

- **Short-lived products, especially packaging**

Packaging has an important function to protect foodstuffs and other products. It generally has a short life of a few days or weeks. Consequently, in the reference period of 2019, more than 95% of the used packaging reappeared in the waste flows.

- **Long-lived products, especially building products**

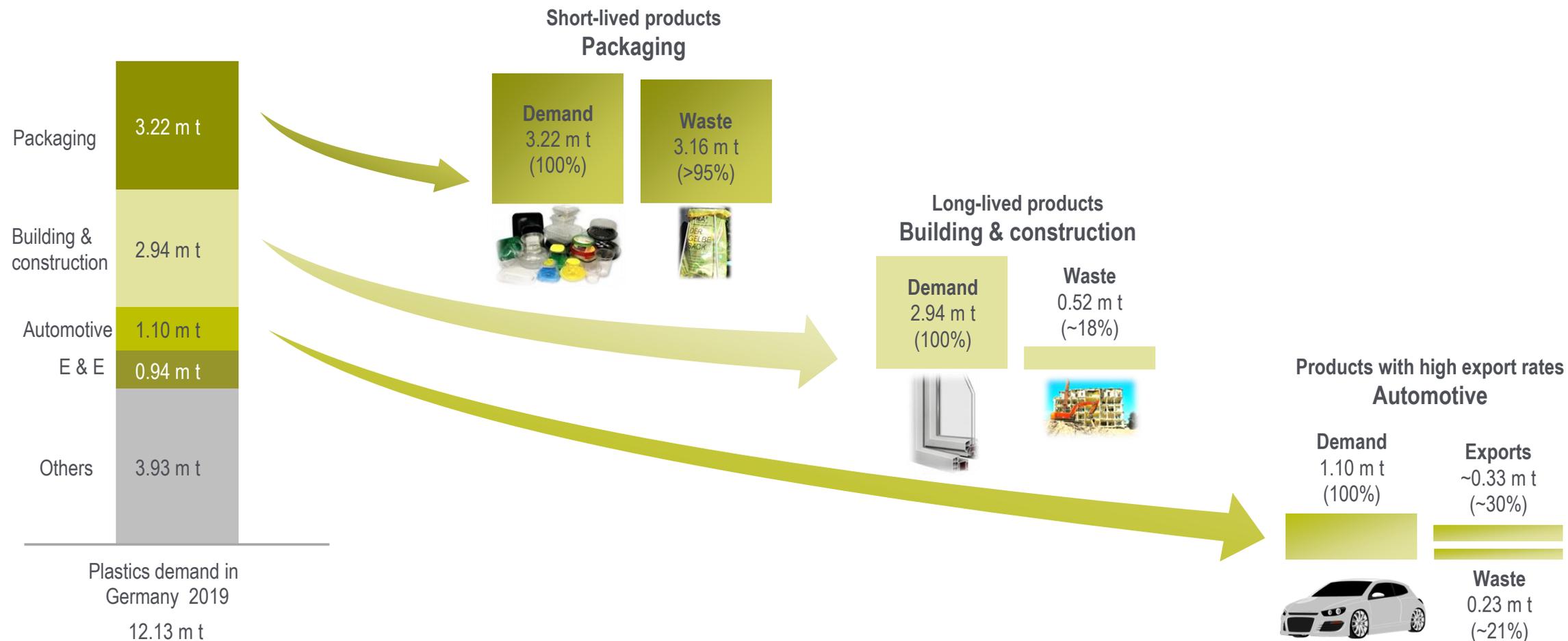
Building & construction products from plastic material, e.g. pipes or windows, generally have a very long life expectancy and service life. It ranges from approx. 25-30 years for floors, 40-50 years for windows to up to more than 80 years for plastic pipes. The combination of this long service life with the fact that plastics in the construction segment have only been used in large quantities for around 40 years and since then the consumption of plastics in building has increased significantly, means that consumption volume and waste volume diverge considerably.

- **Products with a high export share, e.g. automotive**

A third aspect that has significant effects on the generation of waste from products can be seen in the automotive segment. After an average useful life of 10-12 years, the majority of the vehicles used in Germany are exported abroad where they continue to be used (the mean total service life of the vehicles is approx. 15-18 years). This means that less than 560,000 of the approx. 3 million vehicles deleted every year from the German vehicle register end up in German shredder facilities and thus reflected in the waste volume in Germany.

Comparison plastics demand and waste generation

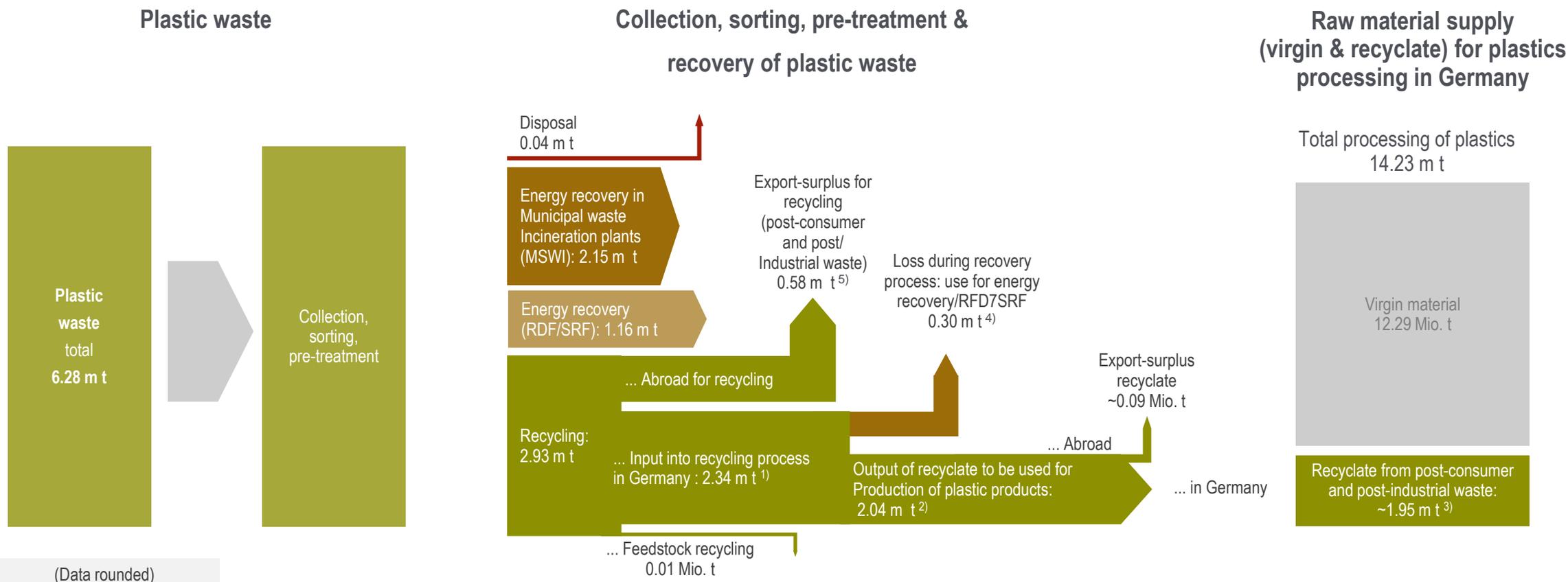
Comparison of plastics consumption and waste quantities in Germany using key examples (2/2)



Overview of the main results

Processing of plastic waste and reuse in plastics processing

Material flow diagram: Processing of plastic waste for re-use in plastics processing



1) Thereof ~1.83 m t input at recyclers as well as ~0.47 m t input into in-house recycling at plastic converters.

2) Thereof ~1.57 m t output from recyclers as well as ~0.47 m t output through in-house recycling at plastic converters.

3) Incl. ~0.15 m t recycle at recyclers with own production.

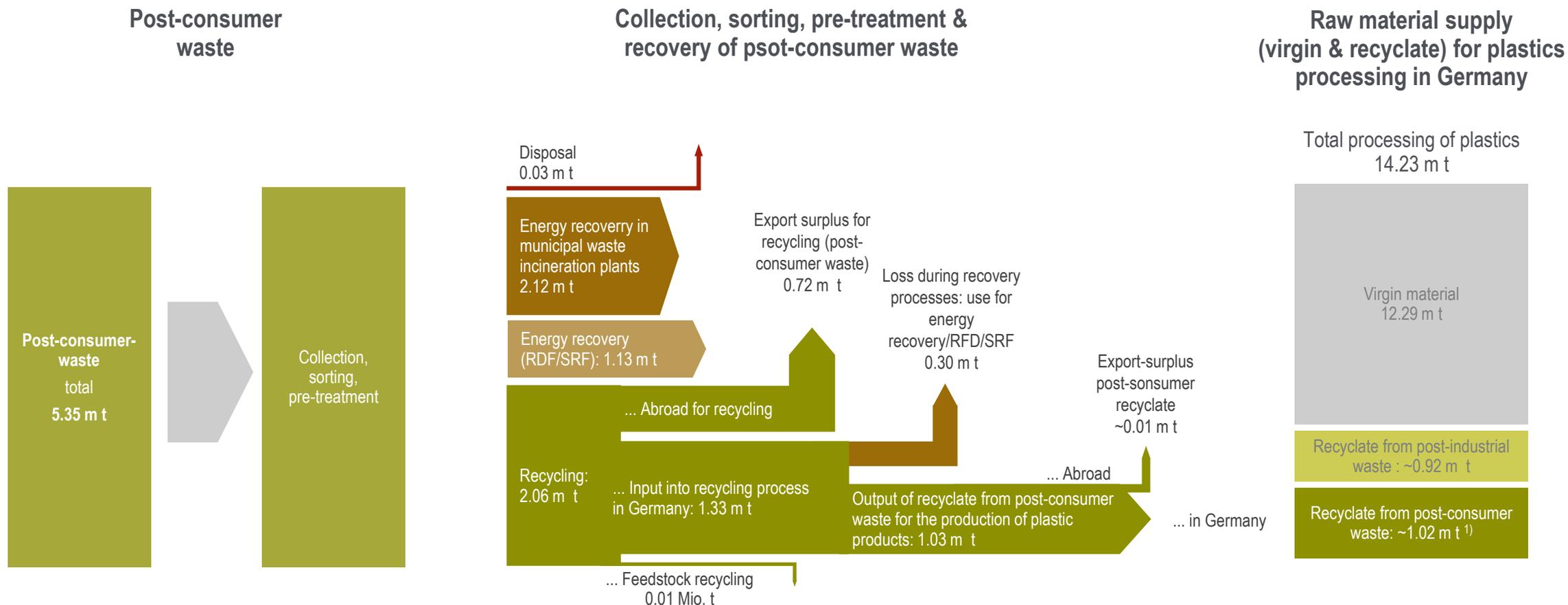
4) Low amount of process losses during recycling of post-industrial-waste have already been considered in the presented data for "energy recovery in MSWI and/or RDF/SRF".

5) Results from an export surplus for post-consumer waste of 0.72 m t and an import surplus for post-industrial waste of 0.14 m t.

Overview of the main results

Processing of plastic waste and reuse in plastics processing

Material flow image: Processing of post-consumer waste for reuse in plastics processing



(Data rounded off)

¹⁾ Incl. ~ 0.15 m t. recyclate at recyclers with own production.

Overview of the main results

Processing of plastic waste and reuse in plastics processing

Material flow image: Processing of plastic waste for reuse in plastics processing

- A total of 6.28 m t of plastic waste was collected in Germany in 2019 and sent for material or energy recovery. Post-consumer waste accounts for 5.35 m t .
- A total 2.93 m t of all plastic waste or 2.06 m t of post-consumer waste is sent for material recycling.
- The export surplus of all plastic waste amounts to 0.58 m t ; in the post-consumer waste sector 0.72 m t. This means that in Germany more post-industrial waste is imported than exported.
- The total output of recycled material is 2.04 m t. This corresponds to a good 32% in terms of the amount of plastic waste. Of this amount, 1.95 m t are used in Germany for the manufacture of products.
- In the field of post-consumer waste the output of recyclate is 1.03 m t (approx. 19% of the waste volume), of which 1.02 m t is used in Germany for the manufacture of products.
- Related to the volume of plastics processed, the share of recyclate is thus 13.7%, and for recyclate from post-consumer waste 7.2%.
- Of the total of around 1,95 m t of recyclate used in Germany, approx. 1.36 m is used as a supplement to or substitution for virgin material, 0.58 m t as substitute for materials such as concrete, wood and steel, and 0.01 m t as a reducing agent in the steel production process.
- With recyclate from post-consumer waste (total of around 1.02 m t), the quantity used for the substitution of virgin material is 0.43 m t, for the substitution of other materials 0.58 m t, and as a reducing agent in the steel process 0.01 m t.

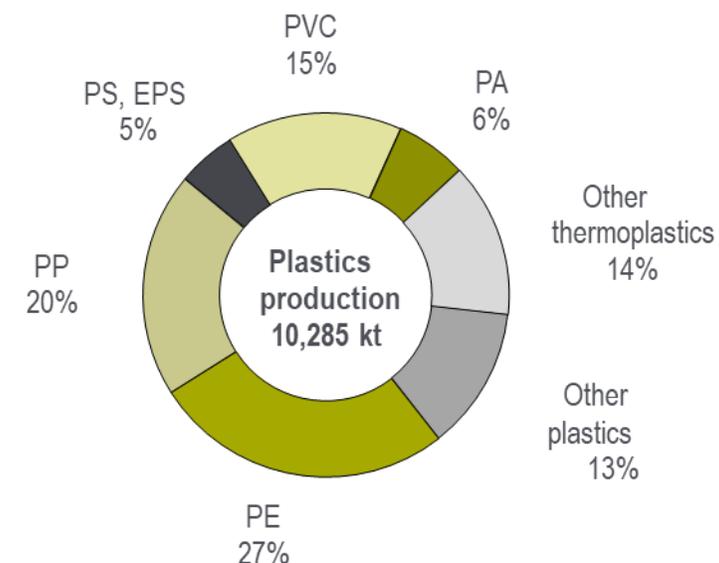
Plastics production

Plastics production (materials/virgin) in Germany

Production volumes (virgin material) by type of plastic in 2019

Plastics production (Virgin) ¹⁾	Production volume		Delta vs. 2017	
	2017	2019	CAGR	Total growth
PE	2,970	2,735	-4.0%	-7.9%
PP	2,250	2,055	-4.4%	-8.7%
PS, EPS	590	535	-4.8%	-9.3%
PVC	1,640	1,595	-1.4%	-2.7%
PA	670	650	-1.5%	-3.0%
Other thermoplastics ²⁾	1,705	1,410	-9.1%	-17.3%
Other plastics ³⁾	1,190	1,305	4.7%	9.7%
Total	11.015	10.285	-3.4%	-6.6%

Share of production quantities 2019



- In 2019, plastics production (virgin material) in Germany totaled almost 10.3 m t. The production volume was thus around 6.6% below the level of 2017.
- Only "Other plastics" (including PUR) saw volume growth.
- For polyolefins (PE, PP), volume decreases in the order of -7.9% (for PE, including PE-LD/LLD, PE-HD/MD) and -8.7% (PP) were observed.
- Significant declines were also recorded for PS, PS-E and "other thermoplastics" (including PET, ABS, ASA, SAN, PMMA, PC, POM).

1) For reasons of confidentiality, a separate quantity statement for individual types of plastic is provided by 3 or more relevant producers

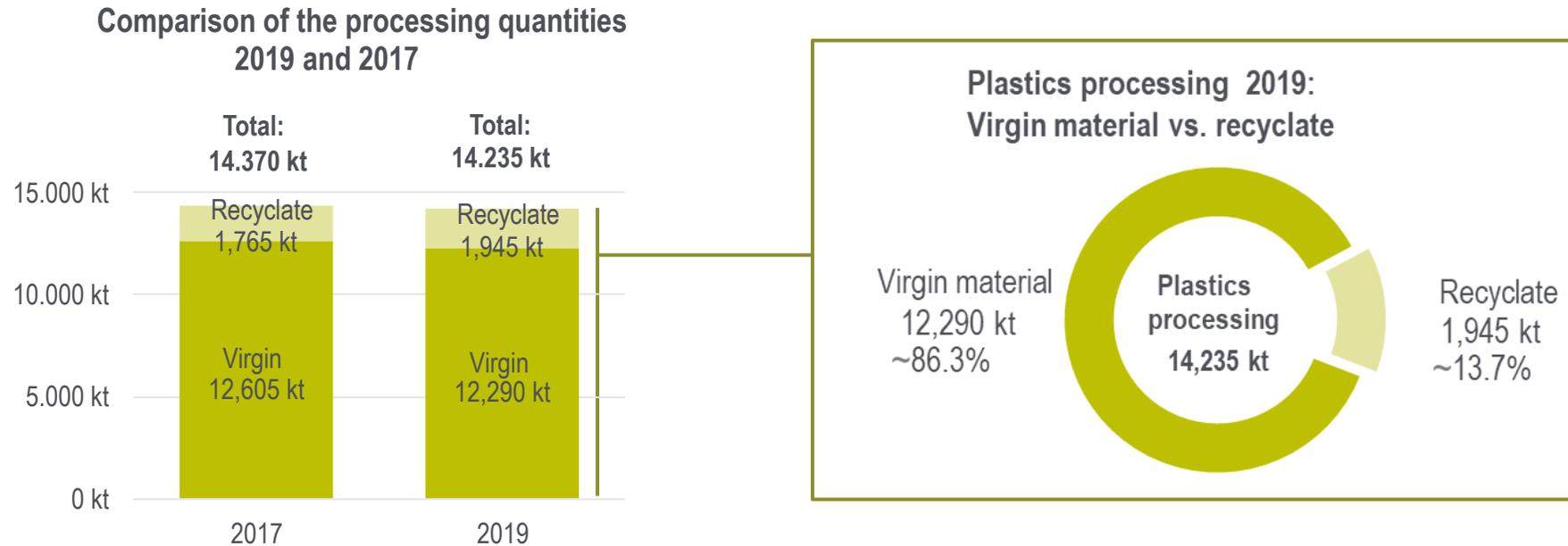
2) and others. PET, ABS, ASA, SAN, PMMA, PC, POM etc.

3) and others. PUR

Plastics processing

Overview: Processing of virgin and recycled material 2019/2017

Processing of virgin and recycled material: Overview 2019/2017



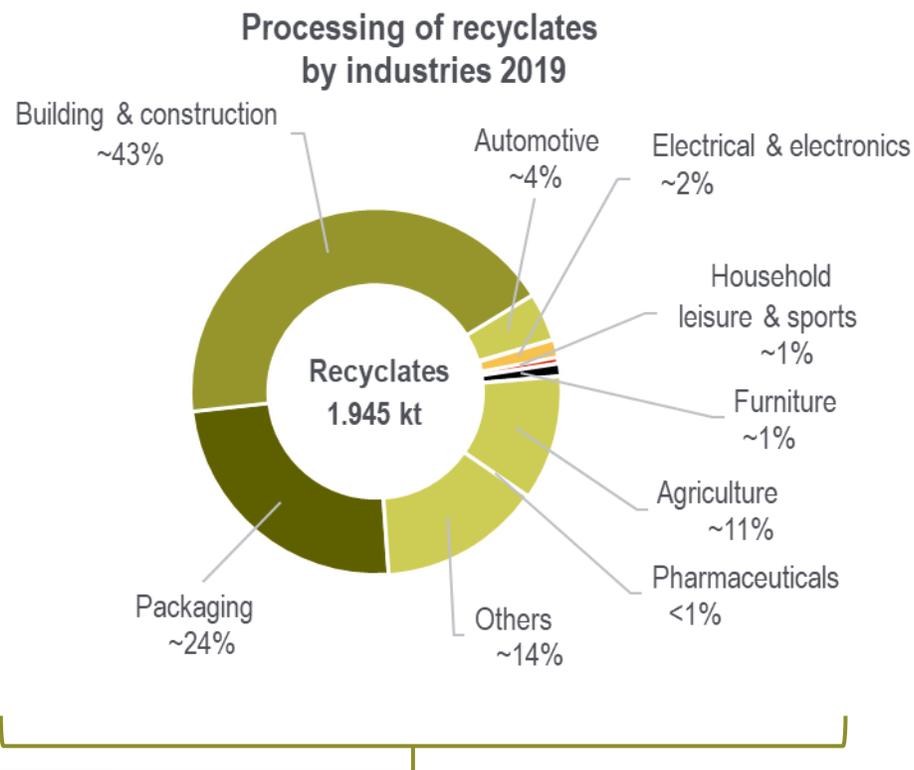
- The processing quantity (input) determined for the year 2019 totaled 14,235 kt - including virgin material and recycled material. Compared to the last survey for the year 2017, this results in a decrease in the processing quantity of approx. 0.9% (CAGR 0.5%).
- Based on the determined recycled material quantity of 1,945 kt, this resulted in a share of 13.7% for recycled material of the total processing quantity in 2019. The share of virgin material was 86.3%.
- The amount of recycled material used has increased by about 180 kt or 10.2% compared to 2017. At the same time, the processing quantity of virgin material has decreased by about 315 kt. This represents a decrease of 2.5%.

Plastics processing

Overview: Processing of virgin and recycled material by industry

Volume of plastic materials processed by relevant industries 2019

Plastic processing 2019	In total (Virgin mat. and recycle) (kt)	Processing of virgin material and recycle			
		Virgin material (kt)	Recyclate (kt)	Virgin material (%)	Recyclate (%)
Packaging	4,369	3,895	474	89.1%	10.9%
Building & construction	3,583	2,749	834	76.7%	23.3%
Automotive	1,509	1,426	83	94.5%	5.5%
Electrical & electronic	881	850	31	96.5%	3.5%
Household / leisure & sports	464	454	10	97.8%	2.2%
Furniture	456	435	21	95.4%	4.6%
Agriculture	586	372	214	63.5%	36.5%
Pharmaceuticals	271	271	0	99.9%	0.2%
Others	2,116	1,839	277	86.9%	13.1%
Total	14,235	12,290	1,945	86.3%	13.7%

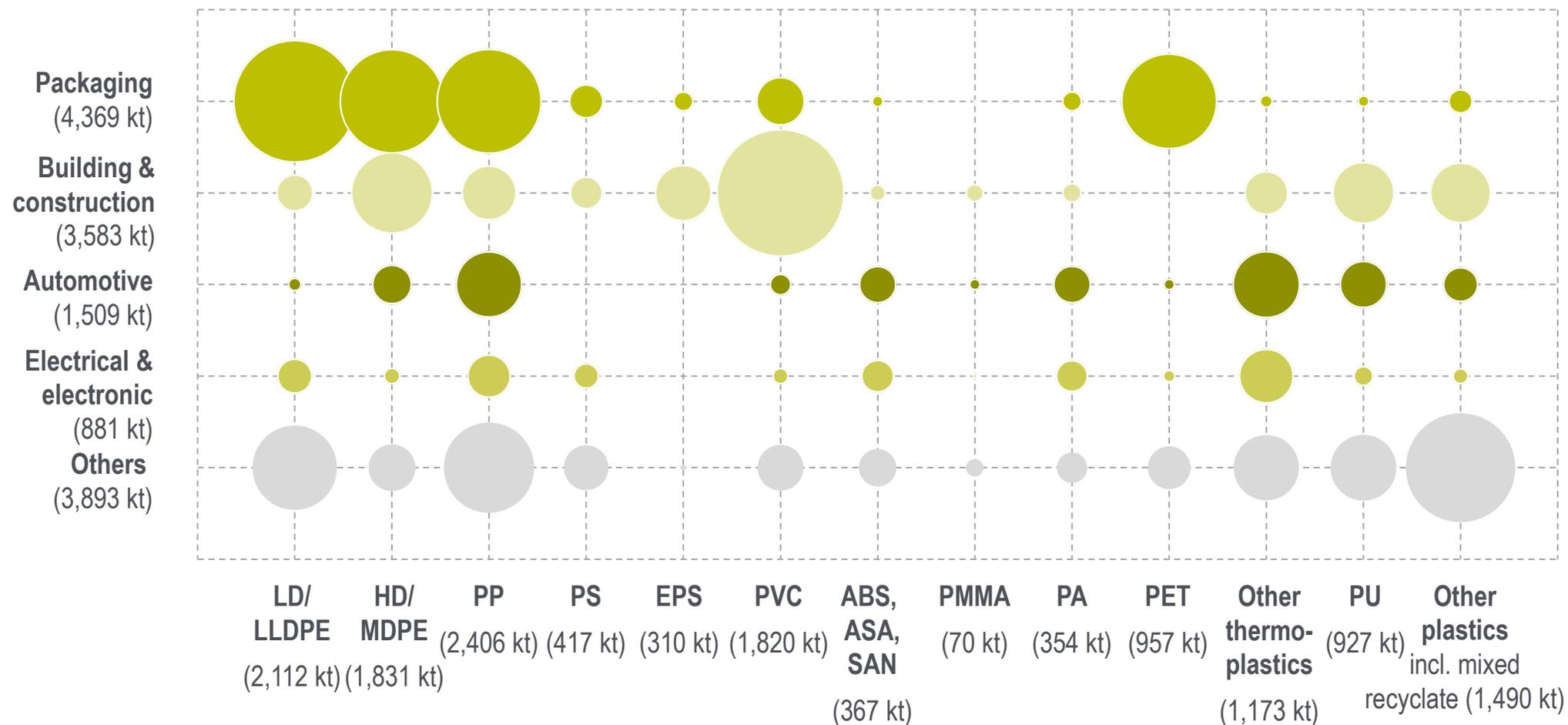


- The different application areas show different degrees of use of recycled material (from post-consumer or post-industrial waste).
- Significant amounts of recycled material are found in particular in agricultural, construction and packaging applications. In each of these three segments, the share of recycled material exceeds 10% (10.9% in packaging, 23.3% in construction and 36.5% in agricultural applications).

Polymer processing

Polymer types and industries

Structure of processed plastics (including virgin and recycled materials) within the industries: Overview



Plastic waste and recovery

Post-consumer waste according to fields of application and their recovery

Post-consumer waste by major fields of application

Application	Comparison share of plastics consumption vs. Waste accumulation		Post-consumer waste in kt		Delta vs. 2017	
	Plastics consumption	Waste accumulation	2017	2019	Nominal	CAGR
Packaging	26.6%	59.1%	3,081	3,160	2.6%	1.3%
Building & construct.	24.3%	9.8%	495	522	5.4%	2.7%
Automotive	9.1%	4.4%	232	233	0.5%	0.3%
Electrical & electronic	7.7%	5.9%	307	316	3.0%	1.5%
Household, sports & leisure	5.0%	3.2%	158	169	7.0%	3.4%
Agriculture	4.6%	5.5%	277	295	6.4%	3.2%
Others ¹⁾	5.3%	12.3%	651	655	0.7%	0.3%
Total	100%	100%	5,201	5,350	2.9%	1.4%



Quoats 2019 (2017)

■ Recycling rate	39%	(39%)
– mechanical	38%	(38%)
– feedstock	<1%	(1%)
■ Recovery rate	99%	(99%)
– energy	61%	(60%)
■ Disposal	1%	(1%)
– landfill	1%	(1%)

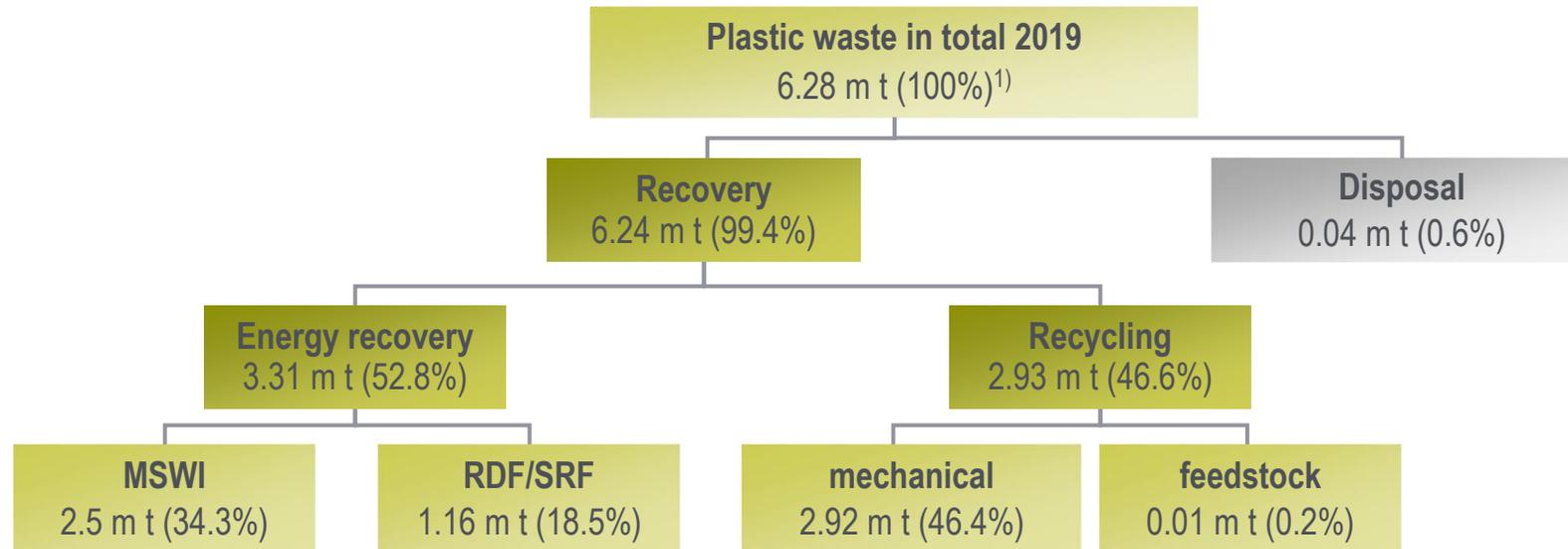
- In 2019 higher quantities of post-consumer waste were recorded than in 2017 in all areas of application.
- Growth rates range between <1% (e.g. in the automotive sector) and >6% (e.g. in agriculture and household goods, sports, games and leisure).
- The amount of plastic packaging waste generated has increased by a total of 2.6% compared to 2017. In the construction sector, the volume of long-lived plastic construction products (e.g. windows, pipes, floors), which are being replaced, for example, as part of renovation projects, continued to increase.

¹⁾ "Others" includes various fields of application with low percentages (e.g. furniture, medical, technical applications, machine construction etc.).

Plastic waste and recovery

Recovery of plastic waste - including post-industrial waste

Total recovery of plastic waste (including post-industrial waste)



Of the calculated approx. 6.28 m t of plastic waste in Germany in 2019, 46.4% was recycled, less than 1% raw material, 52.8% was recovered energetically and 0.6% was deposited in landfills. The shares of material recycling and energy recovery have changed only insignificantly compared to 2017. In terms of energy recovery, the use of plastic waste as a substitute fuel continues to play an important role (18.5% of total plastic waste) - compared to 2017, this volume has increased by approx. 0.06 m t.

The recycling quantities refer to plastic waste produced in Germany, regardless of whether it was recycled in Germany itself or in other countries. The recycling quantities therefore do not represent the recycling quantities that are processed by German recyclers.

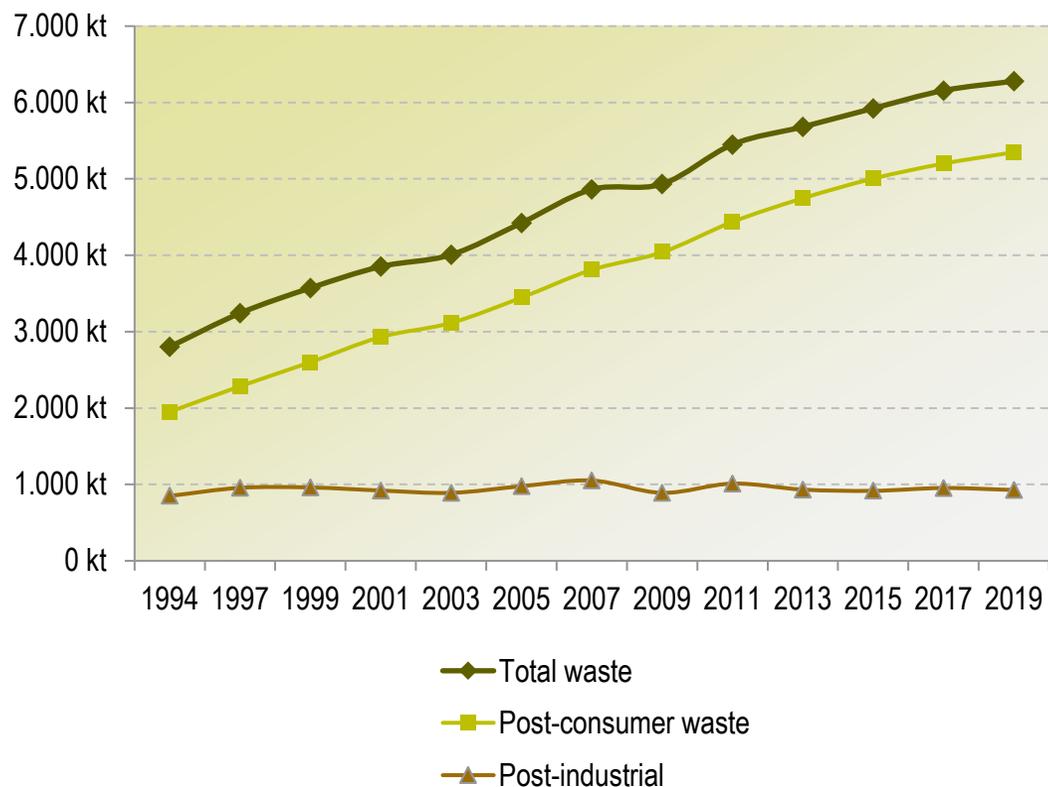
¹⁾ „Thereof 5.35 m t post-consumer waste and 0.93 million tons post-industrial waste

Plastic waste and recovery

Plastic waste including recovery in a time series

Development of plastic waste generation from 1994-2019

Production of plastic waste



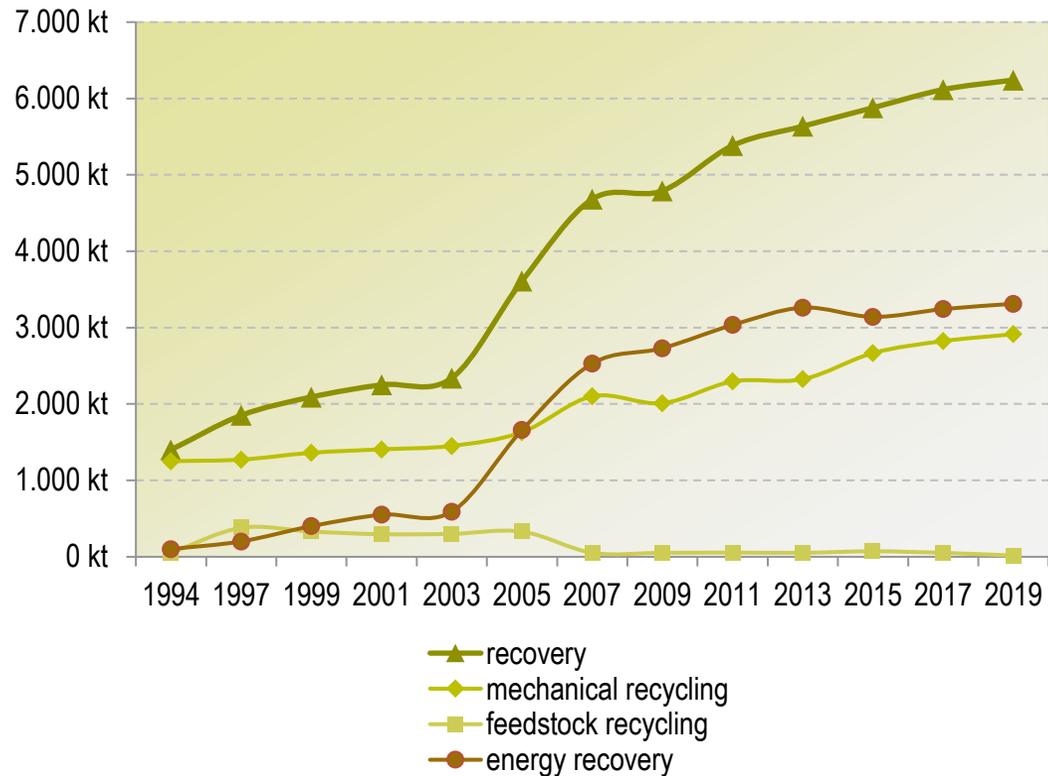
- Plastic waste generation increased within 1994 to 2019 from 2.80 to approx. 6.23 m t. This is an increase by approx. 3.3% per year resp. by approx. 3,43 m t im over the total period.
- This increase is almost fully covered by the raise in the post-consumer area. Waste quantities there increased from 1.95 to approx. 5,35 m t. This represents an increase by approx. 4.1% per year. The increase is in the meantime percentaged above the increase in consumption, which is due to the raising occurrence of medium and long-lived products in the waste.
- Waste generation in the area of production and processing (post-industrial waste), on the other hand, increased only slightly (1994: 850 kt / 2019: 927 kt) despite a significant increase in production and processing volumes due to improved production and processing procedures. This can be attributed to increases in efficiency, especially in the plastics processing industry.

Plastic waste and recovery

Development of waste recovery in a time series

Development of waste recovery in a time series from 1994 - 2019

Material, raw material and energy recovery



- Mechanical recycling reached its highest value in 2019 and, at approx. 2.91 m t, will be approx. 1.66 m t or over 130% higher than in 1994. The average increase from 1994-2019 was approx. 3.4% annually. After a somewhat restrained development in the years 2009 - 2013, recycling has slightly gained momentum again in the past four years. Nevertheless, further significant increases are necessary to meet the future European and German legal requirements.
- Feedstock recycling, which increased significantly at the beginning of the decade and remained at a level of approx. 300 kt for a long time, amounted to approx. 14 kt in 2019 and was thus below the level of the previous years (mostly 50-70 kt each in the years 2007-2019).
- In 2019, the quantities for energy recovery were slightly above the level of the previous year. In 2019, the share of quantities for use as substitute fuel was just under 19% (of total plastic waste) and 21% (of post-consumer waste).

Attachment

Glossary (1/8)

Plastic production, processing and consumption

<p>Plastics production</p>	<p>The focus here is on plastics for the production of plastics products by polymerization, which are sold to the processing industry in the form of molding compounds (e.g. powder, granules, starting materials, e.g. PU raw materials).</p> <p>Plastics production as a whole does, however, also include resins that are used as binders e.g. in the surface coatings segment. Polymers that only become plastics through their processing are not included in this part of the study. They are covered in the section of the study on “Plastics processing“. This part of the study focuses on production volumes produced at sites in Germany.</p>
<p>Plastics processing</p>	<p>This part of the study covers the processing or conversion of plastics in the form of primary materials or recycle into products. The focus is on processing volumes produced at sites in Germany.</p>
<p>Plastics consumption</p>	<p>This covers the plastics consumption of private and commercial consumers within Germany. For calculating plastics consumption, imports and exports have been subtracted from volumes for plastics processing. In the field of packaging, only imports and exports of non-filled packaging were taken into account.</p>

Attachment Glossary (2/8)

Differentiation between virgin material and recyclate

Virgin material	<p>New plastic material (also: virgin material, primary material) is defined as molding compounds (e.g. powder, granules, starting materials, e.g. PUR raw materials) produced by polymerization, which are sold to the processing industry. Raw materials obtained from the recycling of post-industrial or post-consumer waste are not included here (see "plastics recyclate").</p>
Plastic recyclate	<p>Plastic recyclate is obtained from the recycling of post-industrial or post-consumer waste. The processing to recyclate takes place in the form of regrind, regranulates, regenerates or compounds, agglomerates or compactates. The produced recyclate is again used in the processing to plastic products.</p> <p>For practical reasons of data collection and in the interest of international comparability of the collected data, a material definition based on the international standard ISO 14021 is used in this study and the preceding studies in agreement with the German Federal Ministry of the Environment. The definition has no effect on the reported quantities of post-consumer materials.</p> <p>Against the background of the increased importance of the use of recycled materials, it is planned to review the definition of post-industrial material on which the study is based in the context of the next study in the context of the technical discussion in Europe and international standardization. This will be done in the interest of the greatest possible transparency and comparability of the data.</p>

Attachment

Glossary (3/8)

Where plastics waste is generated

Plastic producers	In the study, plastics producers are taken no mean only raw material producers weho sell the products which they produce by polymerization to the further processing industry in the form of molding compounds (e.g. powder, granules, starting materials, e.g. PU raw materials). The resins udes as binders e.g. in the surface coatings segment are thus not included in this group. They are only taken into account in the overall production figures.
Plastics processors	Plastics processors or converters are companies that, either as their main activity or within a production area, process plastics as primary materials or recyclate into products and/or, to a certain extent, process external end-of-life plastics and incorporate them into the processing process.
Plastics recyclers	Plastics recyclers are campanies that purchase unprocessed plastic waste or residual materials from an external source, process these materials and turn them into intermediate products (agglomerate, millbase, regrind, compounds) and/or end products, or use them for the production of further end products such as chemical raw materials (monomers/synthesis gas etc.) or for the production of energy in the form of heat, steam or electricity.
Commerical consumers	Commerical consumers cover all private and public companies from production, trade and services in which plastic waste is generated.
Private households	Private households without commerical activities.

Attachment Glossary (4/8)

Types of waste, disposal, recovery and disposal

Post-industrial waste	Post-industrial waste is plastics that arise during the manufacture (production) or processing of plastics and leave the plant or process for treatment. As a rule, the materials are produced in a single type and the contents are known to the user as far as possible. Materials that are reused in the same process, at the same location and for the same application - are considered by-products.
Post-consumer waste	Post- consumer waste is waste from both the commercial and the household sectors after the plastics have reached the end of their useful life (short-lived and long-lived). It also includes waste produced during the installation, assembly or laying of e.g. pipes, cables, floors, awnings etc. The waste is frequently soiled and/or mixed.
Disposal	The recovery and removal of waste.
Recovery	Recovery covers both material recycling and energy recovery. They recycled volumes refer to plastic waste occurring in Germany, irrespective of whether it was recovered in Germany or in other countries. The recovered quantities thus do not represent the volumes processed by German recovering companies.
removal	Landfilling according to defined criteria or incineration without adequate energy output.

Attachment Glossary (5/8)

Material, mechanical and raw material recycling

Material recycling	Material recycling is subdivided into mechanical recycling and feedstock recycling.
Mechanical recycling	Processing of specific plastic waste into secondary raw materials or products without any significant modification to the chemical structure of the material.
Feedstock recycling	Conversion of plastic-containing waste fractions into monomers or for the production of new materials by modifying the chemical structure of the respective waste fractions by cracking, gasification or depolymerization, but without energy recovery and incineration.

Attachment Glossary (6/8)

Energy recovery and RDF/SRF

<p>Energy recovery</p>	<p>Energy recovery covers both incineration in modern waste incinerators (MSWI, Municipal Solid Waste Incineration) and the use as substitute fuels (RDF/SRF) – see below – in power plants and cement factories. With energy recovery, the technical definition is taken as the basis: incineration in a waste incinerator with effective energy output or with energy utilization.</p>
<p>RDF/SRF</p>	<p>Refuse Derived Fuels (RDF) are produced from the treatment or processing of waste streams with high calorific value. Specified RDFs are used together with conventional fuels in so-called co-combustion, mainly in cement, lime and lignite power plants, and to a large extent also in industrial power plants (high-calorific fraction) or as the sole fuel in RDF power plants. Plants using RDF must at least meet the requirements of the EU Directive (2000/76/EC) on the incineration and co-incineration of waste throughout Europe. In Germany, the 17th BImSchV applies to waste incineration and co-incineration plants. For example, the secondary fuels (SBS) specifically processed from selected material flows are used to a large extent in cement power plants due to the higher quality requirements resulting from sophisticated processing technologies. With energy shares of about 15% and above, raw waste such as used tires, plastics, industrial and commercial waste, as well as meat and bone meal and animal fats are suitable for use in the cement industry as substitute fuels.</p>

Attachment

Glossary (7/8)

Plastic types / Abbreviations for plastic types

LD/LLDPE	Low-density / linear low-density polyethylene
HD/MDPE	High-density / medium-density polyethylene
PP	Polypropylene
PS	Polystyrene
EPS	Expanded polystyrene (EPS) incl. XPS (extrusion foamed polystyrene)
PVC	Polyvinylchlorid
ABS, ASA, SAN	Acrylonitrile-butadiene-styrene, acrylonitrile-styrene-acrylate, styrene-acrylonitrile copolymer
PMMA	Polymethylmethacrylate
PA	Polyamide
PET	Polyethylenterephthalate
Other thermoplastics	Other thermoplastics, e.g. POM (polyoxymethylene), PC (polycarbonate), PBT (polybutylenterephthalate), blends etc.
PUR	Polyurethane
Other plastics	Other plastics, e.g. thermosetting plastics such epoxy, phenolic and polyester resins, melamine resins, urea resins

Attachment Glossary (8/8)

Others

CAGR	CAGR stands for "Compound Annual Growth Rate". The CAGR represents the average annual growth rate of a variable under consideration. The CAGR thus represents the average percentage by which the initial value of a time series grows for the reporting years until the final value is reached at the end of the reporting period.
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Attachment Photos

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