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Abstract

## Material flow analysis plastics in Germany 2017

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KONZEPTE  
VERWERTUNG

**PlasticsEurope**  
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**AGPU**  
NETZWERK - WISSEN - DIALOG

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**VDMA**

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Gesamtverband  
Kunststoffverarbeitende  
Industrie e.V.

**pro**  
Industrieverband  
Hilfsstoffe und Konsumprodukte  
aus Kunststoff e.V.

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Verband Technische  
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**AK**

**FSK**  
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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 recycling, 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 recycling
- 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, bvse, IK, VDMA, BDE**, of the **AGPU** (for the field of PVC), the **KRV**, the **GKV** – with its trade associations **pro-K, TecPart, AVK** and **FSK** – and the **IG BCE**.

The survey was made from March to August 2018. The study was validated by an external expert.

# 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 2,800 invitations (in some cases several contacts per company, e.g. at several company sites) were sent out as part of the study. Some 320 companies took part in the survey.
- **Experts exploration**  
In addition, about 50 additional 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

## Validation by an external expert

- The study on the "Material flow analysis for plastics in Germany 2017" was validated **by an external expert**.
- The external report was drawn up by **ecocycle GmbH** based in Eilsdorf ([www.ecocycle.de](http://www.ecocycle.de)).
- The **process was accompanied by ecocycle GmbH** and included among other things the following aspects:
  - Examination of the **procedure** and **methodology**
  - Examination of **survey documents** (e.g. logic of the content and structure of the questionnaire)
  - Examination of the **representativeness** of the **market players** covered
  - Examination of the **transparency, logics, structure** and **plausibility**
  - Examination of adequate presentation of basic **definitions**
  - Examination of the **plausibility of the data**
- The **result of the report** shows that the study meets the above requirements. The publisher of the study has received a test report to this effect.



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## Plastics 2017 – 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 21.8 m t in 2017.



**Plastics production from virgin material** in 2017 was around 19.9 m t. The production of relevance for plastic materials was 11.0 m t and thus approx. 8.5% above the level of 2015. For the supply of raw materials for the production of plastic products, 1.9 m t of recyclate was additionally available.



**Plastics processing**, including the use of recyclate, totaled 14.4 m t in 2017. There was a small increase not only with packaging and construction - the largest fields in terms of volume - but also with vehicle manufacture, electrical, furniture, household goods and medical technology. The total quantity of recyclate used was 1.8 m t or 12.3%.



**Plastics consumption** by end-consumers rose in the last two years, reaching a total of around 11.8 m t in 2017. A comparison with the quantities processed in Germany shows an export surplus of around 18% for plastics products and products with a substantial plastic content (e.g. automotive).

## Plastics 2017 – A brief overview (2/2)



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

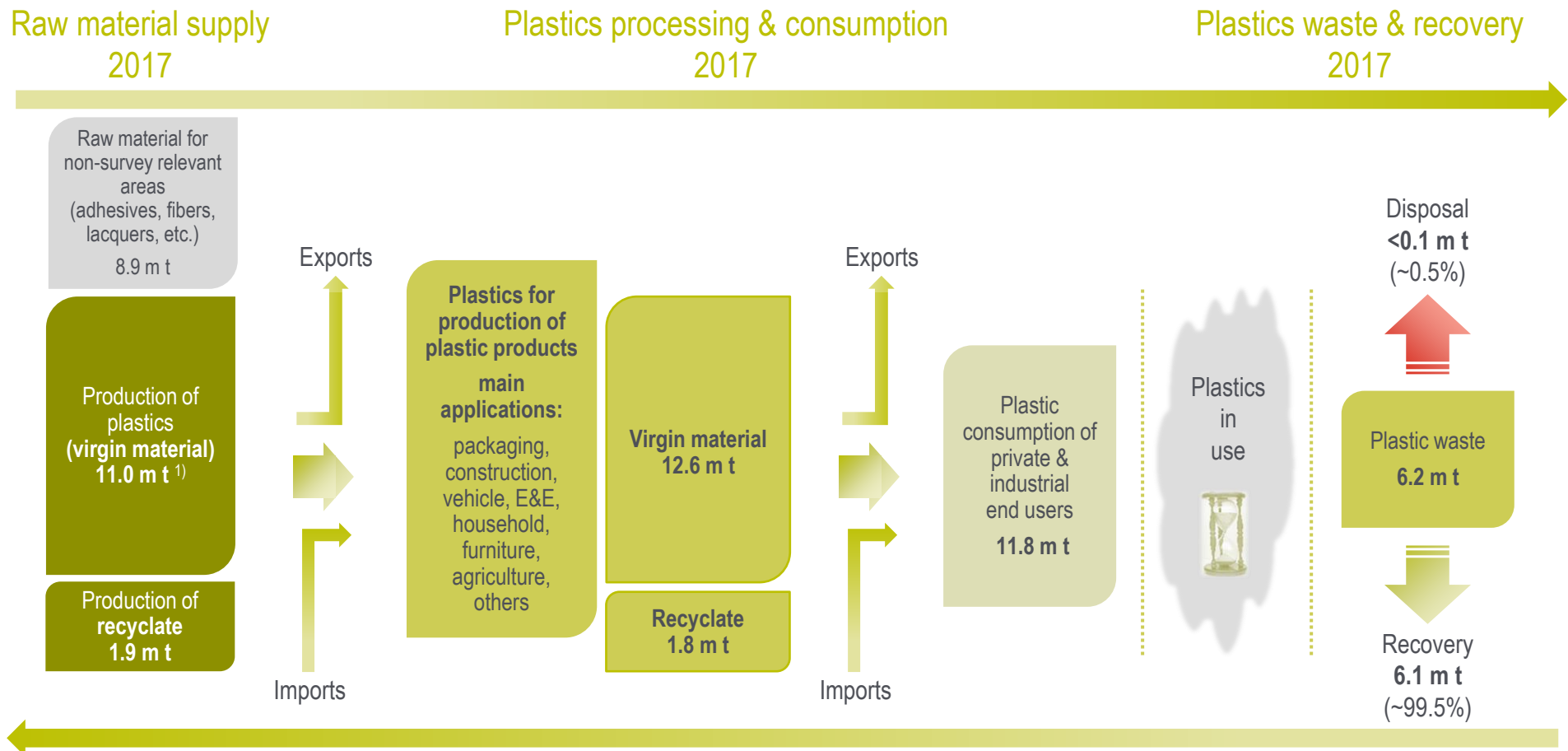


**Plastics recycling and the use of plastics recyclate have become established as an important part of the plastics industry and raw material supply.** Of the plastic waste generated in Germany in 2017, around 2.8 m t went for mechanical recycling. Compared with 2015, this was an increase in the mechanical recycling volume of 5.9%. One of the main contributors here was the increase in the recycling of post-consumer waste. From the total waste volume, approx. 1.9 m t of recyclate is recovered for the production of plastic products in Germany. Related to the total volume of waste, this represents approx. 30%. The plastic recyclate obtained from production / processing waste and post-consumer waste is used above all in the construction segment and for the production of packaging, but also in agricultural, vehicle and electrical & electronic applications. The proportion of plastic recyclate in the processing volume totals 12.3%; the proportion of post-consumer recyclate is 5.6% or approx. 810 kt.



**The amount of plastic waste used for generating energy remained relatively stable compared with 2015.** The volume was approx. 3.2 m t after 3.1 m t in 2015. In the field of energy recovery, the proportion of substitute fuels also remained relatively stable (approx. 18% of the total plastic waste or 20% of post-consumer waste).

# Material flow analysis plastics in Germany 2017: Overview of the main results



<sup>1)</sup> LD/LLDPE, HD/MDPE, PP, PVC, PS, EPS, PA, PET, ABS, ASA, SAN, PMMA, other thermosets, other plastics, including PU



## Comparison plastics demand and waste generation

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. 11.8 m t in 2017. 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 2017, 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.

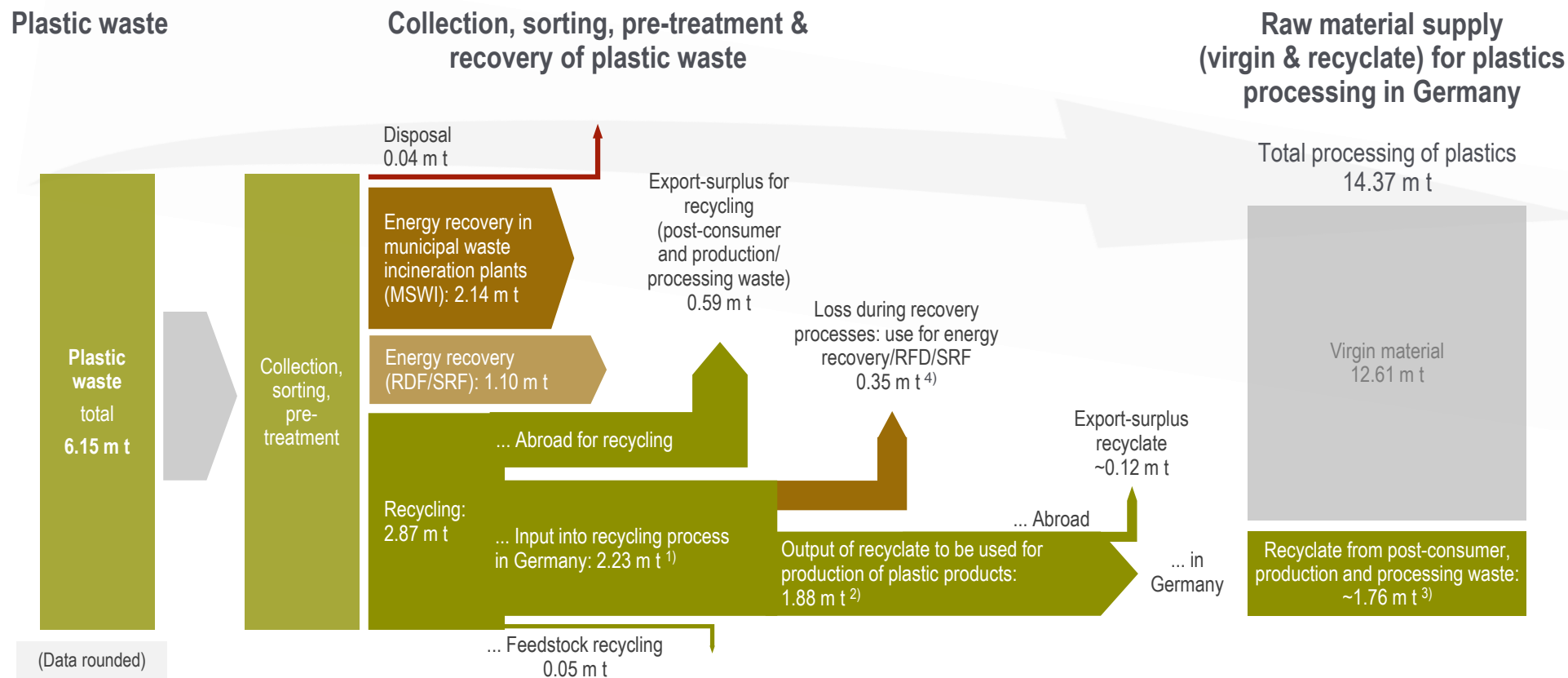
- **Products with a high export share, e.g. automotive**

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 500,000 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



# Collection, sorting, pre-treatment, recovery of plastic waste and reuse of recyclate for products (post-consumer & production/processing waste)



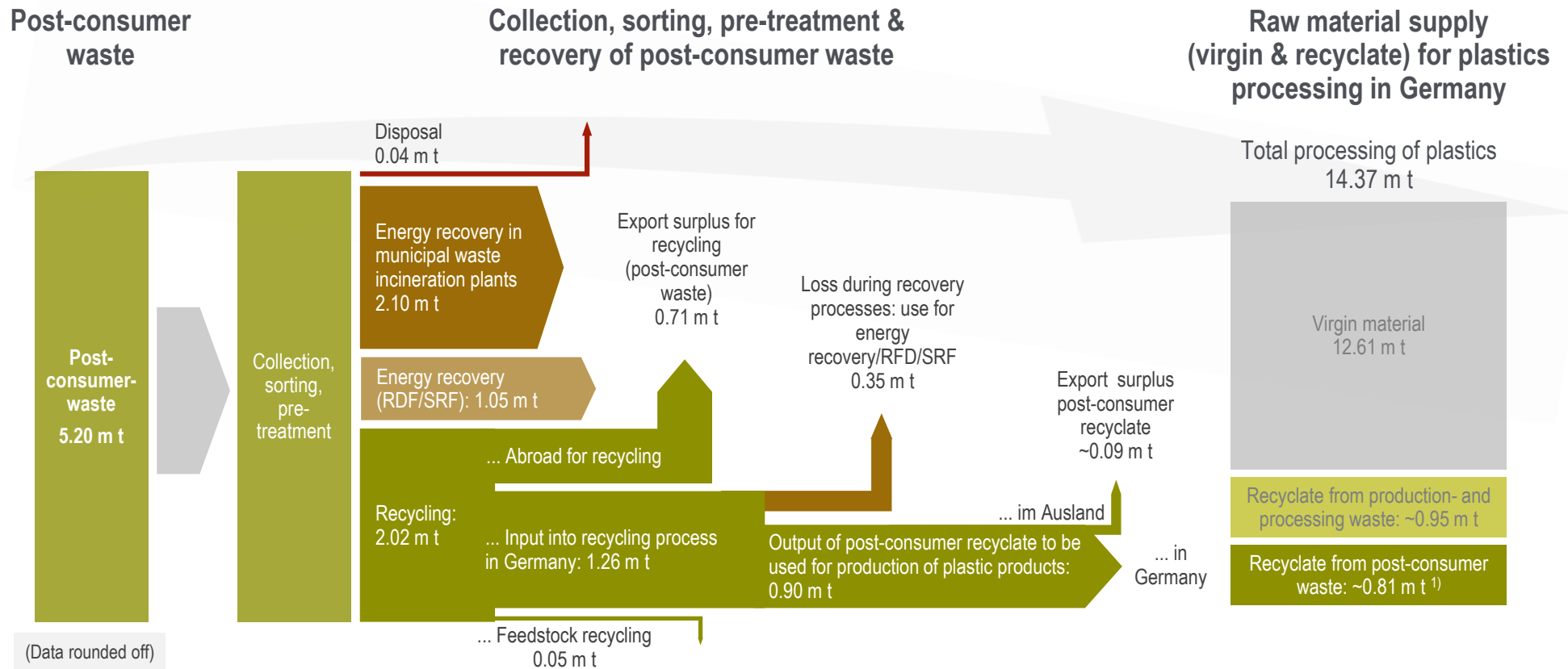
<sup>1)</sup> Thereof ~1.76 m t input at recyclers as well as ~0.47 m t input into in-house recycling at plastic converters.

<sup>2)</sup> Thereof ~1.41 m t output from recyclers as well as ~0.47 m t output through in-house recycling at plastic converters.

<sup>3)</sup> Incl. ~0.135 m t recyclate at recyclers with own production.

<sup>4)</sup> Low amount of process losses during recycling of production and processing have already been considered in the presented data for "energy recovery in MSWI and/or RDF/SRF".

# Collection, sorting, pre-treatment, recovery of plastic waste and reuse of recyclate for products (post-consumer waste)



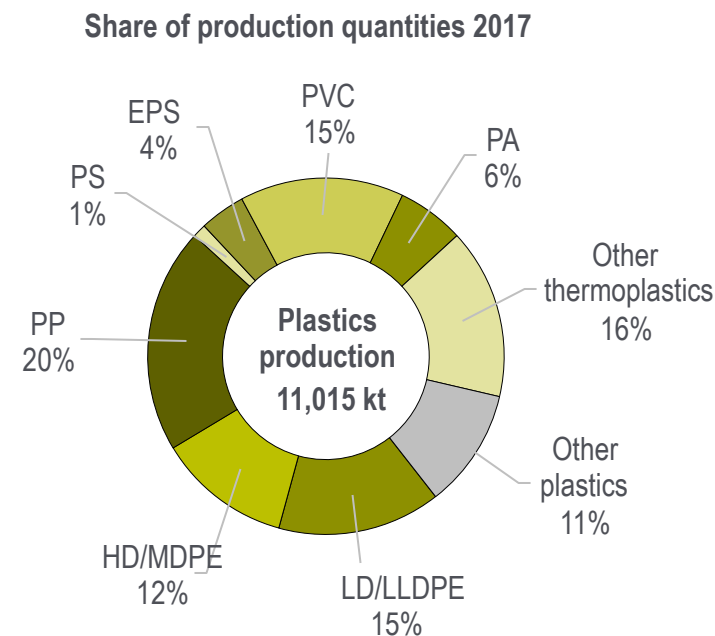
<sup>1)</sup> Incl. ~0.135 m t recyclate at recyclers with own production.

## Treatment of plastic waste and reuse in plastics processing

- A total of 6.15 m t of plastic waste is collected in Germany and sent for material recycling or energy recovery. The share of post-consumer waste is 5.20 m t.
- A total of 2.87 m t of all plastic waste or 2.02 m t of post-consumer waste is sent for material recycling
- The export surplus of all plastic waste is 0.59 m t; in the field of post-consumer waste, 0.71 m t. This means that, in Germany, more production and processing waste is imported than exported.
- The total output of recyclate is 1.88 m t. This represents approx. 30% in relation to the volume of plastic waste. Of this, 1.76 m t is used in Germany for the manufacture of new products.
- In the field of post-consumer waste the output of recyclate is 0.90 m t (approx. 17% of the waste volume), of which 0.81 m t is used in Germany for the manufacture of new products.
- Related to the volume of plastics processed, the share of recyclate is thus 12.3% in total, and for post-consumer recyclate, approx. 5.6%.
- Of the total of around 1.76 m t of recyclate used in Germany, approx. 1.3 m t is used as a supplement to or substitution for virgin material, 0.4 m t as substitute for materials such as concrete, wood and steel, and 0.5 m t as a reducing agent in the steel production process.
- With post-consumer recyclate (total of around 0.85 m t), the quantity used for the substitution of virgin material is 0.4 m t, for the substitution of other materials 0.4 m t, and as a reducing agent in the steel process 0.05 m t.

## Plastics production (raw material / virgin)

Plastics production (Virgin material)	Production in kt <sup>1)</sup>		Delta vs. 2015 in % <sup>1)</sup>	
	2015	2017	CAGR	Total growth
LD/LLDPE	1,560	1,630	+2.2%	+4.5%
HD/MDPE	1,240	1,340	+4.0%	+8.1%
PP	2,000	2,250	+6.1%	+12.5%
PS	135	135	+0.0%	+0.0%
EPS <sup>1)</sup>	400	455	+6.7%	+13.8%
PVC	1,550	1,640	+2.9%	+5.8%
PA <sup>1)</sup>	615	670	+4.4%	+8.9%
Other thermoplastics <sup>2)</sup>	1,520	1,705	+5.9%	+12.2%
Other plastics	1,130	1,190	+2.6%	+5.3%
<b>Total</b>	<b>10,150</b>	<b>11,015</b>	<b>+4.2%</b>	<b>+8.5%</b>

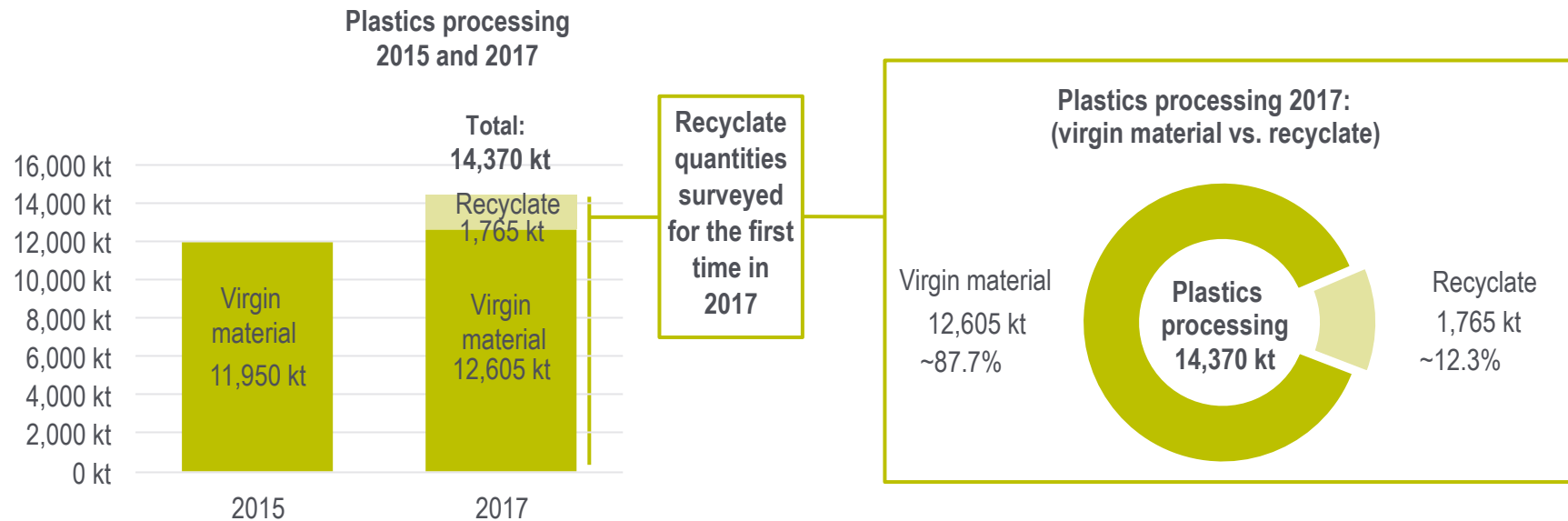


- Plastics production in Germany in 2017 totaled 11.0 m t.
- The production volume in 2017 was thus around 8.5% above the level of 2015.
- Increased volumes were recorded for all types of plastic with the exception of PS.

<sup>1)</sup> Limited comparability for 2017/2015 with the plastics EPS and PA (due to consideration of further production capacities)

<sup>2)</sup> e.g. PET, ABS, ASA, SAN, PMMA, PC, POM etc.

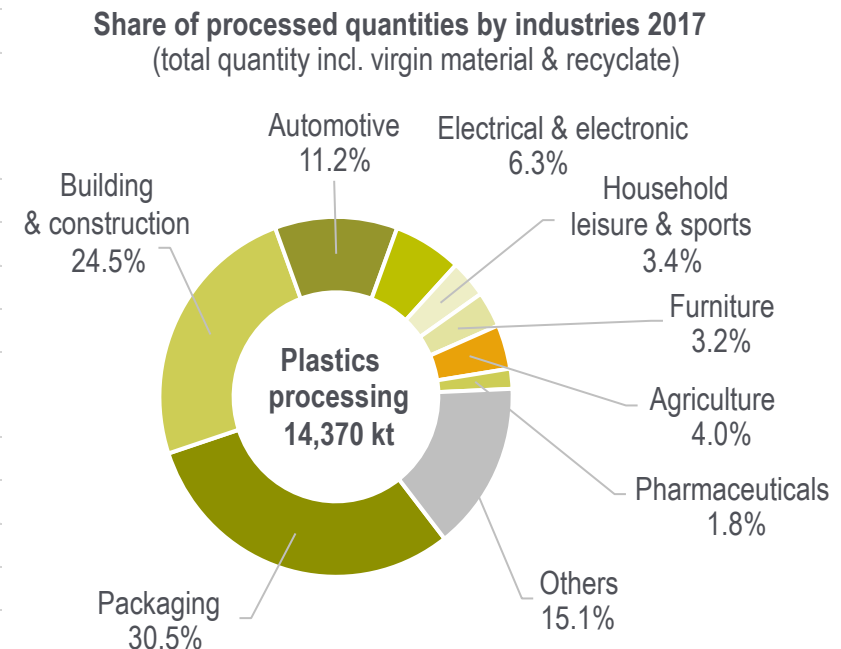
## Processing of virgin material and recyclate



- The volume of virgin material processed in Germany in 2017 was approx. 12,605 kt. Compared with the last survey for 2015, this represents an overall growth of 5.5% or a CAGR of 2.7%.
- The processed volume of recyclate (recyclate from post-consumer waste and production/processing waste) was documented for the first time in the present survey for 2017.
- Based on the documented recyclate volume of 1.765 kt, this gives a recyclate share of 12.3% of the total processing volume.

## Processing of virgin material and recyclate by industries

Plastics processing 2017	In total (Virgin mat. and recyclate) (kt)	Processing of virgin material and recyclate			
		Virgin material (kt)	Recyclate (kt)	Virgin material (%)	Recyclate (%)
Packaging	4,378	3,979	399	90.9%	9.1%
Building & construction	3,520	2,763	758	78.5%	21.5%
Automotive	1,611	1,534	77	95.2%	4.8%
Electrical & electronic	901	872	29	96.8%	3.2%
Household / leisure & sports	490	480	10	98.0%	2.0%
Furniture	463	444	19	96.0%	4.0%
Agriculture	568	370	198	65.1%	34.9%
Pharmaceuticals	262	262	0	99.9%	0.1%
Others	2,176	1,901	275	87.4%	12.6%
<b>Total</b>	<b>14,370</b>	<b>12,605</b>	<b>1,765</b>	<b>87.7%</b>	<b>12.3%</b>

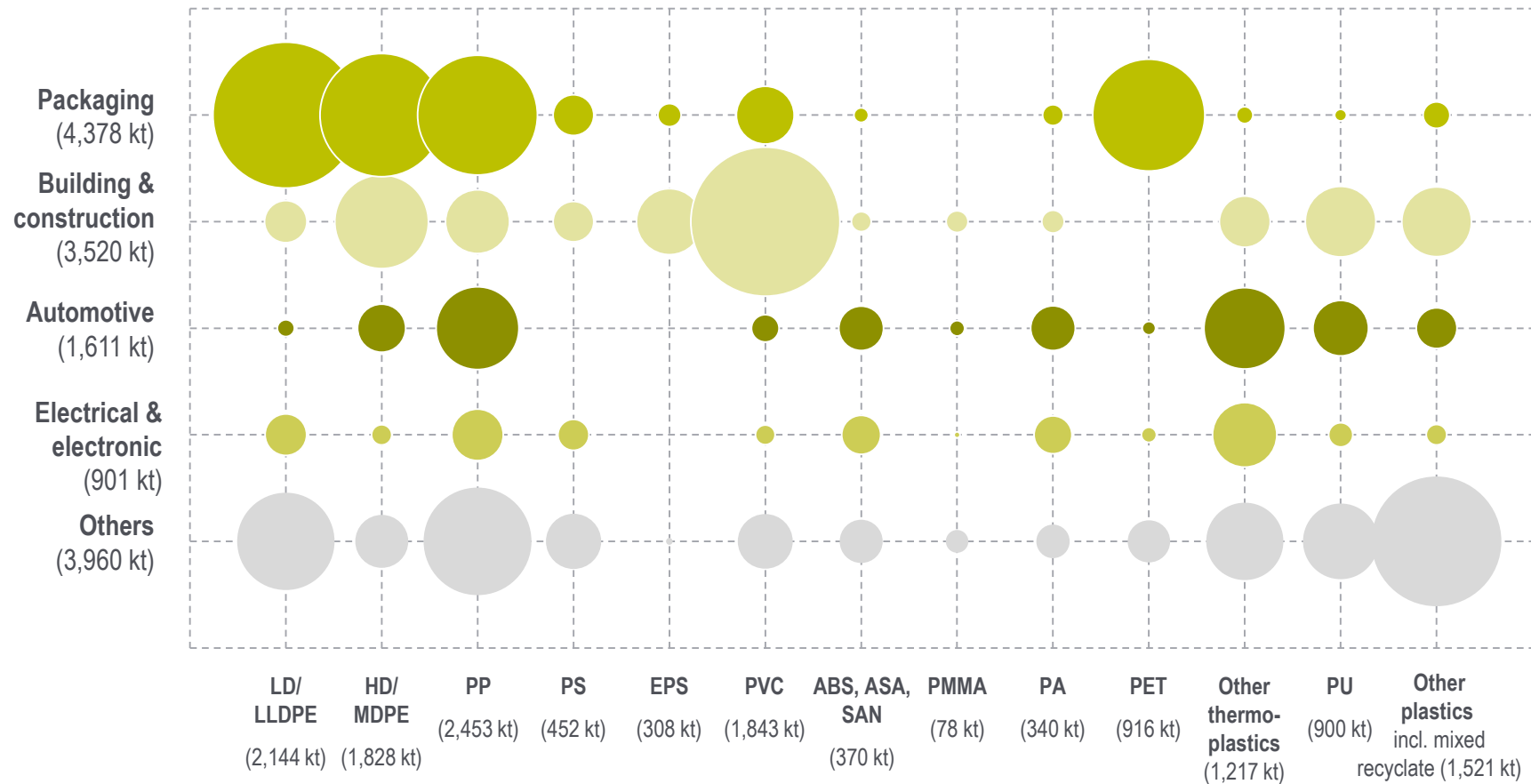


The processed volume of plastic materials (virgin material and recyclate) in Germany in 2017 was around 14.4 m t.

The first study of the use of recyclate (from post-consumer waste and production/processing waste) shows differing levels of recyclate use in a comparison of the various industry sectors. Significant quantities of recyclate are found in particular in agricultural, construction and packaging applications. In these three segments, the proportion of recyclate is around 9% (packaging) or higher (around 22% in construction and around 35% in agricultural applications).




# Polymer types and industries



## Post-consumer waste by industries and recovery

Application	Comparison share of plastics consumption vs. waste accumulation		Post-consumer waste in kt		Delta vs. 2015	
	Plastics consumption	Waste accumulation	2017	2015	Nominal	CAGR
Packaging	26.5%	59.2%	3,081	3,015	2.2%	1.1%
Building & construct.	22.4%	9.5%	495	455	8.8%	4.3%
Automotive	9.3%	4.5%	232	220	5.5%	2.7%
Electrical & electronic	8.0%	5.9%	307	280	9.6%	4.7%
Household, sports & leisure	5.3%	3.0%	158	150	5.3%	2.6%
Agriculture	5.3%	5.3%	277	260	6.5%	3.2%
Others	23.2%	12.5%	651	625	4.2%	2.1%
<b>Total</b>	<b>100%</b>	<b>100.0%</b>	<b>5,201</b>	<b>5,005</b>	<b>3.9%</b>	<b>1.9%</b>



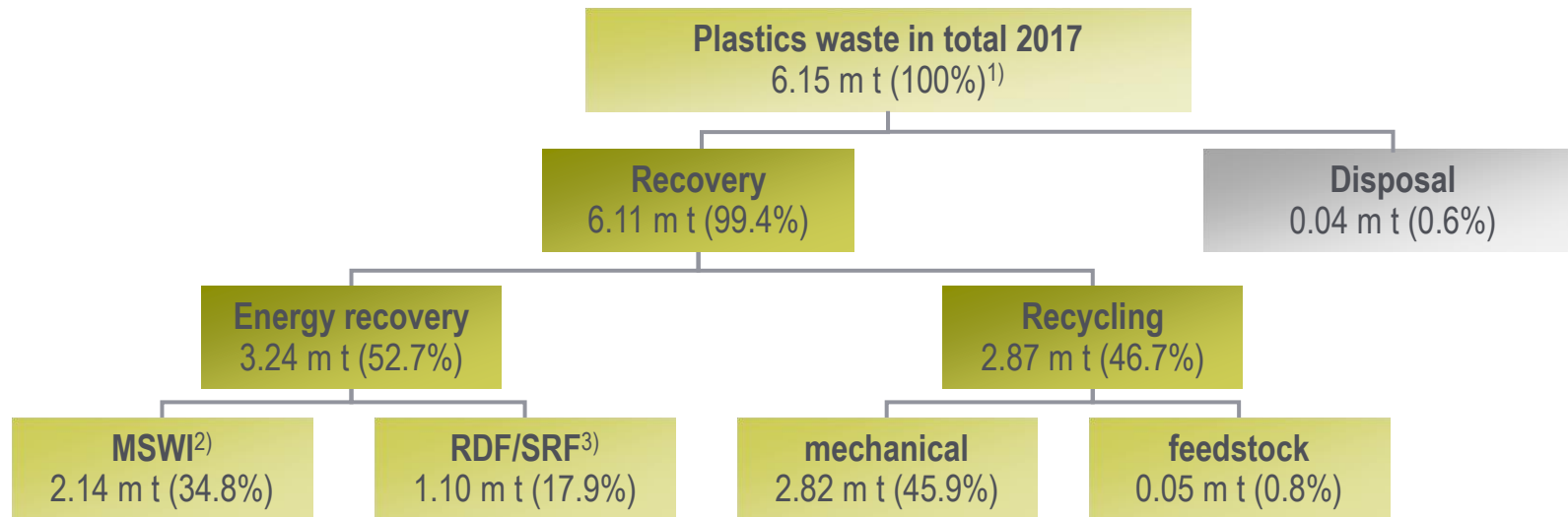
**Quotas 2017 (2015)**

- **Recycling rate** **39%** (38%)
  - mechanical 38% (37%)
  - feedstock 1% (1%)
- **Recovery rate** **99%** (99%)
  - energy 60% (61%)
- **Disposal** **1%** (1%)
  - landfill 1% (1%)

- In 2017, higher quantities of post-consumer waste were recorded than in 2015 in all areas of application.
- The recycling rate (mechanical and feedstock recycling) for post-consumer waste was 39%.
- The majority of recycling is based on the recycling of packaging. The main basis for this are household packaging as part of the activities of the dual systems, the recycling of PET bottles, and plastic film from transport and industry.

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

## Plastics waste treatment – incl. production and processing waste



Of the documented approx. 6.15 m t of plastic waste in Germany in 2017, 45.9% underwent mechanical recycling, less than 1% was used for feedstock recycling, 52.7% was sent for energy recovery and 0.6% was landfilled. The percentages for material recycling and energy recovery have changed only very slightly compared with 2015. The recycling quantities refer to plastic waste generated in Germany irrespective of whether it was recycled in Germany or in other countries.

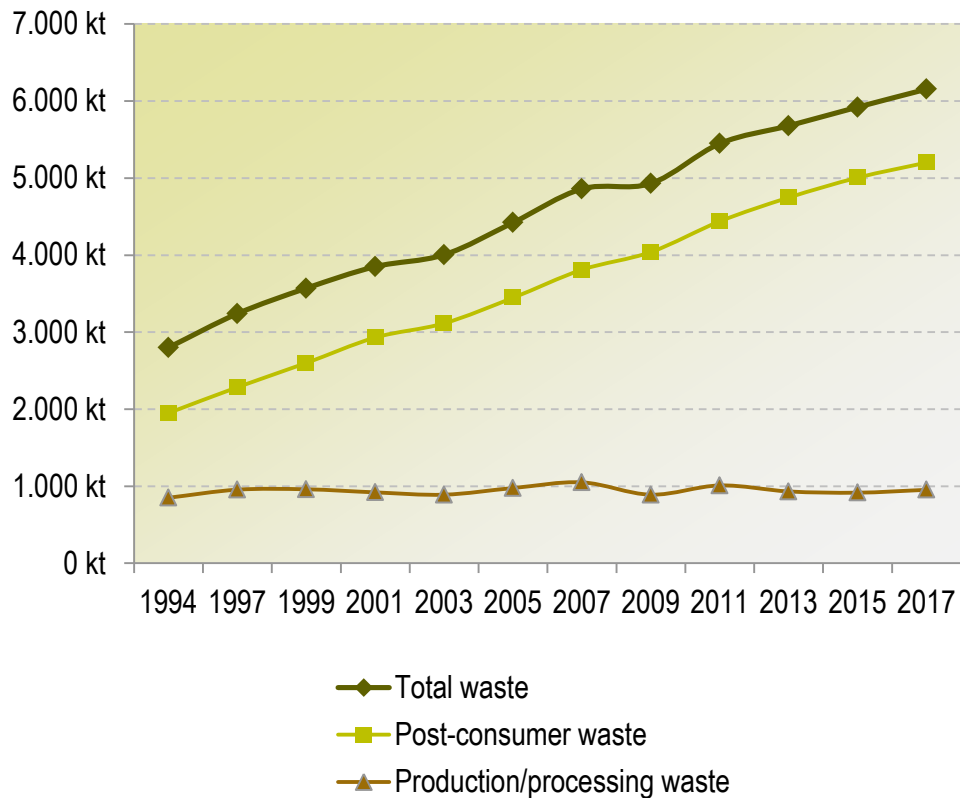
The given recycling volumes thus do not correspond to the recycling volumes processed at German recyclers. In the figures for energy recovery, the use of plastic waste as a substitute fuel continues to play an important role (~18% related to the total plastic waste).

1) Thereof 5.20 m t post-consumer waste as well as 0.95 m t production and processing waste

2) Municipal Solid Waste Incineration

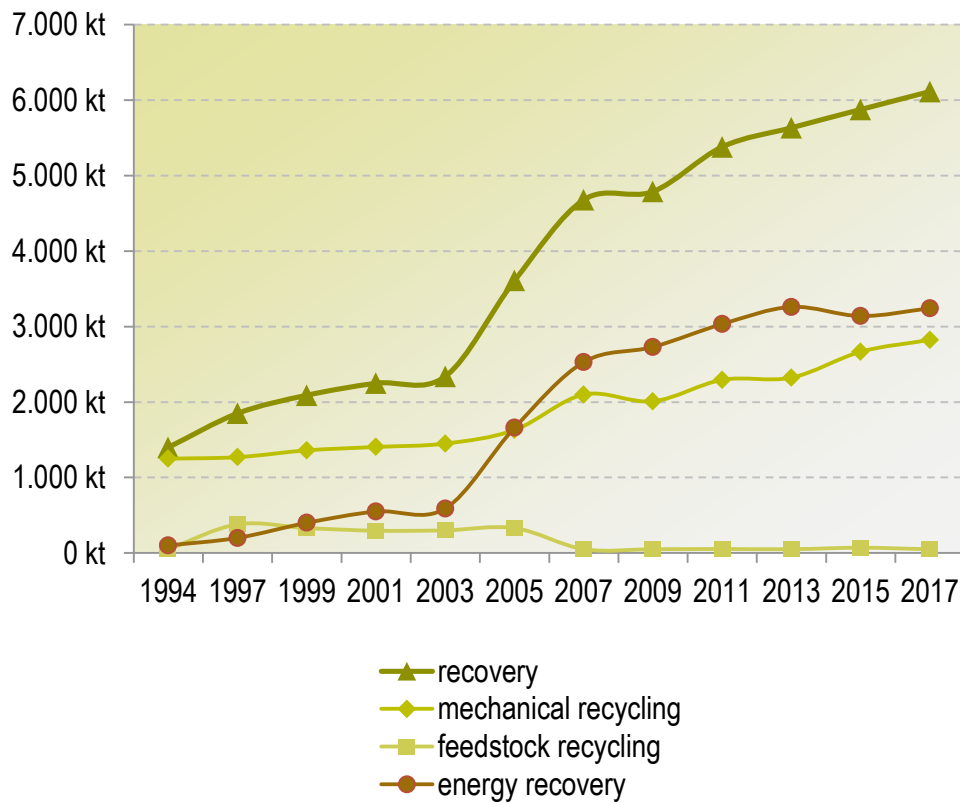
3) Refuse-Derived Fuel / Solid Recovered Fuel

## Development of plastic waste generation from 1994 - 2017



- Plastic waste generation increased within 1994 to 2017 from 2.8 to approx. 6.15 m t. This is an increase by approx. 3,5% per year resp. by approx. 3.35 m t 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. 5.20 m t. This represents an increase by approx. 4.4% 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 increased slightly only (1994: 850 kt / 2017: 953 kt), despite significantly higher production and processing volumes. This is due to a higher efficiency in particular in the plastics processing industry.

## Development of plastic waste recovery from 1994 - 2017



- Mechanical recycling reached its highest figure in 2017 at approx. 2.82 m t. This is approx. 1.57 m t more than the figure for 1994 – equal to a rise of more than 125%. The average annual increase from 1994 to 2017 was around 3.6%. After a somewhat subdued development in the years from 2009-2013, recycling has regained momentum in the last four years.
- Feedstock recycling, which increased considerably at the beginning of the decade and remained for a long time at a level of approx. 300 kt, was only around 49 kt in 2017 – similar to 2009-2013 – and is thus more or less back to its starting level of 1994.
- The quantities used for energy recovery in 2017 were slightly below the level of 2013. The proportion used for fuel substitutes was 18% in 2017 (of total plastic waste) or 20% (of post-consumer waste).

## Glossary (1/6)

### Plastics production, processing and consumption, recyclate and virgin material

Plastics production	<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>
Plastics processing	<p>This part of the study covers the processing or conversion of plastics in the form of primary materials or recyclate into products. The focus is on processing volumes produced at sites in Germany.</p>
Plastics consumption	<p>This covers the plastics consumption of private and commercial consumers within Germany. For calculating plastics consumption, imports and exports have been subtracted from the volumes for plastics processing. In the field of packaging, only imports and exports of non-filled packaging were taken into account.</p>

## Glossary (2/6)

### Distinction between virgin material and recyclate

Virgin material	Virgin or primary material describes molding compounds produced by polymerization (e.g. powder, granules, starting materials, e.g. PU raw materials), which are sold on to the further processing industry. Raw materials obtained from the recycling of production/processing waste or post-consumer waste are not included here (see "Plastic recyclate")
Plastic recyclate	Plastic recyclate is obtained from the recycling of production/processing waste or post-consumer waste. The processing into recyclate is carried out in the form of mill base, regrind/regenerated material or compounds, agglomerates or compacted material. The produced recyclate is used for processing into plastic products.

## Glossary (3/6)

### Where plastic waste is generated

Plastics producers	In the study, plastics producers are taken to mean only raw material producers who 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 used 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 recycle 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 companies 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.
Commercial consumers	Commercial consumers cover all private and public companies from production, trade and services in which plastic waste is generated.
Private households	Private households without commercial activities.



## Glossary (4/6)

### Types of waste, recycling and disposal

Production and processing waste	Production and processing waste is waste generated during the production or processing of plastics and subsequently leaves the production line to be reprocessed. As a rule, the waste is ready sorted / segregated and the specifications are known to the user.
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.
Recycling	Recycling covers both material recycling and energy recovery. The recycled volumes refer to plastic waste occurring in Germany, irrespective of whether it was recycled in Germany or in other countries. The recycled quantities thus do not represent the volumes processed by German recycling companies.
Material recycling	Material recycling is subdivided into mechanical recycling and feedstock recycling.
Mechanical recycling	Processing of specified 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.

## Glossary (5/6)

### Types of waste, recovery and disposal

Energy recovery	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.
RDF/SRF	<p>Substitute fuels (refuse-derived fuels (RDF) and solid recovered fuels (SRF)) are produced from the processing of high-calorific waste flows. Specified substitute fuels are used together with conventional fuels in so-called co-incineration, above all in cement, limestone and lignite power plants, on a large extent also in industrial power plants (high-calorific fraction) or as the sole fuel in substitute fuel power plants. Plants that use substitute fuels must comply in Europe to at least the requirements of EU Directive (2000/76/EG) for the incineration and co-incineration of waste. In Germany, the 17<sup>th</sup> Federal Emission Control Act applies to waste incineration and co-incineration plants.</p> <p>For example, the secondary fuels specifically processed from selected material flows are used primarily in the cement power plants because of the higher quality requirements through demanding processing technologies. With energy contents of approx. 15% and more, raw waste such as old tires, plastics, industrial and commercial waste, animal meal and animal fats are suitable for the production of substitute fuels for use in the cement industry.</p>
Disposal	Landfilling according to defined criteria or incineration without adequate energy output.

## Glossary (6/6)

### Plastic types / Abbreviations for plastics

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

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